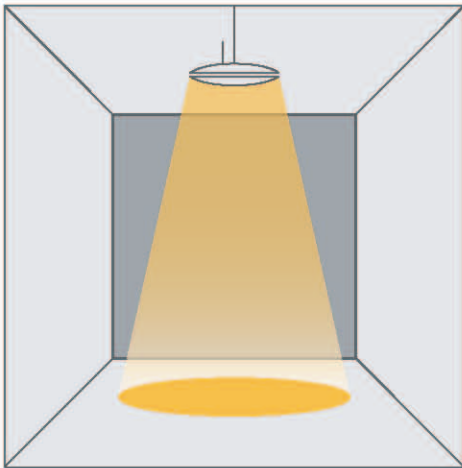


TECHNICAL BASIS FOR LIGHTING DESIGN

ILLUMINATION LEVEL

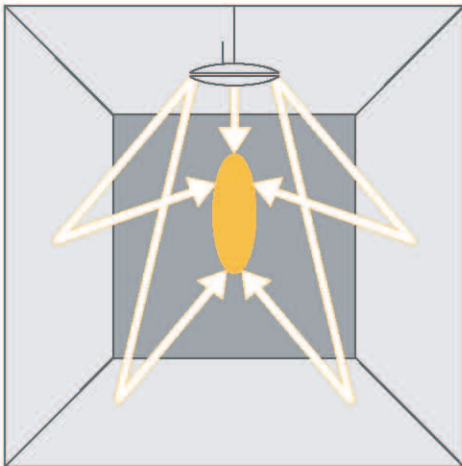
Custom lighting is a solution - key factors in adequate lighting.



Illumination level

One of the most significant factors for room illumination is the illumination level measured in "lux" or "footcandle". It defines the intensity of light emitted over a given area. Due to the deterioration of vision, the elderly need a higher illumination level to be able to cope with daily tasks. The threshold areas between light and dark such as entryways have to be kept brightly lit, especially on the inside, to help the eye better adjust to the inside when entering from the brighter outside.

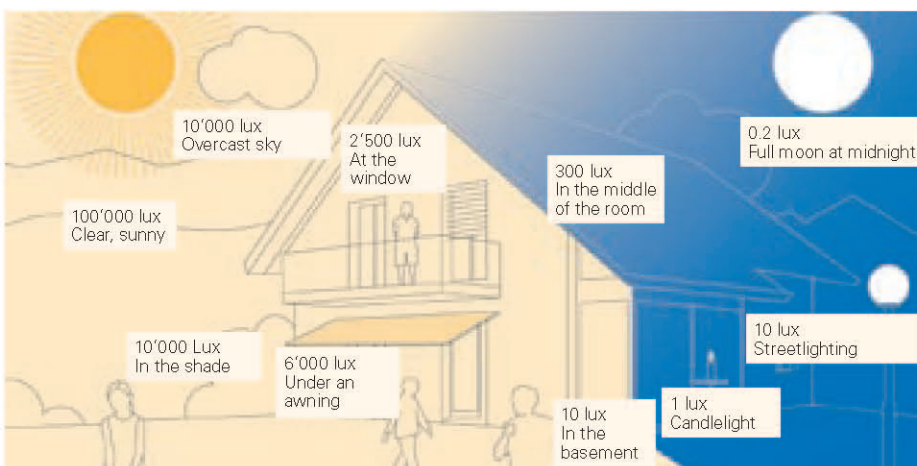
Adequate illumination levels reduce feelings of insecurity, the risk of accidents, anxiety, and passiveness among other things.



Cylindrical illumination

Cylindrical illumination is the quantifying parameter for the lighting level of vertical or virtually vertical object surfaces in a room. It is also applied as a standard for determining the brightness in a room and, in particular, the brightness of faces. Ideal cylindrical illumination enhances the recognition of faces, door handles, light switches, colors, and more.

Quality components along with innovative reflector and prism technology allow Derungs Licht AG solutions to achieve optimal cylindrical illumination.



This diagram represents the various approximate illumination levels in everyday life.

TECHNICAL BASIS FOR LIGHTING DESIGN

COLOR RENDERING / COLOR RENDERING PROPERTIES

Custom lighting is a solution - key factors in adequate lighting.

Color rendering

The color emitted by a lit object depends on the spectral composition of the light, giving a vital importance to the spectral composition of the light source. A cool-white light accentuates the blue and the nuances of purple and green. A warm-white light brings out the nuances of red, yellow and orange.

The ability of a light source to copy colors is determined by a number, the color rendering index (CRI). This index defines the ability of a light source to reproduce the colors of various objects faithfully compared with a natural light source. The maximum CRI is represented by the value 100 – 100 CRI means that all the colors of the object are rendered in the same manner as with a natural light source, thus giving a “natural” aspect to the observer. The more the CRI index drifts away from 100, the more the color is distorted.

Lights having high color rendering in the category 1A are required for dermatological examinations, medical therapy and surgery. These are situations that demand excellent color rendering. On one hand, these types of lights provide less light and are more expensive than fluorescent tubes in category 1B

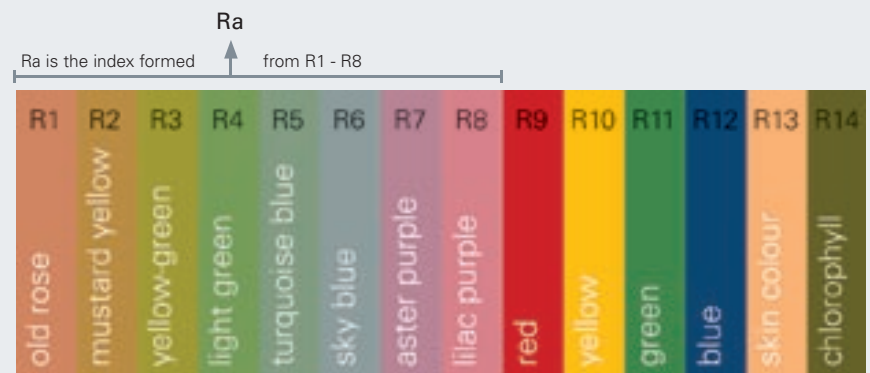
(lights with good color rendering for lighting rooms) but, on the other hand, the physician has a light which renders each color faithfully and perfectly.

Determining the CRI of a light source

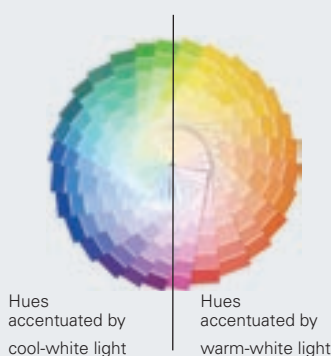
To determine the CRI value of a light source, 14 test colors which dominate our environment are generally illuminated with a light source reference and with the light source to inspect. The smaller the gap between the light source reference and the inspected light source, the better the color rendering quality of this light source.

The test color red R9 has a particularly important role in the medical world given that it is extremely difficult to differentiate the red nuances of in tissues and blood.

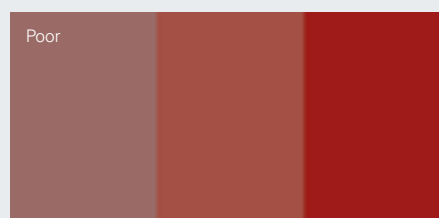
R13 is the “skin color” test color and it generally has a fairly important role for all skin treatment and care (for a better recognition of blood vessels and veins) in medical practices and the cosmetics field.



Color rendering properties



Poor properties of color rendering make it impossible for the eye to recognize all existing colors.



Good properties of color rendering make it possible for the eye to see all actual existing colors.



TECHNICAL BASIS FOR LIGHTING DESIGN

LIGHT COLOR AND LIGHT TEMPERATURE

Custom lighting is a solution - key factors in adequate lighting.

Light color / light temperature

The light temperature characterizes the light color from a light source. The reference test source is often a heated black body radiator (made of platinum) which shows determined colors at determined temperatures. Initially it is dark red, and then red. As the temperature rises, it becomes orange, then yellow, then white, and finally light blue with very high temperatures. A given color may thus be determined by the temperature indication of the black body radiator in K (Kelvin). The Kelvin temperature scale starts at absolute zero (-273°C).

Light colors of light sources

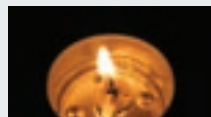
The norm divides light colors of light sources into three groups:

Light color	Light temperature in Kelvin
Warm white	< 3300
Neutral white	3300 - 5300
Day-light white	> 5300

Visual perception table:



Ember / 500 K



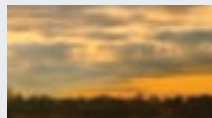
Candle / 1500 K



Lightbulb 40 W / 2680 K



Halogen light bulb / 3200 K



Sun at dusk / 3500 K



Fluorescent tube / 4000K



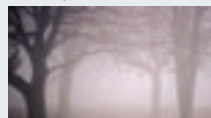
Morning sun / 5000 K



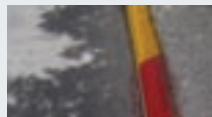
Midday sun / 5500 K



Camera flash / 6000 K



Fog / 8000 K



In the shade / 9-12000 K



Polar light / 15-25000 K

TECHNICAL BASIS FOR LIGHTING DESIGN

HEAT GENERATION AND MANAGEMENT / SHADOWS

Custom lighting is a solution - key factors in adequate lighting.



Heat generation and management of surgical and examination lights

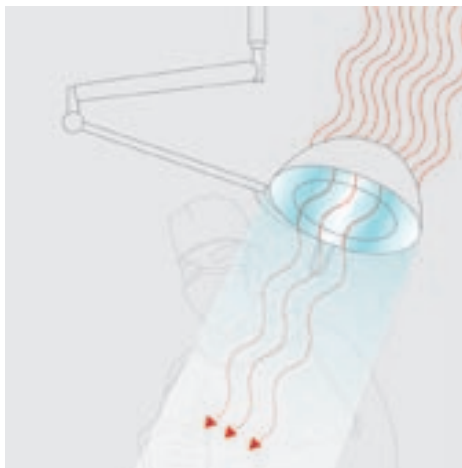
There are two heat zones which cause particular discomfort during medical care:

Heat next to the field of operation

Heat can dry out open wounds faster and encourages the growth of bacteria.

Heat at head-level

In general, the head of the luminaire is very close to the physician's head during surgery. This heat emission by the light affects their performance (the hotter it becomes, the quicker the sensation of fatigue appears) and may cause headaches.



Avoiding heat generation

Heat absorption filters, specific luminaire head designs, can allow to reduce or even get rid of this heat generation at head level or above the field of operation. It is thus possible to work in better work conditions regarding the heat issue.

Heat absorption filters

They reflect the infrared light so the heat cannot be generated through the front part.

Luminaire head design

Chimney effect – thanks to the twin-wall housing of the luminaire head, the heat evacuates upwards like in a chimney.

Efficient optics

The ideal situation is to never allow heat to form in the first place. A professional lighting technique, with the lowest light source power is the solution --> heat reduction!

Shadow formation

The casting of shadow and light is essential to facilitate movement in a room and to perceive objects. For our spatial vision, we need shadows on the objects. On the other hand, shadows are unwelcome and disturbing during medical examinations or surgeries. In this case, shadows distract the medical professionals, diminish the luminous intensity and may interfere with a sure, precise, and concentrated medical procedure.