



# Good Lighting for Health Care Premises 7



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*Moving towards the "health hotel": at hospitals and doctor's surgeries, patients need to feel confident about the medical services they are being offered. At the same time, competition for patients is becoming increasingly intense. Good lighting helps secure a sustained competitive edge.*



1

Lighting for health.



2

# Lighting for the health service

## Capacity reduction 1990 – 2001\*

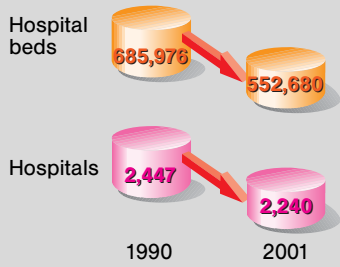


Fig. 1

## Increase in performance and efficiency 1990 – 2001\*

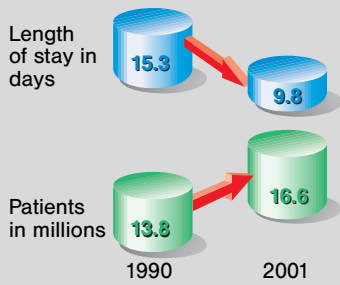


Fig. 2

\* Source: Deutsche Krankenhausgesellschaft e.V., „Zahlen, Daten, Fakten 2003“

## Health sector in flux

With all the changing requirements which the modern health system needs to meet, it has never been truer to speak of a “health sector in flux”: greater pressure to cut costs, more assertive, better-informed patients, technological advances, new treatment methods and a steadily ageing population – the challenges for hospital managements and established physicians are many and complex.

The trends are clear: the number of hospital beds is being reduced and the number of hospitals is

diminishing (see Fig 1). At the same time, a growing number of patients are being hospitalized – but for significantly shorter periods of time (see Fig. 2). Against this backdrop, competition between hospitals is likely to become even more intense.

In today’s health market, the kind of facilities that supplied medical services in the past are finding it increasingly difficult to compete. Those that succeed are providers offering services which are tailored to patients’ needs and which thus convince and win patients over as clients.

## Lighting as a factor of competition

This is where lighting comes in – as a factor of competition – providing architectural features and shaping interior design. Patients expect surroundings in which they feel comfortable and at ease. What counts is no longer just medical equipment and the qualifications and reputation of the attendant physicians. In hospitals, as well as in most areas of the ambulatory health care system, patients expect the standard of service and facilities of a “health hotel”.

# The health sector in flux.





# Lighting functions

In hospitals and medical practices, lighting performs several functions:

- Patients expect attractive lighting for a sense of well-being – an expectation met by lighting systems which make a prestigious design statement while ensuring the right degree of visibility and visual comfort. In patients' rooms especially, a homely atmosphere is required.
- For doctors and nursing staff, lighting plays an important functional role. From operating theatre to sick-bed, it facilitates the tasks they perform. It also has a motivating effect and helps boost staff morale – which, in turn, benefits patients.
- Similar needs are met for non-medical personnel, in administration and all other areas. Good lighting facilitates the performance of visual tasks, reduces the risk of mistakes and heightens motivation.

## Economical lighting

All artificial lighting consumes electricity – but power consumption should be as low as possible to keep operating costs down. This can be achieved with modern lighting technology: economical lamps, efficient electronics and luminaires with optimized optical controls make for lighting with low power requirements.

Comparison of obsolete and modern lighting systems (see Fig. 3) shows that the modern lighting system (4) consumes only 25 percent of the energy consumed by the oldest lighting system (1).

## Lighting management

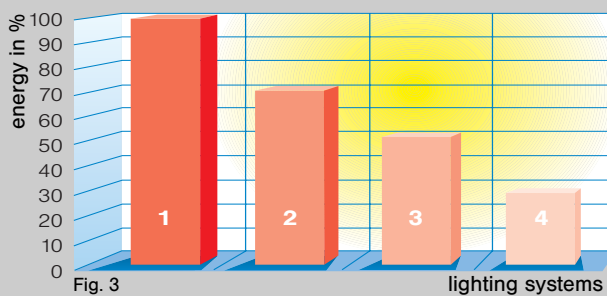
Lighting for people must also be flexible and tailored to requirements. This can be achieved with adjustable luminaires and lighting systems on different switching circuits. Control can be partially or fully automated in a lighting management system. Detailed information on this subject is contained in booklet 12 of this series of publications (see page 53): "Lighting quality with electronics".

## Examination and treatment rooms

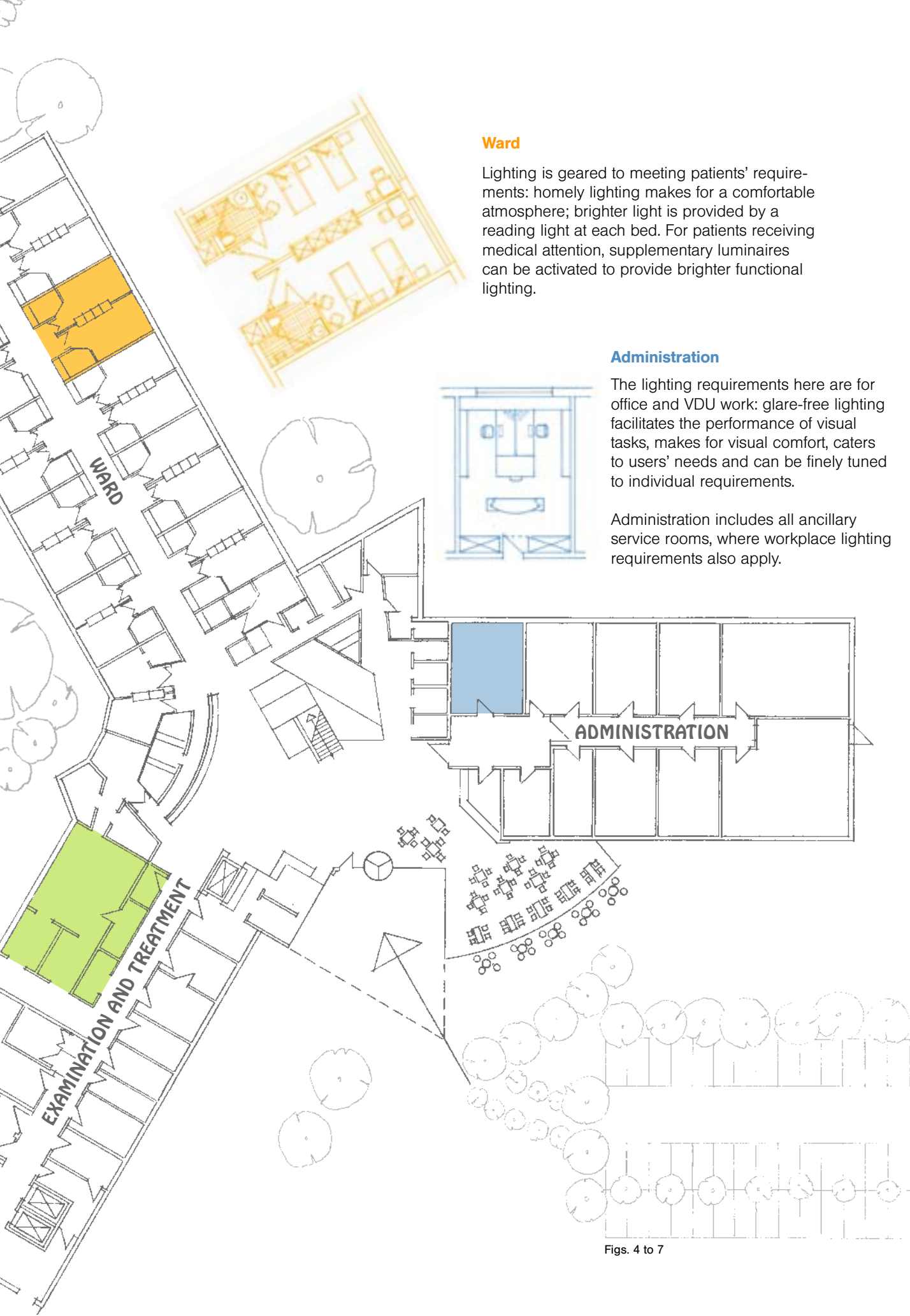
Lighting here is geared to meeting medical and technical requirements. The important thing is to provide optimum functional lighting for the tasks which doctors and nursing staff need to perform. For patients, lighting should be attractive and promote a sense of wellbeing. Above all, care must be taken to ensure that lights do not dazzle.

### New lighting systems save energy

Technological progress: the modern lighting system (4) requires only 25 percent of the energy consumed by the oldest lighting system (1).



- 1 luminaires with opal diffusers, standard fluorescent lamps, conventional ballast (CB)
- 2 luminaires with specular reflector, directional beam, three-band fluorescent lamps, low-loss ballast (LB)
- 3 luminaires with specular reflector, directional beam, three-band fluorescent lamps, electronic ballast (EB)
- 4 as 3, but with daylight- and presence-dependent regulation



### Ward

Lighting is geared to meeting patients' requirements: homely lighting makes for a comfortable atmosphere; brighter light is provided by a reading light at each bed. For patients receiving medical attention, supplementary luminaires can be activated to provide brighter functional lighting.

### Administration

The lighting requirements here are for office and VDU work: glare-free lighting facilitates the performance of visual tasks, makes for visual comfort, caters to users' needs and can be finely tuned to individual requirements.

Administration includes all ancillary service rooms, where workplace lighting requirements also apply.

Figs. 4 to 7

# Reception

For most patients, the prospect of a spell in hospital is not a pleasant one. Far from being happy that they are on the road to recovery, they feel a mixture of helplessness, agitation, anxiety and hope. And the emotions experienced by patients are largely shared by visitors.

### Light inspires confidence and provides guidance

Attractive lighting in an entrance area can help minimize the sense of trepidation felt by patients and visitors. A harmonious lighting atmosphere quiets apprehension, gives reassurance, makes the surroundings look inviting and inspires confidence. The second important function lighting performs is guidance: a person who can easily get bearings is less likely to feel intimidated.

As a general rule, entrance areas consist of four room zones: the actual entrance, the reception desk, the reception area and areas leading deeper into the building. Architecture and lighting need to distinguish these zones and provide clear guidance.

### General and accent lighting

Meeting these requirements calls for both direct and

indirect lighting, which is provided by a combination of lighting systems furnishing a full lighting solution: uniform general lighting conveys a sense of security and facilitates orientation while accentuating light on ceilings and walls makes the atmosphere less formal.

General lighting is mostly realised with direct or direct/indirect luminaires and economical three-band fluorescent lamps or compact fluorescent lamps. Accent lighting is partially provided by wall luminaires with indirect beams. For route lighting, appropriately positioned downlights or other direct luminaires are a suitable solution. Alternatives today are orientation luminaires with long-life LEDs (light-emitting diodes).

### Adaptation zone

At the entrance to a building, people stepping in from the street go from bright daylight into darker surroundings during the day and from darkness into a brightly lit interior at night. So that their eyes can adjust to the different levels of brightness, adaptation zones should be provided: lighting at the entrance should be particularly bright during the day and the level of interior lighting should decrease towards of the exit at night.



4



5

Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
3.6	Reception desk	300	22	80

For notes on lighting quality features, see page 49.

### Reception desk: light for communication

For both visitors and staff, the visual tasks performed at the reception desk are more demanding than in the rest of the room. To enable the one to recognize the other with ease, vertical illuminance should be increased: additional light from the side – e.g. from wall luminaires – makes for balanced lighting on faces and desktop. This facilitates communication.





*Lighting adds lustre*

*Sophisticated reception lighting signals an institution worthy of respect – a quality vital for a hospital in today's competitive health market. Architecture and lighting design give incoming patients a sense of confidence, shaping the first and crucial impression which the reception area makes.*

*A harmonious lighting atmosphere quells apprehension, lends reassurance, gives an interior an inviting air and inspires confidence. Lighting also provides guidance and thus makes a hospital entrance less intimidating.*

6



7



9



8



10

## Wards

Individuality, independence, comfort. Hospitals are slowly coming to realise that patients are reluctant to do without the trappings of normal life. For many, choosing a hospital is not just a matter of checking out its medical reputation; the “homeliness” of its wards is another important consideration. And rightly so. After all, most of a patient's stay in hospital is spent in a ward.

In rooms for which patients pay a supplement, good lighting is a particularly important competitive asset. As hospitals change from places for treating the sick into health “service centres”, it is mostly only private hospital operators who recognize the key importance of optimum lighting as an element of interior design.

Apart from medical supply units (see page 8), additional or alternative facilities may include direct or direct/indirect ceiling luminaires, reading lights, wall luminaires and luminaires for orientation. Three-band fluorescent lamps and compact fluorescent lamps work even more efficiently when operated by electronic ballasts (EBs).

### Lighting requirements

The lighting requirements of patients' rooms are met by a number of separately switched lighting systems:

- general comfort lighting
- reading light for the patient
- lighting for bedside examinations and treatment
- night/observation lighting
- orientation lighting.

### Comfortable atmosphere

The general lighting should create a comfortable atmosphere and should suffice for the performance of simple nursing duties. Illuminance should be 100 lux and the light colour of the lamps should be warm white. Additional indirect lighting makes the room seem larger, brighter and more appealing. Each bed also requires a reading light (300 lux).

### Examination and treatment

The illuminance needed for bedside medical and nursing tasks can be provided jointly by all the lighting system components in the room. However, uniformity should not be less than 1:2. Lighting needs to be glare-free for doctors and nursing staff but not necessarily for patients. The correct illuminance levels are 300 lux for simple examinations and 1,000 lux for more complex ones.

### Patient care at night

Night/observation lighting should enable nursing staff to move around ward rooms safely and monitor the patients in them. To make sure patients in bed are not dazzled by the lighting, beams need to be directed onto the ceiling or walls. Illuminance should be 5 lux.

### Orientation lighting

Orientation lighting is useful for helping patients find their way at night without disturbing others in the room. Luminaires should be mounted below bed level and in the vicinity of the door. Wide-angled light distribution in the lower luminaire segment is recommended.



Fig. 8



Fig. 9



Fig. 10



Fig. 11

Ward lighting: general lighting (Fig. 8), reading light for patients (Fig. 9), lighting for bedside examinations and treatment (Fig. 10), night-watch lighting (Fig. 11). All lighting systems need to be separately switched.

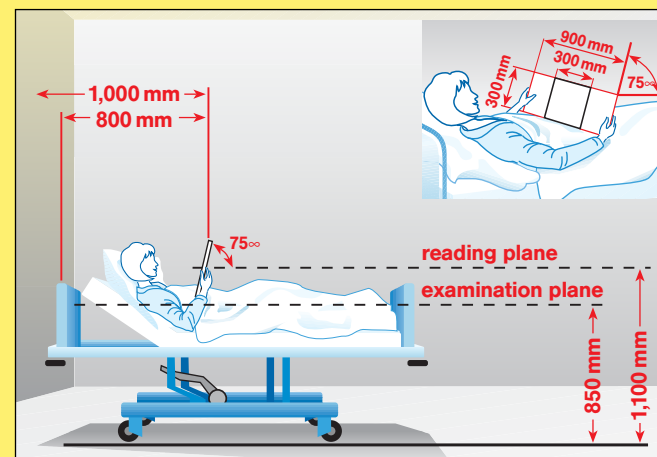


Fig. 12

### Requirements for patients' beds

The reading plane at a patient's bed is defined in draft standard E DIN 5035-3 as a surface – 900 mm wide by 300 mm high – inclined at 75° to the horizontal with a mid-point 1,100 mm above floor level and 800 mm from the head of the bed. 300 lux illuminance is required. In the case of non-static reading luminaires, it is enough if 300 lux is achieved over any 300 x 300 mm reading area within the reading plane.

To prevent direct glare, the luminous surfaces of a luminaire visible from the bed should be limited to 1,000 cd/m<sup>2</sup> luminance. The maximum admissible luminance of the ceiling perceived in the patient's field of vision is 500 cd/m<sup>2</sup>. The luminance of reading lights in the direct field of vision of other patients must not exceed 1,000 cd/m<sup>2</sup>. Direct field of vision is defined as all the points that can be perceived by someone reclining in a horizontal position with head turned at any angle.





11



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*Correct lighting does much to create a homely, comfortable atmosphere in patients' rooms. The most important functional lighting for the patient is the reading light assigned to the bed. The illuminance needed for bedside medical and nursing activities can be made up by all the lighting system components in the room.*



13

**Minimum requirements according to DIN EN 12464-1**

Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>7.3</b>	<b>Wards, maternity wards</b>			
7.3.1	General lighting	100	19	80
★	General lighting in infants' wards	200	19	80
7.3.2	Reading lighting	300	19	80
7.3.3	Simple examinations	300	19	80
7.3.4	Examination and treatment	1,000	19	90
7.3.5	Night-lighting, observation lighting	5	-	80
★	Night lighting, observation lighting in infants' wards	20	-	8
★	Orientation lighting	-	-	-
7.3.6	Bathrooms and toilets for patients	200	22	80

*For notes on lighting quality features, see page 49.*

## Medical supply units

The idea of the medical supply unit has its origins in the row of luminaires that used to be installed in hospital wards, generally at the head of patients' beds. Today's installations, however, incorporate all the supply lines, connections and controls needed to supply a patient with lighting, power, communication facilities and medical gases.

Medical supply units and their accessories are products as defined by the German Medical Products Act (MPG) and thus conform to EU Directive 93/42/EEC. Their range of features can be tailored to medical and/or other requirements and can be upgraded at any time. The units are delivered fully assembled and tested by the manufacturer and are generally connected to the relevant supply systems from the corridor.

### Horizontal or vertical

Medical supply units are now available in both horizontal and vertical designs. While horizontal systems continue to be the functional solution of choice for standard wards, vertical systems – often with a dec-

orative wood finish – blend seamlessly with the furnishings of higher-grade patients' rooms and underline their homely atmosphere.

To permit variable room use, the bed axis dimensions of horizontal supply units should be easy to adjust. This also enables changes to be made swiftly in response to personal requests by patients.

### Integrated lighting

The systems integrated to address lighting tasks permit

- comfortable, indirect general lighting
- glare-free lighting for reading
- tailored examination lighting
- observation lighting for staff at night.

### Electronic communication

Medical supply units are designed to be customized, e.g. to incorporate electronic communication points. Thus modified, they enable patients to access the Internet with a notebook and provide doctors and nurses with easy access to computerized patient records.

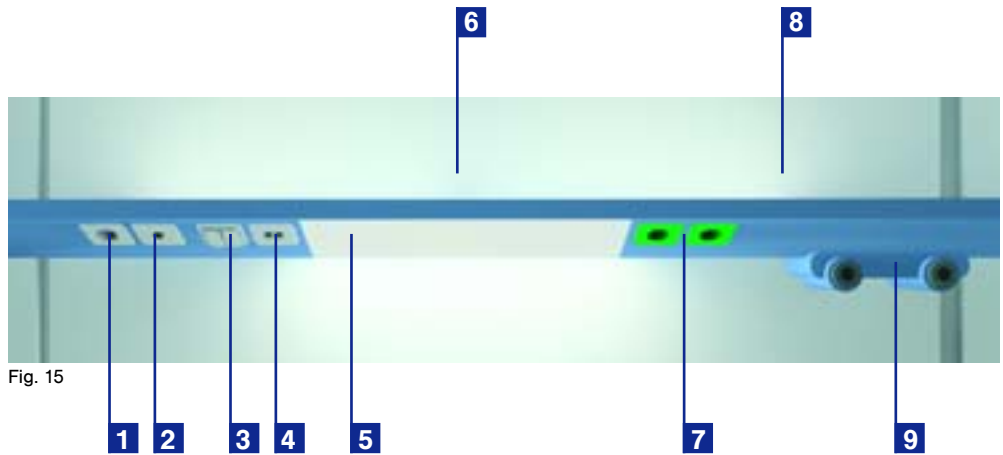
*Medical supply units incorporate all the supply lines, connections and controls needed to supply a patient with lighting, power, communication facilities and medical gases.*



Fig. 13



Fig. 14



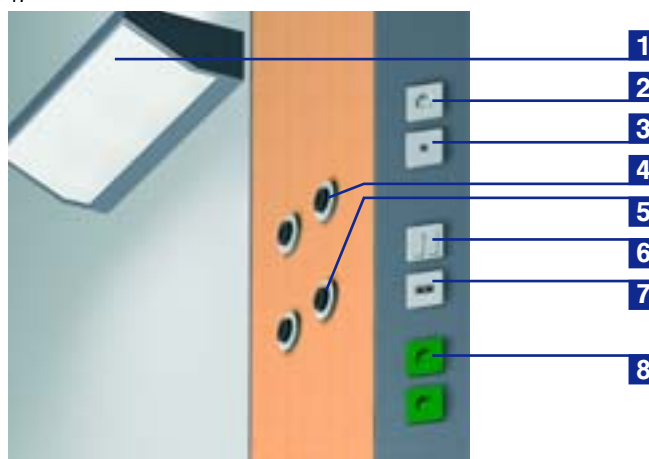
### Horizontal

- 1 230 V earthed socket
- 2 Low-voltage socket for the unit for calling a nurse, switching bed lights on/off and operating the radio
- 3 Switches for reading light and general lighting
- 4 Telephone sockets
- 5 Glare-free reading lights
- 6 Indirect general lighting
- 7 230 V earthed sockets connected to the emergency power supply system
- 8 Glare-free indirect observation lighting
- 9 Outlets for medical gases (compressed air, oxygen)



### Vertical

- 1 Glare-free reading light
- 2 230 V earthed socket
- 3 Low-voltage socket for the unit for calling a nurse, switching bed lights on/off and operating the radio
- 4 Compressed air outlet
- 5 Oxygen outlet
- 6 Switches for reading light and general lighting (the latter is normally installed separate from the medical supply unit)
- 7 Telephone sockets
- 8 230 V earthed sockets connected to the emergency power supply system





## Intermediate wards

The radical change sweeping the health care sector has produced totally new types of room. Among them: special intermediate wards for patients who need more supervision than others but not the constant monitoring provided in an intensive care unit.

### Lighting as in regular wards

Doctors and nursing staff need the same amount of light here as for bedside examinations and treatment in a regular ward:

300/ 1,000 lux illuminance.

To that extent, intermediate ward lighting is no different from that in normal wards (see page 6). To meet the higher requirements of the more intensive care pro-

vided, however, it is advisable to take higher values as a basis for planning: the lighting requirements lie between those of ordinary wards and intensive care units (see page 28).

The very poorly patients assigned to intermediate wards find gentle indirect lighting particularly agreeable. Care should thus always be taken to ensure that it is possible to switch from bright direct lighting to soft low indirect lighting.

Apart from medical supply units (see page 8), additional or alternative facilities may include direct or direct/indirect ceiling luminaires, reading lights, wall luminaires and orientation luminaires.



18



19

*For the minimum requirements set out in DIN EN 12464-1 for the lighting described on these two pages, see the "Wards" table on page 6.*

*The lighting requirements of intermediate wards lie between those of ordinary wards and intensive care units (see page 28).*

*More light is needed in intermediate wards than in ordinary wards. This is necessary to meet the higher requirements of the more intensive care provided.*



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# Maternity ward

Generally speaking, children's ward furnishings should be more homely than those of ordinary wards (see page 6) because sick children are particularly sensitive to their surroundings. They also respond more sensitively to lighting atmosphere.

- Room colours should be warm (light colour: warm white).
- Where rooms are designed for more than one patient, light zones give a sense of privacy.
- The lighting needs to be dimmable.
- The positive effect of comfortable lighting is underpinned by supplementary domestic-style luminaires.

### Child safety

Children who have been acutely ill feel a desperate

need to catch up on the exercise they missed. Here, lighting makes for greater safety by ensuring that hazards which could cause a child to trip or fall are clearly visible.

For safety reasons, children's wards are not equipped with medical supply units with electrical connections and sockets. Lighting controls should also be out of children's reach – and children's wards are no place for low decorative pendant luminaires and portable standard luminaires.

### More light for infants

In rooms reserved for infants, general and night/observation lighting needs to be brighter than in other children's wards because of the intensive care and monitoring procedures performed by hospital staff.



22



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Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>7.8</b>	<b>Delivery rooms</b>			
7.8.1	General lighting	300	19	80
7.8.2	Examination and treatment	1,000	19	80

For notes on lighting quality features, see page 49.



23

*Delivery room lighting: the blend of direct and indirect lighting – with preferably dimmable light sources – creates an atmosphere of homeliness and warmth, inspires confidence and conveys a sense of security.*



## Doctors' and nurses' rooms

Doctors' and nurses' rooms are primarily offices – invariably equipped with computer workstations, sometimes open to the public. So from a lighting viewpoint, too, doctors' and nurses' rooms need to be treated as offices (see page 34) – with particular care taken to ensure that anti-glare requirements (for both direct and indirect glare) are met. Minimum illuminance: 500 lux.

Direct/indirect lighting – realized with pendant or standard luminaires, for example – is often the popular choice for an office. The reason for this is that the illumination of the ceiling is found particularly agreeable. Where reading and writing tasks are performed, individually switched task lighting makes for better visual performance and greater visual comfort. Economical light sources include fluorescent and compact fluorescent lamps, which are both particularly energy-efficient when operated by electronic ballasts (EBs).

### Multifunctional nurses' rooms

Nurses' rooms have other functions, too. They are meeting rooms and rest rooms for nursing staff during breaks; they are used for preparing certain nursing procedures, and they are a retreat for the night nurse.

Lower lighting is required for communication and rest breaks than for office work, so the lighting systems installed should be dimmable. Lighting atmosphere can also be made more agreeable and comfortable by the use of supplementary accentuating light, realized with wall luminaires for tungsten halogen lamps, for example, on one or more switching circuits.

The activities involved in preparing nursing procedures normally require no more than the level of lighting provided by ordinary office lighting. Sorting pharmaceuticals and making up medication for patients are possible exceptions. Because of the care that needs to be taken, these are highly demanding visual tasks. Display luminaires, cabinet luminaires or ceiling luminaires designed to raise vertical illuminance at medicine cabinets provide supplementary lighting to facilitate their performance.

### Doctors' rooms

Where doctors' rooms have communication zones and double as rest rooms, supplementary accent lighting is recommended as for nurses' rooms. Doctors' rooms which are used for examinations have the same lighting requirements as dedicated examination rooms (see page 18).



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*Doctors' and nurses' rooms are mostly used as offices, so meeting anti-glare requirements is a primary lighting requirement. To facilitate other room uses, it is recommended that the lighting should be dimmable – e.g. to permit high lighting levels for making up patients' medication and comfortable lighting for rest breaks.*

**Minimum requirements according to DIN EN 12464-1**

Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>7.2</b>	<b>Staff rooms</b>			
7.2.1	Duty rooms	500	19	80
7.2.2	Staff rest rooms	300	19	80

For notes on lighting quality features, see page 49.

## Corridors, staircases and day rooms

### Corridors

As well as functioning as communication routes, corridors in wards and operating theatre suites double as work areas for attending to patients in adjacent rooms. Ward corridors are also a place where disabled or visually handicapped people can move around and where patients and visitors talk. The correct illuminance levels here are thus 200 lux (ward) and 300 lux (operating theatre suite). Good uniformity should also be ensured.

At night, the lighting level can be lowered to 50 lux. Accentuating light in corridors – highlighting sections of wall, for example – heightens vertical illuminance and enhances visual comfort. To ensure that patients transported along corridors in bed are not dazzled, lamps should be well shielded from view from below.

Corridors function as adaptation zones, making it easier for the eye to adapt to different brightness levels: between darkened patients' rooms and brightly lit duty and service rooms at night and between bright daylight rooms and illuminated but normally windowless communication routes during the day. Incidentally, even corridors with windows require lighting during the day so that an adequate level of lighting is ensured.

To ensure that the faces of oncoming persons are clearly identifiable, vertical illuminance should be raised, at least in corridors with lift access points. Wall luminaires with direct/indirect beams are a suitable solution here.

### Staircases

Stairs are hazard zones, not only for people in poor physical condition. Generally speaking, it is more dangerous to fall down stairs than to stumble on the way up. So correct staircase lighting is lighting which ensures that the individual stairs are clearly perceived from above. Light directed downwards from the top of the stairs also makes for short, soft shadows, enabling treads to be clearly distinguished and readily identified.

Like corridor lighting, staircase lighting in hospitals should be designed to provide 200 lux illuminance and not the standard 150 lux stipulated in DIN EN 12464-1. Supplementary lighting close to floor level – generally comprised of wall luminaires following the course of the stairs – makes for a surer footing. LED orientation lighting is a particularly energy-efficient option.

### Day rooms

Where day rooms are well used, this is primarily because their architecture and furnishings lend them appeal. And much of that appeal can be generated by accentuating and homely lighting. Direct/indirect light from ceiling and/or wall luminaires creates a stimulating atmosphere for communication. Where seating arrangements are fixed, supplementary pendant luminaires can be assigned to tables to provide direct lighting. Where rooms are also used for watching television, the lighting should be dimmer-controlled.



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*The operating costs of corridor lighting are not high*

*Because corridors and stairwells mostly lack windows and thus require maintained lighting, operating costs are often feared to be high. In actual fact, however, corridor lighting is not expensive. Where 200 lux horizontal illuminance is realized instead of 100 lux – which is a must in a hospital – the power consumed over a 12-hour period in a 10-metre-long corridor costs only 0.12 euros more, which is approximately the price of one kilowatt/hour.*

*This sample calculation is based on an energy-efficient lighting system comprising recessed luminaires, three-band fluorescent lamps and electronic ballasts (EBs).*



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**Assessment area in corridors**

*As a general rule, the quality features for hospital corridor lighting apply to the entire corridor. In some cases, 0.5 metre-wide strips along the walls on the right and left can be excluded from the assessment area.*

**Minimum requirements according to DIN EN 12464-1**

Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>1.1</b>	<b>Traffic zones</b>			
1.1.2	Stairs, escalators, travelators Recommended for traffic zones in the health service	150 200	25 22	40 80
<b>7.1</b>	<b>7.1 Rooms for general use</b>			
7.1.1	Waiting rooms	200	22	80
7.1.2	Corridors: during the day	200	22	80
7.1.3	Corridors: during the night	50	22	80
★	Corridors in operating theatre areas	300	19	80
7.1.4	Day rooms	200	22	80

*Hospital corridors and stairwells require 200 lux illuminance. Day rooms acquire appeal where accentuating, homely lighting creates an inviting atmosphere.*



# Outpatient departments and waiting areas

## Examination and treatment

In outpatient departments, examinations are conducted and treatment provided for all kinds of ailments. So the rooms in outpatient departments have basically the same lighting requirements as examination and treatment rooms (see page 18). Except for examination luminaires, there should be no general lighting luminaires positioned directly over the treatment trolley.

For emergencies in outpatient departments, additional instruments and equipment need to be organized fast. This calls for a high level of lighting. Ultrasound examinations are also conducted here and, like all scanning procedures, depend on monitors being reflection-free (see also pages 22, 34). The level of lighting in adjacent rooms should be similar to that in the examination room. In corridors, 200 lux illuminance is correct.

For doctors and nurses, examination room lighting needs to meet purely functional requirements. Patients, however, who arrive tense and anxious, prefer more comfortable lighting. Lighting zones, e.g. separate changing areas, are therefore recommended.

Ceiling luminaires with economical three-band fluorescent lamps and compact

fluorescent lamps for direct or direct/indirect lighting are the preferred solution for outpatient department lighting. Indirect lighting – also realized with wall luminaires beside treatment trolleys – makes for a more comfortable atmosphere. For reliable diagnosis, the correct light colour for lamps is neutral white, with a colour temperature between 3,800 and 5,300 degrees Kelvin. Having the option of switching lights on or off from the point of examination or from a remote control device makes it easier for physicians to tailor lighting to their requirements.

## Waiting areas

In the waiting area of an outpatient department, where people may be agitated, anxious or in pain, an agreeable lighting atmosphere has a settling, calming effect. This is achieved by using more indirect lighting, warm-white lamps, different lighting systems for different parts of the waiting area and not-too-dramatic accent lighting.

For patients on trolleys in areas screened off from the general waiting area, indirect lighting is also the correct choice. Accent lighting is not needed here. Ceiling luminaires – if used at all – need to be well shielded to prevent supine patients being dazzled.



35



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37

Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>s</sub>
7.1.1	Waiting rooms	200	22	80
7.4.1	Waiting rooms for reading	300	22	80
7.4.2	General lighting for examination and treatment	500	19	90
7.4.2	Examination and treatment	1,000	19	90
7.9.4	Plaster rooms	500	19	80



38



39



41



*Outpatient department rooms are general examination and treatment rooms and have the same lighting requirements. In waiting areas, an agreeable lighting atmosphere has a calming, settling effect.*

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## General examination and treatment rooms

Perfect for physician and nurse, pleasant for the patient – this formula applies particularly to examination and treatment room lighting. For general examination rooms, 500 lux illuminance is enough to meet general lighting requirements but 1,000 lux is required at the point of examination. This task lighting can be provided by positioning fixed or portable examination luminaires at the treatment trolley or chair or by increasing the general lighting to the required illuminance level.

### VDU support

As a general rule, examination room lighting needs to cater for the use of visual display units (VDUs), such as those used for ultrasound and other scanning procedures (see also page 22) and, increasingly, for the direct entry of data into computerized patient records. For the lighting designer, this means ensuring reflection-free screens (see also page 34). A balanced ratio between the brightness at a screen and keyboard and the illuminance of the immediate surroundings facilitates the visual task for doctors switching their gaze frequently back and forth between patient and monitor.

### Direct/indirect lighting

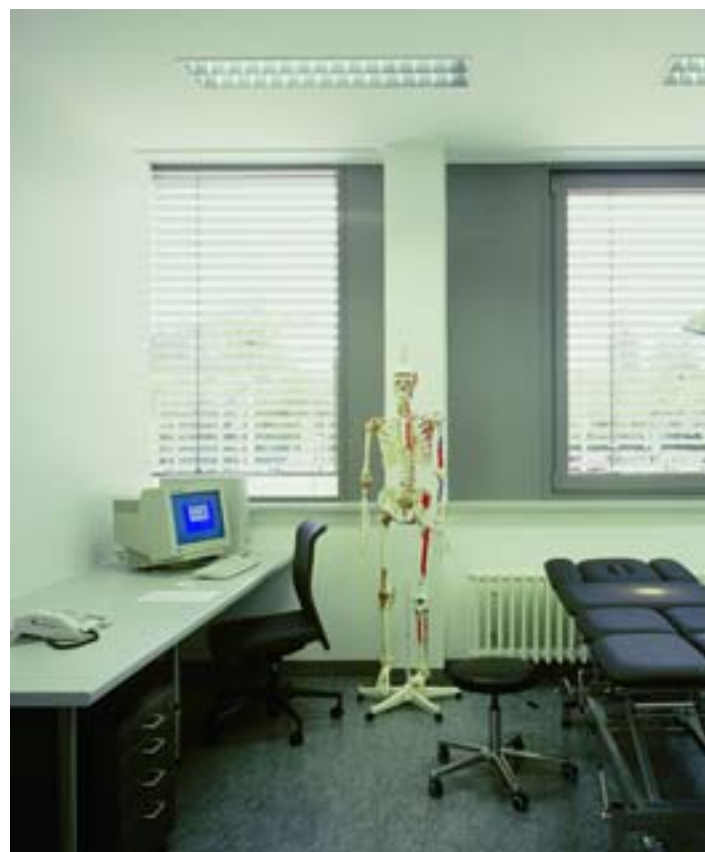
For general lighting, ceiling luminaires fitted with three-band fluorescent lamps or compact fluorescent lamps for direct/indirect lighting are the preferred solution today. Examination luminaires provide direct light only. A relatively high proportion of indirect light gives the room a more agreeable, more comfortable appearance, which is welcomed by patients.

For studying x-ray images, the lighting level needs to be lowered to 30 lux (see page 23 for minimum requirements according to DIN EN 12464-1). This is done either by manually deactivating or dimming some of the lighting or by activating a pre-programmed lighting scene in a lighting management system.

For reliable diagnosis, the correct light colour for lamps is neutral white, with a colour temperature between 3,800 and 5,300 degrees Kelvin. Having the option of switching lights on or off from the point of examination or from a remote control device makes it easier for physicians to tailor lighting to their requirements. Even more convenient is a system for activating pre-programmed lighting scenes.



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### Minimum requirements according to DIN EN 12464-1

Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>7.4</b>	<b>Examination rooms (general)</b>			
7.4.1	General lighting	500	19	90
7.4.2	Examination and treatment	1,000	19	90
7.9.4	Plaster rooms	500	19	80

For notes on lighting quality features, see page 49.





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*Adequate light is very important, not only for diagnosis. Examination luminaires or an appropriate increase in general lighting provide the 1,000 lux illuminance required at the point of examination.*



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## Special examination and treatment rooms

Basically, the lighting requirements of special examination and treatment rooms are similar to those of general ones, although the illuminance of the general lighting can be between 300 and 500 lux. The examination lighting, however, needs to be geared to the nature and procedures of the special examinations and treatments conducted.

The level of lighting required in the room also varies; it often needs to be lowered to the adaptation level of the eye for the performance of the relevant visual task. Dimmable lighting is essential. Even more convenient is a lighting management system for activating pre-programmed lighting scenes.

For fairly dark examination rooms in particular, it is important to ensure that illuminance in neighbouring rooms and areas differs by no more than a factor of 10. Where this cannot be ensured, adaptation zones are needed to make for smooth transitions between the different lighting levels.

Correct lighting for the visual tasks performed is provided by luminaires for three-band fluorescent lamps or compact fluorescent lamps switched in groups and operated by dimmable electronic ballasts (EBs) as well as special examination luminaires. What is important to ensure is that doctors can switch and/or regulate lighting from the point where they conduct examinations. For

reliable diagnosis, the correct light colour for lamps is neutral white, with a colour temperature between 3,800 and 5,300 degrees Kelvin.

### Special examinations, special lighting

Special examination and treatment rooms with special lighting requirements are needed, for example, for ophthalmic, ENT, gynaecological, dermatological and endoscopic examinations and for dental treatment, scanning procedures and dialysis.

### Ophthalmic examinations

For external examinations of the human eye, at least 1,000 lux illuminance is required. For reading tests, vertical illuminance should be 500 lux. For dioptrics, the physician needs dimmable general lighting with a brightness control range of 10 to 300 lux. And for certain special examinations, illuminance must be lowered to less than 10 lux.

### ENT examinations

The illuminance provided by the general lighting should be 300 lux. For external ENT examinations, 1,000 lux is required; for internal examinations, medical appliances provide light where it is needed.

### Gynaecological examinations

The recommended illuminance level for general lighting is 500 lux. For examinations, 1,000 lux is needed. For internal examinations, medical appliances provide light where it is needed.



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Special examinations and treatments call for special lighting. Physicians need to be able to switch and/or regulate both general and task lighting luminaires from a central point. Even more convenient is a lighting management system for activating pre-programmed lighting scenes.



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Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>7.5</b>	<b>Eye examination rooms</b>			
7.5.1	General lighting	300	19	80
7.5.2	Examination of the outer eye	1,000	-	90
7.5.3	Reading and colour vision tests with vision charts	500	16	90
★	Skiascopy, refractometry, ophthalmoscopy, ophthalmometry	50	19	90
★	Perimetry, adaptometry	≤ 10	19	90
<b>7.6</b>	<b>Ear examination rooms</b>			
7.6.1	General lighting	300	19	80
7.6.2	Ear examination	1,000	-	90

For notes on lighting quality features, see page 49.



## Special examination and treatment rooms

### Dermatological examinations

The illuminance provided by the general lighting needs to be 500 lux. For detailed examinations of the skin, 1,000 lux is required. For accurate appraisal of skin and skin colour changes, neutral white and daylight white are both suitable light colours; the colour rendering index of the lamps needs to be  $R_a \geq 90$ .

### Dental treatment

500 lux is recommended for the general lighting in dental examination and treatment rooms (zone E1, see fig. 17). At the patient (zone E2), the illuminance needs to be 1,000 lux and in the operating cavity (E3) at least 5,000 lux is required. Special treatment luminaires meeting the requirements of DIN EN ISO 9680 are standard equipment in all dental practices. To ensure that the reclining patient is not exposed to discomforting glare, asymmetrical-beam ceiling luminaires should be positioned outside a 2.5 x 2.5-metre area above the chair.

The correct light colour for lamps is neutral white or daylight white; for colour-matching dentures, daylight white with a colour temperature above 6,000 degrees Kelvin (at 5,000 lux) is required. The colour rendering index of the lamps needs to be  $R_a \geq 90$ . The same requirements apply to dental laboratories (see page 32).

### Scanning

Scanner room lighting needs to meet special require-

ments. This is because the illuminance of the general lighting needs to be lowered for images displayed on monitors. The same applies where x-ray images need to be studied in a film viewer.

Where images are generated on a screen, it is important that they should be reflection-free (see also page 34). A balanced ratio between the brightness at a screen and keyboard and the illuminance of the surroundings facilitates the visual task for the physician.

### Endoscopy

A higher level of illuminance is needed for the preparation of endoscopic examinations than for the examinations themselves. Because of the generally low luminance inside the endoscope, endoscopy itself requires illuminance in the room to be lowered to 50 lux or less. This applies to both direct and video endoscopy.

### Dialysis

For dialysis procedures, the illuminance provided by the general lighting should be 500 lux. Like hospital wards (see page 6), dialysis rooms should be furnished with comfortable indirect general lighting and direct reading lighting.

Dialysis sessions last several hours. During them, patients read, watch television, rest or sleep. Dialysis room lighting should enable them to do so without discomfort.



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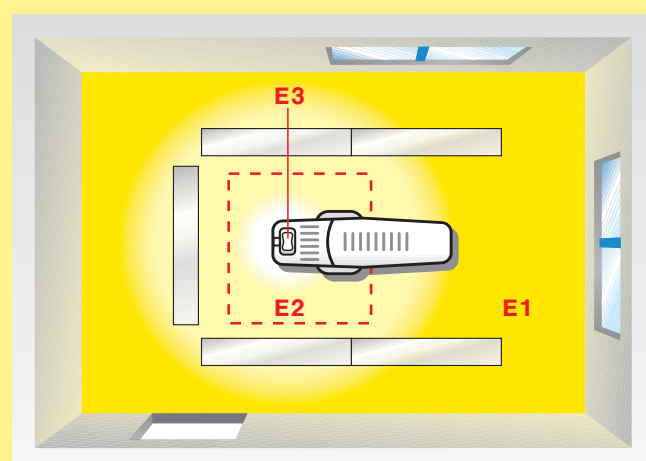


Fig. 17

*Arrangement of luminaires in a dental examination and treatment room: 500 lux is needed in the communication and preparation zone (E1), 1,000 lux at the patient (E2) and 5,000 lux at the point of treatment (E3).*



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Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>7.12</b>	<b>Dentists</b>			
7.12.1	General lighting	500	19	90
7.12.2	At the patient	1,000	-	90
7.12.3	Operating cavity	5,000	-	90
7.12.4	White teeth matching	5,000	-	90
<b>7.7</b>	<b>Scanner rooms</b>			
7.7.1	General lighting	300	19	80
7.7.2	Scanners with image enhancers and television systems	50	19	80
★	Direct monitoring on viewers	30	-	80
<b>7.9</b>	<b>Treatment rooms (general)</b>			
7.9.1	Dialysis	500	19	80
★	Dialysis, general lighting	100	19	80
★	Dialysis, reading lighting	300	19	80
7.9.2	Dermatology	500	19	90
7.9.3	Endoscopy rooms	300	19	80
★	Endoscopic examinations	50	19	80
7.9.4	Plaster rooms	500	19	80

For notes on lighting quality features, see page 49.



# Operating theatres and recovery rooms

## Surgical lighting

Surgical operations present the greatest challenges of all for physicians and medical personnel, particularly in terms of visual performance. For this reason, special surgical luminaires meeting the specifications of DIN EN 60601-2-41 are used to provide 10,000 – 160,000 lux in the operating field (zone E3, see Fig 18).

To avoid adaptation problems for the human eye when lines of sight switch between the operating field and the surrounding area, the illuminance of the room lighting needs to be graduated. Up to 2,000 lux in the immediate vicinity of the operating table (zone E2) facilitates adaptation. This lighting needs to be provided in addition to the general room lighting (zone E1) rated at 1,000 lux illuminance.

## Surround lighting

Surround lighting prevents problems of adaptation arising from the marked difference in luminance between the operating field lighting and the general lighting.

The immediate surroundings of the operating table encompass an area measuring approximately 3 x 3 metres centred on the oper-

ating table. Illuminance in this area, measured 1 metre above floor level, must not fall below 1,000 lux at any point. Taking into account other supply systems in this part of the ceiling, the aim should be to provide for a mean illuminance of 2,000 lux. Ceiling luminaires clustered as tightly as possible around the operating table avoid glare and prevent shadows being cast by members of the surgical team.

The following reflectance values are recommended: ceiling > 0.7; walls > 0.5; floor > 0.2; masking sheets and the surgical team's clothing and gloves > 0.3. All surfaces – especially those of surgical instruments – should be matt finished.

## Clean room luminaires IP 65

Clean room luminaires protected to IP 65 are used to provide surround and general lighting. These luminaires meet the hygiene requirements of rooms where surgical operations are performed.

*Special surgical luminaires deliver the very high illuminance levels required for the operating field.*

Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>7.10</b>	<b>Operating theatre area</b>			
7.10.1	Pre-op and recovery rooms	500	19	90
★	Recovery phase	100	19	90
★	Supplementary lighting	1,000	19	90
7.10.2	Operating theatres	1,000	19	90
7.10.3	Operating field	-	-	-
★	Immediate surroundings (target lux value)	2,000	19	90

For notes on lighting quality features, see page 49.



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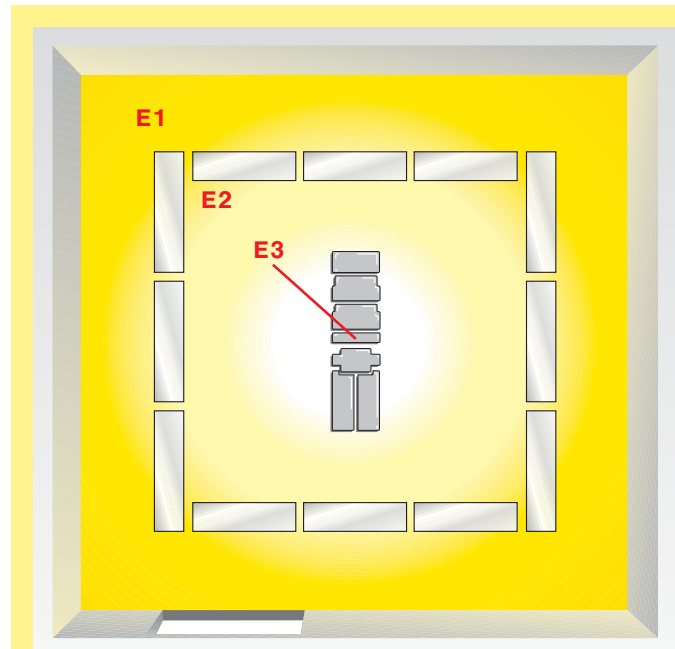


Fig. 18  
Operating theatre lighting consists of three components: general lighting designed to produce 1,000 lux for the room in general (E1), surround lighting generating 2,000 lux for the immediate surroundings of the operating table (E2) and lighting for the operating field (E3) designed to deliver 10,000 to 160,000 lux, depending on the kind of operation being performed.





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## Operating theatres and recovery rooms

### Light colour in operating theatres

The colour of the surround and general lighting should roughly match that of the operating field lighting. For the visual tasks involved in surgical procedures, neutral white light with a colour temperature  $> 3,800$  degrees Kelvin is the suitable option; the colour rendering index of the lamps needs to be  $R_a \geq 90$ .

### Lower lighting for minimally invasive surgery

Minimally invasive surgical procedures require much lower lighting than conventional surgery. Basically, the lighting should be lowered to the same level as for scanning and endoscopic procedures (see page 22).

Away from the actual site of the surgery, however, more light is needed – for monitoring the delivery of anaesthetic, for example. Diverse lighting levels thus need to be realizable to cater for the various visual tasks performed in operating rooms for minimally invasive surgery. Dimmable lighting and the possibility of switching and/or regulating lighting from the operating table or activating pre-programmed lighting scenes are fundamental requirements.

Modern operating theatre lighting and supply systems permit a variety of lighting settings, also catering, therefore, to the needs of minimally invasive surgery. One new system offers the option of general lighting plus indirect lighting directly over the operating field. The site of the operation itself

thus remains relatively dark during minimally invasive operations; the lighting level can be adjusted as required by the operator.

### Operating theatre ancillary rooms

An adequate level of brightness is also needed in ancillary rooms. Here, 500 lux illuminance is required for the visual tasks addressed by doctors and medical personnel. Hygiene requirements, too, play a role: cleaning operations call for a minimum of 500 lux.

### Recovery rooms

In recovery rooms, 100 lux illuminance is adequate for general lighting, which needs to be shielded along patients' lines of sight to minimize the risk of glare. Supine patients recovering from surgery should not be dazzled by direct light from ceiling luminaires. Indirect lighting, such as that provided by wall luminaires, is a suitable option.

Recovery rooms also require supplementary lighting, so that in an emergency illuminance at the bed can be increased to 1,000 lux. The risk of the patient being temporarily dazzled by this direct light cannot always be avoided.

### Corridor lighting

DIN EN 12464-1 stipulates 300 lux for corridors in operating theatre suites. Because higher illuminance facilitates adaptation for staff entering ancillary rooms (500 and 100 lux general lighting) from a bright operating theatre (1,000 lux), 500 lux is better.



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### Reliable operating frequency: 45 kHz EBs

Because the operating frequencies of the electronic ballasts (EBs) normally used for operating fluorescent lamps are too close to those

of table controls, disruptions could occur in the wireless control of operating tables. The risk of interference is eliminated where EB operating frequency is higher



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than that of the IR controls (35...40 kHz): EBs for operating theatre use have an operating frequency of > 45 (...69) kHz instead of the normal 25...30 kHz.



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Recovery rooms require subdued lighting for patients in the recovery phase and bright lighting for monitoring and emergency procedures. The risk of patients being temporarily dazzled by bright light cannot always be avoided. However, dazzling lights over patients must never be on for longer than is absolutely necessary (photos 62 and 63).



# Intensive care units

## Three-stage general lighting

Rest for severely ill patients, constant patient monitoring and fast response times in emergencies – these are key requirements in an intensive care unit (ICU). The conditions needed to realize them are met by general lighting designed to permit three different lighting levels:

- predominantly indirect lighting providing low 100 lux illuminance for the kind of comfort lighting designed to promote convalescence in ordinary wards;
- supplementary direct lighting producing 300 lux illuminance for simple bedside examinations and treatment;
- 1,000 lux illuminance for emergencies. This is realized either by activating more luminaires or by switching on all the lamps in three-lamp luminaires instead of just one for 300 lux.

For the visual tasks performed by doctors and medical personnel, the correct light colour for the lamps is neutral white, with a colour temperature between 3,800 and 5,300 degrees Kelvin. The colour rendering index needs to be  $R_a \geq 90$ .

Unlike in ordinary wards, the lighting systems used in ICU rooms are generally separate from the more complex installations for medical equipment. Comfort lighting (see page 6) is an exception. The medical supply units (see page 47) installed in ICUs are more amply equipped than those used in ordinary and intermediate wards.

## Observation lighting

Supplementary observation lighting enables patients and medical equipment to be monitored at night. To ensure that supine patients are not exposed to glare, lighting needs to be indirect, with beams directed at ceiling or walls. As a rule, it is integrated in medical supply units. Recommended illuminance: 20 lux.

## Observation windows

In rooms where patients are monitored through observation windows, the level of lighting needs to be significantly lower than in the room being monitored. Dimmable lighting is thus advisable here. Also, care must be taken to ensure that the lighting does not cause glare or visual interference due to reflections on the glass.



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### Minimum requirements according to DIN EN 12464-1

Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>7.11</b>	<b>Intensive care unit</b>			
7.11.1	General lighting	100	19	90
7.11.2	Simple examinations	300	19	90
7.11.3	Examination and treatment	1,000	19	90
7.11.4	Night watch	20	19	90

For notes on lighting quality features, see page 49.



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*Four lighting levels for intensive care: 100 lux for comfort lighting to promote convalescence, 300 lux for simple examinations and treatment, 1,000 lux for emergency procedures, 20 lux for night-time supervision.*



# Rehabilitation and therapy

Good lighting stimulates, motivates and thus promotes convalescence. After acute illness, the duration and success of therapy and rehabilitation depend to a crucial extent on the psychological wellbeing of the patient.

## Therapy rooms

In rooms used for physical, radiological or electromedical procedures – physiotherapy, massage, medicinal packs, baths and radiotherapy – 300 lux illuminance is required. A bright, attractive colour scheme is enhanced by general lighting with warm-white three-band fluorescent lamps. Coloured light can also be used for accent lighting.

Lighting must also take account of the special requirements of particular therapies. Where water is used, for example, damp or wet patches on the floor

need to be made clearly visible to reduce the risk of accidents.

## Pools

Because direct light is reflected by the surface of a pool and can thus dazzle a therapist at the pool edge, ceiling luminaires should be positioned at the sides. Where this is not possible, reflections can be reduced by using luminaires with asymmetrical beams.

Underwater lighting also reduces the risk of dazzling reflections on a pool surface. Moreover, it facilitates the supervision of bathers and gives those in the water a greater sense of security. Where pools are illuminated, therapy is better accepted.

Underwater lighting must be realized only with luminaires specifically designed for the purpose.

*A sense of psychological wellbeing plays an important role in motivating patients on the road to recovery. It is boosted by a bright, attractive colour scheme and warm-white light. Coloured light can also be useful. Depending on colour or colour sequence, it has a soothing or stimulating effect.*

Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>7.9</b>	<b>Treatment rooms (general)</b>			
7.9.5	Medical baths	300	19	80
7.9.6	Massage and radiotherapy	300	19	80

For notes on lighting quality features, see page 49.



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## Light helps heal

Artificial lighting is not only useful for banishing darkness. It is also used in medicine. Below are a few examples of light's therapeutic applications:

Short-wave infrared radiation activates circulation, helps alleviate pain and promotes healing. Focused light with a near-solar spectrum helps promote the healing process in cases of skin complaints, activates vitamins and stimulates the active ingredients of medicines. Blue light is used to treat bilirubin disorders, especially jaundice in newborn babies. Ultraviolet spots which emit tanning UVA rays and little UVB radiation work gently to give the skin a healthy tan.

Very bright "light showers" provide relief from the winter blues syndrome SAD (seasonal affective disorders) and help alleviate the symptoms of jetlag.

Coloured light can have a soothing effect, cross-fading from one colour to another can have a stimulating one. These effects are increasingly used at wellness centres – in illuminated ceilings, illuminated walls and smaller colour displays.

Coloured light can also be used in interiors to simulate the dynamism of daylight. The light sources employed are RGB fluorescent lamps (red, green, blue) – which can be mixed with all colours, including white – or LEDs.



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## Ancillary operations

All ancillary operations are workplaces and have workplace lighting requirements, which are normally met by general lighting with three-band fluorescent lamps for 300 or 500 lux illuminance. For more difficult visual tasks, supplementary lighting should be provided by workplace luminaires. Where visual tasks are more difficult throughout the room, the lighting level as a whole should be higher. In rooms with VDU workplaces, it is essential that lighting meets anti-glare requirements (direct and reflected glare, see page 34).

### Laboratories and pharmacies

The need for accurate identification and caution in laboratories and pharmacies means that good visual conditions are required in the immediate vicinity of the workplace. This calls for 500 lux illuminance, good glare limitation and optimal colour rendering (index  $R_a \geq 90$ ) by lamps. The recommended light colour is neutral white.

Workplaces where work involves matching colours are an exception. Reliable analysis of laboratory samples and tests calls for daylight-white lamps with a

colour temperature above 6,000 degrees Kelvin as well as 1,000 lux illuminance.

This recommendation also applies to dental laboratories, where many more requirements need to be met for difficult work on dental prostheses.

For storing and selecting pharmaceutical products in pharmacies, the vertical illuminance at shelving units and cupboards needs to be raised to at least 300 lux – 500 lux where reading tasks needs to be performed. This supplementary light can be provided by ceiling luminaires with appropriate beams, display luminaires or recessed cabinet luminaires.

### Kitchens and laundries

Kitchens require 500 lux general lighting; for laundries, 300 lux is adequate. In both, the presence of steam makes it advisable to use luminaires for damp interiors, which are protected to IP 54.

### Ancillary rooms

For reasons of hygiene, dirty-work areas require at least 200 lux illuminance. In sterilization and disinfection rooms, 300 lux illuminance is needed.

*From laboratories and pharmacies to kitchens and laundries – all ancillary operation lighting needs to meet workplace requirements. In rooms with VDU workstations, glare-free lighting is a top priority. Difficult visual tasks call for higher lighting levels.*



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Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>2.11</b>	<b>Laundries</b>			
2.11.2	Washing and dry cleaning	300	25	80
2.11.3	Ironing, pressing	300	25	80
2.11.4	Inspection and repairs	750	19	80
<b>5.2.2</b>	<b>Kitchens</b>	500	22	80
<b>7.13</b>	<b>Laboratories and pharmacies</b>			
7.13.1	General lighting	500	19	80
7.13.2	Colour inspection	1,000	19	90
★	<b>Dental laboratories</b>			
	<b>Preliminary and final inspection selection of dentures, ceramics, acrylic veneering:</b>			
★	General lighting	1,000	19	90
★	Task lighting	1,500	19	90
	<b>Designing, measuring, mould-making, modelling, working up</b>			
★	General lighting	1,000	19	80
★	Task lighting	1,500	19	80
★	General lighting for embedding and polishing	750	19	80
★	Task lighting for polishing	1,500	19	80
★	General lighting for duplicating, embedding (metal), grinding models	500	19	80
★	Task lighting for duplicating, grinding models	1,000	19	80
★	General lighting for casting and soldering	300	19	80
<b>7.14</b>	<b>Decontamination rooms</b>			
7.14.1	Sterilisation rooms	300	22	80
7.14.2	Disinfection rooms	300	22	80

For notes on lighting quality features, see page 49.



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Whether cellular or group, combi or open plan – there are basically three lighting options for offices:

- Room-related lighting, which provides uniform lighting throughout the room.
- Task area lighting – recommended where several task areas in a room are used to address different visual tasks and thus require different lighting levels. It is also an option where visual divisions are needed to identify different “workplace clusters”.
- Work surface lighting, used to supplement basic lighting where a tailored lighting level is needed for a particular visual task performed at a particular point in the task area.

### Office favourite: direct/indirect lighting

Pendant or standard luminaires with direct/indirect beams are a popular choice for offices. Most people find the kind of light they cast particularly agreeable. New technologies and miniaturized lamps permit luminaires of extremely shallow construction with optimal optical controls. Even where VDU screens are sharply inclined, they do not cause glare.

Direct general lighting with recessed ceiling, surface-mounted ceiling or pendant luminaires has been a long-time favourite, one whose principal appeal lies in its uniformity. Specular louvers distribute the highly directional light and ensure the glare limitation required.

Indirect general lighting with direct task lighting by workplace luminaires have

gained acceptance as a two-component solution. Luminaires mounted on the desktop need to be shielded for VDU work as specified in DIN 5035-8.

### Accent lighting

Luminaires for line-voltage or low-voltage tungsten halogen lamps – on walls, above or in display cabinets, as picture lights – are among the recommended options for office accent lighting. Fitted with halogen lamps, the luminaires should be separately switched and dimmer controlled. Because accent lighting generally creates patches of higher luminance, care must be taken to ensure it does not lead to annoying reflected glare.

### Avoiding glare

As a general rule – but especially at VDU workplaces – glare impairs visual performance and interferes with visual comfort. A distinction is made between direct glare – such as that caused by the unshielded light of a ceiling luminaire or by other luminous surfaces, including windows – and reflected glare. Here, light is directed into the eye by shiny surfaces; reflections on computer screens are particularly common.

Direct glare can be avoided by choosing suitable luminaires and arranging luminaires and workplaces correctly. Reflected glare at VDU workplaces can be avoided by ensuring that monitors are positioned so that reflections cannot be cast onto screens by bright surfaces such as windows, luminaires or light-coloured walls.



Fig. 19

The UGR (Unified Glare Rating) method takes account of all the luminaires in the lighting system which contribute to a sensation of glare as well as the brightness of walls and ceilings.

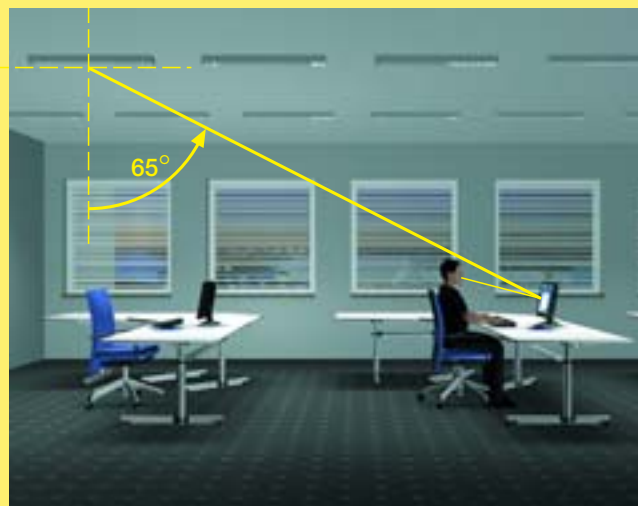


Fig. 20

Depending on the class of VDU, the mean luminance of luminaires which could be reflected on the screen needs to be limited to 200 cd/m<sup>2</sup> or 1,000 cd/m<sup>2</sup> above a threshold angle of radiation of  $\geq 65^\circ$  (calculated at 15° intervals all around the vertical axis).

### Minimum requirements according to DIN EN 12464-1

Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
<b>3</b>	<b>Offices</b>			
3.1	Filing, copying, communication zones, etc.	300	19	80
3.2	Writing, typing, reading, data processing	500	19	80
3.5	Conference and meeting rooms	500	19	80
3.7	Archives	200	25	80

For notes on lighting quality features, see page 49.



Fig. 21



Fig. 22



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Fig. 23



Fig. 24



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Office lighting – examples of lighting in a cellular office (Fig. 21), a prestige office (Fig. 22), a group office (Fig. 23), a combi office (Fig. 24) and an open plan office (Fig. 25)

Detailed information on “Good Lighting for Offices and Office Buildings” is contained in booklet 4 of this series (see page 53).



Fig. 25



# Cafeterias and restaurants

Attractive architecture, effective interior design and an agreeable lighting atmosphere can create areas in a hospital which feel nothing like parts of a hospital. Cafeterias and restaurants are a good example. They are a place where patients and visitors can switch off and relax, where hospital staff spend their breaks, where people come for a drink or a meal even if they have no other business at the hospital. What is needed here is decorative lighting with atmosphere and emotional appeal.

### Differentiated lighting

Catering facility lighting should be differentiated, using diverse lighting systems to lend structure to the space: pendant luminaires for tables, wall luminaires and downlights for moderately raising the lighting level, downlights and spots for accent lighting.

Suitable light sources are luminaires for compact fluorescent lamps, line-voltage and low-voltage tungsten halogen lamps and – for interiors with higher ceilings – metal halide lamps with low power ratings. Warm-white light makes for an agreeable atmosphere and colour rendering needs to be very good (index  $R_a \geq 90$ ) so that food and drinks

are perceived in their natural colours.

### Avoiding glare

Catering facility lighting offers a great deal of scope for design but limits are reached where visual performance and visual comfort are severely impaired. Care must also be taken to ensure there is no risk of direct glare from general-diffuse lamps or wrongly positioned luminaires and that reflected glare on shiny tabletops is kept within limits. Excessive modelling makes faces harder to identify, so this too should be avoided. And the view across or around the room is more agreeable if differences in luminance are not too marked.

### More light where food is presented

In terms of brightness, service areas should remain in the background - but only where visual performance is not affected. It would not be appropriate at a cashpoint, for example. All areas where food and drinks are presented, however, including buffets, serving counters and sales points for snacks, require brighter lighting than the rest of the room. This makes it easier for guests to get bearings and perform the visual task of selecting food.

Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	$R_a$
<b>5.2</b>	<b>Restaurants</b>			
5.2.1	Reception/cashier desk porters desk	300	22	80
5.2.2	Kitchens	500	22	80
5.2.3	Restaurants, dining rooms, function rooms	-	-	80
5.2.4	Self-service restaurants	200	22	80
5.2.5	Buffet	300	22	80



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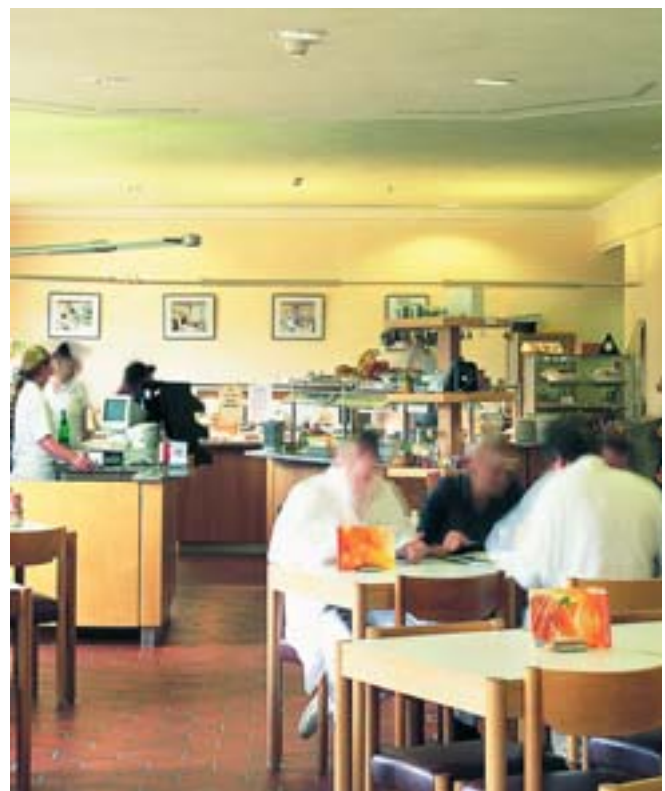


85

*A place to switch off and unwind: decorative lighting with atmosphere and emotional appeal makes cafeterias and restaurants a popular meeting-point. Catering facilities offer the lighting planner lots of scope for design – but glare needs to be avoided.*



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## Outdoor areas

Roads and road entrances, footpaths, car-parks, gardens, approach routes for emergency vehicles, helicopter landing pads – there are numerous places around a hospital that need lighting at night. The main purpose of that lighting is security: it guards against accidents and crime. At the same time, though, attractive outdoor lighting helps boost a hospital's image and profile.

### Roads and road entrances

Luminaires need to provide enough light for everyone using the roads on the hospital site. For mixed traffic – comprising slowly moving and parking vehicles, cyclists and pedestrians – a minimum of 3 lux illumination is needed, at least 7 lux where traffic density is greater. Vehicle entrances and exits require higher illuminance levels or a different light colour.

### Footpaths

Low footpath luminaires, such as bollard luminaires, are the solution for pathways used exclusively by pedestrians. They help ensure clear identification of obstacles, hazards and oncoming pedestrians and make for better visual orientation. The illuminance required depends on the brightness of the surroundings: it should always be more than 1 lux and at least 5 lux for paths with steps or uneven surfaces. Illuminated or spotlighted signs – well-shielded to prevent glare – are important for basic orientation.

### Parking facilities

The same luminaires are used for parking facilities as

for streetlighting, if necessary with lower mounting heights. The level of illuminance required depends on the volume of traffic: 15 lux where the average number of vehicles is high, 7 lux where it is low.

### Gardens

Footpaths in gardens have the same lighting requirements as other paths on the site. Additional floodlighting of trees and shrubs can heighten the prestige value of the exterior lighting.

### Emergency vehicle approach roads

For emergency vehicle approach roads, which are normally covered, an effective adaptation zone is needed at night to help emergency vehicle drivers arriving in darkness at a brightly lit Accident and Emergency entrance. The 50 lux illuminance at the beginning of the approach road should rise in stages to 200 lux at the end. The adaptation zone also provides visual guidance.

### Helipads

In addition to signal lighting, helipads need floodlighting. This has to be bright enough to ensure smooth emergency transport operations but must not dazzle pilots.

### Outdoor lighting standards

The standards current in Germany are DIN 5044 "Stationary traffic lighting" and DIN 67528 "Lighting of parking areas and indoor car-parks". The European standard E DIN EN 12464-2 applies to outdoor workplaces.



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The main purpose of outdoor lighting is security: it guards against accidents and crime. At the same time, it helps boost a hospital's image and profile.

Detailed information about "Good Lighting for Safety on Roads, Paths and Squares" is contained in booklet 3 of this series (see page 53).

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FGL - 3D-visualization ©

Abb. 26

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## Doctors' surgeries

Good lighting in medical practices extends a welcome to the patient at the entrance. An agreeable, bright, warm atmosphere gives reassurance and inspires confidence, making patients attending a surgery or medical centre feel they are in good hands.

Doctors' surgeries are used for a variety of activities, each one involving demanding visual tasks: office work in the reception area and at consulting room desks, examination and treatment procedures in examination rooms, and analyses in the laboratory.

### Reception and waiting room

The lighting requirements here are the same as for equivalent rooms or areas in a hospital. At reception desks (see page 4), higher vertical illuminance facilitates identification and communication. In waiting rooms (see page 16), an agreeable lighting atmosphere has a settling and soothing effect. One important thing to remember is that at least 300 lux illuminance is needed to ensure good reading conditions for waiting patients. The 200 lux recommended as standard is not enough for this visual task.

### Examination and treatment rooms

Depending on whether they are classed as general (see page 18) or special (see

page 20), examination and treatment rooms require 500 or 300 lux illuminance. Supplementary lighting for the 1,000 lux needed at treatment couches or chairs is provided by fixed or portable examination luminaires or supplementary general lighting.

### VDU support

Even in doctor's surgeries, the PC is today an indispensable tool. For the lighting designer, this means ensuring that reflections on screens are avoided (see also page 34). A balanced ratio between the brightness at a screen, keyboard and work materials and the illuminance of the surrounding area facilitates the visual task for doctors switching their gaze frequently back and forth between patient and monitor.

### Direct/indirect lighting

For general lighting, ceiling luminaires with economical fluorescent or compact fluorescent lamps for direct/indirect lighting are the preferred solution today. Examination luminaires provide direct light only. A relatively high proportion of indirect light gives the room a more agreeable, more comfortable appearance, which is welcomed by patients. Also important to remember: doctors need to be able to switch, control and/or regulate the lighting from the point where they conduct examinations.



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Good lighting is a prime requirement for ensuring that patients attending surgeries or medical centres feel they are in good hands. The lighting requirements are the same as for equivalent rooms or areas in hospitals.



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Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
7.1.1	<b>Doctors' surgeries</b> Waiting rooms	200	22	80
★	Waiting rooms with reading tasks	300	22	80
★	Reception	500	19	80
<b>7.4</b>	<b>7.4 Examination rooms</b>			
7.4.1	7.4.1 General lighting	500	19	80
7.4.2	Examination and treatment	1,000	19	80

For notes on lighting quality features, see page 49.



# Sanatoria, nursing homes and retirement homes

Comfortable lighting is an important factor shaping the sense of wellbeing of a patient in hospital. But it is only in “health hotels” that patients’ rooms are truly homely. Rooms in sanatoria, nursing homes and retirement homes should always feel like a home from home – because their occupants may be there for a fairly long time.

### Home in a room

The requirements of this ‘home in a room’ are similar to those of a hotel room. The lighting concept needs to cater for the activities associated with all the different parts of a home: entrance hall, living room, bedroom, dining room, sometimes even kitchen. Lighting solutions here are provided by ceiling, standard, tabletop and wall luminaires. In the case of bedside and armchair reading lights, easy adjustment, e.g. articulated jointing, is an important design feature. To minimize glare, the general lighting should be largely indirect. For demanding visual tasks such as reading, handiwork or activities in the kitchen, direct lighting needs to be available.

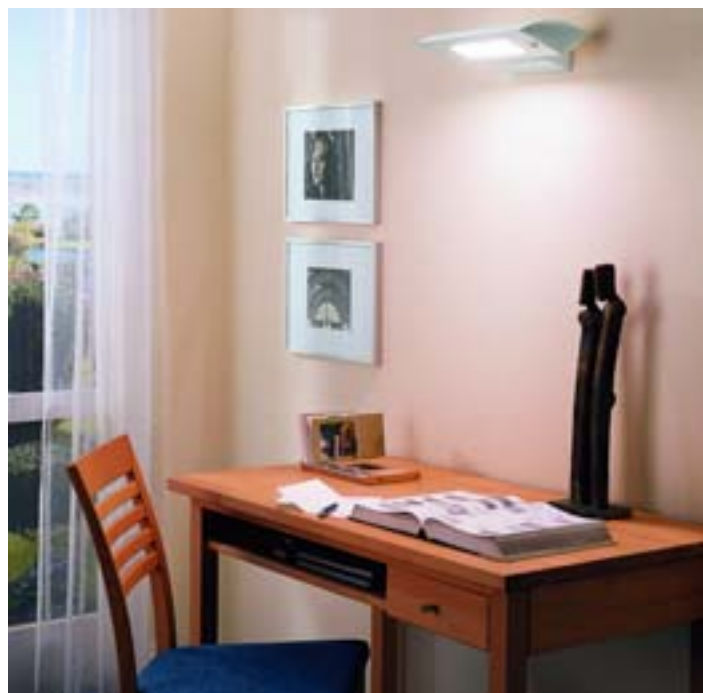
### The older we get, the more light we need

Account must also be taken of the declining visual acuity of older people: even a normal-sighted sixty-year-old needs at least twice as much light as a young person to get the same impression of brightness. At the same time, older people are significantly more sensitive to glare, so highly focused light should be avoided. The illuminance produced by the general lighting needs to be at least 100 lux; the illuminance of the direct light for reading and similar visual tasks should be at least 300 lux; higher illuminance levels are better.

Lighting for sanitary facilities needs to be bright and cheerful. It ensures safety and makes daily life easier for all residents.

### Day rooms

Accentuating, homely lighting is also a must for day rooms. Direct/indirect light cast by ceiling and/or wall luminaires facilitates communication; where seating arrangements are fixed, pendant luminaires for direct lighting can be assigned to tables. Where rooms are used as television lounges, the lighting should be dimmable.



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Minimum requirements according to DIN EN 12464-1				
Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in Lux	UGR <sub>L</sub>	R <sub>a</sub>
	<b>Nursing and retirement homes</b>			
	Living/bedrooms			
★	General lighting	100	19	80
★	Reading lighting	300	19	80
★	Lighting at dining tables and desks	200	–	80
7.1.4	Day rooms	200	22	80
7.3.6	Bathrooms and toilets	200	22	80

For notes on lighting quality features, see page 49.



*In sanatoria, nursing homes and retirement homes, life for residents basically revolves around the living room/bedroom. So furnishings and lighting should create a homely impression. The lighting concept of this one-room residential unit is the same as that of a hotel room: it needs to meet the functional requirements of every part of a home - from entrance hall to living room, bedroom to dining room, and sometimes even kitchen.*

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# Lamps

These two pages show a selection of the most important types of lamps for health care applications.

## 1, 2 Incandescent lamps

The traditional incandescent lamp is still the most widely used light source of all. This is due in part to the wide range of different units available. Reflector and bowl reflector lamps provide decorative directional lighting. Incandescent lamps emit an agreeable warm-white light with good colour rendering properties and can be dimmer-controlled. Their luminous efficacy, however, is relatively low and their service life short.

## 3, 4, 5, 6 Tungsten halogen lamps (230 Volt)

Tungsten halogen lamps for 230 V line voltage produce an agreeable white light with very good colour rendering properties. Their service life is longer than that of incandescent lamps and their luminous efficacy higher. Dimming control presents no problems. They are also available as reflector lamps.

## 7, 8 Low-voltage tungsten halogen lamps (12 Volt)

Low-voltage tungsten halogen lamps have the same characteristics as lamps for line voltage. To operate them, however, a transformer is needed to reduce the line voltage to 12 Volts. IRC (Infra Red Coating) lamps consume 30 percent less power for the same luminous flux. With appropriate transformers and dimmers, they can be dimmer-controlled.

## 9, 10 Energy-saving lamps

Energy-saving lamps are compact fluorescent lamps. They are nearly the same size as incandescent lamps and have the same screw base (E14/E27). The electronic ballast (EB) required is integrated in the lamps. Energy-saving lamps consume 80% less power and have a considerably longer life than incandescent lamps.

## 11, 12, 13, 14 Compact fluorescent lamps

Unlike energy-saving lamps, compact fluorescent lamps have a plug-in base; the ballast needs to be integrated in the lamp. Compact fluorescent lamps have the same characteristics as three-band fluorescent lamps. Here, too, luminous efficacy is improved, service life lengthened and visual comfort heightened by EB operation. Lamps can be dimmed by dimmable EBs.

## 15, 16 Metal halide lamps

These high-pressure discharge lamps are noted for their high luminous efficacy and excellent colour rendering properties. With modern metal halide lamps with a ceramic burner, light colour remains constant throughout the life of the lamp. Inductive ballasts and starters or EBs are needed to operate metal halide lamps.

## 17, 18, 19 Linear three-band fluorescent lamps

Three-band fluorescent lamps are noted for their high luminous efficacy, good colour rendering properties and long service life. Operated by electronic ballasts (EBs), they achieve even higher luminous efficacy, a longer service life and greater visual comfort. 16 mm diameter lamps are designed for EB operation only. Dimming control of three-band fluorescent luminaires is possible with appropriate EBs.

## 20 Light-emitting diodes (LEDs)

LEDs are available in numerous shapes and colours. They are extremely small, have a high resistance to impact and emit neither IR nor UV radiation. They have a very long service life. LEDs with a special fluorescent coating produce white light. The most important lighting applications at present are in orientation and decorative lighting. LEDs are designed for d.c. operation.

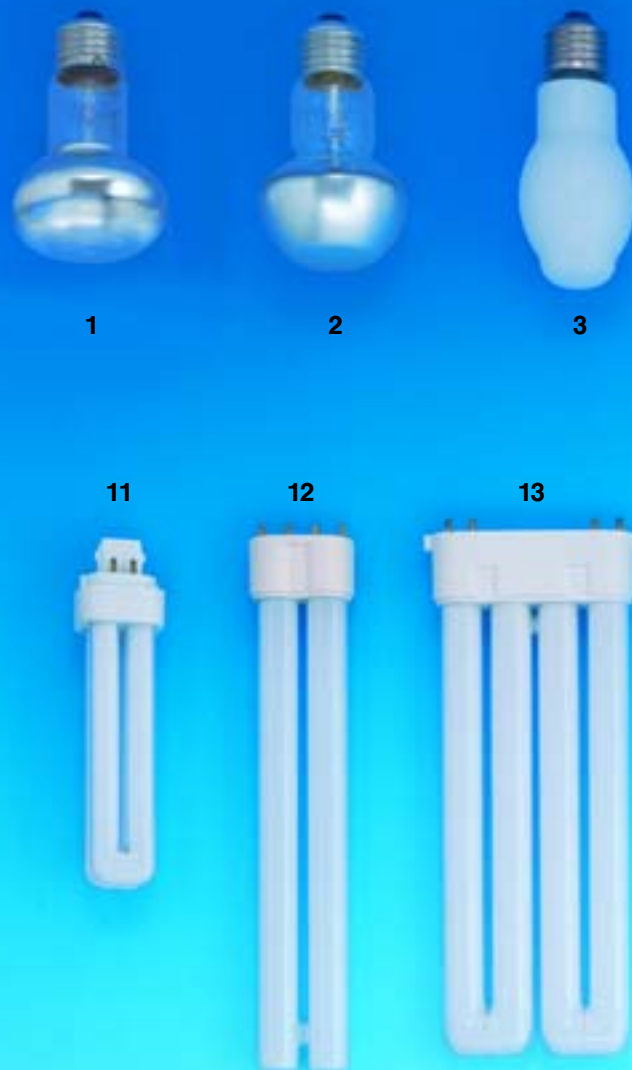


Illustration No.	Lamp type	Power rating (Watts)
<b>Incandescent lamps</b>		
1	Reflector lamps	30 – 100
2	Bowl reflector lamps	40 – 100
<b>Tungsten halogen lamps (230 V)</b>		
3	With jacket	25 – 250
4	Mini-format	25 – 75
5	With base at both ends	60 – 2,000
6	With reflector	40 – 100
<b>Low-voltage tungsten halogen lamps (12 V)</b>		
7	With reflector	20 – 100
8	Pin-based	5 – 100
<b>Energy-saving lamps</b>		
9	Candle-shape	5 – 12
10	Incandescent-shape	5 – 23
<b>Compact fluorescent lamps</b>		
11	2-, 4- and 6-tube lamp	5 – 120
12	2-tube lamp	18 – 80
13	4-tube lamp	18 – 36
14	2D lamp	10 – 55
<b>Metal halide lamps</b>		
15	With base at one end	35 – 150
16	With base at both ends	70 – 400
<b>Linear three-band fluorescent lamps</b>		
17	Ø 16 mm with high luminous efficacy <sup>1)</sup>	14 – 35
18	Ø 16 mm with high luminous flux <sup>1)</sup>	24 – 80
19	Ø 26 mm	18 – 58
<b>Light-emitting diodes (LEDs)</b>		
20	Individual LEDs <sup>4)</sup>	0.7 – 1.5

Light colour:

ww = warm white, nw = neutral white, dw = daylight white



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17+18



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Luminous flux (Lumens)	Luminous efficacy (Lumens/Watt)	Light colour	Colour rendering index R <sub>a</sub>	Base
-	-	ww	≥ 90	E14; E27
-	-	ww	≥ 90	E14; E27
260 – 4,350	10 – 17	ww	≥ 90	E14; E27
260 – 1,100	10 – 15	ww	≥ 90	G9
840 – 44,400	14 – 22	ww	≥ 90	R7s
-	-	ww	≥ 90	E14; E27; GZ10; GU10
-	-	ww	≥ 90	GU5,3
60 – 2,200	12 – 22	ww	≥ 90	G4; GY6,35
150 – 600	30 – 50	ww	80 < 90	E14
150 – 1,350	30 – 59	ww	80 < 90	E27
250 – 9,000	50 – 75	ww, nw	80 < 90	G23; G24; GX24; 2G7/8
1,200 – 6,000	67 – 75	ww, nw, dw	80 < 90	2G11
1,100 – 2,800	61 – 78	ww, nw	80 < 90	2G10
650 – 3,900	65 – 71	ww, nw, dw	80 < 90	GR8; GR10; GRY10
3,300 – 14,000	85 – 95	ww, nw	≥ 90; 80 < 90,	G8,5; G12;
6,500 – 36,000	90	ww, nw	≥ 90; 80 < 90,	RX7s; Fc2
1,250 – 3,650 <sup>2)</sup>	89 – 104	ww, nw, dw	80 < 90	G5
1,850 – 7,000 <sup>2)</sup>	77 – 88	ww, nw, dw	80 < 90	G5
1,350 – 5,200	75 – 90 <sup>3)</sup>	ww, nw, dw	80 < 90	G13
18 – 27	13 – 23	-	-	-

1) For EB operation only  
2) Luminous flux at 35°C

3) Luminous efficacy increases to 81 – 100 lm/W with EB operation.  
4) The illustration shows individual LEDs on a flexible printed-circuit board.



# Luminaires

For the many lighting and design requirements of health care applications, there is a wide range of luminaires and medical supply units available.

The examples shown on these two pages are only a selection. A number of special luminaires, such as those for surgical lighting, light therapy or underwater lighting in therapy rooms, have been omitted.



Figs. 27 + 28

**Pendant luminaires**  
for direct/indirect lighting



Figs. 29 + 30

**Spots**  
for power track (left) or as individual luminaire (right)



Figs. 31 + 32

**Examination luminaires**  
static (left) and mobile (right)



Figs. 33 + 34

**Lower luminaires**  
as surface-mounted (left) and recessed luminaire (right)  
or as square luminaires (not shown)



Figs. 35 + 36

**Downlights**  
with symmetrical beam (left) and  
with asymmetrical beam (right)



Figs. 37 + 38

**Wall luminaires**  
as surface-mounted luminaire (left)  
or as recessed luminaire (right)



Figs. 39 + 40

**Clean room luminaires**  
(degree of protection IP 65) for operating theatres



Figs. 41 + 42

**Medical supply units, horizontal**  
for intensive care units



Figs. 49 + 50

**Medical supply units, horizontal**  
for wards



Figs. 43 + 44

**Medical supply units, vertical**  
for wards



Figs. 51 + 52

**Flexible reading luminaires**  
at patient's bed



Figs. 45 + 46

**Escape sign luminaires**



Figs. 53 + 54

**Floods**  
for exterior lighting, e.g. in adaptation zones for emergency  
vehicle approach routes



Figs. 47 + 48

**Post-top luminaires**



Figs. 55 + 56

**Bollard luminaires** (left)  
**Light stelae** (right)





### **Adaptation**

Adaptation to differences in brightness is performed in the human eye by receptors on the retina and changes in the size of the pupil. The adaptive process – and hence the time it takes – depend on the levels of luminance before and after any change in brightness. Adaptation from dark to light takes only seconds; in the other direction, the adaptive process takes minutes.

The state of adaptation affects visual performance at any moment: the more light available, the more rapidly efficient visual performance can be restored. Visual impairment occurs where the eye cannot adapt to differences in brightness fast enough.

### **Lamp**

No lamp, no light: the term “lamp” refers to an engineered artificial light source – incandescent lamp, fluorescent lamp, etc..

### **Luminaire**

The term “luminaire” refers to the entire electric light fitting, including all the components needed to mount and operate the lamp. Luminaires protect lamps, distribute their light and prevent them causing glare.

### **Luminous efficacy**

Luminous efficacy is the measure of a lamp’s efficiency. It indicates how much light (luminous flux in lumens) a lamp generates from the electricity it consumes (power in Watts). The higher the ratio of lumens to Watts, the more efficiently the lamp works.

### **Luminous flux**

Luminous flux ( $\phi$ ) is the rate at which light is emitted by a lamp. It describes the visible light radiating from a light source in all directions and is measured in lumens (lm).

### **Luminous intensity**

Luminous intensity (symbol: I) indicates the amount of luminous flux radiated in a particular direction by reflector lamps and luminaires. It is measured in candelas (cd). Joining the points on a diagram showing the luminous intensity generated at different angles produces an intensity distribution curve (IDC).

### **Reflectance**

Reflectance indicates the percentage of luminous flux reflected by a surface. The reflectance of light-coloured surfaces is high; that of dark surfaces is low. This means that the darker room furnishings are, the more light is needed to create the same brightness.

### **Visual performance**

Visual performance is determined by the visual acuity of the eye, its sensitivity to differences in brightness and darkness, and the speed at which objects are perceived.

### **Visual task**

Visual tasks are defined by light/dark and colour contrasts and the size of details. They are a defining factor of visual performance. The more difficult the visual task, the higher the lighting level needs to be.

### **Standardized quality features**

Since March 2003, lighting quality features for artificial lighting in hospitals and other health care buildings have been defined by the European standard DIN EN 12464-1 “Lighting of Indoor Workplaces”. This is supplemented by E DIN 5035-3 “Lighting for Health Care Premises”, which is still in draft form at the time of going to press.

What is important to remember is that standards always cite minimum requirements; better values make for higher lighting quality.

Detailed information about lighting quality features is contained in booklet 1 “Lighting with Artificial Light” and booklet 12 “Lighting Quality with Electronics” of this series (see page 53).

### **Illuminance**

Illuminance (symbol: E) has a major bearing on the speed, reliability and ease with which visual tasks are perceived and performed. It is measured in lux (lx) and indicates the amount of luminous flux from a light source that falls on a given surface: 1 lux illuminance is where an area of 1 square metre is uniformly illuminated by 1 lumen of luminous flux. 1 lux is produced, for example, by the flame of an ordinary candle positioned 1 metre away. Measurements are taken on horizontal and vertical surfaces.

The illuminance values stated in DIN EN 12464-1 relate to the task area. This is the area where the actual visual task is performed. The illuminance of the sur-

rounding area can be one step lower in the illuminance scale.

Uniform distribution of brightness makes a visual task easier to perform. Uniformity of illuminance is the ratio of the lowest to the mean illuminance registered and should be at least 0.7 in the task area.

The mean illuminance values set out in the standards are service values which must be maintained at all times. Once mean illuminance falls to their level, maintenance work needs to be performed. When new lighting is planned, allowance needs to be made for a service factor to take account of the ageing and soiling of lamps, luminaires and room surfaces. The draft standard E DIN 5035-3 recommends a service factor of 0.8 for rooms where hygiene requirements are high or duration of room use limited. For all other rooms, the recommended service factor is 0.67.

### **Luminance distribution**

Luminance (symbol: L) is the brightness of an illuminated or luminous surface as perceived by the human eye and is measured in candelas per unit area ( $\text{cd}/\text{m}^2$ ,  $\text{cd}/\text{cm}^2$ ). It impacts on visual performance and visual comfort. The higher the luminance, the better the visual acuity, contrast sensitivity and performance of ocular functions.

The luminance of a surface depends on its reflectance and the illuminance registered on it. This is why a white room appears

brighter than a room with dark furnishings where illuminance is the same.

Visual comfort is impaired

- where luminance is too low and differences in luminance are too slight; this creates a dull and non-stimulating lighting atmosphere;
- where differences in luminance are too marked; this gives rise to fatigue because of the constant need for adaptation;
- where luminance is too high; this can cause glare.

### Glare limitation

Glare can be caused directly by luminaires or other surfaces – even windows – which are excessively bright (direct glare). It can also be caused indirectly by reflections on shiny surfaces (reflected glare). Both direct and reflected glare are a source of visual discomfort (psychological glare) and impair visual performance (physiological glare).

Protection from direct glare is provided by shielding lamps. Direct glare is assessed by the UGR (Unified Glare Rating) method; minimum values for anti-glare shielding are set out in standards. Reflected glare is prevented by judicious positioning of light sources, matt surfaces in the room and optical control elements which limit the luminance of luminaires.

### Direction of light and modelling

Shapes and surfaces in the room need to be clearly (visual performance) and easily (visual comfort) identifiable. This calls for balanced, soft-edged shadowing. Shadow formation is affected by the direction of light, which is itself defined by the distribution of luminaires and their arrangement in the room.

Highly directional light gives rise to deep hard-edged shadows. Where

no shadows are present, however – which happens when lighting is very diffuse – the effect is equally unpleasant. According to DIN EN 12464-1, the correct degree of modelling is achieved with a balanced ratio of directional and diffuse lighting.

For demanding visual tasks, visual performance is considerably improved by directional lighting.

### Light colour

Light colour describes the intrinsic colour of the light radiated by a lamp. It is based on colour temperature (closest colour temperature  $T_{CP}$ ) and expressed in degrees Kelvin (K):

warm white (ww) < 3,300 K  
 neutral white (nw) 3,300 K to 5,300 K  
 daylight white (dw) > 5,300 K

The light generated by lamps of the same light colour can have different colour rendering properties.

Light colours affect the atmosphere of a room and thus impact on visual comfort: warm white light is felt to be homely and cosy, neutral white light strikes a more businesslike note. Daylight white light is suitable only for interiors where illuminance exceeds 1,000 lx – below which it creates a wan, monotonous atmosphere – or where visual tasks require precise identification of colours, e.g. in dermatological or dental examination rooms.

### Colour rendering

The colour rendering property of a lamp indicates the effect its light has on the appearance of coloured objects. It is rated by reference to the  $R_a$  index, which indicates how natural colours appear under a lamp's light. The colour rendering properties of lamps have implications for visual performance and visual comfort.

## Minimum lighting requirements according to DIN EN 12464-1 and E DIN 5035-3

The standard minimum lighting requirements for most of the health sector applications presented in this booklet are set out in a table. The figures are taken from DIN EN 12464-1:

2003-03 "Light and Lighting – Lighting of Indoor Work Places" and – where marked with an asterisk – from the national draft supplement to the European standard, E DIN 5035-3

"Artificial Lighting – Lighting for Health Care Premises". Additional recommendations are made for certain applications.

### $\bar{E}_m$ in lux

This is the service value of mean illuminance in lux. Illuminance must never fall below this level.

### Ref. no.

This is the reference number of the lighting application in the DIN EN 12464-1 table. Applications marked with an asterisk are taken from E DIN 5035-3.

### Type of interior, task or activity

DIN EN 12464-1 groups interiors on the basis of the visual tasks or activities performed in them.

### UGR<sub>L</sub>

This shows the direct glare limiting index calculated by the unified glare rating (UGR) method.

### $R_a$

This indicates the colour rendering index, which describes the colour rendering properties of lamps.

### Minimum requirements according to DIN EN 12464-1

Ref. no.	Type of interior, task or activity	$\bar{E}_m$ in lux	UGR <sub>L</sub>	$R_a$
1.1	<b>Traffic zones</b>			
1.1.2	Stairs, escalators, travolators. Recommended for traffic zones in health care facilities	150	25	40
		200	22	80
7.1	<b>Rooms for general use</b>			
7.1.2	Corridors: during the day	200	22	80
7.1.3	Corridors: during the night	50	22	80
★	Corridors in operating theatre areas	300	19	80



The colour rendering index is based on frequently found test colours.  $R_a = 100$  is the best rating; the lower the index value the poorer the colour rendering properties. In interiors, a colour rendering index of  $R_a = 80$  should be regarded as a minimum.

### Daylight utilization

The rhythm of day and night and the dynamics of daylight have a fundamental impact on the way we live. Daylight indoors is found agreeable – and the more daylight harnessed the better. DIN EN 12464-1 thus states that “daylight may provide all or part of the lighting for visual tasks”. It also stipulates, however, that supplementary artificial lighting is also needed.

Electronic daylight-dependent regulation systems harness daylight to reduce power consumption: they respond to changes in the level of incident daylight available and dim or deactivate parts of the artificial lighting accordingly. Detailed information is contained in booklet 12 “Lighting Quality with Electronics” of this series (see page 53).

### Energy-efficient lighting

Subject to the proviso that “it is important not to compromise the visual aspects of a lighting installation simply to reduce energy consumption”, DIN EN 12464-1 states that lighting installations should meet the lighting requirements of a particular space without waste of energy.

The energy efficiency of a lighting system depends on the power savings realized by lamps and ballast/lamp

systems with high luminous efficacy ratings, luminaires with good light output ratios, long-life lamps, operating devices and luminaires, and assembly- and maintenance-friendly design.

### Lighting electronics

Electronic operating devices for lamps enhance lighting comfort, for example by providing flicker-free light. At the same time, they are extremely energy-efficient. Lighting electronics is a prerequisite for convenient, power-saving lighting management. The most important electronic operating device in interior lighting is the electronic ballast (EB) for operating linear fluorescent lamps and compact fluorescent lamps.

### Lighting management

Lighting management encompasses all systems which go beyond mere “on/off” control. This requires “intelligent” electronic operating devices. What is more, lighting needs to be operable in different control states, so individual luminaires or groups of luminaires need to be separately addressable.

Lighting management makes lighting more flexible, enabling it to be tailored more easily to requirements. Also, lighting management saves energy, for example through daylight-dependent and/or presence-dependent regulation. Detailed information on this subject can be found in booklet 12 “Lighting Quality with Electronics” of this series (see page 53) and at the websites [www.dali-ag.org](http://www.dali-ag.org) and [www.licht.de](http://www.licht.de)

**DIN EN 1838** Lighting applications – Emergency lighting

**DIN EN 12464-1** Light and lighting – Lighting of work places, Part 1 Indoor work places

**E DIN EN 12464-2** Light and lighting – Lighting of work places, Part 2 outdoor work places

**DIN EN 12665** Light and lighting – Basic terms and criteria for specifying lighting requirements

**DIN 5034** Daylight in interiors

**E DIN 5035-3** Artificial lighting, Part 3: Lighting for health care premises

**E DIN 5035-7** Artificial lighting, Part 7: Lighting for rooms with VDU work stations or VDU-assisted workplaces

**DIN 5035-8** Artificial lighting, Part 8: Special requirements for the lighting of single work-places in offices and similar rooms

**DIN 5044** Stationary traffic lighting – Street lighting for automobile traffic  
Part 1: General requirements and recommendations  
Part 2: Calculation and measurement

**DIN EN 60598-2-25** Luminaires, Part 2: Particular requirements, Section 25: Luminaires for use in clinical areas of hospitals and health care buildings

**DIN EN 793** (VDE 0750 Part 211) Special requirements for the safety of medical supply units

**VDE 0107** Power installations in hospitals and rooms for medical use in buildings other than hospitals

**SP 2.4** (trade association information 856) **Beleuchtung im Büro** (Office Lighting), in the VBG Prävention series of publications, published by the German trade association VBG and Deutsche Lichttechnische Gesellschaft e.V. (LiTG)

### Emergency lighting

*In hospitals and other health care facilities, emergency lighting powered by a source other than mains electricity is required for many interiors. It is needed to ensure that patients, visitors and staff can exit the building safely in the event of a power failure. This requires safety lighting for escape routes and escape route signs.*

*In operating theatres, mains-independent emergency lighting is needed to provide full backup lighting as well as safety lighting for escape*

*routes. It must be ensured that surgical operations can continue and be completed as if no power failure had occurred.*

*The lighting requirements for the installation, operation and maintenance of emergency lighting systems are set out in DIN EN 1838; the electrical requirements are listed in DIN VDE 0108. Detailed information is contained in booklet 10 of this series, “Notbeleuchtung, Sicherheitsbeleuchtung” (currently available only in German, see page 53).*

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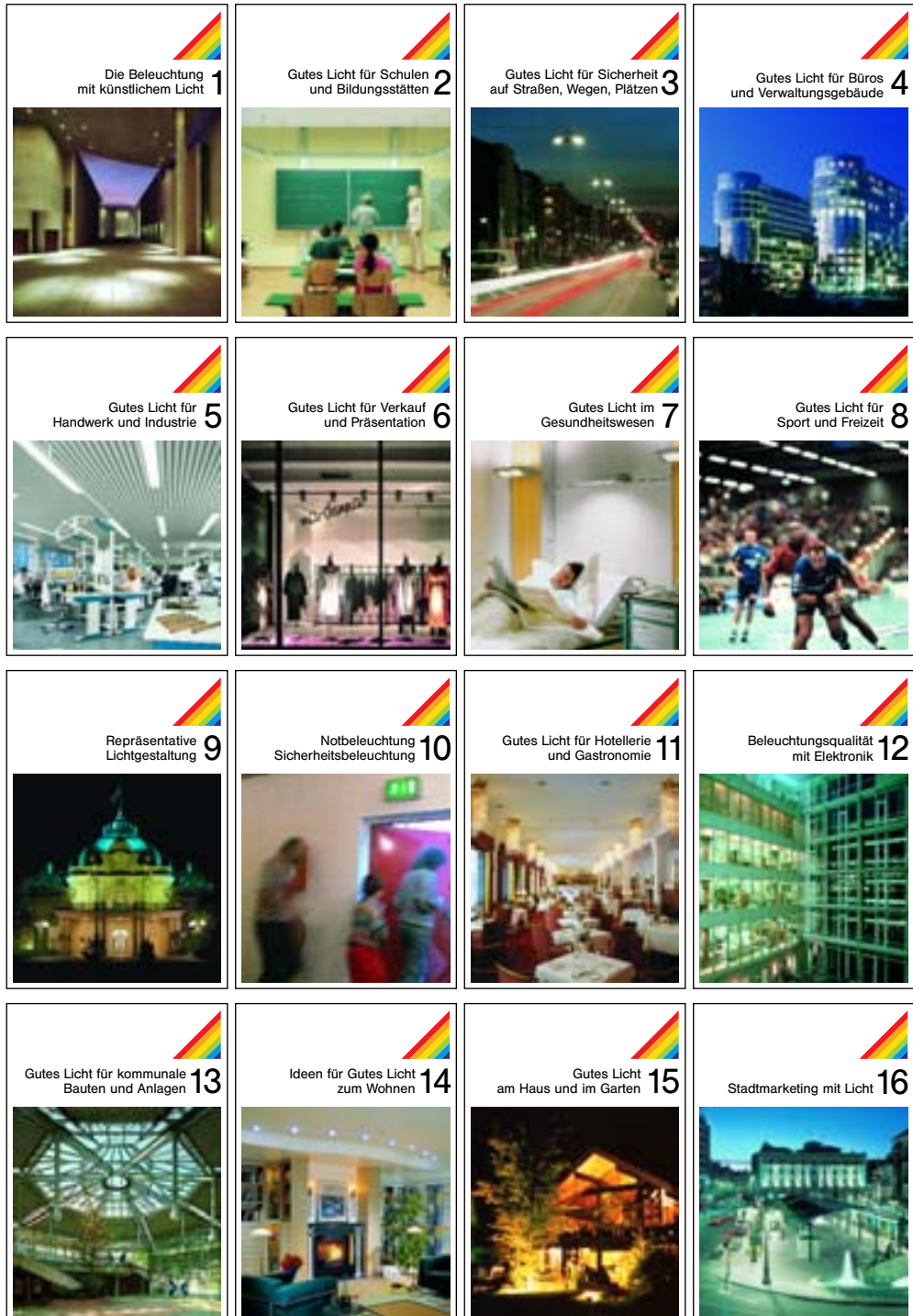
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