Dodge Digital Products: hazardous location guidance, divisions

Industrial environments may include areas in which a combustible material is used or generated as part of a process. These areas are called “Hazardous (Classified) Locations” (HazLoc) in the Americas and “Potentially Explosive Areas” in other parts of the world. For the purposes of this paper, the term “Ex Area” will be used when referring to locations in which a combustible material is identified. Where an Ex Area is identified, there are restrictions on the types of equipment that can be used.

The process owner or facility owner is wholly responsible for determining the area classification.

When a combustible material is identified, the process or facility owner is required by law to classify those areas in which the combustible material may be present under certain conditions. The result is an “Area Classification Map” which summarizes the material properties and the extent of the Ex Area to be used for equipment planning and selection purposes.

Documentation of the Hazardous Area

An area classification starts with understanding the processes and the materials used in each step of the process. Combustible materials may be added to a process or be a by-product of the process. In addition, the process may change the properties of a material or generate a potential source of ignition. Therefore, the process owner is responsible for determining whether or not an area should be designated as an Ex Area and documenting the pertinent information on the Area Classification Drawing and associated documentation (see *NFPA 70, para 500.4*).

This documentation shall be available to the authority having jurisdiction (AHJ) and those authorized to design, install, inspect, maintain, or operate electrical equipment at the location.

OSHA requires that employees are warned of potentially dangerous situations and that they are protected as much as possible from harm during work. The area classification is an essential document to help convey potential hazards to those who are or may be in the area. The area classification document also helps maintenance and facility personnel select, install, commission, and maintain the equipment in an appropriate manner. The strict requirements for equipment operating in Ex Areas is described in NFPA 70, para 500 thru 516.

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This document is intended only to summarize the main definitions of Ex Areas so the reader may understand where the Dodge products may be installed and used.

Combustible materials and designation of risk

At a high level, the area classification provides an indication of the potential hazard (material(s) used or generated) along with the probability of a combustible mixture being present. In the US, there are 3 general material designations – noted as "CLASS I, II or III" – and 2 general probability designations – noted as "DIVISION 1 or 2".

A summary of the various general area classifications is summarized below. The contents may be found in *NFPA 70, para 500.5*.

TABLE 1 SUMMARY OF GENERAL AREA CLASSIFICATION MEANING

	MATERIAL	DIVISION 1	DIVISION 2
CLASS I	Flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors	Where ignitable concentrations can exist under: 1) normal operating conditions, or 2) liquids stored above flashpoints might exist frequently due to repair or maintenance or leakage, or 3) breakdown or faulty operation may result in the release of ignitable concentrations at the same time as equipment may become an ignition source	Where: 1) gases and vapors are confined within a closed system, or 2) positive mechanical ventilation is present, or 3) adjacent to a Class I Division 1 location where combustible concentrations may occasionally exist
CLASS II	Combustible dusts	Where dust is in the air under: 1) normal operating conditions, or 2) release due to mechanical failure or abnormal operation at the same time a potential ignition source is present, or 3) the material is a conductive material (metals are classified as Group E)	Where dust is in the air under: 1) abnormal operating conditions but not at combustible concentrations, or 2) accumulations are present but insufficient to interfere with normal operation, but may become airborne under fault conditions, or 3) accumulations could be sufficient to interfere with the safe dissipation of heat or could be ignitable by abnormal operation or failure of the equipment

TABLE 1 SUMMARY OF GENERAL AREA CLASSIFICATION MEANING			
	MATERIAL	DIVISION 1	DIVISION 2
CLASS III	Non-metallic combustible or ignitable fibers / flyings *metallic fibers and flyings are always CLASS II*	Where fibers and flyings are in the air under: 1) normal operating conditions, or 2) release due to mechanical failure or abnormal operation at the same time a potential ignition source is present, or 3) ignitable fibers and flyings are handled, manufactured, or used	Where fibers and flyings are in the air under: 1) abnormal operating conditions, or 2) accumulations are present but insufficient to interfere with normal operation, but may become airborne under fault conditions, or 3) ignitable fibers and flyings are stored or handled

Material Groups

Each material is further divided into a Group which is intended to provide an indication as to the ease of igniting the material. The summary of the material Group designation is summarized below:

TABLE 2 SUMMARY OF MATERIAL GROUPS			
CLASS	GROUP	GENERAL DEFINITION	EXAMPLE(S)
I	A	Acetylene	Acetylene
	B	Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having either: 1) Maximum experimental safe gap > 0.45 mm and less than or equal to 0.75 mm, or 2) minimum igniting current ratio less than or equal to 0.40	Hydrogen, Butadiene, Ethylene oxide, Propylene oxide, Acrolein
	C	Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having either: 1) Maximum experimental safe gap greater than 0.45 mm and less than or equal to 0.75 mm, or	Ethylene, Carbon monoxide, Ether, Hydrogen sulfide, Mophline, Cyclopropane, Ethyl, Isoprene, Acetaldhyde

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TABLE 2 SUMMARY OF MATERIAL GROUPS			
CLASS	GROUP	GENERAL DEFINITION	EXAMPLE(S)
		2) minimum igniting current ratio greater than to 0.40 and less than or equal to 0.80	
	D	Flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor mixed with air that may burn or explode, having either: 1) Maximum experimental safe gap greater than 0.75 mm, or 2) minimum igniting current ratio greater than 0.80	Propane, Methane (natural gas), Acetone, Ammonia, Benzene, Butane, Ethanol, Hexane, Methanol, Vinyl chloride, Naphtha
II	E	Metal dusts and other dusts with conductive properties	Aluminum, magnesium, Bronze, Chromium, Titanium, Zinc, commercial alloys
	F	Carbonaceous dusts that have more than 8% total entrapped volatiles	Coal, carbon black, charcoal, coke dusts
	G	Combustible dusts not included in Group E or F	Flour, Grain, Wood, Sugar, Starch, Organic dusts, Plastics, Chemicals
III	FIBERS / FLYINGS	Materials too large to be classified as dusts Not further sub-divided	Wood Shavings, Yarn Fibers, Fabric fibers

In summary, a Group A gas (Acetylene) is much easier to ignite than a Group D gas (Propane). Similarly, a metal dust poses more of a risk than a non-metallic dust or a fiber / flying. It should also be noted that where the combustible media is a solid particulate (dust or fiber / flying), the particle size and humidity pay a tremendous role in the explosion properties and as such, each stage in a process may require property verification and testing periodically to ensure the area classification remains applicable.

Protecting against explosions

Where the process cannot be changed to remove the Ex Area, strict requirements regarding the types of equipment to be used in the location are implemented. Such equipment must be “protected” by one or more of the protection techniques as described in NFPA 70, para 500.7.

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The OPTIFY™ Performance Sensor has been assessed, certified, identified and labeled as intrinsically safe (Ex ia) which allows it to be used in nearly any Ex Area. Furthermore, NFPA 70, para 500.8(B)(2) specifically states the following:

> *Equipment identified for a Division 1 location shall be permitted in a Division 2 location of the same class, group, and temperature class…*

The remainder of 500.8(B)(2) states that intrinsically safe equipment shall be installed per the applicable Control Drawing, if there is one. The Performance Sensor does not require physical connections to other equipment and, as such, does not require a Control Drawing. Thus, the Performance Sensor may be installed in a Division 2 location with the same class, group and temperature code as the markings.

Equipment Markings

All equipment which has been assessed, identified, and listed for use in Ex Areas must also be marked (see NFPA 500.8(C)). The markings shall include the following:

Table 3 – product marking requirements for USA

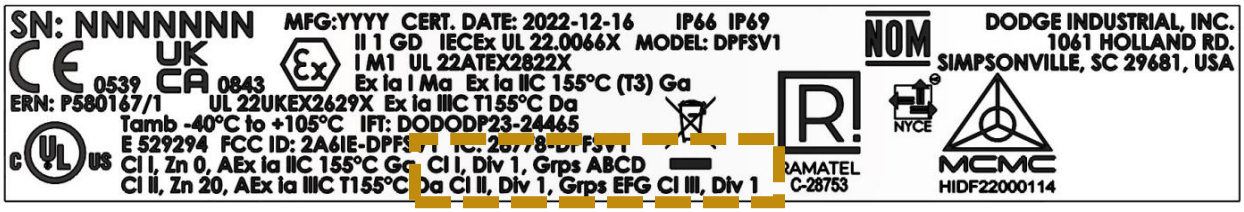
Marking	Explanation	Paragraph in NFPA 70
Class (Cl)	Each material class must be identified	500.8(C)(1)
Division (Div)	Div 2 = restriction to division 2 only Div 1 = both division 1 and division 2 Omitted = assumed Div1	500.8(C)(2)
Group(s) (Grps)	Material subgroups necessary for Class I and Class II No subgroup for Class III	500.6(A) and 500.6(B) 500.6(C) and 500.6(D)
Temperature (T-code) or Max surface temperature	Class I uses T-codes Classes II and III use maximum surface temperature	500.8(C)(4)
Ambient temperature range	-25˚C to +40˚C assumed if not marked	500.8(C)(5)

Explanation of Intrinsic Safety

An intrinsically-safe device is one in which the electrical energy is guaranteed to be insufficient to generate an explosion under various fault conditions. In the case of the Performance Sensor, this evaluation has considered two, internal, simultaneous, independent faults, also known as dual-fault tolerance, and the markings include "ia" to indicate that even under two faults, the sensor is incapable of igniting atmospheres which contain combustible materials.

There are 3 different levels of "intrinsic safety" markings to denote the number of independent, simultaneous faults that have been applied during the assessment. The equipment is considered to be suitable if it does not become an ignition source even if the faults are applied.

The markings are also an indication as to where the device may be installed. The image below shows the full markings on the Performance Sensor. The HazLoc markings discussed in this paper are shown in the bottom 2 lines of text, outlined by the box.



Note that there are also "zone" system markings and other HazLoc markings for other areas of the world. This paper is not addressing the other HazLoc markings, nor the "zone" system markings.

Table 4 – summary of intrinsic safety markings

MARKING	NUMBER OF FAULTS	ALLOWED IN:	
		DIVISIONS	NFPA 70 PARAGRAPH
Ex ia	2	*Div 1 (may be omitted from markings)* *Div 2*	*500.8(C)(2)* *500.8(B)(2)*
Ex ib	1	Div 1* (special circumstance) Div 2	 500.8(B)(2) & 500.85(C(2)
Ex ic	none	Div 2	500.8(C)(2)

Summary of Hazardous (Classified) Location definitions

The following definitions may be helpful in understanding this document.

FLASHPOINT = Temperature at which evaporation of a flammable liquid is sufficient to guarantee a combustible mixture in air at normal atmospheric pressure

FLAMMABLE LIQUID = a liquid which may generate a vapor which is combustible in air under standard atmospheric pressure and temperature

VOLATILE FLAMMABLE LIQUID = a flammable liquid having a flash point below 38˚C (100˚F) or a flammable liquid whose temperature is able its flash point, or a Class II combustible liquid that has a vapor pressure not exceeding 276 kPa (40 psia) at 38˚C (100˚F) and whose temperature is above its flashpoint

COMBUSTIBLE DUST = solid particles that are 500 micrometers or smaller (i.e. material passing a US No 35 standard sieve) that can form an explosible mixture when suspended in air at standard atmospheric pressure and temperature

COMBUSTIBLE FIBERS / FLYINGS = Fibers / Flyings where any dimension is greater than 500 micrometers in nominal size, which can form an explosible mixture when suspended in air at standard atmospheric pressure and temperature

IGNITABLE FIBERS / FLYINGS = Fibers / Flyings where any dimension is greater than 500 micrometers in nominal size, which are not likely to be in suspension in quantities to produce an explosible mixture, but could produce an ignitable layer fire hazard

CLASS = general category of combustible material; there are 3 classes as summarized in Table 1

GROUP = designation intended to provide a general measure of ignitibility; there are 7 groups as summarized in Table 2

IGNITION TEMPERATURE = temperature at which a fuel can ignite once exposed to an ignition source

AUTO IGNITION TEMPERATURE (AIT) = temperature at which a combustible material will self-ignite

LAYER IGNITION TEMPERATURE = minimum temperature at which a layer of combustible dust will self-ignite and usually noted as T_{layer}; usually determined through test and noted in area classification documents

CLOUD IGNITION TEMPERATURE = minimum temperature at which a combustible dust will self-ignite when suspended in air under standard atmospheric pressure and usually noted as T_{cloud}; usually determined through test and noted in area classification documents

TEMPERATURE CODE (T-CODE) = short cut notation (**T1, T2, T3, T4, T5, or T6**) to indicate the minimum AIT for a Class I material; Table 4 summarizes the T-codes used in the USA under the Division system

Table 4 – USA Division T-codes

CODE	AIT (°F)	AIT (°C)
T1	842	450
T2	572	300
T2A	536	280
T2B	500	260
T2C	445	230
T2D	419	215
T3	392	200
T3A	356	180
T3B	329	165
T3C	320	160
T4	275	135
T4A	248	120
T5	212	100
T6	185	85

MAXIMUM EXPERIMENTAL SAFE GAP (MESG) = maximum separation between two smooth surfaces (approximately 1 inch wide) through which the energy from an explosion of a specific material on one side will not transmit to the other side; a narrow gap is needed for highly combustible materials

MINIMUM IGNITION CURRENT (MIC) RATIO = ratio of minimum current needed to ignite a specific gas or vapor as compared to that needed to ignite coal dust; a lower ratio indicates a material which is much easier to ignite