Australian Government
Department of Industry, Science, Energy and Resources

IEA 4E SSL Annex – Australia Update

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21 October 2021

Background

- 20 April 2018, Energy Ministers agreed to further improve lighting energy efficiency regulation by phasing out inefficient halogen light bulbs in Australia and introducing minimum standards for LED light bulbs in Australia and New Zealand in line with European Union (EU) standards.
- The Decision Regulation Impact Statement is available here http://energyrating.gov.au/document/decision-ris-lighting
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    - *Note – integrated LED luminaires not included in this decision*

Standards Development

- March 2021 – two standards published:
  - Revision of AS4934.2 – MEPS for incandescent lamps – expansion to phase out some halogen lamps
  - New AS/NZS 5341 LED lamps—Test methods—Energy and functional performance
- AS/NZS 5341 brings together and references the range of international (e.g. IEC and CIE) and regional standards for use in testing LED performance parameters. In particular:
  - Provides details on measuring non-active mode power consumption of LED lamps, including those with additional non-illumination functions (multi-function lamps) based on IEC 63103.
  - Compiles methods for measurement of luminous flux maintenance and determination of L70B50 (also a requirement of EU reg)
  - Cross reference table of regional lighting standards
  - Could also be used for specifying testing for incentive programs or procurement activities.
  - https://store.standards.org.au/product/as-nzs-5341-2021

Stakeholder Consultation

- LED Technical Working Group formed in May 2021 to consult with stakeholders on drafting of LED lamp specific MEPS based on EU regulations (which are much broader).
- Has met five times - issues include:
  - Aspects of the EU regulation that are not relevant (such as some exclusions) as the EU scope is broader (i.e. all light sources) than that proposed for the Australian/New Zealand regulation;
  - Issues not included in the lighting EU Ecodesign regulation because they are already addressed in other regulation in Europe – harmonics, Photo-biological safety
  - Opportunities to allow for more flexible approaches to demonstrate compliance in the Australian/New Zealand regulation.

Stakeholder Consultation

- Variations discussed (not final) include:
  - Measurement of useful luminous flux –option to measure forward face of the lamp (corresponding to a cone with angle of 180°)
  - Definitions aligned with IEC/CIE definitions where possible
  - Energy efficiency based on minimum required efficacy rather than maximum power (same compliance outcome)
  - Colour consistency – in addition to six-step MacAdam's ellipse, allow six-step u`v` circle or less. Currently trying to set out guidance to suppliers as to how 'new' MacAdam ellipses may be formulated
  - Photobiological safety – alternate approach based on maximum luminance.
  - Discussing whether the exclusion for colour-tuneable lamps should be narrowed to not exclude LED lamps that contain phosphor materials for light conversion (RGBW)
  - Preferred rated luminous flux values as set out in IEC62612 amendment 1:2015 (section 9.1)

Specialist Stakeholder consultation

- Also reaching out to a range of specialist suppliers and users of LED lighting (aviation, marine, defence, medical, appliances, nuclear science, pets, coral)
- Trying to work out which Ecodesign exclusions are relevant to our narrower scope (LED lamps only)

"…. it seems that the Australian Gov takes the reptile husbandry serious…." (EU pet lamp supplier)

Recent and Upcoming LED Testing

- LED Luminaire Testing – now complete apart from endurance
  - Testing of 29 integrated LED luminaires to monitor quality of market as replacement to halogen and linear fluorescent.
- LED lifetime research testing
  - Intended to support SSL Annex work plan. Results expected by end November.
  - Measurement of the rate of decline in light output while lamps are operated at an elevated ambient temperature for 1,500 hours.
  - Measurement of same models at more normal ambient temperatures and monitored for other modes of failure e.g. colour shift, flicker and mechanical failure.
  - Analysis of this data is expected to support the development of an accelerated test at higher ambient temperatures that can be used to predict the operational lifetime of products at typical ambient operating temperatures.
  - Sample types: GU10 MR16 single COB, E27 A60 LED filament, E27 A60 LED multichip

Other LED Activities

- Working with Australian Radiation and Nuclear Safety Agency (ARPANSA) to prepare consumer advice on Lighting and health
- Ripple Current Testing
  - Ripple current signals have been found to cause LED lamps, particularly with dimmers, to flicker, or vary light levels.
  - A draft test method has been developed – and recently trailed with several ‘good’ and ‘bad’ LED lamp models and dimmers to evaluate test method.
  - Conducting more field measurements to better understand variation in signal frequency and strength.
- User Guide on calculation of Street Light energy metrics.
  - Application of AS/NZS 1158.3.1 Lighting for roads and public spaces - includes metrics similar to EN 13201-5:2015 Energy Performance Indicators

Preparation for LED MEPS

- Defining MacAdam Ellipses anywhere
- Collective presentation format for product efficacies (adjusted efficacy)
- Benchmark testing

MacAdam Ellipse Determination

- Only 7 ellipses defined in international standard (IES 60081 based on Mercury emission lines & fluorescent phosphors)
- EU Reg 2019/2020 allows chromaticity centre (for product) to be anywhere in white colour space
- Therefore need to be able to create 6-step MacAdam ellipse anywhere. Use Optimised Friele Primary Colours
  - Based on formulae in Chickering, JOSA V57 n4, "Optimization of the MacAdam-Modified 1965 Friele Color-Difference Formula" and Chickering, JOSA V61 n1, "FMC Color-Difference Formulas: Clarification Concerning Usage".
  - OSRAM ColorCalculator uses g values from FMC-1 procedures

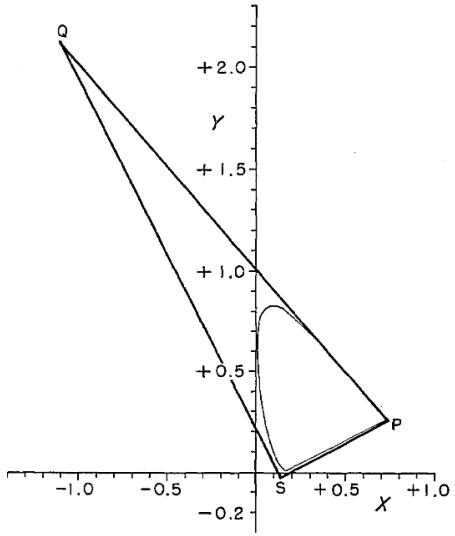
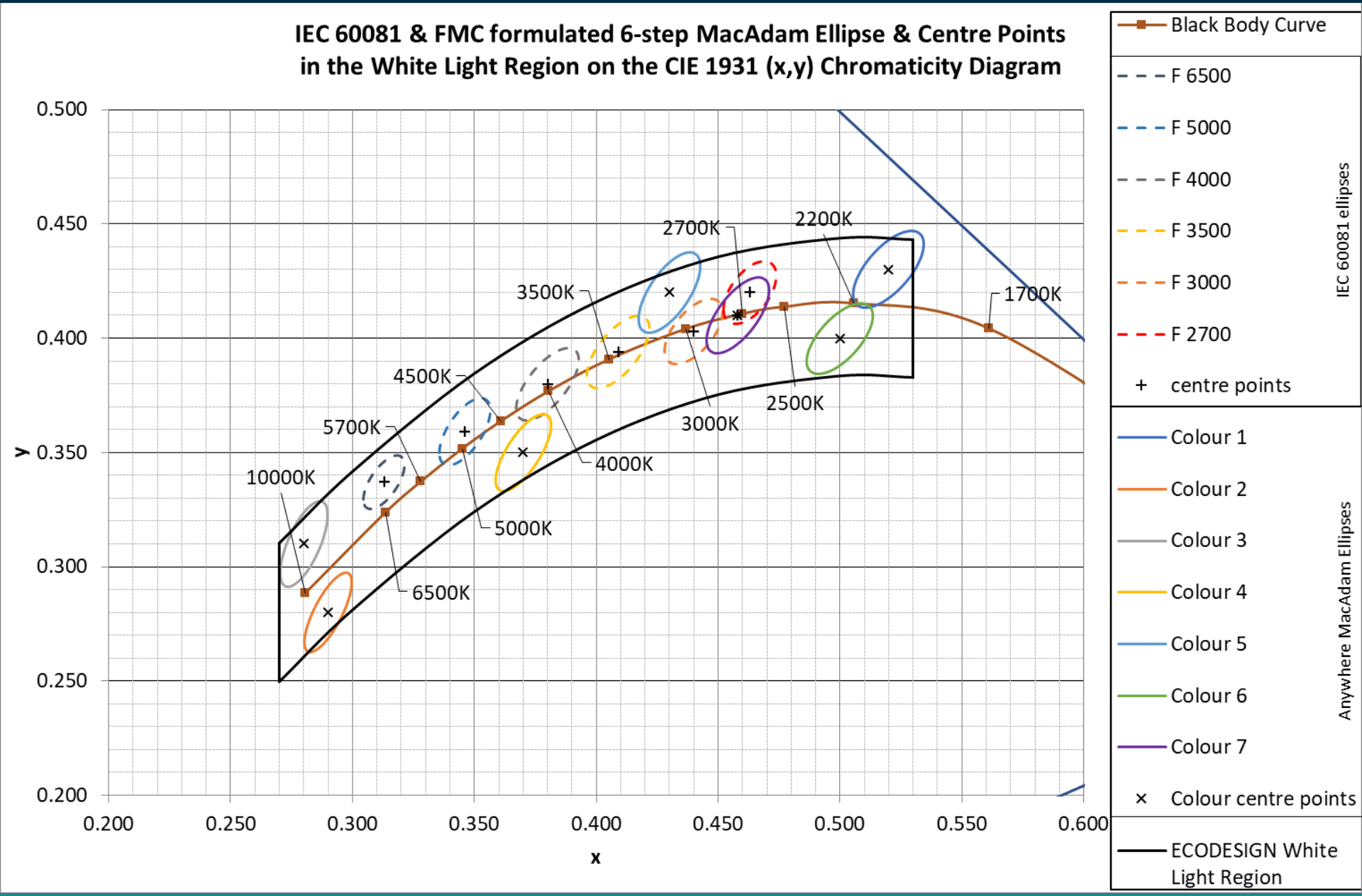


FIG. 11. Location of optimized Friele primaries in relation to C.I.E. 1931 chromaticity diagram.


IEC 60081 & FMC formulated 6-step MacAdam Ellipse & Centre Points
in the White Light Region on the CIE 1931 (x,y) Chromaticity Diagram
0.500
0.450
0.400
0.350
0.300
0.250
0.200
y
0.200
0.250
0.300
0.350
0.400
0.450
0.500
0.550
0.600
x
10000K
5700K
4500K
3500K
2700K
2200K
1700K
3000K
2500K
4000K
5000K
6500K
Black Body Curve
F 6500
F 5000
F 4000
F 3500
F 3000
F 2700
centre points
IEC 60081 ellipses
Colour 1
Colour 2
Colour 3
Colour 4
Colour 5
Colour 6
Colour 7
Colour centre points
Anywhere MacAdam Ellipses
ECODESIGN White Light Region

Test Results (Adjusted Efficacy approach)

Efficacy:

$$\eta_{lamp.min} = \left(\frac{F \times \eta}{C \times R}\right) \times \left[1 - \frac{(L \times F \times \eta)}{(L \times F \times \eta) + \Phi}\right]$$

Adjusted Efficacy:

Efficacy

$$(C \times R) \times \eta_{lamp.min} = (F \times \eta) \times \left[1 - \frac{(L \times F \times \eta)}{(L \times F \times \eta) + \Phi}\right]$$

Factors
- MV / ELV
- Non Dir / Dir
- Colour tuneable
- High luminance

Factor
- CRI

Factor
- Non dir / Dir

Constant
- 120 lm/W

Factor
- Non-connected
- Connected

Useful lumens

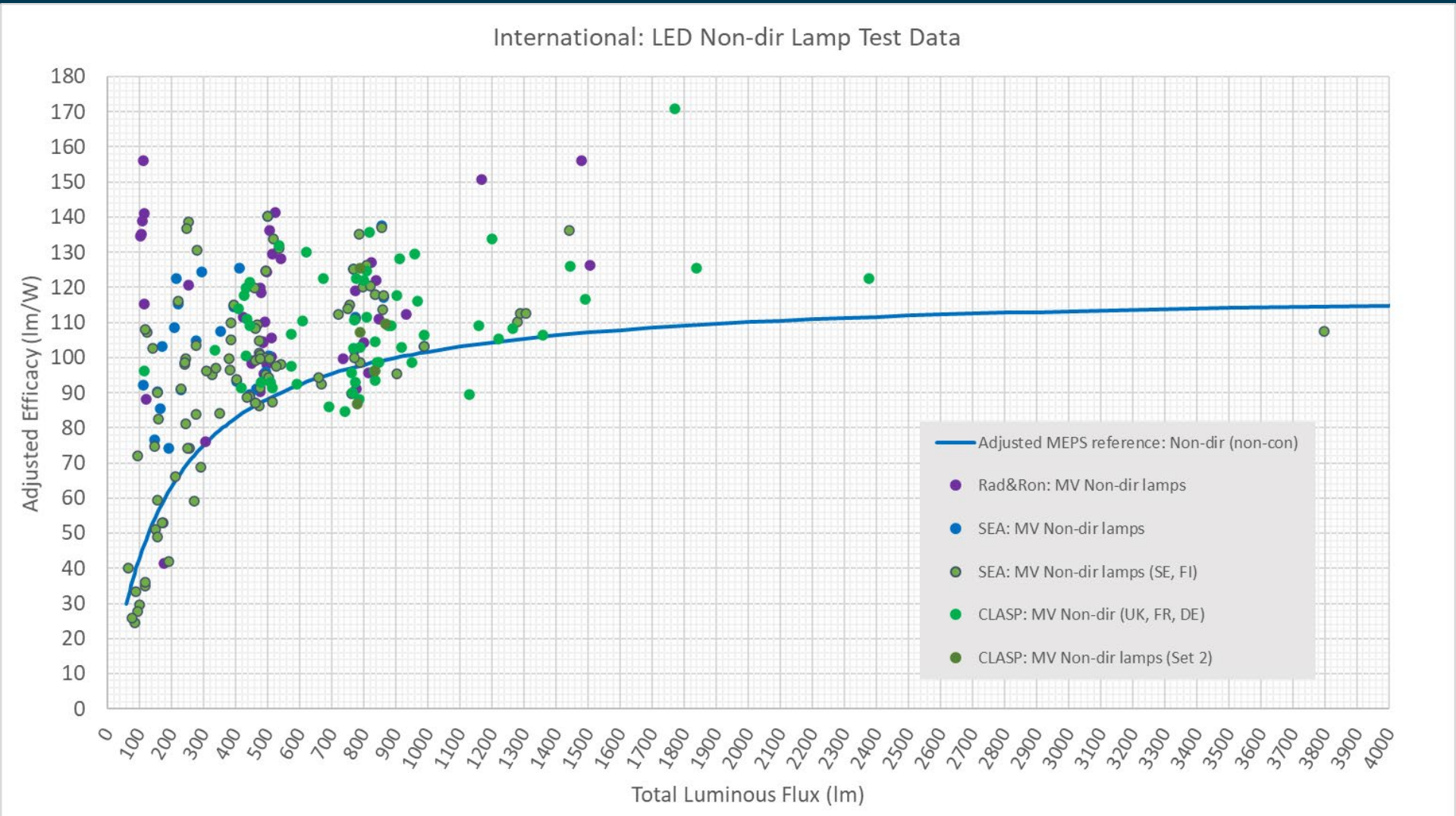
Only need 4 graphs for the main categories of light sources:

1. Non-directional, non-connected
2. Directional, non-connected
3. Non-directional, connected
4. Directional, connected

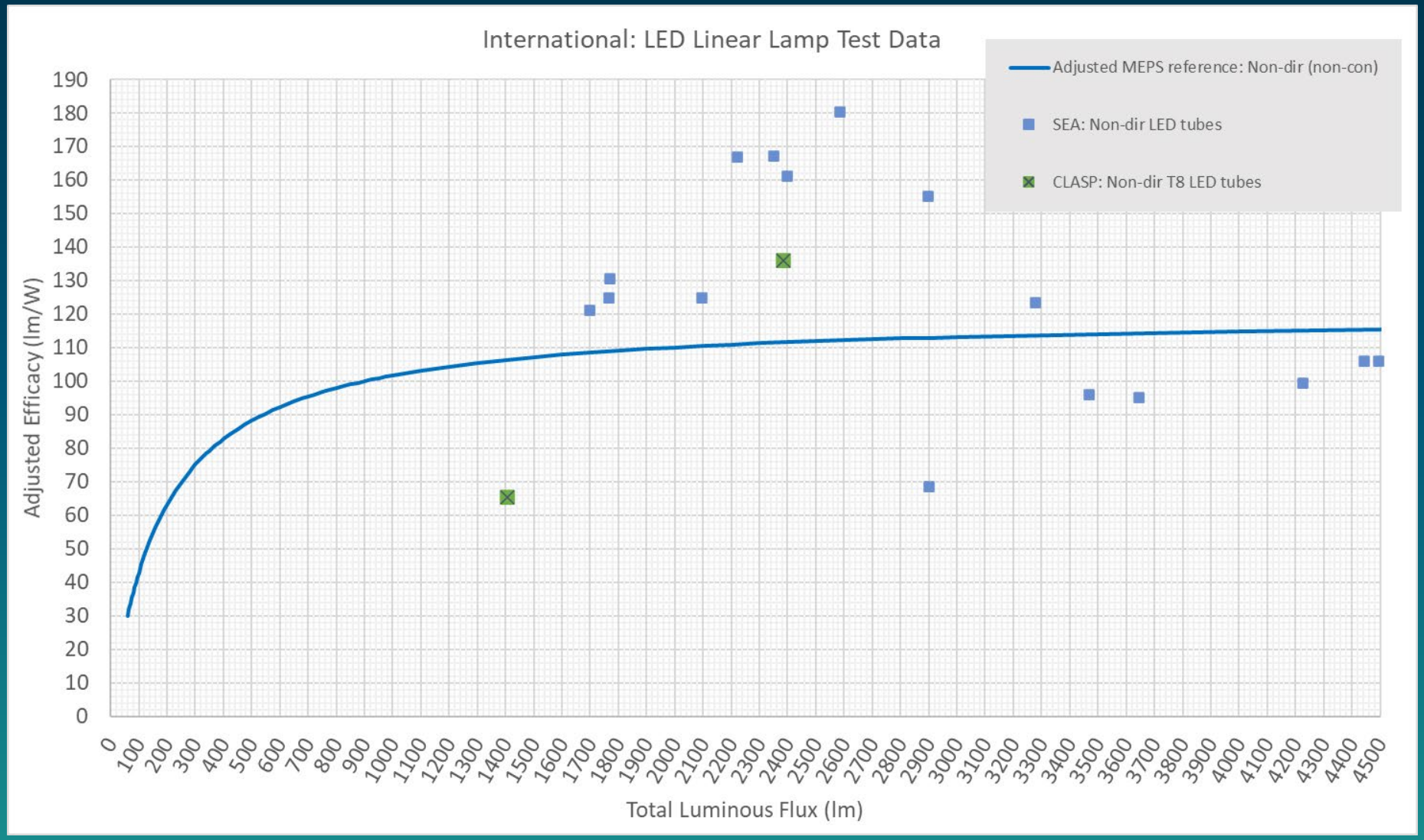
$$P_{onmax} = C \times (L + \Phi_{use}/(F \times \eta)) \times R;$$

$$\frac{P_{onmax}}{(C \times R)} = L + \frac{\Phi}{(F \times \eta)}$$

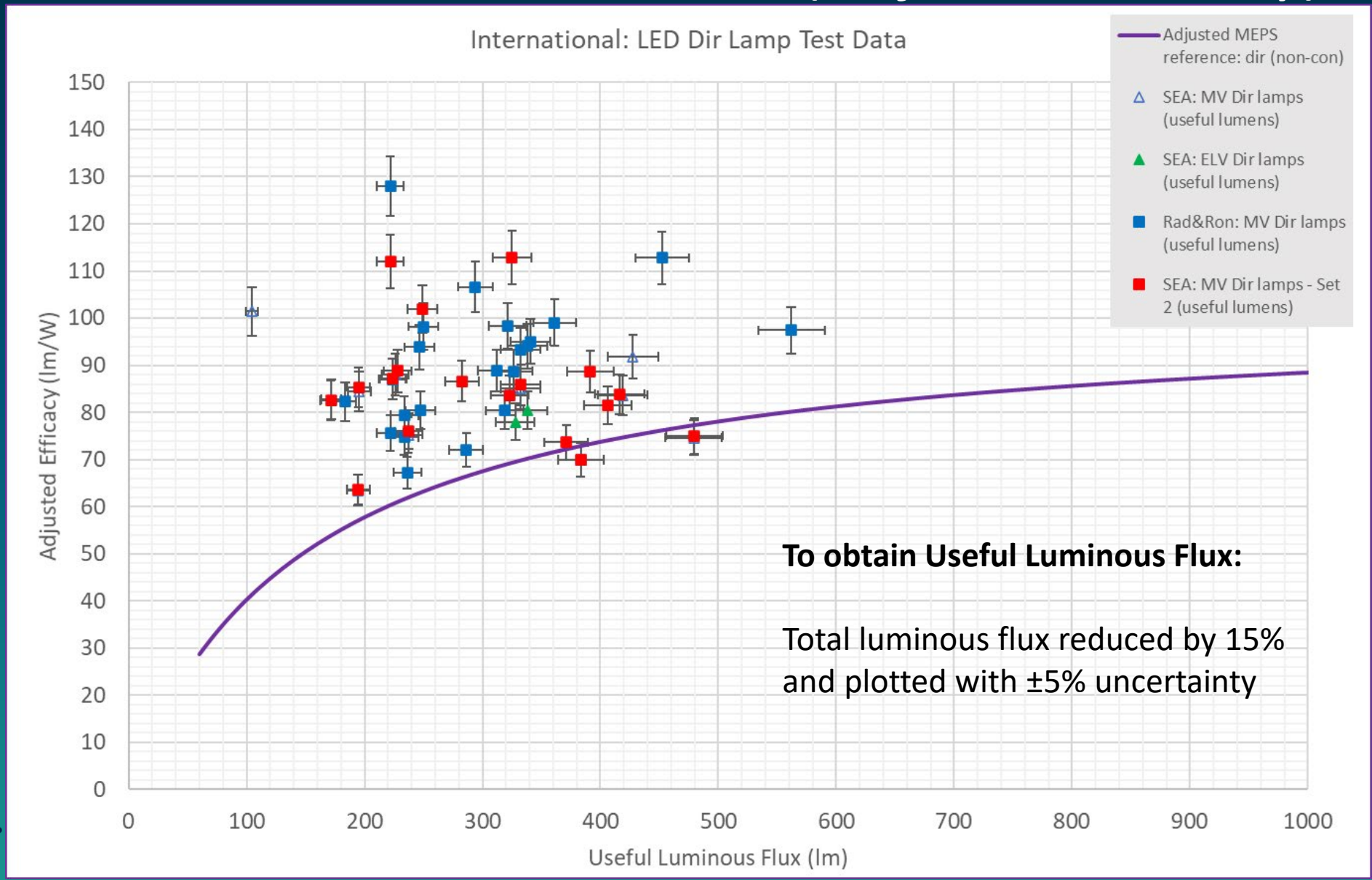
Int'l Lamp Test Results (Adjusted Efficacy)



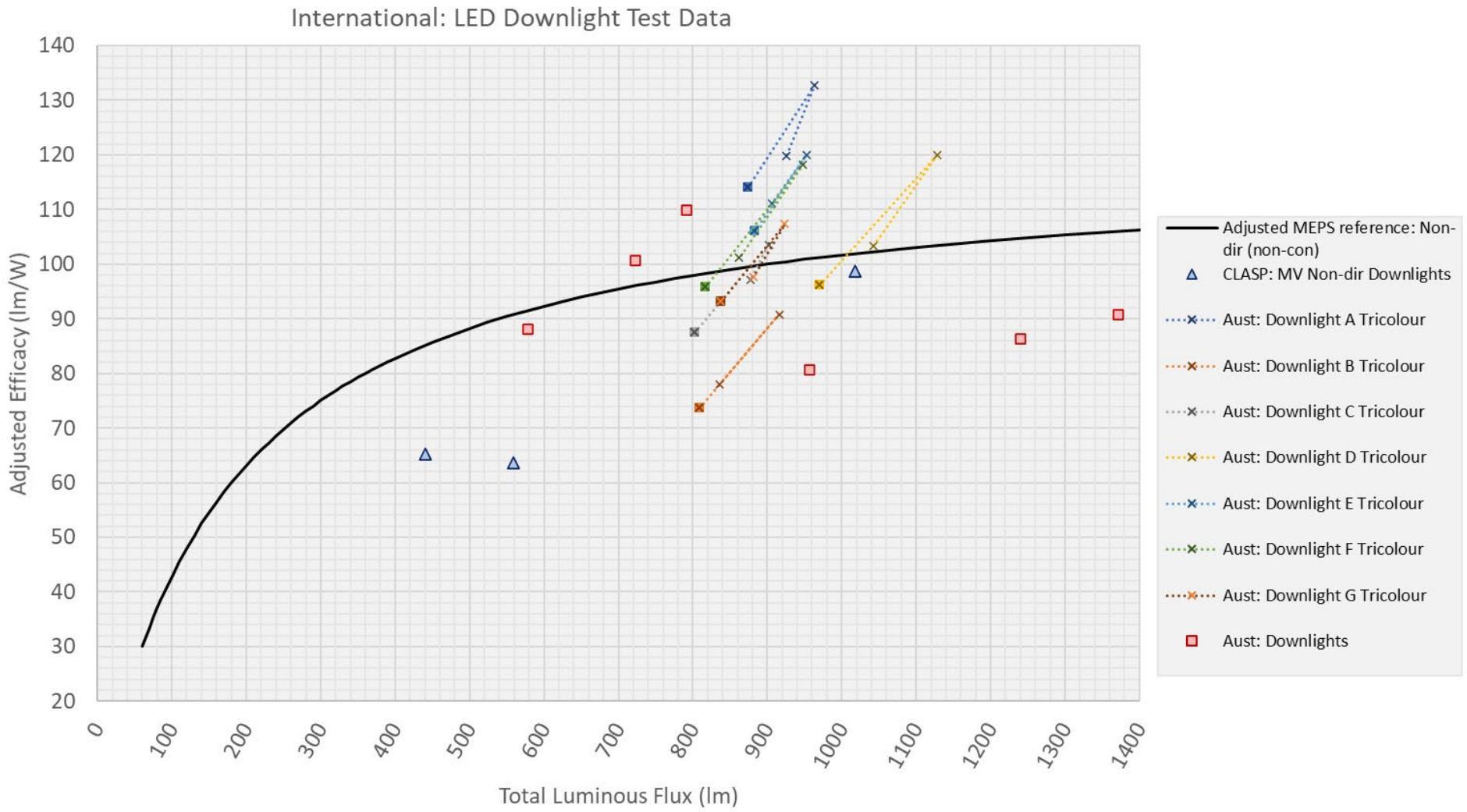
Int'l Lamp Test Results (Adjusted Efficacy)



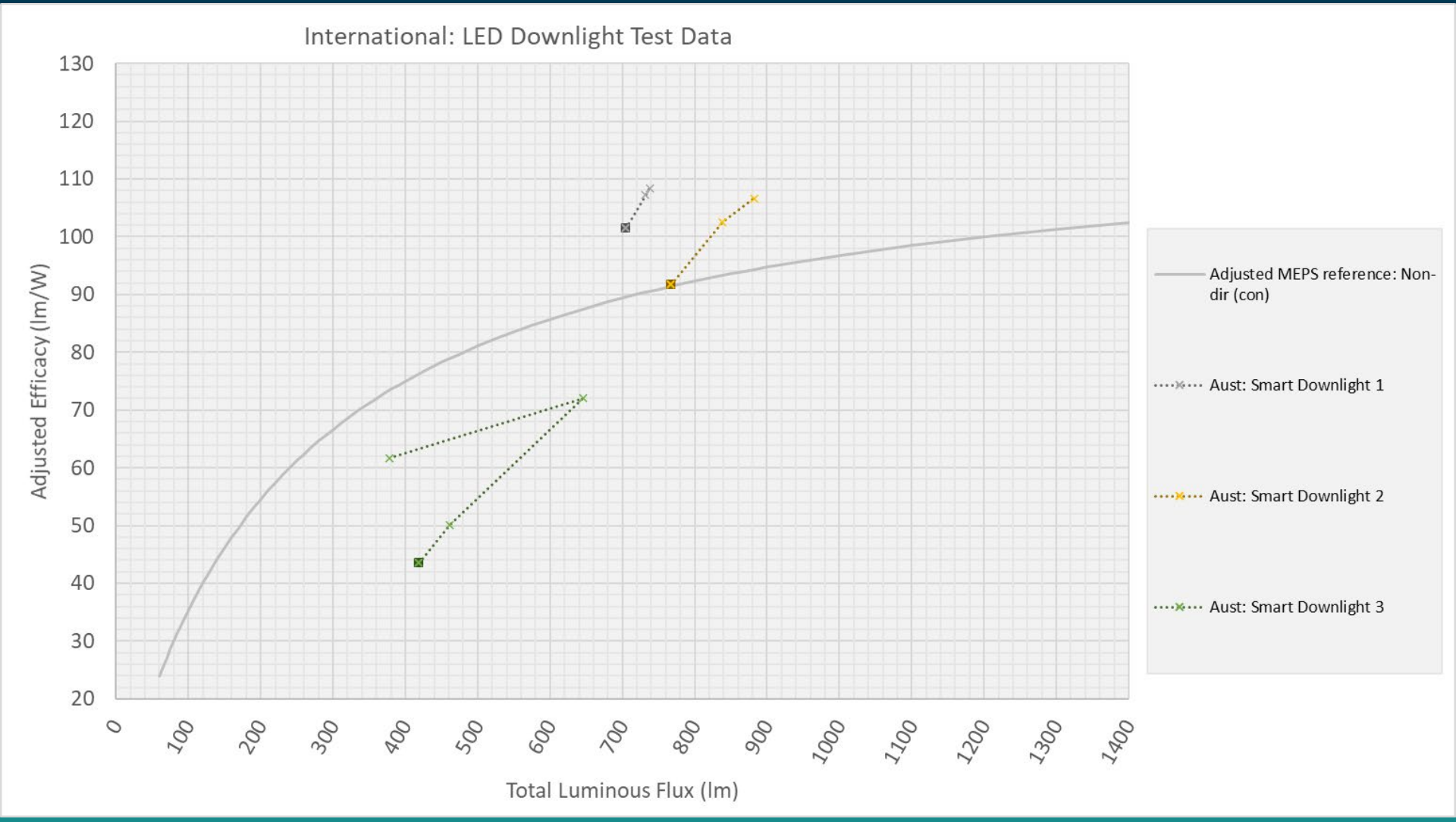
Int'l Luminaire Test Results (Adjusted Efficacy)



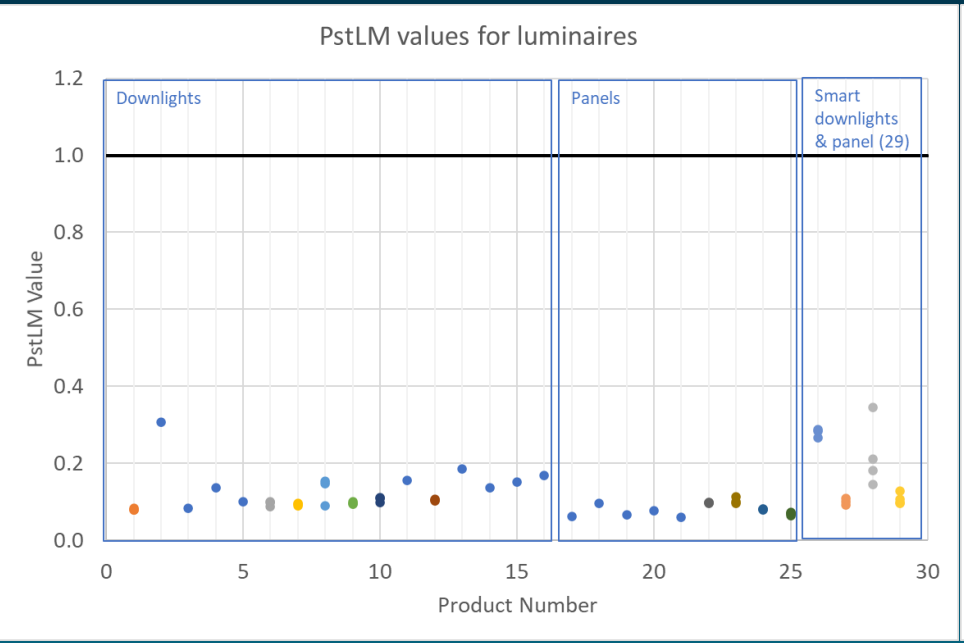
Int'l Luminaire Test Results (Adjusted Efficacy)

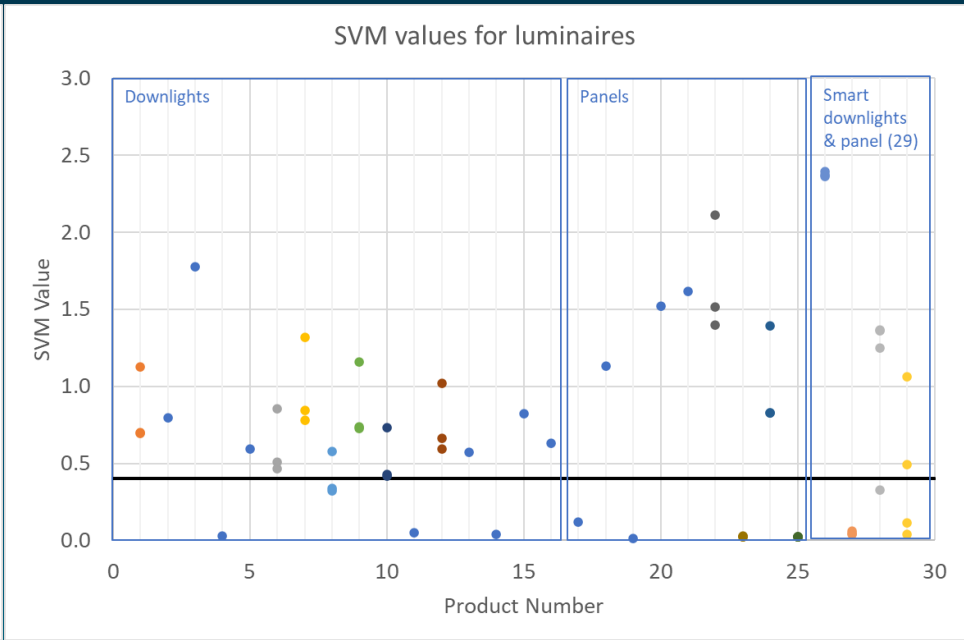


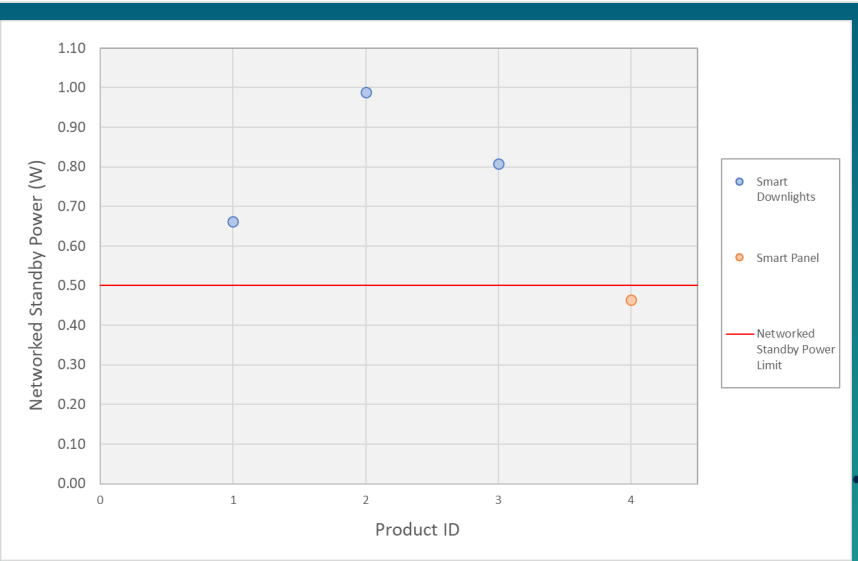
Aust Luminaire Test Results (Adjusted Efficacy)

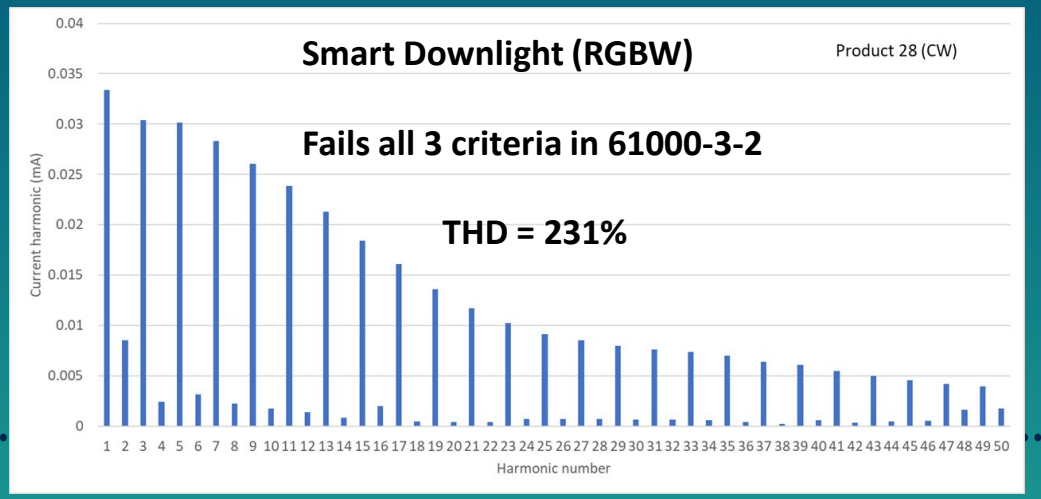


Aust Luminaire Test Results (other metrics)









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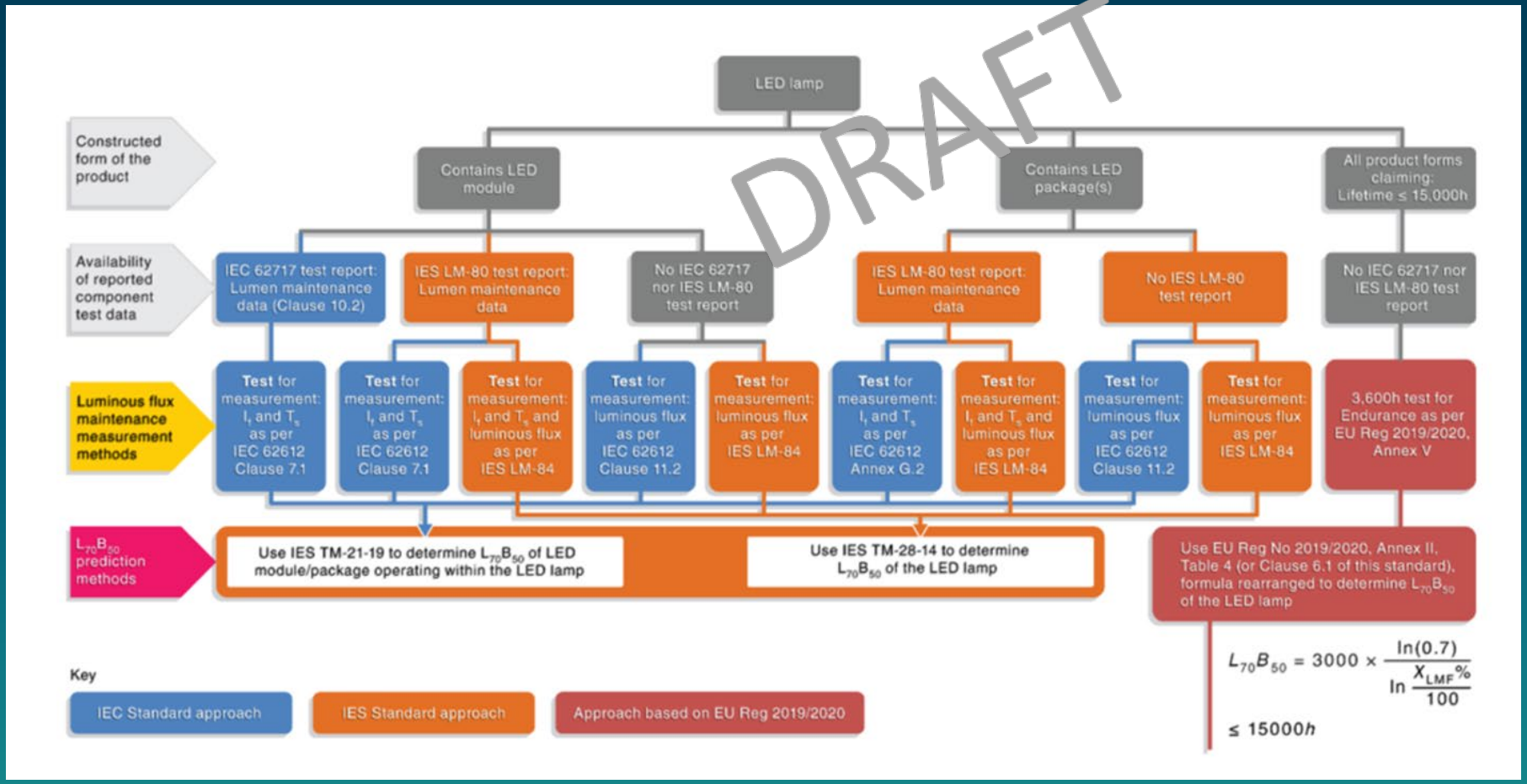
Methods for measurement of luminous flux maintenance and determination of L70B50



Example of cross reference of regional test standards

Table A.2 Cross-reference of alternative regional test standard clauses

AS/NZS 5341:2020	CIE S 025/E:2015	EN 13032-4:2015+A1:2019	ANSI/IES LM-79-19
2.1 General	4.1 Laboratory Requirements for Tests – General	4.1 Laboratory requirements – General	Annex D Tolerance Interval vs Acceptance Interval
2.2 Laboratory and environmental conditions	4.2 Laboratory Requirements for Tests – Laboratory and Environmental Conditions	4.2 Laboratory requirements – Laboratory and Environmental Conditions	4.0 Physical and Environmental Test Conditions
2.3 Electrical power supply	4.3.3 Laboratory Requirements for Tests – Electrical Test Conditions and Electrical Equipment – Electrical Power Supply	4.3.3 Laboratory requirements – Electrical Test Conditions and Electrical Equipment – Electrical Power Supply	5.1 Power Supply Requirements
2.4 Photometric and colorimetric measurement equipment	4.5.1 Laboratory Requirements for Tests Photometric and Colorimetric Measurement Instruments	4.5 Laboratory requirements – Photometric and Colorimetric Measurement Instruments	7.0 Total Luminous Flux and Integrated Optical Measurements 8.0 Luminous Intensity or Optical Angular Distribution Measurement
3.4 Mounting of device under test	5.3 Preparation, Mounting and Operating Conditions – Mounting	5.3 Preparation, mounting and operating conditions – Mounting	6.0 Test Preparation