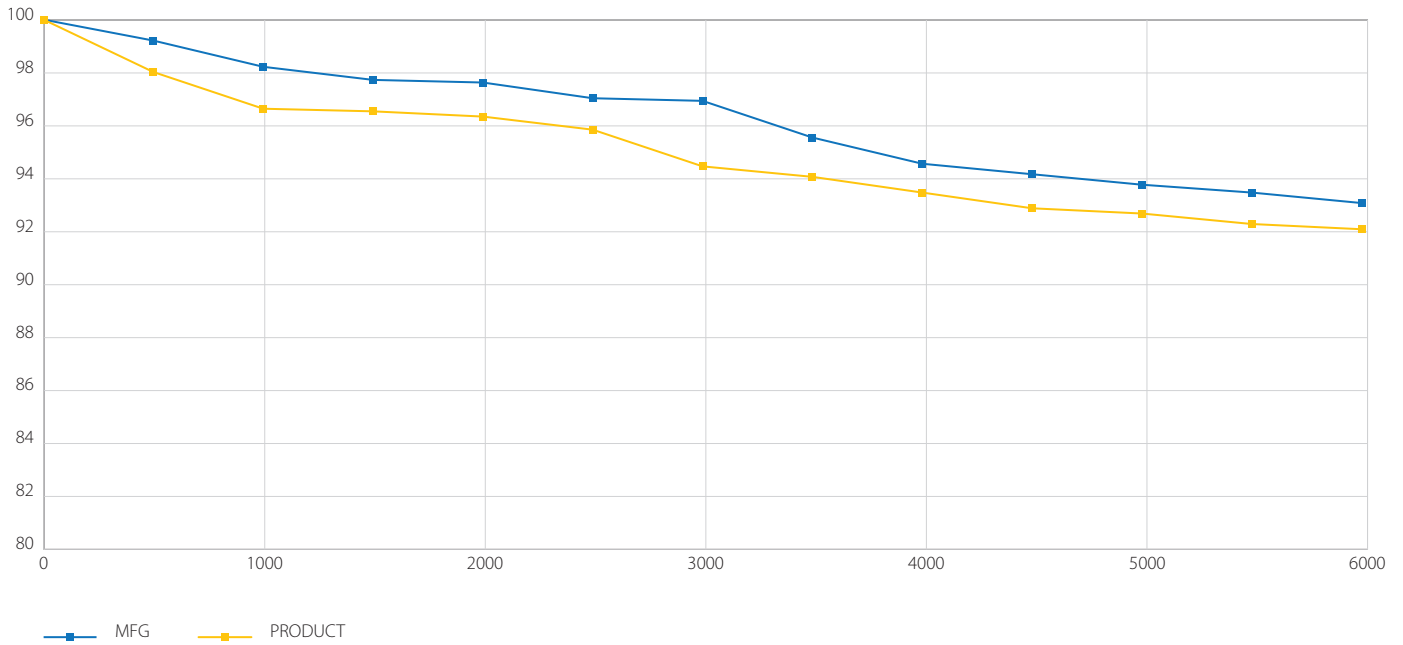
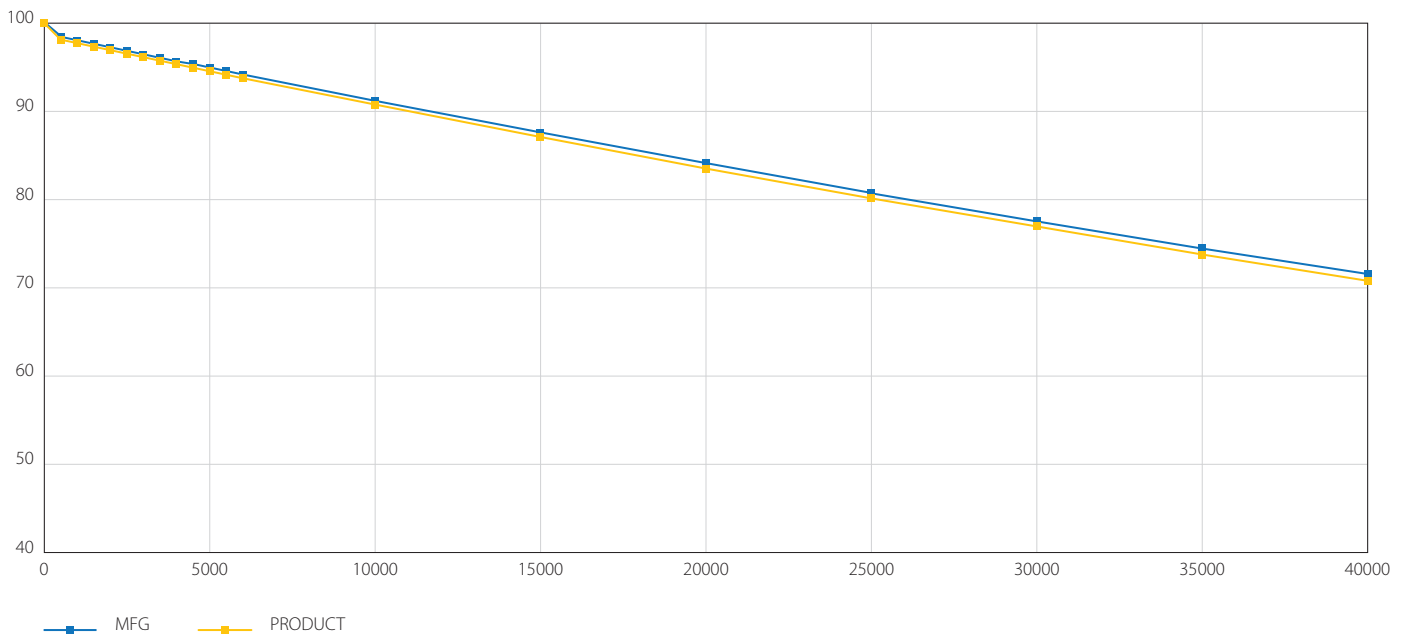


### LUMEN

Lumen MFG vs Product 0-6000 Hours

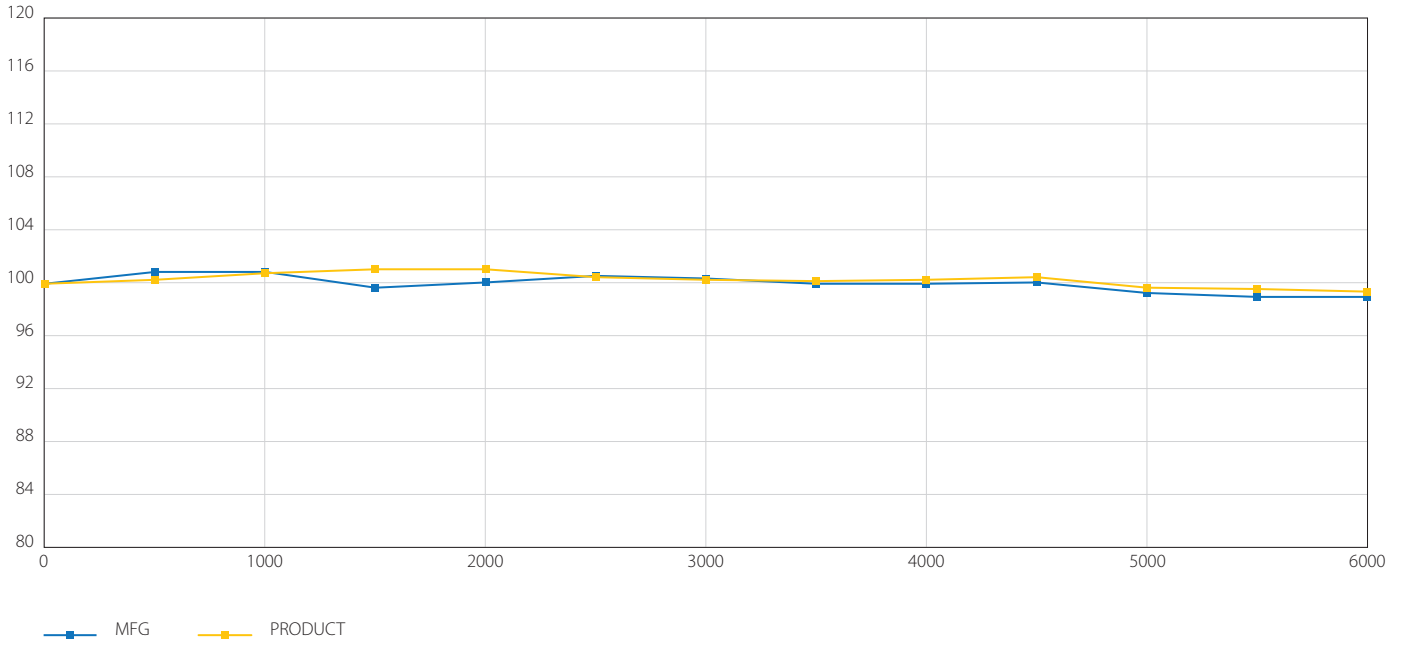


Lumen extrapolated values to 40000 Hours

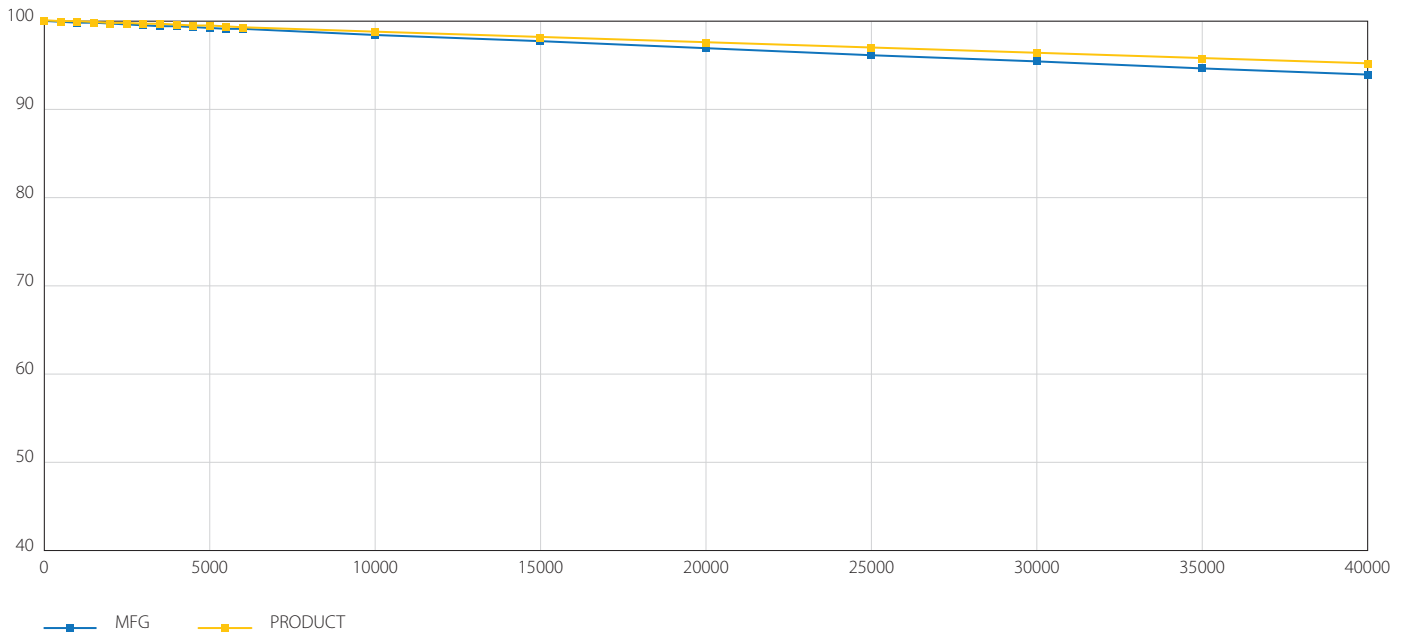


### COLOR TEMPERATURE

CCT MFG vs Product 0-6000 Hours

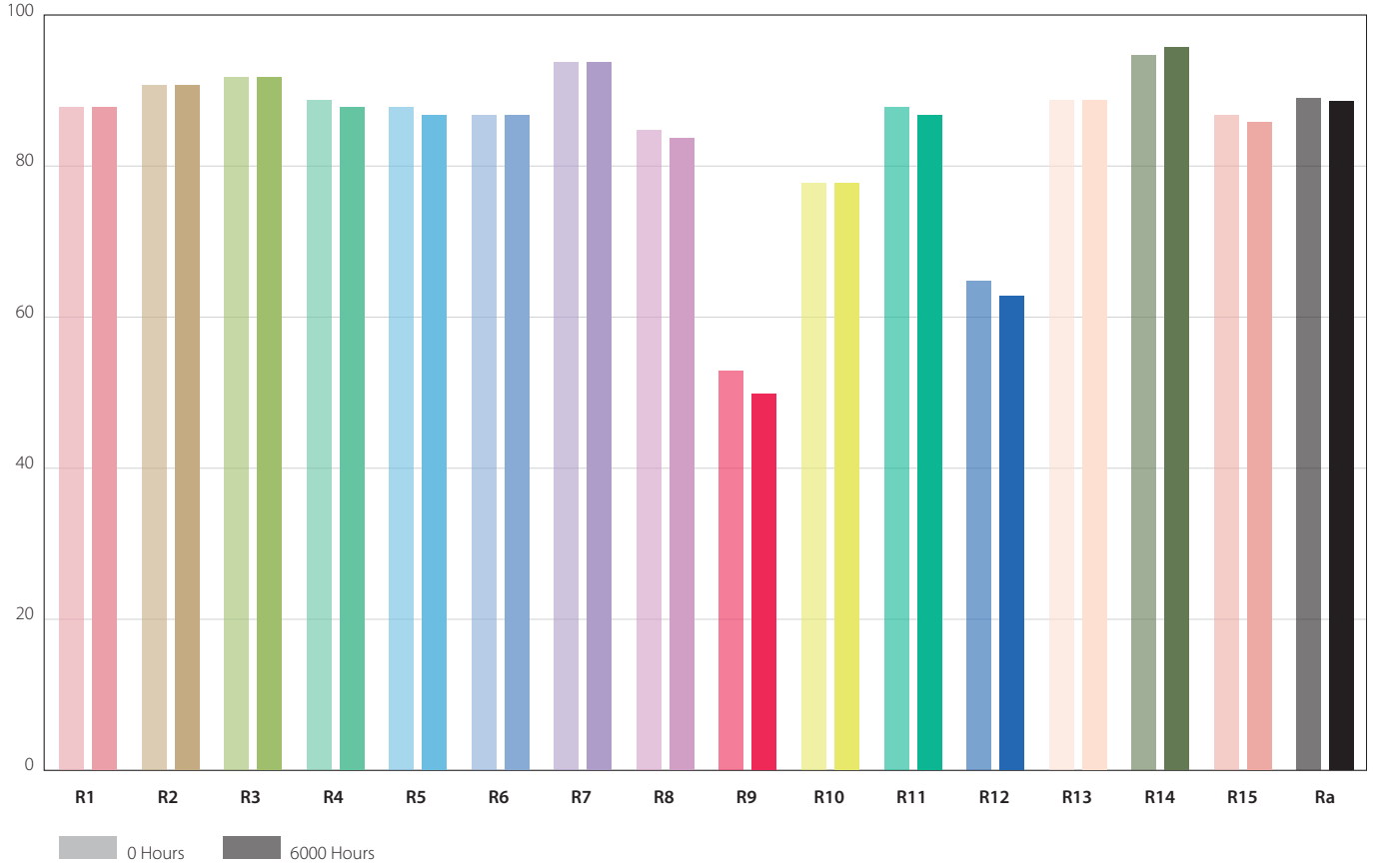


CCT extrapolated values to 40000 Hours



**CRI**

Rendering Index Evolution





One of the benefits that LED light sources can provide is very long usable life. Unlike other lighting technologies, LEDs typically do not fail catastrophically during use. However, over time the light output will gradually depreciate. At some point in time, the light emitted from an LED depreciates to a level where it is no longer considered adequate for a specific application. It is important in lighting design to understand when this “useful lifetime” of an LED source is reached.

IES LM-80-08 is the Approved Method for Measuring Lumen Maintenance of LED Light Sources. It defines the setup, conditions, and procedures for performing lumen maintenance testing of LED modules. LM-80-08 is the IES recommendation that is used widely to characterize the lumen depreciation behavior of LEDs.

AYRTON’s LED module manufacturers routinely provide Illuminating Engineering Society (IES) LM-80-08 reports for their products with data collected during testing for 6000 hours or more. Ayrton carries out its own lifetime tests alongside those of the LED module manufacturer and both sets of data are provided for purposes of comparison. The rated Lumen Maintenance life of an LED is the elapsed operating time over which an LED light source maintains a given percentage of its initial light output. It is defined as  $L_p$ , where  $p$  is the percentage value.

For example,  $L_{70}$  is the time (in hours) when the light output from the LED has dropped to 70% of its initial output. The time when the rated lumen

maintenance life of an LED light source is reached is dependent upon many variables, including the operating temperature, drive current, and the technology and materials used to construct the products.

The LM-80 standard calls for operating a set of LED modules for a minimum of 6,000 hours under well controlled operating conditions (e.g. a constant DC drive current in a thermal chamber where the LED temperature and surrounding air temperature are controlled within specified limits). The LED modules samples are regularly removed (every 1,000 hours) from the thermal chamber in order to test relevant electrical and optical parameters for each LED modules, including light output, and color point. Once the test reaches at least 6,000 hours, all test data is summarized in a comprehensive LM-80 test report. Therefore, all results published by Ayrton are performed under the light engine manufacturers and Ayrton’s test conditions and use of the product in conditions outside of these standard test conditions may result in the lumen maintenance of the LED engine being different to that obtained under these test conditions.

This Technical Memorandum recommends also a method of projecting the Lumen Maintenance of LED Light Sources from the data obtained by LM-80-08 testing. This document was developed by a dedicated TM-21 Working Group of LED industry professionals. The analyses of the LM-80-08 test data provided by major LED manufacturers are used to rationalize and support this document. Much of this LM-80-08 data were from testing that extended to 10000 hours and beyond.

Once a minimum of 6,000 hours of LM-80-08 testing has been completed, the test results can be used to project the rated lumen maintenance life of the module. Per IES TM-21-2011, an exponential least squares curve fit to each of the averaged data points between 1,000 and 6,000 hours is then performed. The curve can then be projected forward to give a long-term lumen maintenance behavior of the LED module.

**REFERENCES**

- Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules by Illuminating Engineering Society
- Projecting Long Term Lumen Maintenance of LED Lighting Source by Illuminating Engineering Society
- Addendum B for TM-21-11: Projecting Long Term Lumen Maintenance of LED Light Sources by Illuminating Engineering Society