

SAFETY APPROVED FLASHLIGHTS: UNDERSTANDING THE REQUIREMENTS

INTRODUCTION & OVERVIEW

Any flashlight that is intended to be used in a hazardous location must be tested and approved for that use because it is considered a source of ignition. Flashlights create heat using electrical energy, have a filament that can burn at extremely high temperatures, and produce a small spark when they are switched on. Add air and a hazardous atmosphere, and a fire or explosion could result.

Article 500 of the USA's National Electric Code (NEC), published by the National Fire Protection Association (NFPA), describes flashlights as portable or transportable equipment having self-contained power supplies, which could potentially become an ignition source in hazardous locations.

Manufacturers of flashlights intended for use in hazardous environments must take special precautions in the design of their products to reduce the likelihood of a hazardous substance ignition taking place. Their flashlights must also pass a series of rigorous tests, conducted by recognized safety approval organizations, before being approved for use in potentially hazardous environments.

This report explains the systems for classifying hazardous locations and substances in the USA and overseas, along with what it means to have safety approvals.

CLASSIFICATION OF HAZARDOUS LOCATIONS

Flashlights and other equipment intended for use in hazardous locations must be tested for safe operation. The hazardous location where a flashlight will be used dictates the safety requirements it must meet.

Hazardous locations are areas where fire or explosion threats may exist due to the presence of flammable gases, vapors or liquids, combustible dusts or ignitable fibers or flyings. These locations are classified according to the properties of the hazardous materials and the likelihood of flammable concentrations of them being present.

The objective of classifying hazardous locations is to identify areas where sources of ignition on flashlights or other equipment need to be eliminated or rendered ineffective.

In North America, hazardous locations are categorized, following guidelines set down in the NEC, by four criteria:

- **Class:** Defines the nature of the potentially hazardous materials that are present.
- **Division:** Classifies the likelihood of sufficient concentrations of the hazardous materials being present to pose a risk of fire or explosion.
- **Group:** Categorizes specific hazardous materials within each class by similarity of their properties or characteristics.
- **Ignition Temperature:** Groups hazardous materials according to the temperature at which they will ignite.

An examination of each of these categories follows, starting with Class, which defines the nature of the hazard.

Classes

There are three classes of hazardous materials that could be present in potentially explosive mixtures:

- **Class I: Flammable Gases, Vapors, or Liquids**

This is considered the most hazardous class. Typical locations where these materials are found include:

- Oil refineries
- Paint warehouses
- Spray booths
- Offshore oil rigs

An example of a Class I hazardous material is gasoline. As a vapor or liquid, it is ignitable and explosive.

- **Class II: Combustible Dusts.**

Typical locations where these materials are found include:

- Coal mines
- Munitions factories
- Grain silos
- Hay storage facilities

Flour and cornstarch are examples of Class II materials. As a compact mass, they may only burn or smolder, but when finely distributed in air, they can become explosive. Another example is metallic dusts, such as aluminum or magnesium. They can burn very violently, and can become explosive when finely distributed in

air.

- Class III: Ignitable fibers and flyings.

Typical locations for these hazardous materials include:

- Paper mills
- Woodworking facilities
- Textile mills
- Cotton gins

Examples of Class III materials are ignitable fibers, such as rayon, nylon and cotton; and flyings such as sawdust or wood chips.

Once an area's hazardous Class has been determined, the next step is to determine its Division, which measures the degree of the hazard, in other words, the probability that it will be present at a particular location.

Divisions

Each class is divided into two divisions, as defined in NEC Article 500:

- Division 1: This is a location where an ignitable concentration of a hazardous material is present under normal operating conditions. The hazard may exist some or all of the time under normal operating conditions. The shorthand description for Division 1 is "Hazard likely".

An example of a Division 1 location is the inside of an oil or gas tank.

- Division 2: This is a location where an ignitable concentration of a hazardous material is present only under abnormal operating conditions, not under normal ones, but where a fire or explosion could still occur. "Hazard not likely" is the shorthand description for Division 2.

An example of a Division 2 location is the area around a fuel tank. Another example is a manufacturing facility where a flammable substance such as gasoline flows through pipes. In this case, the explosive material would only be present if something goes wrong, such as a pipeline leak, not under normal operating conditions.

Within each Class, a flashlight that is approved and certified for use in a Division 1 location can also be used in a Division 2 location.

Conditions for classification into the three Classes and two Divisions are defined in

the following NEC articles:

- Article 501: Class I, Division 1 and 2 locations, for hazards due to flammable gases, vapors or liquids.
- Article 502: Class II, Division 1 and 2 locations, for hazards may due to combustible dusts.
- Article 503: Class III, Division 1 and 2 locations, for hazards due to ignitable fibers and flyings.

According to NEC Article 504, flashlights and other equipment used in hazardous locations must meet specific requirements or "protection methods" as the NEC calls it. Equipment used in a Division 1 area must be explosion-proof, intrinsically safe, or purged and pressurized.

NEC Article 504 defines intrinsically safe as an apparatus in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions. Intrinsic safety protection is unique explosion protection compared to other explosion protections. In other types of explosion protection, care is taken to confine the ignition source (spark or excess heat) within the device to prevent it from contacting the hazardous material. Intrinsically safe protection requires the device to be incapable of creating a spark or heat sufficient to cause ignition of the hazardous material.

Division 2 area equipment must be nonincendiary, nonsparking, purged and pressurized, hermetically sealed, or sealed, according to NEC Article 504.

Nonincendiary equipment, required in a Division 2 situation, is equipment in which, according to NEC Article 504, "any arc or thermal effect produced under intended operation conditions of the equipment is not capable, under the test conditions specified, of igniting the specified gas or vapor air mixture."

National Fire Protection Association (NFPA) document 497 specifies the procedures for classification of Class I materials into Division 1 and Division 2 locations for chemical process areas.

NFPA document 499 specifies the procedures for classification of Class II materials into Division 1 and Division 2 locations for chemical process areas.

NFPA 497 and 499 also contain diagrams of typical Division 1 and Division 2 locations in chemical process areas.

Once the Class and Division of a hazardous location where a flashlight will be used have been determined, the next step is to decide which Group the location belongs in.

Groups

Group designations are used to classify hazardous materials that have similar characteristics, especially their ignition-related properties. Groups further define and specify the extent of the hazard.

Groups for Class I and Class II are designed by the letters A through G. Groups A through D are for Class I materials. Groups E through G are Groups for Class II materials. Class III materials have no separate groups.

Examples of materials in Groups A through D, for Class I materials, include:

- Group A: Acetylene
- Group B: Acrolein, arsine, butadiene, ethylene oxide, propylene oxide, propyl nitrate, hydrogen, and fuel and combustible process gases containing more than 30% hydrogen by volume.
- Group C: Acetaldehyde, allyl alcohol, n-butyraldehyde, carbon monoxide, crotonaldehyde, cyclopropane, diethyl ether, diethylamine, epichlorohydrin, ethylene, ethyl ether, ethylenimine, ethyl mercaptan, ethyl sulfide, hydrogen cyanide, hydrogen sulfide, morpholine, 2-nitropropane, tetrahydrofuran, and unsymmetrical dimethyl hydrazine.
- Group D: Acetic acid (glacial), acetone, acrylonitrile, ammonia, benzene, butane, 1-butanol (butyl alcohol), 2-butanol (secondary butyl alcohol), n-butyl acetate, isobutyl acetate, di-isobutylene, ethane, ethanol (ethyl alcohol), ethyl acetate, ethyl acrylate (inhibited), ethylene diamine (anhydrous), ethylene dichloride, ethylene glycol monomethyl ether, gasoline, heptanes, hexanes, isoprene, isopropyl ether, mesityl oxide, methane (natural gas), methanol (methyl alcohol), 3-methyl-1 butanol (isoamyl alcohol), methyl ethyl ketone, 2-methyl-1-propanol (isobutyl alcohol), 2-methyl-2-propanol (tertiary butyl alcohol), petroleum naphtha, pyridine, octanes, pentanes, 1-pentanol (amyl alcohol), propane, 1-propanol (propyl alcohol), 2-propanol (isopropyl alcohol), propylene, styrene, toluene, vinyl acetate, vinyl chloride, xylenes

Examples of materials in Groups E through G, for Class II materials, include:

- Group E: Combustible metal dusts, including aluminum, magnesium and their commercial alloys
- Group F: Carbonaceous dusts, including coal, carbon black, charcoal and coke
- Group G: Dusts not included in Groups E and F, including wood, plastics, flour, starch, grain or chemical dusts

The following table summarizes the NEC classification guidelines for Class, Group and Division designations.

Hazardous Area Classification Guidelines

Substance	Class	Typical Environments	Group	Division
Flammable Gases, Vapors or Liquids (e.g. Acetylene, Hydrogen, Ethylene, Propane)	Class I	<ul style="list-style-type: none"> • Oil Refinery • Paint Warehouse • Spray Booth • Offshore Oil Rig 	A (Acetylene) B (Hydrogen) C (Ethylene) D (Propane)	Division 1 (hazard can exist under normal operating conditions) Division 2 (hazard not likely under normal operating conditions)
Combustible Dusts (e.g. Metals [Division 1 only], Coal, Grain)	Class II	<ul style="list-style-type: none"> • Coal Mine • Munitions Factory • Grain Silo • Hay Storage Facility 	E (Metals, Division 1 only) F (Coal) G (Grain)	Division 1 (hazard can exist under normal operating conditions) Division 2 (hazard not likely under normal)

				operating conditions
Ignitable Fibers & Flyings (e.g. Machined Magnesium)	Class III	<ul style="list-style-type: none"> • Paper Mill • Woodworking Facility • Textile Mill • Cotton Gin 	N/A	Division 1 (hazard can exist under normal operating conditions) Division 2 (hazard not likely under normal operating conditions)

Ignition Temperature

In addition to hazardous substances having physical properties that make them different from each other (Class designation), and different flammable or explosive characteristics once they are ignited (Group designation), along with different Divisions (defining whether ignitable concentrations are present at a location under normal operating conditions), these substances also have an ignition temperature. This is the minimum temperature at which a substance will start to burn or explode.

Materials can have the same physical properties (their Class) and similar explosive properties (their Group), but substantially different ignition temperatures. There is no consistent relationship between Class/Group and ignition temperature.

According to NEC Article 500.8, the maximum surface temperature of the exposed surface of a flashlight or other electrical apparatus must always be lower than the ignition temperature of the gas or vapor mixture where it's being used.

For example, a common Class I, Group D material, acetone, has an ignition temperature of 465°C. Gasoline, also in Class I, Group D, has an ignition temperature of 280°C. This means that a flashlight that is safety-approved for use with Class I, Group D materials but has a maximum surface temperature of 300°C could safely be used in an acetone environment, but not in one with gasoline present.

The Temperature Class (T1 to T6) indicates the ignition temperature of a specific

flammable material. The flashlight user must make sure that the temperature marking on approved equipment does not designate a temperature greater than the ignition temperature of any hazardous material that is present, even if the flashlight meets the requirements for Class, Division and Group at the location.

NEC Article 500.8 specifies that a Temperature Class marking must appear on all flashlights or other equipment that is approved for Class I, Division 1 hazardous locations. All approved equipment is temperature-rated from T1 (surface temperature less than or equal to 450°C) to T6 (surface temperature less than or equal to 85°C), as summarized in the following tables.

.Summary of Temperature Classes

Temperature Class	Maximum Surface Temperature (°C) of Flashlight	Ignition Temperature of Combustible Material (°C)
T1	450	>450
T2	300	>300
T3	200	>200
T4	135	>135
T5	100	>100
T6	85	>85

Ignition Temperatures & Temperature Classes of Typical Flammable Gases and Vapors (Class I, Division 1)

Gas/Vapor	Ignition Temperature (°C)	Temperature Class
Acetaldehyde	140	T4
Acetic acid	485	T1
Acetic anhydride	330	T2
Acetone	540	T1

Acetylene	305	T2
Ammonia	630	T1
Amylacetate	380	T2
Benzene	220	T3
Benzol	555	T1
Carbon disulfide	95	T6
Carbon monoxide	605	T1
Cyclohexene	430	T2
1,2-Dichlorethane	440	T2
Diesel fuel	220 up to 300	T3
Ethane	515	T1
Ethylacetate	460	T1
Ethylalcohol	425	T2
Ethylchloride	510	T1
Ethylene	425	T2
Ethylenoxide	440	T2
Ethylether	180	T4
Ethyl glycol	235	T3
Fuel oil	220 up to 300	T3
Hydrogen	560	T1
Hydrogen disulfide	270	T3
Methane	595 (650)	T1
Methanol	455	T1
Methyl chloride	625	T1
n-Butane	365	T2

n-Butylalcohol	340	T2
n-Hexane	240	T3
n-Propylalcohol	405	T2
Naphthaline	520	T1
Oleic acid	360	T2
Phenol	595	T1
Propane	470	T1
Tetraline	425	T2
Toluole	535	T1

INTERNATIONAL SAFETY STANDARDS

Just as the NEC defines and classifies hazardous locations and substances in the USA, other organizations do so in other parts of the world:

- The Canadian Electrical Code (CEC) sets safety standards for Canada. The Canadian Standards Association (CSA) mark means that all applicable safety standards for Canada have been met. *(Writer's note: Insert CSA graphic)*
- ATEX (abbreviated from the French, ATmospheres Explosibles) sets safety standards for Europe. *(Writer's note: Insert ATEX graphic)*
- The International Electrotechnical Commission (IEC) sets international standards. *(Writer's note: Insert IEC graphic)*

Countries outside of Europe and North America can specify safety compliance with ATEX, NEC or IEC standards for flashlights and other equipment.

The Zone System

Most countries outside of North America deal with hazardous gases and vapors in a system that separates the areas into Zones rather than Divisions. Like Divisions, Zones are based on the probability of hazardous substances being present in the atmosphere in sufficient quantities for a fire or explosion to occur.

There are four main differences between the Division and Zone systems:

- Zones are based on how often (frequency and duration) the hazard is present. Divisions, on the other hand, are based on whether the hazard is present under normal or abnormal conditions.
- The zone system uses three Zones instead of two Divisions.
- For gases, vapors and liquids (Class I), the NEC's Division 1 is divided into two distinct zones, Zone 0 and Zone 1. Zone 1 is roughly equivalent to Division 1 for Class I.
- For combustible dusts (Class II), the NEC's Division 1 is divided into Zones 20 and 21. Zone 21 is roughly equivalent to Division 1 for Class II.

The following table compares the Division and Zone systems

Comparison of Division & Zone System

Divisions	Zones
Division 1 (Class I): Where ignitable concentrations of the hazardous gas, vapor or liquid can exist all the time or some of the time under normal operating conditions	Zone 0 (Class I): Where ignitable concentrations of the hazardous gas, vapor or liquid are present continuously or for long periods of time under normal operating conditions Zone 1 (Class I): Where ignitable concentrations of the hazardous gas, vapor or liquid are likely to exist under normal operating conditions
Division 2 (Class I): Where ignitable concentrations of the hazardous gas, vapor or liquid are not likely to exist under normal operating conditions	Zone 2 (Class I): Where ignitable concentrations of the hazardous gas, vapor or liquid are not likely to exist under normal operating conditions.
Division 1 (Class II): Where ignitable concentrations of the hazardous combustible dust can exist all the time or some of the time under normal operating conditions	Zone 20 (Class II): Where ignitable concentrations of the hazardous combustible dust are present continuously or for long periods of time under normal operating conditions Zone 21 (Class II): Where ignitable concentrations of the hazardous

	combustible dust are likely to exist under normal operating conditions
Division 2 (Class II): Where ignitable concentrations of the hazardous combustible dust are not likely to exist under normal operating conditions	Zone 22 (Class II): Where ignitable concentrations of the hazardous combustible dust are not likely to exist under normal operating conditions.

Like the Division system, the Zone system divides hazardous materials into groups. But there are two main differences between the systems:

- The Division system's groups are in order of decreasing hazard, from most to least ignitable, starting with Group A. The Zone system's groups are in the opposite order, of increasing hazards, from least (Group A) to most ignitable.
- The Zone system specifies three sub-groups (A, B, C) for hazardous gases, vapors and liquids. The Division system uses four (A, B, C, D).

Under Articles 505 and 506, the NEC recognizes the Zone system and allows, on a limited basis, the use of Zone-certified equipment to be installed in Division-classified areas. But most existing area locations in North America are still classified under the Division system.

NEC Article 505 covers the requirements for Zones 0, 1 and 2 of the Zone classification system as an alternative to the Division classification system covered in NEC Article 500.

NEC Article 506 provides similar information for Zones 20, 21 and 22.

Today, most flashlights and other equipment are manufactured in either an NEC (Divisional) or an ATEX/IEC (Zone) safety compliance version. With increasing globalization, a standard global safety standard could eventually be developed.

SAFETY APPROVAL ORGANIZATIONS

Any flashlight that is intended for use in a hazardous location must be certified and approved by a recognized and accredited organization.

There are many organizations that test and certify flashlights and other equipment, both in the USA and around the world. Their marks on a product mean that it has been tested and checked for compliance with applicable safety standards.

Some Major Safety Approval Organizations

Organization	Mark	Jurisdiction
Underwriters Laboratory	<i>(Insert graphic for each organization in this column)</i>	USA
Canadian Underwriters Laboratory		Canada
Intertek		North America
SGS US Testing Company		USA
Factory Mutual Research Corporation		Worldwide

Pelican Flashlights: Your Passport Through Hazardous Locations

Whether you're working in a Class I oil refinery or in the silo of a Class III textile mill, safety is always a concern. Your flashlight shouldn't add to your worries. Pelican builds lighting tools that are approved to specific hazardous environments. The user should confirm that the light they intend to use has the correct approval for the area it will be used in. In fact, we make more safety-approved lights than anyone else.

Pelican safety approved flashlights have been tested and approved by the world's leading independent laboratories. It's your assurance that the flashlight you choose will be safe and reliable for the job.

Although safety features of Pelican flashlights vary with each model, following are a few innovations we have adopted over our 30 year history:

- O-Ring Seal: Prevents vapors and gases from entering the body of the flashlight and being ignited by a switch spark.
- One-Way Purge Valve: Allows hydrogen to escape from the flashlight's body.
- Hydrogen-Absorbing Pellets in Lamp Modules: A back-up system that absorbs any residual hydrogen retained inside the flashlight. No gas means no spark.
- Battery Polarity Tray: Makes operating a flashlight impossible if one or more batteries are inverted. This safeguards against dangerous outgassing of explosive

hydrogen from an accidentally reversed battery.

Pelican offers safety flashlights for any work situation. To find the right light for your job, visit us at www.Pelican.com/safety.

The information provided herein is being provided for informational purposes only. Pelican Products, Inc. makes no representations as to the accuracy, quality, timeliness, or completeness of the information and you should not rely upon the information contained herein. You use this information at your own risk. Pelican Products, Inc., its parent, subsidiaries, affiliates, employees, distributors, directors, and agents are not liable for any errors or omissions in its content or delivery, or for any form of loss or damage (including any consequential, indirect, incidental, special, or exemplary damages, even if known to us) that may result from its use.