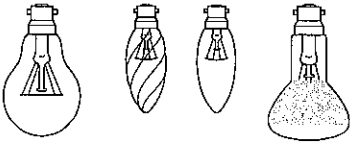
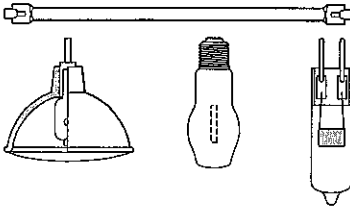
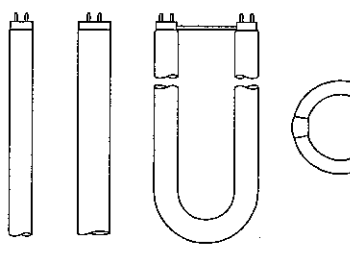
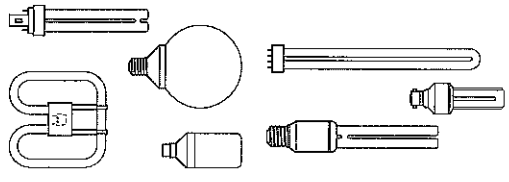


Appendix 3: Lamps

This appendix has been included to provide designers with an overview of the performance of a range of lamp types which could be used in schools. The information is presented mainly to help the designer make a first selection and it is assumed that manufacturers' data will be used for design purposes.


The data on pages 54 and 55 includes information on lamp efficacy, lamp life and colour performance together with the run-up and re-strike characteristics, and dimming capabilities.

Appendix 3a: Lamp Types

	<p>General lighting service (GLS), Reflector (R) and (PAR), tungsten filament lamps</p> <p>Advantages: Point sources; Excellent colour rendering; Warm colour appearance; Dimmable; Cheap (GLS only, Reflector and PAR lamps are relatively expensive); Instant start; No Control gear required.</p> <p>Disadvantages: Short Life; Low efficacy; Sensitive to voltage variations and vibrations (any structural borne vibrations which shake the filament will reduce life, consider Rough Service lamps.)</p>
	<p>Low and Mains Voltage Tungsten Halogen Lamps Linear and Capsule TH (K), Reflector TH (M)</p> <p>Advantages: Point source; Excellent colour rendering; Warm colour appearance; Dimmable (Hard fired dimmer required); Instant start; range of wattages, sizes, and beam angles.</p> <p>Disadvantages: Low efficacy; low voltage 12 volt lamps require a transformer; Relatively expensive (compared to GLS); Sensitive to voltage variations and vibrations (any structural borne vibrations which shake the filament will reduce life, consider Rough Service Lamps).</p>
	<p>Low Pressure Mercury Discharge Tubular Fluorescent Lamps (MCF)</p> <p>Advantages: Linear lamp, with some exceptions (circular, U shape not widely used – old technology); High Efficacy; Various colour appearances, Cheap; Long life; T12 - Halophosphate old technology 38mm tube, less efficient than - T8 - 26mm lamps Triphosphor, Generally better colour rendering than T12, new generation have low mercury content and low output depreciation. T5 - Triphosphor smaller lamp diameter 16mm tube, highest efficacy. All run off High Frequency Control gear, T12 & T8 will also run off Standard and low loss wire wound ballasts. Dimmable circuits are available for most types of fluorescent lamps.</p> <p>Disadvantages: Diffuse source; standard lengths; Control gear required; T5 only works on HF gear which is expensive.</p>
	<p>Low Power Compact Fluorescent Lamps (SL, PL, 2D, 2L)</p> <p>Advantages: Smaller size than linear fluorescent; Some lamps dimmable; High efficacy; Long life; Relatively Cheap; some sizes can be used as direct tungsten lamp replacements (complete with control gear). High frequency gear available for higher wattage lamps (greater than 2x13w).</p> <p>Disadvantages: Diffuse source; Requires control gear; most circuits run at low power factor; tube wall very bright, can cause glare.</p>

Lamp illustrations reproduced from CIBSE Code for interior lighting (1994) with the permission of the Chartered Institution of Building Services Engineers, 222 Balham High Road, London, SW12 9BS

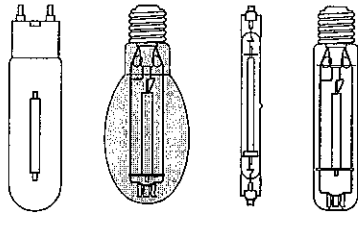
Appendix 3b: Lamp Types



Low Pressure Sodium Lamp (SOX)

Advantages:
Very High efficacy; long Life; relatively cheap; various wattages.

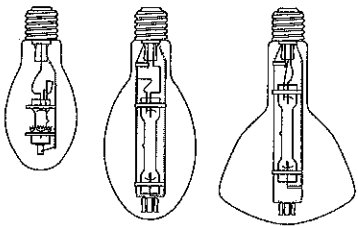
Disadvantages:
Mono-chromatic (yellow) light; no colour rendering; requires control gear. Run-up time required to reach full output.



High Pressure Sodium (SONDL)

Advantages:
High efficacy; Long life except "white" SON.

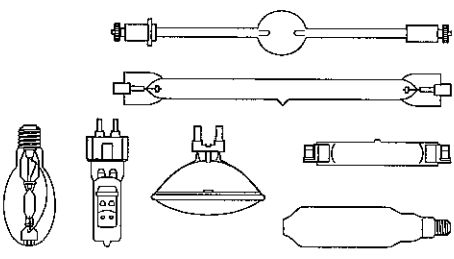
Disadvantages:
Effect of light source can be oppressive when used in an interior, except "white" SON; poor to average colour rendering except "white" SON which is good; colour appearance is warm (golden white); Requires control gear; requires run-up time.



High Pressure Mercury Vapour (MBF)

Advantages:
Long life; various wattages; De luxe versions average to good colour rendering; relatively cheap.

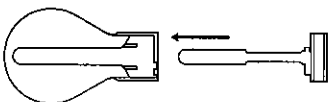
Disadvantages:
Generally poor to average colour rendering; poor efficacy; requires control gear; requires run-up time. Blue-green white light.



High Pressure Metal Halide Lamps (MBI, MBIF)

Advantages:
High efficacy; good colour rendering; warm/intermediate/cold colour appearance versions available; average to long life depending on wattage. Ceramic arc versions - good colour stability, longer life.

Disadvantages:
Some lamps change colour through life; high UV output-source needs glass cover; failure unpredictable; No British Standard. Requires control gear; requires run-up time. Ceramic arc versions - more expensive.



Induction Lamp

Advantages:
Very long life (except reflector lamp which is long life); low pressure lamp; good colour rendering; no flicker; virtually maintenance free.

Disadvantages:
Limited range; high electromagnetic radiation generated, requiring careful use; small lumen packages; diffuse source.

Lamp illustrations reproduced from CIBSE *Code for interior lighting* (1994) with the permission of the Chartered Institution of Building Services Engineers, 222 Balham High Road, London, SW12 9BS

Appendix 3: Lamps

Appendix 3c: Lamp data

Lamp type	Colour Rendering group/Colour Temperature, K (see Note 3)	Efficacy (approximate) Lumens/Lamp Watt (see Note 2)	Typical lamp life (hours)	Typical range of lamp power rating (wattage)	Control gear required	Lamp start-up time (Approx)	Lamp re-strike time (see Note 4)
Tungsten							
Mains (230V) GLS and reflector	1A/2700K	8-12	1000	15-1000	No	Instant	Instant
PAR	1A/2700K	10-12	2000	80-500	No	Instant	Instant
Tungsten halogen	1A/2900K	10-18	2000	50-100	No	Instant	Instant
Linear tungsten halogen	1A/2900K	14-22	2000	60-2000	No	Instant	Instant
Low voltage (12V) tungsten halogen	1A/3000K	12-25	3000-5000	5-100	Transformer	Instant	Instant
Fluorescent							
T12 (Halophosphate)	2/3000-5000K	60-80	7500	20-125	Yes	1-3 secs	1-3 secs
T8 (Triphosphor)	1A,1B/3000-6000K	60-95	7500-15,000	18-70	Yes	1-3 secs	1-3 secs
T5	1B/3000-4000K	95-110	10,000-15,000	14-50	Yes	1-3 secs	1-3 secs
Circular	2/3000-5000K	30-50	7500	22-60	Yes	1-3 secs	1-2 secs
Compact	1B/3000-6000K	43-83	7,000-10,000	5-55	Yes	1-3 secs	1-3 secs
Low pressure Sodium (SOX)	None	100-190	12,000-16,000	18-180	Yes	8-12 mins	Prompt <55w 10 mins >90w
High pressure Sodium (SON)							
Standard	4/2000	65-140	16,000-20,000	50-1000	Yes	1.5-6 mins	>1 min
De luxe	2/2200	75-90	12,000-16,000	150-400	Yes	5-6 mins	>1 min
White	1B/2500	35-50	5,000-10,000	35-100	Yes	5-6 mins	>30 secs
Mercury Vapour (MBF)							
Standard	3/4000	40-60	24,000-29,000	50-1000	Yes	2-5 mins	4-7 mins
De Luxe	2/3400	40-60	24,000-29,000	50-400	Yes	2-5 mins	4-7 mins
Metal halide (MBI)							
Single ended	1B,2/3000-4200	60-68	6000	70-150	Yes	3-6 mins	6-10 mins
Double ended	1B,2/3000-4200	68-75	6000	70-250	Yes	3-6 mins	6-10 mins
Tubular/elliptical	1A,2/4000-6000	70-80	6000-15000	70-1000	Yes	3-6 mins	6-20 mins
Ceramic arc tube	1B/3000	70-75	6000-8000	35-150	Yes	3-6 mins	6-10 mins
Induction							
Standard	1B/3000-4000	70	60,000	55-85	Yes	Prompt	Prompt
Reflector	1B/3000	47	10,000	23	Built in	Prompt	Prompt

Notes to Appendix 3: Lamps

Note 1: The tabular data provide an indication of lamp performance: for exact data, information from manufacturers should be consulted.

Note 2: The power consumption of the control gear associated with discharge lamps should be included in estimating the efficacy of the installation: values vary and should be obtained from the manufacturer.

Note 3: See tables on the right for colour rendering groups and correlated colour temperature classes as defined by CIE.

Note 4: The re-strike time after an interruption to the electrical supply. 'Prompt' re-strike is not instantaneous but barely noticeable. Instant re-strike is available for all double ended high intensity discharge lamps using special high voltage ignitors, but they are too expensive for general use and do not affect the lamp start-up time.

Colour rendering groups	CIE general colour rendering index (R_a)	Typical application
1A	$R_a \geq 90$	Wherever accurate colour matching is required, eg, colour printing inspection
1B	$80 \leq R_a < 90$	Wherever accurate colour judgements are necessary and/or good colour rendering is required for reasons of appearance, eg, shops and other commercial premises.
2	$60 \leq R_a < 80$	Wherever moderate colour rendering is required.
3	$40 \leq R_a < 60$	Wherever colour rendering is of little significance but marked distortion of colour is unacceptable.
4	$20 \leq R_a < 40$	Wherever colour rendering is of no importance at all and marked distortion of colour is acceptable.

Correlated Colour Temperature (CCT)	CCT Class
$CCT \leq 3300$ K	Warm
3300 K < CCT ≤ 5300 K	Intermediate*
5300 K < CCT	Cold

* This class covers a large range of correlated colour temperatures. Experience in the UK suggests that light sources with correlated colour temperatures approaching the 5300 K end of the range will usually be considered to have a 'cool' colour appearance.

Appendix 4: Control gear

All discharge lamps require control gear to limit the current taken by the lamp it controls. There are various types of control gear which effect the overall performance of a lamp.

Control gear for Fluorescent lamps

Standard control gear consists of a basic unit with relatively high losses and harmonic components. Unless specified otherwise most luminaires will be supplied with this gear.

Low loss gear is slightly more expensive but generally the losses are half those of standard gear. The physical size allows it to be installed in most luminaires. For

energy efficiency this is the minimum standard which should be adopted.

Super low loss gear is more expensive than low loss gear with roughly half the losses but the physical size is larger making it difficult to use in most luminaires.

High frequency gear is electronic gear. It is lighter and has the lowest electrical losses of all the conventional types of gear. It is much more expensive than conventional (wire wound) gear. It can be supplied in dimming form (more expensive still).

There is no simple payback advantage for this type of gear, at present. The life of the gear (not yet proven) is thought to be