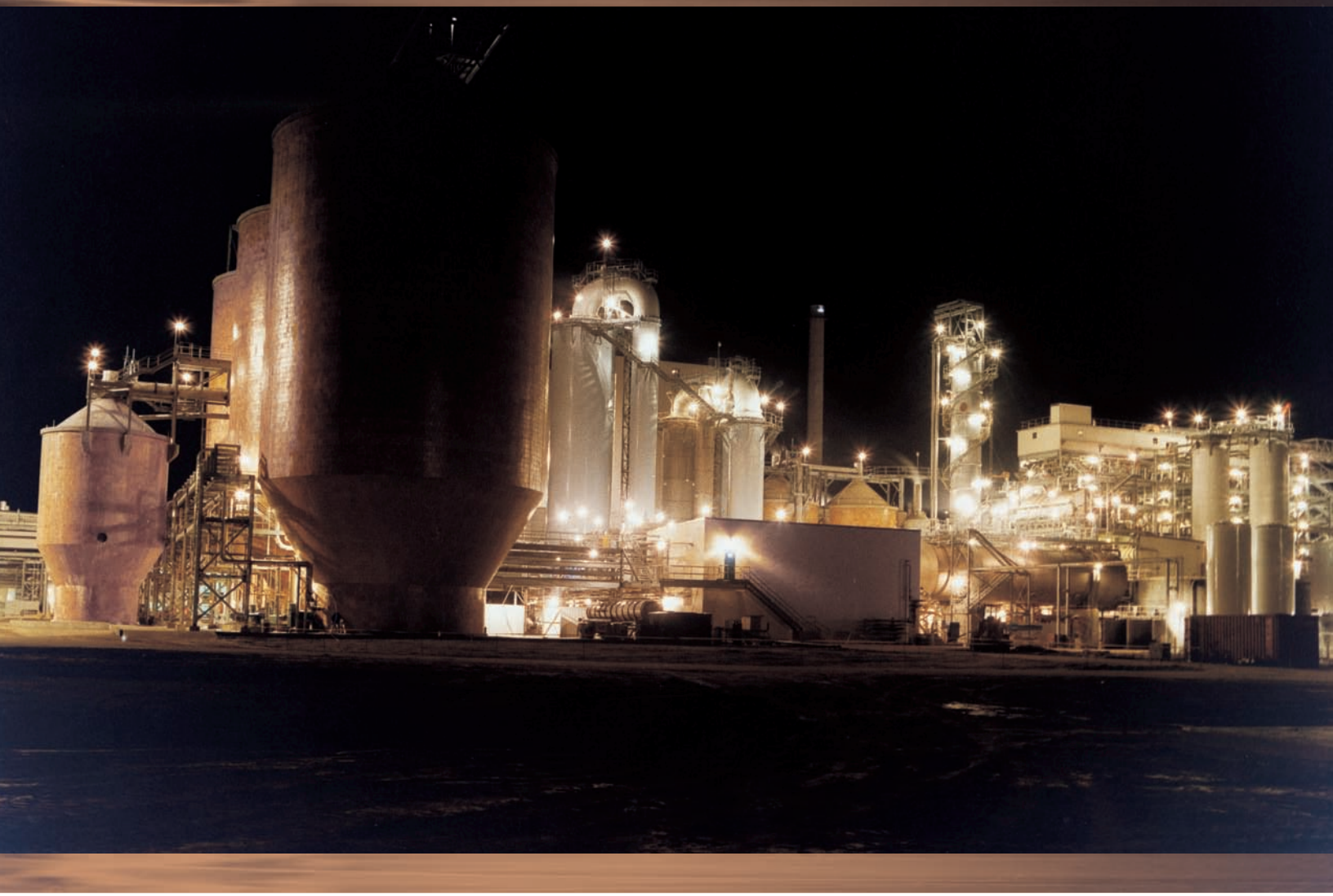
Hazardous Lighting Guide

HOLOPHANE®
LEADER IN LIGHTING SOLUTIONS

experience lighting's best.



About Holophane

Holophane is the leader in lighting solutions with over a century's experience in providing a wide range of lighting systems with the lowest total cost of ownership, remarkable visual comfort, and superior visibility. Holophane products represent the ultimate in lighting innovation, performance, versatility and longevity.

Hazardous facilities have many of the same light requirements as other applications. Lighting systems must provide high levels of visibility and uniformity without shadows and glare. They must create a functional environment that is safe and productive.

Yet, luminaires must be rugged enough to perform in the presence of hazardous substances such as flammable gasses, liquids and vapors, combustible dusts and ignitable fibers and flyings. Often, luminaires must operate in a wide range of ambient temperatures and in damp and wet locations.

Holophane luminaires deliver maximum performance in Class I, II and III hazardous areas. Durable prismatic glass and acrylic optics control light distribution, ensuring efficiency in a wide array of applications. Features such as low copper aluminum housing and stainless steel hardware ensure longevity with minimal maintenance.

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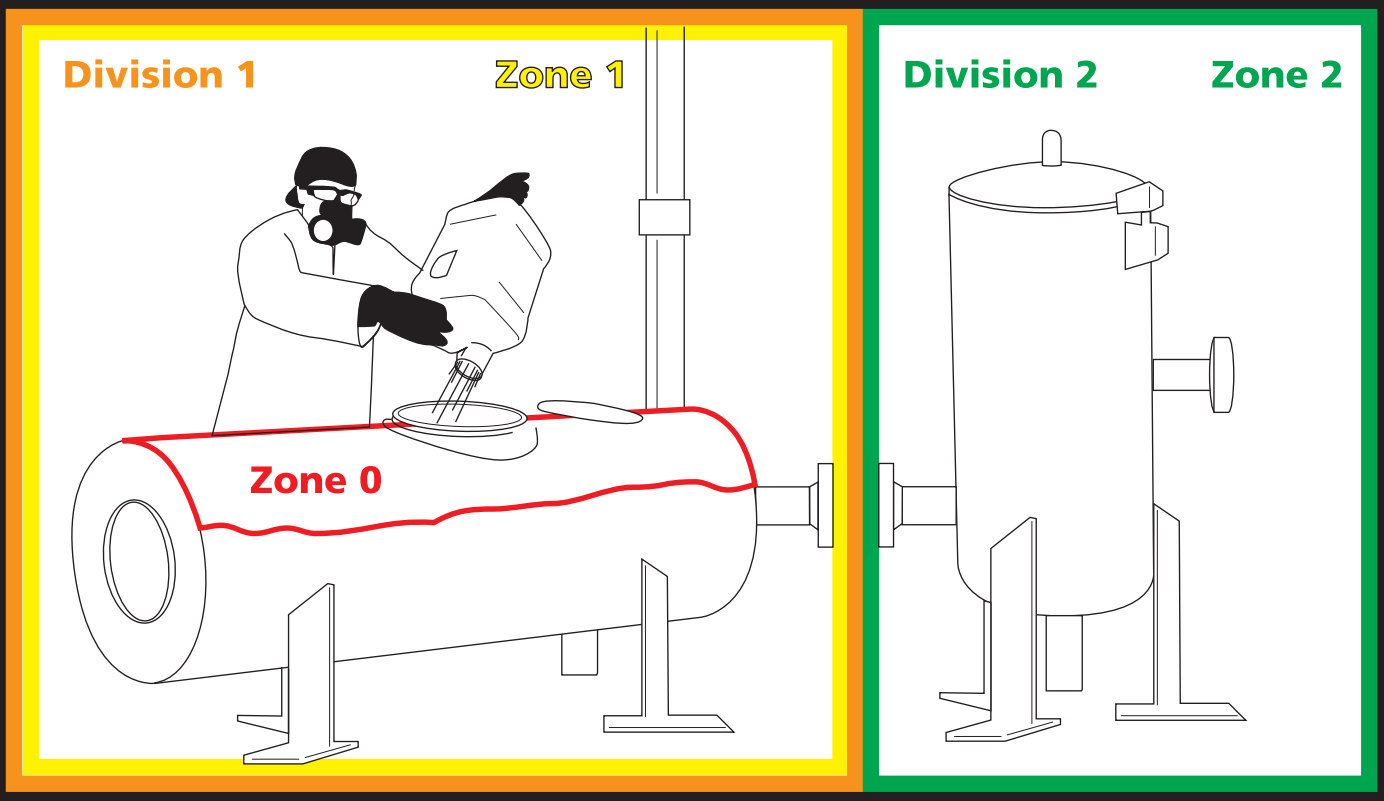


Open vessel

Sealed vessel

Division 1 Normally Present		**Division 2** Not Normally Present
Zone 0 Continuously Present	**Zone 1** Likely to be Present	**Zone 2** Not Likely to be Present

NEC/IEC Classifications

Hazardous locations can be made a safe place to work when proper equipment rated for the environment is used. Guidelines and electrical codes provided by NEC/CEC and IEC/CENELEC aid in the proper classification of hazardous areas and appropriate equipment use under such conditions throughout the world. NEC standards are used primarily in the U.S. and Canada, where as IEC/CENELEC is used throughout Europe and other parts of the world.

Both the NEC (1996) and CEC (1998) recognize the IEC/CENELEC Zonal classification method.

While both the Division and Zonal method can be used to classify hazardous locations, caution must be used when attempting to apply both systems for the same application. The NEC/CEC Division classification method differs from the IEC/CENELEC Zonal standards.

NEC/CEC: U.S./Canada Standard

NEC: National Electrical Code
CEC: Canadian Electrical Code

NEC/CEC employs Class, Division, and Group classification system in the identification of hazardous locations. Classes are divided into "Divisions" and are defined by the likelihood ignitable concentrations are present.

Class I - Gases, Vapors and Liquids (Normal Operating Conditions)

Division 1 Ignitible, flammable, or combustible concentrations are present some of the time or all the time.

Division 2 Ignitible, flammable, or combustible concentrations are NOT likely to be present.

IEC/CENELEC: European Standard

IEC: International Electrotechnical Commission
CENELEC: European Committee for Electrotechnical Standardization

Classifications of hazardous locations under IEC/CENELEC standards are divided into "Zone 0", "Zone 1", and "Zone 2". Zones are identified by the likelihood and length of time in which sufficient quantities of flammable or combustible content are present in a specified area.

Class I - Gases, Vapors and Liquids (Normal Operating Conditions)

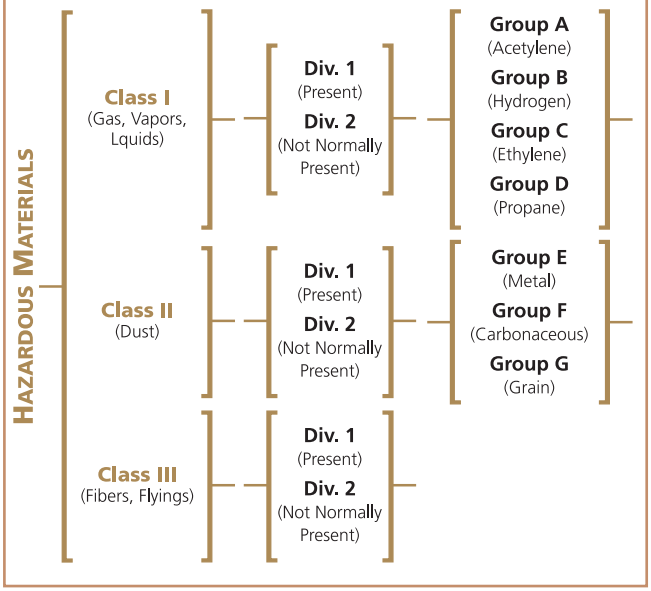
Zone 0 Ignitible, flammable, or combustible concentrations exist continuously or for prolong periods.

Zone 1 Ignitible, flammable, or combustible concentrations are likely to exist, or only for short periods.

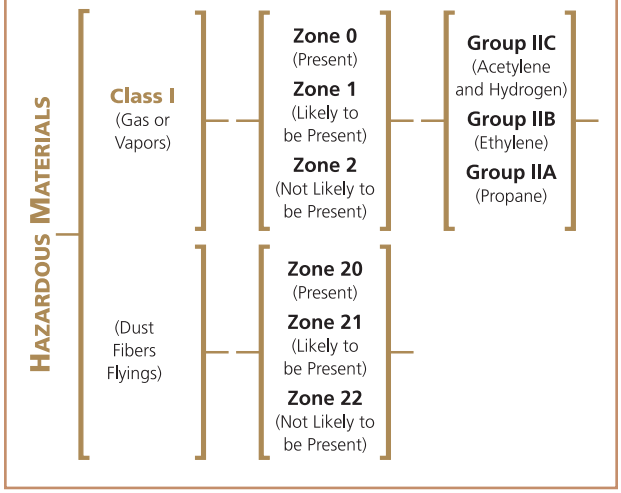
Zone 2 Ignitible, flammable, or combustible concentrations are NOT likely to exist.

Hazardous locations are classified under the umbrella of classes. Each class is further divided into "Divisions" or "Zones".

Steps for classifying hazardous materials per NEC/CEC codes



Steps for classifying hazardous materials per IEC/CENELEC codes



Note:
Zones 20, 21 and 22 do not include metal dust

Examples of Class II:
Group E: Metal dust – aluminum, magnesium & commercial alloys.
Group F: Carbonaceous dust – coal, carbon black, charcoal, and coke dust.
Group G: Grain dust – flour, grain, wood, plastic, and chemicals.

NEC Classifications

The definitions below are taken from the National Electric Code 2008, developed by the National Fire Protection Association.

Class I Locations: Class I locations are those in which flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures.

Class I, Division 1: A Class I, Division 1 location is a location:

(1) In which ignitible concentrations of flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors can exist under normal operating conditions, or

(2) In which ignitible concentrations of such flammable gases, flammable liquid-produced vapors, or combustible liquids above their flash points may exist frequently because of repair or maintenance operations or because of leakage, or

(3) In which breakdown or faulty operation of equipment or processes might release ignitible concentrations of flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.

Class I, Division 2. A Class I, Division 2 location is a location:

(1) In which volatile flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors are handled, processed or used, but in which the liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in a case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment; or

(2) In which ignitable concentrations of flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors are normally prevented by positive mechanical ventilation and which might become hazardous through failure or abnormal operation of the ventilating equipment; or

(3) That is adjacent to a Class I, Division 1 location, and to which ignitible concentrations of flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors above their flash points might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Class II Locations: Classes II locations are those that are hazardous because of the presence of combustible dust.

Class II, Division 1. Class II, Division 1 location is a location:

(1) In which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitible mixtures; or

(2) Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitible mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electrical equipment, through operation of protection devices, or from other causes; or

(3) In which Group E (Metals) combustible dusts may be present in quantities sufficient to be hazardous.

Class II, Division 2. A Class II, Division 2 location is a location

(1) In which combustible dust due to abnormal operations may be present in the air quantities sufficient to produce explosive or ignitible mixtures; or

(2) Where combustible dust accumulations are present but are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but could as a result of infrequent malfunctioning of handling or processing equipment become suspended in the air; or

(3) In which combustible dust accumulations on, in, or in the vicinity of the electrical equipment could be sufficient to interfere with the safe dissipation of heat from electrical equipment, or could be ignitible by abnormal operation or failure of electrical equipment.

Class II Groups

Materials	Divisions
E (Metals)	1
F (Coal)	1 and 2
G (Grain)	1 and 2

Class III Locations: Class III locations are those that are hazardous because of the presence of easily ignitible fibers or materials producing combustible flyings are handled, manufactured, or used, but in which such fibers/flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitible mixtures.

Class III, Division 1. A Class III, Division 1 location is a location in which easily ignitible fibers/flyings are handled, manufactured, or used.

Class III, Division 2. A Class III, Division 2 location is a location in which easily ignitible fibers/flyings are stored or handled other than in the process of manufacture.

Zone Classifications

The definitions below are taken from the National Electric Code 2008, developed by the National Fire Protection Association.

Class I, Zone 0, 1, and 2. Class I, Zone 0, 1, and 2 locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures.

Class I, Zone 0. Class I, Zone 0 is a location in which

(1) Ignitible concentrations of flammable gases or vapors are present continuously, or

(2) Ignitible concentrations of flammable gases or vapors are present for long periods of time.

Class I, Zone 1. Class I, Zone 1 is a location

(1) In which ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions; or

(2) In which ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or

(3) In which equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitible concentrations of flammable gases or vapors and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or

(4) That is adjacent to a Class I, Zone 0 location, from which ignitible concentrations of vapors could be communicated, unless communication is prevented by adequate positive pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Class I, Zone 2. Class I, Zone 2 is a location

(1) In which ignitable concentrations of flammable gases or vapors are not likely to occur in normal operation and, if they do occur, will exist only for a short period; or

(2) In which volatile flammable liquids, flammable gases, or flammable vapors are handled, processed, or used but in which the liquids, gases, or vapors normally are confined within closed containers of closed systems from which they can escape, only as a result of accidental rupture or breakdown of the containers or system, or as a result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, used; or

(3) In which ignitible concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation but which may become hazardous as a result of failure or abnormal operation of the ventilation equipment; or

(4) That is adjacent to a Class I, Zone 1 location, from which ignitible concentrations of flammable gases or vapors could be communicated, unless communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Note:
NEC zonal classification in article 505 & 506 may not contain exact contents of IEC/EN 60079.

NEC/IEC Summary

The definitions below are taken from the National Electric Code 2008, developed by the National Fire Protection Association.

Implementation of Zone Classification System

Classification of areas, engineering and design, selection of equipment and wiring methods, installation and inspection shall be performed by qualified persons.

Dual Classification

Class I

In instances of areas within the same facility classified separately, Class I, Zone 2 locations shall be permitted to abut, but not overlap, Class I, Division 2 locations. Class I, Zone 0 or Zone 1 locations shall not abut Class I, Division 1 or Division 2 locations.

Class II & Class III

In instances of areas within the same facility classified separately, Zone 22 locations shall be permitted to abut, but not overlap, Class II or Class III, Division 2 locations. Zone 20 or Zone 21 locations shall not abut Class II or Class III, Division 1 or Division 2 locations.

Reclassification Permitted

Class I

A Class I, Division 1 or Division 2 location shall be permitted to be reclassified as a Class I, Zone 0, Zone 1, or Zone 2 location, provided all of the space that is classified because of a single flammable gas or vapor source is reclassified under the requirements of Article 505 of the NEC Handbook.

Class II & Class III

A Class II or Class III, Division 1 or Division 2 location shall be permitted to be reclassified as a Zone 20, Zone 21 or Zone 22 location, provided that all of the space that is classified because of a single combustible dust or ignitible fiber/flying source is reclassified under the requirements of Article 506 of the NEC Handbook.

T codes & Temperature:

Each liquid, gas, vapor and dust will have a specific ignition temperature. In order to ensure proper use of luminaires and equipment both the NEC and IEC use temperature ratings called, "T Codes." While NEC and IEC temperature classification differ, both specify the maximum operating temperature of luminaires at 40°C (104°F) ambient temperature. NEC Article 500 and 505 indicate that T Code rating of luminaires shall not exceed ignition temperature of the specific gas and vapors encountered in the environment; or shall be less than the ignition temperature of dusts encountered in the environment.

T Codes & Temperature

Division 1, Division 2			Zone 0, Zone 1, Zone 2		
T Code	Maximum Surface Temperature		T Code	Maximum Surface Temperature	
T1	450°C	842°F	T1	≤450°C	≤842°F
T2	300°C	572°F	T2	≤300°C	≤572°F
T2A	280°C	536°F			
T2B	260°C	500°F			
T2C	230°C	446°F			
T2D	215°C	419°F			
T3	200°C	392°F	T3	≤200°C	≤392°F
T3A	180°C	356°F			
T3B	165°C	329°F			
T3C	160°C	320°F			
T4	135°C	275°F	T4	≤135°C	≤275°F
T4A	120°C	248°F			
T5	100°C	212°F	T5	≤100°C	≤212°F
T6	85°C	185°F	T6	≤85°C	≤185°F

IEC IP Ratings

IEC standards separate the measures of protection by using a 2 digit nomenclature in the ingress protection (IP) rating system. The first digit describes the degree of protection for solid matter and the second digit describes the degree of protection for liquid matter. For example, in an "IP65" rating the first digit, "6" would indicate the luminaire is dust tight; additionally the second digit, "'5" would signify ingress protection against jets of water.

Ingress Protection (IP) Codes – IEC 60529

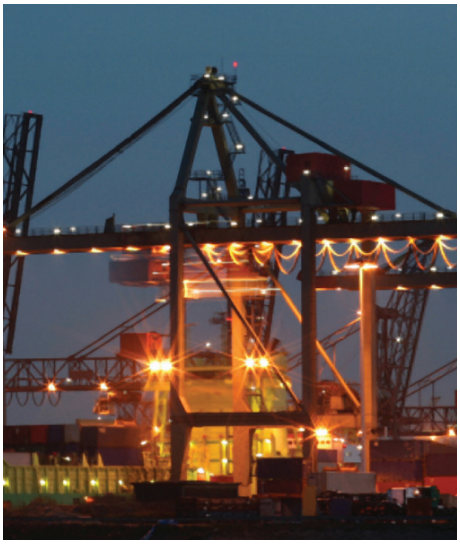
First Digit IP-X6	Against ingress of solid foreign objects	Second Digit IP-6X	Against ingress of water with harmful effects
0	non-protected	0	non-protected
1	≥ 50mm diameter	1	vertically dripping
2	≥ 12.5mm diameter	2	dripping (15° tilted)
3	≥ 2.5mm diameter	3	spraying
4	≥ 1.0mm diameter	4	splashing
5	dust-protected	5	jetting
6	dust-tight	6	powerful jetting
	-	7	temporary immersion
	-	8	continuous immersion

Ignition Temperatures and Flash Points

The following definition is from Article 500 of the NEC Handbook:

The Ignition Temperature of a solid, liquid, or gaseous substance is the minimum temperature required to initiate or cause self-sustained combustion independent of heating or heated element.

Flash Point is the temperature at which the material gives off vapors that ignite when the temperature reaches the ignition temperature, provided the air-fuel ratio is within the proper range.



Group	Atmosphere	Ignition Temperature (AIT)		Flash Point	
		C	F	C	F
A	Acetylene	305	581		
B	Acrolein	235	455		
	Butadeine	420	788	-76	-104.8
	Ethylene Oxide	429	804.2	-20	-4
	Hydrogen	520	968		
	Propylene Oxide	449	840.2	-37	-34.6
	Propyl Nitrate	175	347	20	68
C	Acetaldehyde	175	347	-38	-36.4
	Allyl Alcohol	378	712.4	22	71.6
	n-Butyraldehyde	218	424.4	-12	10.4
	Carbon Monoxide	609	1128.2		
	Crotonaldehyde	232	449.6	13	55.4
	Diethyl Ether	160	320	-45	-49
	Diethylamine	312	593.6	-28	-18.4
	Epicholorohydrin	411	771.8	33	91.4
	Ethylene	450	842		
	Ethylenimine	320	725	-11	12.2
	Ethyl Mercaptan	300	572	-18	-0.4
	Hydrogen Sulfide	260	500	0	32
	Tetrahydrofuran	321	609.8	-14	6.8
D	Acetic Acid	464	867.2	43	109.4
	Acetone	465	869		
	Acrylonitrile	481	897.8	-26	-14.8
	Ammonia	498	928.4		
	Benzene	498	928.4	-11	12.2
	n-Butane	288	550.4		
	n-Butyl Acetate	421	789.8	22	71.6
	Di-Isobutylene	391	735.8	2	35.6
	Ethane	472	881.6	-29	-20.2
	Ethanol	363	685.4	13	55.4
	Ethyl Acetate	427	800.6	-4	24.8
	Ethyl Acrylate	372	701.6	9	48.2
	Ethylenediamine	385	725	33	91.4
	Ethylene Dichloride	413	775.4	13	55.4
	Gasoline	280	536	-46	-50.8
	n-Heptane	204	399.2	-4	24.8
	n-Hexane	225	437	-23	-9.4
	Isoprene	220	428	-54	-65.2
	Isopropyl Ether	443	829.4	-28	-18.4
	Methane	630	1166	-223	-369.4
	Methanol	385	725	12	53.6
	Methyl Ethyl Ketone	404	759.2	-6	21.2
	Methyl Isobutyl Ketone	440	824	31	87.8
	2 Methyl-1-Propanol	223	433.4	-40	-40
	2 Methyl-2-Propanol	478	892.4		
	Pyridine	482	899.6	20	68
	n-Octane	206	402.8	13	55.4
	n-Pentane	243	469.4	-40	-40
	1-Pentanol	300	572	33	91.4
	Propane	450	842	-104	-155.2
	1-Propanol	413	775.4	15	59
	2-Propanol	399	750.2	12	53.6
	Propylene	455	851	-108	-162.4
	Styrene	490	914	31	87.8
	Toluene	480	896	4	39.2

NEMA/IEC Ingress Protection

In the United States the National Electrical Manufacturers Association (NEMA) has developed its own standard for "Enclosure Types" to specify the degree of ingress, corrosion, and environmental protection. The NEMA 250 standard explains Enclosure Type Ratings with levels of protection against access to hazardous parts of the enclosure; protection against ingress of gases, solids, liquids; protection against corrosive agents; and specify indoor, outdoor, and hazardous locations. NEMA standards can be viewed as more stringent and, therefore, can be converted to IEC IP Rating classifications; however, the opposite is not permitted, where IEC IP Ratings cannot be converted to NEMA Enclosure Type ratings.

NEMA ENCLOSURE TYPE	INTENDED USE & DESCRIPTION	IEC CLASSIFICATION: INGRESS PROTECTION RATING
1 [1]	Indoor - Protection against: access to hazardous parts and ingress of falling dirt.	IP10
2 [1]	Indoor - Protection against: access to hazardous parts, ingress of falling dirt; ingress of dripping and light splashing of water.	IP11
3	Outdoor – Protection against: access to hazardous parts; ingress of rain, snow and sleet [2]; ingress of windblown dust, lint, fibers, and flyings.	IP54
3R [1]	Outdoor – Protection against: access to hazardous parts; ingress of rain, snow and sleet [2]	IP14
3S	Outdoor – Protection against: access to hazardous parts; ingress of rain, snow and sleet [3]; ingress of windblown dust, lint, fibers, and flyings.	IP54
4	Indoor or Outdoor – Protection against: access to hazardous parts; ingress of rain, snow and sleet [2]; ingress of windblown, circulating, and settling airborne dust, lint, fibers, and flyings [4]; ingress of falling dirt; and ingress of dripping, splashing and hose directed water.	IP56
4X	Indoor or Outdoor – Protection against: access to hazardous parts; ingress of rain, snow and sleet [2]; ingress of windblown, circulating, and settling airborne dust, lint, fibers, and flyings [4]; ingress of falling dirt; ingress of dripping, splashing and hose directed water; and corrosive agents.	IP56
5	Indoor - Protection against: access to hazardous parts, ingress of falling dirt; ingress of dripping and light splashing of water; ingress of settling airborne dust, lint, fibers, and flyings [4]	IP52
6	Indoor or Outdoor – Protection against: access to hazardous parts; ingress of rain, snow and sleet [2]; ingress of windblown, circulating, and settling airborne dust, lint, fibers, and flyings [4]; ingress of falling dirt; ingress of dripping, splashing, hose directed water and occasional temporary submersion.	IP67
6P	Indoor or Outdoor – Protection against: access to hazardous parts; ingress of rain, snow and sleet [2]; ingress of windblown, circulating, and settling airborne dust, lint, fibers, and flyings [4]; ingress of falling dirt; ingress of dripping, splashing, hose directed water and occasional prolonged submersion.	IP67
12	Indoor – Protection against: access to hazardous parts; ingress of falling dirt; and ingress of dripping and light splashing water; ingress of circulating and settling airborne dust, lint, fibers, and flyings [4]; and oil and coolant seepage. Enclosure constructed without knockouts.	IP52
12K	Indoor – Protection against: access to hazardous parts; ingress of falling dirt; and ingress of dripping and light splashing water; ingress of circulating and settling airborne dust, lint, fibers, and flyings [4]; oil and coolant seepage. Enclosure constructed with knockouts	IP52
13	Indoor – Protection against: access to hazardous parts; ingress of falling dirt; and ingress of dripping and light splashing water; ingress of circulating and settling airborne dust, lint, fibers, and flyings [4]; oil and coolant seepage, spraying and splashing.	IP54

1 These enclosures may be ventilated.
2 External operating mechanisms are not required to be operable when the enclosure is ice covered.
3 External operating mechanisms are operable when the enclosure is ice covered.
4 These fibers and flyings are nonhazardous materials and are not considered Class III type ignitable fibers or combustible flyings.

Corrosion

Certain applications require luminaires to be in harsh environments where they are exposed to corrosive agents. In marine type or coastal area environments, fixtures must be resilient enough to withstand corrosion from salt water. Luminaires listed for "Outside-Type (Salt Water)" are subjected to a Salt Spray (Fog) test for 200 hours, as indicated in ASTM B117. Luminaires with the listing cannot show pitting, cracking, or deterioration more severe than an established material standard at the conclusion of the test.

Holophane luminaires are engineered and tested beyond standard requirements. Our marine listed luminaires are rigorously tested and must exceed the Salt Spray (fog) requirements for a minimum of 1000 hours. Holophane's luminaires are built to deliver maximum performance and durability in hostile, corrosive environments for long-term, maintenance free operation.

NEC/IEC Protection Methods

Both the "Division" and "Zone" classification method have various appropriate types of protection methods with respect to the environment classified.

NEC Protection Techniques

Area	Protection Techniques
Class I	
Div. 1	• Intrinsic safety
	• Explosionproof
	• Purged/pressurized (Type X or Y)
	• Class I, Zone 0 intrinsic safety, "ia"
Div. 2	• Hermetically-sealed
	• Nonincendive
	• Non-sparking
	• Purged/pressurized (Type Z)
	• Any Class I, Division 1 technique
	• Any Class I, Zone 0, 1 or 2 technique
Class II	
Div. 1	• Intrinsic safety
	• Dust-ignitionproof
	• Pressurized
Div. 2	• Dusttight
	• Hermetically-sealed
	• Nonincendive
	• Pressurized
	• Any Class II, Division 1 technique
Class III	
Div. 1	• Intrinsic safety
	• Dusttight
	• Hermetically-sealed
Div. 2	• Nonincendive
	• Any Class III, Division 1 technique

NEC Article 501.5 & 505.9 specifies guidelines under which Zone listed equipment can be used in Division classified locations, and Division identified equipment to be used in a Zone classified location.

- **NEC Article 501.5 Zone Equipment**
  Equipment listed and marked in accordance with Article 505 for use in: (1) Class I, Zone 0, 1, or 2 are permitted in Class I, Division 2 locations for the same gas and with a suitable temperature class; (2) Class I, Zone 0 locations shall be permitted in Class I, Division 1 or Division 2 locations for the same gas and with a suitable temperature class.

- **NEC Article 505.9 Division Equipment**
  Equipment identified for Class I, Division 1 or Class I, Division 2 and is marked in accordance with Article 500 are permitted to be marked with Class I, Zone 1 or Class I Zone 2 for the applicable gas and with a suitable temperature class.

IEC Protection Techniques

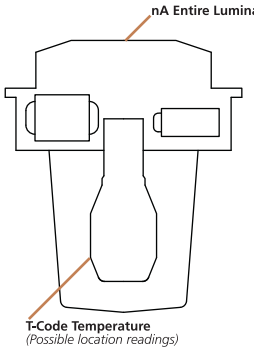
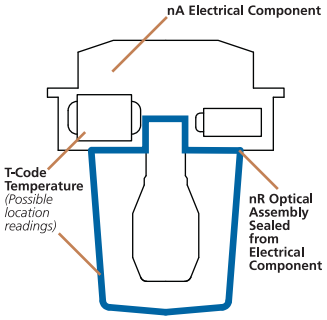
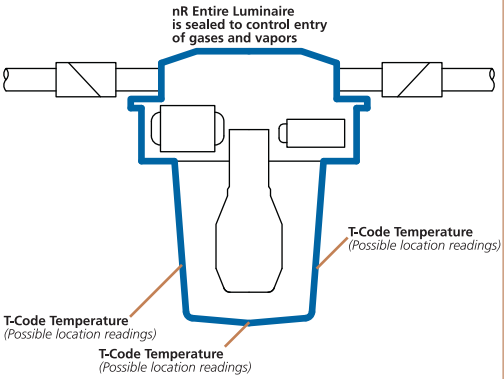
Area	Protection Techniques
Class I	
Zone 0	• Intrinsic safety, "ia"
	• Encapsulation, "ma"
	• Class I, Div 1 intrinsic safety
Zone 1	• Flameproof, "d"
	• Pressurization, "px" or "py"
	• Powder filling, "q"
	• 0il immersion, "o"
	• Increased safety, "e"
	• Intrinsic safety, ''ib''
	• Encapsulation "mb''
	• Any Zone 0 technique
	• Any Class I, Div 1 technique
Zone 2	• Pressurization, "pz"
	• Intrinsic safety, "ic"
	• Encapsulated, "nC"
	• Energy-limited, "nL" ("nC" for USA)
	• Hermetically-sealed, "nC"
	• Nonincendive, "nC"
	• Non-sparking, "nA"
	• Restricted breathing, "nR"
	• Sealed, "nC"
	• Self-protected Energy-limited, "nA nL" ("nL" for Canada)
	• Any Zone 0 or 1 technique
	• Any Class I, Div 1 or 2 technique
Class II	
Zone 20	• Enclosure, "tD"
	• Intrinsic safety, "iaD"
	• Encapsulation "maD"
	• Class II, Div 1 intrinsic safety technique
	• Class II, Div 1 dust-ignitionproof technique
Zone 21	• Enclosure, "tD"
	• Pressurization "pD"
	• Intrinsic safety, "ibD"
	• Encapsulation, "mbD"
	• Any Zone 20 technique
	• Any Class II, Div 1 technique
Zone 22	• Enclosure, "tD''
	• Any Zone 20 or 21 technique
	• Any Class II, Div 1 or 2 technique

Restricted Breathing

The Restricted Breathing,(nR) protection method is a commonly used technique in Class I, Zone 2 atmospheres. nR requires a component (used in conjunction with non-sparking, (nA) or the entire luminaire to be sealed in order to control the entry of gas or vapors to less than the lower flammable limit.

Usually the optical component encasing the lamp will have the highest surface temperature. Consequently nR has been used to seal the optical component (restricting entry of gases and vapors) in conjunction with non-sparking (nA) of the electrical component. Maximum surface temperature normally surveyed at the operating lamp temperature can now be taken at electrical housing, which is lower and can lead to a higher numeric T-Code rating.

Similarly an entire luminaire can be sealed using nR, leading maximum temperature readings to be taken on exterior of the luminaire, resulting in even higher numeric T-code ratings.

Area Classification	Class I, Div 2	Class I, Zone 2	Class I, Zone 2
Protection Method	**nA** non-sparking *(Entire Luminaire)*	**nR** *(Optical Assembly)*	**nR** *(Entire Luminaire)*
		nA *(Electrical Assembly)*	
			
T-code example	**T1 (325°C)**	**T4 (121-135°C)**	**T5 (85-100°C)**
T-code measurement locations	Internal/External temperatures. T-code most likely based on lamp envelope.	nR Optical Assembly excludes lamp temperatures. T-code most likely based on ballast temperature or optic exterior temperature.	nR of entire luminaire excludes all internal temperatures. T-code most likely based on optic exterior temperature.
Rating	Good (lowest) T-code	Better (higher) T-code No additional equipment is necessary to ensure function of restricted breathing protection.	Best (highest) T-code Installation requires Conduit/Cable seal to insure function of restricted breathing protection.

Hazardous Applications

Holophane lighting systems meet the specific needs of many environments, from bulk storage facilities and production process areas to petroleum refining facilities, solvent extraction plants and textile mills. Precise optical control ensures flexible fixture placement, with robust materials allowing fixtures to operate in a wide range of ambient temperatures.

Class I locations:

- Petroleum refining facilities
- Ethanol facilities
- Dip tanks containing flammable or combustible liquids
- Dry cleaning plants
- Petrochemical plants
- Plants manufacturing organic coatings
- Petroleum dispensing areas
- Solvent extraction plants
- Plants manufacturing or using pyroxyle (nitrocellulose) type and other plastics (Class II also)
- Locations where inhalation anesthetics are used
- Utility gas plants, operations involving storage and handling of liquefied petroleum and natural gas
- Aircraft hangers and fuel servicing areas

Class II locations:

- Grain elevators and bulk handling facilities
- Manufacture and storage of magnesium
- Manufacture and storage of starch
- Fireworks manufacture and storage
- Flour and feed mills
- Areas for packaging and handling of pulverized sugar and cocoa
- Facilities for the manufacture of magnesium and aluminum powder
- Some coal preparation plants and coal handling facilities
- Spice grinding plants
- Confectionary manufacturing plants

Class III locations:

- Wood working plants
- Textile mills
- Cotton gins and cotton seed mills
- Flax producing plants

Environmental Considerations

The analysis of environmental factors such as user needs and preferences, electrical code, safety regulations, maintenance requirements and energy consumption are taken into account in the design of a lighting plan.

Light Levels: Best practices indicate when designing to light level requirements, focus should be on mean lumens at a predetermined time in the future. All facilities use lighting technology that depreciates over time; Light Loss Factors such as Thermal Factor, Luminaire Dirt Depreciation, Ballast Factor, and Lamp Lumen Depreciation can all contribute to lower light levels reaching a work plane over time. Holophane's advanced ballast technology, optical control and thermal management delivers more usable light per luminaire, allowing the use of fewer luminaires while maintaining required light levels.

Safety Requirements: Sufficient vertical and horizontal illumination levels promote a safer work environment and minimize on-the-job injuries. Uniform light levels enhance overall visibility throughout the space and help to eliminate dark and hot spots. Unevenly illuminated spaces require eyes to constantly adapt to differing light levels causing fatigue. Excessive glare from luminaires result in discomfort and poor visual contrast that can compromise user functions and well-being. Holophane luminaires deliver exceptionally balanced vertical and horizontal illumination, uniformity, and greater visual comfort to facilitate a safe and productive work place.

Physical Limitations: Functional elements such as ceiling height, room surface finishes, work plane height, windows, skylights or other fenestrations, equipment size and shape, space geometry, flexibility requirements, removal of hazardous wastes, and existing wiring conditions can affect lighting design and light supplied to tasks. Pipes and lines can often block light from reaching critical pieces of equipment. Holophane luminaires are available with a variety of optics including long and narrow, square, or asymmetric photometric distributions - enabling tailored solutions for different applications and lighting requirements. Holophane luminaires also provide an element of uplight that provides more indirect illumination and reduces contrast between ceiling and luminaire.

Maintenance Requirements: In many industrial applications, luminaires are mounted at high elevations, directly over machinery, tall racks or in locations where special equipment is required to access the luminaire. Servicing difficult to reach fixtures can be challenging and labor intensive. Holophane's meticulous attention to detail in optical design, thermal management and manufacturing provide luminaires with durability and dependability - ensuring long term maintenance-free operation. Glass optics resists electrostatic charges that attract dirt and dust - wiping the glass during re-lamping will restore efficiency to 100% of the initial output.

With Holophane's Petrolux III series, maintenance is fast, safe, and easy. A captive optical component with tool-less re-lamping promotes safe and quick lamp maintenance. The available universal mounting bracket allows for ceiling, pendant, wall or stanchion mount, resulting in fewer parts to be stocked and inventoried. Holophane offers an optional External Capacitor Module that extends fixture life while minimizing maintenance backed by an eight year warranty.

c UL US LISTED IEC NSF

Regulatory Compliance: Along with energy requirements, other general regulations necessitate consideration. Regulatory agencies include but are not limited to ADA, NFPA, NEC, UL, OSHA, USDA, NSF, NEMA, ANSI/IESNA, and the IEC. Your local Holophane sales representative can help determine appropriate lighting systems for specific applications.

Illumination Considerations

A successful lighting plan satisfies the requirements of the space and illumination needs of the users. A well illuminated environment also provides both optimized visibility and greater visual comfort that helps maintain a safe and productive work place. Illumination levels, Light Loss Factors, Uniformity, Glare, Color Rendering Index, and Correlated Color Temperature are a few major factors to consider when designing a lighting system.

When choosing a new lighting system for long term success, it is critical to consider the following:

Illuminance levels: Illuminance is the quantity of light reaching a horizontal or vertical surface and is measured in units of "footcandles" (lumens per square foot), or "lux" (lumens per square meter). Relatively high levels of vertical and horizontal illumination are required to model fine detail of parts, take precise instrument readings, inspect proper equipment functionality and perform necessary maintenance.

Uniformity: Uniform lighting enhances visibility and greater visual comfort. Evenly illuminated spaces can enhance modeling of objects while reducing user fatigue from constant visual adaptation. Consistent horizontal and vertical illumination facilitates accurate reading of meter gauges, labels and signs; as well as, quick detection of people and movements. Holophane advanced optics simultaneously provide uniform illumination, reduce dark spots, and allow for wider luminaire spacing.

Glare: Excessive glare can lead to visual discomfort and compromise both general visibility, and visual contrast. Holophane's precisely controlled optics distributes light evenly and effectively without the negative effects of glare; allowing easy and comfortable rendering of objects and the surrounding environment.

Color Rendering: Color rendering is the ability of the light source (the lamp) to represent the true colors of an object. The closer the color rendering index (CRI) is to 100, the more natural the colors will appear. Metal halide HID and fluorescent lamp sources have higher CRI, and will be more appropriate for color sensitive areas as compared to high pressure sodium sources.

Correlated Color Temperature (CCT): The CCT of a lamp is measured in units of Kelvin. Lamps with higher Kelvin (5000K – 6000K) will have a cooler color appearance with more white light. Conversely a lower Kelvin lamp (2000K – 3000K) will have a warmer color appearance with more yellowish light. CCT can often be used as a reference to standardize the lamps used in an application to create consistency throughout the space.

Light Loss Factors (LLF): All aspects of environmental conditions, luminaire construction, and performance are taken into account in determining LLF. LLF are used to adjust lighting calculations from a controlled laboratory environment to actual field conditions and from an initial installation condition to a maintained predetermined time frame condition.

- **Luminaire Dirt Depreciation (LDD):** LDD is the accumulation of dirt on a luminaire resulting in a loss of light. Holophane's borosilicate glass optics resist electrostatic charges that attract dirt and dust. Wiping the glass during re-lamping will restore efficiency to 100%.

- **Lamp Lumen Depreciation (LLD):** Lumen output will gradually decrease over the life of a lamp. Mean lumens are determined at 40% of the rated lamp life. Different lamp sources will have varying LLD values, which will also fluctuate depending on the frequency and duration between each start. LLD can be calculated by dividing mean lumens by initial lumens (values are readily available from lamp manufacturers).

- **Thermal Factor:** Higher luminaire mounting heights generally results in hotter ambient operating temperatures; this is especially true in unconditioned spaces. Lamp technologies such as fluorescents and LEDs are much more temperature sensitive, having distinct optimal operating temperatures with maximum light output. HID lamps are more versatile and allow full lamp lumen output over a broader range of cold and hot ambient temperatures. Holophane luminaires incorporate thermal management of the lamp and ballast to ensure 100% lumen output and long term reliable operation.

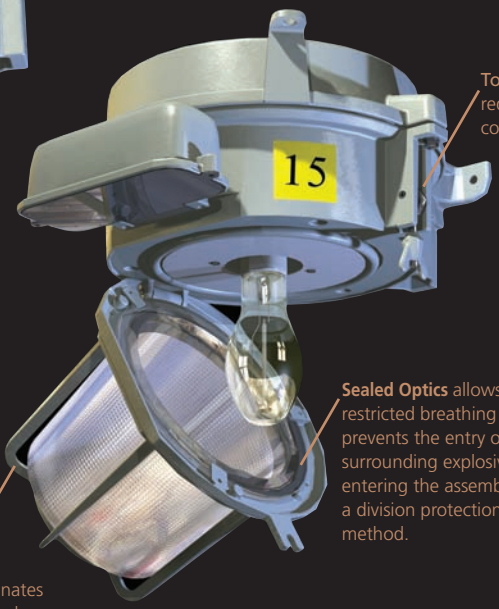
- **Ballast Factor (BF):** A ballast factor of 1.0 represents a lamp that is operating at full wattage. BF less than 1.0 indicates a lamp will not receive the intended wattage, which results in lower light output. All Holophane manufactured ballasts have a BF of 1.0.

Robust Housing with a hinged integral ballast is made of heavy duty low-copper aluminum to protect against corrosive environments.

Universal Mount is designed to offer flexibility and meet mechanical requirements of today's lighting system. One configuration does it all, eliminating the need to have a complex fixture schedule or carry multiple models in your maintenance storeroom.

External Capacitor Module reduces operating costs by extending the capacitor life up to 5 times vs. being mounted inside the electrical housing.

Optically Engineered Refractors are designed to provide precise light control, incorporates an internal reflector, reduces cost of ownership, and reduces maintenance costs.



Tool-less Relamping reduces maintenance costs

Sealed Optics allows for restricted breathing which prevents the entry of a surrounding explosive gas entering the assembly and a division protection method.

Captive Optic and Wire Guard reduces maintenance and eliminates the loss of the wireguard components.

P3S Low Profile

Classified Location Products

Vantage® VH

Vantage® VZ

Petrolux® III Series
(P3S - Low Profile)

Petrolux® III Series
(P3M - Medium)

Petrolux® III Series
(P3L - Large)

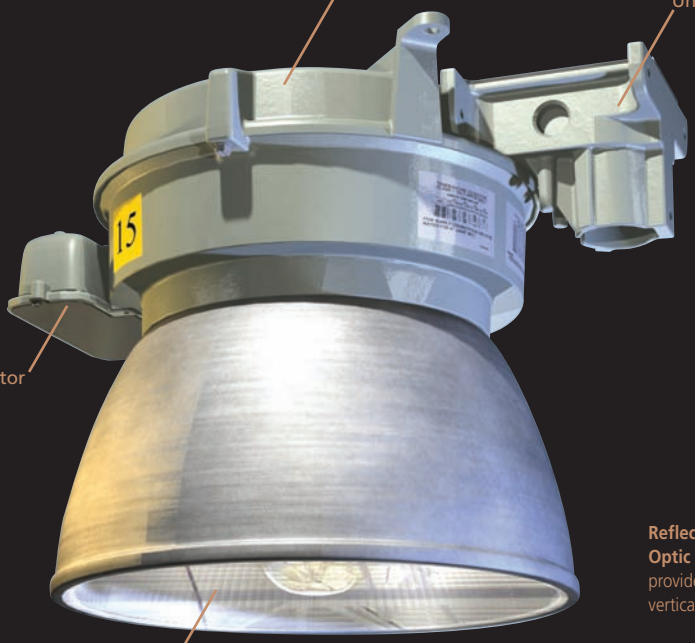
Petrolume®

Predator®

DeLeon® HD

DeSoto® HR

DeSoto® M70



P3M Medium

Vantage VZ

Unclassified Location Products

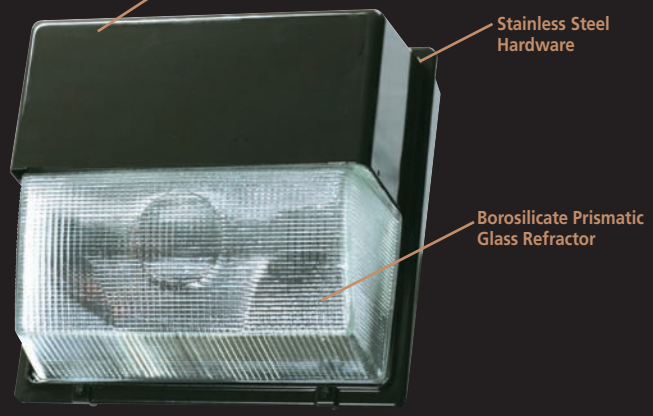
Petrolux® III Series

Prismalume® Series | Prismpack® Series | Enduralume®

Indoor Refractopack®

IntelliBay® | IntelliVue®

Controlume® | HES | HBW/HCW | 7200 Prismatite®



Wallpack WH

Predator

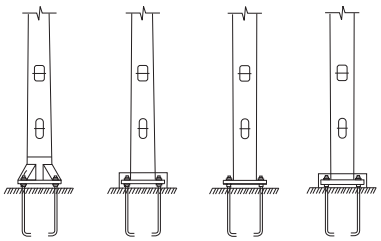
Outdoor Products

Wallpack® WH
(Classified Location)

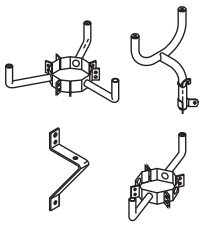
Predator®
(Classified Location)

Prismbeam® II

Outdoor Substation



Aluminum and Steel Poles



Brackets and Mounting Hardware

HMAO™ Series

HMSC

Lowering Devices

Surveillance Camera

Mongoose®

Economics of Lighting

A lighting system can be divided into three components: initial, operating and maintenance cost. "Total cost of ownership" can be calculated by adding all three of these elements.

It is important to note that initial or unit costs are only part of an overall equation; instead, a careful analysis of lighting requirements and total cost of ownership should be considered. When using an energy efficient and optically superior luminaire, higher unit costs are quickly offset by using fewer luminaires. Fewer luminaires translates to savings in installation, energy consumption, and maintenance over the life of the product.

Holophane's pioneering research and engineering deliver products with lowest total cost of ownership. Superior optical designs provide products with more usable light using fewer luminaires. Exceptional thermal control enables long term maintenance-free operation with consistent high light output. Holophane's precision optics allow for wider spacing between luminaires, reducing the total number of fixtures required to be installed, operated, and maintained.

Summary

Reliable lighting in a hazardous environment requires rugged materials and precise engineering to maximize safety and assure long-term performance. Holophane luminaires are designed for the harshest applications, supplying high levels of visibility combined with operating efficiency and maintenance ease.

Contact your local Holophane sales representative for lighting insight and expertise. Your trained sales professional will help you find the best solution for your next hazardous location project.

HOLOPHANE®
LEADER IN LIGHTING SOLUTIONS

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Holophane Canada, Inc. 9040 Leslie Street, Suite 208, Richmond Hill, ON L4B 3M4

Holophane Europe Limited, Bond Ave., Milton Keynes MK1 1JG, England

Holophane, S.A. de C.V., Apartado Postal No. 986, Naucalpan de Juarez, 53000 Edo. de Mexico

Contact your local Holophane factory sales representative for application assistance, and computer-aided design and cost studies. For information on other Holophane products and systems, call the Inside Sales Service Department at 866-759-1577. In Canada call 905-707-5830 or fax 905-707-5695.

Limited Warranty and Limitation of Liability Refer to the Holophane limited material warranty and limitation of liability on this product, which are published in the "Terms and Conditions" section of the current Buyers Guide, and is available from your local Holophane sales representative.

Visit our web site at ww.holophane.com

Certain airborne contaminants can diminish the integrity of acrylic. Please refer to the Acrylic Environmental Compatibility Chart (HL-2445) for suitable uses.

Luminaires may utilize fluorescent or high intensity discharge sources that contain small amounts of mercury. New disposal labeling for these lamps includes the mercury identifier shown on the left to indicate that the lamp contains mercury and should be disposed of in accordance with local requirements.

Hg

Information sources regarding lamp recycling and disposal are included on the packaging of most mercury-containing lamps and also can be located at www.lamprecycle.org.

Product specifications may change without notice. Please contact your local Holophane factory sales representative for the latest product information.

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