TCS 065 - 2018

Specification for

The Supply of

LED Road Lighting Luminaires

December 2018
Rev A

keeping victorians connected

TCS 065 – 2018

Foreword

This specification has been developed by VicRoads. It is one of a number of technical specifications, and associated standard drawings, which set out the requirements for roadside ITS devices, traffic signal equipment and other electrical equipment and associated devices and control systems.

This specification is intended for use in all relevant works undertaken by or on behalf of VicRoads.

VicRoads Standard Drawings, Specifications and Guidelines are available for downloading from VicRoads website at the following address under 'Tenders & Suppliers', http://www.vicroads.vic.gov.au/itsspecs

Specification updates. VicRoads specifications and associated standard drawings are subject to periodic review. To keep the specifications up to date, amendments or new editions are issued as necessary. It is therefore important for users of VicRoads specifications to ensure that they have the latest version and associated amendments.

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PREFACE

A. TELECOMMUNICATIONS EQUIPMENT

A.1 All telecommunications equipment shall comply with relevant requirements of the Australian Communications and Media Authority (ACMA). Such equipment shall be labelled with a Regulatory Compliance Mark.

B. CHANGES TO THIS SPECIFICATION

B.1 The main changes to this specification from the previous version are listed below:

- Updated in line with latest version of SA/SNZ 1158.6
- General revision and update

Revision History

Version	Revision	Date	Author	Description
2014	A	Nov 2014	SJS	First release
2014	B	Jan 2015	SJS	Updates
2016	A	March 2016	SJS	Updated following new TS 1158.6:2015
2016	B	Aug 2016	SJS	Minor updates
2018	A	Dec 2018	SJS	Updated following amendments to TS 1158.6 2015. Addition of tunnel and pedestrian luminaires.

Contents

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

1.1.1 This specification covers the requirements of LED road lighting luminaires intended for use in Category V3 lighting schemes in accordance with AS/NZS 1158.1.1.

1.1.2 This specification also covers the requirements for luminaires intended for use in tunnel environments.

1.2 GENERAL

1.2.1 The LED road lighting luminaires to be used in Victoria shall comply with all relevant requirements of AS/NZS 1158.6.

1.2.2 LED road lighting luminaires shall be designed to provide not less than 100,000 hours of operation.

1.3 DEFINITIONS

1.3.1 The definitions used in AS/NZS 1158.0 shall apply to this specification.

SECTION 2 RELATED SPECIFICATIONS AND DRAWINGS

2.1 GENERAL

2.1.1 The fabrication and supply of all components shall conform to all relevant Australian Standards.

2.1.2 All installation works shall conform to the relevant VicRoads specifications and related specifications and standards as indicated throughout this document.

2.1.3 The most current version of the following related Australian Standards are defined:

AS/NZS 3000	Wiring Rules
AS/NZS 1158.1.1	Lighting for roads and public spaces Part 1.1: Vehicular traffic (Category V) lighting – Performance and design requirements
AS/NZS 1158.1.2	Lighting for roads and public spaces Part 1.2: Vehicular traffic (Category V) lighting – Guide to design, installation, operation and maintenance
AS/NZS 1158.1.3	Lighting for roads and public spaces Part 1.3: Vehicular traffic (Category V) lighting – Guide to design, installation, operation and maintenance
AS/NZS 1158.2	Lighting for roads and public spaces Part 2: Computer procedures for the calculation of light technical parameters for Category V and Category P lighting
AS/NZS 1158.6	Lighting for roads and public spaces Part 6: Luminaires
AS/NZS 60598.1	Luminaires – General requirements and tests
AS 60529	Degrees of protection provided by enclosures (IP code)
AS 60038	Standard voltages
AS 61000.6.2	Generic standards – Immunity for residential, commercial and light industrial environments
AS 61000.6.3	Generic standards – Emission standard for residential, commercial and light industrial environments

2.1.4 The most current version of the following International Standards are defined:

IES LM-80-08	Approved Method: Measuring Lumen Maintenance of LED Light Sources
IES TM-21-11	Projecting Long Term Lumen Maintenance of LED Light Sources

2.2 EXCEPTIONS AND CLARIFICATION TO AS 1158.6

The requirements of AS 1158.6 shall apply to LED luminaires with the exception of the following clauses.

AS 1158.6 Clause	Description	Exceptions to AS 1158.6 Clause
1.6.2 (b)	Information on interior of luminaire	Clause does not apply
1.6.2 (c)	Information on interior of luminaire	Clause does not apply
1.6.2 (d)	Information on interior of luminaire	Clause does not apply
1.6.3	Coded information on exterior of luminaire	See Clause 4.2 of this specification
2.2.2 (a)	Required ingress protection	Clause does not apply
2.2.3	Impact resistance	See Clause 4.3.1 of this specification for further clarification
2.4	Visors and lenses	See Clause 4.3.2 of this specification for further clarification
2.8.1.2.1 (a)	Attachment by bolt and locking device	Clause does not apply
2.8.1.2.1 (c)	Attachment by bolt and locking device	Clause does not apply
2.8.1.2.1 (d)	Attachment by bolt and locking device	Clause does not apply
2.8.1.3	Adjustment of upcast	See Clauses 4.3.5 and 4.3.6 of this specification for further clarification
2.8.2	Top entry luminaires	Clause does not apply
2.9.2	Post top luminaires	Clause does not apply
2.9.3	Top entry luminaires	Clause does not apply
3.2.2	Magnetic ballasts for HID lamps	Clause does not apply
3.2.3	Ignitors	Clause does not apply
3.3	Requirements for HID lamps	Clause does not apply
3.4	Requirements for fluorescent lamps	Clause does not apply
3.8	Luminaire switching	See Clause 4.4.2 of this specification for further clarification
4	Additional requirements for particular luminaires	Clause does not apply
5.3	Ballast losses	Clause does not apply
5.7	Photometric test requirements for SSL luminaires	See Clause 5.1 of this specification for further clarification
5.8.2	Minimum luminaire efficacy rating - HID Example	Clause does not apply
6.4	Statement of compliance	This clause is replaced with Appendix C of this specification.

SECTION 3 ACRONYMS

3.1 The acronyms used in this document shall be interpreted as follows:

AMCS	Asset Monitoring and Control System
ARR	The arrangement of luminaires in a lighting scheme as defined in AS/NZS 1158.0 and AS/NZS 1158.2
AS	Australian Standard
HPS	High Pressure Sodium
HPSM	High Power Surface Mounted
IESNA	Illuminating Engineering Society of North America
IP	Ingress Protection
K	Colour temperature expressed as degrees Kelvin
LED	Light Emitting Diode
LTP	Light Technical Parameters
NZS	New Zealand Standard
Smart Cell	A wireless luminaire controller
W_k	Carriageway width as defined in Table A1

SECTION 4 REQUIREMENTS

4.1 GENERAL REQUIREMENTS

4.1.1 The luminaire body shall have a design life of not less than 20 years.

4.1.2 The luminaire electronics, including the LED's, shall have a design life of not less than 15 years.

4.1.3 The complete luminaire shall be capable of replacing existing HPS luminaires one-for-one and maintaining Category V3 lighting.

4.1.4 LED luminaires shall meet Category V3 lighting requirements at pole spacings up to 85m as detailed in Appendix A.

4.1.5 LED luminaires shall meet Category V3 lighting requirements at luminaire heights specified in Appendix A.

4.1.6 The LED luminaire shall provide a minimum of 30% reduction of total system watts compared to the equivalent HPS luminaire.

4.2 MARKING

4.2.1 In addition to the requirements of Clause 1.6.3 of AS/NZS 1158.6, the exterior of the luminaire shall be marked as shown in Figure 4.1 below.

NOTE: The purpose of this additional marking is to enable easy identification of LED luminaire type

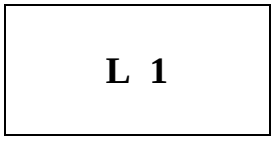

Figure 4.1: Example of External Marking

Where:

- 'L' shall indicate that the luminaire is LED.
- '1' shall indicate that it replaces a 150W HPS.
- '2' shall indicate that it replaces a 250W HPS.
- '4' shall indicate that it replaces a 400W HPS.

4.2.2 Any additional markings deemed by the manufacturer to be useful, such as the lighting distribution type (T2 standard, T3 forward throw, etc).

4.3 MECHANICAL REQUIREMENTS

4.3.1 The complete luminaire shall achieve a resistance to external impact of 'Moderate' (i.e. not less than IK06) as detailed in Clause 2.2 and Table 2.1 of SA/SNZ 1158.6.

4.3.2 To keep glare to a minimum, only Aeroscreen type visors shall be used.

4.3.3 Semi cut-off visors are not permitted.

4.3.4 Means of attachment shall be as detailed in Table 4.1 below.

Luminare type	Entry Type	Spigot size
'V'category luminaire	Side entry	43mm OD
'P' category luminaire	Side entry	43mm OD
Pedestrian tunnel	As specified in individual tender documents	N/A
Vehicle tunnel	As specified in individual tender documents	N/A

Table 4.1: Means of attachment

4.3.5 Luminaires shall be designed with a zero degree upcast.

4.3.6 Where an adjustable upcast facility is provided, it shall be capable of having all but the zero upcast angle position blocked to prevent incorrect installation.

4.3.7 The maximum mass of luminaires shall not exceed 15kg as detailed in Table 2.2 of SS/SNZ 1158.6.

4.4 ELECTRICAL REQUIREMENTS

4.4.1 Internal Wiring

4.4.1.1 All internal wiring shall be suitably insulated and mechanically protected.

4.4.2 Protection Against Electric Shock

4.4.2.1 The luminaires shall be constructed so that no live parts are accessible during installation.

4.4.2.2 Basic insulated parts shall not be used on the outer surface of the luminaire without appropriate protection to avoid accidental contact.

4.4.2.3 Protection against electric shock shall be maintained in any position.

4.4.3 Luminaire switching

4.4.3.1 Luminaires supplied for VicRoads lighting schemes shall include a 7 pin NEMA socket as detailed in 3.8.1 (c) of SA/SNZ 1158.6.

4.4.3.2 The NEMA socket shall be wired to be fully compatible with VicRoads AMCS and associated 'smart' PE cell.

4.4.3.3 VicRoads AMCS requirements are detailed in Appendix B.

4.4.4 EMC Compliance

4.4.4.1 Luminaires shall comply with the requirements of AS CISPR 15 for emissions.

4.4.4.2 The luminaire shall carry the AMCA Compliance Mark.

4.5 PHOTOMETRIC REQUIREMENTS

4.5.1 LED's shall be subject to all required photometric testing as described in this specification and SA/SNZ 1158.6.

4.5.2 Luminous intensity output shall be designed to meet the minimum requirements for Category V3 road lighting after ten years field service.

4.5.3 LED luminaires shall provide a colour temperature within the range of 4,000K as detailed in Table 5.3 of SA/SNZ 1158.6.

4.5.4 For all 'V' category lighting, the maximum Threshold Increment (TI) allowed shall be 15%. This has been determined based on observations that a threshold above 15% for an LED luminaire is considered to produce unacceptable levels of glare.

NOTE: The specified TI of 15% is less than the allowed maximum of 20 detailed in Table 2.2 of AS/NZS 1158.1.1. and is determined from approved software program.

SECTION 5 PERFORMANCE AND TESTING

5.1 GENERAL

5.1.1 In addition to the 'Performance and Testing' requirements detailed in Section 5 of SA/SNZ 1158.6, LED luminaires shall meet the following requirements.

5.1.2 The LED's shall undergo testing in accordance with LM-80-08 for a minimum of 10,000 hours.

5.1.3 Results of the LM-80 testing shall be entered into a standard TM-21 table.

5.1.4 At 60,000 hours, the TM-21 table shall indicate a lumen maintenance level of not less than 95%.

5.1.5 The LED road lighting luminaires shall meet the values of Light Technical Parameters (LTPs) for Category V lighting as specified in Table 2.2 of AS/NZS 1158.1.1 for Category V3 lighting scheme.

5.1.6 Section 3.1 & 3.2 of AS/NZS 1158.2 shall apply to the calculation of the LTPs for Category V lighting.

5.1.7 For Category V straight road elements, the specific software package SAA STANSHELL is required to calculate the luminance-based LTPs. Appendix A of AS/NZS 1158.2 provides more information.

5.1.8 Appendix A details the minimum photometric performance requirements.

5.2 WARRANTY PERIOD

5.2.1 The design life of the LEDs in luminaires shall be a minimum of 15 years in-field operation.

5.2.2 To provide confidence that this will be achieved, the minimum warranty period shall be 10 years 'on-pole'.

5.2.3 Any luminaire fault that occurs during the warranty period shall be rectified at no cost to VicRoads.

SECTION 6 TUNNEL AND UNDERPASS LUMINAIRES

6.1 GENERAL

6.1.1 Luminaires for tunnels and underpasses shall:

a) Comply with all relevant requirements of SA/SNZ 1158.6 and this specification.
b) Be capable providing lighting levels that comply with all the performance and design requirements of AS/NZS 1158.5.
c) Be fully compatible with VicRoads AMCS as detailed in Appendix B.
d) Be covered by a minimum 7 year warranty.

6.1.2 Luminaires designed to provide a counter beam luminous distribution shall not be used as recommended in AS 1158.5 Appendix C.

6.2 PHOTOMETRIC PERFORMANCE

6.2.1 A sample tunnel design showing compliance with the LTP's of AS/NZS 1158.5 shall be provided if requested.

SECTION 7 PEDESTRIAN LUMINAIRES

7.1 GENERAL

7.1.1 VicRoads does not specifically evaluate or approve luminaires designed for 'P' category lighting schemes.

7.1.2 Luminaires for 'P' category schemes shall:

a) Be approved for use by the local Distribution Business.
b) Be covered by a 10 year 'on-pole' warranty.
c) Where specified in individual tender documents, be fully compatible with VicRoads AMCS as detailed in Appendix B.

7.1.3 Alternative pedestrian luminaires may be considered on a case by case basis.

7.2 PEDESTRIAN TUNNELS

7.2.1 Luminaires used in a pedestrian tunnel shall:

1. Comply with all relevant requirements of SA/SNZ 1158.6 and this specification.
2. Provide lighting levels that comply with all the performance and design requirements of AS/NZS 1158.3.1.
3. Be fully compatible with VicRoads AMCS as detailed in Appendix B.
4. Be covered by a minimum 7 year warranty.
5. Have a minimum IK rating of IK 10.

SECTION 8 DOCUMENTATION

8.1 GENERAL

8.1.1 The following shall be provided:

a) A full description of the luminaire;
b) The dimensional outline drawing of the luminaire;
c) Isolux /calculations/diagrams demonstrating compliance with LTPs as required by AS/NZS 1158.2;
d) Evidence of compliance with photometric performance requirements detailed in Appendix A.
e) Any relevant test reports for the luminaire, eg. EMC, IP;
f) LM-80-08 report;
g) TM-21-11 report; and
h) NATA Certified photometric data I-tables in the CIE 132 format as required by Section 4 of AS/NZS 1158.2.

8.2 PHOTOMETRIC INFORMATION

8.2.1 Photometric test report detailing luminous intensity levels for use with Isolux calculations.

8.2.2 Photometric test reports shall be from a laboratory accredited by National Association of testing Authorities, Australia (NATA) or equivalent.

8.2.3 All photometric tests shall be conducted on a complete, fully assembled luminaire.

8.2.4 Tests on partially disassembled luminaires will not be accepted.

APPENDIX A

PHOTOMETRIC PERFORMANCE CRITERIA

(Normative)

A1. LUMINAIRE OUTPUT

A1.1 Table A1 provides the minimum spacing for each LED luminaire type and the relevant installation arrangement.

A1.2 All spacings shall be based on a maximum Threshold Increment (TI) of 15%.

Table A1 – Photometric Parameters

Luminaire Type	Mounting Height (m)	W_k (m)	Over Hang (m)	Spacing (m)		
				ARR 1	ARR 3	ARR 6*
L1 (150W HPS replacement)	9	8	0	44	44	45
			1.5	52	52	50
			2.0	52	52	50
			3.0	50	50	50
L2 (250W HPS replacement)	12.5	12	0	55	55	50
			1.5	60	65	60
			2.0	70	70	70
			3.0	72	72	70
		14	0	N/A	55	50
			1.5	N/A	62	55
			2.0	N/A	55	50
			3.0	N/A	55	55
L4 (400W HPS replacement)	15	14	0	65	75	63
			1.5	65	75	75
			2.0	75	75	80
			3.0	80	80	85
		17	0	N/A	75	60
			1.5	N/A	75	55
			2.0	N/A	80	50
			3.0	N/A	80	50

* use 6m median width.

A1.3 For the purpose of clarity, the Designated ARR 1, 3 and 6 as detailed in AS/NZS 1158.2 have been reproduced in Figure A1 below.

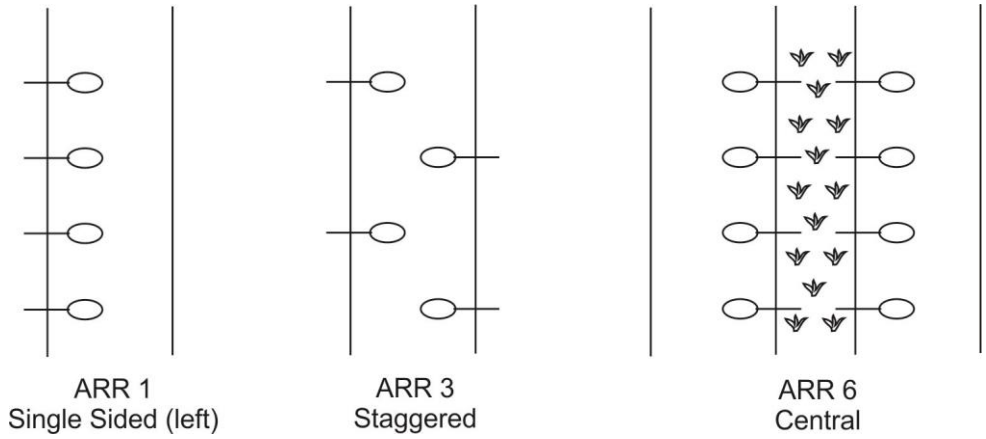

Figure A1 – Designated Lighting Arrangements from AS/NZS 1158.2

APPENDIX B

ASSET MONITORING AND CONTROL SYSTEM (AMCS)

(Normative)

B1. GENERAL

B1.1 To enable the remote monitoring and control of VicRoads lighting schemes and individual luminaires, all luminaires shall be fully compatible with VicRoads AMCS.

B1.2 VicRoads current AMCS platform is Traffic Technologies TST.

B1.3 The typical arrangement for TST operation for 'V' category luminaires is via the TST smart cell (i.e. 'I-Cell').

B1.4 The 'I-Cell' connects to the luminaire via the 7 pin NEMA socket.

B1.5 For installations in tunnels or underpasses, a TST compatible RS485 interface module is required.

B2. COMPLIANCE TESTING

B2.1 All luminaires shall be tested for compatibility with TST.

B2.2 To facilitate testing, the luminaire supplier may choose to:

- Arrange directly with Traffic Technologies for testing to be carried out; or
- Engage a VicRoads approved consultant to manage the testing;

B2.3 VicRoads reserves the right to have a representative present for all testing.

B2.4 Following a successful compatibility test, the suppler will be:

- Provided with a statement from VicRoads confirming compatibly (only if a VicRoads representative is present at all testing); or
- Receive a certificate or letter from Traffic Technologies confirming compatibility.

APPENDIX C

REQUIREMENTS FOR TYPE APPROVAL

(Normative)

C1. GENERAL

C1.1 To enable assessment for the purpose of granting Type Approval, the supplier is to submit a formal request for Type Approval accompanied by the following:

a. A complete working sample of the luminaire.

b. An outline drawing showing the general presentation and overall dimensions of the complete luminaire.

c. Documentation to demonstrate that the luminaire has been manufactured and supplied under an approved quality assurance system.

d. Documentation to demonstrate that the luminaire conforms to the requirements of this specification. This may be by means of submitting test results from approved and appropriately qualified independent testing organisations, or providing the suppliers assurance that the product complies with each paragraph of the specification.

e. Copy of the 'IES' and 'CIE' files created by the NATA accredited test laboratory.

f. Pole spacing calculations using the above files and an approved program shall be submitted to demonstrate compliance with Category V requirements at VicRoads nominated spacings. See Appendix A.

C2. REQUIRED NATA ACCREDITED TESTING

C2.1 Notwithstanding A1 above, the supplier shall submit test results from a NATA accredited testing organisation (or approved ILAC laboratory) to demonstrate compliance with the following clauses of:

Document	Clause	Test
SA/SNZ 1158.6	2.2.2	Ingress Protection
	2.2.3	Impact Resistance
	5.4	Vibration Test
	5.5	Impulse Voltage Test
	5.6	Thermal Endurance and Thermal Testing Requirements
	5.7	Photometric tests
	6.3	Photometric data
TCS 065	4.4.3	EMC
	5.1	Photometric performance

C3. OTHER REQUIRED TESTING

a. Compatibility with VicRoads AMCS.

b. Once the luminaire has been assessed as meeting the requirements of B1, B2 and B3(a), a field test may be conducted for up to 12 months.

c. VicRoads may require additional information or testing to be carried out as part of its evaluation of the product.

d. The supplier is required to supply and install the LED luminaire at any nominated test site to demonstrate compliance with Category V3.

e. VicRoads may require the supplier to cover the costs of an 'on-road' light level survey.

f. If the product is approved, a Certificate of Type Approval will be provided to the supplier. Until such time as this Certificate is issued, the product is not to be used in the State of Victoria.

C4. ASSESSMENT PROCEDURE

C4.1 The assessment procedure for a LED luminaire will include, but not be limited to, the following:

a. Assessment of construction, workmanship and critical dimensions.
b. Evaluation of the submitted data against the requirements of the specification.
c. Installation and testing of the LED luminaire.

C4.2 Where some of these procedures have been completed prior to formal submission, the results will be considered in the evaluation, provided there is no relevant change in the design. The supplier is to state whether tests carried out prior to formal submission were carried out on an identical sample.

APPENDIX D

HIGH POWER SURFACE MOUNT LED

(Informative)

D.1 BACKGROUND INFORMATION

D.1.1 The luminous intensity for LED light sources is known to degrade over time. This is referred to as *lumen loss*. The degree of degradation and the time over which this occurs depends on a number of factors. These factors include such things as:

- LED technology used;
- LED colour;
- Drive current applied to the LED; and
- Temperature of the LED junction.

D.1.2 To help prevent the LED's from degrading beyond minimum required luminous intensity levels, when new, LED's typically produce considerably higher luminous intensities than the minimum required.

D.1.3 The initial luminous intensity levels are typically calculated from accepted lumen loss factors.

D.1.4 Lumen loss factors applied to initial luminous intensities are intended to ensure that, at the end of anticipated life, the minimum value of luminous intensity will be maintained.

D.2 DETERMINING LUMEN LOSS OF LED's

D.2.1 LED luminaires are required to be designed to provide a life expectancy of 100,000 hours however, actually testing LED's for 100,000 hours is not practicable.

D.2.2 In order to determine the life of an LED, the Illuminating Engineering Society of North America (IESNA), together with the LED industry, developed a standard methodology for testing lumen maintenance of LED's.

D.2.3 This methodology provides a common test methodology and has been widely accepted throughout the LED industry. This has resulted in two separate IESNA 'standards' being produced. These are:

1. **LM-80** – The standard method and procedure for measuring LED lumen depreciation of solid- state lighting sources, such as LED packages, modules and arrays; and
2. **TM-21** – Currently a memorandum which recommends a method to project the lumen maintenance of an LED based on the results of LM-80.

D.3 LUMEN MAINTENANCE OF A LED LIGHT SOURCE LM-80 TEST

D.3.1 To test the lumen maintenance of a LED of light source, LM-80 test requires:

1. A minimum of 20 units of LED's be tested at each of the temperature settings;
2. Conducting the tests at three different ambient temperature, 55ºC, 85ºC (LM-80 specified) and a third temperature specified by the manufacturer using the same drive current;

3. Recording the initial measurements of lumens and chromaticity as required;
4. Recording subsequent measurements of lumens and chromaticity at a nominal interval of 1,000 hours;
5. Record a minimum of 6 measurements;
6. Additional measurements beyond 6,000 hours are encouraged; and
7. Using the recorded measurements to populate a TM-21 table to calculate the average extrapolated life expectancy to 70% of initial luminance (up to a maximum of six times the measurement period).

D.3.2 The resultant average lumen measurement at 6,000 hours is referred to as the average Lumen Maintenance at 6,000 hours.

D.3.3 The intent of this is to provide a guide as to the expected life of the LED under test.

D.3.4 At the completion of the test, a table of data for each LED tested will show the lumen depreciation over the test period.

D.3.5 A series of tests are carried out using different parameters such as ambient temperature and LED drive current.

D.3.6 Table 1 below is a sample of the LM-80 test report summary.

Ambient Temp.	LED Drive Current	Test Period In hours	Lumen Maintenance at end of test
85ºC	1000mA	13608	98.7%
105ºC	1000mA	12096	97.4%
55ºC	1500mA	12096	99.2%
85ºC	1500mA	12096	98.3%

Table 1: LM-80 Test Results

D.4 TM-21 PROJECTION

D.4.1 Another standard developed by IESNA is TM-21, 'Projecting Long Term Lumen Maintenance of LED light Sources'. This document was developed to provide a standard method for predicting future lumen maintenance levels based on the LM-80 test data.

D.4.2 Many manufacturers and authorities worldwide are adopting this standard for predicting LED lumen maintenance.

D.4.3 TM-21 takes data from LM-80 and applies a series of specific equations. From these results, lumen maintenance extrapolations are derived.

D.4.4 TM-21 specifies that lumen maintenance values must not be projected beyond six times the test duration. i.e. if the LED has been tested for 10,000 hours, then the TM-21 projection should be limited to 60,000 hours.

D.4.5 The resulting lumen maintenance figure is expressed as a percentage of the initial measured lumen output, e.g. if the projected lumen output at 60,000 hours was 70% then lumen maintenance is expressed as $L_{70.}$