AD TT solutions

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UNDERSTANDING IEC 60079-11:2023

comprehensive guide to the revamped standard

About ADOTT Solutions

At ADOTT Solutions, we specialize in comprehensive engineering services that bring your ideas to life. From hardware and software design to product manufacturing and intrinsic safety certification, we provide end-to-end solutions tailored to your unique needs. Our team of experienced engineers excels in delivering complex services and finding creative engineering solutions for diverse industries.

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Frida is a Mechanical CAD Engineer with a degree in Industrial Design. She has contributed to a remarkable list of product industrial designs, prototyping, and composite experiments to develop enclosures for highly volatile environments while not sacrificing user-friendliness, requiring lightweight but rugged solutions.

Frida's expertise lies in designing safe enclosures for hazardous environments. Outdated standards can lead to misinterpretations and safety risks. This guide is her way of bridging that gap by sharing her knowledge of the updated IEC 60079-11:2023.

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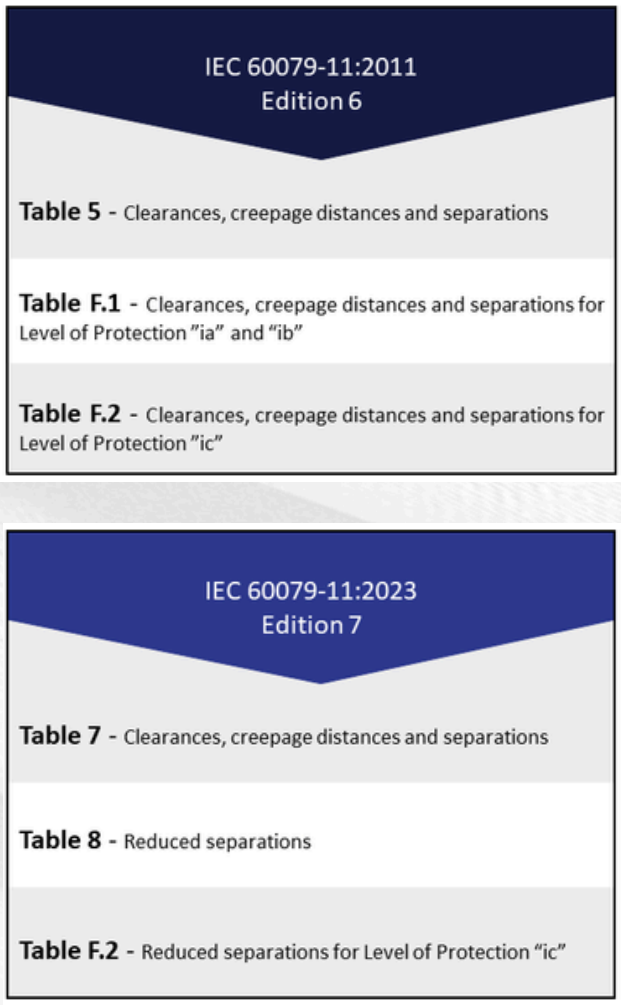
CHAPTER #1

Major Changes in Enclosures, Connections, and Encapsulation Chapters

Significant General Changes Spanning Multiple Clauses

Let's start with changes that are in connection with multiple chapters. Some definitions have been removed from **Edition 7** because they are now **included in IEC 60079-0**. For example, terms like 'coating,' 'countable faults,' 'non-countable faults,' 'encapsulation,' and 'casting' fall into this category. Additionally, some definitions were deemed unnecessary for inclusion here and have been removed, such as 'fault' and 'infallible separation.' **New definitions** have been added to Clause 3, including 'spark test apparatus', 'non-hazardous area accessory', and 'transient rating'.

As a result of the document's re-arrangement, there have been changes in the **numbering of the tables**, which are illustrated in the following table:



Thermal Ignition Compliance and Conditions for Assessment Requirements in Edition 7

Products must fulfill two basic criteria: **spark ignition and thermal ignition requirements**. The IEC 60079-11:2023 specifies in detail the assessment conditions, like Um, Ui, Ii, and Pi applications. It is essential to consider the service temperature when meeting these requirements and conditions. [Clause 5.2.1]

> Intrinsically safe circuits shall not be capable of causing ignition under the most onerous conditions, except where permitted elsewhere in this document.
>
> – IEC 60079-11:2023

<u>General Information about the Conditions</u>

Edition 7 provides examples regarding standard heating practices. It is important to take into account the closely located series or parallel components that may carry fault currents. Additionally, testing for heating above the **service temperature** is not a relevant method, as the most challenging service temperature should be used for testing.

<u>Changes in Thermal Ignition Compliance</u>

According to the new standard, the power dissipation in tracks or wiring should not be more than 1.3W for temperature classification T4, in case of ambient temperatures up to 40°C. If the **Tamb exceeds 40°C**, the power limits must be reduced as specified in **IEC 60079-0, Table 4.** [Clause 5.4.1]

The wire thermal assessment **formula** has been corrected in Edition 7. [Clause 5.4.3]

$$I = I_f \sqrt{\frac{(t - T_a)(1 + \alpha(T - T_a))}{(T - T_a)(1 + \alpha(t - T_a))}}$$

The Intrinsic Safety proficiency assessment was conducted under IECEx. In light of the changes introduced in the new standard regarding thermal ignition compliance, it is essential to review and validate any products that were previously certified under older standards. **Ensure that your products meet the updated requirements** and comply with the latest regulations to maintain safety and performance standards.

Requirements for Enclosures of Equipment

To ensure compliance for **Group IIIC**, it is crucial to verify that the enclosure satisfies the separation requirements stated in **Tables 7, 8, and 9**. The level of protection necessary depends on the specific table being followed unless the protection level is assured by separations and not the enclosure:

- For **Table 7**, a minimum of **IP5X** is required
- For either **Table 8 or Table 9**, at least **IP54** is necessary

If the separation is reduced, the enclosure must still provide a minimum of **IP54** and include any **Specific Condition of Use**, such as cable glands, thread adapters, and blanking elements, that maintain the IP rating in the certificate. [Clause 6.2.4]

Changes to Internal Connections and Connectors

The previous version of the standard did not differentiate between faults in internal connections. Edition 7 clarifies the distinction between **countable faults** (based on available data using IPC standards) and **non-countable faults**. These distinctions are applied to **Levels of Protection 'ia'** and **'ib'**. [Clause 6.4.1]

Level of Protection	Minimum Number of Tracks or Vias	Minimum Conductor Thickness (µm)	Minimum Track Width or Via Circumference (mm)
"ia"	1	30 (outer layers) 24 (inner layers)	2
	2	30 (outer layers) 24 (inner layers)	1
	3	Adequately sized	Adequately sized

Table 6 – Requirements for infallible circuit board tracks and vias in IEC 60079-11:2023

Another significant change in **IEC 60079-11:2023** is the requirement that circuits must remain intrinsically safe even after complete disconnection of a connector, applicable to connectors not considered infallible. A connector is considered **infallible** when it comprises at least 3 independent connecting elements for '**ia**' and 2 for '**ib**' with current-carrying details specified in Edition 7. While some previously certified products may already meet this requirement due to **IECEx standard practices** (redundancy), we recommend verifying your certified product. [Clause 6.4.2.2]

The implementation of new **copper thickness requirements** for PCB tracks and vias is crucial for achieving infallible connections. [Clause 6.4.2.4]

Updates in the Separation of Conductive Parts

The most notable change in this chapter is the inclusion of **Dielectric Strength test voltages**, which were absent in the previous edition. Additionally, what was once an annex – the Reduced Separation Table 8 – has now become an **integral part of the standard**. [Clause 6.5.3.2]

Furthermore, Edition 7 outlines the required type and **routine tests**, versus Edition 6, which merely referenced other standards. It provides clarity regarding when each test is applicable. Notable examples include the casting compound and PCB coating tests for **reduced distances**. [Clause 6.5.6.2, 6.5.6.3, 6.5.6.5]

Existing certified Ex Equipment that relies on reduced separation will **need to undergo reassessment and testing** as required, following the tests now clearly specified in the new edition of the standard.

Encapsulation

> Encapsulation may be applied by casting, pouring or moulding.
>
> – IEC 60079-11:2023

The implementation of a **routine inspection** requirement has been deemed necessary for encapsulated parts to ensure the acceptable application of the encapsulant during manufacturing. From the manufacturer's perspective, this is of utmost importance as it allows them to exercise control over the verification procedure. To comply with this obligation, a **quality audit** is mandated, alongside the **QAR requirements** which serve as the practical implementation of the verification method. [Clause 6.6.1]

In Edition 7, it is imperative that the **Continuous Operating Temperature** (COT) of the encapsulant remains within the regular operational requirements. Any deviation from this requirement would necessitate stricter obligations. This implies that the compound must **not display any visible damage,** and the IEC 60079-11:2023 provides examples of potential damage. [Clause 6.6.1]

Furthermore, if **intrinsic safety** depends on the encapsulant, the standard requires more profound specification of **material parameters** [Clause 6.7], such as

- Pre-treatment of surfaces
- Encapsulant name and trademark
- Colour of the material
- Additives, etc.

CHAPTER #2

Major Changes in Rating and Electrical Components

Rating of Components on Which Intrinsic Safety Depends

According to the 7th Edition, it has been stated that equipment possessing a Level of Protection designated as ‘ia’ or ‘ib’ must not exceed 2/3 of its maximum current, voltage, and power rating.

For components that the intrinsic safety depends on at Level of Protection ‘ic’, a safety factor of 1.5 is not mandatory if the circuit remains within the defined maximum current and voltage rating,

- Does not surpass the defined maximum power rating during non-countable faults.
- During normal operation, the equipment should not surpass 2/3 of its power rating.

Components for Level of Protection ‘ic’ are considered to fail if they are not within their manufacturer’s rating following the application of faults. [Clause 7.1]

Semiconductors

Components Which Have a Conductivity Between Conductors and Insulators

> Analysis of integrated circuits based on failure rates of particular failure modes other than stated is not permitted by this document.
>
> – IEC 60079-11:2023

Namely: This clarifies that the assessment of semiconductors cannot be considered based on failure rates. [Clause 7.7.1]

Another new requirement in this Edition 7 is the usage and explanation of those programmable components. For all Level of Protection at service temperature definition shall be assumed that this component operates normally. [Clause 7.7.8]

Relays

Elements That React to a Small Change in anElectrical Current

The latest edition of the standard, IEC 60079-11:2023, now provides detailed explanations regarding the rating criteria for relays, which encompass requirements related to dielectric strength and connection to an intrinsically safe circuit.

One noteworthy change introduced in IEC 60079-11:2023 is that it considers the gap between a relay's coil and contacts as a fault for relays that rely on intrinsic safety. On the other hand, relays for 'ic' circuits are only required to comply with the relevant industrial standards.

Additionally, if the current or power value exceeds the specified threshold for relays with reduced separation, an additional acceptance criterion has been included to the standard, as outlined in [Clause 7.9.2], which references IEC 61810-1: Electromechanical elementary relays – Part 1: General and Safety Requirements.

Fuses

Device That Provides Overcurrent Protection

In the world of electrical safety, even a tiny component like a fuse plays a crucial role, and IEC 60079-11 Edition 7 brings some **noteworthy clarifications to fuse usage.**

> A single suitably rated fuse is sufficient to provide protection.
>
> – IEC 60079-11:2023

Another new part of the chapter is that the cold resistance of a fuse cannot be used to **limit the breaking current.** However, this does not exclude the use of the cold resistance to limit current in the **rest of the circuit or to protect other components.**

This point also explains that fuses connected to the main supply are permitted to have a **breaking capacity of less than 1500 A.** In this case, the manufacturer shall specify the maximum prospective current allowed for the circuit in their instructions. [Clause 7.11]

Supercapacitors

Energy Storage Devices Using Reversible Adsorption and Desorption

As per the established **Edition 7** standard, supercapacitors are categorized as **cells and batteries.** [Clause 7.12.1]

In **Intrinsically Safe equipment**, it is permissible to connect supercapacitors in parallel without compromising intrinsic safety. However, it is important to note that **supercapacitors have**

- the capability of **storing energy** based on their specified capacitance,
- but they do not have the ability to **regulate their voltage**. [Clause 7.15]

Temperature-Sensitive and Monitoring Components- Thermal Devices Changes

The latest version of **IEC 60079-11** has introduced a dedicated chapter for Thermal Devices, accompanied by **additional requirements and evaluative procedures.** [Clause 7.16]

Temperature sensors may be utilized for the purpose of ensuring intrinsic safety; however, it is inevitable that they comply with **Table 19 – Rating and failure modes of temperature sensors.** [Clause 7.16.2.2]

Level of Protection	Safety factor applied to the rating			Failure mode		
	U	I [a]	P [a]	Open circuit	Short circuit	$0 < R_T$ [c] $< \infty$
"ia" and "ib"	1,0	1,5	1,5	Countable fault	Countable fault	Countable fault
"ic"	1,0	1,0	1,5 [b] 1,0 [b]	Not applied	Not applied	Not applied

Positive Temperature Coefficient (PTC) and **Polymer Positive Temperature Coefficient** (PPTC) devices are now allowed to limit temperature without requiring extra control circuits. Aligned with they are compliant with the relevant requirements and **Table 21 – Rating and failure modes of PTC devices used to limit temperature.** [Clause 7.16.2.4]

CHAPTER #3

Major Changes in Cells, Batteries and Tests

Protection Against Polarity Reversal

Firstly, what is **polarity reversal**? This is when the **positive and the negative polarity** on the battery is reversed. During installation, ensure the correct polarity connection **to prevent damage or sparks**. Every intrinsically safe apparatus must prevent polarity reversal, like:

- **power supplies** to intrinsically safe apparatus, or
- at **connections between** cells of battery or supercapacitors.

For this purpose, a **single diode** (with intrinsic safe rating) is acceptable. [Clause 6.8]

Another way of protection can be a **mechanical poka-yoke design** that makes the wrong polarisation physically impossible.

Cells and Batteries Design Requirements

The most requirement change and clarification get involved in the cells and batteries clauses in IEC 60079-11:2023. So, firstly let's check the points that relate to the design aspects of cells and batteries.

Primary and Secondary Cells and Batteries - General

Some cells and batteries, like lithium-ion, may catch fire during a short circuit at a reversed connection. The previous Edition 6 standard allowed the use of lithium-ion cells. Of course, if those were tested following the standard. Next to that, required a declaration from the manufacturer to confirm the safe use of them in intrinsic safe apparatus. Edition 7 deleted this section. Lithium-ion or other cells and batteries are now usable if they successfully pass the specified tests, eliminating the need for an additional declaration.

The following requirement refers to an intrinsic safe (IS) apparatus in which one's batteries permitted to charge inside an explosive atmosphere is present. At temperature rise needs to be considered electrolyte leakage therefore at testing of charge electrolyte leakage must be observed. [Clause 7.12.1]

Battery Structure Connected with IEC 60079-11:2023

When a battery structure is designed with internal separation based on Edition 7, short circuits between cells do not need to be considered. However, a single-cell short circuit shall be considered a non-countable fault. The exception to this is the surface temperature test when a single cell is considered to fail to short circuit. [Clause 7.12.2]

Ventilation at Cells and Batteries

For IS apparatus containing chargeable batteries inside hazardous areas, the manufacturer must demonstrate that the concentration of hydrogen level does not exceed the defined values.

> The manufacturer does not mean the manufacturer of the battery
>
> – IEC 60079-11:2023 Edition 7

This chapter declares a test criterion, too. The cell containers, which ones sealed (that enclose the cells) do not need to submit to pressure test in accordance cells and batteries test requirement chapter (9.14.4) in IEC 60079-11:2023. [Clause 7.12.4]

Cell Voltages Test Requirements

In IEC 60079-0 Explosive atmospheres – Part 0 Standard contains a table about cell (primary and secondary) voltage. When your choice of the cell cannot be found in this table, it shall be tested to find the nominal voltage of the cell. This test was detailed in Edition 7:

- Testing process: referring to the test chapter (9.8) in the current Standard
- Test temperature: maximum open circuit voltage at room temperature
- Charging after the test: needs to use the manufacturer-specified method

[Clause 7.12.5]

Test of Cells and Batteries

Ventilation at Cells and Batteries

PREPARATION OF TEST

- Edition 7 clarified that a cell or battery for testing purposes always needs to be new and previously unused.
- For tests the removal of the current limiting device is required.
- For dust layer tests every testing temperature and required sample quantity has been defined

DURING THE TESTING PROCESS

Every test requires continuous current and voltage under cell and battery tests. Any sudden drop in current or voltage was not allowed. To be insured the testing conditions are stable.

RESULT OF THE TEST

When the test result is an explosion or fire of the cell (or battery), those are prohibited to use for Level of Protection “ia” or “ib”. [Clause 9.14.1]

Electrolyte Leakage Test Requirements of Cells and Batteries

This section of the IEC 60079-11:2023 describes test parameters, and what the samples need to undergo. There is a new criterion for Level of protection “ic”: testing is not required but is sufficient to establish compliance with electrolyte leakage requirements.

There is also an alternative testing assessment for sealed case batteries. After the described test the sample can be placed for 12 hrs on blotting paper and evaluated after that. [Clause 9.14.2]

Spark and Thermal Ignition Tests of Cells and Batteries

For cells not changed in explosive atmospheres, a single cell is not required to be tested for spark ignition in case the peak open circuit voltage is less than 4.5V. [Clause 9.14.3.2]

From the thermal ignition point of view, the IEC 60079-11 Edition 7 declared that temperature measurement shall be done (at a single-cell test) in the middle of the cell concerning its longitudinal axis.

Level of protection “ib” gets an alternative test for lithium-ion rechargeable cells. Next to that, at Level of Protection “ia” and “ib” always need to use requirements of 7.12.3, if electrolyte leakage appears during the maximum surface temperature test. A new statement was added referring to thermal ignition. Only a single sample needs to be tested for compliance with the Level of Protection “ic” thermal ignition. [Clause 9.14.3.3]

Routine Verifications and Tests

In IEC 60079-11 Edition 7 the routine test became more specified and detailed. For batch verification of conformal coating and encapsulation, the standard contains exact numbers based on ISO 2859-1 [Clause 10.4].

For transformers with Level of Protection “ic”, the following new rule was added. If the relevant industrial standard does not require a routine test, no routine test is required according to Edition 7. [Clause 10.3.2].

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