MR16 LED Retrofit Lamps:
Quality, Consistency and Reliability

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Abstract

Light-emitting diode (LED) MR16 lamps have recently become part of the residential lighting market, bringing with them a new lighting paradigm. Consumers previously accustomed to halogen MR16 technology must now select suitable LED replacements based on their photometric information. In the wake of stories of exaggerated lumen outputs and inaccurate marketing literature, this research takes a snapshot of MR16 LED residential lighting in New Zealand to evaluate its status.

Forty-eight readily available products (six repetitions of eight types) were tested in Massey University's integrating sphere. Initial investigations focused on baseline photometric values to determine whether claims of halogen equivalency were justified and if manufacturers' photometric information was valid. Lamp quality was checked using ENERGY STAR as a basis, and variation across each six-lamp sample was checked to determine whether consistency could be assured to the consumer.

The effect of heat on LEDs was investigated through a 6,000 hour test. This saw groups of lamps running continuously in both downlights and free air in a simulated residential installation in Auckland, New Zealand. As well as analysing whether such mounting arrangements caused different levels of non-recoverable deterioration over time, the study also considered the general behaviour of all lamps over the test period.

The study had mixed results, and revealed that care must be taken when purchasing MR16 LED lamps in New Zealand due to these varied levels of quality.

Significantly, one lamp type was found to mechanically deteriorate over time such that it proved a fire risk. This was exacerbated by high temperature and the lamps mounted in downlights deteriorated 2,000 hours before their free air equivalents showed signs of similar behaviour.

With 25% of the lamps sampled in the study shown to be seriously flawed, it is clear that appropriate regulation is required in order to ensure that MR16 LED lamps sold in New Zealand are fit for purpose.

The study concludes by suggesting further areas for research which were limited by time constraints. All of these proposed investigations would enrich the existing findings.

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Acronyms and Abbreviations

$\Delta u'v'$	Colour difference recorded as the change in (u', v') coordinates on the CIE 1976 diagram.
AC	Alternating Current
ANSI	American National Standards Institute
CA	"Closed Abutted" rating of heat can which, under the now superseded downlight code, allowed ceiling insulation to be abutted to the luminaire
CALiPER	Commercially Available LED Product Evaluation and Reporting
CCT	Correlated Colour Temperature
CFL	Compact Fluorescent Lamp
CIE	International Commission on Illumination
CRI	Colour Rendering Index
DC	Direct Current
DOE	U.S. Department Of Energy
D_{uv}	Colour difference recorded as the change in (u, v) coordinates on the CIE 1960 diagram.
EECA	Energy Efficiency and Conservation Authority
HEEP	Household Energy End-use Project
IESANZ	Illuminating Engineering Society of Australia and New Zealand
IESNA	Illuminating Engineering Society of North America
IR	Infra-red
K	Kelvin
KEMA	Consultancy company (now known as DNV KEMA)
LED	Light-emitting diode
LM-79	LM-79-08 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
LM-80	LM-80-08 Approved Method: Measuring Lumen Maintenance of LED Light Sources

lm/W	Lumens per Watt
MEPS	Minimum Energy Performance Standards
MR	Multifaceted Reflector
NEMA	National Electrical Manufacturers Association
NGLIA	Next Generation Lighting Industry Alliance
nm	Nanometre
P-N	Positive-Negative
R_9	Saturated red value used for colour rendering
R_a	General colour rendering index
SDCM	Standard deviation of colour matching
SSL	Solid-state lighting
T_j	Junction temperature
TM-21	TM-21-11 Projecting Long Term Lumen Maintenance of LED Light Sources