6.7 Lighting maintenance

When a lighting installation is first commissioned conditions are at their optimal, that is the luminaires, lamps and reflective surfaces in the space are new and clean. Through the life of the installation these conditions will deteriorate as age and dirt reduce the effectiveness of the lighting. Consequently when designing a lighting installation it is common to design for a maintained lighting value, that is the lighting level achieved when the luminaires, lamps and reflective surfaces are at their oldest or dirtiest.

To calculate maintained lighting levels it is necessary to calculate the light loss at the point when the luminaires, lamps and reflective surfaces are at their oldest or dirtiest. This means that the maintenance cycle for the installation must be defined.

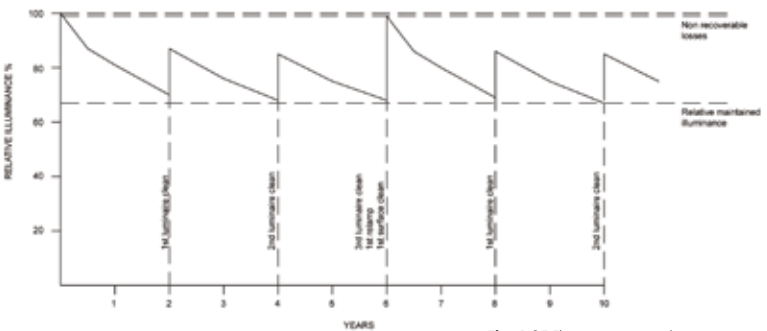

Fig. 6.35 The maintenance cycle

The maintenance cycle consists of three main activities:

1. Cleaning and maintaining the luminaire
2. Cleaning and maintaining the lamp
3. Cleaning and maintaining the reflective surfaces in the lit space. In exterior area lighting the impact of reflective surfaces may be negligible. However in applications such as tunnels and underpasses, and also the lighting of building facades regular cleaning can improve the performance of the lighting scheme.

An example is shown in Figure 6.35, in which the luminaire is cleaned every two years, and is cleaned and re-lamped and the reflective surfaces are cleaned every six years. In this example the installation maintenance factor is 67 per cent, so at worst case only 67 per cent of the initial lighting level is being realised. Note, the installation will never reach the initial lighting levels achieved when new, as deterioration of some of the components within the luminaire, and of the surface finishes within the space, cannot be fully recovered by cleaning.

The main factors that influence the loss of lighting performance through life for an installation are:

- The cleanliness of the environment. In industrial or urban environments airborne dirt will be much higher than in clean room or rural environments. Therefore either the luminaires and reflective surfaces within the space will need cleaning more often or the maintenance factor for the installation will be reduced.
- The type of luminaire specified within the installation. In dirty environments using an open luminaire will allow dirt deposition within the luminaire that is very difficult to clean. Using a sealed unit prevents dirt from entering the luminaire and therefore only the external surfaces require cleaning and may be cleaned more vigorously.
- The lamp technology used within the installation. Different lamp types have different characteristics with respect to lumen maintenance and lamp life and deciding when to relamp is a compromise between these two factors. Selecting a lamp with good lumen maintenance through life will reduce the light loss due to lamp aging. However, the installation performance also relies on all (or at least the majority) of lamps working. So either a spot lamp replacement system must be used where any failed lamps are immediately replaced, or the installation maintenance factor must include an adjustment for the percentage of broken lamps expected before relamping. Therefore, relamping must be done when the lamp lumens have reached a minimum acceptable value and the number of failed lamps in the installation has reached a maximum acceptable level.

Specific Techniques

The installation maintenance factor is then the product of all the maintenance factors of the installation components.

$MF_{installation}$ = luminaire MF x lamp lumen MF x lamp survival MF x reflective surface MF

Where

luminaire MF	the amount of light lost due to the luminaire through aging and dirt deposition on the luminaire
lamp lumen MF	the amount of light lost due to a reduction in lamp flux as the lamp ages
lamp survival MF	the amount of light lost due to failed lamps which are not immediately replaced
reflective surface MF	the amount of light lost due to reduced reflection from surfaces within the installation

Data for these factors should be available from manufacturers. However the data will assume the unit is operating within normal conditions as specified by the manufacturer. Operating outside these conditions could (and probably will) alter the characteristics of the unit. For example operating a lamp in a hot environment may increase the lumen output of the lamp, but at expense of lumen maintenance and lamp life.

Many lighting design software allow the maintenance schedule to be defined and use this to calculate an installation maintenance factor. However further guidance on calculating and using maintenance factors may be found in publications CIE 97-2006 - Maintenance of Indoor Electric Lighting Systems and CIE 154:2003 - The Maintenance of Outdoor Lighting Systems

Standard tables for luminaire and room surface maintenance factors exist in CIE 97 and in the absence of more comprehensive manufacturers data these may be used. They rely on the classification of the environment being lit into very clean, clean, normal or dirty, and classification of the luminaire according to its resistance to the effects of dirt (type A to G).

Specific Techniques

Table 6.2 gives help in deciding which environment should be used, along with advice on typical cleaning intervals.

Inspection interval	Environment	Activity or Task area
3 years	Very Clean	Clean rooms, semi conductor plants, hospital clinical areas*, computer centres
	Clean	Offices, schools, hospital wards
2 years	Normal	Shops, laboratories, restaurants, warehouses, assembly areas, workshops
1 year	Dirty	Steelworks, chemical works, foundries, welding, polishing, woodwork

Table 6.2 Typical inspection periods for differing environmental conditions

*In clinical areas more frequent inspections may be required

Table 6.3 gives guidance on deciding the type of luminaire, which is then used in the luminaire maintenance table to determine the luminaire maintenance factor.

Type	Luminare type	Luminaire description
A	Bare batten	bare lamp luminaires
B	Open top housing (natural ventilated and "self cleaning" types)	Direct-indirect luminaires without cover, direct-indirect luminaires with indirect reflector and closed optical device, wallwashing luminaires (vertical opening), wall mounted luminaires open top and base, downlights with open top
C	Closed top housing (unventilated)	Recessed and surface mounted luminaires (e.g. with louvres), downlights, spotlights
D	Enclosed IP2X	General purpose luminaires with closed covers and optics
E	Dust proof IP5X	Dust proof IP5X (protected, clean room luminaires)
F	Indirect lighting and uplight	Free standing, pendant, wall mounted uplighters with closed base, cove lights
G	Air handling and forced ventilated	Air handling body and optic used with air-conditioning or ventilation systems

Table 6.3 Luminaire type and description

When the environment and luminaire type have been determined the tables shown below may be used to give the luminaire maintenance factor and room surface maintenance factor. The room surface maintenance factor depends upon the downward flux fraction (DFF) for the luminaire, which is defined as

DFF = downward light output ratio / total light output ratio.

Elapsed time between cleanings in years	0	0.5				1.0				1.5			
Environment Luminaire type	Any	VC	C	N	D	VC	C	N	D	VC	C	N	D
A	1	0.98	0.95	0.92	0.88	0.96	0.93	0.89	0.83	0.95	0.91	0.87	0.80
B	1	0.96	0.95	0.91	0.88	0.95	0.90	0.86	0.83	0.94	0.87	0.83	0.79
C	1	0.95	0.93	0.89	0.85	0.94	0.89	0.81	0.75	0.93	0.84	0.74	0.66
D	1	0.94	0.92	0.87	0.83	0.94	0.88	0.82	0.77	0.93	0.85	0.79	0.73
E	1	0.94	0.96	0.93	0.91	0.96	0.94	0.90	0.86	0.92	0.92	0.88	0.83
F	1	0.94	0.92	0.89	0.85	0.93	0.86	0.81	0.74	0.91	0.81	0.73	0.65
G	1	1,00	1.00	0.99	0.98	1.00	0.99	0.96	0.93	0.99	0.97	0.94	0.89

Elapsed time between cleanings in years	0	2.0				2.5				3.0			
Environment Luminaire type	Any	VC	C	N	D	VC	C	N	D	VC	C	N	D
A	1	0.94	0.89	0.84	0.78	0.93	0.87	0.82	0.75	0.92	0.85	0.79	0.73
B	1	0.92	0.84	0.80	0.75	0.91	0.82	0.76	0.71	0.89	0.79	0.74	0.68
C	1	0.91	0.80	0.69	0.59	0.89	0.77	0.64	0.54	0.87	0.74	0.61	0.52
D	1	0.91	0.83	0.77	0.71	0.90	0.81	0.75	0.68	0.89	0.79	0.73	0.65
E	1	0.93	0.91	0.86	0.81	0.92	0.90	0.85	0.80	0.92	0.90	0.84	0.79
F	1	0.88	0.77	0.66	0.57	0.86	0.73	0.60	0.51	0.85	0.70	0.55	0.45
G	1	0.99	0.96	0.92	0.87	0.98	0.95	0.91	0.86	0.98	0.95	0.90	0.85

Table 6.4 Luminaire maintenance factors based upon type and environment

reflectances ceiling/walls/floor	time/yrs	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00
	environment	room surface maintenance factors – utilisation plane												
0.80/0.70/0.20	very clean	1.00	0.97	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	clean	1.00	0.93	0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
	normal	1.00	0.88	0.86	0.86	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
	dirty	1.00	0.81	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
0.80/0.50/0.20	very clean	1.00	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
	clean	1.00	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
	normal	1.00	0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	dirty	1.00	0.86	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
0.80/0.30/0.20	very clean	1.00	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
	clean	1.00	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
	normal	1.00	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
	dirty	1.00	0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
0.70/0.70/0.20	very clean	1.00	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
	clean	1.00	0.94	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
	normal	1.00	0.89	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
	dirty	1.00	0.83	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
0.70/0.50/0.20	very clean	1.00	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
	clean	1.00	0.96	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
	normal	1.00	0.92	0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	dirty	1.00	0.87	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
0.70/0.30/0.20	very clean	1.00	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
	clean	1.00	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
	normal	1.00	0.95	0.94	0.94	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
	dirty	1.00	0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
0.50/0.70/0.20	very clean	1.00	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
	clean	1.00	0.95	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
	normal	1.00	0.91	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
	dirty	1.00	0.85	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
0.50/0.50/0.20	very clean	1.00	0.98	0.98	0.98	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
	clean	1.00	0.97	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	normal	1.00	0.94	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
	dirty	1.00	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
0.50/0.30/0.20	very clean	1.00	0.99	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
	clean	1.00	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
	normal	1.00	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	dirty	1.00	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92

Table 6.5 Room surface maintenance factors for DFF=1.0 (direct luminaires)

Table 6.6 Room surface maintenance factors for DFF=0.5 (direct/indirect luminaries)

reflectances ceiling/walls/floor	time/yrs	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00
	environment	**room surface maintenance factors – utilisation plane**												
0.80/0.70/0.20	very clean	1.00	0.95	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
	clean	1.00	0.90	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
	normal	1.00	0.81	0.78	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
	dirty	1.00	0.70	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
0.80/0.50/0.20	very clean	1.00	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	clean	1.00	0.93	0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	normal	1.00	0.85	0.83	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
	dirty	1.00	0.76	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
0.80/0.30/0.20	very clean	1.00	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
	clean	1.00	0.94	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
	normal	1.00	0.89	0.87	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
	dirty	1.00	0.81	0.79	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.70/0.70/0.20	very clean	1.00	0.96	0.94	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
	clean	1.00	0.91	0.89	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
	normal	1.00	0.83	0.80	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
	dirty	1.00	0.72	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.70/0.50/0.20	very clean	1.00	0.97	0.96	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	clean	1.00	0.93	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
	normal	1.00	0.87	0.84	0.84	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
	dirty	1.00	0.77	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.70/0.30/0.20	very clean	1.00	0.98	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
	clean	1.00	0.95	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
	normal	1.00	0.90	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
	dirty	1.00	0.82	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
0.50/0.70/0.20	very clean	1.00	0.97	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
	clean	1.00	0.93	0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	normal	1.00	0.86	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
	dirty	1.00	0.76	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
0.50/0.50/0.20	very clean	1.00	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
	clean	1.00	0.94	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
	normal	1.00	0.89	0.87	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
	dirty	1.00	0.81	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
0.50/0.30/0.20	very clean	1.00	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
	clean	1.00	0.96	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
	normal	1.00	0.92	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	dirty	1.00	0.85	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84

reflectances ceiling/walls/floor	time/yrs	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00
	environment	room surface maintenance factors – utilisation plane												
0.80/0.70/0.20	very clean	1.00	0.93	0.91	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.89
	clean	1.00	0.86	0.82	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
	normal	1.00	0.72	0.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
	dirty	1.00	0.54	0.50	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
0.80/0.50/0.20	very clean	1.00	0.94	0.93	0.92	0.92	0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.91
	clean	1.00	0.88	0.85	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
	normal	1.00	0.76	0.72	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	dirty	1.00	0.59	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
0.80/0.30/0.20	very clean	1.00	0.96	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
	clean	1.00	0.90	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
	normal	1.00	0.80	0.76	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	dirty	1.00	0.64	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
0.70/0.70/0.20	very clean	1.00	0.93	0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	clean	1.00	0.86	0.83	0.82	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
	normal	1.00	0.73	0.68	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
	dirty	1.00	0.55	0.51	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
0.70/0.50/0.20	very clean	1.00	0.95	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
	clean	1.00	0.89	0.86	0.85	0.85	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
	normal	1.00	0.77	0.73	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	dirty	1.00	0.60	0.56	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
0.70/0.30/0.20	very clean	1.00	0.96	0.94	0.94	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
	clean	1.00	0.91	0.88	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
	normal	1.00	0.80	0.77	0.76	0.76	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.75
	dirty	1.00	0.65	0.61	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
0.50/0.70/0.20	very clean	1.00	0.94	0.92	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
	clean	1.00	0.87	0.84	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
	normal	1.00	0.75	0.70	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
	dirty	1.00	0.57	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
0.50/0.50/0.20	very clean	1.00	0.95	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
	clean	1.00	0.90	0.87	0.86	0.86	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
	normal	1.00	0.78	0.74	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
	dirty	1.00	0.61	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
0.50/0.30/0.20	very clean	1.00	0.96	0.95	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
	clean	1.00	0.91	0.89	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
	normal	1.00	0.81	0.78	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77
	dirty	1.00	0.66	0.62	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61

Table 6.7 Room surface maintenance factors for DFF=0 (indirect luminaires)

To determine the lamp lumen maintenance factor and lamp survival factor data published by lamp manufacturers should be used. Examples are shown below.

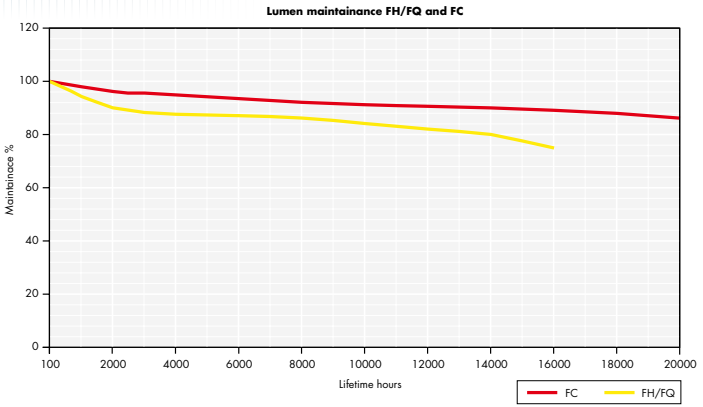

Figure 6.36 Example lumen maintenance curve (courtesy Osram)

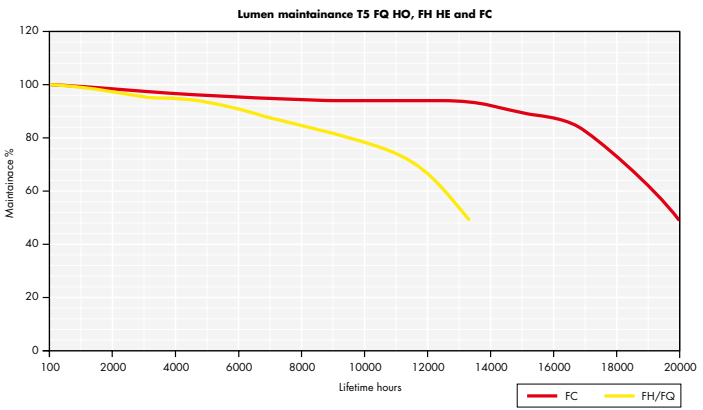

Figure 6.37 Example lamp survival curve (courtesy Osram)

Specific Techniques

For example, a closed top recessed louvred luminaire with an upward light output ratio of zero uses 14W T16 lamps (Osram FH), and is installed in an office with surface reflectance's of ceiling:70%, walls:50% and floor:20%. The room and luminaires are cleaned every three years, and the lamps are replaced every 8000 hours. Therefore:

Luminaire maintenance factor (LMF)
Luminaire is a closed top recessed louvred fitting, which is type C. As the luminaire is installed in an office this is a clean environment. Therefore, from Table 6.4 for a cleaning interval of three years the luminaire maintenance factor is given as 0.74.

Room surface maintenance factor (RSMF)
As the luminaire has an upward light output ratio of zero the downward light output ratio must be the same as the total light output ratio, and therefore the DFF equals one. Using Table 6.5 for reflectance's 0.80/0.50/0.20 gives a room surface maintenance factor of 0.94.

Lamp lumen maintenance factor (LLMF)
From Figure 6.36 when the lamp has been running for 8000 hours the lamp lumens has reduced to 92% of the original output (red curve).

Lamp survival factor (LSF)
From the red curve on Figure 6.37 when the lamps have been operating for 8000 hours 96% of the lamps will still be functional (e.g. 4% of the lamps will have failed).

Thus the maintenance factor is:

MF = MF * RSMF * LLMF * LSF

= 0.74 * 0.94 * 0.92 * 0.96

= 0.614