Abstract
This technical white paper addresses primary specifications and classification of hazardous area/hazardous locations safety issues, industry regulations and security standards across the globe. This white paper will also give insight on class 1 division 2 and zone system particularly for chemical, petrochemical and other similar industries where explosion protected equipment is a necessity.

With a focus on maintaining completely safe industrial working environment, this paper will provide information on Arista’s UL class 1 division 2 certified non incendive, corrosion resistant thin clients industrial panel PCs, touch panel PCs, specifically designed to be used in chemical, petrochemical, food processing, cold storage pharmaceutical and other harsh industrial environment.
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Introduction
The complexity of today’s industrial automation needs, demands a safe and secure working environment. In certain industries, the manufacturing, processing, or storing flammable materials release gases or vapors in the atmosphere which can result in an explosion or hazard. To ensure a high level of security in these areas, most of the countries have outlined laws, regulations and guidelines. Manufactures and end users are required to comply with security regulations to avoid any hazard.

Understanding the tough industrial needs Arista’s talented team of engineers focus on the safety essentials and comply with electrical equipment regulations according to hazardous classified locations and different country’s standard. Arista works very hard over every certification and testing centre for the design and manufacturing of equipment.

What is an explosion?
An Explosion is a sudden expansion involving physical or chemical decay with a rapid increase in pressure, resulting in a heavy blast and shock. In a chemical explosion molecule decomposes into combustible gases produced at a very high temperature. For an explosion to take place three factors which are flammable materials, air (oxygen) and ignition sources has to be present in sufficient quantities in the atmosphere.

Refer to figure 1 below:

![Figure 1](image_url)

There are several ways to protect and avoid electrical equipment hazard where the presence of flammable materials, combustible items and fibers is common.
An explosion does not occur only in the presence of flammable materials, there should be sufficient quantity of flammable materials present for any hazard to occur. However, there are plenty of classifications and requirements that fall under hazardous zone and their level of severity. Country wise regulations with detailed explanation are listed below.

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Standard &amp; Marking</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td><img src="image" alt="UL Listed" /></td>
<td>For North America hazardous locations, equipment certification are performed by nationally recognized laboratories UL, MET, FM and CSA. In addition, the American National Standard Institute coordinates US standard to be used internationally and allow equipment to be used globally.</td>
</tr>
<tr>
<td>Europe</td>
<td><img src="image" alt="Ex ATEX" /></td>
<td>This standard is in accordance with EU directives; EN 60079 and 61241 specifically cover explosion protection. The CE along with Ex mark follows indications of the group and category. Also, if Group II equipment relates to the gases (G) or dust (D)</td>
</tr>
<tr>
<td>International</td>
<td><img src="image" alt="IEC Ex" /></td>
<td>This standard addresses “Hazardous Locations”, “Hazardous Area”, and “Explosive Atmosphere”. Places where flammable liquids, vapors, gases or combustible dusts along with sufficient quantities to cause fire or explosion.</td>
</tr>
</tbody>
</table>
Design Regulations for anti-explosion electrical industrial automation equipments.
Regulations are specifically meant for equipment to be used in hazardous locations defined by law. However, these might vary according to the location, country laws and other factors. Equipment not pertaining to regulations can counter delay in their shipping and face legal and liability issues.

Regulations for Class/Division system are formulated by NEC, CEC, OSHA and NFPA (National Fire Protection Association). It is mandatory for every manufacturer to adhere by compliance, these are monitored by UL and other testing groups as mentioned above. After equipment pass test they are provided with a certificate stating; “explosion protection safety conditions are met and they are secured to be used for production”.
Non-Incendive standard defined for Electrical equipment

International Society of Automation (ISA) and the American National Standard Institute (ANSI) have defined the non-incendive standard for electrical equipments to be used in hazardous locations. These standards provide design, construction and electrical marking requirements to be used in Class I and Class II, and Class III, Division 1 and 2 hazardous locations.

Hazardous zone and their classification

In simple terms, hazardous classified location is any area, building, commercial or industrial premises which are likely to be exposed to fire or explosion due to the presence of flammable gases, vapors, flammable liquids, combustible dusts and other similar things in the very high amount. Hazardous locations can be classified into various categories according to the nature of flammable vapors or liquids. These categories can be defined by classes and classified by NFPA Publication 70, NEC and CEC. Below are the classification of locations and division, which define the type of explosive or ignitable substance present in the atmosphere.

Class Definition: North America Classification System

In the United States and North America, manufacturer’s in general follow standards set up by National Electric Code (NEC). Other popular classifications are NFPA publication and CEC. These benchmarks along with NEC specify type of hazardous materials based on class, division and groups.

Class/Division standards are the primary methods catering the design and manufacturing of industrial equipments across North America. The in-depth classification is widespread but it addresses all aspects of explosion protection and safety measures best practices. All these classes are categorized as per different explosives or ignitable substances that are found in the Atmosphere. The intent of this paper is to focus primarily on Class I division 2 locations and its further classification.
Refer to the brief explanation and description below for the North America Classification system.

<table>
<thead>
<tr>
<th>Class</th>
<th>Area</th>
<th>Division</th>
<th>Group</th>
<th>Temperature Class</th>
</tr>
</thead>
</table>
| Hazardous materials categories are classified by NFPA Publication 70, NEC and CEC. The three classes define the type of explosive or ignitable material present in the atmosphere. **Class I:** Locations where flammable gases or vapors are found. **Class II:** Locations where combustible dust, which can be involved in an event of ignition. **Class III:** Locations with presence of frequent ignitable fibers or flyers. | It defines the possibility of hazardous materials to be present and use of appropriate equipment with safe installation practices. | The classes mentioned are further classified into Division I and Division II.  
  • Division 1  
    Ignitable concentrations of flammable gases or vapors, they might exist because of frequent repair, maintenance, operations or any sort of leakage. Also breakdown and equipment with fault or failure are in this division.  
  • Division 2  
    Volatile flammable liquids or gases stored in containers or closed system, but are exposed in any sort of accident, breakdown or abnormal operation of equipment. | Division I and II are further classified into groups of hazardous material with varying gases, vapors or dusts in the air. The groups are defined of flammable materials rating with respect to other materials. | It is the maximum temperature meant for equipment operating on the surface of equipment and should not go beyond the ignition temperature of the nearby atmosphere. |
**Zone System Classification**

As discussed above, Class/Division systems are specifically used in North America for the purpose of regulating and defining hazardous locations for equipment safe handling and installation. However, outside of North America, the zone system is being used as a primary source equipment in manufacturing and installation. Zone systems are quite similar to class/division systems; they define and categorize hazardous areas and potential risk sources.

Refer figure 2 for a detailed classification.

<table>
<thead>
<tr>
<th>Zone 0</th>
<th>Zone 1</th>
<th>Zone 2</th>
</tr>
</thead>
</table>
| Concentration of flammable gases or vapors for long periods must be present for an area to be considered class 1 zone 0. | Concentrations of flammable gases or vapors under normal conditions, they might be present due to repair, maintenance or leakage or there is any fault in equipment it qualifies for class 1 zone 1 location. | 1. Volatile flammable liquids, gases or vapors handled, processed or used but can escape, rupture or breakdown of containers.
2. Ignitable concentrations of flammable gases or vapors prevented by positive ventilation but can become hazardous due to failure or abnormal ventilation.
3. Location next to Class 1 Zone 1 where concentrations of flammable material can communicate falls in zone 2. |

**Figure 2**

Likewise, there are other zones that cover potential flammable dust hazard, refer to the table below:

<table>
<thead>
<tr>
<th>Zone 20</th>
<th>Zone 21</th>
<th>Zone 22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent or large presence of flammable dust</td>
<td>Occasional or less presence of flammable dust</td>
<td>Very less chances for presence of flammable dust</td>
</tr>
</tbody>
</table>
To get a clearer picture, frequency of occurrence of an event determines the hazard level of that location. Hence, the more flammable materials are present in atmosphere the more are chances for an explosion to occur.

Refer to the table below:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant, rare or occasionally</td>
<td>Zone 0 and 1</td>
</tr>
<tr>
<td>Irregular condition</td>
<td>Zone 2</td>
</tr>
</tbody>
</table>

In addition, it is important to understand how the flammable substances/materials are categorized and how to get a better understanding of each of them.

Refer to figure 3 below:

**Flammable substance**

- **Gas**: Flammable gas are compounds of hydrogen and carbon which are highly flammable even with little reaction possibility. Example: Hydrogen, acetylene, ammonia etc.

- **Liquids/Vapors**: Flammable liquids and vapors when present in sufficient quantities at room temperature can turn into potential explosion hazard. Flash point of flammable liquid is the lowest temperature at which vapors can arise and ignite. Example: Hydrocarbons

- **Solids**: Unlike gas and liquids, for solid flammable materials, a dust cloud can settle if it is not ignited. If removal and cleaning of layers is not done, dust can build up resulting in explosion. Initially on a smaller level but can result in serious bigger explosions. Example: Dust fibres

**Figure 3**

**Note**: Ignition or explosion can only occur when flammable gas, liquid or solid material have their lower and upper flammability limits. Hence, not necessarily the presence of flammable material will result in a fire hazard.
**Temperature Class definition and explanation:**

Equipments used in hazardous area are assigned to a temperature class which defines maximum surface temperature the device can go. In particular, this temperature should not exceed the ignition temperature of the atmosphere. With minimum presence of ignition temperature even in normal atmospheric pressure a spark or flame is able to set fire or a combustion or independent heating of the element. The dedicated rating for a temperature class also helps in preventing combustion that is dependent on the combustion point of the material present in that area.

Temperature classification are given to hazardous areas and temperature class ratings are applied to instruments. Values for the temperature classification ranges from T1 to T6, where T1 implies a minimum ignition temperature (>450 °C [842 °F]) and T6 has a minimum ignition temperature >85 °C [185 °F].

**Temperature class rating,** this relates to the maximum temperature instrument is supposed to produce typically at a 40°C environmental temperature. However, this might vary in reference to other ratings. T1 thru T6 are used in temperature class ratings, where T1 is maximum temperature generated by instrument at 40°C is 450°C and T6 is the maximum generated by the instrument is 85°C.

Refer to table below for a detailed view:

<table>
<thead>
<tr>
<th>Temperature classification/Rating</th>
<th>Min Ignition Temperature/Area</th>
<th>Max instrument temperature/Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>&gt;450 °C, 842 °F</td>
<td>450 °C, 842 °F</td>
</tr>
<tr>
<td>T2</td>
<td>&gt;300 °C, 572 °F</td>
<td>300 °C, 572 °F</td>
</tr>
<tr>
<td>T3</td>
<td>&gt;200 °C, 392 °F</td>
<td>200 °C, 392 °F</td>
</tr>
<tr>
<td>T4</td>
<td>&gt;135 °C, 275 °F</td>
<td>135 °C, 275 °F</td>
</tr>
<tr>
<td>T5</td>
<td>&gt;100 °C, 212 °F</td>
<td>100 °C, 212 °F</td>
</tr>
<tr>
<td>T6</td>
<td>&gt;85 °C, 185 °F</td>
<td>85 °C, 185 °F</td>
</tr>
</tbody>
</table>
Differentiating Class/Division system with their Zone system

**Differentiating class/division with zone**

- **NEC/CEC Standards**
- **Type of hazardous Area classification and protection**
- **ATEX/IECEX Standards**

- **Type of Hazardous substance present**
  - **Class 1 (Gas & Vapors)**
  - **Class 2 (Dust Particles)**
  - **Class 3 (Fibres and flyings)**

- **Possibility of hazardous substance to be present in this areas**
  - **Division 1 When chances present under normal working conditions**
  - **Division 2 When chances are less likely to be present under normal working conditions.**

- **Possibility of hazardous substance to be present in this areas**
  - **Zone 0,1,2 (Gas & Vapors)**
  - **Zone 20,21,22 (Dust)**

- **Persisant occurance during normal working conditions ZONE 0 (Gases & Vapors) ZONE 20 (Dust)**
- **Less chances to ve presnet during normal work environment ZONE 1 (Gases & Vapors) ZONE 22 (Dust)**
- **Less possibility to being present under normal operations ZONE 2 (Gases & Vapors) ZONE 22 (Dust)**
Sources of Ignition

It is also important to know what sources can initiate a hazard, below is the list. Table A provides a general source of ignition while Table B shows ignition sources from industrial electrical equipments.

### Table A

<table>
<thead>
<tr>
<th>Sources</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open flame</td>
<td>Match, lighter, cigarette or similar products. Heater, electric blanket or any other similar equipment.</td>
</tr>
<tr>
<td>Electric powered devices</td>
<td></td>
</tr>
<tr>
<td>Fuel-gas equipments</td>
<td>Gas fire, heating device etc</td>
</tr>
<tr>
<td>Hot objects</td>
<td>Spark, hot pipes etc</td>
</tr>
<tr>
<td>Chemical Reaction</td>
<td>Very rare</td>
</tr>
<tr>
<td>Exposure to heat from external source like a fire nearby.</td>
<td></td>
</tr>
<tr>
<td>Unknown or spontaneous heating</td>
<td>Usually happens due to leakage, oil soaked rugs etc.</td>
</tr>
<tr>
<td>Radio Frequency (range 1 &amp; 2)</td>
<td></td>
</tr>
<tr>
<td>Ultrasonic</td>
<td></td>
</tr>
<tr>
<td>Lightening</td>
<td></td>
</tr>
</tbody>
</table>
Table B

<table>
<thead>
<tr>
<th>Sources</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Spark</td>
<td>Takes place when circuits are broken, or there is often breakage in the circuits.</td>
</tr>
<tr>
<td>Hot surface</td>
<td>Hot surface ignition takes place due to the heat provided by coils, lamps, resistors or hot bearings. Hence, resulting is sudden fire.</td>
</tr>
<tr>
<td>Friction</td>
<td>Usually happens due to a strike between case or enclosure.</td>
</tr>
</tbody>
</table>

**Installing and operating equipments in hazardous locations**

The mission of every manufacturer, industry owner, and installer is to adhere to the regulations and standards for maximum security in their facility. Specifically for hazardous locations following safety guidelines is a must, it helps in avoiding any kind of danger and potential hazard instances.

Refer to the figure 4 below:

<table>
<thead>
<tr>
<th>Plant Owner</th>
<th>Installing Authority</th>
<th>Equipment Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Responsible for safe operations, monitoring and maintainence of HMI document.</td>
<td>• Responsible for selecting and installing approved HMI equipments.</td>
<td>• Design and develop equipments to used in Hazardous Locations.</td>
</tr>
</tbody>
</table>

**Figure 4**

**Protection techniques: Hazardous Area**

Hazardous area can be defined as any industrial space with presence of three fundamental components: flammable substance, oxidizer and source of flame/ignition. Hence such areas
require specialized equipment to prevent and avoid explosion. This might sound as a straightforward process but it isn't, these are guided by regulations, guidelines and laws which are already discussed above in this paper.

The National Electrical Code (NEC), National Fire Protection Association, OSHA has set up benchmarks for hazardous area explosion protection. North America region Factory Manual (FM) and Underwriters Laboratories (UL); and Canadian Standard Association (CSA) for Canada are the certifying agencies, recently the two of them are working together on implementing programs to be made valid in both countries.

Electrical equipment to be used in hazardous area should be installed with one or more protection techniques for proper and secure operations.

As mentioned earlier, there are several methods by which equipment can be made flame and explosion proof, limiting energy and other sources.

Refer to the figure below for a detailed explanation.

<table>
<thead>
<tr>
<th>Protection Method</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explosion proof equipment</td>
<td>To meet the criteria for explosion proof rating, the enclosure should be able to prevent explosion, extinguish flames internally so that external ignition are prevented.</td>
</tr>
<tr>
<td>Dust-ignition proof equipment</td>
<td>It will exclude dust; prevent sparks and ignition in exterior dust on the enclosure.</td>
</tr>
<tr>
<td>Hermetically sealed Equipment</td>
<td>Equipment is sealed against the external atmosphere to prevent entry of hazardous gases or vapors.</td>
</tr>
<tr>
<td>Intrinsic safety or non-incendive</td>
<td>Equipment electric circuits are designed in a specialized way and do not release sufficient energy for an ignition to occur. Non incendive circuits and components prevent any kind of arc or thermal effect.</td>
</tr>
<tr>
<td>Purged and pressurized system</td>
<td>Equipment with internal circuits under pressure and ejects any sort of combustible gas and dust.</td>
</tr>
</tbody>
</table>
Arista offers a wide range of panel mount and fully sealed TPC, ARP-2200AP-G00 and ARP-5500AX-G00 Series, designed for use in environments where the existence of flammable gases or vapors and/or combustible dust may be presence in the air during an abnormal occurrence such as a spill or a leak and to prevent ignition of flammable substances like gases, vapors and liquids that are present within Class 1 Division 2 hazardous zone applications.

ARP-2200AP-G00 Series is Panel Mount TPC products family and ARP-5500AX-G00 is stainless steel fully sealed, fully enclosed TPC which has no external vents hence protect the components from gases, dust, dirt, moisture, chemicals, oil, and other external contaminants in an explosive environment. Both series are powered by Intel i7 CPU and integrated LCD display size ranging from 15”, 17”, 19” to 21.5”. Powered by Intel i7 CPU and up to 16GB system memory and can run on Windows 64-bit operating system to meet most of SCADA/HMI applications. 21.5” Wide Screen, 16:9 aspect ratio, full HD 1920 x 1080 resolution keeps Arista's Class 1 Division 2 hazardous zone TPC ahead of market trend.

Both ARP-2200AP and ARP-5500AX Series have ACP Enabled Thin Client version as well. ARP-2200AP and ARP-5500AX Series ACP Enabled Thin Client version offers centralized management solutions for factory floor, plant operational and hazardous area locations.

ARP-2200AP-G00:

![Image of ARP-2200AP-G00 TPC panel and operator wearing protective gear.]
UL/CSA Listed safety standards, non incentive industrial panel PC for use in Class 1 Division 2 Groups A, B, C, D Hazardous classified locations.
- Panel Mount NEMA4/4X Bezel
- The HMI application meets Class I Division 2 hazardous locations (North America Classification).
- 15", 17", 19", 21.5" Active Matrix TFT LCD Display
- Black Powder Coated or Stainless Steel Bezel
- 5-Wire Resistive Touch or Tempered Glass
- Intel Core i7 Mobile
- Up to 16GB DDR3 SO-DIMM Memory
- Dual Gigabit LAN

ARP-5500AX-G00:

UL/CSA Listed safety standards, non incentive industrial panel PC for use in Class 1 Division 2 Groups A, B, C, D Hazardous classified locations.
- Sealed with stainless steel enclosure
- The HMI application meets Class I Division 2 hazardous locations (North America Classification).
- 15", 17", 19", 21.5" Active Matrix TFT LCD Display
- Black Powder Coated or Stainless Steel Bezel
- 5-Wire Resistive Touch or Tempered Glass
- Intel Core i7 Mobile
- Up to 16GB DDR3 SO-DIMM Memory
- Dual Gigabit LAN
About Us:

Arista is a pioneer in the industry of product development, engineering and manufacturing of industrial computers and displays. Originally formed in 1994, Arista has offices in China, India and Taiwan. With years of experience and expertise in Industrial Panel PCs, Industrial Monitors, Box PCs and Fanless Embedded computers, Rack Mount Computers, ACP ThinManager Ready Thin Clients, embedded CPU Boards and video Extender/Switches. Arista has served customers with reliability, Integrity and Trust. Find out more here.

Disclaimer

This paper only provides an overview of hazardous area and zone classification for equipment safety. This paper should not be considered as a substitute for safety guidelines or regulations. It is also recommended to consult an official legal advisory or other concerned authority for latest and updated safety regulations.