IEA Technology Collaboration Programme
on Energy Efficient End-Use Equipment

IEA-4E SSL Annex - Task 2
Lifetime of SSL Lamps and Luminaires

Webinar 2022-11-29

Steve Coyne and ?????

iea-4e.org

Predictive life test incorporating accelerated aging

Australian Research Activity

Current Research

- To gather test data to explore accelerated LED lifetime testing through the measurement of the rate of decline in light output while a lamp is operated at an elevated ambient temperature (e.g. 60 °C) for 1,500 hours and linking with luminous flux relationship for ambient and junction temperatures.

Test Method

1. Accelerated Degradation Test (ADT)

a) Lamps #1 - #5:

Operate in thermal chamber at a constant 60°C ambient temperature for a total of 1500 hours with measurements conducted at 0 hours and at 150-hour intervals

b) Lamps #11 - #15:

Store (i.e. no power connected) in thermal chamber at a constant 60°C ambient temperature for a total of 1500 hours with measurements conducted at 0 hours, and subsequently at 150-hour intervals.

c) Measurement of photometric quantities (flux, spectral, TLM) of lamps

2. Pulse and Soak Tests

a) Lamps (#6 - #10):

Measure at start-up (pulse) & stabilised (soak) total luminous flux in integrating sphere at ambient temps of 25°C and 40°C to 100°C in 10°C steps

Model Types to Test

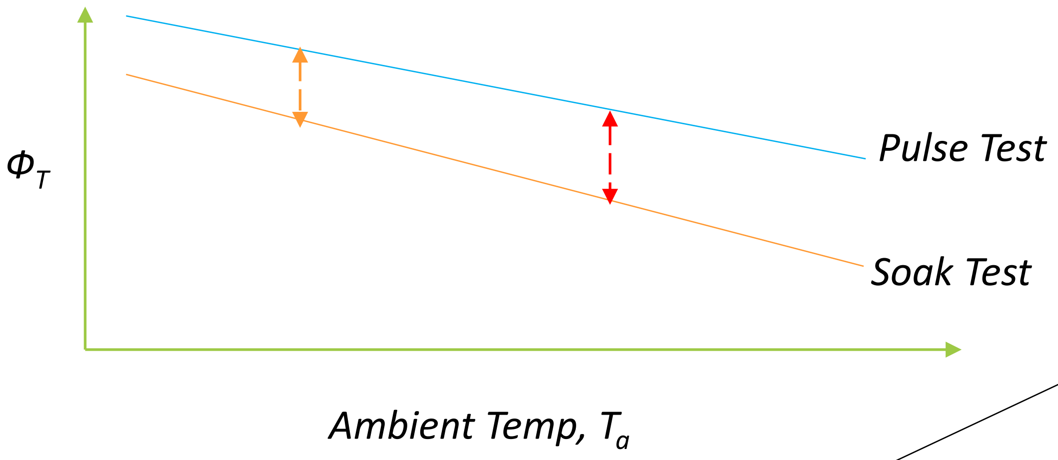
Sample types selected

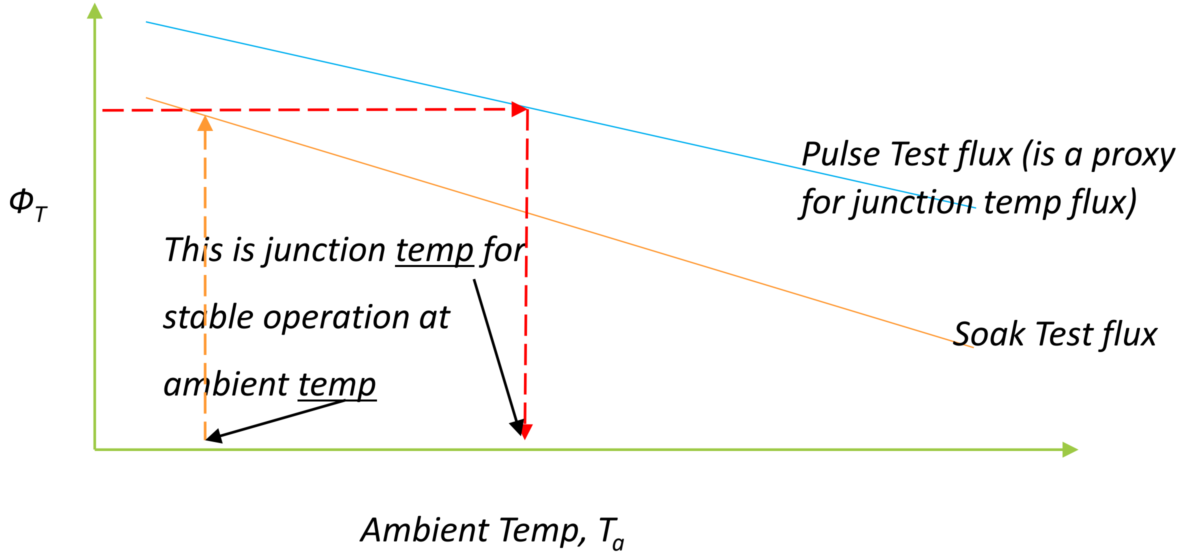
Five A-shape models are under test (16 units of each)

Selected "quality" (brand) products. Do not want lamps to fail early (not the purpose of this research).

LN Code	Lamp type	LED type	Dim	Rated Power	Rated Lumens	Calculated Rated efficacy	Lifetime	CCT	Reason for selection	Unit Price
LNLED185	A80	COB	no	19	2300	121.1	10,000	6500	High powered lamp with low life yet still high efficacy claim.	$ 22.00
LNLED186	A61	COB	no	9	840	93.3	15,000	CW	Average efficacy and typical life claims	$ 5.00
LNLED187	A50	COB	no	6	470	78.3	15,000	WW	Very low efficacy claim but typical life claim	$ 7.00
LNLED188	A60	Filament	no	9.5	1350	142.1	15,000	WW	Expected filament efficacy claim but no life claim	$ 12.30
LNLED189	Fancy	Filament	yes	5	470	94.0	25,000	3000	Very low efficacy claim for filament LED and but long life claim	$ 9.90

Reminder: Pulse – Soak Test Theory



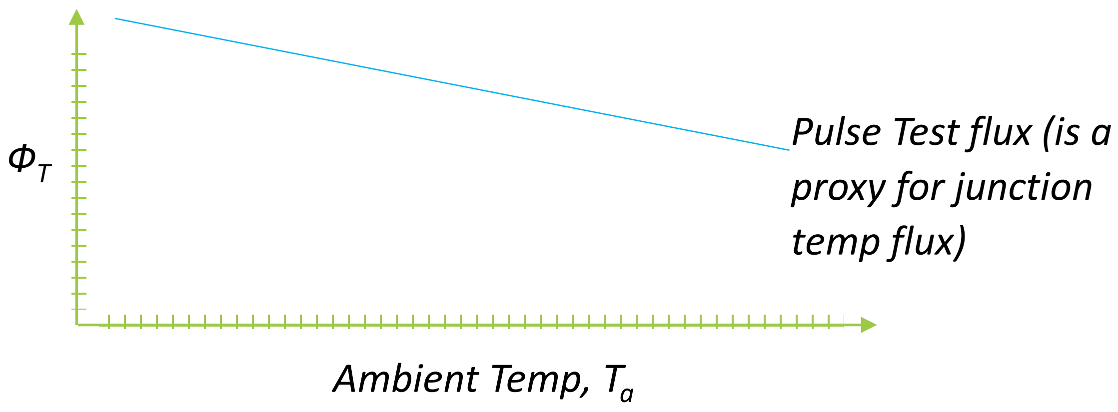


Pulse Test

Thermal co-efficient

$$K_T = 1 + \alpha.\Delta T$$
$$= 1 + \alpha.(T_0 - T_1)$$

K_T is determined from a **pulse test** (0.5 s) with fixed drive current, I, and various ambient temperatures, which are same as the LED chip junction temperatures.

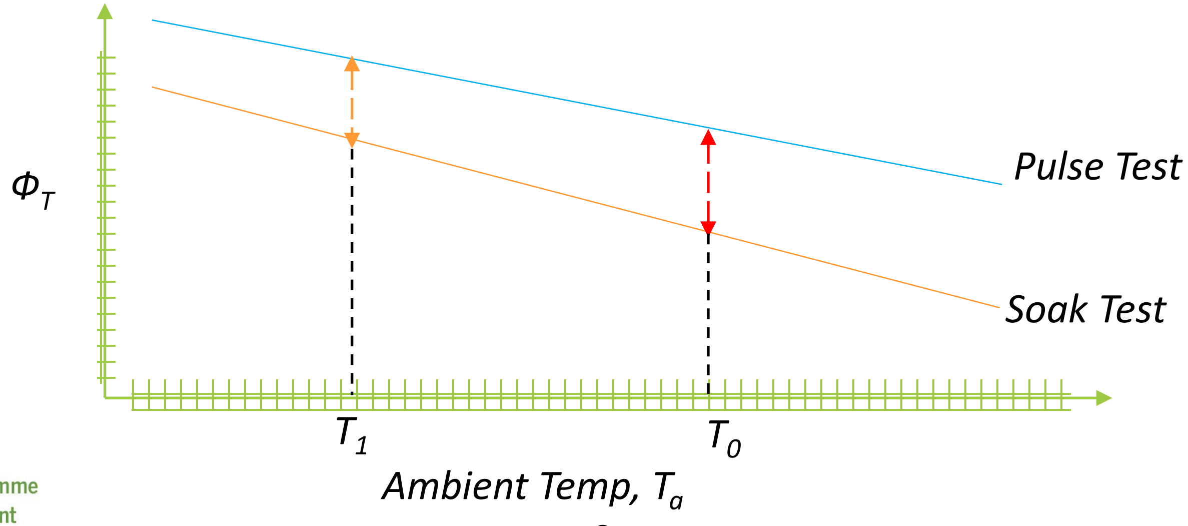


Soak Test

Current-thermal interaction co-efficient

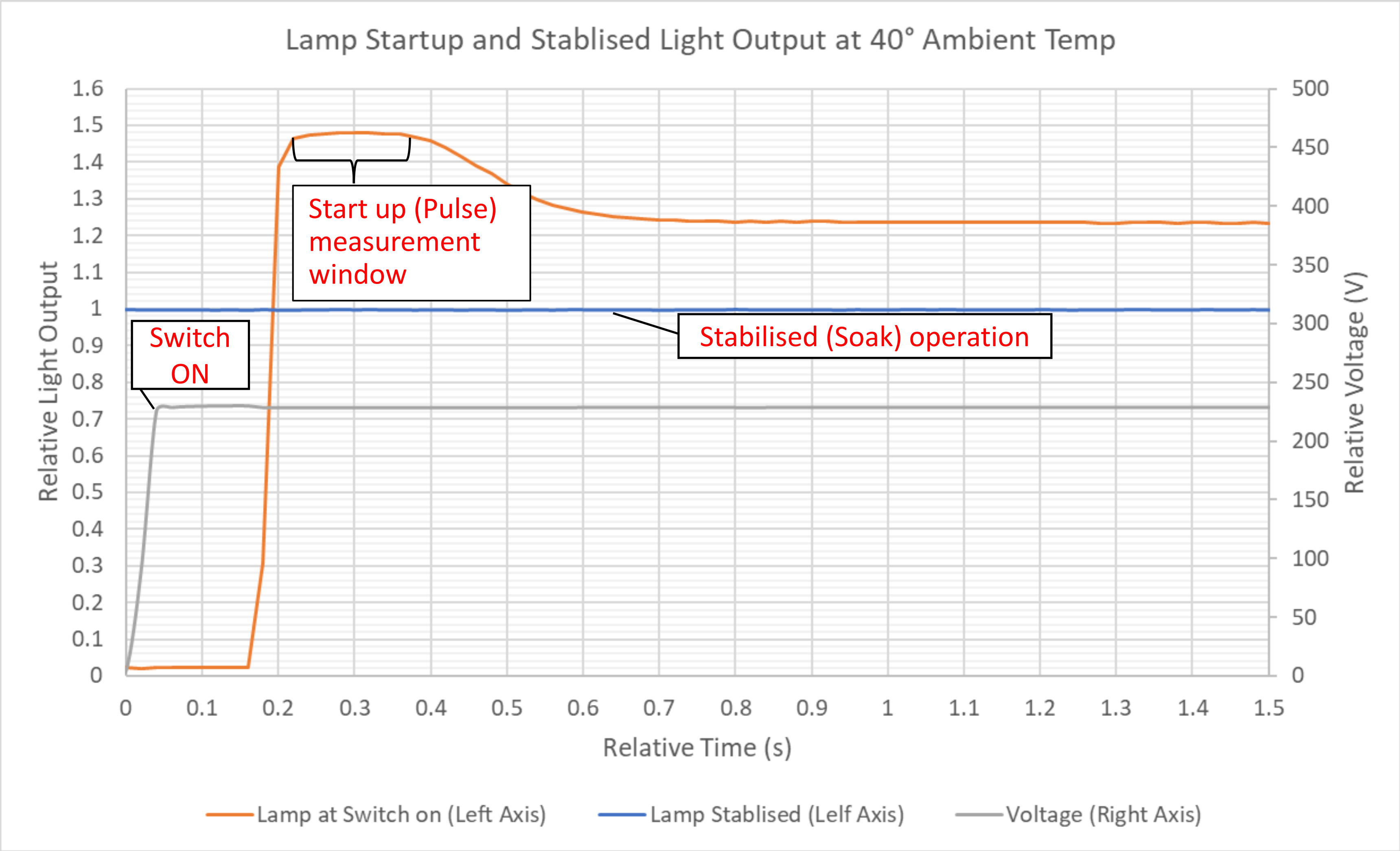
$$K_{iT} = \frac{\left(\emptyset_{P_{T_0}} - \emptyset_{S_{T_0}}\right)}{\left(\emptyset_{P_{T_1}} - \emptyset_{S_{T_1}}\right)}$$

K_{iT} is determined from combination of the **pulse test** results above and a **soak test** with fixed drive current, I, with stabilised LED chip operating junction temperatures for the set ambient temperatures of T_0 and T_1.



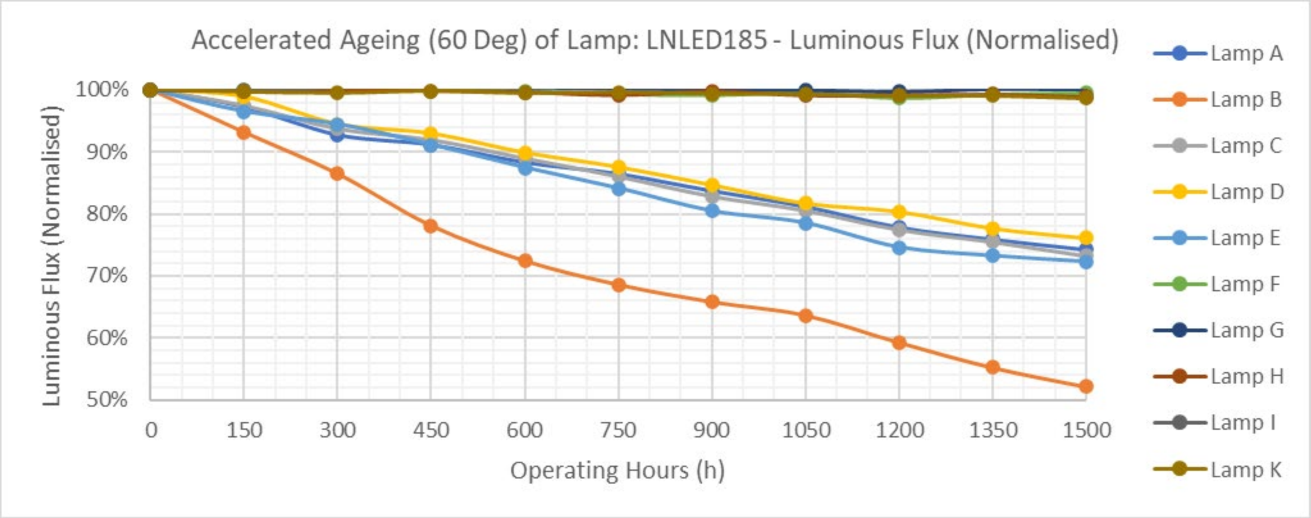
Pulse Test Timing

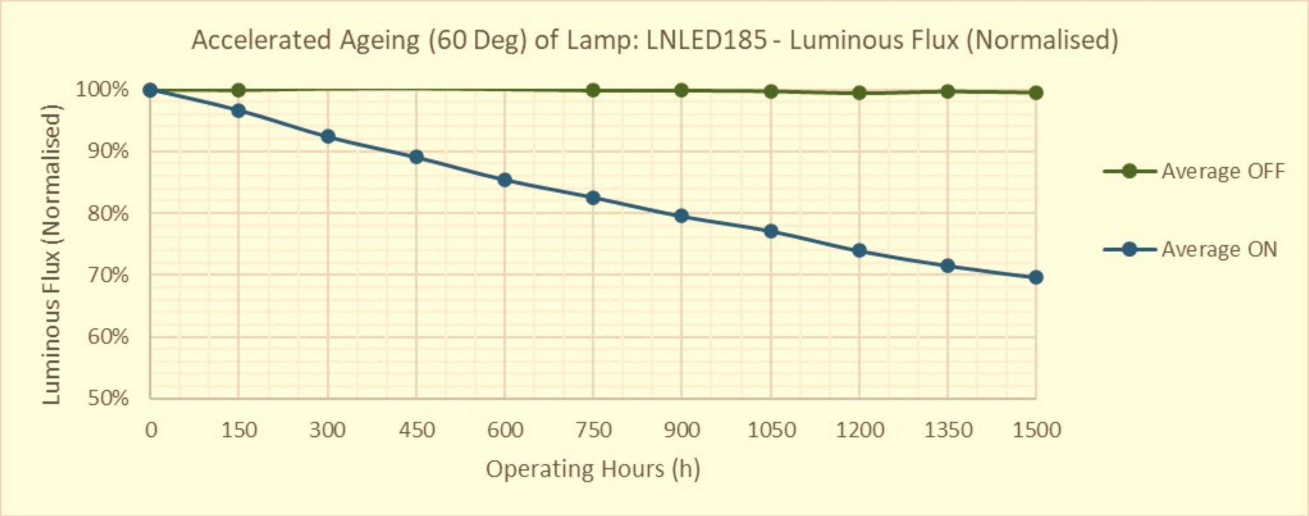
Example of Pulse & Soak Test Results



Accelerated Ageing Test – Luminous Flux Results

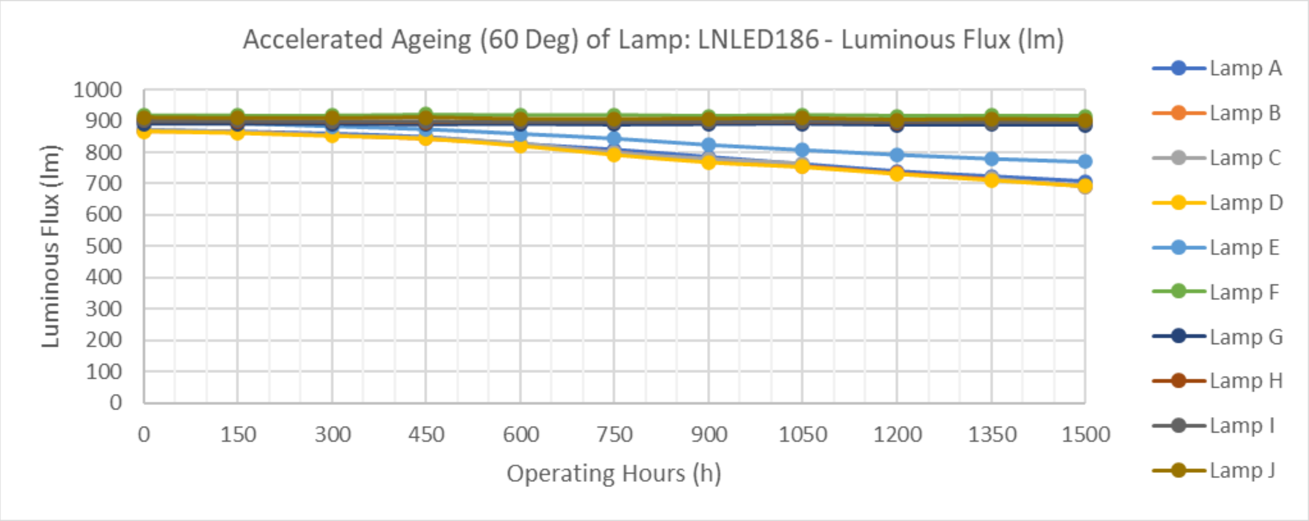
LNLED 185

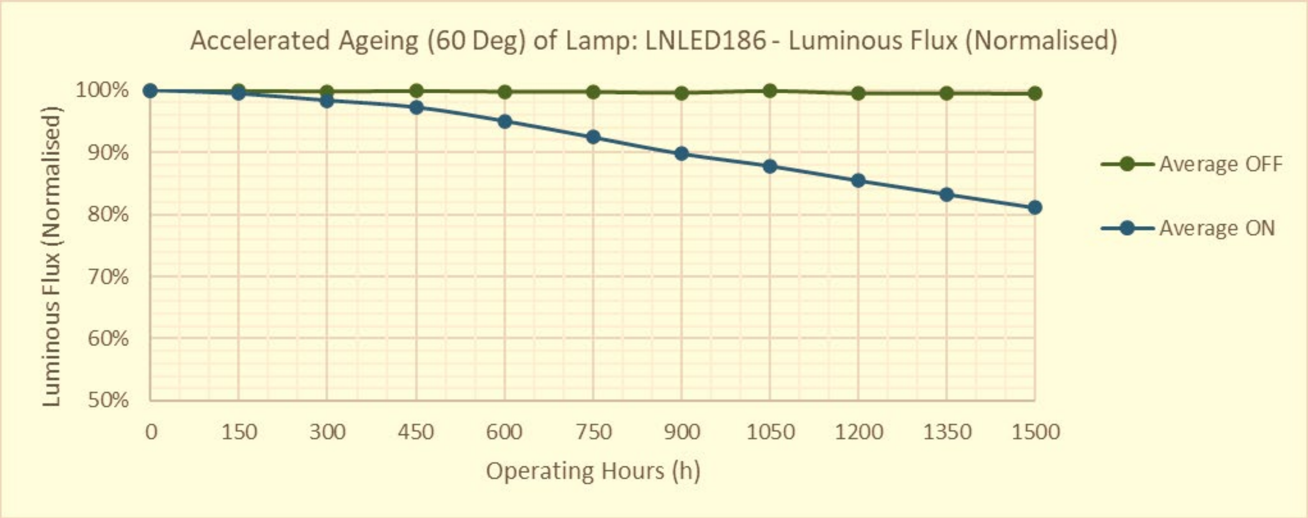




Accelerated Ageing Test – Luminous Flux Results

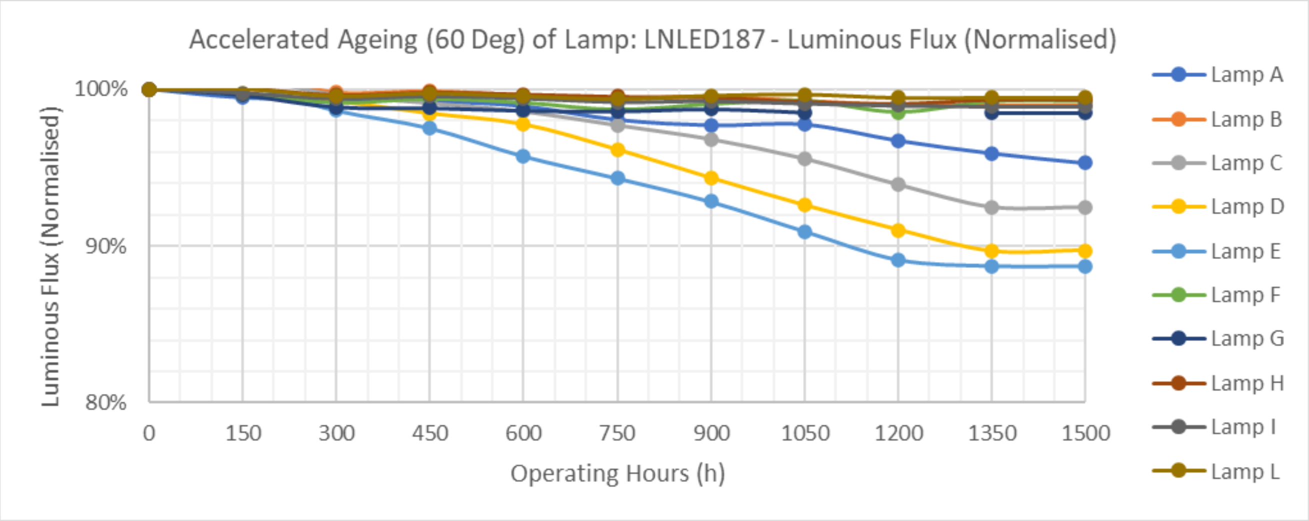
LNLED 186

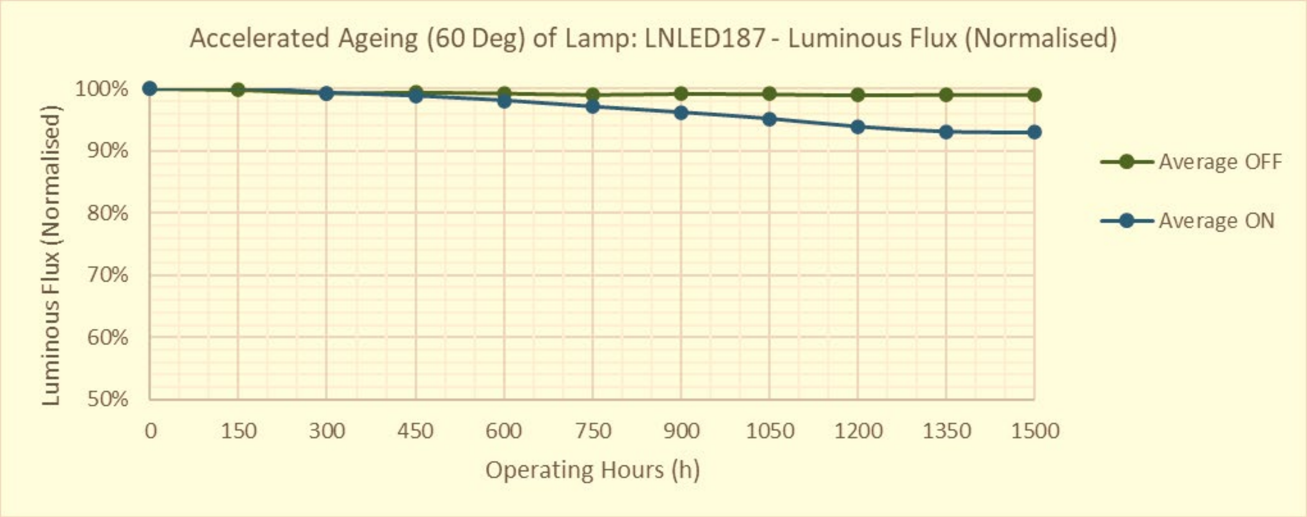




Accelerated Ageing Test – Luminous Flux Results

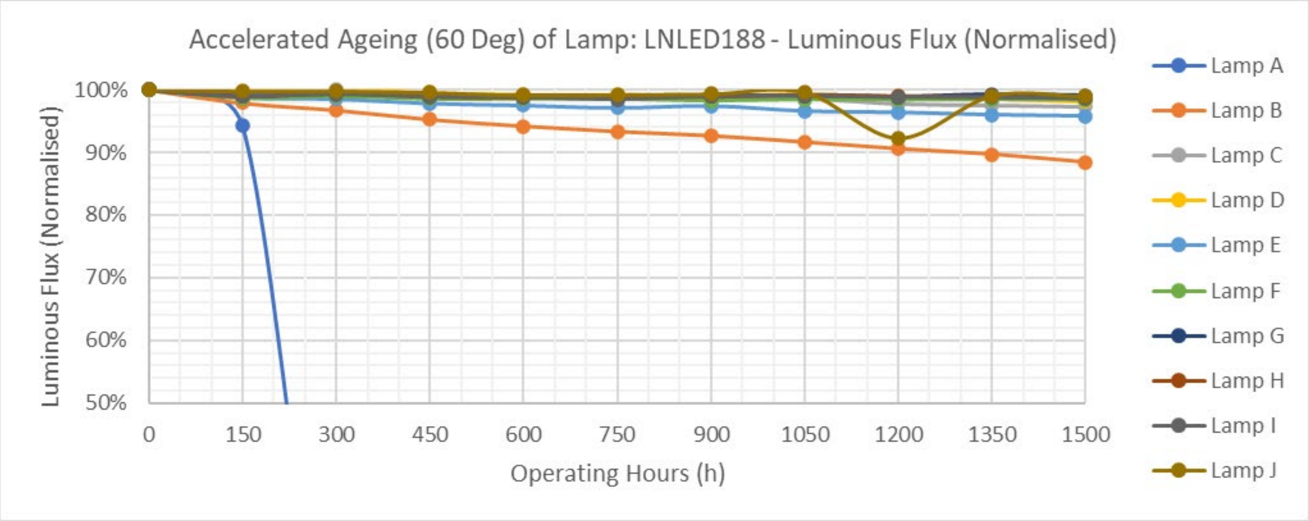
LNLED 187

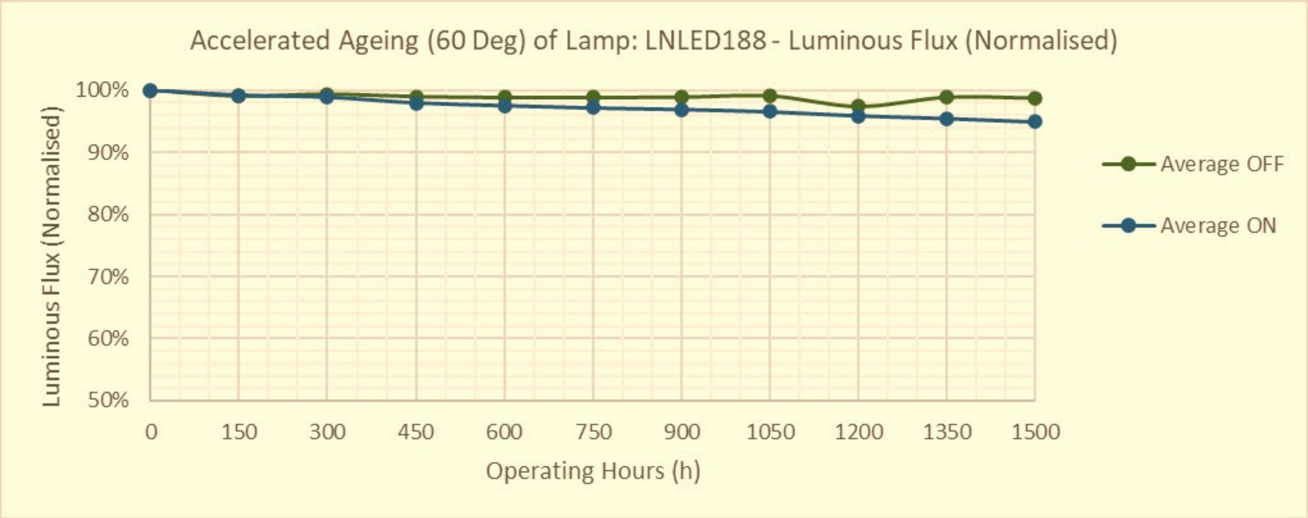




Accelerated Ageing Test – Luminous Flux Results

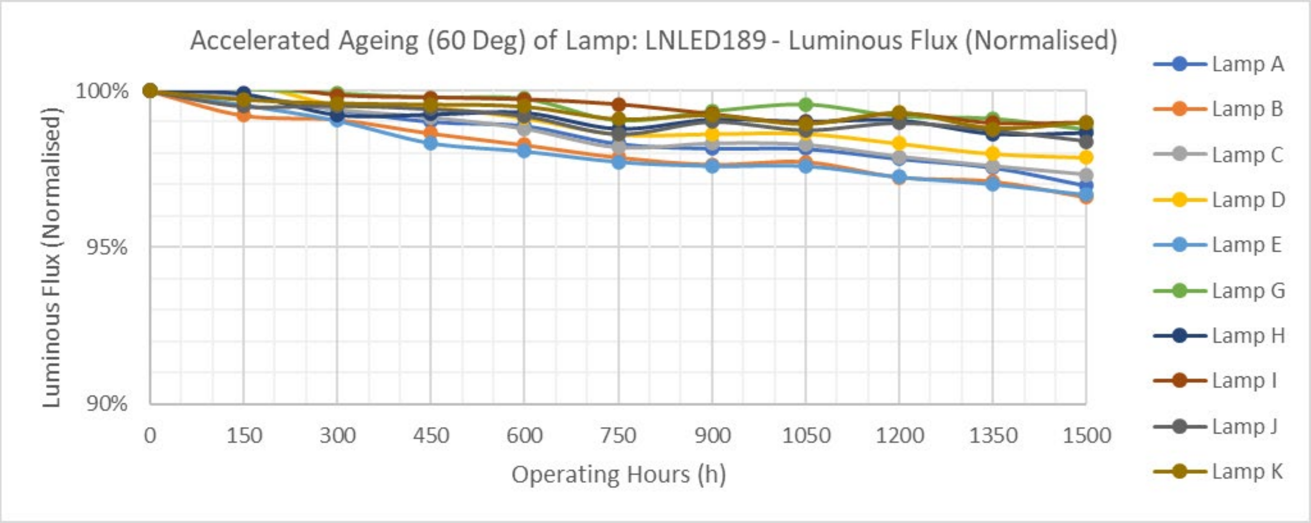
LNLED 188

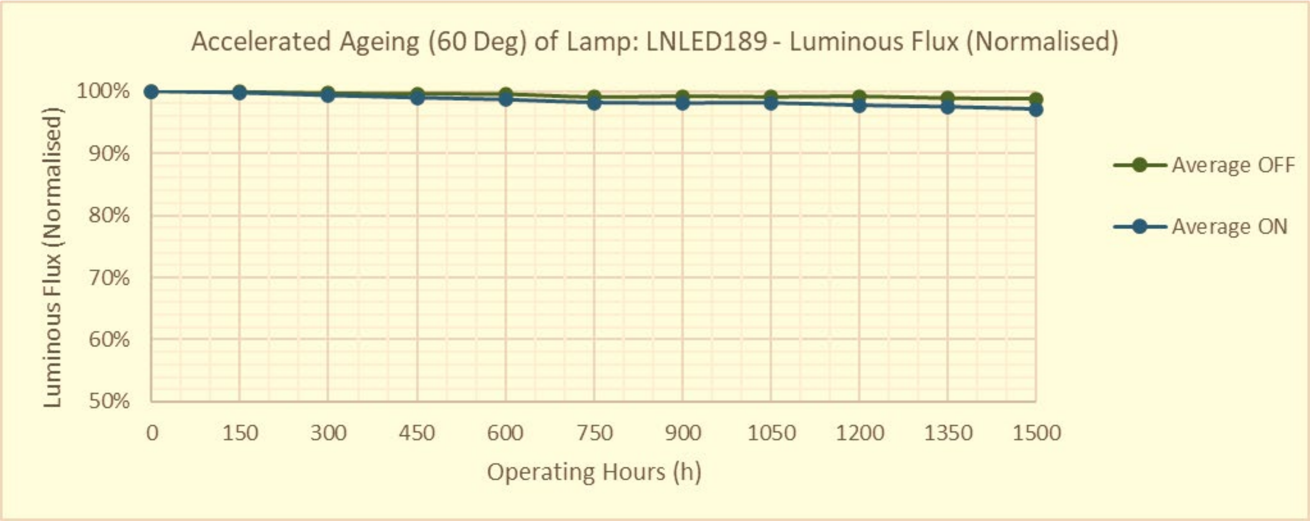




Accelerated Ageing Test – Luminous Flux Results

LNLED 189





From Earlier Presentation (May 2021)

Predictive equation

$$L_{70,\,25^{\circ}} = -\left[\frac{ln\left(\frac{0.7}{A_{25^{\circ}}}\right)}{\beta_{25^{\circ}}}\right]$$

ADT test

$$A_{25^{\circ}} = A_{60^{\circ}}$$

With values derived from:

Pulse test

Pulse & Soak tests

$$\beta_{25^{\circ}} = \beta_{60^{\circ}} - \frac{ln\left(K_{T_{(60^{\circ}:25^{\circ})}} \,.\, K_{iT_{(60^{\circ}:25^{\circ})}}\right)}{L_{70,\,60^{\circ}}}$$

ADT test

Results: Prediction based on Accelerated Life Test & Pulse Soak Test

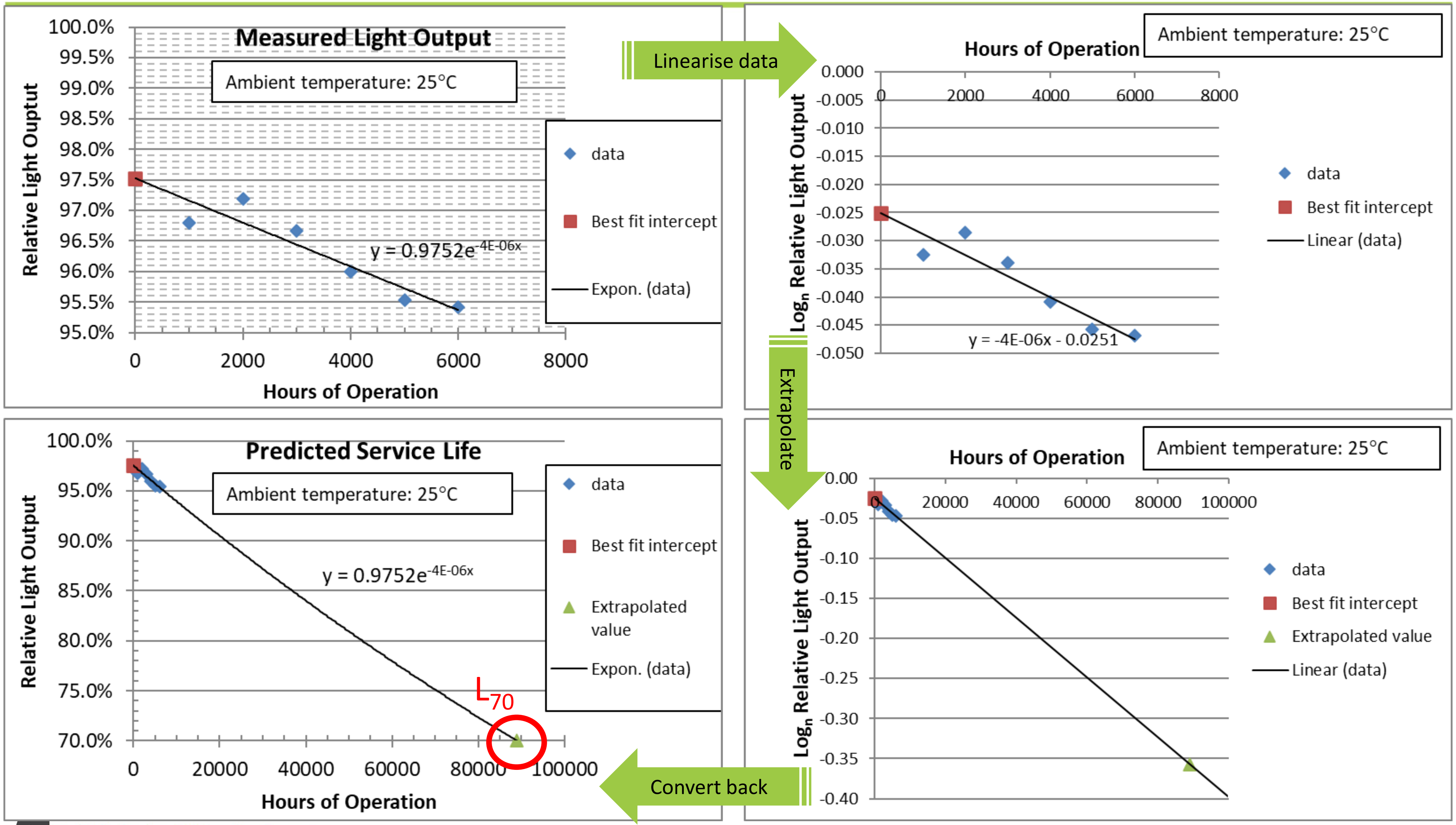
	$A_{60°}$	$\beta_{60°}$	K_T	K_{iT}	$L_{70,60°}$	Predicted $L_{70,25°}$	Rated $L_{70,25°}$
LNLED 185	0.995748	-0.00025	0.917486	1.030325	1,438	1,711	12,000
LNLED 186	1.023181	-0.00015	0.893814	0.93969	2,566	4,748	15,000
LNLED 187	1.00904	-5.5E-05	0.879594	0.979994	6,608	11,127	15,000
LNLED 188	0.997225	-3.3E-05	0.92831	0.888968	10,740	23,490	15,000
LNLED 189	0.998672	-1.9E-05	0.920403	0.888731	18,792	43,238	15,000

Need to correlate with results from recognised test and prediction methods (ANSI/IES LM84 and ANSI/IES TM28).

Osram

- **Propose to use Lamps #11 - #15 which have been stored at 60 deg C and tested at 150 hour which showed no change in measured values.**

Recognised Method for L_{70} Measurement / Prediction



Analysis Ongoing.....