This technical guide outlines the design and use of equipment protected against the ignition of hazardous atmospheres formed from gases, vapours or dusts. The information given applies specifically to Chalmit Lighting products and can also be used as a general guide.

The guide refers to equipment and methods complying with safety practices being used throughout the world. This material is included both for completeness and because Chalmit operates throughout the world supplying all lighting requirements. Chalmit hazardous area products are designed and manufactured in accordance with the best engineering practices and to well established construction standards for explosion protected equipment.

The equipment must be selected, installed, maintained and disposed of in accordance with any regulation or legislation appropriate to its use. Reference must be made to the data sheets and the certification applying to each individual product.

The guide also refers to construction standards and application codes. The correct application of protected equipment is a specialist subject and these notes must be treated as being only informative. In addition to the Chalmit technical information users must themselves study the relevant codes of practice and construction standards.

Installation operation and maintenance manuals (IOM) are enclosed with each product and are available on request. These contain information essential to the safe use of the equipment and must be read and understood by installers and users before putting equipment into service. Much of the information is also available on the Chalmit website. Usually this will be for the latest version of a particular range. If detailed information on superseded product is needed Chalmit should be contacted directly.

International, Regional and National Standards - Ongoing Changes

This revised technical introduction was prepared in 2009 during a period of transition in the history of Ex standardisation. As such this section aims to highlight some of the current initiatives underway to simplify and rationalise product standards on a global scale.

The process of developing product standards which initially began with the invention of equipment for the safe operation of “gassy mines”, led to the standardisation of the “flameproof” and “intrinsic safety” concepts for product design. The standardisation of equipment on a national basis is now in its final stage of transition with the final move towards global standardisation under the IEC Ex scheme. This may cause some confusion in the short term but leads to international uniformity.

IEC Standards & ATEX

The early IEC standards were largely based on the national standards of European countries.

The first EU Directive [1976] for product standardisation prompted the rapid development of Euro-normes [EN] which were numbered in the EN 50014 etc. series. Gradually the IEC 79 series, later re-numbered 60079- series were updated using the EN's as a basis but with growing international input. These were mostly the gas hazard standards. In the late 1990's it was agreed in CENELEC that all work that could be carried out at IEC level, would be, and the standards voted in parallel as IEC standards and EN's. These standards carry the EN 60079- numbering.

The second ATEX directive [1994], see later section, introduced further factors. The directive covers gas and dust hazards and both electrical and mechanical equipment. It introduced basic requirements for safety, the “Essential Health and Safety Requirements [ESHR's]”. Three levels of safety Categories 1, 2 and 3 were defined effectively as:

Category 1 - “very safe and considering two possible equipment faults”

Category 2 - “safe with one fault”

Category 3 - “safe in normal operation”

Although the performance criteria of the Categories aligned with the expected area of application, the Zones, the designation of equipment protection by zone was removed. The selection of a particular type of explosion protection for a particular zone was by risk assessment.

Rationalisation

In order to eliminate this potentially long term anomaly at international level and to introduce the concept of a declared level of safety, IEC agreed to introduce “Equipment Protection Levels” [EPL's]. These EPL's are Ga, Gb and Gc for gas and Da, Db and Dc for dust. Ma and Mb also exist for mining. These are an alternative and additional specification for equipment made in accordance with the standards.

The key point is that the definitions of product performance are in effect identical to the ATEX Category definitions. In future, rationalisation may see the EPL's incorporated into ATEX.

The basic technical requirements for ATEX and IEC via the IEC Ex scheme (see the section on the IEC Ex scheme) will therefore be identical as EPL's are introduced right across the standards series. The ATEX marking is different from IEC and must be shown in addition to the IEC marking.

Sub-Division

A further effect of the introduction of EPL's is to give a definition to the emergence of sub-divisions in some of the protection concepts. The principle of sub-devision is clear when one considers that Intrinsic Safety was divided into ia and ib and is now complimented by ic. Now encapsulation has sub-devisions of ma, mb and mc and Pressurisation has px, py and pz. Sub-devision of other concepts may be developed in due course and some existing requirements in the Ex n standard may be relocated.

Standards for Combustible Dusts

A further change is the addition to the General Requirements IEC 60079-0 of general requirements common to protection against the ignition of combustible dusts. This enables the dust protection concept standards to be incorporated in the 60079 series.

As many equipment enclosures have certification for both gas and dust, this will be of benefit to both manufacturers and users. The current IEC dust standards are the IEC 61241 series. These cover test methods, construction and use. There are also various equipment standard concepts:

- tD, protection by enclosure
- pD pressurisation
- mD encapsulation.

As stated, where possible these IEC 61241 standards are being incorporated into the IEC 60079 series. In Europe these standards are becoming Euro Norms (EN's) and supersede the EN 50281 series.

Euro Norms

Because of the movement towards IEC, references to EN's are not used in this introduction except where there is no current Euro-norme in the IEC series, in which case the EN numbering in the EN 50014 etc. series will be given in brackets.

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Methods of Explosion Protection for Electrical Equipment in Explosive Gas Atmospheres

This catalogue contains a selection of lighting and ancillary equipment suitable for use in areas where explosive atmospheres may occur.

Explosive atmospheres can be ignited by sparks or hot surfaces arising from the use of electrical power.

The hot surfaces can be those of enclosures, components and light sources. Under fault conditions electrical connections may become over-heated and cause arcs or sparks.

In addition, sparks may be the result of the inadvertent discharge of stored energy or from switching contacts. Other possible sources of ignition are electrostatic discharges and frictional sparking.

A number of methods of protecting against ignition have been established and these have been codified in construction standards. These codes enable manufacturers to design equipment of a uniform type and have it tested by certification authorities for compliance with the standards.

The basic methods of protection are summarised in Table 1.

Method	Type Of Protection
Designed to prevent any means of ignition arising	Ex e Increased Safety Ex nA Non Sparking tD (for dust hazards)
Designed to limit the ignition energy of the circuit	Ex i intrinsic Safety Ex op Optical Radiation Ex nL Energy Limitation
Designed to prevent the explosive mixture reaching a means of ignition	Ex m Encapsulation Ex p Pressurisation Ex o Oil immersion Ex nR Restricted Breathing
Designed to prevent any ignition from spreading outside of the apparatus	Ex d Flameproof Enclosure Ex q Powder Filling Ex nC Non Incendive

Table 1 Methods of Explosion Protection

General Requirements IEC 60079-0

This standard contains general requirements common to the series of standards for the protection sub-groups. Equipment will comply with the general requirements except where they are excluded or varied by the individual protection standard detailed below.

Ex d “Flameproof Enclosure” Protection - IEC 60079-1

The potentially incendive parts are contained within an enclosure into which the explosive atmosphere can enter but which will contain any resultant explosion and prevent its transmission outside of the enclosure.

Ex p “Pressurised Equipment” Protection - IEC 60079-2

One type of pressurisation maintains a positive static pressure inside the equipment to prevent entry of gas and another maintains a continuous flow of air or inert gas to neutralise or carry away any explosive mixture entering or being formed within the enclosure. In the case of Ex p, the source of release can be internal.

Essential to these methods are continuous monitoring systems to ensure their reliability and purging schedules on installation and following opening for maintenance.

Ex q “Powder Filling” Protection - IEC 60079-5

This technique involves the mounting of potentially incendive components in an enclosure filled with quartz or solid glass particles. The powder filling prevents explosive ignition. It was originally developed to protect heavy duty traction batteries. The method is now primarily of use where the incendive action is related to the abnormal release of electrical energy by the rupture of fuses or failure of components used in electronic equipment.

The likelihood of possible incendive failure of the components is assessed and precautions taken to minimise it. Usually Ex q is used for discrete sub-assemblies and components inside Ex e equipment.

Ex o "Oil immersion" Protection - IEC 60079-6

This is a technique primarily used for oil filled equipment. The oil acts as an insulating medium.

Ex e "Increased Safety" Protection - IEC 60079-7

Normally sparking components are excluded from this method of protection. Other components are designed to substantially reduce the likelihood of the occurrence of fault conditions which could cause ignition. This is done by reducing and controlling working temperatures, ensuring the electrical connections are reliable, increasing insulation effectiveness and reducing the probability of contamination by dirt and moisture ingress.

Ex i "Intrinsic Safety" Protection - IEC 60079-11

The circuit parameters are reliably controlled to reduce potential spark energy to below that which will ignite the specific gas mixture. This includes the occurrence of one (coded ib) or two (coded ia) component faults and consequent failures in the circuit. Ex ic has no countable faults.

It should be noted that this method does not entirely protect against the local over-heating of damaged connections or conductors. These should be kept sound and suitably enclosed against damage.

Ex n "Non Sparking" Protection - IEC 60079-15

For this method, precautions are taken with connections and wiring to increase reliability, though not to as high a degree as for Ex e. Where internal surfaces are hotter than the desired T rating, they can be tightly enclosed to prevent the ready ingress of an explosive atmosphere. This is the "restricted breathing enclosure" technique.

The 'Non Sparking' concept also requires that high ingress protection ratings of IP65 and above are built into the design. The coding Ex nR denotes that the protection method employs a restricted breathing enclosure. The restricted enclosure may be confined to the part of the equipment containing the hot components such as lamps. Where the normal non-sparking construction is used the coding is nA.

There are other sub codes, nL - energy limitation and nC - non incendive, which refer to simplified forms of other protection methods listed above. The codes are used individually.

The Ex n methods have been developed specifically for the design of equipment used in the remotely hazardous area, Zone 2. Ex n meets the basic requirements for ATEX category 3.

Ex m "Encapsulation" Protection - IEC 60079-18

Potentially incendive components are encapsulated, usually by organic resins, which exclude the explosive atmosphere and control the surface temperature under normal and fault conditions. The likelihood of overheating and disruptive failure of the components is assessed and precautions taken to minimise any effect on the protection.

Ex op "Optical radiation" - IEC 60079-28

This is primarily concerned with the control of pulsed and continuous wave optical radiation through fibre optic cable with restrictions on the ratio of emitted optical power to the irradiated area.

The protection concepts include Inherently Safe which is analogous to Ex i and provides over-power/energy fault protection. Other methods include mechanical protection of the fibre and optical interlocks.

Ex t "Dust Protection by Enclosure" - IEC 60079-31

This method is applicable to electrical equipment protected by enclosure and surface temperature limitation for use in explosive and dust atmospheres. This standard will supersede replace IEC 61241-1. IEC 60079-31 combines practices A and B into a single practice.

Protection against the Ignition of Atmospheres containing Dusts

Most of the gas protection techniques will in practice protect against dust ignition. The enclosure method, where dust is effectively excluded and the external surface temperature defined, is generally used for lighting.

In the product data this is referred to as "dust protected enclosure". This is currently standardised as tD with sub-division into Practice A and Practice B as defined in 60079-14. With the advent of EPL the coding tD will be superseded by ta, tb and tc, and Practice A and B will be combined.

Sub divisions of Ex m; maD and mbD, Ex i; iaD and ibD also Ex p; pD have been introduced for dusts.

Classification of Hazardous Areas and the use of Protected Equipment

Codes of practice have been established for the classification of the potential hazards, the selection of suitable equipment to protect against the hazard and its installation and maintenance. The codes of practice list the methods of protection which, if used individually or in combination, may be employed to achieve an acceptable margin of safety.

The hazardous areas are classified in Table 2 according to IEC 60079-10-1 and IEC 61241-10-2.

Zone	Description
Zone 0 and Zone 20	An area in which an explosive atmosphere is continuously present or for long periods or frequently
Zone 1 and Zone 21	An area in which an explosive atmosphere is likely to occur occasionally in normal operation
Zone 2 and Zone 22	An area in which an explosive atmosphere is not likely to occur in normal operation but, if it does occur, will persist for a short period only

Table 2 Hazardous Areas Classification

Note: the definitions are for areas containing gas mist or vapour mixtures with air. The dust Zones have been added for ease of understanding and the definitions are effectively the same.

The deployment of protected apparatus in hazardous areas classified to IEC 60079-10-1 and EN 60079-10-2 is summarised according to IEC 60079-14 in table 3.

Zone	Type of Protection Assigned to Equipment	EPL
Zone 0	Ex ia Ex ma and types of protection suitable for Zone 0 as constructed to IEC 60079-26	Ga
Zone 1	Any type of protection suitable for Zone 0 and Ex d, Ex ib, Ex py, Ex e, Ex q and Ex mb (Also see notes on Ex s protection)	Gb
Zone 2	Any type of protection suitable for Zone 0 or 1 and Ex n, Ex mc, Ex ic, Ex pz and Ex o (Also see notes on Ex s protection)	Gc
Zone 20	tD A20, tD B20, iaD and maD	Da
Zone 21	Any type of protection suitable for Zone 20 and tD A21, tD B21, ibD, mbD and pD	Db
Zone 22	Any type of protection suitable for Zone 20 or 21 and tD A22 IP 6X	Dc

Table 3 Selection of Protected Equipment in Hazardous Areas generally according to IEC 60079-14

The suffix A and B for the dust protection methods refer to the two Practices A and B for the assessment of temperature with and without dust layers.

The EU ATEX Directives

The relevant directives of the EU are:

- 94/9/EC Equipment and protective systems intended for use in potentially explosive
- 99/92/EC Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.

The directives are adopted into national law by the individual member states. Some candidate entrant states have also aligned their national regulations with ATEX.

ATEX covers hazards arising from the use of both electrical and mechanical equipment in explosive atmospheres. The ATEX equipment directive and the accompanying health and safety directive, specifying the protection of workers, apply to the European Union. The safety directive requires hazardous areas to be subjected to a risk analysis, classified into Zones and suitably equipped.

The manufacturer must make a declaration of compliance with the equipment directive and apply the CE mark before the product can be placed on the market in the EU.

The EU ATEX Directives (continued)

The individual governments of the member states appoint “Notified Bodies” to carry out testing and certification. Equipment is divided into Equipment Groups (Group I for mining and Group II non-mining), the ignitable component of the explosive atmosphere, Gas (G) and Dust (D) and Categories 1, 2 and 3. The Categories provide respectively, very high, high and normal levels of protection against ignition.

The Categories should be considered as achieving the level of protection obtained by applying the existing protection techniques (Ex d, Ex e, Ex i, etc) no numerical basis has yet been devised for the expected safety level of categories or of equipment. Alternatively, the existing techniques can be replaced or supplemented by new concepts and engineering judgements made by the manufacturer in the design and construction of the equipment. Where required, this would be validated by notified bodies performing an EC type examination of the product.

In practice, the Categories are equated to suitability for Zones. The actual category of equipment specified by the user for a Zone will depend on the overall risk assessment. Zoning considers only the probability of the occurrence of an explosive atmosphere, its extent and duration. It does not consider possible consequential effects of an ignition having taken place, or of the environmental conditions at a particular site. Equipment will be marked with the Grouping and Category in addition to the marking required by the individual protection standards.

Protection Codes for Chalmit Products

The range of Chalmit Lighting products fall within Group II for industrial and hazardous area applications and cover designation as Category 2 or 3. This means that products will generally be suitable for use in Zone 1 and 2 areas as defined by the codes of practice for area classification (IEC 60079-10) and selection (IEC 60079-14 etc). These codes of practice provide the user with guidance in selecting equipment needed to obtain the degree of safety that is required for the particular hazardous area application.

The ATEX directive lists “The Essential Health and Safety Requirements” (EHSR's) required to comply with the directive, in addition the product must be “safe”. The term “safe” covers any property which is not covered by the directive, but is known to or could have been reasonably foreseen by the manufacturer. Compliance with the Euro-norme gives a presumption of conformity with those aspects of the directive covered by the standard. Lists of these standards are published in the official journal (OJ) of the EU.

The European Commission web site (www.europa.eu) contains a large quantity of material concerning the directives along with the actual directive itself and the guidelines for its application.

Examination Certificates

An EC type examination by a notified body is mandatory for Category 1 and 2 electrical equipment but not for Category 3.

Chalmit Lighting have chosen to obtain a certificate of compliance from a third party for Category 3 equipment in order to ensure customer confidence and continue the long standing practice that Chalmit has used for Ex n equipment.

The designation EC can not be used for certification of Category 3 equipment. In the data the term “type examination” rather than “EC type examination” is used for Category 3 equipment.

IEC & ATEX

The relationship between IEC Equipment Protection Levels, ATEX Categories and applications is shown below in table 4.

IEC EPL	ATEX Category	Degree of Safety	Design Requirement (condensed)	Expected Zone of use
Ga	Category 1	Very high level of protection	Two independent means of protection or safe with two independent faults	Zone 0
Da	Category 1			Zone 20
Gb	Category 2	High level of protection	Safe with frequently occurring disturbances or with a normal operating fault	Zone 1
Db	Category 2			Zone 21
Gc	Category 3	Enhanced level of protection	Safe in normal operation	Zone 2
Dc	Category 3			Zone 22

Table 4 EPL, Atex Category, Design Requirements and Expected Application

Equipment Protection Levels (EPLs) are used as part of a risk assessment approach to the selection of Ex equipment. It is beneficial to identify and mark equipment according to their inherent ignition risk thus making selection easier and provide the basis of a better risk assessment approach, where appropriate.

Marking of an ATEX Product and the CE Mark

A product that carries the ATEX marking will include the CE mark, CE Ex, the Group, the Category and the Category sub-group G or D. The product also carries the normal coding, Ex d etc. and the surface temperature and ambient temperature (Tamb) ratings. The Group also forms part of the marking in the product standards and pre-dates ATEX.

The Category is additional to the the marking in accordance with the standard. This means that all of the familiar marking is still present. All products carry the general product safety and electromagnetic compatibility CE mark on the product, installation manual or packaging, as appropriate.

The marking attests that the product meets the requirements of the Low Voltage and Electro-Magnetic Compatibility (EMC) directives of the EU as transposed into UK law. If the product carries the CE mark for ATEX it is not repeated. The scope of compliance is given in the IOM. Products exported directly outside of the European Community are not required to carry any CE marking but local marking regulations may apply.

Surface Temperature Rating and Gas Grouping

Any explosive mixture can be classified for explosion protection under two main characteristics, temperature of ignition by a hot surface and the spark energy to ignite it.

The spark energy of ignition is also related to the intensity of the explosion. This latter property is crucial to the design of the joints in flameproof enclosures (Ex d) and the energy level limit of intrinsically safe (Ex i) and energy limited circuits.

Other important subsidiary characteristics are the specific gravity and flash point, which are used in the determination of the area classification.

Surface Temperature for Ignition

The surface temperature rating is measured in the most onerous design attitude at the most severe supply voltage condition within the design tolerance. Usually this is +10% of rated voltage for lighting and with any fault or overload condition which could normally occur in service.

A normal overload condition for motors may be the starting or stalled condition and, for luminaires, the end of life of a lamp. In the case of Ex d, Ex m, Ex q, Ex nR and dust proof enclosure methods, the maximum temperature is measured on the external surface. In other methods of protection the maximum internal temperature of the equipment is measured.

The explosive mixtures are allocated into broad bands giving the Temperature Classes shown in Table 5.

Temperature Class	Maximum Surface Temperature °C
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

Table 5 Classification of Maximum Surface Temperatures for Electrical Equipment IEC 60079-0

For dust protection using the enclosure methods, the surface temperature is limited to a given value in °C, the T grouping prefix is not used.

Gas Grouping

The gases, vapours and dusts are classified as shown in Table 6. The possible number of chemical compounds is extensive and the list shown is only representative.

The changes introduced in IEC 60079-0 Edition 5 affect the marking of Groupings as all Group II and III equipment must be marked with the subdivision A, B, or C

Group	Representative Gasses and Dusts
I	All underground coal mining. Firedamp (methane)
IIA	Industrial methane, propane, petrol and the majority of industrial gasses
IIB	Ethylene, coke oven gas and other industrial gasses
IIC	Hydrogen, acetylene, carbon disulphide
IIIA	Combustible flyings
IIIB	Non-conductive dust
IIIC	Conductive dust

Table 6 Gas and Dust Grouping for Electrical Equipment for IEC 60079-0

Protection against the Ignition of Explosive Atmospheres formed from Combustible Dust

In this catalogue are products for use with ignitable dusts. Explosives dusts i.e. those not requiring the presence of air to ignite are outside the scope of ignitable dust protection.

With respect to the formation of an explosive atmosphere, the nature of dust is very different to that of gas or vapour. Dust, unlike gas does not disperse, it remains until cleared away by manual means or ventilation and can form layers. Layers of dust can ignite at much lower temperatures than clouds. This is because layers can insulate and increase the temperature and also because layers of some dust are prone to spontaneous combustion. The ignition of layers results in burning which can subsequently translate into an explosion. Layers have the potential to be disturbed and form clouds. Ignition data for dusts is given for clouds and layers. Typically, dust in a cloud form is harder to ignite than gas either by a hot surface or a spark.

The maximum allowable surface temperature for equipment present in dust clouds is de-rated from the actual surface temperature of ignition of the dust. The allowable surface temperature for layers is subject to further de-rating where layers exceed 5mm thick and extra heavy layers require special laboratory investigation by the specifier or user.

When installing floodlights, care must be taken to ensure that the face of the glass is positioned at such an angle that dust cannot settle. Ignitable atmospheres caused by dust may also be prevented from arising by ventilation, containment and by good housekeeping.

Area Classification

The area classification for dust is similar to that for gas, namely, Zone 20, Zone 21 and Zone 22, depending on the likelihood of a hazardous dust atmosphere being present (refer to table 2). As a generality, the zones are smaller than those for gas. Equipment may be marked as suitable for both gas and dust hazards.

If the equipment carries marking for both dust and gas this does not mean both at the same time.

Where an explosive gas atmosphere and a combustible dust atmosphere are or may be present at the same time, the simultaneous presence of both shall be considered and may require additional protective measures. The potential for ignition must be investigated by a qualified person.

Protection Methods

The enclosure method, where dust is effectively excluded and the external surface temperature defined, is generally used for lighting. In the product data this is referred to as "dust protected enclosure". This is now standardised as tD with sub-division into Practice A and Practice B. The next edition of IEC 60079-14 shall align with the protection concepts and include ta, tb and tc with Practice A and Practice B combined.

Sub divisions of Ex m; maD and mbD, Ex i; iaD and ibD also Ex p; pD have been introduced.

The dust ignition protection method for products in this catalogue is by surface temperature limitation and enclosure to IP6X or IP5X as appropriate. IP6X is required for ATEX Category 1 and 2 and for conducting dusts in any Category. Ingress of a conducting dust can cause incendive insulation failure. IP5X is a minimum for Category 3. The surface temperature is limited to a given value in °C.

The table below outlines the difference between practices A and B.

Practice A	Practice B
Performance based	Performance based and prescriptive
Maximum surface temperature is determined with 5 mm layer of dust and installation rules require 75K margin between the surface temperature and ignition temperature of a particular dust.	Maximum surface temperature is determined with 12.5 mm layer of dust and installation rules require 25K margin between the surface temperature and ignition temperature of a particular dust.
A method of achieving the required dust ingress protection by the use of resilient seals on joints and rubbing seals on rotating or moving shafts or spindles and determining dust ingress according to IEC 60529 - IP code.	A method of achieving the required dust ingress protection by specified widths and clearances between joint faces and, in the case of shafts and spindles, specified lengths and diametrical clearances and determining dust ingress by a heat cycling test.

Table 7 Comparison of Practice A and B for Dust Protected Enclosures

Reference is also made in this catalogue to products for use in NEC Class II and Class III locations. NEC dust protected products are to UL 844. The construction and testing is different to that specified in the Euro-norme but is very similar to the alternative Practice B given in the IEC standard.

The IEC Ex Scheme

The IEC Ex scheme is an international certification scheme based on the use of IEC standards.

This is now well established and has a large group of participants including all the major manufacturing countries. In each member country, test laboratories and certification bodies have been vetted and joined the scheme. These organisations now accept each other's test reports prepared under the scheme and issue certificates of conformity with IEC standards. The certificates will carry the IEC certification mark.

The ultimate objective is the acceptance of one certificate regardless of origin to show that explosion proof equipment is safe for use. A fundamental requirement of the scheme is that participating countries align their national standards with IEC.

International Standards

Two distinct groups of equipment standards used world-wide are the IEC/EN (Euronorme) series of standards and those used in the USA and areas influenced by US practice. A large proportion of work on hazardous area and equipment standards is now being carried out at IEC level and almost all EN's are identical with IEC.

Many countries which have their own national standards have adopted the IEC standards in their entirety or incorporated material from them. The practice in the US has developed differently. The US engineering practice, legal requirements, regulations and the use of approval organisations such as UL, FM and ISA mean that, whilst the safety principles are much the same as in the rest of the world, the detail is significantly different. The US code of practice is the National Electrical Code (NEC) and the 'standard' exclusively used, until recently, for luminaires is ANSI/UL844.

This standard integrates the designation of the hazardous area in which equipment is designed to be used and the protection method. For lighting purposes the types of protection are a flameproof type and a non-sparking type. These are used in Class 1 Division 1, and Class 1 Division 2 areas which are broadly equivalent to Zone 1 and Zone 2 respectively. Dust and fibre hazards are Classes II and III.

The only basic technical difference between these and the equivalent IEC/EN standards is that the ANSI/UL844 'non-sparking' technique, known as 'enclosed and gasketed', does not use the restricted breathing method. This is one factor which accounts for the generally higher surface temperature ratings of ANSI/UL844 listed equipment and the practical need for a greater number of temperature sub-divisions. Another factor is that the ANSI standard specifies higher test pressures for flameproof equipment. In the case of HID luminaires this results in the lampglass being smaller and the surface temperature inevitably hotter.

The construction and testing of dust protected enclosures is different to EN but is currently partially incorporated as an additional alternative in the IEC standards. In both codes the gases and compounds are classified by surface temperature of ignition and grouped into ignition groups for the dimensioning of flameproof joints and for intrinsic safety. The classification and grouping are broadly similar to IEC but differ in detail. The classification and protection cannot be mixed and must be used as complementary pairs.

A general comparison between IEC and NEC practice for gas hazard protection is shown in Tables 8 and 9. The US standards are also influenced by the use of conduit wiring systems which, in contrast to cable, form a flameproof distribution method for Class 1 Division 1 and a damage and ingress protected distribution method for Division 2.

NEC - Zone Classification

The NEC has now introduced the Zone classification concept for gas hazards as an alternative to the Division method.

To support this UL and ISA have now introduced their own IEC based protection standards for use in the alternative Zones. These standards are intended to become single ANSI documents. The objective is that the two systems will run in parallel until the older US system becomes obsolete. This will take many years. The new US standards, although based on IEC, may differ from IEC although great effort is being made to ensure that differences do not occur except where there are major difficulties such as the continuation of the long standing US practice of using ordinary motors in Class 1 division 2.

Certification to IEC based US standards can not be considered as being identical to IEC. The wiring methods currently remain unchanged from those traditional in the USA.

Products may be marked for both Divisions and Zones. Where product complies with the US standard based on IEC the designation AEx is applied on the marking.

Canadian Approvals

The Canadian practice has been a hybrid of US and European. The mining industry in Canada was much influenced by Europe which led to the use of European methods elsewhere. Through the joint accreditation system with the US (NRTL) there is a degree of overlap but the detail of this can not be addressed properly in this introduction. Canada has now adopted the zone system for new construction.

Chalmit Lighting is part of the Harsh and Hazardous division of Hubbell Inc, as such Chamlit can supply the products of sister company Killark providing a complete product portfolio to meet US and Canadian standards and codes. The combined range is comprehensive encompassing the vast majority of lighting products needed to satisfy applications in hazardous areas throughout the world.

Maximum Temperature ˚C	Surface Temperature Classification	
	EN 50014	ANSI/UL844
450	T1	T1
300	T2	T2
280	280°C (T2)	T2A
260	260°C (T2)	T2B
230	230°C (T2)	T2C
210	215°C (T2)	T2D
200	T3	T3
180	180°C (T3)	T3A
160	165°C (T3)	T3B
160	160°C (T3)	T3C
135	T4	T4
120	120°C (T4)	T4A
100	T5	T5
85	T6	T6

Table 8 Comparison of Surface Temperature Classification IEC and NEC

Representative Gas	Explosion Group IEC 60079-0	Explosion Group National Electrical Code
Acetylene	IIC	A
Carbon disulphide	IIC	B
Hydrogen	IIC	B
Ethylene oxide	IIB	B
Hydrogen sulphide	IIB	C
Ethylene	IIB	C
Acrylo-nitrile	IIA	D
Industrial methane	IIA	D
Propane	IIA	D
Ethyl acetate	IIA	D

Table 9 Comparison of Representative Gases in IEC and NEC Gas Groups

Ingress Protection

The surface temperature classification and gas grouping are the primary safety considerations. A major secondary parameter is protection against the ingress of solid bodies and liquids. In some cases the degree of ingress protection (IP) forms part of the standard requirement of the explosion protection method.

Where equipment is used in dirty or wet conditions, high resistance to ingress contributes to the reliability of explosion protection in that electrical faults within the equipment are often the result of water ingress.

For Chalmit products, the appropriate standard is IEC 60529. The definitions of the IP code are summarised in Table 9. It will be noted that many Chalmit luminaires have both IP66 and IP67 ratings. This is because the IP66 test can be more severe than IP67 for some constructions. The US has a system using the ANSI/NEMA 250 code which is similar but also contains tests for corrosion resistance.

First Digit Numeral	Degree of Protection (Foreign Bodies)	Second Digit Numeral	Degree of Protection (Liquids)
0	No protection	0	No protection
1	Protection against ingress of large solid foreign bodies	1	Protection against drops of water
2	Protection against ingress of medium sized solid foreign bodies	2	Protection against drops of liquid falling at any angle up to 15° from vertical
3	Protection against ingress of small solid foreign bodies greater in diameter than 2.5mm	3	Protection against rain falling at any angle up to 60° from the vertical
4	Protection against ingress of small solid foreign bodies greater in diameter than 1mm	4	Protection against splashing. Liquid splashed from any direction shall have no harmful effect
5	Protection against the ingress of dust in an amount sufficient to interfere with satisfactory operation of the enclosed equipment	5	Protection against water projected by nozzle from any direction
6	Complete protection against ingress of dust	6	Protection against powerful water jets
		7	Protection against temporary immersion in water
		8	Protection against indefinite immersion in water. Tests to be agreed between supplier and customer.

Table 10 Definition of Ingress Protection

Resistance to Mechanical Damage

The standards usually contain two levels of impact resistance these being appropriate to high and low risk of impact.

The selection will depend on the mounting position. If the equipment is only suitable for low impact the certificate is suffixed X or the information is included in the installation information.

The tests are conducted at both below the lowest permitted ambient temperature and above the highest. 10 Joules is equivalent to 1 Kilogram dropped from a height of 1 metre. A 25 mm diameter hemispherical steel impact piece is used. Chalmit equipment usually exceeds the minimum level by a substantial margin.

Part of apparatus tested	Impact energy in Joules IEC 60079-0	
	High risk of mechanical danger	Low risk of mechanical danger
Enclosures and Guards	7	4
Light transmitting parts without guard	4	2
Light transmitting parts with guard when tested without guard	2	1

Table 11 Impact Energy Requirements for IEC 60079-0 Group II Equipment

IK Code

In addition to the index of protection against the ingress of foreign bodies and liquids, a third figure is sometimes quoted. This relates to the minimum levels of resistance to mechanical damage as measured by test methods producing an impact energy measured in Joules or Newton metres.

It is often referred to as the IK code, the levels of protection for this index are detailed in Table 12 below.

The test method is not the same as in the IEC standards.

IK Code	IK00	IK01	IK02	IK03	IK04	IK05	IK06	IK07	IK08	IK09	IK10
Impact energy (Joule)	a	0.14	0.2	0.35	0.5	0.7	1	2	5	10	20

[a] Not protected to this standard

Table 12 Impact Energy Requirements IK Code

Compliance with General Product Standards

Luminaires are designed to comply with normal product construction standards, such as IEC 60598, where the requirements do not conflict with those in the Ex protection standard. This also applies to internal components such as lampholders, terminals and control gear.

Equipment complying with the individual product standard will have its internal components operating within their own rated parameters when operated at the maximum rated ambient temperature of the finished product. This contributes to the reliability and, ultimately, the safety of the installation. Compliance with product standards is the normal method of claiming compliance with the Low Voltage Directive of the EU.

Operational Temperatures - Tamb

The operational temperature limits, Tamb, are based on both product function and the Ex protection standards. As a general guide the normal upper limit is 40°C but some equipment is rated at other temperatures which may be linked to the surface temperature rating or the temperature limit of operation. The normal lower limit for Ex products is -20°C unless otherwise noted on the certificate or data. 40°C to -20°C is the standard level given in IEC 60079-0 and if these are the limits, the product does not need to be marked with the Tamb.

Where the range is other than 40°C to -20°C the upper and lower limits are both marked. The lowest certified Tamb is not always the actual lowest temperature for functional operation, especially for luminaires where the lamp may not be suitable because of temperature limitation.

In some cases the lowest temperature for Ex use is lower than a temperature at which the lamp will start or the product will function properly. The lower limits of operation and starting for lamps and for batteries can be obtained from Chalmit. A guide is -40°C for HPS, -30°C for Metal halide, -25°C for Mercury vapour, -45°C for LED and as low as -30°C for fluorescent depending on the control gear used and -10°C for battery operated equipment.

'X' suffix on Certificate

Some products carry a suffix 'X' after the certificate number. This denotes “special certification conditions”. These are given on the certificate and in the installation manual. The conditions usually relate to cable entry, operation, lamps, orientation, installation position and location, impact level or maintenance. They must be observed by the user.

Delayed Opening

In those cases where internal temperatures are greater than the T rating or where energy is stored in electrical components, a delay before opening is marked on the equipment. This will give a minimum time limit to be observed following the interruption of electrical power. This allows for cooling and discharge of energy. It applies most practically to Ex d equipment.

For Category 3 equipment, opening times are not usually given as it is inferred that an explosive atmosphere is unlikely to occur during maintenance operations.

Cabling and Cable Glands

Ex d floodlights and well-glass luminaires in this catalogue feature indirect entry via Ex e terminal enclosures. This means that the terminal chamber is separated from the main chamber by a flameproof barrier. Cable glands must satisfy the requirements for Ex e entry with reference to IP rating and impact. The cables must satisfy any requirement laid down in an installation code of practice.

Where the entry is via an indirect Ex d terminal chamber or directly into an Ex d enclosure, Ex d cable glands must be used. The method for selecting cable gland types for Ex d is set out in the code of practice IEC 60079-14.

Where glands are fitted as part of the equipment, the diameter of the supply cables used must be suitable for accommodation within the cable glands supplied. If not correct the glands must be replaced by the user. The terminal size and looping facility available is shown in the product data sheets and IOM. Where there is an option, the requirement must be stated on the order. Equipment is usually despatched with one or more permanent entry plug(s) and one travel plug which will keep out moisture during transport, storage and initial installation.

Ex nR with a restricted breathing enclosure is provided with a means of achieving the gas-tight seal needed to attain the protection method. It is the responsibility of the user to ensure that the cable entry system is satisfactory.

In relation to cable temperature, some products require to be supplied by cables with temperature ratings above 70°C (ordinary PVC), particularly where the product is rated for higher ambient temperatures. The cable temperature is shown on the rating plate and in the installation manual. The rating is based on the maximum rated ambient. Where cable temperatures exceed 70°C at the maximum rated ambient, Chalmit now gives the actual temperature rise at the cable entry. The user can relate this to the actual operating condition and select appropriate cables. At their own discretion users may choose to adjust the cable temperature ratings of those products with specific cable temperatures on this basis.

For Ex nR luminaires in this catalogue, the cable glands which may be used are listed in the certificate pertaining to that piece of equipment. This is to ensure that the restricted breathing properties are maintained. A list of suitable cable glands is given in the installation leaflet supplied with the product and available on request from Chalmit.

Where cables do not enter directly into the restricted breathing enclosure the designation is Ex nA nR and special glands are not required, however the ingress protection and impact requirements must be met. Information on this can be found in the individual product installation leaflet.

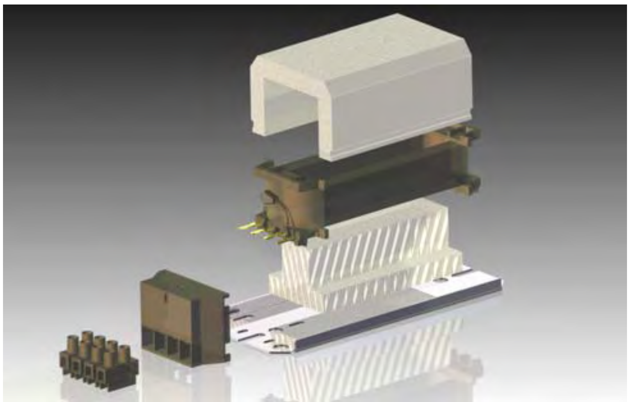
Lamps and Control Gear

Lamps fall into two broad categories, incandescent lamps where the light is generated by a hot wire element and discharge lamps where the light is generated by an electrical discharge enclosed in a containment vessel usually referred to as the arc tube. Discharge lamps either produce light directly from the hot gas discharge, as is the case with high pressure sodium and metal halide, or by conversion from UV to visible light using a phosphor which absorbs one wavelength and emits another. Phosphors are used in fluorescent and mercury vapour lamps.

Apart from some specialist “induction” lamps where the plasma is generated by an external magnetic field, the electrical arc in discharge lamps is formed between electrodes within a vessel or arc tube. Discharge lamps are divided into two types. Low pressure lamps with an evacuated glass vessel filled with inert gas at low pressure and a small amount of metal, usually mercury, and high pressure types where the quartz or ceramic arc tube is filled with sodium, mercury and sometimes a combination of rare earth metals which vaporise at high temperature.

The high pressure lamp types have an outer evacuated enclosure to reduce heat loss and protect against the severe corrosion which would occur if the hot arc tube were to be exposed to the atmosphere.

The electric arc generated to strike the lamp is unstable so control gear is needed to stabilise it, hence the common term “ballast”. Some discharge lamps are designed so that they can be initiated at normal mains supply voltage but the optimisation of output and efficiency usually means that an enhanced voltage is needed to initiate the arc. Depending on the requirement, this is produced by resonant circuits which boost the voltage during starting or by a separate ignitor producing a high voltage pulse. Fluorescent lamps have cathodes which are usually pre-heated providing ionisation to aid initiation of the arc. Ex e fluorescent lamps use cold start technology to initiate the electrical arc.



Light emitting diodes (LED) produce light directly by using solid state technology. These are being developed rapidly and have now reached output levels and efficiency where they can be used for illumination rather than decoration and indication also providing extended, maintenance free installation.

Lamps and Control Gear (continued)

The different types of lamps have various characteristics: instant light/slow run up; instant re-strike/long delay: good/poor colour rendering (colour rendering is a method of comparing colours as they appear under a given lamp with their appearance in natural daylight); long/medium life; high/low efficiency; cost; size; fragility; ability to run at low or high temperature; vibration resistance; maximum power; etc. Some lamps are so hot or so bulky that their use must be confined to certain types of Ex protection.

No single lamp type is ideal for all lighting applications but a combination of fluorescent and powerful high intensity discharge lamps will accomplish most tasks. The user must select the combination of light source and protection which suits the application. Table 13 gives a summary of lamp characteristics and their application as applied to general Ex usage. It must be stressed that this is a broad summary and that considerations of lamp economics are both complex and subjective. This applies especially to views on economical life.

Details of the specific lamp types required for individual Chalmit luminaires can be found in ordering information section at the end of this catalogue.

The lamp output shown is given in lumens. The lumen is a unit of light which quantifies the amount of luminous power in the visible range. Large diffuse light sources such as fluorescent and coated HID types can not readily be focussed. The ability of the lamp and luminaire to deliver the light to a working surface varies considerably with the lamp type, reflector and luminaire design.

As a general rule, the smaller power lamps of each type have lower efficiency and shorter lives, often significantly so. The lamp manufacturers provide large amounts of data but the tables of lamp mortality combined with the reduction of output over the lamp life (lumen depreciation) need to be studied carefully to make a refined judgement. The amount of switching is also an important factor.

Lamp Type	Tubular Fluorescent and 2 Leg Compact	Compact Fluorescent	High Pressure Sodium	Metal Halide	Mercury Vapour	Incandescent. GLS and Tungsten Halogen	Light Emitting Diodes (High Power LED) ****
Lamp Power range W	18 to 58W	9 to 55W	70 to 1 kW	70 to 2kW	80 to 400W	40 to 2000W	Up to 8W
Output range Lumens	up to 6000	up to 4800	6000/13000**	5000/20000	3400/22000	375/3100	Varies
Physical size	Long	Small	Small to medium	Small to medium	Medium	Medium	Very small
Temperature of lamp	Cool	Cool	Hot	Very hot	Medium	Medium to very high	Cool
Efficiency lumens per circuit watt	up to 90	Up to 85	Up to 125	Up to 90	Up to 70	Up to 21	Up to 90
Instant light	Yes	Yes	No ***	No	No	Yes	Yes
Lumen depreciation	Slow	Slow	Negligible	Quick	Slow	Negligible	Slow
Colour rendering Ra	Good up to 90	Good up to 90	Poor up to 40	Good up to 90	Fair up to 65	V Good 95/100	Good up to 90
Economical life max (hrs)	40000*	12000	30000	12000	10000	1000	Up to 80000
Ability to be focussed for floodlighting	No	Limited	Good (tubular)	Good (tubular)	Limited	Some (tubular linear)	Yes
Emergency operation	Easy	Easy	No	No	No	Very easy (but inefficient)	Yes
Vibration resistance	Medium	Medium	Good	Good	Good	Poor	Very Good
Most common equipment Ex protection methods	Ex nA Ex e	Ex n Ex d	Ex d Ex nR	Ex d Ex nR	Ex d Ex nR	Ex e Ex d Ex nR	Ex e Ex nA Ex d
T amb range °C	-20 to 55	-20 to 55	-50 to 60	-30 to 55	-20 to 55	-50 to 60	-55 to 55
Common T ratings	T6 to T4	T6 to T4	T4 to T2	T4 to T2	T4 to T2	T6 to T2	T6 to T4

Table 13 Summary of Lamp Characteristics and their Application

* Most fluorescent lamps have an economical life of 15,000 hrs but some higher specification lamps are available which can run economically for up to 80,000 hours.

** Equal to or less than 48,000 hours when "twin arc" lamps are used. (See note below)

*** HPS lamps are available which have two arc tubes in parallel inside the same envelope and are commonly known as "twin arc" lamps. They give 15% light output immediately after a brief supply interruption which extinguishes the lamp. They also give a longer service life.

**** LED figures represent single chip devices; multichip devices can consume considerably more power. Economic lifetime and efficiency are directly affected by temperature.

Lamp Standardisation

Most IEC type lamps are now standardised in form and cap dimensions even when, as newly developed lamps, they are not included in a standard.

The US type lamps are generally somewhat different and are designed for use with US control gear. Some US fluorescent lamps are superficially identical to IEC lamps but may not run reliably on IEC control gear and vice versa. In addition, some US HPS lamps are identical in operating characteristics with IEC lamps but others have different operating characteristics. US and IEC lamp-cap sizes are often different.

US metal halide lamps usually have quite different operating characteristics to European lamps and there are many varieties. Most must be operated on US control gear and sometimes a specific make of control gear if warranties are to be valid. Great care must be taken with the use of all metal halide lamps and details of their application will be found in the instruction manuals.

Most products for IEC applications in this catalogue are designed to use metal halide lamps compatible with HPS (SON) ballasts. Lamps will also run satisfactorily provided they are compatible with both HPS and MBFU ballast impedances. In all cases check control gear for compatibility. If in doubt with metal halide lamps please contact your local Chalmit representative.

Care must also be taken with the specification of compact fluorescent lamps, particularly whether they need to have a starting switch in the lamp. Most of the luminaires in the catalogue use 4-pin compact fluorescent lamps without internal starter switches. HPS/SON lamps with internal ignitors must not be used in Ex n or Ex N equipment. All Chalmit HID luminaires are suitable for use with twin arc HPS/SON lamps.

Please consult Chalmit or your local representative if there are any uncertainties concerning lamps.

Control Gear and Electrical Supplies

Incandescent, tungsten-halogen and MBTF(self ballasted discharge) lamps are matched to the supply available and must be ordered accordingly. Discharge lamps are matched to the supply by the use of control gear. The control gear may be suitable for a single rated voltage or, by having taps or by a 'universal' or regulating design, may be suitable for a range of rated voltages. Usually discharge lamps will be standardised, refer to the section above on lamps for possible miss-match. Supplies will have a tolerance on the rated or nominal voltage and, in general, the lamps will have a shorter life and produce more light when the actual voltage is higher than rated.

This effect is reduced or eliminated with full regulation, usually by electronic control. Electronic control is now common for fluorescent lamps and this gives additional benefits in efficiency and lamp life. There are however technical and operational problems with the use of electronic control for HID lamps. In particular these concern the temperature limitations of economical electronic power supplies. Also the efficiency benefits are proportionately much lower than for fluorescent lamps. For these reasons electronic control for high power HID lamps is some way in the future. Operation above rated voltage will also reduce the life of control gear and enclosures, especially where operation is continuous and at the maximum allowable Tamb. The product standards are currently based on having a normal maximum variation of +/-6% and an extreme variation of +/-10% of rated voltage.

There is a problem in the UK caused by the rationalisation of nominal supply to 230V throughout the EU. The nominal supply in the UK is now 230V whereas the actual measured supply usually remains at or near 240V. Most Chalmit products will have a number of taps which can be selected to match the actual average supply voltage. Continuous operation at more than 6% above of the nominal control gear setting is not advised. To avoid this occurring the ordering of equipment for the actual site voltage or with taps or the use of control gear having regulated operation is required. Many Chalmit products with wound control gear are power factor corrected to values greater than 0.85 depending on the lamp and supply voltage and frequency. PFC can be omitted where supplies have large harmonic components which could damage capacitors.

Products with electronic control gear have a power factor near unity. Further information is contained in the product installation manuals available to download from the website (www.chalmit.com). Most Chalmit control gear for high pressure discharge lamps now has thermal protection against the possible effects of rare faults occurring when lamps reach the end of their life.

Emergency Lighting

Some luminaires for emergency lighting are contained in the catalogue. Where remote battery supplies are available these can supply GLS or tungsten-halogen lamps of appropriate rating from dc supplies.

Luminaires such as Protecta III, Acclaim, Curie Elite, NexLED and Stirling II with electronic ballasts, can power fluorescent lamps from dc supplies. Most of the remaining range can be run at mains ac voltage from a UPS but the characteristics of the UPS must be compatible with those of the luminaire. For details of operation where full information is not included in the catalogue refer to Chalmit technical sales (techsupport@chalmit.com).
The Protecta III, Acclaim, Curie Elite and Stirling II luminaires are also available with integral, self contained nickel-cadmium batteries to provide illumination on ac mains failure. The output is a given percentage of the full luminaire output depending on the lamp size chosen and the duration required.

Applications

Chalmit luminaires use a wide range of lamps, each of which is suited to its particular application. The use of high intensity discharge lamps in floodlighting and high bay applications reduces the number of luminaires required with a consequential reduction in the amount of installation and maintenance time as well as cost.

The Chalmit range also includes a number of luminaires for single point or local illumination and those using fluorescent lamps provide instant illumination of good light quality using low cost sources. The HID sources allow a compact luminaire construction that will reliably attain a high degree of ingress protection. Many fluorescent sources and the smaller HID sources can be housed in luminaires having plastic enclosures and these have additional applications in certain corrosive environments. The wide range of products and lamps ensures that Chalmit can supply the correct luminaire for the application.

To assist you in developing a lighting design that will provide the optimum performance from Chalmit products for your specific applications, Chalmit have developed a user friendly lighting design package called CHALMLITE™. This software programme is available free of charge and includes unique internal & external quantity estimators to provide a quick indication of the luminaire quantities required. Chalmit also offer a lighting design service to assist in the development of complex lighting designs tailored to meet exact project requirements.

Glossary

ANSI	American National Standards Institute
ATEX	Abr. Directive 94/9/EC Equipment and protective systems intended for use in potentially explosive atmospheres
BASEEFA	British Approvals Service for Electrical Equipment in Explosive Atmospheres. This was a government organisation that is now closed
BASEEFA 2001	A private organisation which has taken on much of the work of BASEEFA
BSI	British Standards Institution
CAA	Civil Aviation Authority (UK)
CEN	Committee European de Normalisation
CENELEC	Committee European de Normalisation Electrique
CIE	Commision Internationale de Leclairage
CSA	Canadian Standards Association
EC	European Communities
EECS	Electrical Equipment Certification Service (UK). Parent organisation of BASEEFA, now closed
ERA	The Electrical Research Association (hazardous area testing section became part of ITS)
EU	The European Union
FM	Factory Mutual (US)
IEC	International Electro-technical Commission
IP	Ingress Protection

ISA	Instrument Society of America
ITS	Intertek Testing Services (formerly part of ERA)
KEMA	Netherlands Testing Laboratory
NEMA	National Electrical Manufacturers Association (US)
NRTL	Nationally Recognised Testing Laboratories (US)
SCS	SIRA Certification Service (UK)
SOLAS	Safety of Life at Sea (convention)
T	Surface Temperature (Max)
Ta/Tamb	Ambient Temperature
UL	Underwriters Laboratory Inc.
	LAMP TYPES
HID	High intensity discharge
CFL	Compact fluorescent
MBFU	Mercury vapour
MBI/HQI	Metal Halide
MBTF	Blended mercury vapour
SON/HPS	High pressure sodium
TH	Tungsten-halogen
QL	Induction Lamp
LED	Light Emitting Diode