Better Buildings By Design 2010

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Efficiency Vermont

Learning Objectives

Efficient Lighting Fundamentals

- **At the end of this program, participants will be able to:**
  - Understand key techniques and common terminology of energy efficient lighting.
  - Understand how to apply knowledge of lighting terminology toward the proper selection of light sources.
  - Strengthen your communications with lighting designers, suppliers and manufacturers.
  - Increase your understanding of lighting decisions on your projects.

LIGHTING TERMINOLOGY

QUANTITY OF LIGHT

LUMENS

FOOTCANDLES

ILLUMINANCE

LUMINANCE

EFFICACY

APPEARANCE OF LIGHT

COLOR TEMPERATURE

COLOR RENDERING

LIGHTING TERMINOLOGY

LUMEN: A unit of light flow, or luminous flux. The lumen rating of a lamp is a measure of the total light output of the lamp.

LUMEN: The amount of light generated by a light source, at the source.

Glossary definition as defined by Architectural Lighting Magazine 2008.

LIGHTING TERMINOLOGY

FOOTCANDLE (FC): The English unit of measurement of the illuminance (or light level) on a surface. One footcandle is equal to one lumen per square foot.

FOOTCANDLE (FC): The amount of illumination measured (with a light meter) on a vertical or horizontal surface.

We do not see footcandles.

Glossary definition as defined by Architectural Lighting Magazine 2008.

LIGHTING TERMINOLOGY

ILLUMINANCE: A photometric term that quantifies light incident on a surface or plane. Illuminance is commonly called light level. It is expressed as lumens per square foot (footcandles), or lumens per square meter (lux).

ILLUMINANCE: The term for what a what a light meter measures (in footcandles).

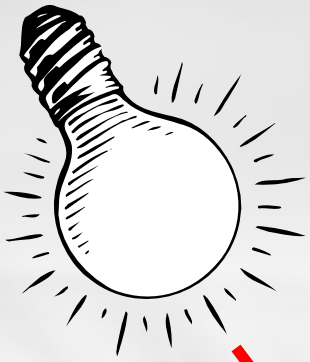
Glossary definition as defined by Architectural Lighting Magazine 2008.

LIGHTING TERMINOLOGY

LUMINANCE: A photometric term that quantifies brightness of a light source or of an illuminated surface that reflects light. It is expressed as footlamberts (English units) or candelas per square meter (Metric units).

LUMINANCE: The term for what we actually see, which is reflected illumination off of a surface.

Glossary definition as defined by Architectural Lighting Magazine 2008.



LUMENS

LUMINANCE
(REFLECTED LIGHT)

ILLUMINANCE
(FOOTCANDLES)

LIGHTING TERMINOLOGY

EFFICACY: A metric used to compare light output to energy consumption. Efficacy is measured in lumens per watt. Efficacy is similar to efficiency, but is expressed in dissimilar units. For example, if a 100-watt source produces 9000 lumens, then the efficacy is 90 lumens per watt.

EFFICACY: Lumens per watt.

Glossary definition as defined by Architectural Lighting Magazine 2008.

LIGHTING TERMINOLOGY

COLOR TEMPERATURE: The color temperature is a specification of the color appearance of a light source, relating the color to a reference source heated to a particular temperature, measured by the thermal unit Kelvin. The measurement can also be described as the "warmth" or "coolness" of a light source. Generally, sources below 3200K are considered "warm;" while those above 4000K are considered "cool" sources.

COLOR TEMPERATURE: The outward appearance of the color of a light source (i.e. warm or cool).

Glossary definition as defined by Architectural Lighting Magazine 2008.

LIGHTING TERMINOLOGY

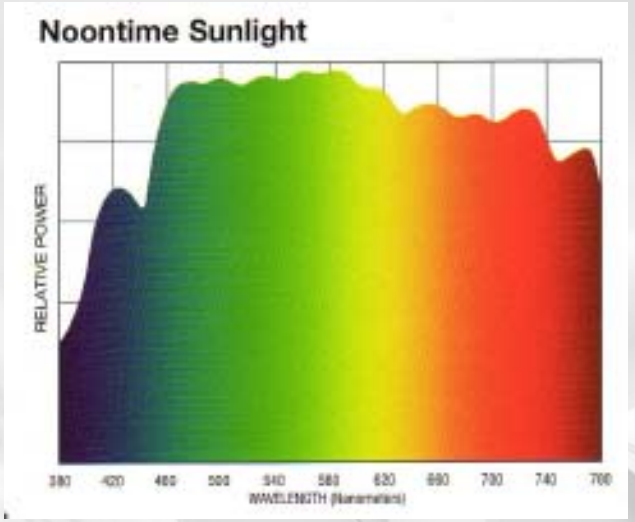
LIGHTING TERMINOLOGY

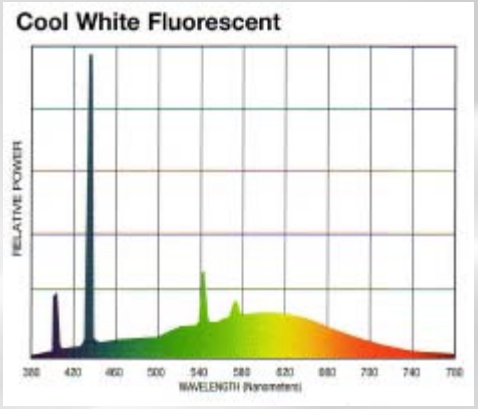
COLOR RENDERING INDEX (CRI): A scale of the effect of a light source on the color appearance of an object compared to its color appearance under a reference light source. Expressed on a scale of 1 to 100, where 100 indicates no color shift. A low CRI rating suggests that the colors of objects will appear unnatural under that particular light source.

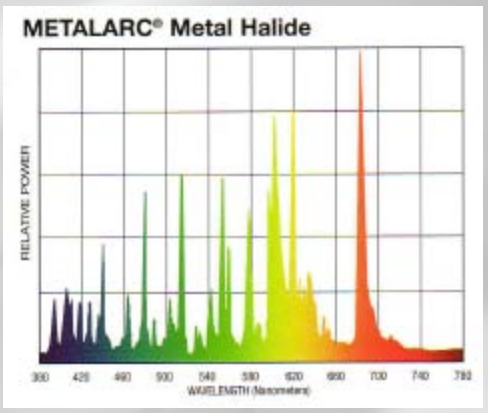
COLOR RENDERING INDEX (CRI): The ability of a light source to render colors in comparison to other light sources of a similar color temperature.

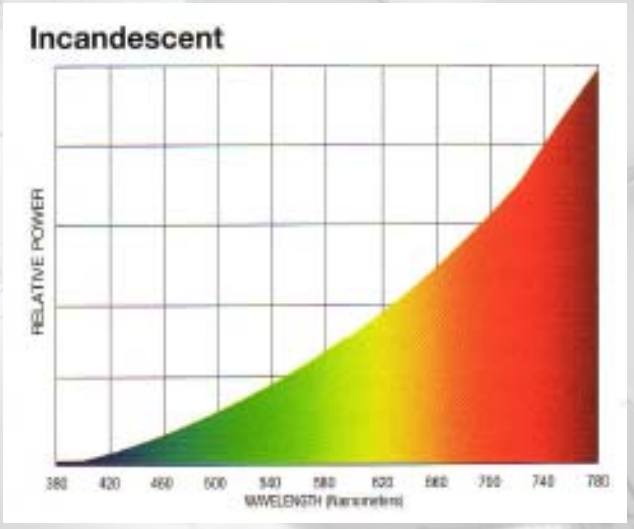
Glossary definition as defined by Architectural Lighting Magazine 2008.

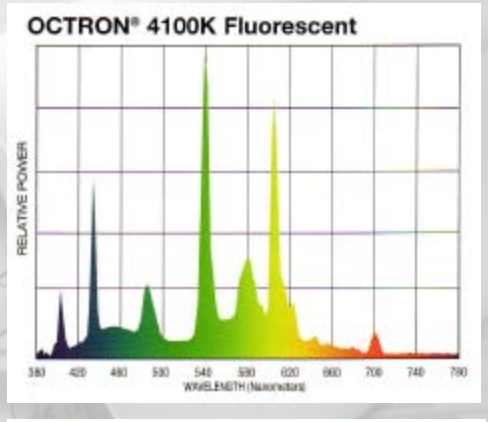
Spectral Power Distribution Graphs

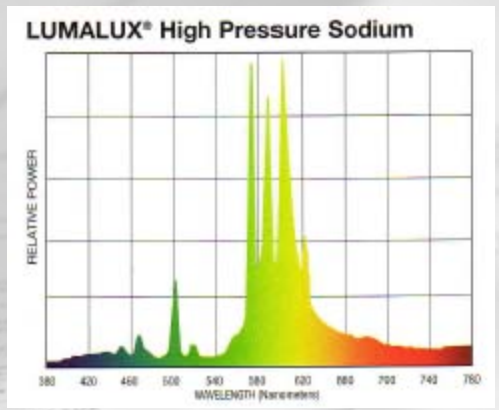


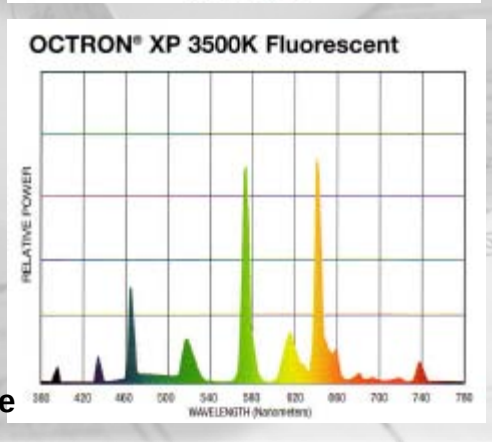












DETERMINING FACTORS

Color Temperature	Initial Cost	Heat Production
Color Rendering	Operating Cost	Fixture Compatibility
Color Changing	Replacement Cost	UV Transmittance
Light Output (actual)	Ease of Maintenance	Code Compliance
Lumen Output	Availability	Energy Efficiency
Efficacy	Lamp Life	Accessorization
Distribution	Physical Size	Soft / Hard Edge
Dimmability	Physical Appearance	Effect on People

Lamp Data Comparison

GENERAL PURPOSE LAMPS

Watts	Bulb	Base	Product Number	Symbols & Footnotes	Ordering Abbreviation	Volts	Pkg Qty	Description	Class & Filament	Avg Rated Life(hrs)	Lumens Beam Angle CBCP	LCL (in)	MOL (in)
75	A19	Med	10970		75A/W/4/RP	120	48	Soft White	C, CC-8	750	1170	3.13	4.44
			10967		75A/W/RP	120	24	Soft White	C, CC-8	750	1170	3.13	4.44
			12500		75A/CL	120	120	Clear	C, CC-8	750	1200	3.13	4.44
			11225		75A/CL/RP	120	24	Clear	C, CC-8	750	1200	3.13	4.44
			12502	130,188	75A/CL	130	120	Clear	C, CC-8	750	1190	3.13	4.44

@ 120 volts, approximate to 66 watts, 910 lumens, 1875 hours

DULUX® EL SELF-BALLASTED COMPACT FLUORESCENT LAMPS

Mini Twist Compact Fluorescent Lamps

Nominal Wattage	Bulb	MOL (in)	Base	Product Number	Ordering Abbreviation	Voltage	Pkg Qty	Avg Rated Life (hrs)	CCT (K)	CRI	Approx Lumens Initial @25°C/77°F	Mean	Symbols & Footnotes
13	MINITWIST	4.6	Medium	29727	CF13EL/MICRO/830/RP2	120	12	12000	3000	82	825	660	1,3,8, 9,12,14,20
		4.5	Medium	29376	CF13EL/MINI/830	120	6	8000	3000	82	800	640	1,3,8, 9,12,14,20
		4.2	Medium	29059	CF13EL/SUPER/827/BL	120	6	10000	2700	82	880	704	1,3,8, 9,12,14,20
				29449	CF13EL/SUPER/830/BL	120	6	10000	3000	82	880	704	1,3,8, 9,12,14,20
				29713	CF13EL/SUPER/835/BL	120	6	10000	3500	82	800	640	1,3,8, 9,12,14,20
		4.6	Medium	29567	CF13EL/MINI/841	120	6	10000	4100	82	800	640	1,3,8, 9,12,14,20

NAMING A LIGHT SOURCE

WATTS / SHAPE / SIZE / ATTRIBUTES

75 / A / 19 / CL

50 / PAR / 20 / NFL25

75 / PAR / 20 / NSP15

F32 / T / 8 / 830

F26 / TBX / / 830

Lamp Data Comparison

Watts	Bulb	Base	Product Number	Symbols & Footnotes	Ordering Abbreviation	Volts	Pkg Qty	Beam Type	Class & Filament	Avg Rated Life(hrs)	Lumens CCT	CBCP	Beam Angle	MOL (in)
50	PAR30LN	E26 Med	14482	★ 40,73,116,134,137,162	50PAR30LN/HAL/NSP9	130	15	NSP	C,CC-8	2500	660 2850	7000	10	4.63
			@ 120 volts, approximate 44 watts, 500 lumens, 5000 hours											
			14520	★ 40,73,116,134	50PAR30LN/HAL/NFL25	120	15	NFL	C,CC-8	2500	660 2850	2100	25	4.63
			14822	★ 40,73,116,134	50PAR30LN/HAL/NFL	120	6	NFL	C,CC-8	2500	660 2850	2100	25	4.63
			14478	★ 40,73,116,134,137,162	50PAR30LN/HAL/NFL25	130	15	NFL	C,CC-8	2500	660 2850	2100	25	4.63
			@ 120 volts, approximate 44 watts, 500 lumens, 5000 hours											
			14537	★ 40,73,116,134	50PAR30LN/HAL/WFL50	120	15	WFL	C,CC-8	2500	660 2850	660	50	4.63

Reflector Compact Fluorescent Lamps

Nominal Wattage	Bulb	MOL (in)	Base	Product Number	Ordering Abbreviation	Voltage	Pkg Qty	Avg Rated Life (hrs)	CCT (K)	CRI	Approx Lumens Initial @25°C/77°F	Mean	Symbols & Footnotes
9	R20	3.94	Medium	29638	CF9EL/R20/827	120	6	8000	2700	82	300	240	1,3,6, 9,12,14,20
				29640	CF9EL/R20/830/BL	120	6	8000	3000	82	300	240	1,3,6, 9,12,14,20
14	R20	4.25	Medium	29624	CF14EL/R20/827	120	6	8000	2700	82	495	396	1,3,6, 9,12,14,20
				29687	CF14EL/R20/830/BL	120	6	8000	3000	82	495	396	1,3,6, 9,12,14,20
15	BR30	5.5	Medium	29465	CF15EL/BR30/DIM/827	120	6	6000	2700	82	600	480	1,3,6, 9,12,14,20
				29667	CF15EL/BR30/DIM/830/BL	120	6	8000	3000	82	600	480	1,3,6, 9,12,14,20

Lamp Data Comparison

Watts	Bulb	Base	Product Number	Symbols & Footnotes	Ordering Abbreviation	Volts	Pkg Qty	Beam Type	Class & Filament	Avg Rated Life(hrs)	Lumens CCT	CBCP	Beam Angle	MOL (in)
50	PAR30LN	E26 Med	14482	★ 40,73,116,134,137,162	50PAR30LN/HAL/NSP9	130	15	NSP	C,CC-8	2500	660 2850	7000	10	4.63
			@ 120 volts, approximate 44 watts, 500 lumens, 5000 hours											
			14520	★ 40,73,116,134	50PAR30LN/HAL/NFL25	120	15	NFL	C,CC-8	2500	660 2850	2100	25	4.63
			14822	★ 40,73,116,134	50PAR30LN/HAL/NFL	120	6	NFL	C,CC-8	2500	660 2850	2100	25	4.63
			14478	★ 40,73,116,134,137,162	50PAR30LN/HAL/NFL25	130	15	NFL	C,CC-8	2500	660 2850	2100	25	4.63
			@ 120 volts, approximate 44 watts, 500 lumens, 5000 hours											
			14537	★ 40,73,116,134	50PAR30LN/HAL/WFL50	120	15	WFL	C,CC-8	2500	660 2850	660	50	4.63

Reflector Compact Fluorescent Lamps

Nominal Wattage	Bulb	MOL (in)	Base	Product Number	Ordering Abbreviation	Voltage	Pkg Qty	Avg Rated Life (hrs)	CCT (K)	CRI	Approx Lumens Initial @25°C/77°F	Mean	Symbols & Footnotes
9	R20	3.94	Medium	29638	CF9EL/R20/827	120	6	8000	2700	82	300	240	1,3,6, 9,12,14,20
				29640	CF9EL/R20/830/BL	120	6	8000	3000	82	300	240	1,3,6, 9,12,14,20
14	R20	4.25	Medium	29624	CF14EL/R20/827	120	6	8000	2700	82	495	396	1,3,6, 9,12,14,20
				29687	CF14EL/R20/830/BL	120	6	8000	3000	82	495	396	1,3,6, 9,12,14,20
15	BR30	5.5	Medium	29465	CF15EL/BR30/DIM/827	120	6	6000	2700	82	600	480	1,3,6, 9,12,14,20
				29667	CF15EL/BR30/DIM/830/BL	120	6	8000	3000	82	600	480	1,3,6, 9,12,14,20

Lamp Data Comparison

R LAMP SPECIFICATIONS

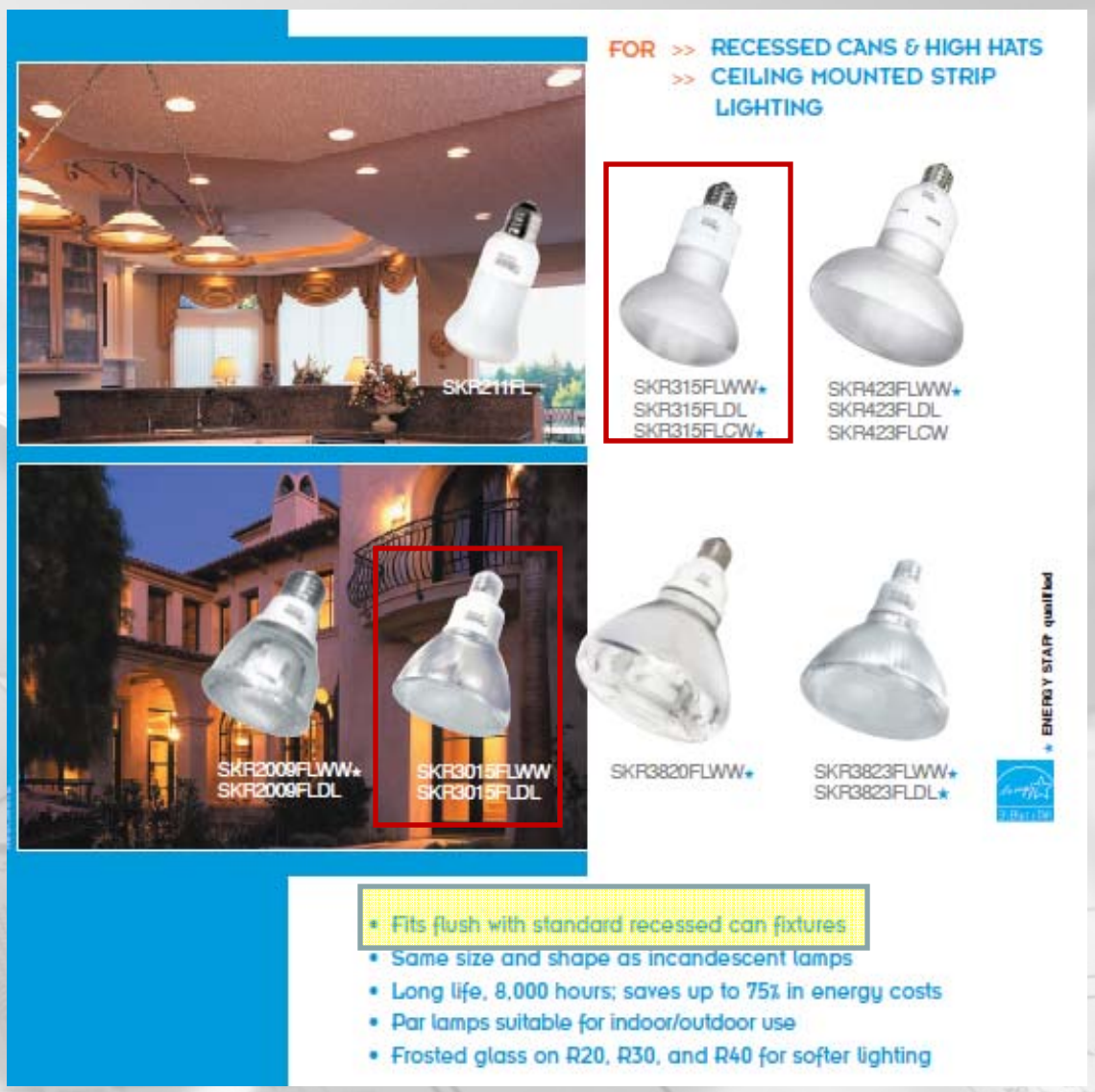
Watts	Order Code	Description	Incandescent Equivalent	Lumens	Lamp Life (Hrs)	Pack Type	Case Pack	Dimensions (W" x MOL")	K
11	07011	SKR211FLWW R20 FloodMax	40	400	8,000	Box	25	2.5 x 4.8	2700
★ 15	33015	SKR315FLWW R30 FloodMax	75	750	8,000	Box	12	3.75 x 5.6	2700
★ 15	33031	SKR315FLCW R30 FloodMax Cool White	40	550	10,000	Box	12	3.75 x 5.6	4100
15	33019	SKR315FLDL R30 FloodMax Daylight	75	690	8,000	Box	12	3.75 x 5.6	5000
★ 23	33023	SKR423FLWW R40 FloodMax	125	1300	8,000	Box	12	4.9 x 6.25	2700
23	33030	SKR423FLCW R40 FloodMax Cool White	125	1300	8,000	Box	12	4.9 x 6.25	4100
23	70282	SKR423FLDL R40 FloodMax Daylight	125	1300	8,000	Box	12	4.9 x 6.25	5000

PAR LAMP SPECIFICATIONS

Watts	Order Code	Description	Incandescent Equivalent	Lumens	Lamp Life (Hrs)	Pack Type	Case Pack	Dimensions (W" x MOL")	K
★ 9	11197	SKR2009FLWW Par20 Indoor/Outdoor	30	300	8,000	Box	12	2.45 x 3.8	2700
9	11199	SKR2009FLDL Par20 Indoor/Outdoor	30	330	8,000	Box	12	2.45 x 3.8	5000
★ 15	33010	SKR3015FLWW Par30 Indoor/Outdoor	75	760	8,000	Box	12	3.75 x 5.1	2700
15	33020	SKR3015FLDL Par30 In-Outdoor Daylight	75	650	8,000	Box	12	3.75 x 5.1	5000
★ 20	33032	SKR3820FLWW Par38 Indoor/Outdoor	75	900	8,000	Box	12	4.8 x 6.5	2700
★ 23	33016	SKR3823FLWW Par38 Indoor/Outdoor	100	1370	8,000	Box	12	5 x 6.2	2700
★ 23	11150	SKR3823FLDL Par38 In-Outdoor Daylight	100	1200	8,000	Box	12	5 x 6.2	5000

All specifications are subject to change without notice

Lamp Data Comparison



LIGHTING TERMINOLOGY

LIGHTING TERMINOLOGY

SIZE

SIZE

LIGHTING TERMINOLOGY

LIGHTING TERMINOLOGY

LIGHTING TERMINOLOGY

Layers of Light

General (ambient)

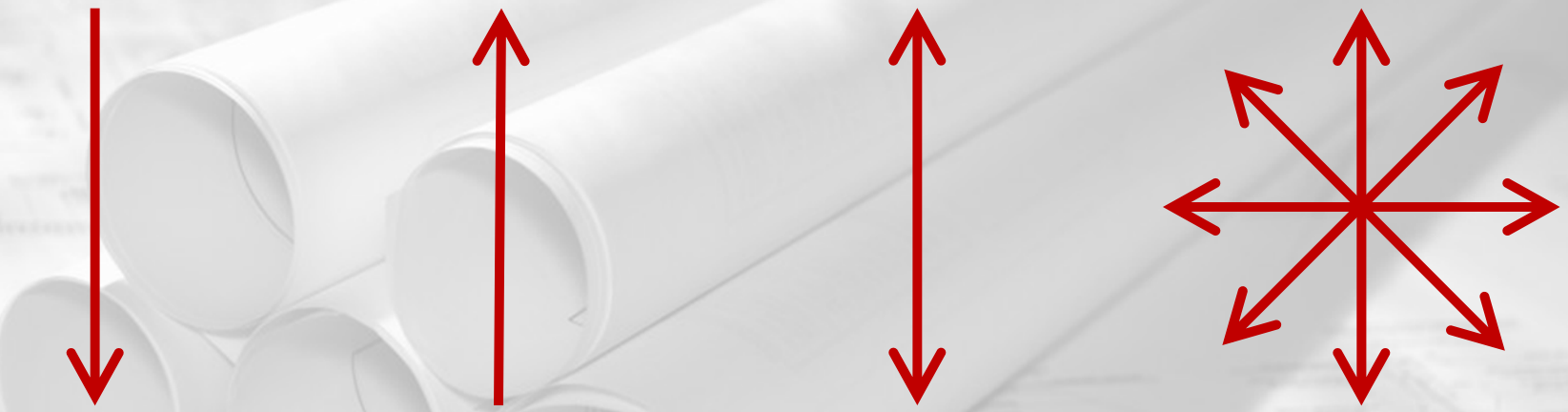
Task

Accent

Sparkle

LIGHTING TERMINOLOGY

Distribution



Direct

Indirect

Indirect / Direct

Diffuse (general)