In the case of luminaires with mirror reflectors direct glare control improves the greater the cut-off angle, i.e. narrow beam spreads. The standard cut-off angles are 30° and 40°. It is not possible to limit reflected glare by increasing the cut-off angle, however. Correct positioning of the luminaires is essential in order to avoid reflected glare. Any luminaire installed in the critical area of the ceiling over a workplace is a potential source of reflected glare. The critical area can be defined as that portion of the ceiling which is seen by the user in a mirror covering the working area.

3.3.2.11 Safety requirements

Luminaires are required to meet the safety requirements in all cases; in Germany this is usually guaranteed through the provision of a VDE seal of approval. In some cases there are other requirements that have to be met and the luminaires marked accordingly. This applies primarily to fire safety when luminaires are installed in or on furniture or other inflammable materials. Special requirements also have to be fulfilled by luminaires that are to be operated in damp or dusty atmospheres, or in rooms where there is a danger of explosion.

Luminaires are classified according to their Mode of Protection and Protection Class, whereby the protection class indicates the type of protection provided against electric shock, and the Mode of Protection its degree of protection against contact, dust and moisture. Luminaires for application in environments exposed to danger of explosion must meet a further set of requirements.
To ensure safety against fire, luminaires designed for discharge lamps, which are to be mounted on inflammable or easily inflammable materials, must meet the criteria to be marked with the F symbol.

Luminaires to be mounted on furniture require the M seal of approval if they are to be installed on or in inflammable materials. If the flammability of the materials is not known, the MM symbol is required.

3.3.2.12 Relation to acoustics and air conditioning

The acoustics are of primary importance in concert halls, theatres, auditoriums and multipurpose spaces. Acoustical criteria are therefore treated with priority when the ceiling is designed; this may have an influence on the choice and arrangement of the luminaires. Recessed downlights have been proven to be the most suitable for this kind of lighting task, as they have the smallest surface area which may be acoustically significant.

Air-conditioning similarly gives rise to a number of questions; requirements laid down by the lighting and the airconditioning have to be coordinated to ensure that the ceiling design is harmonious and no conflicts arise in the organisation of ducting. Air-handling luminaires result in a considerable reduction of ceiling apertures and contribute towards creating a uniform ceiling layout. Depending on their design these luminaires can handle air supply, air return, or both air supply and return. If more luminaires are required than for air-conditioning purposes, air-handling dummies can be used that are identical in appearance to the air-handling luminaires, but are not connected to the ventilation system. Air-handling versions of both louvred luminaires and downlights are available.

3.3.2.13 Accessories

A wide variety of luminaires can be equipped with accessories to change their lighting or mechanical properties. These include filters to change the luminous colour or to reduce the UV or infrared radiation, spread lenses to change distribution characteristics, anti-dazzle equipment or mechanical shields, e.g. for protection relating to ball games. For further details, refer to section 2.6.5.

3.3.2.14 Lighting control and theatrical effects

Theatrical effects are increasingly being applied in the field of architectural lighting. These include dramatic contrasts, the use of coloured light and projections using masks and gobos.

Some of these effects can be obtained using conventional luminaires, through striking qualities such as coloured light, or by dramatic modelling, by using accent lighting to divide up the space or by using suitable lighting control. Some luminaires can be equipped with filters and lens systems that allow distribution characteristics to be changed and projections of effects using masks and gobos which are particularly suitable for such lighting tasks.

If a high degree of flexibility is required along with the possibility to control lighting effects with respect to time and location, then special luminaires are required that allow colour changing and the variability in light distribution, or possibly even direction control by remote control. Such luminaires, which have been used primarily for show lighting to date, are now being developed for interior and exterior architectural lighting.

3.3.3 Lighting layout

Depending on the specific lighting project, there may be a number of conditions that determine the lighting layout. The first is related to the particular lighting tasks. Differentiated lighting for different parts of the room or functional areas may result in the luminaires having to be arranged accordingly, e.g. the arrangement of downlights above a seating area or the positioning of downlights and floodlights in a modern control room. Uniform lighting will require the luminaires to be arranged regularly across the area.

The lighting layout may also depend on the form of the ceiling; existing ceiling grids and modules, but also ceiling joists or other ceiling shapes form structures that have to be taken into account when planning the lighting layout. In some cases it is also necessary to coordinate planning with the engineers responsible for air-conditioning and acoustics to ensure that the cabling installation is carried out safely and that the ceiling appearance is acceptable.

The lighting layout should not be based entirely on technical or functional conditions; in spite of all the preconditions there is wide scope for arranging the luminaires in accordance with the design concept. The lighting should not be confined by purely technical considerations, but also take into account the aesthetics of ceiling design. In quantitative lighting design it has become common practice to plan the lighting layout of ceiling-mounted luminaires to produce a completely uniform grid, with the aim of providing uniformly distributed lighting. By superimposing light distribution patterns it is possible to produce uniform lighting also by means of a differentiated lighting layout. On the other hand, differentiated lighting can also be achieved with a uniform arrangement of various luminaires. Consequently, there is no direct link between lighting layout and lighting effect; by exploiting the wide range of luminaires available it is possible to achieve a designed pattern of lighting effects using a variety of lighting layouts. The lighting design should make use of this scope producing ceiling designs that combine functional lighting with an aesthetic lighting layout that relates to the architecture.

It is neither possible nor practical to present a comprehensive formal language for the design of lighting layouts; the ceiling design of a lighting installation is developed in each specific case from the correlation of lighting tasks, technical prerequisites, architectural structures and design ideas. It is, however, possible to describe a series of basic concepts which show some general approaches to the form and design of luminaire patterns on ceiling sufaces.

One approach is to consider the point as a basic design element. In the broadest sense the point can be any individual luminaire, or even any compact and spatially isolated group of luminaires. This category of design elements not only includes downlights, but also larger luminaires such as louvred luminaires and even groups of these individual elements, provided that their total surface area is small in relation to the overall surface of the ceiling.

The simplest layout of these points is a regular grid, in a parallel or staggered arrangement. A regular pattern of identical luminaires can easily result in a monotonous ceiling appearance, plus the fact that differentiated lighting is practically out of the question. An alternating grid of different individual luminaires or luminaire combinations can produce more interesting arrangements; in this case luminaires of the same or different types can then be purposefully combined. The use of different luminaire types, by alternating positioning or through combinations, allows the lighting qualities of a visual environment to be carefully controlled. A further step towards more complex design forms is the linear arrangement of point sources. In contrast to simple lighting layouts in grid patterns, the ceiling design in this case relates more closely to the architecture of the space – the ceiling is no longer simply covered with a grid of luminaires, but is designed along the lines dictated by the architectural