Attachment 8.12

Public Lighting Opex Forecast

May 2014

Contents

Document and Amendment History

Version Number	Publish Date	Author	Summary of Changes
1	7/4/14	John Bedding	Final
2	21/5/14	John Bedding	Final with Formatting

PUBLIC LIGHTING – Operational Expenditure and associated cost build up model

1. Background

There are two direct sources of operational expenditure; scheduled and unscheduled maintenance. This document describes the activities associated with this work, issues faced, expenditure during the current regulatory period and forecast expenditure and revenue requirements for the financial year (FY) 2015 - 2019 regulatory control period.

1.1 Scheduled Maintenance

Scheduled maintenance includes bulk lamp replacement, photoelectric cell (PE cells) replacement (BLR), steel lighting pole inspection, night patrols and routine tasks performed in conjunction with the BLR such as cleaning of the visor. The BLR is currently performed on a 30 month cycle for lamps and a 60 month cycle for PE cells. Ausgrid has adopted this strategy over this particular cycle time so that service availability and lighting levels are maintained and comply with the levels specified in the Lighting for public roads and spaces Australian standard AS1158 and in doing so minimise unscheduled maintenance costs associated with repairing failed lights and maintaining illumination levels.

Ausgrid has determined that a 30 month cycle is the optimum cycle for the current inventory of lamps and luminaires on our network. The optimum timing of these cycles is dependent on technical and financial constraints. Technical constraints consist of the lumen depreciation and mortality characteristics of lamps as well as the cleaning interval of the luminaire. Financial constraints largely focus around the difference in unit costs between scheduled maintenance (contractor BLR rates) and unscheduled maintenance (Ausgrid spot replacement costs). The optimisation of the bulk lamp replacement period is via the minimisation of the total cost of ownership. At present Ausgrid is constrained to a maximum of a 3 year BLR as the Mercury Vapour luminaires installed on major roads would fall out of compliance to the lighting levels specified in AS1158 beyond this (see appendix B).

Scheduled maintenance is mainly performed by external service providers. Rates are sought by competitive tender and expenditure is relatively predicable. Materials used as part of the BLR are issued free to the external service providers from Ausgrid stores and the rate of their use and procurement cost is also relatively predictable.

1.2 Unscheduled Maintenance

Unscheduled maintenance comprises tasks which are performed in response to a reported fault or maintenance issue outside of the BLR. This work is generally performed by Ausgrid’s Network Operations field staff as part of their overhead line duties. The most common unscheduled maintenance task is the replacement of a failed lamp or PE cell. While the crew is on site, an inspection is performed to check if any additional work needs to be performed. This inspection includes:

- Lenses that are opaque or substantially discoloured, cracked, improperly secured, damaged or missing;
- Damaged or missing seals;
- Moisture within the luminaire;
- Damaged or corroded supports, luminaires, brackets or connections;
- Improperly aligned luminaire or brackets; and
- Any other circumstances or defects, which may affect the ongoing performance of the luminaire.

Ausgrid has accumulated comprehensive information on the number of instances of unscheduled maintenance which has been used to forecast future spot maintenance requirements per lamp type.

2. Operational Expenditure

Ausgrid maintains approximately 249,000 luminaires in its network area. 170,000 of these are on minor or residential roads and 79,000 on major or traffic routes roads.

Expenditure is broken up into the following categories

- Bulk contract – Labour costs associated with scheduled maintenance
- Bulk materials – Materials costs associated with scheduled maintenance
- Spot labour – Labour costs associated with unscheduled maintenance
- Spot materials – Materials costs associated with unscheduled maintenance
- EWP costs – Elevated work platform costs associated with unscheduled maintenance
- Connections – Maintenance costs associated with connections
- Overheads – overheads associated with the employment of staff
- Corporate overheads – overheads associated with the running of the business

Maintenance costs per lamp type are built up of costs associated with each of these categories.

2.1 FY10 – FY14 Expenditure

Table 1 summarises Ausgrid's operational expenditure and the number of luminaires that have undergone both scheduled and unscheduled maintenance during the 2009 - 2014 regulatory control period.

Table 1 – Operational expenditure FY10 - FY13 ($M)

	2009/10	2010/11	2011/12	2012/13	2013/14 (YTD)
Regulatory allowance	11.7	13.9	14.1	14.5	14.9
Actual Spend	18.8	19.7	19.6	19.7	19.9
Difference (actual - allowance)	7.1	5.8	5.5	5.2	5.0
Comprising:					
Maintenance undertaken on minor roads	86,083	85,035	80,359	90,552	84,103
Maintenance undertaken on major roads	38,499	37,939	39,474	39,753	38,052

During this period, Ausgrid's operational expenditure was in the order of 40% over the regulatory allowance for maintenance charges in the AER's 2010 determination. As bulk contract and bulk materials categories are reasonably predictable, the increased spend was assumed to come from the spot labour, spot materials and associated equipment cost categories. In order to confirm this assumption a maintenance requirements analysis study (summarised in Appendix A) was undertaken to determine the actual frequency that the various lamp technologies and luminaires required unscheduled maintenance.

The analysis highlighted a significant area that has contributed to Ausgrid's apparent over expenditure of operating costs for the public lighting network, compared with the regulatory allowance. It is apparent that the assumed failure rates for the 2010 AER determination are in most cases very low and in some cases lower than the manufacturer's claimed failure rates. For example within supporting documentation for attachment 8.12 – Public Lighting Opex Forecast - Manufacturers Failure Data Sheets (ID00282) shows that for 250W and 400W Mercury Vapour lamps a failure rate of approximately 19% over a 3 year period could be expected, which when annualised is approximately 6.33%, whereas the AERs determination allowed for a 1.68% and 1.45% failure rate for 250W and 400W mercury respectively. Manufacturer's failure rates do not consider the environmental conditions the lamps will experience and should be considered as an absolute best case. Table 2 summarises the difference between Ausgrid's actual attendance rates, the theoretical and AER 2010 determination findings.

Table 2 – Comparison of unscheduled maintenance rates

Lamp Description / (BLR Cycle)	2009 AER Determination Annual Failure rate	Ausgrid analysis annualised unscheduled maintenance attendance rates	Annualised manufacturers lamp failure rate at BLR Cycle time
MBF1x125 (3 yr)	2.96%	13.57%	6.33%/2.00%*
MBF1x250 (3 yr)	1.68%	11.83%	6.33%
MBF1x400 (3 yr)	1.45%	12.53%	6.33%
MBF1x42 (3 yr)	4.01%	15.41%	2.33%
MBF1x50 (3 yr)	1.01%	18.91%	6.33%/2.00%*
MBF1x700 (3 yr)	4.83%	18.46%	11.66%
MBF1x80 (3 yr)	2.43%	8.26%	6.33%/2.00%*
SON1x100 (3 yr)	2.66%	13.44%	1.50%
SON1x150 (4 yr)	3.18%	12.57%	1.50%/1.00%*
SON1x250 (4 yr)	3.65%	13.12%	1.50%/1.00%*
SON1x400 (4 yr)	4.30%	14.40%	1.50%/1.00%*
SON1x70 (3 yr)	2.39%	12.10%	2.00%
TF1x40 (3 yr)	36.00%	15.85%	2.33%
TF2x20 (3 yr)	11.00%	10.29%	4.50%
* Ausgrid changed to longer life lamps during this regulatory control period. The lower failure rate is the failure rate associated with the new lamp type			

Using the analysis results Ausgrid was able to reconcile the actual spend to the calculated allowance using the approved 2009 opex cost build-up model. The AER recommended a 4 year BLR for all HPS on TRL roads and a 3 year for all other lamp types. These assumptions were removed and Ausgrid's actual 2.5 year BLR was used. Table 3 summarises the results.

Table 3 - Comparison of 2010-14 regulatory allowance, actual operating expenditure and failure rate analysis $(M)

	Bulk contract	Bulk materials	Spot labour	Spot materials	EWP costs	Connections	Overheads	Total
FY10 - AER	5.71	1.21	1.07	0.08	0.84	2.07	2.74	13.71
FY10 - Analysis	6.03	1.34	2.60	0.22	2.05	2.07	3.57	17.87
FY10 - Actual								18.76
FY11 - AER	5.71	1.24	1.13	0.08	0.86	2.12	2.78	13.92
FY11 - Analysis	6.03	1.37	2.76	0.23	2.10	2.12	3.65	18.25
FY11 - Actual								19.70
FY12 - AER	5.71	1.27	1.19	0.08	0.88	2.17	2.82	14.12
FY12 - Analysis	6.03	1.40	2.90	0.23	2.15	2.17	3.72	18.60
FY12 - Actual								19.63
FY13 - AER	5.85	1.30	1.24	0.09	0.90	2.23	2.90	14.50
FY13 - Analysis	6.18	1.44	3.02	0.24	2.20	2.23	3.82	19.12
FY 13 - Actual								19.66
FY14 - AER	5.99	1.33	1.28	0.09	0.92	2.28	2.97	14.87
FY14 - Analysis	6.33	1.47	3.11	0.24	2.26	2.28	3.92	19.62
FY14 – Actual (YTD March 14)								19.90

The results in Table 3 show a strong correlation between Ausgrid's actual opex and the calculated costs when actual attendance rates are applied. This further reinforces the results of the analysis and supports the proposition that these historical failure rates should be applied as the basis to determine the FY15 - FY19 operating expenditure allowance.

2.2 FY15 – FY19 Expenditure

Ausgrid is proposing a continuation of the current 30 month BLR cycle. However, Ausgrid intends to increase the BLR cycle to 36 months within the 2015-19 regulatory control period, with a view to further increase to 48 months after appropriate analysis has been undertaken on the effect of the roll out of new technology. The time frame in which Ausgrid moves to the longer cycle will be dictated by the roll out of these capital replacement programs.

Ausgrid is proposing that the current opex cost build up model be used for the FY15 – 19 regulatory control period, updated with current inputs. Two key changes that have been made are:

1. A flat rate of 25% overhead has not been assumed for each price. Instead, a percentage has been calculated, using the Ausgrid Cost Allocation Method (within supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262)). On costs have been removed from the base labour rate, to ensure overhead costs have not been double counted and;

2. Ausgrid has adopted the failure rates from the 2013 maintenance requirements analysis to determine how much reactive maintenance will be required during the regulatory control period. This change is necessary, as Ausgrid has observed many more reactive repairs during the current regulatory control period than was assumed in the AER's 2010 determination.

The estimated expenditure is based on the current inventory of lamp types. Table 4 is the estimated maintenance costs over the FY15 – FY19 regulatory control period.

Table 4 – Forecast operational expenditure through FY15- FY19 ($M)

Year	20014/15	2015/16	2016/17	2017/18	2018/19
Bulk contract	5.44	5.56	5.69	5.84	5.98
Bulk materials	1.21	1.23	1.26	1.29	1.33
Spot labour	4.10	4.26	4.45	4.66	4.87
Spot materials	0.27	0.27	0.28	0.29	0.29
EWP costs	1.64	1.67	1.71	1.75	1.80
Connections	2.44	2.49	2.55	2.62	2.68
Overheads	2.72	2.79	2.87	2.96	3.05
Corporate overheads	1.54	1.58	1.63	1.68	1.73
Total	19.40	19.85	20.46	21.09	21.74

Ausgrid is proposing a number of capital programs over the FY15 – FY19 regulatory control period aimed at increasing efficiency and reducing the total operational expenditure. More specifically the roll out of this new technology is aimed at reducing unscheduled maintenance and ultimately extending the length of the BLR cycle to 4 years. Attachment 8.08 – Public lighting capex investment plan summary, further details these proposed programs.

Table 5 details the reductions in opex if the programs are completed as per the proposed schedule.

Table 5 – Forecast opex reductions if proposed capital programs are completed ($M)

	FY15	FY16	FY17	FY18	FY19
Opex reductions	0.65	1.3	1.7	2.0	2.1

It should be noted that once a luminaire is no longer serviceable, Ausgrid replaces this fitting with the technologies that are planned to be rolled out in the investment plans. The opex saving associated with this reactive replacement is immediately passed on to the customer.

3. Operational Expenditure Cost Build up Model Inputs

Ausgrid recovers its operational expenditure by charging customers for maintenance associated with the type of lamps installed. Pricing is based on a buildup of all expected scheduled and unscheduled maintenance activities and the cost of materials and labour associated with these tasks. In general the model inputs consist of:

- Scheduled and unscheduled maintenance tasks and the costs and frequencies at which these are performed
- The number of staff required for each task;
- Time to complete various tasks;
- Materials prices;
- Direct and indirect labour rates and;
- Oncosts

Attachment 8.13 - Public Lighting Models contains all models associated with public lighting.

3.1 General assumptions

The first table of inputs in the opex cost build up model is a table of general assumptions.

Table 6 lists these assumptions and gives a general description of the assumption

Table 6 – General assumptions

General Assumptions	Description of assumption	FY 15 Input
CPI (%)	Forecast CPI over the coming regulatory period	2.45%
Labour real price escalation (%)	Forecast labour escalation over the coming regulatory period	1.25%
Lamp real price escalation (%)	Lamp price escalation above CPI	0.00%
Visor real price escalation (%)	Visor price escalation above CPI	0.00%
PE cell real price escalation (%)	PE price escalation above CPI	0.00%
Miscellaneous real price escalation (%)	Miscellaneous materials price escalation above CPI	0.00%
EWP real price escalation (%)	Elevated Work Platform price	0.00%
Growth rate of public lights (%)	Increase in the number of luminaires per year	0.00%
Labour rate ($/hour)	Hourly award labour rate excluding overheads for a linesman	$42.99
Labour rate - overtime ($/hour)	Hourly overtime labour rate excluding overheads for a linesman	$81.26
EWP ($/hour)	Elevated work platform cost per hour	$30.46
Average Visor cost	Weighted average of all visor types Ausgrid currently repair	$40.51
Average PE cell cost	Weighted average of PE cell costs	$10.99
Average miscellaneous materials cost	Materials other than lamps, cells and visors (Not used)	-
Proportion of work in overtime hours (%)	Proportion of public lighting tasks completed in overtime hours	16%
Proportion of work in standard hours (%)	Proportion of public lighting tasks completed in standard hours	84%

Labour oncosts (%)	Oncosts associated with employment of a linesman	58%
Labour proportion of opex (%)	Proportion of labour costs in total opex. Not used in any calculation	38.2%
Corporate Overheads (CAM)	Overheads associated with cost of operating	8.65%
Overhead cost allocation (Direct + Indirect) (%)	Overheads associated with cost of operating	18.01%

3.1.1 CPI

CPI figures have been provided by CEG. CPI figures are used to escalate all materials prices, sub contracted service rates and connection maintenance costs.

3.1.2 Labour price escaltion

Labour price escalation figure have been provided by CEG. This rate is used to escalate labour rates only.

3.1.3 Materials price escalators

Material prices are assumed to increase by CPI only. No further escalation has been included.

3.1.4 Growth rate of public lights

Growth rate of public lights is assumed static for modeling purposes. In reality lamp counts will change and these changes will be reflected in customer charges. Analysis has been performed on the impact on opex of the proposed capital replacement programs if they are rolled out as per the proposed schedule. Table 5 details the potential opex reductions given these programs go ahead. The associated reduction in opex costs with the installation of new technology is immediately passed on to customers as their inventory will reflect the actual installed inventory.

3.1.5 Labour Rate

A comprehensive analysis was carried out which involved determining a labour rate for overhead linesmen for particular cost centres who would be involved in public lighting work. The rate was drawn from information provided by Ausgrid's SAP accounting system. This rate represents the cost of employing the linesman for normal time working hours. This rate is the direct award rate of pay for linesman only and does not include oncosts or overheads. See supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262).

3.1.6 Labour Rate – Overtime

The overtime rate considers the amount of work performed at 1.5x, 2.0x and 2.5x. A weighted average of 1.89x was calculated and used for this assumption. Supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262).

3.1.7 Elevated Work Platform (EWP) rate

All unscheduled maintenance requires the use of an Elevated work platform (EWP). Ausgrid has three sizes of EWP's. Supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262) details the sizes and the population of each in our fleet. A weighted average was calculated and included in the cost build up model. The FY14 hourly rate calculated is $29.73. EWP costs increase by CPI only over the FY15 – FY19 regulatory control period. There is no other escalation used.

3.1.8 Average Visor/PE cell/miscellaneous cost

Supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262) details the calculations of the average visor and PE cell costs. Ausgrid requires to hold stock of up to 38 different visor types. A weighted average of the usage of these visors was calculated over the period 03/13 – 02/14 to include in the pricing model.

There are two types of PE cells in Ausgrids network, namely D2 base and NEMA base cells. Again a weighted average of the usage over the same period was calculated and included in the pricing model.

The miscellaneous materials cost is not used in any calculations.

3.1.9 Proportion of work in overtime/standard hours

The proportion of public lighting task completed in overtime to standard time was calculated using actual data from FY13 to YTD 2014. See supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262).

3.1.10 Labour Oncosts

Oncosts include the following costs of employment:

- Annual leave
- Sick leave
- Public Holidays
- Superannuation
- Long Service Leave
- Payroll tax

The rates at which the oncosts are applied are tabled below:

Table 7 - Oncost allocations

Award / General / Part-time Labour	Accumulation Superannuation	Defined Benefit Superannuation
Annual Leave	9.01%	9.01%
Sick Leave	3.63%	3.63%
Public Holidays	4.51%	4.51%
Superannuation	17.54%	41.84%
Long Service Leave	8.08%	8.08%
Supplementary Super		2.69%
Preserved Sick Leave		4.57%
Payroll Tax	8.21%	10.02%
Total On-Cost Rate	**50.98%**	**84.35%**

Supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262) details the calculation of the oncost rate that has been entered into the opex pricing model. This rate has been averaged from the oncosts associated with linesman from all overhead cost centres that perform public lighting tasks.

3.1.11 Overheads

The overhead rate represents the indirect costs which enable the linesman to carry out the work in the organisation.

Overhead allocations include the following:

- **Other Labour:** amounts for the employee's unproductive time used for training, wet weather, breakdown, stand-down and allowances for any back pay or supervision entitlements.
- **Fleet:** Includes the cost of vehicles and running expenses.
- **Non labour:** protective clothing, minor materials, contract services, communications, tolls, taxes, IT, training costs of a non labour nature.
- **Indirect Labour:** Management costs for that organisational group and higher and including the cost of some support areas.

- **Indirect Non Labour:** Management related costs and other costs of a non labour nature.

The overhead rate has been calculated using historical values. Public lighting opex overheads are calculated as a percentage of all cost associated with public lighting opex. Supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262) details these calculations.

3.1.12 Corporate Overheads

Corporate overhead expenses fall under the following categories:

- Finance & Compliance & Internal Communications
- Human Resources & Health, Safety & Environment
- Information, Communication & Technology
- Insurance
- Networks NSW Management
- Property

The corporate overhead rate is calculated by the ratio of the total cost allocated to public lighting by the total opex spend.

Supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – 'Impact of Proposed CAM on Base Year' (ID00265) details the corporate overhead allocations to public lighting and supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262) details the calculation of the corporate overhead rate.

3.2 Unscheduled maintenance assumptions

Unscheduled maintenance (spot maintenance) of lamps and other components still occur regardless of whether there is a bulk maintenance regime is in place or not. Whilst an effective bulk replacement regime will reduce the number of failures which occur between replacement cycles, spot maintenance is still required to fix failures that occur between bulk replacement periods.

The model calculates the cost of labour, vehicles/equipment and materials that will be required to maintain all components as they fail. The rates that individual lamp types required some form of unscheduled maintenance was the subject of the study in Appendix A, and are listed in Table 9.

Table 8 lists the assumptions used in the calculations of the Spot Materials and Spot Labour cost components.

Table 8 – Unscheduled maintenance assumptions

Opex model inputs description	Inputs
Number of workers in standard crew	2.00
Additional workers on traffic route	1.00
Time required for average spot lamp replacement (hours)	0.76
Time for PE Cell replacement (hours)	0
Time for other spot maintenance task (hours)	0
Annual average failure rate for PE cells	1.42%
Annual average failure rates for other components	1.00% Not Used

Ausgrid uses two staff for all residential roads (category p roads) and three staff when work is required to be performed on a traffic route (category V roads).

The 'Time required for an average spot lamp replacement' is 45.6 minutes (0.76 x 60mins). A clear distinction needs to be made between the time to complete an unscheduled maintenance task and a scheduled maintenance task. Unlike bulk lamp replacements, these repairs are not located on adjoining poles and are not all the same in nature. Consequently, each repair will involve:

- Travel to the site;
- Set-up of work site and tools, etc;
- Identify fault;
- Make repair;
- Test repair; and
- Clear work site and pack away tools.

The time to complete a number of various tasks was the subject of a substantial study undertaken by Ausgrid and is detailed within supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – 'Public Lighting Time in Motion study' (ID00266).

The "Time for PE Cell replacement" and "Time for other spot maintenance tasks" are 0 as the rates of attendance used to calculate the frequency of lamp changes also covers these tasks. Ausgrid therefore considers this labour component will be covered in the "Time required for an average spot lamp replacement"

Failure rates for PE cells and other components have been carried over from the AER's 2010 determination. These cells allow for the recovery of the materials costs associated with the spot replacement of this equipment.

The relationship between the annual revenue requirements and the unscheduled maintenance assumptions are as follows:

Annual spot labour revenue requirement = Labour rate x hours required for repair x number of staff x annualised attendance rate

3.3 Unscheduled maintenance attendance rates (Failure Rates) Inputs

Ausgrid has not calculated failure rates for each individual component, what has been calculated are the number of times a particular lamp type has required some form of unscheduled maintenance. This may be for any number of reasons however the attendance will be initiated from a reported fault.

Ausgrid undertook a comprehensive study of all unscheduled maintenance attendances for all major lamp types. Ausgrid has used the results of this study in the opex cost build up model so as to accurately reflect costs associated with unscheduled maintenance. Appendix A of this document details this study and presents the results. Failure rates for lamp types that were not included in this study have been carried over from the AER's 2010 determination. Table 9 summarises the results. It should be noted that these results are not lamp failure rates, they are a percentage of the population that required some form of unscheduled maintenance within the period. These results also represent the actual attendance rates with the BLR in place.

Table 9 – Maintenance Requirements Analysis Results

Lamp Type	η	β	% call out at 2.5 years	% call out at 3 years	% call out at 4 years	Days to 10% receive call out	Burning Hours to 10% receive call out
MBF1x125	2657	0.7319	36.71%	40.71%	47.54%	123	1473
MBF1x250	3421	0.7242	31.89%	35.48%	41.71%	153	1836
MBF1x400	2933	0.7628	33.66%	37.60%	44.42%	153	1842
MBF1x42	1751	1.017	40.27%	46.23%	56.45%	192	2299
MBF1x50	1266	1.22	48.86%	56.73%	69.58%	200	2402
MBF1x700	1462	0.7408	50.60%	55.39%	63.17%	70	841
MBF1x80	4939	0.8334	21.71%	24.79%	30.38%	332	3982
SON1x100	2559	0.7789	36.10%	40.32%	47.58%	142	1708
SON1x150	2231	0.8446	37.50%	42.20%	50.29%	155	1864
SON1x250	2055	0.864	39.10%	44.04%	52.49%	152	1823
SON1x400	1751	0.8405	43.91%	49.03%	57.61%	120	1444
SON1x70	3282	0.7258	32.63%	36.29%	42.62%	148	1773
TF1x40	2070	0.6882	43.40%	47.54%	54.45%	79	944
TF2x20	4175	0.7445	27.55%	30.87%	36.71%	203	2438

Notes:

η (the characteristic life) is the time (in days) at which 63.2% of the population are expected to fail

β (the shape parameter). β > 1 gives an increasing failure rate in time. β < 1 the failure rate in time is decreasing. It is intuitive to think that β should be > 1 in all instances as the longer the period of time the greater the expected failure rate. However as there is a BLR in place, many of the lamps are replaced before they fail, so this data cannot be captured. The β of < 1 suggests a random failure shape parameter, which is what Ausgrid experiences.

The rates are then annualised according the BLR cycle time. For example, the annual unscheduled maintenance attendance rate for an MBFx125 on a 3 year BLR cycle would be:

40.71% / 3 = 13.57%

3.4 Material Price Inputs

Material prices for the majority of equipment used on public lighting are sourced by competitive tender. Supporting documentation for attachment 8.12 – Public Lighting Opex Forecast - Public lighting tender assessments (ID93656) includes tender documentation and recommendations to award for all public lighting materials. Where equipment is no longer purchased or used but is still required for price modeling, the last known price is used or the 2010 AER determination figure is carried over.

The relationship between the material price inputs and revenue requirements is as follows:

Annual spot material revenue requirement = Material price x annualised attendance rate per lamp type x population of particular component

Material prices increase by CPI only over the FY15 – FY19 regulatory control period. There is no other escalation used.

3.5 Connection inputs

The connection charges are the recovery of costs associated with underground connections only. Ausgrid does not include any charges for overhead connected street lights. This charge is to cover the costs associated with the repair and reinstatement of underground street lighting faults as well as the periodic inspection for electrical integrity.

When an underground connection of a public light fails, due to water ingress, corrosion or other reasons, Ausgrid must dig up the connection to repair it. This is a time consuming and labour intensive as faults are notoriously difficult to find and complicated to repair. Repair invariably requires other skilled staff like testing technicians, cable jointers and substation technicians. It is common for these types of tasks to require traffic control given the long period of time required to undertake the repair. While only a small number of underground connections fail per year, the cost of repair is relatively high.

Ausgrid has maintained the same rates in real terms from our 2008 proposal and the 2008 proposal was based on the 2005 proposal to IPART.

The calculation for the revenue requirements of connection repairs are as follows:

Annual Connection revenue requirement = Flat rate (as per connection type) x number of connections

3.6 Scheduled maintenance assumptions

Table 10 lists the tasks, cycle times and rates associated with the BLR program. These rates and cycle times form the inputs used to calculate the costs associated with Bulk Contract and Bulk Materials expenditure.

The FY15 BLR rates are derived from FY13 tendered sub contractor rates escalated by CPI. All BLR tender details can be found in the supporting documentation of attachment 8.12 – Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1 (ID00262).

The BLR is driven around the need to periodically replace lamps and PE cells to maintain compliance with the relevant Australian Standards whilst minimising the costs associated with this. The tasks that cover the relamping of all luminaire are the 'Servicing of Minor Luminaire – Scheduled' and 'Servicing of Major Luminaire – Scheduled' and the task that covers PE cell replacement is 'Replacement of Photo-electric Cell'. The other tasks listed below are performed as required and the cycle times are calculated from the historical frequencies that the various tasks are performed. Within supporting documentation for attachment 8.12 - 'Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262) summarises the frequencies at which these other tasks were performed and the calculation of the cycle times.

Ausgrid intends to move to a 3 year cycle within the coming regulatory period and as such this is the input we have used in the cost build up model. Moving from a 2.5 year to 3 year is likely to derive an increase in unit costs per task due to the fact that BLR contractors would have less work per year yet have the same fixed costs, however Ausgrid has used the current 2.5 year BLR rates in the opex pricing model.

Table 10 – BLR task cycle times and rates

Description of Task	Cycle Time	FY 15 Rate ($)
Servicing of Minor Luminaire - Scheduled	3.00	21.91
Servicing of Major Luminaire - Scheduled	3.00	25.96
Replacement of Minor Luminaire Visor	42.71	12.18
Replacement of Major Luminaire Visor	42.71	14.51
Replacement of Photo-electric Cell	6.00	4.09
Minor Non-Electrical Repair	217.85	33.91
General Electrical Work	24.98	86.77
Minor Electrical Work	46.30	143.64
Major Electrical Work	81.82	256.65
Electrical Work Previously Completed by Ausgrid	-	-
Quarterly Night Time Traffic Route Luminaire (TRL) Patrol	8,990.00	11,918.87
Annual Night Time Patrol of All Serviced Luminaires	4,007.44	8,653.84
Ad Hoc Works Order	-	-
Ad Hoc Patrolling And Reporting of Defects (Per Crew Hour)	-	-

The relationship between cycle times, unit rates and revenue requirements are detailed below:

Annual revenue requirement = unit rate x lamp count x 1/cycle Time

For example:

'Servicing of Major Luminaire – Scheduled' (i.e. bulk replamping on major roads)

Annual revenue requirement = 25.96 x 79,000 x 1/3 = $683,611

That is, the annual revenue requirement for the labour component of the 'Servicing of Major Luminaire – Scheduled' is $683,611.

The less intuitive cycle times and rates are the 'Quarterly Night Time Traffic Route Luminaire (TRL) Patrol' and 'Annual Night Time Patrol of All Serviced Luminaires'. The quarterly night patrols are performed by external service providers in the South and East regions and by Ausgrid field staff in all other regions. They are a means of detecting faults on major traffic routes that are unlikely to be reported by the general public. Having an alternative means of fault detection on these routes is a requirement of AS1158. Rates for the South and East are competitively tendered contract rates and are given as a lump sum per quarterly patrol. Supporting documentation for attachment 8.12 - Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262) details these. Ausgrid has then calculated a price per lamp based on these contract rates and applied it across the rest of the network. The cycle time is such that the annual cost of these patrols is spread across the entire population of street lights.

The annual night patrols are an inspection of all street lights and are performed by contractors only. Rates are again competitively tendered contract rates and are given as a lump sum per patrol and the cycle time is such that the annual cost of this patrol is spread over the entire population.

Cycle times that have no value in Table 10 are not used in any calculations as they are no longer tasks that are performed by the BLR contractors.

4. Previous determination decisions

The AER's final decision titled 'EnergyAustralia distribution determination 2009-10 to 2013-14 – Alternative control (public lighting) services, April 2010' yielded a number of questions regarding Ausgrid's (EnergyAustralia) opex forecasts. Section 3 'Operating expenditure' of the above mentioned document outlines a number of points that Ausgrid either did not provide enough supporting information or consultants review of the information led to a different outcome. Over the period Ausgrid has worked towards answering some of the questions raised and sought to improve the way in which public lighting data is captured and reported.

Labour Rates

Ausgrid's base labour rate (FY15) in both capital annuity and opex cost build up models is $42.99. This figure has been determined by a calculation of the average award rate of pay of a linesman from all cost centers that perform street lighting tasks. The overtime rate has been determined to be 1.89 times the standard hourly rate and has been calculated from the historical number of overtime hours worked at the various penalty rates in financial years 2013 and 2014. Ausgrid offers 1.5x, 2.0x and 2.5x penalty rates. The calculation of 1.89 times is a ratio of the real hours worked to the number of penalty rate hours paid.

The proposed proportion of work performed in overtime hours has been calculated to be 16%. This is a reduction of 1.4% from the last determination. This figure is again based on the historical amount of work performed by overhead linesmen from all cost centers associated with public lighting capital and maintenance tasks.

Supporting calculations for all labour rates can be found within supporting documentation for attachment 8.12 - Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262).

Bulk Lamp Replacement Cycle

The 2010 determination recommended that Ausgrid apply a 4 year bulk lamp replacement (BLR) to all high pressure sodium (HPS) luminaires on traffic routes and a 3 year (BLR) to all other luminaires. Ausgrid had and still has reservations about applying two different length cycles within our network for the same reason we had in 2010. Ausgrid approached our BLR contractors to price based on the split cycles that the AER recommended.

Active Tree Services made the following statement:

> *"We see no impact on the unit prices for the residential works regardless of the period, nor do we foresee a change in unit prices for a change in Period when the Res/TRL remain the same (e.g. both 3, 3.5 or 4 yrs). Where there is a difference in the Period between Residential and TRL we estimate an increase in costs of 20% for the TRL due to the additional travel and a reduction in economy of scale having to work in 2 different geographic areas in an individual month. There will also be slightly increased costs administering two different areas/references at the same time. We believe extended Periods will add to the number of adhoc works for failed lamps detected during the programmed audits, however, as these items are not included in the BLR unit costs they have not been included in our calculations for this exercise."*

Utility Asset Management's also provided an approximate increase in rates and their justifications comments were:

- *Loss of productivity for crews revisiting ISG plans*
- *Additional fuel expenses for crews due to above mentioned first point*
- *Additional auditing expenses as TRL/NTRL maps are separated*
- *Additional administration (scheduling of more maps, reconciliation of maps, etc)*
- *Potential for additional Traffic control as NTRL nears intersections of TRL & vice versa*

Ausgrid continues to replace the technology that limits the length of the BLR beyond 3 years. Appendix B details the technical constraints of this technology and the potential compliance issues that moving to a longer BLR will have. Until all of the high wattage mercury vapour luminaires are replaced (as per Ausgrid's invest plans for the FY15 – FY19 regulatory control period) we will be limited to a maximum 3 year BLR.

Overhead Rates

Ausgrid has calculated its public lighting operational and capital expense overhead rates separately. The opex overhead rate is based on historical overhead expenditure and the capex is based on forecast expenditure. Both overhead rates have reduced from the 2010 decision. Calculations of the opex overhead rates are detailed within supporting documentation for attachment 8.12 - Public Lighting Opex Forecast – '2014.04.29 Public Lighting Opex - Consolidated Supporting Figures v1' (ID00262) and the capital overhead rate calculation is detailed within supporting documentation for attachment 8.08 - Public lighting capex investment plan summary – '2014.05.21 Post June 09 Capex Revenue & Resource V1' (ID00263).

Spot Maintenance Time Requirements

The 2010 decision reduced the proposed spot repair time (time for minor tasks such as a lamp or pe cell change) to 31.7 minutes from a proposed 40 minutes. Ausgrid undertook a time in motion study to accurately record the amount of time the various public lighting tasks take. The supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – 'Public Lighting Time in Motion' (ID00266) study along with the supporting calculations in attachment 8.12 – Public Lighting Opex Forecast – 'Public Lighting Time Motion Study.xls' (ID00266) gives the details of this study and has calculated a time of 45.4 minutes to complete a minor spot maintenance task.

Assumed spot lamp failure

Section 3.2 of this document details the attendance rates of the various lamp technologies. Ausgrid is deliberately calling these attendance rates rather than failure rates as the calculated numbers are the percentages of the population that are attended for spot maintenance for any number of reasons, not just a lamp failure. These attendance rates were the outcome of the Weibull analysis in Appendix A. A similar study was performed in 2010 titled 'Street Lighting MRA Review, 13 Jan 2010'. The results of this study were significantly lower than expected and not in line with operational expenditure for that period. One significant difference between the two studies is the amount of failure records used in each study. The 2013 analysis used 47,683 failure and 218,215 suspended records over a 2.5 year period where the 2010 study had only 15,571 failure and 437,523 suspended records over a 3.5 year period. This explains the significant difference in results between the two studies. The results of the recent study is able to reconcile the reported operational expenditure over the FY10 – FY14 regulatory control period as per Table 3 - Comparison of 2010-14 regulatory allowance, actual operating expenditure and failure rate analysis $(M), which further supports the use of these rates in the opex cost build up pricing model.

5. Summary

Ausgrid has been under recovering its Public Lighting operational expenditure throughout the FY09 – FY14 regulatory period. This proposal is seeking an increase to maintenance costs across the major lamp types so that these costs better reflect the cost to serve. Ausgrid has proposed a number of capital programs aimed at reducing Public Lighting opex, however until these programs are rolled out the operational costs will remain at the levels they are now.

Ausgrid understands that theoretically costs can be reduced by increasing the cycle times associated with scheduled maintenance; however with Ausgrid's current public lighting inventory the total operational costs are extremely sensitive to these cycle times as unscheduled maintenance rates of the major lamp types are higher than expected and higher than what was accepted in the previous determination. It is for this reason that Ausgrid has targeted a number of technologies on its network to be replaced with more efficient and reliable technology.

Ausgrid is continuing its improvement of data collection of failure rates of particular components so that better analysis can be undertaken to determine the financial optimum BLR cycle. However, it does believe that the analysis undertaken as part of this submission is accurate and correctly represents Ausgrid's operational expenditure.

Appendix A – Maintenance Requirements analysis summary

Background

This review was undertaken to determine the rates of attendance for unscheduled maintenance to the various lamp technologies on Ausgrid's public lighting network. This study was performed so as to justify the unscheduled maintenance component of Ausgrid's operational expenditure revenue requirements in the FY15 – FY19 regulatory control period.

This analysis included all major lamp types that are maintained by Ausgrid. These lamps may be found in several different luminaire types however the type of luminaire is not considered to be a factor that affects lamp life and has been excluded from this analysis. Luminaires that are maintained by Ausgrid are classed as rate 1 (Ausgrid funded) and rate 2 (customer funded). Ausgrid does not have data for rate 3 lamps, which are privately owned and maintained. The period of analysis is from the 1 November 2010 to 30 April 2013. This period covers a full 2.5 year BLR cycle.

Table 11 lists the lamp types that were included; these make up 99% of the inventory of lamps in Ausgrid's service area.

Table 11 – Lamp types included in analysis

Description	Lamp Code	Population as at April 2013
125W Mercury Vapour	MBF1*125	5838
250W Mercury Vapour	MBF1*250	18716
400W Mercury Vapour	MBF1*400	7300
42W Compact Fluorescent	MBF1*42	48366
50W Mercury Vapour	MBF1*50	12682
700W Mercury Vapour	MBF1*700	124
80W Mercury Vapour	MBF1*80	79874
100W High Pressure Sodium	SON1*100	1432
150W High Pressure Sodium	SON1*150	19742
250W High Pressure Sodium	SON1*250	25112
400W High Pressure Sodium	SON1*400	2170
70W High Pressure Sodium	SON1*70	2177
40W Tubular Fluorescent	TF1*40	694
Twin 20W Tubular Fluorescent	TF2*20	21870
Total		**246097**
All rate 1 and rate 2 lamps		**248452**

All planned and unplanned maintenance tasks that are performed on a streetlight are recorded as notifications in SAP. Notifications are classified by the codes listed below:

- M1 – Planned Maintenance
- M2 – Corrective
- M3 – Breakdown
- M4 – Nature induced breakdown
- M5 – Damage by 3rd party
- M6 – Rotable repair (minor refurbishment)
- M7 – Minor capital replacement

M1 notifications are scheduled maintenance (BLR), M2 – M6 are unscheduled (spot) maintenance and M7 are capital replacements (luminaire/bracket replacements). Along with the classification type more specific data on the action taken such date, lamp or PE cell replacement, wattage, pole number and equipment number is also captured.

The majority of spot maintenance is made up of M3 notifications and the majority of these involve a lamp and PE cell change. M7 notifications are typically when a luminaire is replaced because of a failure or upgrade. M7 notifications are thus excluded from this analysis as they are recorded as capital expenditure. Table 12 shows the breakdown of the notifications included in the following failure rate analysis.

Table 12 - Breakdown of notifications

Classification type	number recorded over period	% of total
M1	244051	73.43%
M2	3597	1.08%
M3	63442	19.09%
M4	262	0.08%
M5	0	0.00%
M6	0	0.00%
M7	21012	6.32%
Total	332364	

Weibull Analysis

To determine the failure rate characteristics of the various lamp types a Weibull Analysis was undertaken using the notification data extracted from SAP. The method used to obtain the raw input data was as follows:

1. For each pole number, identify and group the lamp type and obtain the date of the M1 notification within the period of analysis;
2. Obtain the dates of all M2 – M6 notifications;
3. Calculate the number of days between steps 1 and 2;
4. Calculate the number of days between additional M2 – M6 tasks per streetlight; and
5. Convert days to the equivalent streetlight burning hours. A day was equated to an average of 12 burning hours.

This process resulted in a list of how often each streetlight is attended throughout the analysis period. In some cases there may only be a single M1 notification, in this case the record is considered suspended data as that particular lamp has not failed since the BLR. In other cases, there may be one M1 and up to six other notifications on a given streetlight, this is considered failure data as it represents an actual number of days between unscheduled maintenance attendances. Notifications that were less than 10 days after the M1 notification have been excluded. This allows for data entry errors or duplications and incorrect installation/handling/transport issues.

The final data set for the Weibull analysis comprised of 47,683 failure and 218,215 suspended data records totalling 265,898 records. Table 13 summarises the results of this analysis.

Table 13 - Weibull analysis results summary

Lamp Type	η	β	% call out at 2.5 years	% call out at 3 years	% call out at 4 years	Days to 10% receive call out	Burning Hours to 10% receive call out
MBF1*125	2657	0.7319	36.71%	40.71%	47.54%	123	1473
MBF1*250	3421	0.7242	31.89%	35.48%	41.71%	153	1836
MBF1*400	2933	0.7628	33.66%	37.60%	44.42%	153	1842
MBF1*42	1751	1.017	40.27%	46.23%	56.45%	192	2299
MBF1*50	1266	1.22	48.86%	56.73%	69.58%	200	2402
MBF1*700	1462	0.7408	50.60%	55.39%	63.17%	70	841
MBF1*80	4939	0.8334	21.71%	24.79%	30.38%	332	3982
SON1*100	2559	0.7789	36.10%	40.32%	47.58%	142	1708
SON1*150	2231	0.8446	37.50%	42.20%	50.29%	155	1864
SON1*250	2055	0.864	39.10%	44.04%	52.49%	152	1823
SON1*400	1751	0.8405	43.91%	49.03%	57.61%	120	1444
SON1*70	3282	0.7258	32.63%	36.29%	42.62%	148	1773
TF1*40	2070	0.6882	43.40%	47.54%	54.45%	79	944
TF2*20	4175	0.7445	27.55%	30.87%	36.71%	203	2438

Notes:

η (the characteristic life) is the time (in days) at which 63.2% of the population are expected to fail

β (the shape parameter). β > 1 gives an increasing failure rate in time. β < 1 the failure rate in time is decreasing. It is intuitive to think that β should be > 1 in all instances as the longer the period of time the greater the expected failure rate. However as there is a BLR in place, many of the lamps are replaced before they fail, so this data cannot be captured. The β of < 1 suggests a random failure shape parameter, which is what Ausgrid experience.

The results show a significantly higher number of unscheduled maintenance occurrences than was expected. Table 14 details the rates assumed in the 2009 determination, those from Ausgrid's analysis and the manufacturers' published lamp failure rates, based on an annualised 4 year BLR for HPS lamps on TRL roads and a 3 year BLR for all other lamps.

Table 14 – Comparison of failure rates

Lamp Description / (BLR Cycle)	2009 AER Determination Annual Failure rate	Ausgrid analysis unscheduled maintenance annual attendance rates	Annualised manufacturers lamp failure rate at BLR Cycle time
MBF1x125 (3 yr)	2.96%	13.57%	6.33%/2.00%*
MBF1x250 (3 yr)	1.68%	11.83%	6.33%
MBF1x400 (3 yr)	1.45%	12.53%	6.33%
MBF1x42 (3 yr)	4.01%	15.41%	2.33%
MBF1x50 (3 yr)	1.01%	18.91%	6.33%/2.00%*
MBF1x700 (3 yr)	4.83%	18.46%	11.66%
MBF1x80 (3 yr)	2.43%	8.26%	6.33%/2.00%*
SON1x100 (3 yr)	2.66%	13.44%	1.50%
SON1x150 (4 yr)	3.18%	12.57%	1.50%/1.00%*
SON1x250 (4 yr)	3.65%	13.12%	1.50%/1.00%*
SON1x400 (4 yr)	4.30%	14.40%	1.50%/1.00%*
SON1x70 (3 yr)	2.39%	12.10%	2.00%
TF1x40 (3 yr)	36.00%	15.85%	2.33%
TF2x20 (3 yr)	11.00%	10.29%	4.50%

* Ausgrid changed to longer life lamps during this regulatory control period. The lower failure rate is the failure rate associated with the new lamp type

Further details of this study can be found in supporting documentation for attachment 8.12 – Public Lighting Opex Forecast – 'WEIBULL Summary Data.xls' (ID00261).

APPENDIX B – TECHNICAL CONSTRAINTS OF HIGH WATTAGE MERCURY VAPOUR LAMPS

Ausgrid has approximately 25,000 luminaires that contain high wattage Mercury Vapour lamps on its network. Mercury lamps of wattages greater than 250W are considered high wattage and are predominantly installed on category V (major/TRL) roads.

These lamp types constrain Ausgrid to moving to a BLR cycle any greater than 3 years because of their particular luminous flux and survival rate characteristics. Figure 1 details these characteristics and Table 15 summarises this data.

Luminous flux behavior or lamp lumen maintenance factor (LLMF) is the reduction of light output from the lamp per the number of hours burned. The survival rate or lamp survival factor (LSF) is the expected number of lamps to survive per number of hours burned.

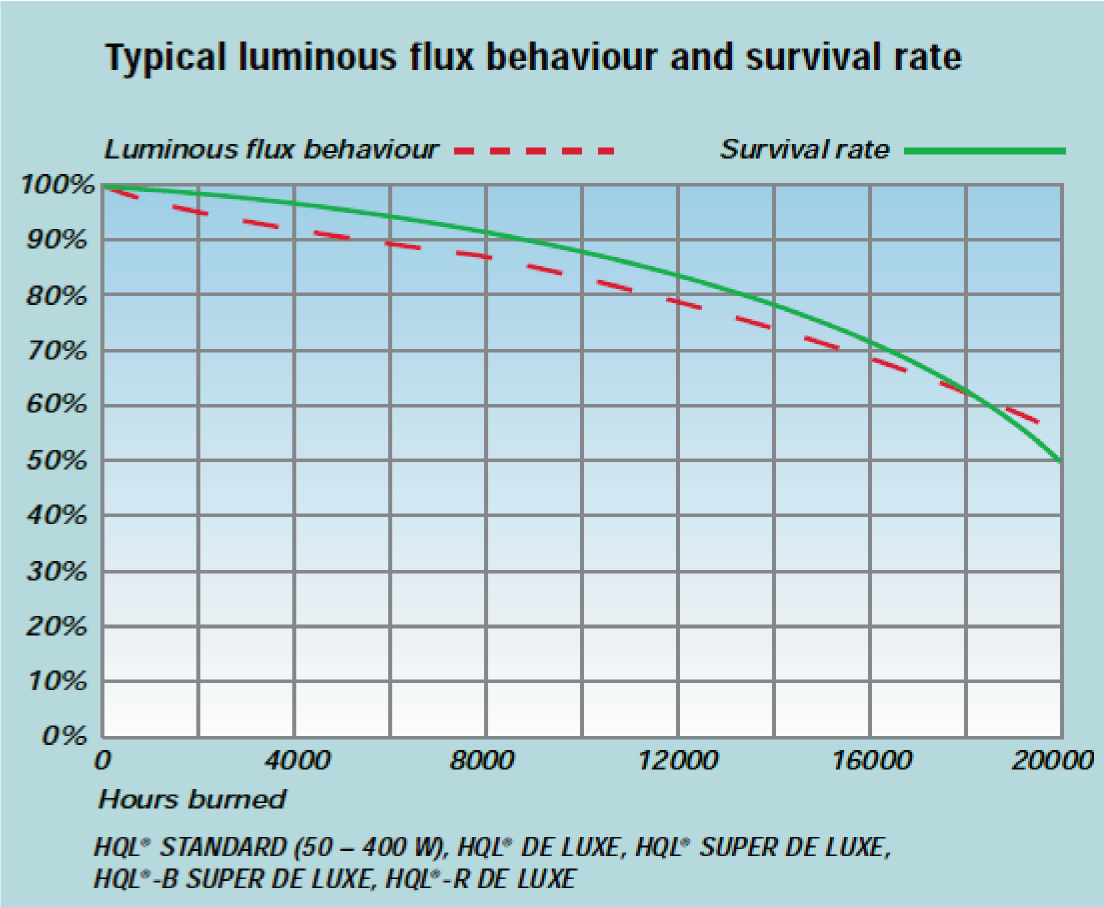

Figure 1 - 250W & 400W LLMF & LSF

Manufacturers data											
Hours burned	0	2000	4000	6000	8000	10000	12000	14000	16000	18000	20000
Years	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Months	0	6	12	18	24	30	36	42	48	54	60
LSF	100%	98%	96%	94%	91%	88%	83%	78%	71%	62%	50%
LLMF	100%	95%	92%	89%	87%	83%	79%	74%	69%	62%	55%

Table 15 - 250W & 400W LLMF & LSF

AS1158.1.1:2005 – *Lighting for roads and public spaces - Vehicular traffic (Category V) lighting - Performance and design requirements*, specifies the lighting levels for various category V road scenarios. Compliance to this standard is met by design, that is, for and installation to comply with this standard a computer based illumination design is required. The lighting designer therefore needs to take into consideration the fact that the lumen output of a lamp will decrease over time and factor this into the design. Accordingly, the designer must know the maintenance regime in place. The industry standard design practice is to design to a maintenance factor of 0.7. This means that the installation can drop to 70% of its initial lighting levels and still maintain the illumination requirements of AS1158.

Table 16 has been taken directly from AS1158. The luminaire maintenance factor (LMF) is the degradation of light associated with the build up of dirt and dust both inside and outside the luminaire. This table along with the LLMF values of the lamp is used to determine the overall light output of the luminaire against time.

MF = LLMF x LMF

For the 250W and 400W mercury vapour lamps the total reduction in light output from an IP6x luminaire in a medium pollution zone over a 3 year BLR period would be as follows;

MF = LLMF x LMF = 0.79 x 0.87 = 0.68 = 68%

For the same scenario over a 4 year BLR period:

MF = LLMF x LMF = 0.69 x 0.84 = 0.58 = 58%

This suggests that the installation would drop out of compliance before the bulk lamp replacement would replace the lamps if the installation was designed with a maintenance factor of 0.7. This would therefore be considered a non compliant installation and this is the constraint that Ausgrid faces.

Table 16 - AS1158 Luminaire Maintenance Factors

TABLE F1

LUMINAIRE MAINTENANCE FACTORS

Cleaning interval	Luminaire IP rating					
	IP 5X			IP 6X		
	Pollution category[a)]			Pollution category[a)]		
Months	High	Medium	Low	High	Medium	Low
12	0.89	0.90	0.92	0.91	0.92	0.93
18	0.87	0.88	0.91	0.90	0.91	0.92
24	0.84	0.86	0.90	0.88	0.89	0.91
36	0.76	0.82	0.88	0.83	0.87	0.90
48	0.66	0.76	0.86	0.75	0.84	0.89

a) The *high* pollution category applies for centres of cities and large towns and for heavy industrial areas, *medium* for semi-urban, residential suburbs and light industrial areas, *low* for outer residential suburbs and rural areas.

NOTE: The values of luminaire maintenance factor are based on those given in BS 5489 Part 1:2003 with those for a 48 month cleaning interval being an extrapolation of that data set; further extrapolation by cleaning interval is not recommended.