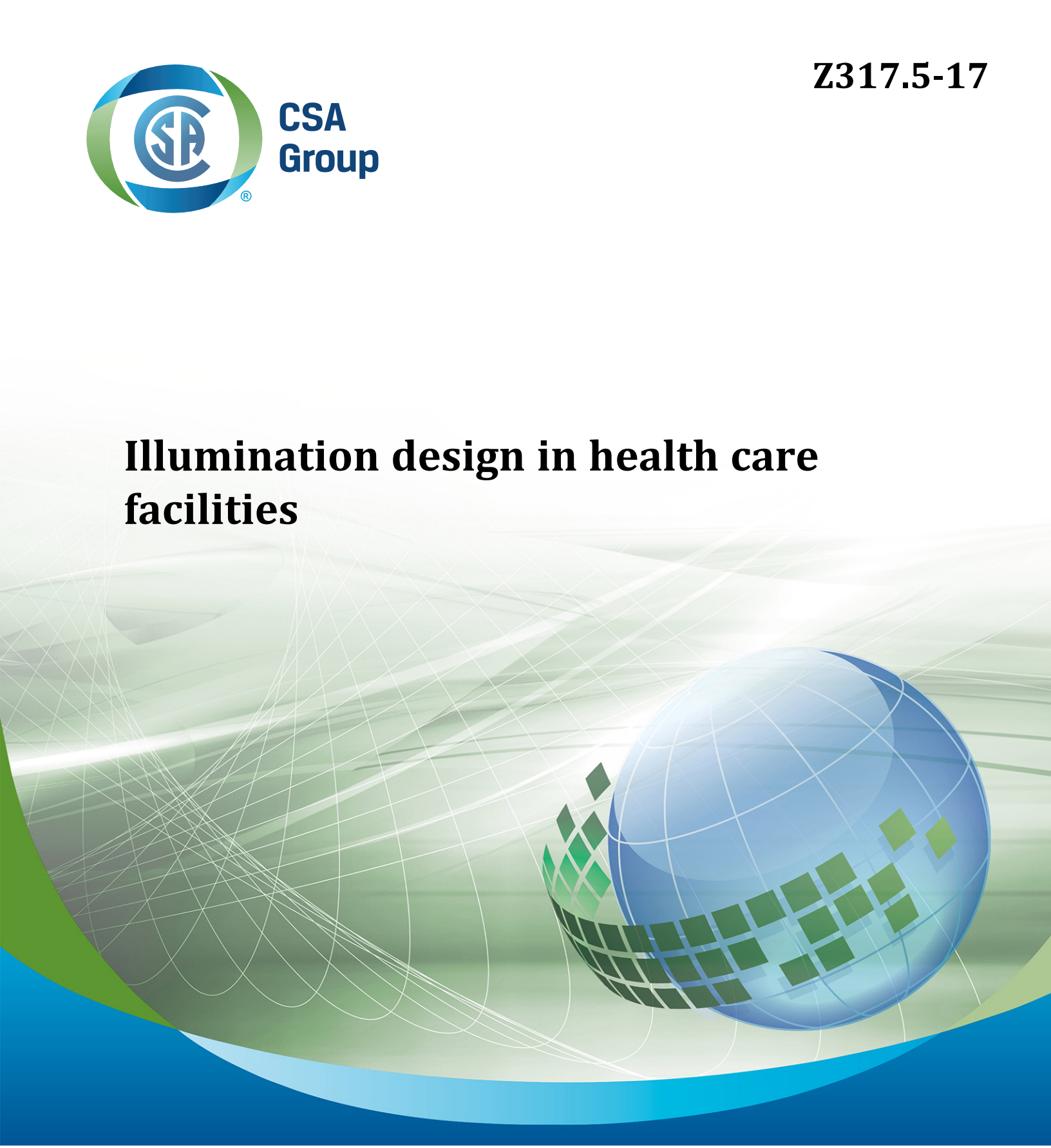
CSA Group

Z317.5-17

Illumination design in health care facilities



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Illumination design in health care facilities

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Preface

This is the third edition of CSA Standard Z317.5, *Illumination design in health care facilities*, and it supersedes the previous editions published in 1998 and 1989. It is one of a series of Standards that establishes criteria for the development of a health-promoting environment in health care facilities.

Illumination design in health care facilities must serve many purposes. The system as a whole, and its subsystems, must provide suitable illumination for many diverse tasks which have varying degrees of importance. It must be integrated with a variety of space usages; it must contribute to safety; and it must be efficient, low in maintenance, and able to serve a facility that might operate 24 h a day, 365 days a year.

Two major factors govern adequate illumination in each area and for each activity in the health care facility:

a) the quality of the illumination, i.e., the colour rendition and the distribution of luminance; and
b) the quantity of illumination.

It is recognized that age influences the suitability of lighting levels in the performance of tasks. The mean age within Canadian health care facilities is rising, resulting in the need for higher lighting levels. The lighting levels in this Standard have been specified based on a minimum user population age of 55. It is recognized that this can lead to an increase in energy consumption. Where appropriate and with proper consultation, the lighting levels may be modified to suit individual needs.

This Standard has been written for as wide an audience as possible, including designers, consultants, health care facility administration, and engineering departments. Every effort has been made not to restrict the application of new technologies within the health care facility. However, proper evaluation of new technologies prior to implementation is needed to ensure overall safety.

This Standard is not intended to be used as a textbook on lighting. The IES *Lighting Handbook* and other similar materials, courses, and seminars are recommended for this purpose.

CSA Group acknowledges that the development of the third edition of this Standard was made possible, in part, by the financial support of the governments of Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Nunavut, Ontario, Prince Edward Island, Québec, Saskatchewan, and Yukon as administered by the Canadian Agency for Drugs and Technologies in Health (CADTH).

This Standard was prepared by the Subcommittee on Illumination in Health Care Facilities, under the jurisdiction of the Technical Committee on Health Care Facilities and the Strategic Steering Committee on Health Care Technology, and has been formally approved by the Technical Committee.

Notes:

1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*
2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*
3) *This Standard was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*

4) *To submit a request for interpretation of this Standard, please send the following information to* ***inquiries@csagroup.org*** *and include "Request for interpretation" in the subject line:*
   a) *define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;*
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   a) *Standard designation (number);*
   b) *relevant clause, table, and/or figure number;*
   c) *wording of the proposed change; and*
   d) *rationale for the change.*

Z317.5-17
Illumination design in health care facilities

1 Scope

1.1

This Standard provides specific design criteria for illumination in various locations within a health care facility.

Note: *Lighting is both an art and a science. The basic technical criteria given in this Standard are not intended to inhibit creative design, but rather to ensure that minimum requirements are met.*

1.2

This Standard deals with

a) illumination sources;
b) luminaires;
c) illumination levels (see Table 1); and
d) guidelines for specific areas and tasks.

1.3

This Standard does not deal with

a) therapeutic illumination devices (e.g., phototherapy lamps); and
b) special purpose devices such as UV sources for sterilization.

1.4

This Standard addresses requirements for illumination design. However, it is not meant to remove the need for consultation with users regarding specific or unusual requirements.

1.5

The requirements in this Standard are intended to be subordinate to applicable Provincial, Federal, or local regulatory authorities.

1.6

In this Standard, “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; “should” is used to express a recommendation or that which is advised but not required; and “may” is used to express an option or that which is permissible within the limits of the Standard.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

2 Reference publications

This Standard refers to the following publications and where such reference is made it shall be to the edition listed below, including all amendments published thereto.

CSA Group

B651-12
Accessible design for the built environment

C22.1-15
Canadian electrical code, part I (23rd edition), safety standard for electrical installations

C22.2 No. 9.0-96 (R2016)
General requirements for luminaires

C22.2 No. 250.4-14
Portable luminaires

C22.2 No. 84-05 (R2015)
Incandescent lamps

C22.2 No. 141-15
Emergency lighting equipment

CAN/CSA-C22.2 No. 250.13-14
Light emitting diode (LED) equipment for lighting applications

CAN/CSA-C22.2 No. 60601.1.2:16
Medical electrical equipment, Part 1-2: General requirements for basic safety and essential performance — Collateral standard: Electromagnetic disturbances — Requirements and tests

CAN/CSA-CEI/IEC CISPR 11-04 (R2013)
Industrial, scientific and medical (ISM) radio-frequency equipment — Electromagnetic disturbance characteristics — Limits and methods of measurement

Z32-15
Electrical safety and essential electrical systems in health care facilities

Z412-00 (R2016)
Guideline on office ergonomics

Z7396.1-12
Medical gas pipeline systems — Part 1: Pipelines for medical gases, medical vacuum, medical support gases, and anaesthetic gas scavenging systems

CAN/CSA-Z317.2-15
Special requirements for heating, ventilation, and air conditioning (HVAC) systems in health care facilities

Z317.14-17 (under development)
Wayfinding in health care facilities

CIE (International Commission on Illumination)
CIE 013.3-1995
Method of measuring and specifying colour rendering properties of light sources

Environment Canada
Handbook on PCBs in electrical equipment

IES/ASHRAE (Illuminating Engineering Society/American Society of Heating, Refrigerating and Air-Conditioning Engineers)
90.1-2016
Energy Standard for Buildings except Low-Rise Residential Buildings

IES HB-10-11
The Lighting Handbook, 10th edition

IESNA (*Illuminating Engineering Society of North America*)
RP-5-13
Recommended Practice for Daylighting Buildings

RP-29-06
Lighting for Hospitals and Health Care Facilities

RP-31-14
Recommended Practice for the Economic Analysis of Lighting

NRCC (National Research Council Canada)
National Building Code of Canada, *2015*
National Energy Code for Buildings, 2015

3 Definitions

The following definitions shall apply in this Standard:

Note: *Different terms may be used to refer to the same illuminating engineering parameters (e.g., luminance for brightness, illuminance for illumination). In the following list of definitions, the approved terms are defined and cross-referenced to older terms that are still in limited use.*

Adaptation — the process by which the retina becomes accustomed to more or less light, or light of a different colour.

Addressable lighting controls — components such as switches, sensors, and drivers each with a unique address which can be monitored and programmed without requiring special wiring.

Administrator — the person or designate responsible for the operation of the HCF.

Ambient lighting — the general illumination throughout an area.

Ballast — a device used with fluorescent and high intensity discharge (HID) lamps to obtain the necessary circuit conditions (voltage, current, frequency, and wave form) for starting and operating. It limits the flow of current through the lamp.

Brightness — see **Luminance** and **Subjective brightness**.

Candela (cd, formerly candle) — the SI unit of luminous intensity.

Candlepower (cp) — the luminous intensity of a light source expressed in candelas.
Note: *For the defined relationships between units, see **Illuminance**.*

Colour rendering — the general expression for the effect of a light source on the colour appearance of an object in conscious or subconscious comparison with its colour appearance under a reference light source.

Colour rendering index (of a light source, CRI) — is based on CIE Test Colour Method in CIE 013.3, a measure of the degree to which the perceived colour of an object illuminated by the source conforms to that of the same object illuminated by a reference light source of comparable colour temperature. CRI is measured on a scale of 0-100.
Note: *See Annex G.*

Correlated colour temperature (CCT) — the temperature in units of Kelvin (K) of a blackbody whose chromaticity most nearly resembles that of the light source.
Notes:
1) *The warmer the colour temperature the lower the numeric value of Kelvin.*
2) *See Annex G.*

Contrast (luminance contrast) — the relationship between the luminances of an object or task detail and its immediate background.

Diffuser — a device that redirects or scatters light from a source, primarily by the process of diffuse transmission.

Diffuse reflection — the process by which incident flux is redirected over a range of angles.

Dimming — the ability to control the intensity of luminaires via lighting controls (e.g. dimmer switch, daylight sensor, etc).

Direct glare — glare resulting from excessive luminance and insufficiently shielded light sources within the field of view.

Downlight — a luminaire that directs all the luminous flux down. It is usually recessed, though it may be surface-mounted or suspended.

Driver — an electrical device which regulates the power to an LED or a string (or strings) of LEDs.

Efficacy (lumens per watt) — the quotient of the total of emitted luminous flux from the lamp divided by the electrical power (watts) input to the lamp.

Equivalent sphere illumination (ESI) — the level of sphere illumination that would produce task visibility equivalent to that produced by a specific lighting environment. ESI is a means of measuring and predicting illumination quality as it relates to veiling reflections.
Note: *In Canada, the unit in common use is the ESI foot candle.*

Examination lights — luminaires used for minor medical procedures outside the operating room.

Extra-low voltage — any voltage up to and including 30 V RMS or 42.4 V peak.

Fenestration — any opening or arrangement of openings or windows (normally equipped with media for light control) that allows for the admission of daylight or for the transmission of artificial lighting from one room to another.

Fixture — see **Luminaire**.

Fluorescent lamp (tube) — a low-pressure mercury electric discharge lamp in which a fluorescing coating (phosphor) transforms ultraviolet energy into light.

Flux — see **Luminous flux**.

General illumination — the illumination designed to provide a substantially uniform level of illumination throughout an area, and exclusive of any provision for special, local requirements.

Glare — any brightness relationship that annoys, distracts, or reduces the ability to see easily. An exposed light source within the field of view usually produces excessive glare.

Health care facility (HCF) — a facility where health care is provided on the basis of medical and/or nursing need, and includes, but is not limited to, public hospitals, private hospitals, clinics, health stations, health centres, medical and dental clinics, daycare surgeries, nursing homes, extended care facilities, and long-term care facilities.

High intensity discharge lamps (HID) — a family of lamps that includes mercury, metal halide, and high- and low-pressure sodium types.

Illuminance — the aerial density of the luminous flux incident on a point on a surface.
Note: *If a spherical surface one square metre in area is at a distance of one metre from a point source of one candela, the illuminance produced is one lux at every point on the surface.*

Illumination — the act of illuminating or the state of being illuminated.
Note: *Where reference is made to the quantity of illumination, the approved term is illuminance.*

Incandescent filament lamp (bulb) — a lamp in which light is produced by a filament heated to incandescence by an electric current.

Indirect illumination — illumination provided by luminaires that distribute 90 to 100% of their emitted light upward.

Lamp (light source) — a generic term for an artificial source of visible light. By extension, the term is also used to denote sources that radiate in regions of the spectrum adjacent to the visible.
Note: *A lighting unit consisting of a lamp with shade, reflector, enclosing globe housing, or other accessories is often called a "lamp", although "luminaire" is the approved term.*

Lamp burnout factor — the fractional loss of illuminance due to burned out lamps left in place.

LED lamp (LED, lighting-emitting diode) — semiconductor light source with light emitted when a suitable voltage is applied to the leads.

Light — radiant energy capable of exciting the retina and producing visual sensation. The visible portion of the electromagnetic spectrum extends from approximately 380 to 770 nm. The term "light" applies to this band only.

Lighting controls — devices such as switches or sensors that regulate the amount of light in a given space for specific tasks via input.

Light loss factor — a factor used in calculating the level of illuminance after a given period of time and under given conditions. It takes into account lamp temperature and voltage variations, dirt accumulation on luminaire and room surfaces, lamp depreciation, maintenance procedures, and atmospheric conditions.

Local lighting — the lighting used to provide illuminance over a relatively small area or confined space without providing any significant general illumination.

Lumen (lm) — the unit of luminous flux. If a point source of one candela is located at the centre of a sphere having a radius of unit distance, and an opening of unit area is cut into the surface of the sphere, the amount of luminous flux emitted through that opening is one lumen.

Luminaire — a complete lighting unit consisting of a lamp or lamps, together with parts designed to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply.

Luminaire efficiency — the ratio of the luminous flux (lumens) leaving a luminaire to that emitted by the lamp or lamps being used.

Luminance — the luminous intensity per unit area of a source or surface in a given direction as viewed from that direction.

Luminance ratio — the ratio between the luminances of any two areas in the visual field.

Luminous flux — the time rate of the flow of light.

Lux (lx) — the SI unit for measuring illuminance.
Note: *One lux is equal to one lumen per square meter (1 lm/m^2).*

Matte surface — a surface from which the reflection is predominantly diffuse, and without a significant specular component (e.g., a flat white coating).

Point method — a lighting design procedure using luminaire photometric data.

Portable luminaire — a table or floor lamp or wall unit that is neither permanently fixed in place nor permanently connected to the electrical supply.

Power factor — the active power (watts) divided by the apparent power (volt-amperes), i.e., the product of the RMS input voltage and RMS input current of a ballast.

Quality of lighting — a subjective evaluation of the luminance distribution and colour rendition in a visual environment. The term is used in a positive sense and implies that these attributes contribute favourably to visual performance, visual comfort, ease of seeing, safety, and aesthetics for the specific visual tasks involved.

Quantity of illumination — the number of lumens per unit of area falling on a surface.
Note: *One lux is equal to one lumen per square metre. One foot candle is equal to one lumen per square foot.*

Reflectance — the ratio of the luminous flux reflected by a surface or medium to the flux falling on that surface.
Note: *This general term may be restricted by the use of one or more of the following adjectives: specular (regular), diffuse, spectral.*

Reflected glare — a glare resulting from the specular reflections of high-luminance, polished, or glossy surfaces in the field of view.

Subjective brightness — the subjective attribute of any light sensation giving rise to the perception of luminous intensity. The term includes the qualities brilliant, bright, light, dim, or dark.

Note: *The term brightness was commonly used to refer to measured data. The preferable term in this case is luminance; brightness is thus reserved for the subjective sensation.*

Task lighting — lighting, directed to a specific surface or area that provides illumination for visual tasks.

Tube — see **Fluorescent lamp**.

Tungsten-halogen lamp — a compact, gas-filled, incandescent, tungsten filament lamp in which the enhanced initial efficacy is essentially maintained over the life of the lamp through the addition of halogen compounds to the fill gas.

Veiling reflection — the reflection from a mirror or a highly polished surface which is superimposed on diffuse reflections from a task and which partially or totally obscures the details to be seen by reducing the contrast. It is also called reflected glare.

Note: *Another kind of veiling reflection occurs when one looks through a plate of glass. A reflected image of a bright element or surface can be seen superimposed on what is viewed through the glass plate.*

Visual comfort probability (VCP) — the rating of an illumination system expressed as the percentage of people who will accept and feel comfortable with the level of glare within a given illuminated environment.

Note: *VCP is a means of measuring and predicting illumination quality as it relates to direct glare and luminaire brightness.*

Visual performance — the quantitative assessment of the performance of a visual task, taking into consideration speed and accuracy.

Visual task — those details and objects which must be seen for the performance of a given activity, including the immediate background when it falls within the outline of the task elements.

4 Design considerations

4.1 General

4.1.1 General requirements

The installation of the illumination system shall be in compliance with *Canadian Electrical Code, Part I*.

4.1.2 Specific considerations

The designer/consultant shall consider the task and the services that might be provided within an area. The lighting system shall provide the health care facility with the quantity and quality of illumination needed to perform all functions, while simultaneously recognizing the needs of the the patient, staff and the public as indicated in Clause 5.

Note: *Refer to Annex A for additional information on this topic.*

4.1.3 Energy efficiency

To maximize energy efficiency, the following shall apply to illumination design for new construction and renovation work, and the selection of illumination equipment:

a) multiple-level switching and dimming shall be used where appropriate;

b) efficient light sources (high lumen per watt input) shall be used;
c) efficient luminaires shall be used;
d) luminaire design and application shall permit the luminaire to maintain its correct operating temperature;
e) recommended reflectance factors on ceilings, walls, floors, and furnishings shall be used;
f) the use of incandescent lamps shall be minimized;
g) lighting controls shall be provided to permit luminaires to be turned off when not needed;
h) window brightness shall be controlled;
i) daylighting shall be used to supplement artificial lighting;
j) reduction of luminaire illumination levels shall be considered during daylight hours;
k) a program for regular, routine maintenance shall be developed (see Annex B); and
l) occupancy and vacancy controls shall be considered in non-patient care spaces.

Notes:

1) *Refer to IES/ASHRAE 90.1 or local requirements regarding energy efficiency.*
2) *The health care facility administrator should establish a program to educate staff and maintenance personnel about the above items which might be under their control.*

4.1.4 Functional and aesthetic considerations

When evaluating illumination systems, the following factors shall be considered:

a) compatibility with the patient;
b) compatibility with tasks performed within specific facility areas;
c) visual comfort;
d) compatibility with architectural design;
e) compatibility with permanently mounted equipment, such as that for X-ray suites;
f) flexibility of arrangement;
g) compatibility with HVAC design;
h) compatibility with acoustical requirements;
i) performance (i.e., colour rendering, illuminance level, and illuminance ratios);
j) ease of cleaning and decontamination;
k) economics of selected systems:
    i) initial installation cost;
    ii) maintenance, energy, and other annual costs; and
    iii) depreciation and replacement costs; and

    Note: *Refer to Annex C for additional information.*
l) aesthetics, with focus on maximizing patient well-being, e.g., residential versus clinical.

Notes:

1) *Functional planning of the illumination system by the building owner should include consultation with facility users (e.g., nursing staff, medical staff, and maintenance staff).*
2) *The illumination system should be compatible with the acoustical, thermal, spatial, and aesthetic requirements of each design area. The optimum total environment can only be attained through the co-operative efforts of the owner, architect, facility users, engineers, and specialized consultants.*

4.1.5 Luminance ratios

Luminance ratios should fall within the ranges below to allow for adaptation by the eye:

a) 3 to 1 between task and immediately adjacent surroundings
b) 10 to 1 between task and remote non-adjacent surfaces; and
c) 3 to 1 between a paper task and a video display terminal (VDT).

4.2 Light sources

4.2.1 General requirements

All luminaires, portable luminaires, incandescent lamps, emergency lighting equipment, and LEDs shall meet the requirements of CSA C22.2 No. 9.0, CSA C22.2 No. 84, CSA C22.2 No. 141, CSA C22.2 No. 250.4, and CAN/CSA-C22.2 No. 250.13 respectively.

Note: *Refer to Annex A for additional information on specific light sources.*

4.2.2 Colour

4.2.2.1 Colour temperature

Light sources in all patient care areas shall have a consistent colour temperature, unless the space requires a light source or colour temperature specific to the task, e.g. dental suite, daylight simulation, etc.

Notes:

1) *This requirement is introduced into the Standard in order to ensure that medical staff examine patients under similar, consistent illumination conditions irrespective of the patient's location within the facility. Uniformity of source colour should take precedence over special spectral distribution.*
2) *The generally preferred colour temperature range is 2700 to 4500 K. Consideration can be given to limiting the upper limit to 3500 K to reduce the amount of blue light, especially with the use of LEDs.*

4.2.2.2 Colour rendering index (CRI)

See Annex F for guidance.

4.3 Luminaires

Notes:

1) *Luminaires can have the same general appearance yet differ in their illumination characteristics and performance. Comparisons using distribution curves and data from photometric tests obtained from qualified testing laboratories are the only way to determine equivalency of illumination results.*
2) *No single illumination system can be recommended exclusively. Each system has qualities that might match the requirements for a given situation. The first consideration should be to enable the medical staff and the patient to see adequately. The appearance of the installation within the architectural and decorative design of the health care facility should also be considered.*

4.3.1 General requirements

Luminaire selection should be based on

a) appropriateness for the visual task;
b) appropriateness for the specific facility area;
c) efficiency;
d) photometric distribution;
e) maintainability;
f) initial cost;
g) operating cost;
h) control of glare;
i) aesthetics;
j) environmental impact (including manufacturing, component replacement, disposal and recycling);
k) compliance with local codes and standards; and
l) infection prevention and control.

Note: *Refer to Annex C regarding Items f) and g).*

