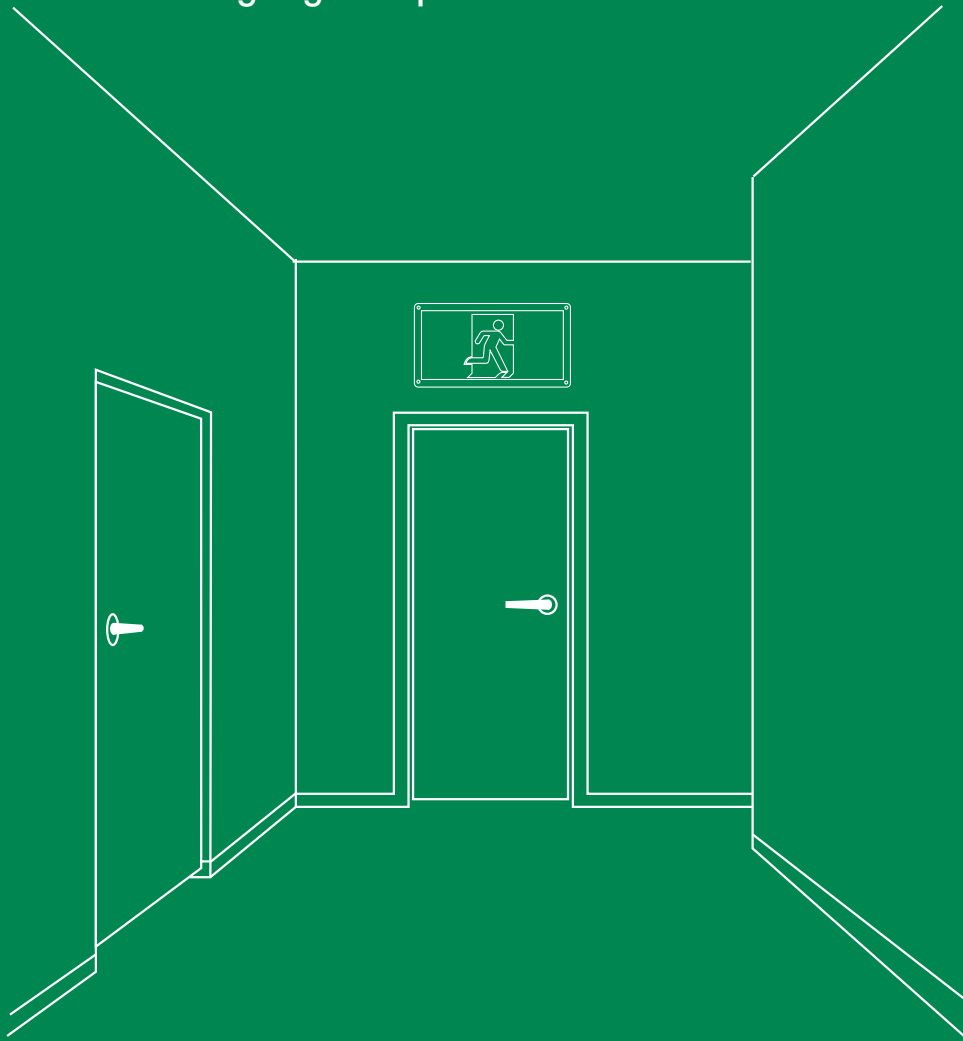


Technical Justification
Alternative Solution
for

Ecoglo S20 Photoluminescent Exit Signs

To meet the Exit Signage Requirements of NZBC Clause F8 'Signs'



VISIBLY BETTER

For the most current solution documents refer to:

www.ecoglo.co.nz

1. Introduction

This document examines the requirements of the New Zealand Building Code Clause F8 Signs (as they relate to exit signage), then shows how Ecoglo photoluminescent exit signs can be used to meet F8, via the following methodology:

- The signs are of suitable size and can be sufficiently bright to be clearly visible;
 - Charging requirements can be prescribed to ensure the signs can be charged to maintain sufficient brightness for the duration specified in F8;
 - The signs can be located in suitable locations to identify escape routes;
 - A verification process can be defined to ensure ongoing compliance with Clause F8.
- Where there are applicable parts of the Ac-

ceptable Solution F8/AS1, these are made use of without further justification. Where this document diverges from F8/AS1, justification is provided. Ecoglo manufactures photoluminescent sign material to different grades of brightness. For exit signage in New Zealand (to meet Clause F8), all photoluminescent sign material is “S20” grade. Throughout this document, any reference to Ecoglo signs means Ecoglo S20 photoluminescent signs.

Note that for buildings where the fire safety design has been carried out using C/VM2, the specific design may not be compatible with passive photoluminescent exit signage such as Ecoglo S20. See Appendix 9 for details.

New Zealand Building Code, Clause F8

1.1 New Zealand Building Code, Clause F8 has the following objective, functional requirement and performance requirements that relate to exit signage:

Objective

F8.1 (a) The objective of this provision is to safeguard people from injury or illness resulting from inadequate identification of escape routes ... in or about the building.

Functional requirement

F8.2 (a) Signs must be provided in and about buildings to identify escape routes.

Performance

F8.3.1 Signs must be clearly visible and readily understandable under all conditions of foreseeable use, including emergency conditions.

F8.3.3 Signs to facilitate escape to a place of safety must be provided and (a) be located to identify the escape routes, and (b) continue to meet the performance requirements in clause F8.3.1 during failure of the main lighting for the period required by performance F6.3.4 and performance F6.3.5.

Clause F8 provides the following definition:

Clearly visible, for the purposes of Clause F8 and in relation to a sign means the nearest such sign is visible and readable at the maximum distance from which it needs to be viewed, to a person who either does not have a visual impairment, or uses corrective lenses.

2. Size and brightness of Ecoglo signs to ensure they are clearly visible

The two critical aspects to consider to ensure visibility of an exit sign are the size of the sign, and how bright it is. More accurately, “luminance contrast” is the determinant, not brightness itself. The eye requires contrast between an object and its background to be able to detect the object. For Ecoglo signs the background is

the (opaque) green area which ensures very good luminance contrast with the photoluminescent foreground both in normal lighting and in the dark. Because of this, brightness (“luminance”) can be used to characterise visibility, without the need for a contrast measurement as well.

2.1 Sign sizes

F8/AS1 stipulates the minimum sizes for exit signs with 16m and 24m maximum viewing distance.

The table below gives the dimensions for Ecoglo signs with 16m and 24m maximum viewing distance.

Ecoglo Sign Code	Viewing Distance	Type	Width (mm)	Height (mm)	Text/Picto Height (mm)
S20-EX2313-16m	16m	Text	230	133	100
S20-RM1616UN-16m	16m	Pictogram	162	162	130
S20-RM2916-16m	16m	Pictogram	290	162	130
S20-RM2916HV-16m	16m	Pictogram	290	162	130
S20-RML2916-16m	16m	Pictogram	290	162	130
S20-RMR2916-16m	16m	Pictogram	290	162	130
DSS20-RMD2916-16m	16m	Pictogram	290	162	130
S20-RMRL2916-16m	16m	Pictogram	290	162	130
S20-RMRL2916HV-16m	16m	Pictogram	290	162	130
DSS20-RMRL2916-16m	16m	Pictogram	290	162	130
DSS20-RMRL2916HV-16m	16m	Pictogram	290	162	130
S20-EX2916-24m	24m	Text	290	162	130
S20-RM2323UN-24m	24m	Pictogram	230	230	195
S20-RM4223-24m	24m	Pictogram	420	230	195
S20-RM4223HV-24m	24m	Pictogram	420	230	195
S20-RML4223-24m	24m	Pictogram	420	230	195
S20-RMR4223-24m	24m	Pictogram	420	230	195
DSS20-RMD4223-24m	24m	Pictogram	420	230	195
S20-RMRL4223-24m	24m	Pictogram	420	230	195
S20-RMRL4223HV-24m	24m	Pictogram	420	230	195
DSS20-RMRL4223-24m	24m	Pictogram	420	230	195
DSS20-RMRL4223HV-24m	24m	Pictogram	420	230	195

For signs with viewing distances greater than 24 metres an alternative solution must be provided as F8/AS1 excludes the use of photoluminescent signs for viewing distances greater than 24m.

There is no technical reason for this restriction. UL924 allows for all exit signs (whether photoluminescent or electrical) to be classified for 50ft (15.2m), 75ft (22.9m), or 100ft (30.5m) viewing distances [UL924 “Standard for Emergency Lighting and Power Equipment” specifies the performance requirements for electrical and photoluminescent exit signs for use in North America. UL924 is ratified by NIST (the Federal US body responsible for ratifying standards as being applicable nationally), and is the mandatory standard for exit signs specified in US and Canadian building codes]. Ecoglo International manufactures photoluminescent exit signs that meet the UL924 100ft classification.

Linear scaling¹, based on maintaining the same subtended visual solid angle across the pictogram elements in the signs, is used to justify the dimensions of Ecoglo signage for viewing distance greater than 24m.

2.2 Sign brightness

During normal lighting conditions the luminance (brightness) of photoluminescent signs is proportional to the illuminance on the sign face from ambient light. During failure of the main lighting, the luminance of photoluminescent signs depends on the brightness and length of time that the previous ambient (“charging”) light had been charging the signs, and also the time since the main lighting has failed. Providing suitable illumination on the face of each photoluminescent sign ensures the signs remain clearly visible during normal occupation, as well as providing sufficient charging to ensure the photoluminescent glow provides suitable visibility after a power failure has caused the loss of all normal lighting.

¹ Both AS/NZS 2293.3 “Emergency Escape Luminaires and Exit Signs” and NZBC F8/AS1 “Signs”) use linear scaling

If an exit sign is required in a location where there is insufficient illumination for any reason, a photoluminescent sign will not be appropriate unless a suitable dedicated light source is also installed, or an Ecoglo Hybrid exit sign is installed.

2.3 Luminance required of Ecoglo signs to ensure suitable visibility during normal lighting conditions

F8/AS1 states “Illumination for charging the photoluminescent signage shall be not less than 100 lux and suitable for charging photoluminescent material.”

This requirement is aimed at ensuring the signage is suitably charged during normal lighting conditions, rather than suitably visible during normal lighting conditions. Later in this document the issue of lighting to ensure suitable charging will be dealt with, but for now, the issue is ensuring suitable visibility during normal lighting conditions.

The prescribed minimum illuminance on the face of a code-compliant photoluminescent exit sign used in USA and Canada is 55 lux, (as specified in UL924 and the International Building Code Chapter 10 “Means of Egress”).

Illuminating the face of the Ecoglo exit signs with 55 lux produces a (reflected) luminance of 12cd/m², which is greater than the required 8cd/m² minimum luminance of the background of an internally illuminated exit sign as specified in F8/AS1 4.5.3 a) i). Therefore, to ensure the luminance of Ecoglo signs is sufficient to be clearly visible in normal lighting conditions, the minimum design level illuminance on the face of the sign shall be 55 lux.

Note that in environments that are dimly lit, where it is reasonable to expect that occupants’ eyes will be adapted to the dim lighting, a lower illuminance on the face of the sign may be appropriate.

2.4 During failure of the main lighting

F8/AS1 specifies a minimum luminance of 30mcd/m² for photoluminescent exit signs. However, visibility (legibility) of any specific sign will depend on variables such as contrast (how opaque the background colour is), variations in the text or pictogram, such as size, edge sharpness and stroke width. Ecoglo pictogram exit signs have been tested in accordance with UL924 “Standard for Safety Emergency

Lighting and Power Equipment” by an independent laboratory to show that they are visible² from 24 metres for more than 90 minutes of darkness (see Appendix 1).

The independent test also verifies that the pictogram signs are visible from 24 metres when emitting a luminance of 21.4mcd/m². The minimum design level luminance for visibility of Ecoglo signs during failure of the main lighting is therefore set at 21.4mcd/m².

3. Charging requirements to ensure the signs can be charged sufficiently to maintain minimum brightness for the duration specified in F8

3.1 Testing

Ecoglo has an in-house (uncertified) test laboratory for measuring the luminance of photoluminescent materials following a wide variety of charging situations. Since 2003 over 3000 tests have been carried out. The test results are regularly benchmarked against independent laboratories, to confirm that the Ecoglo test results are valid.

A combination of independent testing and Ecoglo testing has been used to determine suitable minimum charging conditions for a range of building uses and Risk Groups. The tests have been carried out on fully discharged photoluminescent material (typically 72 hrs or more in complete darkness), so they represent the worst case scenario.

In the vast majority of building situations, exit signs will not be left in complete darkness for such a long time. The photoluminescent material can be seen to be a little bit like a battery, in that the more it is discharged, the longer it takes to re-charge.

Conversely, signs that are exposed to even a small amount of daylight every day re-charge significantly more quickly than the standard tests indicate. Therefore, in most practical situations Ecoglo exit signs will be brighter and will perform for longer than the test results indicate. The charging requirements specified below are based on one or other of the following two acceptance criteria:

1. Acceptable Solution, Clause F8/AS1: Ecoglo signs with minimum dimensions as specified in F8/AS1, illuminated with at least 100 lux on the face, must continue to provide a minimum luminance of 30mcd/m² for the duration prescribed in NZBC Clause F6 whenever the building is occupied.

2. Clause F8: Ecoglo pictogram signs with minimum dimensions as specified in F8/AS1, illuminated with at least 55 lux on the face, must continue to provide a minimum luminance of 21.4mcd/m² for the duration prescribed in NZBC Clause F6 whenever the building is occupied.

² UL924 defines “visible” as “legible (as pertains to text) and distinguishable from other text or symbols.” This satisfies the wording in F8.3.1 “clearly visible and readily understandable”.

3.2 Indoor Charging

Indoor spaces are either lit by electric lighting only, or by daylight when sufficient, or supplemented by electric lighting when daylight is not sufficient.

Daylight through window glass, whether direct or reflected off room surfaces, provides effective charging for Ecoglo signs.

Types of electric lighting that are suitable for charging Ecoglo Exit signs

Ecoglo testing (see Appendix 2, Table 1) has verified that fluorescent, metal halide, or LED lighting (all with a colour temperature of 4000K or greater) are all suitable charging sources for Ecoglo exit signage. If the installed lighting in a building has a colour temperature of less than 4000K, a specific design by Ecoglo is required.

3.2.1 Brightness and duration of the charging light (daylight or electric lighting)

How long the signs need to perform after the main lighting fails depends on the risk class of the building.

Risk Group C: Defined as buildings not in Risk Group A or B, therefore it is: buildings with no more than 1000 occupants and an evacuation time of less than 30 minutes, where occupants are not required to remain in the building until the main lighting is restored.

F8.3.3 requires exit signs in a Risk Group C building to continue to perform during failure of the main lighting for a period of 30 minutes.

Required charging options

Use the following table to determine how much light is required, and whether this needs to be switched on prior to occupation.

How much natural light through windows or skylights is on the face of the sign	Is lighting in the space turned on prior to occupation?	How much light (with a colour temperature of 4000K or greater) does the installed lighting need to put on the face of the sign?	Justification: See Appendix 3
55 lux for at least 6 hours a day	No	55 lux ^{1,2}	A
20 lux for at least 6 hours a day	No	100 lux ^{1,2}	B
20 lux for at least 6 hours a day	Yes - 5 minutes before occupation	55 lux ^{1,2}	C
None	No	200 lux ¹	D
None	Yes - 5 minutes before occupation	100 lux	E
None	Yes - 10 minutes before occupation	55 lux	F

Notes

1. The space that the exit sign serves must have an evacuation time no more than 10 minutes. Essentially all one and two storey school buildings in NZ are likely to have evacuation times less than 10 minutes (see Appendix 4).
2. The installed lighting does not need to be switched on if natural light proves the same lux.

If the lighting is to be controlled with occupancy sensors, Ecoglo signs can be used as long as the light on the face of the signs is controlled to drop to no less than 10 lux when unoccupied.

(Ecoglo test result e420, Appendix 2, Table 2 shows 39.5mcd/m² at 30 minutes following 120 minutes of 10 lux, ie 10 lux is sufficient to maintain an Ecoglo sign's charge above the design level for at least 30 minutes).

For confined spaces such as alcoves, toilets, etc, spaces normally requiring 100 lux or 200 lux can have 55 lux or 100 lux respectively, as long as the signs do not need to be seen from more than 8m (for a 16m viewing distance sign) or 12m (for a 24m viewing distance sign)
- see Appendix 5.

Note that spaces where the occupants are familiar with the escape routes can be occupied in lights-out mode for up to an hour if needed: 20 minutes charge at 100 lux ensures a minimum of 30mcd/m² for 90 minutes (see Appendix 2, Table 2, test e801), therefore at the end of an hour of lights-out occupation, there is still 30 minutes "charge" left in the S20 signs.

Risk Group B: defined as buildings with more than 1000 occupants and/or an evacuation time of 30-90 minutes, where occupants are not required to remain in the building until the main lighting is restored. F8.3.3 requires exit signs in a Risk Group B building to continue to perform during failure of the main lighting for a period of 90 minutes.

Required charging:

Installed lighting and/or daylight must provide at least 55 lux on the face of the Ecoglo signs at all times of occupancy, as well as 30 minutes prior to first occupancy.

Rationale: if the normal lighting fails at or

after 30 minutes of charging (the time of first occupancy), the Ecoglo signs will have at least 26mcd/m² for at least the next 90 minutes (see Ecoglo test result e403, Appendix 2, Table 2).

If the lighting is to be controlled with occupancy sensors, Ecoglo signs can be used as long as the light on the face of the signs is controlled to drop to no less than 20 lux when unoccupied.

Ecoglo test result e609 shows 31.5mcd/m² at 90 minutes following 120 minutes of 21.5 lux, ie ~20 lux is sufficient to maintain an Ecoglo sign's charge to be above the design level for at least 90 minutes (see Appendix 2, Table 2).

Risk Group A: defined as buildings with an evacuation time greater than 90 minutes and/or occupants are required to remain in the building until the main lighting is restored.

Where an emergency power system provides stand-by power for the normal lighting in a Risk Group A building, Ecoglo exit signs will have instantaneous start up in the event of a power failure. Ecoglo exit signs can follow the same protocol as for Risk Group C on the basis that the emergency power system will start up within 30 minutes of the power failure and restore normal lighting levels. So for such a Risk Group A building, where the lighting is kept on 24/7, the installed lighting must provide at least 55 lux on the face of the Ecoglo signs at all times of occupancy, and it can drop to 10 lux in any space that is unoccupied.

3.3 Outdoor charging

Outdoor daylight provides much greater charging of Ecoglo signs than building interiors, so that electric lighting is not needed to charge up Ecoglo exit signs installed outside of built structures.

Testing carried out in Christchurch, between 10th - 15th June, 2007, shows that a worst-case scenario where an Ecoglo sign is mounted vertically in mid-winter, south facing towards a hill slope, ie with low sky exposure, and with no more than 5000 lux illumination from daylight, had an interpolated luminance of 23mcd/m² at midnight, 7 hours after sunset, and a measured luminance of 11.5mcd/m² at 6:45am, 13.75 hours after sunset. This value of 11.5mcd/m² is obviously lower than the previously mentioned acceptable value of 21.4mcd/m². However, analysis of observation visibility

testing carried out by Ecoglo in 2010 that followed a similar protocol to that used in UL924, shows the relationship between luminance and visibility distance for signs of identical size and graphics. This shows that a sign with 53% of the brightness of another sign is visible from 57% of the distance of that other sign. As 11.3mcd/m² is 53% of 21.4mcd/m², this makes the sign visible from at least 57% of the distance that it can be seen compared with the same sign at 21.4mcd/m². So a conservative conclusion is that when an exit sign is installed outdoors, and needs to be visible 24/7, it is suitable for a viewing distance 50% (half) of its rated maximum viewing distance.

If the sign does not need to be seen 24/7, it can be used at its full rated maximum viewing distance for a period of 7 hours after sunset (see Ecoglo test result e235, Appendix 2, Table 2).

4. Suitable locations to identify the escape routes

4.1 Clause F8.3.3(a)

To meet F8.3.3(a), the relevant clause in F8/AS1 is:

“Escape routes shall be identified by Exit signs which are clearly visible and are located:
 (1) *at each point in the open path where a door giving access to a final exit or an exitway is not visible in normal use,*
 (2) *to clearly indicate each door giving access to a final exit or an exitway, and*
 (3) *to clearly identify the route of travel through the exitway.”*

Where exit signs are provided to identify a door on an escape route, the sign shall be positioned on the leaf at or above handle height, or on the vertical surface within 600mm of the door. The sign shall

be positioned where it is least likely to be obscured from view and where it cannot be obscured when the door is open.

4.2 Comment on sign locations at doorways:

F8 comments that internally illuminated (ie with an integrated electrical light source) exit signs are preferable to externally illuminated (ie a painted sign illuminated by an electrical light near the sign) exit signs, because the light is coming directly from the sign, so “are more easily seen in smoke conditions”.

Smoke can readily obliterate even very bright signs, so an important aspect to consider is mounting the sign as low as possible in a room so it has most chance of not being obscured by smoke.

It follows that signs that are mounted at ceiling height are more likely to be obscured

by smoke than signs mounted lower down. Architectural demands, and the practicality of installation of electrical exit signs means that electrical exit signs are often mounted directly to the ceiling.

There are no such restrictions for photoluminescent signs, which can readily be installed on above-door glazing for example.

Good practice deems that the exit sign be mounted above the door but as far as practicable from the ceiling.

Where there are very low ceilings, a suitable mounting position may be on the door itself, as long as the door swings outwards, has a self-closer, and cannot be latched open.

5. Ongoing verification requirements

Processes to ensure the installed signs continue to meet the requirements of Clause F8

5.1 Verification of ongoing luminance

On site measurement is impractical because repeatable testing can only be carried out once the signs have been kept in complete darkness for at least 48 hours, and testing is carried out in a temperature-controlled environment.

Therefore another approach is required. The strontium aluminate based photoluminescent pigments used in Ecoglo signs have inherent long term stability. All photoluminescent products utilise photoluminescent pigments embedded in a clear carrier. With some manufacturing techniques these carriers can age and discolour over time due to UV exposure, especially exposure to unfiltered sunlight. Any discolouration of the carrier will inhibit both the charging and discharging of the pigments and lead to deteriorating luminance over time. Therefore, a suitable test needs to subject the markings to UV through real or simulated outdoor exposure.

Ecoglo markings have been subjected to independent accelerated weathering (UV) testing, in accordance with the only building code that specifies a test for photoluminescent markings to confirm long term stability, suitable for outdoor use: New York City Building Code, Reference Standard 6.1. Section 6 specifies: 1000 hours exposure in accordance with ASTM G155-2004 Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non metallic Materials.

An independent test report confirms that Ecoglo markings meet this requirement (less than 10% reduction in luminance after exposure, see Appendix 6). It is very difficult to translate exposure hours in an accelerated weathering test with real-life outdoor use because UV intensity, air temperature, rainfall, etc vary widely from place to place. However, a rule of thumb equates 1000 hours of ASTM G155 exposure with between 2.5 years and 10 years outdoor use.

5.2 In House Testing

Ecoglo in-house testing has been carried out on Ecoglo material following 6000 hours exposure in accordance with ASTM G-155. This resulted in a 5%-8% reduction in luminance after exposure.

Ecoglo in-house testing has also been carried out on product removed from long term outdoor use. Ecoglo markings installed at the former Jade Stadium, (also former AMI stadium), Wilsons Rd, Christchurch were removed and replaced annually for a period of 10 years. This resulted in a flat trend line (no change in luminance after exposure).

The conclusion drawn from all this data is that Ecoglo signs are very stable to long term outdoor exposure and can be expected to remain clearly visible for at least 15 years. Indoors, where UV is usually negligible, Ecoglo markings can be expected to remain clearly visible for much longer: it seems reasonable to expect this to be at least 30 years.

In-service history can also be used to back up this position: photoluminescent exit signs have been in use in North America for over 15 years, and the chief engineer at Underwriters Laboratories in USA responsible for the NIST-rated UL924 standard (that covers electrical, radioactive and PL exit signs required to meet US building code) stated in 2014: “there is as yet no evidence or analysis that suggests photoluminescent materials degrade at all over time”.

The industry is conditioned to expect ongoing verification of battery back-up exit signs. Battery back-up signs are known to fail quite often, which makes regular testing imperative. However, for PL exit signs, worldwide experience going back nearly 20 years shows that they don’t fail. From all of the above it can be seen that

there is no need for ongoing luminance verification.

5.3 Inspection requirements

It has been established that ongoing luminance verification is not required, but inspection is still warranted to make sure that the signs as installed have not been damaged or removed, and that any electrical light needed to charge the signs is still functioning as intended.

The following inspection and maintenance procedures are recommended to ensure ongoing compliance with Clause F8:

Six-monthly: Inspect the system and carry out any maintenance necessary in order to confirm each statement in the table below.

Annually: Inspect the system in order to confirm each statement in the table below.

Action	Complete
All signs are still configured as at installation and there is no material damage to any of the signs	
All signs are clean from general dust build up and any other specific obscuring deposits	
All signs are clearly visible and have not been covered up	
All lights within 4m of internal S20 signs have been checked that the positions have not altered from design	
All lights within 4m of internal S20 signs are in working order and clean	
All automated lighting control systems are operational as per design	

5.4 Reporting Procedure

All inspection and maintenance records of the above work are to be held on site and are to be available to any authorised inspection agency.

Responsibilities

Six monthly inspection and maintenance is to be carried out by the owner or their

appointed agent.

Annual inspection is to be carried out by an Independent Qualified Person.

Inspection and maintenance records are to be maintained by the owner or their appointed agent.

Inspection records are to be signed off by an Independent Qualified Person.

6. Conclusion

The above has shown that:

- Ecoglo signs are of suitable size and can be sufficiently bright to be clearly visible;
- Charging requirements can be prescribed to ensure the signs can be charged sufficiently to maintain sufficient brightness for the duration specified in F8;

- The signs can be located in suitable locations to identify escape routes;
- A verification process can be defined to ensure ongoing compliance with Clause F8.

In this way Ecoglo signs can be used to meet the requirements of Clause F8.

APPENDIX 1

Test report of Ecoglo Photoluminescent Signs in accordance with UL924.



3933 US Route 11
Cortland, NY, 13045

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November 30, 2010

Mr. Mark Watson
Ecoglo International Ltd.
77 Kinsley Street
Christchurch 8440
New Zealand

Intertek Test Report: 100255767CRT-001Ta

Dear Mr. Watson:

Intertek has completed Observation Visibility testing of the Exit Sign Model# RML420225-24m per your instructions and to some of the indicated requirements of UL Standard for Safety Emergency Lighting and Power Equipment (UL 924, Issue: 02/24/2006, Ed: 9, Rev: 10/22/2009). The test samples of Exit Sign Model# RML420225-24m were received on 08/30/2010 in new condition. The evaluation was performed at Intertek, Cortland, NY, on 11/16/2010 through 11/24/2010. The results of these tests are indicated as follows:

Standard	Clause	Test Completed	Pass / Fail
UL 924	41.2	Observation visibility test	N/A
UL 924	41.3	Luminance measurement test	N/A

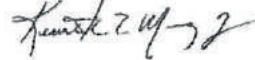
The Exit Sign Model# RML420225-24m were used in the Observation Visibility Test with the following indicated requirements of UL Standard for Safety Emergency Lighting and Power Equipment (UL 924, Issue: 2006/02/24, Ed: 9, Rev: 10/22/2009). The ages and vision requirements of the observers was followed. The charging method was also followed. The passing criteria was for the observer to identify whether the sign was a "Man Running Right" Sign or a "Man Running Left" Sign. At 205 minutes discharge time, the signs failed the criteria. At 145 minutes, the signs passed the criteria. This Test Report concludes the work anticipated for this phase of your project under Intertek quote number 500232723. See attached data for testing details. Any questions can be directed to Aaron Oldweiler at 607-758-6560 or Aaron.Oldweiler@intertek.com .

Reported by



Aaron Oldweiler
Project Engineer

Reviewed by



Kenneth L. Morgan, Jr.
Engineering Team Leader



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Test Data

Client: <u>Ecoglo</u>	Engineer: <u>Aaron Oldweiler</u>	Date: <u>11/24/2010</u>
Job No.: <u>G100255767</u>	Tested By: <u>Aaron Oldweiler</u>	Date: <u>11/24/2010</u>
Product: <u>Exit Sign</u>	Reviewed By: <u>Kenneth L. Morgan, Jr.</u>	Date: <u>11/30/2010</u>
Model No.: <u>RML420225-24m</u>	Standard(s): <u>UL Standard for Safety Emergency Lighting and Power Equipment (UL 924, Issue: 2006/02/24, Ed: 9, Rev: 10/22/2009)</u>	
Sample Control Number(s): <u>213661</u>		

Contents					
Required	Page	Standard	Clause	Test Description	Pass/Fail
NA	1	NA	NA	Report	NA
NA	2	NA	NA	Tests to be Performed	NA
NA	2	NA	NA	Sample Description	NA
NA	2	NA	NA	Equipment used	NA
NA	3	NA	NA	Sample Photos	NA
(X)	4-5	UL 924	41.2	Observation Visibility Test	N/A
(X)	6	UL 924	41.3	Luminance measurement test	N/A

Test sample numbers and descriptions				
Sample #	Intertek Id	Description	Manufacturer	Model #
1	213661	Exit Sign	Ecoglo	RML420225-24m
2	213661	Exit Sign	Ecoglo	RML420225-24m
3	213661	Exit Sign	Ecoglo	RML420225-24m
4	213661	Exit Sign	Ecoglo	RML420225-24m
5	213661	Exit Sign	Ecoglo	RML420225-24m
6	213661	Exit Sign	Ecoglo	RML420225-24m
7	213661	Exit Sign	Ecoglo	RML420225-24m
8	213661	Exit Sign	Ecoglo	RML420225-24m

Test Equipment				
#	Intertek Id	Description	Manufacturer	Cal. Due
1	N1313	Stopwatch	Oslo	12/31/10
2	N904	Thermometer	Cole Parmer	7/15/11
3	L060	Optical Power meter	371	6/24/11
4	O106	Sensor	-	6/24/11
5	Y174	Luminance Monitor	Optronic OL730C	Per use
6	730 C	Radiometer	Optronic	Per use
7	-	Silicon Photo	Optronic	Per use
8	-	Direct View module	Optronic	Per use



Intertek Test Data Sheets

Test Data

Client: <u>Ecoglo</u>	Engineer: <u>Aaron Oldweiler</u>	Date: <u>11/24/2010</u>
Job No.: <u>G100255767</u>	Tested By: <u>Aaron Oldweiler</u>	Date: <u>11/24/2010</u>
Product: <u>Exit Sign</u>	Reviewed By: <u>Kenneth L. Morgan, Jr.</u>	Date: <u>11/30/2010</u>
Model No.: <u>RML420225-24m</u>	UL Standard for Safety Emergency Lighting and Power Equipment (UL 924, Issue: 2006/02/24, Ed: 9, Rev: 10/22/2009)	
Sample Control Number(s): <u>213661</u>	Standard(s): <u></u>	

Photo# 1 – Exit Sign Model# RML420225-24m





Intertek Test Data Sheets

Test Data

Client: Ecoglo Engineer: Aaron Oldweiler Date: 11/24/2010
 Job No.: G100255767 Tested By: Aaron Oldweiler Date: 11/24/2010
 Product: Exit Sign Reviewed By: Kenneth L. Morgan, Jr. Date: 11/30/2010
 Model No.: RML420225-24m Standard(s): UL Standard for Safety Emergency Lighting and Power Equipment (UL 924, Issue: 2006/02/24, Ed: 9, Rev: 10/22/2009)
 Sample Control Number(s): 213661

Observation Visibility Test (UL 924, Clause# 41.2 and per clients passing criteria)

Pass: Fail: X

Test Purpose:
To measure the visibility of the Exit Sign.

Test Method:
 Number of observers: 8, 2 from each age group
 Age groups: 18 – 30, 31 – 40, 41 – 50, and 51 – 70 years
 Visual acuity: at least 20/40 vision
 Sample position: above the floor against a flat black surface in total darkness
 Distance between the sign and point of observation: 24 meters
 Time that observers' eyes are to be acclimated to darkness: 5 minutes
 Max number of signs presented at one time: 2
 Time of each observation: 10 seconds

Test Results: 24 meters, 205 minutes discharge

Observer number	Number of Correct Responses for Directional Indicator
1	4
2	7
3	1
4	1
5	7
6	2
7	0
8	0
Mean	2.75
Sample Standard Deviation	2.92
Lower Cutoff Limit	0.14
Revised Mean	3.67
Specified Minimum Mean (or Revised Mean)	6.4
Result (Pass/Fail)	Fail

To Comply:
 The revised mean should be greater than the specified minimum mean. For Directional Indicator, the Specified Minimum Mean is 6.4 and for Legend, the Specified Minimum Mean is 4.8. The observer shall identify whether the sign was a "Man Running Right" Sign or a "Man Running Left" Sign.

Intertek Comments:
 The product complies with all applicable requirements of the client.
 The product does not comply with the requirements of the client.
 Test Date: 11-17-10 Tested By: AO

Environmental Conditions During Testing: Humidity: 32% RH Pressure: NA Ambient: 70.2°F

Equipment Used (See page 2 for details):

1	2	3	4						
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Intertek Test Data Sheets

Test Data

Client: Ecoglo Engineer: Aaron Oldweiler Date: 11/24/2010
 Job No.: G100255767 Tested By: Aaron Oldweiler Date: 11/24/2010
 Product: Exit Sign Reviewed By: Kenneth L. Morgan, Jr. Date: 11/30/2010
 Model No.: RML420225-24m Standard(s): UL Standard for Safety Emergency Lighting and Power Equipment (UL 924, Issue: 2006/02/24, Ed: 9, Rev: 10/22/2009)
 Sample Control Number(s): 213661

Observation Visibility Test (UL 924, Clause# 41.2 and per clients passing criteria)

Pass: X Fail:

Test Purpose:
 To measure the visibility of the Exit Sign.

Test Method:
 Number of observers: 8, 2 from each age group
 Age groups: 18 – 30, 31 – 40, 41 – 50, and 51 – 70 years
 Visual acuity: at least 20/40 vision
 Sample position: above the floor against a flat black surface in total darkness
 Distance between the sign and point of observation: 24 meters
 Time that observers' eyes are to be acclimated to darkness: 5 minutes
 Max number of signs presented at one time: 2
 Time of each observation: 10 seconds

Test Results: 24 meters, 145 minutes discharge	
Observer number	Number of Correct Responses for Directional Indicator
1	7
2	8
3	7
4	8
5	8
6	8
7	5
8	3
Mean	6.75
Sample Standard Deviation	N/A
Lower Cutoff Limit	N/A
Revised Mean	N/A
Specified Minimum Mean (or Revised Mean)	6.4
Result (Pass/Fail)	Pass

To Comply:
 The revised mean should be greater than the specified minimum mean. For Directional Indicator, the Specified Minimum Mean is 6.4 and for Legend, the Specified Minimum Mean is 4.8. The observer shall identify whether the sign was a "Man Running Right" Sign or a "Man Running Left" Sign.

Intertek Comments:
 The product complies with all applicable requirements of the client.
 The product does not comply with the requirements of the client.
 Test Date: 11-18-10 Tested By: AO

Environmental Conditions During Testing: Humidity: 30% RH Pressure: NA Ambient: 72.3°F

Equipment Used (See page 2 for details):

1	2	3	4						
---	---	---	---	--	--	--	--	--	--



Intertek Test Data Sheets

Test Data

Client: Ecoglo Engineer: Aaron Oldweiler Date: 11/24/2010
 Job No.: G100255767 Tested By: Aaron Oldweiler Date: 11/24/2010
 Product: Exit Sign Reviewed By: Kenneth L. Morgan, Jr. Date: 11/30/2010
 Model No.: RML420225-24m Standard(s): UL Standard for Safety Emergency Lighting and Power Equipment (UL 924, Issue: 2006/02/24, Ed: 9, Rev: 10/22/2009)
 Sample Control Number(s): 213661

Luminance measurement test (UL 924, Clause# 41.3)

Pass: N/A Fail:

Test Purpose:
 Per client instructions: measure luminance on exit signs in 15 minute intervals until 280 minutes.

Test Method:
 Sign charge time: 1 hour
 Charging luminance: Fluorescent light, 54 lux ± 10%.
 Measurement intervals: 15 minutes
 Measurement time: 280 minutes

Test Results:
 Model: RML420225-24m

Luminance measurement (mCD/m²)

Sample	Elapsed Time (minutes)																		
	10	25	40	55	70	85	100	115	130	145	160	175	190	205	220	235	250	265	280
1 - J	211	115	82.7	61.5	46.2	39.1	34.0	29.0	24.9	21.1	17.5	16.9	16.3	14.8	13.9	12.9	12.1	11.1	10.7
2 - K	213	119	83.1	61.3	48.2	40.2	34.6	29.1	25	21.3	17.5	16.7	16.1	14.8	14.4	13.0	12.5	11.2	10.3
3 - L	213	119	81.0	60.5	47.8	38.7	34.4	28.9	25.1	21.4	17.8	17.2	16.2	15.1	13.9	12.8	12.0	11.2	10.5
4 - M	221	123	84.1	63.1	50.7	41.0	35.3	29.7	26	21.8	18.4	17.6	16.7	15.6	14.7	13.4	12.5	11.7	11.0
5 - P	214	117	83.2	63.4	49.2	41.3	35.1	29.9	26.6	21.9	18.4	17.5	16.6	15.5	14.3	13.4	12.5	11.6	10.3
6 - Q	213	121	82.4	62.2	48.4	40.1	34.3	29.1	25.1	21.5	17.9	17.3	16.3	15.1	13.8	13.2	12.2	11.3	10.7
7 - R	210	117	81.2	60.0	47.0	39.6	33.9	29.5	25.2	21.2	17.7	16.9	16.1	14.9	13.7	12.9	12.2	11.4	10.5
8 - S	205	114	78.7	58.8	46.1	38.2	33.4	28.4	24.7	20.8	17.5	16.7	16.0	14.8	13.6	12.9	12.0	11.1	10.4
Average	212.5	118.1	82.1	61.4	48.0	39.8	34.4	29.2	25.3	21.4	17.8	17.1	16.3	15.1	14.0	13.1	12.3	11.3	10.6

To Comply:
 Client is looking for the time at which the signs' luminance drops below 10 mCD/m²

Intertek Comments:
 N/A The product complies with all applicable requirements of this test.
 _____ The product does not comply with the requirements of this test.
 Test Date: 11-24-10 Tested By: AO

Environmental Conditions During Testing: Humidity: 24% RH Pressure: NA Ambient: 69.8°F

Equipment Used (See page 2 for details):

1	2	3	4	5	6	7	8		
---	---	---	---	---	---	---	---	--	--

APPENDIX 2

Ecoglo In-House Test Results

Ecoglo runs an in-house luminance test facility, which is validated by comparative testing with independent test laboratories. The in-house test facility enables the efficient

testing of multiple charging brightness, time, lamp type, and product variations. Ecoglo has carried out over 3000 in-house tests since 2003.

The attached data is extracted from Ecoglo records for the following in-house tests:

Table 1 Verification that fluorescent, metal halide, or LED lighting with a colour temperature of 4000K or greater are all suitable charging sources for Ecoglo exit signage

Test No.	Date	Lamp Type	Charging Lux	Charging Time (min)	Luminance after 30 Minutes (mcd/m ²)
e502	17/05/12	Fluoro 4000K	100	5	35.0
e503	29/05/12	LED 4000K	100	5	56.0
e507	22/06/12	Fluoro 6500K	100	5	43.0
e508	26/02/12	Met Hal 4000K	100	5	47.5
e548	28/05/13	LED 4000K	100	5	30.0

Table 2 Data extracted from Ecoglo in-house testing

Test No.	Date	Charging Lux	Charging Time (min)	Luminance after 30 Minutes (mcd/m ²)	Luminance after 90 Minutes (mcd/m ²)
e235	18/2/08	5000	60		22.0 ¹
e403	08/06/10	54	30		26.5
e403a	08/06/10	54	10	34.5	
e420	25/06/10	10	120	39.5	
e442	09/12/10	54	5	18.0	
e555	02/07/13	54	60		32.5
e609	26/03/14	21.5	120		31.5
e801	30/1/18	100	20		37.5
e814	7/3/18	200	1	39.0	
e817	12/3/18	20	30	42.5	
e819	16/3/18	200	3		56.0

Note: 1. Interpolated value at 420 minutes (7 hours)

Table 3 Data extracted from Ecoglo in-house for two-day testing. The Day 1 charging was for 6 hours with Fluoro 6000K lamp at the stated illuminance, followed by 16 hours darkness, and then the Day 2 charging was with Fluoro 4000K lamp and the stated conditions.

Test ID	Date	Charging Lux day 1	Charging Lux day 2	Charging Time day 2 (min)	Luminance after 10 Minutes day 2 (mcd/m ²)	Luminance after 30 Minutes day 2 (mcd/m ²)
e794	29-30/11/17	55	55	1	31.0	
e810	21-22/2/18	55	55	3		24.0
e842	31/5/18-1/6/18	20	100	3		39.0
e845	6-7/6/18	20	100	1	31.0	
e846a	13-14/6/18	20			5.0 ¹	
e846b	13-14/6/18	20	55	6		38.0

Note: 1. The recorded value of 5mcd/m² was measured just prior to the Day 2 charging

APPENDIX 3

Justifications for charging lux required in different scenarios A.

As mentioned in Section 2.3, 21.4mcd/m² is sufficient luminance for the sign to be seen in a lights-out emergency.

NZBC Clause F8.3.3 requires exit signs in a Risk Group C building to continue to perform during failure of the main lighting for a period of 30 minutes.

Therefore, the performance criteria are that Ecoglo S20 exit signs have a luminance of at least 21.4mcd/m² for at least 30 minutes following failure of the main lighting.

As mentioned in Section 2.2, 55 lux is sufficient illumination for the sign to be visible during normal use.

Test e403a (see Appendix 2, Table 2) shows that following 55 lux charging for 10 minutes, Ecoglo S20 signage is above 21.4mcd/m² (and above 30mcd/m²) for at least 30 minutes. (Meets performance criteria.)

QUT test report 3391-1 (see Appendix 7) shows that following 55 lux charging for 1 hour, Ecoglo S20 signage is above 21.4mcd/m² for at least 150 minutes, (and above 30mcd/m² for at least 105 minutes). (Far exceeds performance criteria.)

Therefore 55 lux continuous illuminance on the sign is sufficient to ensure the sign will be sufficiently charged.

The following explains why lighting does not need to be switched on prior to occupation. At first glance, this might seem to be in contravention of the building code, because Ecoglo S20 exit signs will not always meet the minimum luminance (21.4mcd/m²) when a space is first occupied, if the lighting is not turned on before occupation. To analyse this issue fully, it is first useful to unravel what the deemed intent of the building code is, and from there determine whether that intent is met or not.

Interpretation of the intent of F8.3.1:

"Signs must be clearly visible and readily understandable under all conditions of foreseeable use, including emergency conditions."

Given that the Acceptable Solution is considered to be an acceptable response to the code clauses, it is reasonable to look at both the relevant Code Clauses and the Acceptable Solution, in interpreting the intent and extent of code clause F8.3.1.

Firstly, the relevant Objective wording in F8.1 is to:

"safeguard people from injury or illness resulting from inadequate identification of escape routes..."

It seems reasonable to consider that a foreseeable scenario where a sign is not clearly visible, but its lack of visibility would not be expected to result in injury or illness, would be a trivial scenario that does not breach the intent of the Code.

Secondly, to examine how the Acceptable Solution meets F8.3.1, we must consider F8/AS1 paragraph 4.5.5 which states:

"Alternative supplies providing energy for the illumination of exit signs during interruption of the normal lighting supply shall comply with AS 2293: Parts 1 and 3 and AS/NZS 2293: Part 2 and maintain energy supply for the duration required by NZBC Clause F6."

A period of up to 16 hours following a failure of the main lighting is allowed under AS 2293.3 for the battery to re-charge sufficiently to ensure sufficient illumination during a subsequent failure of the main lighting. A scenario where there is a second power black-out following an initial 1-2 hour black out is clearly foreseeable. In fact, this exact situation occurred in New Zealand several years ago, when a fully occupied North Island hospital administration building (with subground floors) was plunged into darkness when a second black-out occurred later in the same day.

AS/NZS 2293.2 details inspection, maintenance, and testing. The testing of the 'alternative supplies' as mentioned in F8/AS1 4.5.5 is to be carried out at 6-monthly intervals. It is clearly foreseeable that a scenario can arise where in the period between one test and the next test, the battery will fail to maintain sufficient charge, or fail altogether, resulting in the signs not being visible should a black-out occur before the battery is replaced some weeks or months later.

The consequences of the above two scenarios could be significant, and could involve a number of occupants, yet they could both occur with battery-back-up signs that would be deemed to be F8/AS1 compliant.

Therefore, it is reasonable to conclude that F8.3.1 should not be considered to be an absolute requirement: minor transgressions that pose no greater risk (of injury resulting from inadequate identification of the escape routes) than battery-back-up electrical exit signs can be deemed to be acceptable.

What are the foreseeable scenarios where an installed Ecoglo S20 exit sign would not be clearly visible and readily understandable:

1. the first 5-15 seconds when a previously unoccupied dark space is entered and before the lights are turned on;
2. failure of the occupants to turn the lighting on when they enter a dark room;
3. failure of all the electrical lighting in a windowless room prior to first occupation;
4. failure of the main lighting shortly after the lights are turned on in a previously unoccupied dark space (before the signs have been sufficiently re-charged by the main lighting).

Scenario 1: this is clearly very short term, involving only a few occupants. It is reasonable to assume that the occupants would know where the exit door is (because they will have just entered through it), and therefore the Objective wording in F8.1 is not transgressed.

Scenario 2: would also appear to be similarly trivial: it is reasonable to assume that if the lighting is not turned on, the occupants are comfortable in a dark environment, which means they are comfortable with the prospect of leaving that environment should the need arise.

Scenario 3: can be expected to only affect a few people for a short time: it is reasonable to expect that maintenance of the lighting will be requested prior to further occupation of the space.

Scenario 4: needs more analysis: First of all, it is worth noting that even dim daylight-lit spaces will not qualify for Scenario 4: Test e817 (see Appendix 2, Table 2) shows that 20 lux of daylight for 30 minutes is sufficient to charge the signs.

Where the sign is exposed to a minimum of 20 lux for 6 hours or more the previous day the Ecoglo exit signs will not have dropped below 5mcd/m² overnight (see e846a Appendix 2, Table 3).

International Building Code and International Fire Code 2015 Section 1025.4 and NFPA-101 Life Safety Code Chapter 7, 7.2.2.5.5.10 all prescribe a minimum of 5mcd/m² for photoluminescent emergency egress path markings, and Ecoglo F6 Technical Justification (p2) provides evidence that 16mm wide photoluminescent material at 5mcd/m² is usefully visible from a distance of 10 metres. At the moment of first occupation the exit signs, therefore, will still be visible (the first occupier can be expected to be within 10m of the nearest exit sign at that moment), even if the exit signs are less than the design level of 21.4mcd/m². As soon as the electrical lighting is switched on, for every second that the lighting is on, the Ecoglo signs will gain more than 1 second of 'egress time' at or above the design level of 21.4mcd/m². In 1 minute (see test e794 – Appendix 2, Table 3) the signs will be at least at the design level for at least 10 minutes, and by 3 minutes, the full 30 minutes 'egress time' required by F8 will be met (see test e810 – Appendix 2, Table 3). For a building with an evacuation time of no more than 10 minutes, this means that the Ecoglo signs will meet the intent of the code within 1 minute of first occupation. See Appendix 4 for evacuation time examples.

It seems reasonable to conclude that the risk of injury from inadequate visibility of Ecoglo S20 exit signs is low in these circumstances (and therefore does not transgress F8.1), especially given the number of occupants that are likely to be present in the first minute, their likely locations in the building, and their likely familiarity with the location of the escape door.

A reasonable conclusion to be drawn from weighing up the scenarios where an F8/AS1 battery-back-up electrical sign fails to meet F8.3.1 against the scenarios where an Ecoglo S20 exit sign fails to meet F8.3.1 (when not charged with electrical lighting before occupation of the space) is that the S20 sign provides a better fit to F8.3.1 than a battery-back-up electrical exit sign, and therefore meets the intent and extent of the Code. Further, it is reasonable to conclude that the Ecoglo exit signs will not transgress F8.1 (the objective of the code), whereas battery-back-up electrical signs may well transgress F8.1 when they fail to meet F8.3.1 (the performance requirements of the code).

B.

The same rationale holds as for (A) above, except that, instead of tests e794 and e810 (see Appendix 2, Table 3), tests e845 and e842 (see Appendix 2, Table 3) provide the evidence that within 1 minute the signs will be at the design level for at least 10 minutes, and by 3 minutes, the full 30 minutes 'egress time' required by F8 will be met.

C.

The same rationale holds for (A) above, except that, instead of tests e794 and e810 (see Appendix 2, Table 3), test e846b (see Appendix 2, Table 3) provides the evidence that within 1 minute the signs will be at the design level for the full 30 minutes 'egress time' required by F8. [The test is for 6 minutes charging, representing 5 minutes charge prior to occupation.]

D.

The same rationale holds as for (A) above, except that, instead of tests e794 and e810 (see Appendix 2, Table 3), tests e814 and e819 (see Appendix 2, Table 2) provide the evidence that within 1 minute the signs will be at the design level for at least 10 minutes, and by 3 minutes, the full 30 minutes 'egress time' required by F8 will be met.

E.

The Nemoto test report (see Appendix 8) shows that 5 minutes charging at 100 lux ensures full compliance with F8 for at least 30 minutes, as required by NZBC Clause F8.3.3.

F.

Ecoglo test report e403a (see Appendix 2, Table 2) shows that 10 minutes charging at 55 lux ensures full compliance with F8 for at least 30 minutes, as required by NZBC Clause F8.3.3.

APPENDIX 4

Evacuation Time Examples

Refer to the New Zealand Building Code Clause C/MM2 for further details and explanations of terms used here.

RSET can be calculated in accordance with Clause C/MM2, using values of zero for T_d and T_n , since occupants will be immediately aware of a black-out requiring evacuation. For photoluminescent exit signage, the relevant 'evacuation time' is the time between when the lighting fails (requiring the photoluminescent properties of the sign to provide adequate identification of the escape route) and the occupant leaves the space that the exit sign serves.

Looking at table 3.3 in C/MM2, a conservative pre-travel activity time would be 60 seconds. A conservative travel speed can be taken as 1m/second, (including stairways no steeper than 180mm riser, 280mm tread), and a conservative flow rate at a doorway is 50 people per minute per door leaf. An escape route serving up to 100 people through single leaf door sets and up to 120 metres long would have an evacuation time of 3 minutes. An assembly space with capacity for 450 people will require 3.2m of exit door width (which could be two double doors), so if one of these is unusable the evacuation time would be about 5 minutes. If the space had three double doors, the evacuation time with one of these unusable would be 3-4 minutes. This indicates that an evacuation time of less than 10 minutes is realistic in many Risk Group C buildings.

APPENDIX 5

Justification for charging lux required when signs are viewed from less than half their rated distance

Analysis of observation visibility testing carried out by Ecoglo in 2010 that followed a similar protocol to that used in UL924, shows the relationship between luminance and visibility distance for signs of identical size and graphics. This shows that a sign with 53% of the brightness of another sign is visible from 57% of the distance of that other sign.

As 53% of 21.4mcd/m² is 11.3mcd/m², Ecoglo S20 exit signs emitting a luminance of 11.3mcd/m² meet the F8 requirement for visibility at 57% of their maximum viewing distance during failure of the main lighting. Test e442 (see Appendix 2, Table 2) shows 18mcd/m² 30 minutes after 5 minutes of 55 lux charge and Test e502 (see Appendix 2, Table 1) shows 35mcd/m² 30 minutes after 5 minutes of 100 lux charge. It can be reasonably concluded that 55 lux charging is at least 50% as effective as 100 lux charging for short charge times.

Therefore 55 lux is sufficient charging lux for signs that do not need to be viewed from further than 50% of their rated viewing distance.

APPENDIX 6

Test report of Ecoglo Photoluminescent Material Certifying that the material meets NYC RS6.1 Section 6.



REPORT
Intertek ETL SEMKO
 3933 US ROUTE 11 CORTLAND, NEW YORK 13045

Order No. 3078911

Date: November 15, 2005

REPORT NO. 3078911CRT-006

TEST OF FOUR PHOTOLUMINESCENT MATERIAL MODELS

RENDERED TO

ECOGLO LTD.
 77 KINGSLEY ROAD
 CHRISTCHURCH, NEW ZEALAND 8002

DATA REQUESTED

Luminance measurements after activation tests on four photoluminescent material models after UV exposure in accordance with New York City Building Code Reference Standards RS 6-1 and RS 6-1A: Photoluminescent Low-level Exit Path Markings.

AUTHORIZATION

This test service was authorized by signed quote number 18761099.

DEVICES SUBMITTED

The client submitted three photoluminescent material samples each of four Models: G3001C/E2071C, and G5001C/H5001C. The samples were received by Intertek on June 18, 2005 in undamaged condition, and tested as received. The sample designations are E2218Z through E2223Z.

DATE OF TESTS

June 28, 2005 through November 13, 2005.

TEST SUMMARY

NYC Building Code RS 6-1A Photoluminescent Low-level Exit Path Markings	Model G3001C/E2071C	Model G5001C/H5001C
Clause 1.0 Brightnes Rating Post UV Exposure	Complies	Complies

An independent organization testing for safety, performance, and certification.

This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to copy or distribute this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program. Measurement uncertainty budgets have been determined for applicable test methods and are available upon request.

EQUIPMENT LIST

Equipment Used	Model Number	Control Number	Calibration Date
Optronic Luminance Standard	455-6-2	Y174	09/30/04
Optronic based Luminance Meter consisting of:			
Optronic Photometer	730C	E290	06/23/05
Optronic Direct Viewing Module	600	---	---
Optronic Amplified Photodetector	730-5H-LED	---	---
Fisher Scientific Stopwatch	---	N853	05/05
UDT Illumination Meter	S371R	L060	09/02/04

TEST AND TEST METHOD

Selective Process

After evaluation at Intertek, it was determined that Models G3001C and E2071C are identical in regards to luminance performance and that Models G5001C and H5001C are identical in regards to luminance performance.


Luminance Measurements Before and After Weathering Test

The luminance measurements were made on the photoluminescent test samples with the Intertek License Plate Test Apparatus. The center of each test sample was measured at normal (0°) viewing angle. The aperture of the Optronic based luminance meter was adjusted in order to view the maximum area on the test sample. The Intertek License Plate Test Apparatus consists of a Optronic based luminance meter and a horizontal and vertical movement system. The luminance calibration of the luminance meter is traceable to the National Institute of Standards and Technology through the calibration of the Optronic Luminance Standard.

The test samples were conditioned for at least 16 hours at zero footcandle illumination. The photoluminescent material samples were then conditioned for 120 minutes (two hours) by 2 footcandle illumination from a 4100K fluorescent light source. Luminance measurements were made on each test sample at two minutes intervals after conditioning for a period of one hour and at ninety minutes after conditioning. Luminance measurements were reported for ten minutes, sixty minutes and ninety minutes after conditioning.

Weathering Tests

The test samples were sent to Canesis Network Limited for 1000 hours exposure to Xenon Arc light apparatus per ASTM G155 Cycle 1. The samples were returned to Intertek for the post UV luminance measurements. Average post UV luminance measurements must be at least 90% of the initial average luminance measurements at each time interval.

Checked by: 

Intertek ETL SEMKO

RESULTS OF TEST**Luminance Measurements After Two Hours Activation Period**

Model No. G5001C/H5001C
Intertek Sample Nos. E2220Z, E2218Z, E2219Z
Luminance (mcd/m²)

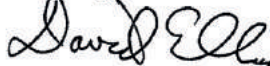
Time After Exposure	Sample One	Sample Two	Sample Three	Average	Specified Minimum
Pre UV Exposure					
Ten Minutes	41.1	40.8	42.3	41.4	30
One Hour	9.96	9.66	10.25	9.96	7.0
Ninety Minutes	6.56	6.37	6.78	6.57	5.0
Post UV Exposure					
Ten Minutes	37.6	37.5	36.9	37.3	37.3*
One Hour	10.09	9.54	10.19	9.94	8.96*
Ninety Minutes	6.97	6.41	7.02	6.80	5.91*

Model No. G3001C/E2071C
Intertek Sample Nos. E2222Z, E2221Z, E2223Z
Luminance (mcd/m²)

Time After Exposure	Sample One	Sample Two	Sample Three	Average	Specified Minimum
Pre UV Exposure					
Ten Minutes	105.6	104.7	107.3	105.9	30
One Hour	29.0	28.5	29.2	28.9	7.0
Ninety Minutes	20.2	19.7	20.1	20.0	5.0
Post UV Exposure					
Ten Minutes	99.1	97.2	100.0	98.8	95.3*
One Hour	27.3	28.4	27.6	27.8	26.0*
Ninety Minutes	18.1	19.4	18.4	18.6	18.0*

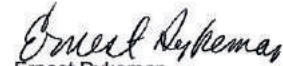
* Specified minimum is 90% of average initial luminance value at each time interval

In Charge Of Tests:



David Ellis
 Project Engineer
 Photometric Testing

Report Reviewed By:



Ernest Dykeman
 Senior Project Engineer
 Photometric Testing

Attachment: None

Intertek ETL SEMKO

APPENDIX 7

Test report of Luminance Measurement of Photoluminescent Materials (Ecoglo S20 Series), based on ASTM 2073-10



Queensland University of Technology

PHOTOMETRIC LABORATORY

REPORT NO: 3391-1

CLIENT: Ecoglo International Ltd

Luminance Measurement of Photoluminescent Materials (Ecoglo S20 Series)

**NATA Accreditation No: 4819
TFI No: T3899
Accredited for compliance with ISO/IEC 17025**

© QUT, 2014

This document is issued in accordance with NATA's accreditation requirements.

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian national standards.

The name or logo of the Queensland University of Technology may not be used in any form on publicity material that may be generated as a result of this report.

Initials 

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PHOTOMETRIC LABORATORY

TEST REPORT

REPORT No: 3391-1

DATE OF TEST: 10th – 11th April 2014

CLIENT: **Ecoglo International LTD**
77 Kingsley St
Christchurch 8023
New Zealand

TEST: **Luminance Measurement of Photoluminescent Materials
(Ecoglo S20 Series)**

ITEM DESCRIPTION: **4 identical samples of Photoluminescence materials**
Dimensions: 100 mm wide x 100 mm high x 2mm thick
Client ID markings on rear of samples :
Batch 1988 – 1335 20 Jan 2014 [Numbers (1) to (4)]
(See photographs on Page 8)

TESTS REQUIRED:
**2 samples to be exposed to an illumination of 54 lux for 1 hour
using lamp of CCT 4000K and**
**2 samples to be exposed to an illumination of 54 lux for 1 hour
using lamp of CCT 4500K**

APPLICABLE STANDARDS:

The samples were tested in accordance with ASTM E2073-10
*Standard Test Method for Photopic Luminance of Photoluminescent
(Phosphorescent) Markings* except the activation illumination in
clause 8.3 is replaced with 54 lux.

Approved Signatory

A/Prof. Ian Cowling

Date of issue: 16th April 2014

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PHOTOMETRIC LABORATORY

TEST REPORT

Report No: 3391-1

Test: Luminance Measurements of Photoluminescent materials (Ecoglo S20 Series)

NOTES ON PROCEDURE:

The preparation and testing procedure of the supplied samples was undertaken using the procedures set out in ASTM 2073-10 *Standard Test Method for Photopic Luminance of Photoluminescent (Phosphorescent) Markings*.

In brief the samples were kept in a dark location for several days to ensure the luminescence was below threshold measurements levels. After this period two samples were exposed to a 1200 mm 36W 8400 fluorescent lamp (CCT = 4000 ± 20K) for 1 hour at an exposure of 54.0 ± 0.1 lux.

In a second test, the other two samples were exposed to a combination of the 36W 8400 lamp used previously, and a 36W 8500 lamp, again at 1 hour at an illumination of 54.0 ± 0.1 lux. The combination of these two lamps on together gave a measured CCT (Correlated Colour Temperature) of 4500 ± 40K measured at the samples.

CCT was measured using the laboratory Konica Minolta CS-500 colour and illuminance meter (Serial No 10001295). The illuminance on the exposure plane was measured using a calibrated laboratory Topcon IM-3 Illuminance meter (Serial No 90160485).


The luminance was measured normal to the surface off the samples with a laboratory Konica Minolta LS-100 luminance meter (Serial no 79413025) which has been calibrated against our laboratory primary standard lamp which itself has been calibrated by the National Measurement Institute (NMI) in Sydney.

The luminance was measured at the following intervals after the exposure lamps were switched off:

- 1, 2, 5 and 10 minutes;
- then every 10 minutes up to 60 minutes;
- then every 15 minutes up to 150 minutes;
- then at 180, 210, 240, 300 and 360 minutes.

UNCERTAINTIES:

For these measurements the values of luminance have an uncertainty of ± 0.001 cd m⁻² (95% confidence level, coverage factor k=2).
 Measurements were taken within 10 seconds of the specified time.

Approved Signatory 
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PHOTOMETRIC LABORATORY

TEST REPORT

Report No: 3391-1

Test: Luminance Measurements of Photoluminescent materials (Ecoglo S20 Series)

RESULTS:

Laboratory conditions:

Temperature: 25 ± 0.5 °C

Humidity: 45 ± 5%

Light Source: 36 W 8400 1200 mm (4000 K) fluorescent tube

Illumination: $E_{av} = 54$ lux for 1 hour; $E_{max}:E_{min} = 1.04$

Table 1: The luminance of the sample at the specified time after exposure.

Time(min)	Sample 2	Sample 3
1	0.625	0.661
2	0.49	0.484
5	0.317	0.318
10	0.225	0.227
20	0.142	0.145
30	0.106	0.107
40	0.082	0.082
50	0.067	0.068
60	0.057	0.058
75	0.045	0.045
90	0.038	0.038
105	0.031	0.032
120	0.028	0.028
135	0.024	0.024
150	0.021	0.022
180	0.018	0.019
210	0.016	0.016
240	0.013	0.014
300	0.009	0.01
360	0.006	0.007

Approved Signatory _____



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TEST REPORT

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Test: Luminance Measurements of Photoluminescent materials (Ecoglo S20 Series)

Graphs of decay- Samples exposed to 36W 8400 fluorescent lamp source

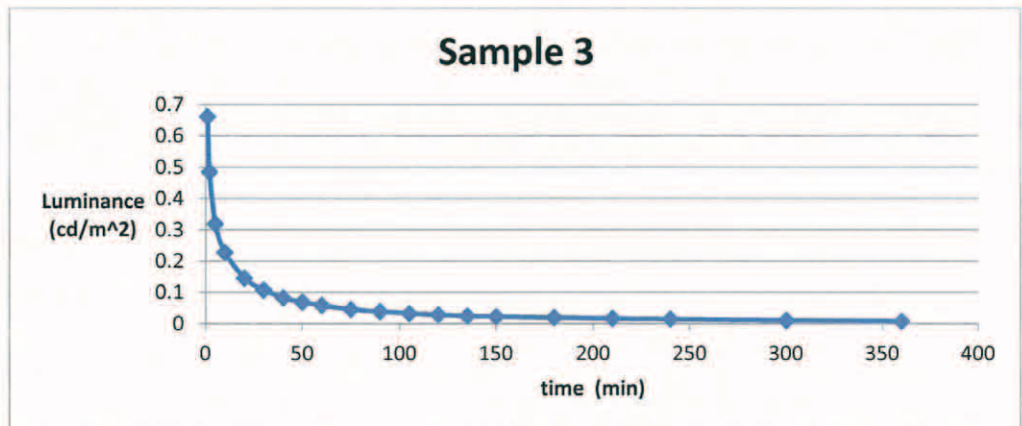
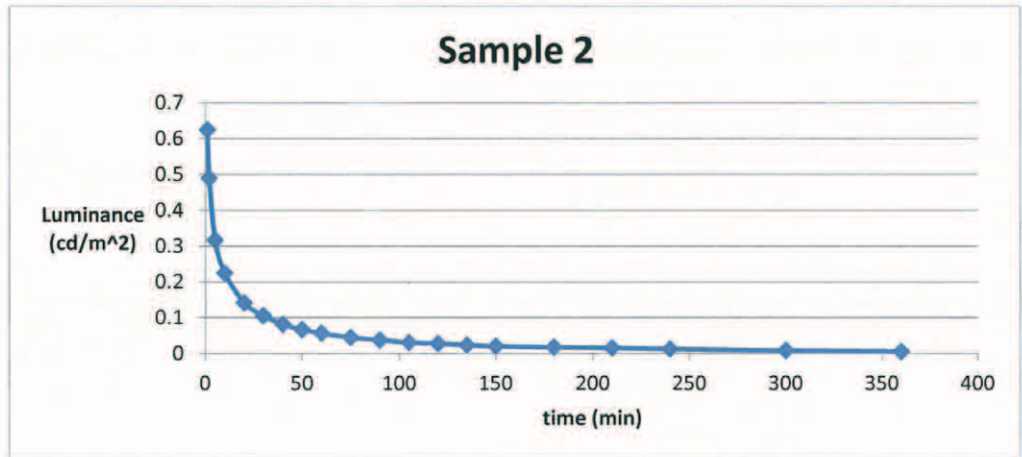



Figure 1. The luminance decay over time of the sample exposed to 8400 fluorescent light source.

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TEST REPORT

Report No: 3391-1

Test: Luminance Measurements of Photoluminescent materials (Ecoglo S20 Series)


RESULTS:

Light Source: 36 W 8400 (4000 K) and 36W 8500 (5000K) fluorescent tube, combined to provide a CCT of 4500 ± 20K

Illumination: $E_{av} = 54$ lux for 1 hour; $E_{max}:E_{min} = 1.04$

Table 2: The luminance of the samples at the specified time after exposure.

Time(min)	Sample 1	Sample 4
1	0.558	0.548
2	0.478	0.446
5	0.367	0.342
10	0.253	0.238
20	0.154	0.147
30	0.115	0.107
40	0.087	0.083
50	0.072	0.069
60	0.061	0.057
75	0.048	0.045
90	0.04	0.036
105	0.032	0.031
120	0.03	0.027
135	0.023	0.022
150	0.022	0.02
180	0.021	0.017
210	0.015	0.015
240	0.013	0.014
300	0.01	0.008
360	0.009	0.006

Approved Signatory 
A/Prof. Ian Cowling

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TEST REPORT

Report No: 3391-1

Test: Luminance Measurements of Photoluminescent materials (Ecoglo S20 Series)

Graphs of decay – Samples exposed to 36W 8400 and 8500 fluorescent lamp source

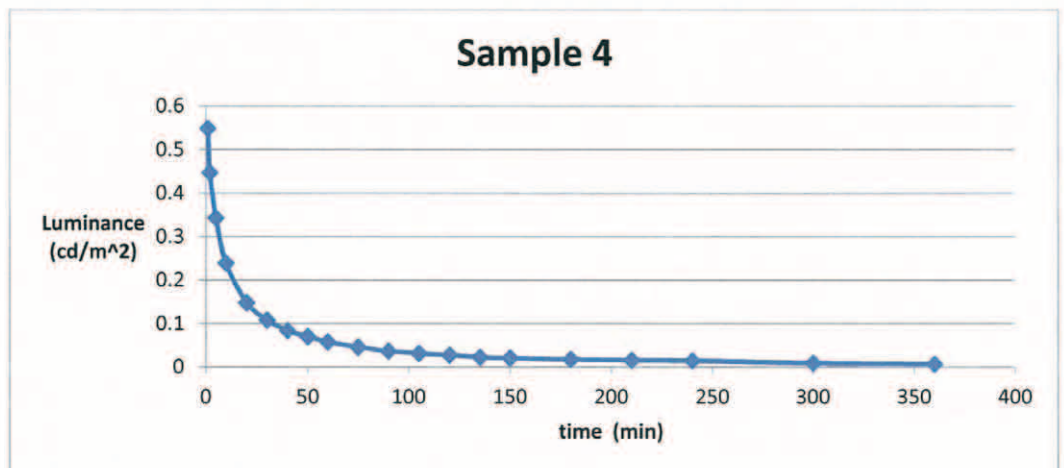
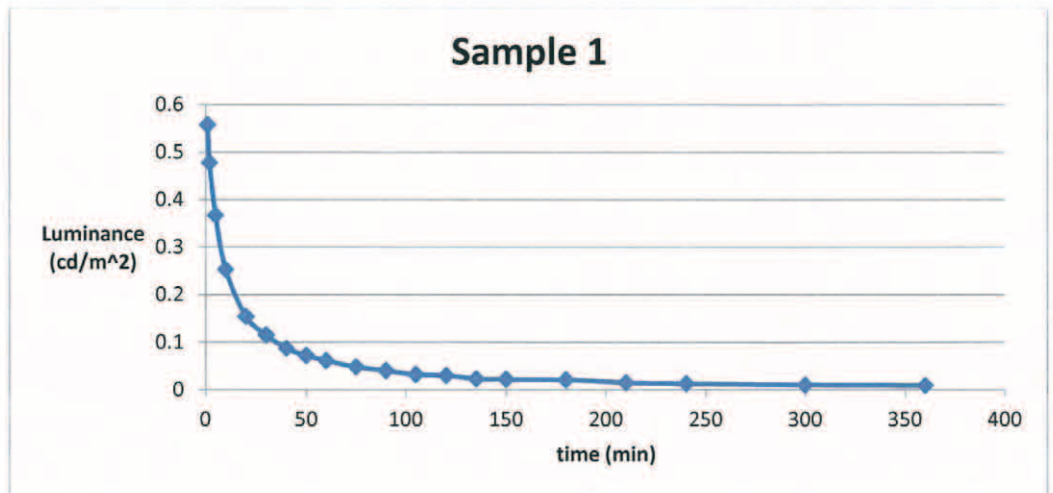



Figure 2. The luminance decay over time of the sample exposed to 8400 and 8500 fluorescent light source, giving a resulting CCT of 4500 ± 50 K.

Approved Signatory 
A/Prof. Ian Cowling

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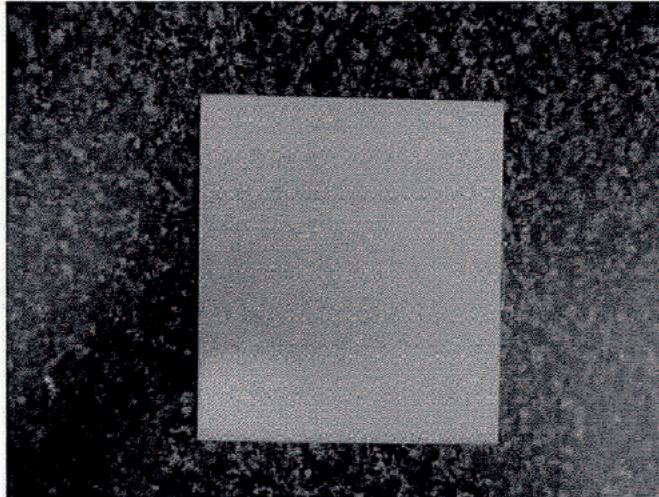
PHOTOMETRIC LABORATORY

TEST REPORT

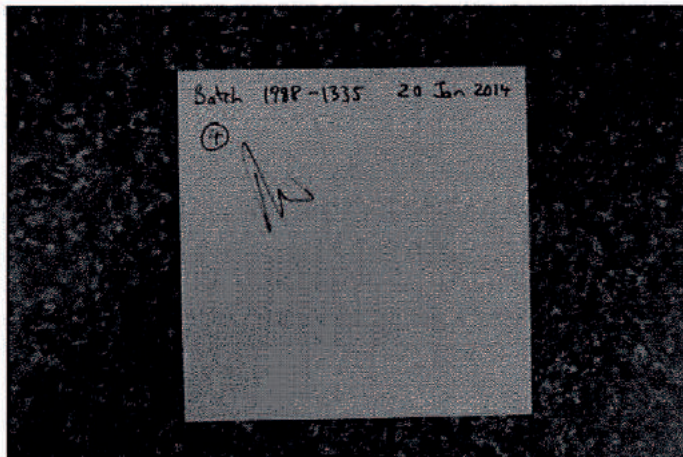
Report No: 3391-1

Test: Luminance Measurements of Photoluminescent materials (Ecoglo S20 Series)


PHOTOS OF THE ECOGLO S20 SERIES MATERIAL SUPPLIED FOR TESTING



Photoluminescent Surface



Rear Surface with ID markings as supplied by the Client

Approved Signatory 
A/Prof. Ian Cowling

Date of issue: 16th April 2014

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APPENDIX 8

Test report of Ecoglo S20 sign material luminance



NEMOTO.,LTD GROUP

July 11, 2012

TEST REPORT

CLIENT : Ecoglo Ltd.

Sample:Ecoglo S20 sign material (LotNo.200809)

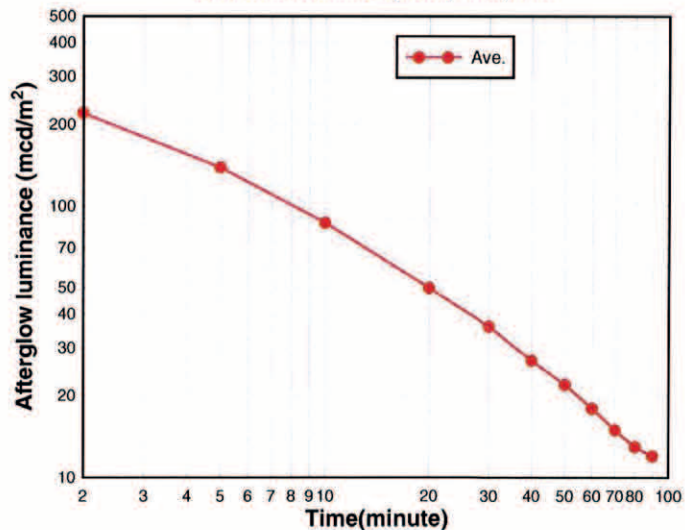
WFL lamp : WFL4200K FL15W.(Toshiba)

Excitation: WFL4200K 100lx, 5min.

Time (minute)	Afterglow luminance (mcd/m ²)			
	Lot.200809-A	Lot.200809-B	Lot.200809-C	Ave.
2	206	209	212	209
5	131	131	134	132
10	82	83	87	84
20	48	48	51	49
30	34	34	36	35
40	26	26	27	27
50	21	21	22	22
60	18	18	18	18
70	15	15	16	15
80	13	13	14	13
90	11	11	12	12

Fig. Afterglow Luminance of Ecoglo S20 sign material

Excitation:WFL FL15W(4200K) 100lx, 5min.



Measured by : K. KANESAKA

Approved by : K. KANESAKA

NEMOTO Lumi-Materials Co.,LTD.

APPENDIX 9

Co-ordination of Ecoglo S20 exit signage with the Fire Safety Design.

Fire Safety Design using the Acceptable Solutions C/AS1-AS7

When the fire safety design has been done in accordance with the Acceptable Solutions (C/AS1 through to C/AS7), photoluminescent exit signs in compliance with Clause F8 satisfy all the requirements for signs.

Fire Safety Design using performance-based methods, eg the Verification Method C/VM2

When a fire engineer uses C/VM2 or an Alternative Solution as the means to show compliance with the fire safety requirements of the NZ Building Code, the following needs to be considered:

NZBC Clauses C4.3 and C4.4 – Movement to a place of safety

This requires the fire engineer to carry out analysis to demonstrate that occupants are not exposed to excessive carbon monoxide, excessive heat, or excessive obscuration of their escape routes due to smoke.

Excessive heat and excessive smoke obscuration only need to be considered in fire cells that are not sprinklered, or in sprinklered firecells where it is possible to expose more than 1000 people in a fire cell to a fire or its effects.

The smoke obscuration analysis is usually done using a model that requires an input value for the obscuration threshold of objects in the escape route. Typically this threshold is selected by the fire engineer on the basis of an occupant's ability to see high contrast objects, and therefore negotiate their way around obstructions on their way through an escape route. This is usually incorporated by using a threshold of 3 (or selecting "reflective signs" in B-RISK if using that model), which is considered applicable to visibility of high contrast objects in obscured conditions. Some fire engineers also choose to base part of their assessment on the obscuration threshold for the exit signage used.

A study carried out in 2015 by a University of Canterbury student reported an obscuration threshold for (passive) photoluminescent signs of 3. The experimental method chosen was different from previous researchers' experimental work to determine obscuration thresholds, and there are grounds for considering that the reported value of 3 is conservative. Nevertheless, this is the only figure available, so without further research, this is the figure that will most likely be assumed by fire engineers for photoluminescent exit signs.

So if the fire engineer has used an obscuration threshold higher than 3 in the model or visibility assessment, passive photoluminescent exit signs such as Ecoglo S20 exit signs should not be used.

If the fire engineer has used an obscuration threshold of 3 (or lower), Ecoglo S20 exit signs can be used.

ECOGLO INTERNATIONAL LIMITED



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