Zone Verses Divisions

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Section 18 of the CSA Canadian Electrical Code (CE Code) covers the installation of equipment and wiring in locations considered hazardous because of the presence of ignitable or explosive materials. Such locations are divided into three classes:

Class I, which contains explosive gas or vapours

Class II, which contains combustible dust

Class III, which contains combustible fibres.

A major change in the 18th edition of the CE Code, published in 1998, introduced the zone system of dividing Class I locations into three zones instead of the two divisions used in previous editions. This was a significant change, affecting all electrical installations in hazardous locations, and is still not entirely understood by everyone.

It would not be appropriate to simply identify the revisions brought about by this change without discussing the principles behind them.

The Division System

Originally, Class I locations were not divided. A location that was subject to the presence of flammable gas or vapour was simply classified as a Class I location. Electrical equipment and wiring located in such areas had to meet the most stringent requirements that were approved at that time.

It was eventually agreed that there was a need to divide Class I into two divisions. It had become obvious that there were many situations where there was a minimal chance that gas or vapour would be present. In fact, it was not expected that gas or vapour would be present at all during normal working conditions, but it was recognized that an accident or other abnormal condition could result in a release of hazardous gas or vapour.

Locations in which the presence of gas or vapour was unlikely under normal situations, were classified Division 2, and were subject to less stringent requirements for equipment and wiring. All other Class I locations were classified Division 1 and continued to be subject to the more stringent requirements.

It should be noted that the principle behind the division of Class I locations is as significant as the actual practical application. Dividing Class I locations into two divisions introduced the principle of “probabilities.” In other words, when classifying hazardous locations it became acceptable to consider the probability, or likelihood, of gas or vapour being present simultaneously with a source of ignition.

Therefore, in the division system, Division 1 locations are those where the likelihood of explosive gas atmospheres occurring is the highest, and Division 2 locations are those where the likelihood is reduced. The Canadian Electrical Code defines Division 1 and 2 as follows:

> (a) Division 1, comprising Class I locations in which:
>
> (i) Hazardous concentrations of flammable gases or vapours exist continuously, intermittently, or periodically under normal operating conditions; or
>
> (ii) Hazardous concentrations of flammable gases or vapours may exist frequently because of repair or maintenance operation or because of leakage.
>
> (b) Division 2, comprising Class I locations in which:
>
> > (i) Flammable volatile liquids, flammable gases, or vapours are handled, processed, or used, but in which the liquids, gases, or vapours are normally confined within closed containers or closed systems from which they can escape only as a result of accidental rupture or breakdown of the containers or systems or the abnormal operation of the equipment by which the liquids or gases are handled, processed, or used; or
> >
> > (ii) Explosive gas atmospheres are not likely to occur in normal operation and, if they do occur, they will exist for a short time only; or
> >
> > (iii) Explosive gas atmospheres are normally prevented by adequate ventilation but which may occur as a result of failure or abnormal operation of the ventilation system; or
> >
> > (iv) The location is adjacent to a Class I, Division 1 location, from which a hazardous concentration of gases or vapours could 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.1

The Zone System

Just as the division system uses two divisions to describe the specifics of Class I locations, the zone system, first published in the CE Code in 1998, uses three zones. The zone system originated in the international community, in standards developed by standards development organizations such as the International Electrotechnical Commission (IEC) and CENELEC (the European standards writing body).

The following is an excerpt from the IEC Standard 60079-10 and explains the probability principle that is used in international standards. (It is interesting to note that the Canadian Electrical Code has followed this same principle in developing standards for equipment and wiring in hazardous locations since the implementation of the division system).

> In most practical situations where flammable materials are used, it is difficult to insure that an explosive gas atmosphere will never occur. It may also be difficult to insure that apparatus will never give rise to a source of ignition. Therefore, in situations where an explosive gas atmosphere has a high likelihood of occurring, reliance is placed on using apparatus which has a low likelihood of creating a source of ignition. Conversely, where the likelihood of an explosive gas atmosphere occurring is reduced, apparatus constructed to a less rigorous standard may be used."2

In the zone system, Zone 0 represents that area where there is the most likelihood of an explosive gas atmosphere being present, Zone 1 is that area where the likelihood is reduced somewhat, and Zone 2 is that area where the likelihood is reduced even further.

The Canadian Electrical Code Rule 18-006 defines Zones 0, 1, and 2 as follows:

> (a) Zone 0, comprising Class I locations in which explosive gas atmospheres are present continuously or are present for long periods;
>
> (b) Zone 1, comprising Class I locations in which:
>
> > (i) Explosive gas atmospheres are likely to occur in normal operation; or
> >
> > (ii) Explosive gas atmospheres may exist frequently because of repair or maintenance operations or because of leakage; or
> >
> > (iii) The location is adjacent to a Class I, Zone 0 location, from which explosive gas atmospheres could be communicated.
>
> (c) Zone 2, comprising Class I locations in which:
>
> > (i) Explosive gas atmospheres are not likely to occur in normal operation and, if they do occur, they will exist for a short time only; or

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

(iii) Explosive gas atmospheres are normally prevented by adequate ventilation but may occur as a result of failure or abnormal operation of the ventilation system; or

(iv) The location is adjacent to a Class I, Zone 1 location from which explosive gas atmospheres could 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.3

The process of changing a two-division system to a three-zone system was simplified by the knowledge that the rather broad allocation of “”Division 1″” would be more specific when split into two parts. These two parts are relative to the frequency and duration of exposure to a release of gas or vapour, i.e.,

Areas having a high likelihood of release (continuous, long periods of time) match the definition of Zone 0.

Areas having a lower likelihood of release (expected but will not occur for long periods) match the definition of Zone 1

Division 2 became Zone 2

Impact on Section 18 (installation rules)

Rule 18-000 Scope
Because of the significance of the changes made to the CE Code, the scope had to be worded to make it clear that any new installation undertaken, subsequent to the adoption of the 1998 edition of the code, would be subject to the zone system of classification. Subrule (1) covers this by stating that Section 18 (which uses the zone system) applies to all locations classified as Class I.

At the same time, there had to be enough flexibility for those existing facilities, already classified to the division system, to continue to operate, expand, or be modified, without an enforced reclassification. As well, the rules related to the division system had to be kept up to date and be available for use with those facilities.

This was accomplished by expanding the Scope from the previous two subrules to the present five. The Scope now includes provisions for the continued use of the division system in specific cases (Subrule 18-000(3)), and mandates the division system rules, located in Appendix J, for those cases (Subrule 18-000(4)).

Rule 18-002 Terminology

There is some new terminology in Section 18 that is particularly important to the application of the zone system.

“Adequate Ventilation.” This term has never been defined in the CE Code prior to the 1998 edition. Adequate ventilation simply means ventilation, either natural or artificial, that is sufficient to prevent the accumulation of vapour/air or gas/air mixtures in concentrations above 25 percent of their lower explosive limit. Both artificial ventilation and natural ventilation are considered in this definition. In previous issues of the code natural ventilation was never a consideration.

“Degree of Protection” and **“Methods of Protection.”** These definitions appear to be related but the difference is quite significant and warrant some discussion.

Degree of protection signifies the degree to which equipment will prevent ingress of foreign bodies such as dust or liquids.

Methods of protection are the methods used in the manufacture of equipment to ensure that it does not become or provide a source of ignition. These terms will appear in several of the revised rules in this section.

“Explosive Gas Atmosphere.” This is defined as a mixture of gas or vapour and air that is within its flammable limits. The term simplifies the previous reference to “flammable gases or vapours which may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.”

“Normal Operation.” This term is used in much of the literature dealing with the zone system and has been defined as the situation when the plant or equipment is operating within its design parameters. An abnormal operation would result in a release of gas or vapour sufficient to develop an explosive gas atmosphere.

Methods of Protection

The division system uses the basic protection features of explosion-proof equipment, purged or pressurized equipment or intrinsically safe equipment. The zone system introduces a number of additional protective principles.

They are defined in the Canadian Electrical Code, so the following is intended as a paraphrase only. (Included in brackets after the name is the symbol that is used to identify each one.)

“Intrinsically Safe” (Intrinsic Safety i, ia, or ib). Intrinsic safety (i) is the intrinsic safety that has been part of the division system. The IEC standards have introduced two new classifications of intrinsically safe:

- Intrinsic safety (ia) provides the same level of protection as intrinsic safety (i) used in the previous edition of the code. During testing, it must continue to provide explosion protection after two countable faults have been applied (countable faults are faults to components of the equipment being tested, not field wiring components).
- Intrinsic safety (ib). Equipment certified with intrinsic safety (ib) does not have quite the same level of backup protection as (ia) or (i). During testing, it must continue to provide explosion protection after only one countable fault has been applied.

“Flameproof” (d). Flameproof equipment provides the same type of protection as explosion-proof. The principle of both is to contain an explosion within the enclosure. Hot gases cool as the increased pressure forces them out though an engineered flame path and will not ignite the surrounding hazardous atmosphere.

“Increased Safety” (e). Equipment which is considered approved under the increased safety standard will have:

- a high impact type of enclosure,
- protection against the ingress of dust and moisture,
- a high degree of safety in the terminals, i.e., splices will not be permitted in an increased safety enclosure, and
- improved tracking distances between terminations.

In general, an increased safety enclosure is one in which steps have been taken to increase the safety that is provided by the enclosure and the equipment that is inside. There will be no arc producing, heat producing or sparking apparatus enclosed in an increased safety enclosure.

The following four methods of protection use similar principles:

- “oil immersed” (o)
- “pressurized” (p)
- “powder filled” (q)
- “encapsulation” (m)

Because of the special type of manufacture, gas or vapour is excluded from contact with those parts of the equipment that produce arcs, sparks or high temperatures. Ignition will therefore not occur.

“Non-sparking” (n). This is a more generalized term and will cover many types of equipment. Basically, the equipment will not produce arcs, sparks, or high temperatures, and it is unlikely that a fault will occur within the equipment.

Refer to the Canadian Electrical Code, Appendix B notes, page 577 for further information, including the standard number, for each method of protection covered in the CAN/CSA – E79 series of standards.

Rule 18-050, Electrical Equipment

Standards governing the manufacture of equipment for use in hazardous locations have traditionally been part of the C22.2 or CAN/CSA C22.2 group of standards. When referring to equipment certified under these standards, the code has stated that equipment that is required to be approved for a class of location, i.e., Class I, must also be approved for the specific gas or vapour that will be present. To simplify this process, gases and vapours having similar properties are grouped together. Group designations used with the division system for Class I locations are Groups A, B, C, and D.

To take full advantage of the move to the zone system, new standards were required to cover the manufacture of equipment intended for Class I, Zone 0, 1, and 2 locations. Standards, based on the IEC standards, were developed and adopted under the CAN/CSA E79 series of standards. To follow the IEC standards as closely as possible, the IEC method of naming gas groups IIA, IIB, and IIC was also adopted.

It is critical to recognize that the gases contained in Group IIA do not correspond to those in Group A. Instead, Group IIA gases correspond to those in Group D. Similarly, Group IIB gases correspond to those in Group C, and Group IIC gases correspond to those in Groups A and B combined. This means greater attention needs to be paid to the marking on the equipment (i.e., is the equipment suitable for Group A or Group IIA gases?)

A complete listing of typical gases and vapours along with a cross reference between the two types of group names is shown in the Canadian Electrical Code Appendix

Rule 18-052 Marking

All electrical equipment must bear a certification mark such as the CSA mark, to confirm that the equipment has been certified, as required by Rule 2-024.

In addition, the marking convention for equipment intended for hazardous locations under the division system includes the class of location, gas group, and temperature or temperature code. A typical marking may be:

Class I, Group D, T4
The marking convention under the zone system includes the Ex or EEx mark to indicate that the equipment is explosion protected, the symbol for the method of protection (d, e, etc.), the gas group, and the temperature code. A typical marking may be:

Ex d IIA T4
The marking conventions between the division and zone systems are quite different and

we can expect to see either one on equipment used in Class I hazardous locations. An important point is that the latter does not include the “”class of location”" and, therefore, equipment with this marking is not permitted in a Class I Division 1 location unless it has had the class of location added.

A table showing the types of equipment permitted and the methods of protection acceptable for use in the zone and division systems is given in the Canadian Electrical Code, Appendix J.

Rule 18-090 Equipment and Wiring in Class I Zone 0 Locations

While a Class I Division 1 location includes the area designated under the zone system as Zone 0, there is a difference between the two systems in the rules for electrical equipment and wiring.

Rules for Class I Division 1 locations include:

explosion-proof equipment and wiring,

equipment and wiring that is pressurized or purged with a protective gas (see Rule 18-002 Special Terminology), or

equipment approved as intrinsically safe and associated wiring that is designed and installed as intrinsically safe.

Rules for Class I Zone 0 locations require intrinsically safe equipment and wiring of the (i) or (ia) types only.

Rule 18-090 also includes the requirements for seals in conduit runs where they leave the Zone 0 location and in cable runs at the first termination in the Zone 0 location.

Rules 18-106 Wiring Methods Class I Zone I

Although the wiring methods for Class I Zone 1 locations are quite similar to those normally permitted in Class I Division I locations, Subrules 18-106(3), (4), and (5) indicate that there are some significant differences.

Subrules (3) and (4) cover the requirements for threaded joints. Subrule (3) permits the use of straight threads in equipment required to be explosion-proof or flameproof design (tapered threads must still be used on the conduit as required in Rule 12-1006). Subrule (4) covers the need for approved adapters in cases where the threads may be metric rather than the more commonly used National Pipe Thread (NPT).

Another point to consider in dealing with threaded joints in a hazardous location is the number of fully engaged threads that are required. With the division system, the

requirement is for 5 fully engaged threads in any hazardous atmosphere. With equipment used in the zone system, 5 fully engaged threads are required in Group IIA or IIB atmospheres, but at least 8 fully engaged threads are required in a Group IIC atmosphere.

Subrule 18-106(5) covers the need for care when terminating conduit or cable in enclosures with the method of protection “”e”" (increased safety). Such entries are to maintain the degree of protection provided by the enclosure. The increased safety principle includes preventing the ingress of dust or moisture into the enclosure. When such an enclosure is installed in the field, steps must be taken to ensure that principle is not compromised.

Rule 18-108 Sealing, Class I, Zone 1

There are two basic differences in the rules for sealing brought about by the move to the zone system.

The type of enclosure that is permitted in a Class I Zone 1 location is significant. For instance, seals will not be required on cables terminating at enclosures with the method protection “e” when run within the zone. Also cables that leave a Zone 1 location will not require a seal providing the cable is greater than 10 m (32.8 ft) in length and there are no excess process or atmospheric pressures involved that may force gas or vapour through the cable.

The need to seal conduit entries into enclosures that are not required to be either explosion-proof or flameproof is another significant difference. There are two reasons for this: the need to ensure dust and moisture cannot enter an increased safety enclosure, and the need to ensure the integrity of an explosion-proof or flameproof wiring system (i. e., a wiring system intended to contain an explosion). A seal must be installed at the transition to a wiring system that is not required to be explosion-proof or flameproof.

Rule 18-156 and Rule 18-158 cover wiring methods and sealing for Zone 2 locations. Since a Class I Zone 2 location is considered equivalent to a Class I Division 2 location, there are no significant differences in either the type of equipment that is permitted, the wiring methods or the requirements for sealing.

1 Canadian Electrical Code – C22.1 – 02

2 CEI IEC Standard 79-10 (60079-10) Third edition, 1995-12

3 Canadian Electrical Code – C22.1 – 02

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