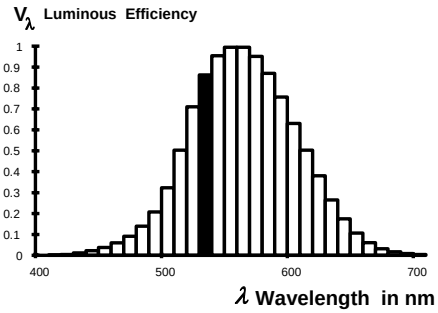
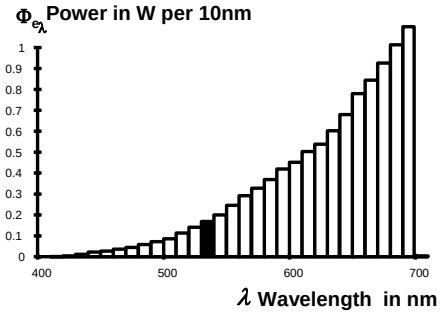
Properties of Light Sources

- Efficacy
- Life
- Colour
- Colour Rendering
- Physical Size
- Optical size
- Lumen maintenance
- Flicker
- Start up characteristics
- Control gear
- Economics



Luminous efficiency of radiation



Spectroradiometric Curve

$$\Phi_V = 683 \sum_{\lambda=400\,nm}^{\lambda=700\,nm} V_\lambda \Phi_{e_\lambda} 10\text{nm} \quad \text{lm}$$

$$\text{Efficacy} = \frac{\text{Light from lamp in Lumens}}{\text{Power consumed by the lamp and control gear in W}}$$

Date	Type of light source	Efficacy
pre-1880	Wax candle	0.1 lm/W
pre-1880	Paraffin lamp	0.3 lm/W
1880	Carbon filament	1.5 lm/W
1905	Carbon filament	4.0 lm/W
1910	Tungsten filament	8.0 lm/W
1930	Tungsten filament	13 lm/W
Today	Tungsten filament	10 - 14 lm/W
Today	Tungsten halogen	12 - 28 lm/W

Range of efficacies for incandescent light sources

Introduced	Type of lamp	Efficacy in lm/w	
		then	now
1932	Mercury	32	60
1981	Compact fluorescent	50	80
1938	Linear fluorescent	25	100
1964	Metal halide	65	100
1965	High pressure sodium	90	140
1932	Low pressure sodium	67	185

Range of efficacies for gas discharge lamps

Lamp type	Efficacy
Low pressure sodium lamp	100 - 200 lm/W
Fluorescent lamps - low pressure mercury	
ordinary fluorescent powders	55 - 60 lm/W
halophosphates	65 - 85 lm/W
triphospher lamps	80 - 100 lm/W
compact lamps	50 - 80 lm/W
High pressure sodium	70 - 140 lm/W
High pressure mercury	38 - 60 lm/W
Metal halide	70 - 100 lm/W

Range of efficacies for discharge lamps

Life of Lamp

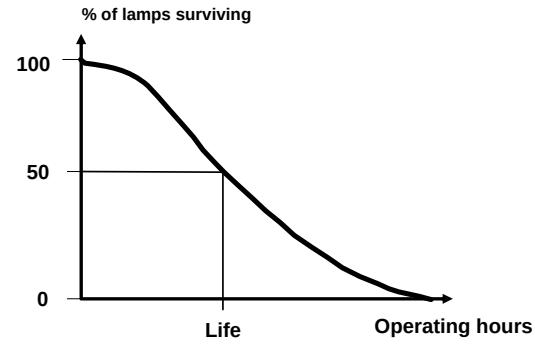
Conditions of service

- orientation of lamp
- frequency of switching
- temperature of lamp

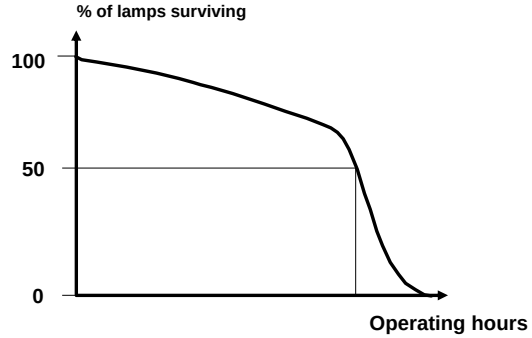
Batch or Individual replacement

Non- extinction failure

- increased flicker
- loss of light output
- poor starting
- change in colour



Lamp survival curve - type 1



Lamp survival curve - type 2

Colour of Light

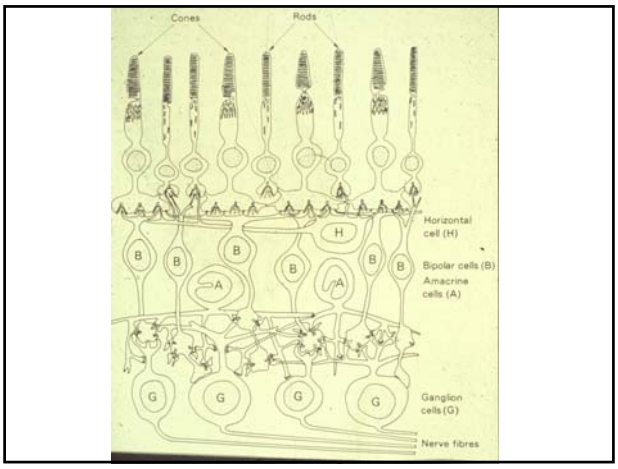
Matching different sources – daylight and electric
uniformity of appearance

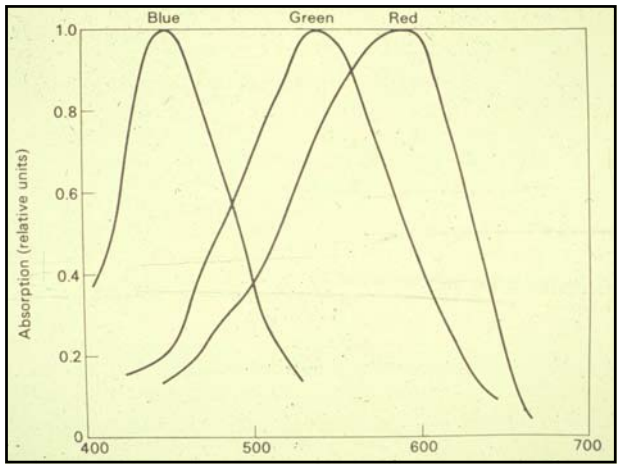
Contrasting colour – define or direct to a display

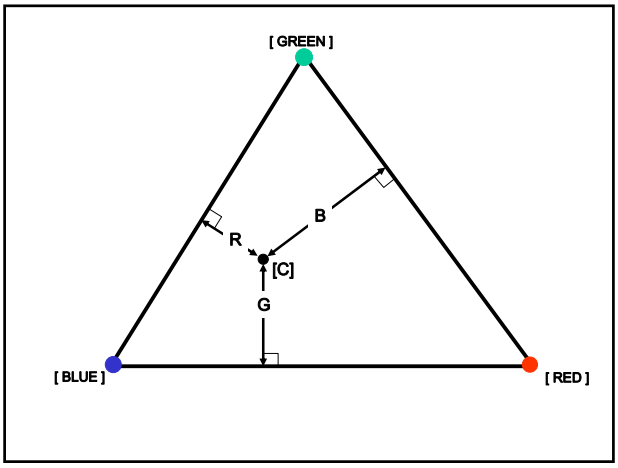
High illuminances - more suited to high CCT

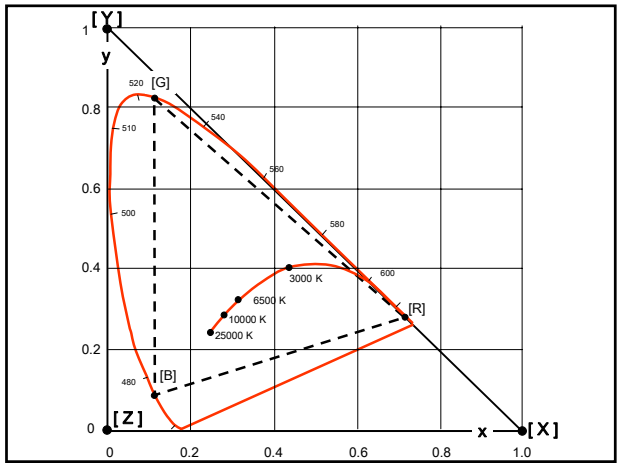
Low illuminances - more suited to low or intermediate CCT

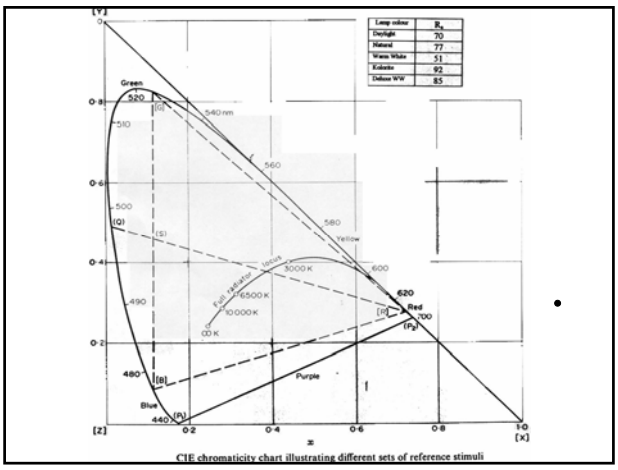
High CCT at low illuminances most unsatisfactory











Source	η - Efficacy in lm/W
Sun at a solar altitude < 7°	90
Sun at a solar altitude > 25°	117
Sun - suggested mean	100
Clear blue sky	150
Average sky	125
Global average	115

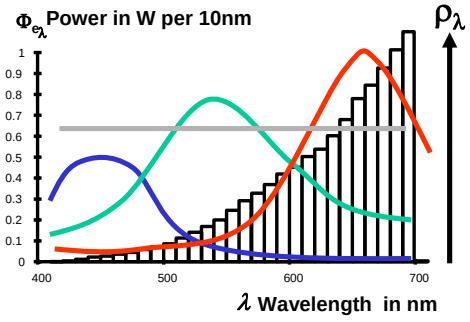
Efficacies of Natural Light

Correlated colour temperature	CCT class
Below 3300 K	Warm
3300 K - 5300 K	Intermediate
Above 5300 K	Cool

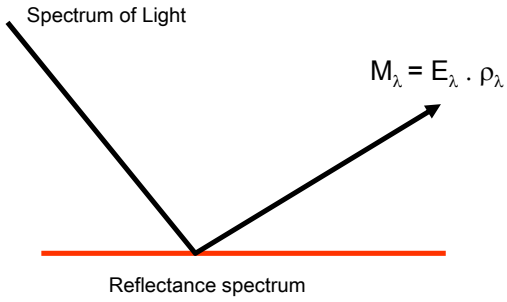
Classes of lamp colour

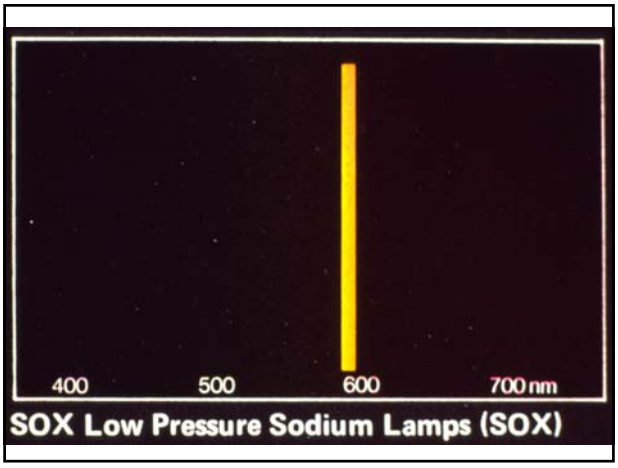
Source	Correlated Colour Temp.
Sun	4,000 K
increasing with solar altitude	5,500 K
Clear sky	10,000 - 100,000 K
Overcast sky	4,500 - 7,000 K
Global clear sky	5,000 - 7,000 K
Most frequently observed	c 6000 K

Correlated Colour Temperature of Natural Light

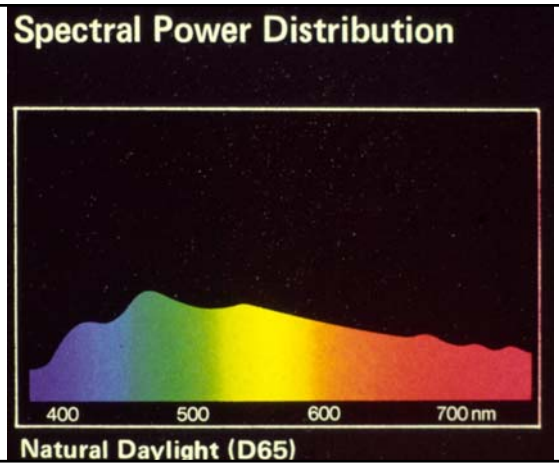


Spectroradiometric Curve

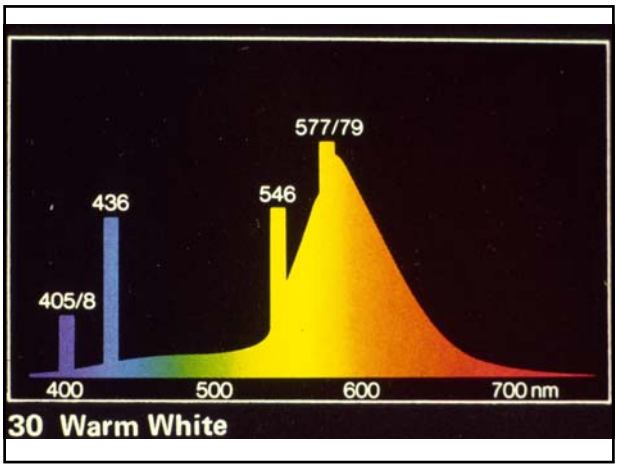


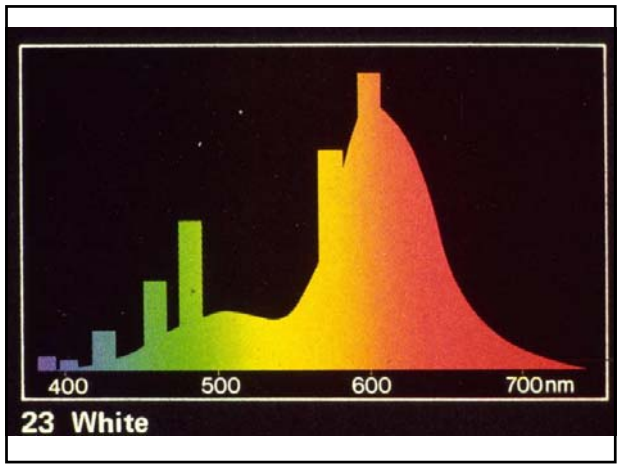


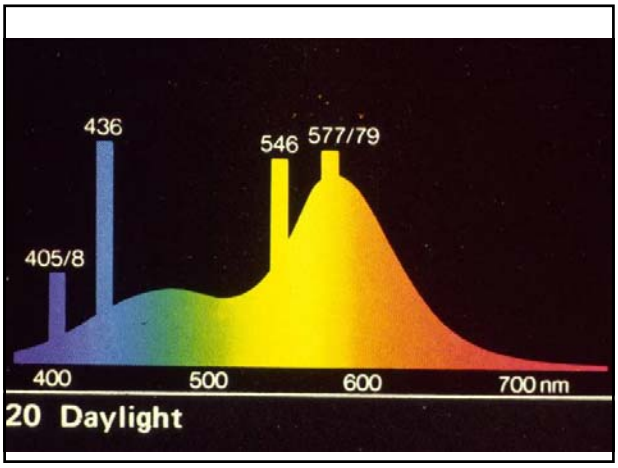
SOX Low Pressure Sodium Lamps (SOX)

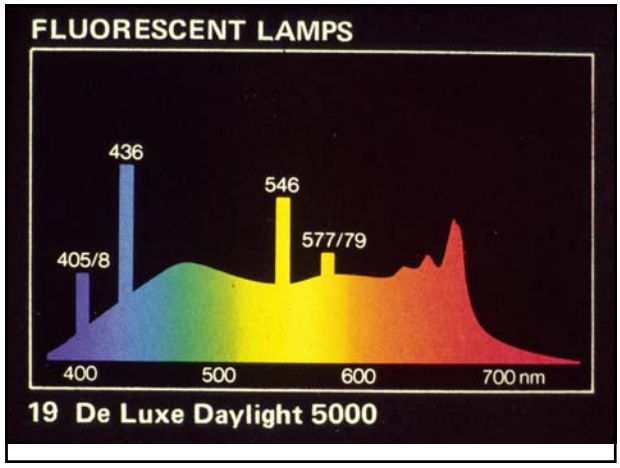


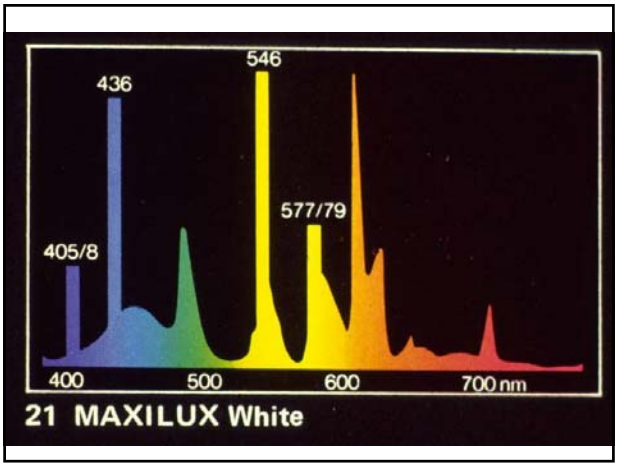
Natural Daylight (D65)

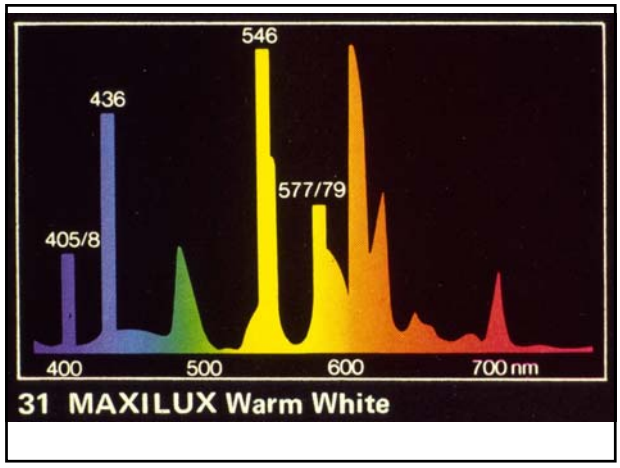

577/79
436
546
405/8
400
500
600
700 nm
30 Warm White

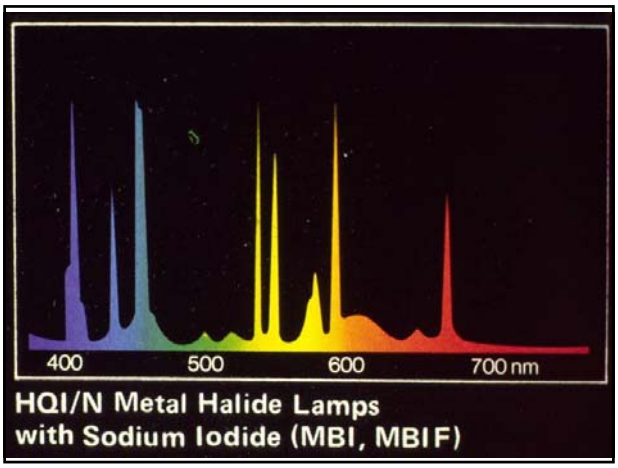

400
500
600
700nm
23 White


436
546
577/79
405/8
400
500
600
700 nm
20 Daylight

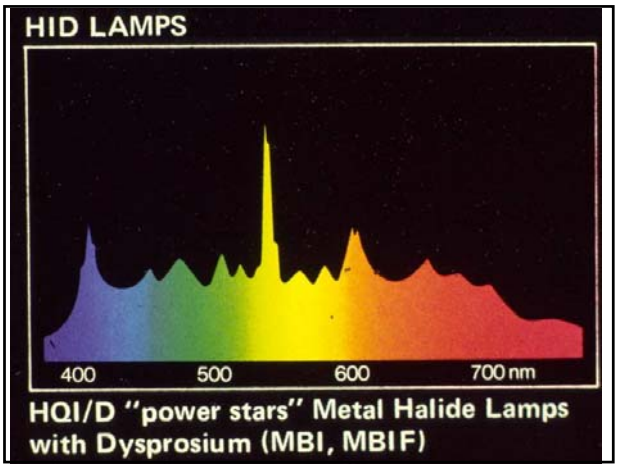

FLUORESCENT LAMPS
436
546
577/79
405/8
400
500
600
700 nm
19 De Luxe Daylight 5000


546
436
577/79
405/8
400
500
600
700 nm
21 MAXILUX White


546
436
577/79
405/8
400
500
600
700 nm
31 MAXILUX Warm White



HQI/N Metal Halide Lamps
with Sodium Iodide (MBI, MBIF)



HQI/D "power stars" Metal Halide Lamps
with Dysprosium (MBI, MBIF)

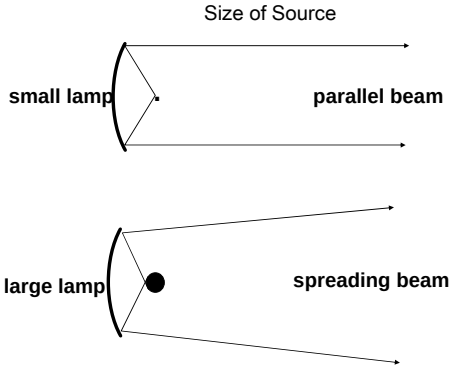
Physical size

Dissipation of heat

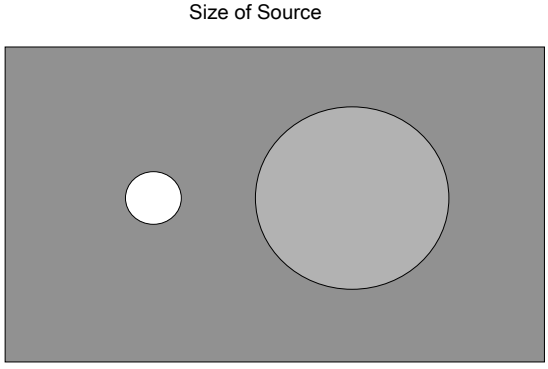
Handling of lamps

Standardising range available on site

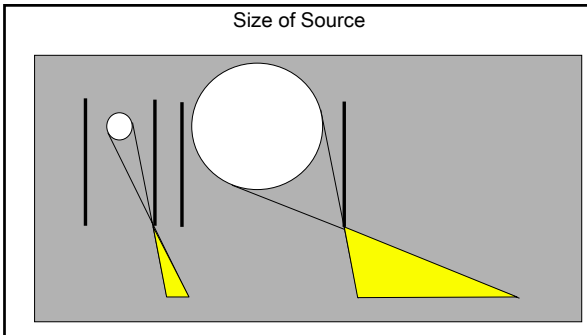
Ceiling unit co-cordination



Optical size and directional control



Reduced discomfort glare



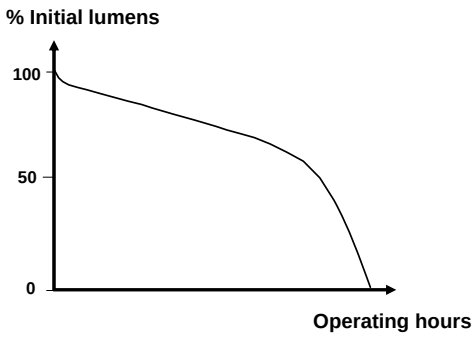
Softer shadows

Lumen maintenance

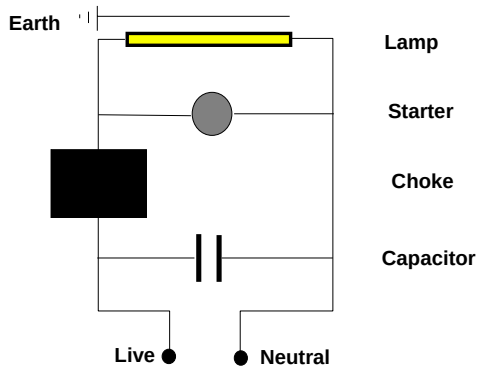
Loss of light output with aging of lamp

Loss of light due to dirt accumulation
- Luminaires
- Room surfaces
- Dirtiness of air

Planned maintenance



Lumen maintenance curves



Control gear