IEC 60079-10-1

Edition 3.0 2020-12

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colour inside

Explosive atmospheres –
Part 10-1: Classification of areas – Explosive gas atmospheres

Atmosphères explosives –
Partie 10-1: Classification des emplacements – Atmosphères explosives gazeuses

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But we can explain the approach from the standard a bit more in the following paper! A copy of the standard can be bought at https://www.evs.ee/en/ (be sure to buy a multi-license copy so you can open it on any device).

Explanation of IEC 60079-10-1 : 2021 Edition 3.0

A good way to perform hazardous area classification is the application of the IEC 60079-10-1 standard. The latest version of this standard was issued in 2020. The standards has a few specific changes compared to the former version of the standard from 2015.

We will outline the general approach of the standard.

General

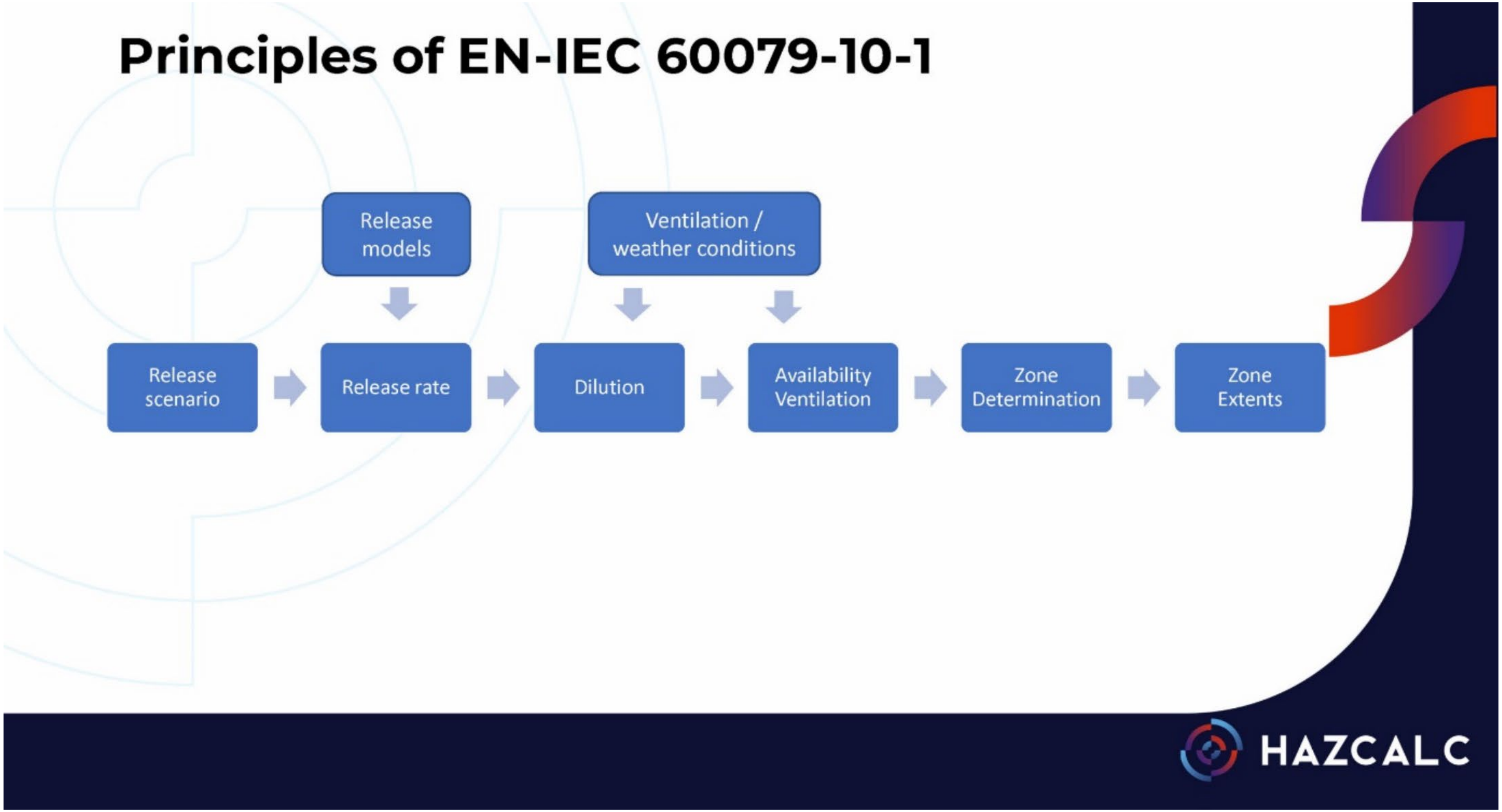
The IEC standard 60079-10-1 can be used for assessing hazardous areas caused by flammable fluids and gases. This standard is not applicable to hazardous areas caused by flammable dusts.

The standard specifies a general approach on how to assess specific scenarios. It is clearly not an example approach like e.g. the examples in the NFPA 497 or in the EI15.

It is an approach which is defided into the following steps:

1. Identify sources of release
2. Calculate the grade of the release;
3. Classification of the dillution of flammable substances in air;
4. Classification of the availability of the ventilation;
5. Determination of the zone classification (see table below);
6. Determination of the extent of the zone.

The principles of IEC 60079-10-1 can also been presented with the following scheme:


Principles of EN-IEC 60079-10-1
Release models
Ventilation / weather conditions
Release scenario
Release rate
Dilution
Availability Ventilation
Zone Determination
Zone Extents
HAZCALC

What are we actually assessing?

With assassing hazardous areas we assess how often an explosive atmosphere must be taken into account in an area or plant section.

The IEC 60079-10-1 standard is a standard from the International Electrotechnical Commission which adopted the zone classification system.

The Class / Division system, which is still used in Northern America, is not implemented in the IEC standard. A reference table between the zone and class/division system, can be used to switch between the two systems.

The following zones for flammable gases and liquids are defined in the IEC standard:

Zone 0: *Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapor or mist is present continuously, for long periods or repeatedly (consider more than 10% of the time or more than 1000 hours);*

Zone 1: *place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to be present occasionally under normal operating conditions (consider less than 10% of the time / 1000 hours but more than 0.1% of the time /10 hours);*

Zone 2: *Place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation and, if it does occur, will persist for a short period (less than 0.1% of the time / 10 hours).*

This means, that the zone depends on the frequency, in which the concentration of gases, vapour or mist, is above the lower explosion limit. After all, only when the concentration of fuel is above the lower explosion limit, a mixture is explosive.

Approach IEC 60079-10-1

1. Sources of release

The first step is to identify the sources of release from an installation of work process. The following release sources are applicable:

Source	**Description**	**Example**
Continuous grade of release	Release which is continuous or is expected to occur frequently or for long periods	The surface of a flammable liquid in a fixed roof tank, with a permanent vent to the atmosphere.
Primary grade of release	Release which can be expected to occur periodically or occasionally during normal operation	Seals of pumps, compressors or valves if release of flammable substance during normal operation is expected.
Secondary grade of release	Release which is not expected to occur in normal operation and, if it does occur, is likely to do so only infrequently and for short periods	Flanges, connections and pipe fittings, where release of flammable substance is not expected during normal operation.

2. Grade of the release

The grade of the release in, mass per second, can be calculated using the equations from the standard. The **grade of the release** stands for the evaporation rate (for liquids) or the gaseous release rate (for gases).

The following information is, in general, needed for the calculation of the grade of the release:

<u>Substance information:</u>

- Substance name
- Molmass (kg/kmol)
- Rel. liquid density (water =1)
- Vapour pressure (Pascal)

- Lower Explosion Limit (LEL in vol%)
- Rel vapour density (air=1)
- Specific heat (J/kg/K)

Process properties:

- Pressure in system (Pa)
- Pool dimensions (for calculating grade of release from spills)
- Leak area (table B.1 in the standard gives guidance)
- Process temperature
- Ambient temperature

Environmental properties:

- Dimensions of the area (for indoor sources of release)
- Ventilation capacity
- Air velocity near the source of release (may be calculated)
- Height of the release (for outdoor sources of release)

The following equations can be used for calculating the grade of the release:

Kind of release	Equation from standard	Example
Pressurized non-choked gas release	$W_g = C_d\, S\, p \sqrt{\frac{M}{Z\,R\,T}\frac{2\gamma}{\gamma-1}\left[1-\left(\frac{p_a}{p}\right)^{(\gamma-1)/\gamma}\right]}\left(\frac{p_a}{p}\right)^{1/\gamma}$ (kg/s)	e.g. leaking flange, leaking pump seal, leaking coupler in pipework
Pressurized choked gas release	$W_g = C_d\, S\, p \sqrt{\gamma \frac{M}{Z\,R\,T}\left(\frac{2}{\gamma+1}\right)^{(\gamma+1)/(\gamma-1)}}$ (kg/s)	e.g. leaking flange, leaking pump seal, leaking coupler in pipework

Kind of release	Equation from standard	Example
Atmospheric liquid pool release	$W_e = \frac{18{,}3 \times 10^{-3} \; u_w^{0{,}78} \; A_p \; p_v \; M^{0{,}667}}{R \times T} (\text{kg/s})$	e.g. pool on ground, pool in diptray, open tank, open drum, open can
Pressurized liquid release	$W = C_d \, S \sqrt{2 \rho \Delta p} \; (\text{kg/s})$	e.g. leaking flange, leaking pump seal, leaking coupler in pipework

note: with the equation for the liquid release, an estimation must be made which part of the release evaporates immediatelly. When this is zero, the equation for the atmospheric pool release must be used.

The grade of the release can be expressed as the **volumetric release characteristic** of the source (m3/s). This can be calculated with the following equation:

$$Q_c = \frac{W_g}{\rho_g \times LFL}$$

3. Dillution

When the grade of release is known, it is important to evaluate, how the concentration of flammable gases is dilluted. Dillution is achieved by ventilation and ventilation can be expressed as the air velocity around the source of release.

The model is based on the assumption that, the higher the air velocity near the source of release is, the higher the dillution is. of course the dillution must be in balance with the grade of the release.

This can be evaluate with figure C.1 from the standard.

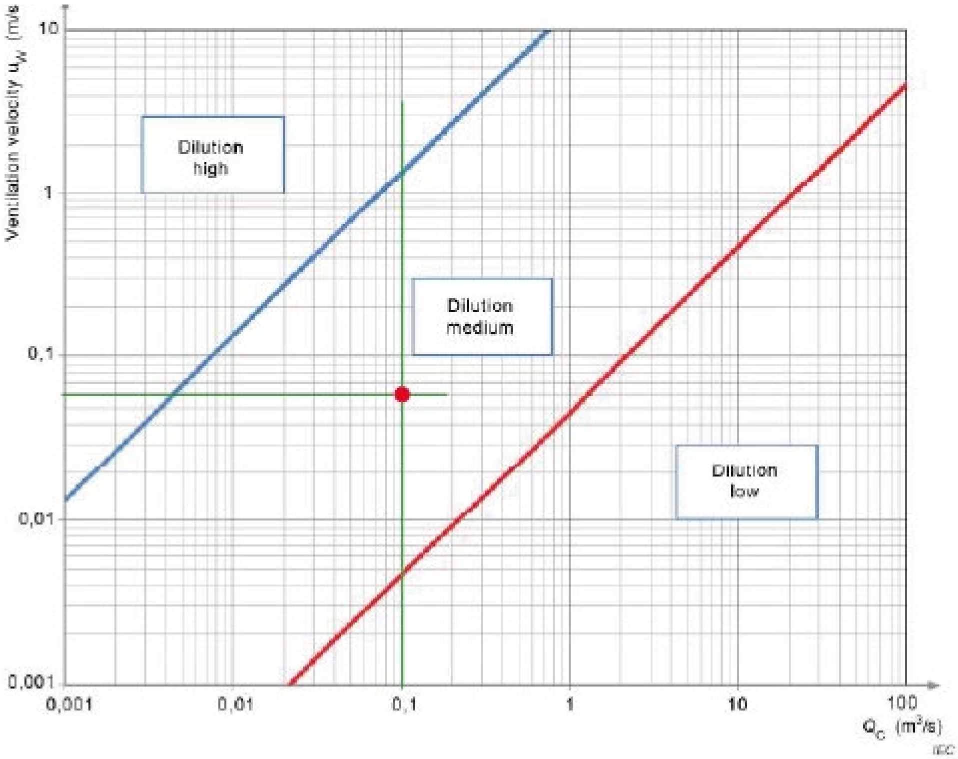


Figure C.1 – Chart for assessing the degree of dilution

On the x-axis, the calculated **volumetric release characteristic** of the source (m3/s) is plotted and on the y-axis the air velocity near the release source is plotted. Based on the values, the intersection of the corresponding lines, results in the **dillution class**.

Background Concentration for indoor situations

For indoor situations the resulting dillution class from figure C.1. is a prelimenary dillution class. The dillutin class for indoor situations depends also on the average background concentration in the area.

The average background concentration in the area under consideration, must be lower than the critical concentration. The critical concentration is a certain percentage of the LEL of the substance. Mostly 25% of the LEL.

The **background concentration (Xb)** can be calculated by the following equation:

The *f factor* is a safety factor, for the efficiency of the ventilation under consideration.

$$X_b = \frac{f \times Q_g}{Q_g + Q_1} = \frac{f \times Q_g}{Q_2} \text{(vol/vol)}$$

f - factor	**Stands for**
f=1	the background concentration is essentially uniform and the outlet is distant from the release itself, so that the concentration at the outlet reflects the mean background concentration.
f>1	there's a gradient of background concentration in the room due to inefficient mixing, and the outlet is distant from the release itself, so that the concentration at the outlet is smaller than the mean background concentration. f may be between 1,5 for mildly inefficient mixing and 5 for very inefficient mixing.

When the background concentration is lower than the critical concentration, than the check is **"OK"** and the dillution class remains the same as the prelimenary dillution class, based on figure C.1.

When the calculated background concentration is higher than the critical concentration, than the check is **"Not OK"** and the **dillution class** becomes **low**.

4. Availability of the ventilation

The availability of the ventilation is classified in three levels of availability:

- **good:** ventilation is present virtually continuously;
- **fair:** ventilation is expected to be present during normal operation. Discontinuities are permitted provided they occur infrequently and for short periods;
- **poor:** ventilation which does not meet the standard of fair or good, but discontinuities are not expected to occur for long periods.

5. Zone classification

Based on all the assessed steps the zones can be classified based on the the following table D.1 from the standard.

Grade of release	Effectiveness of Ventilation						
	High Dilution			Medium Dilution			Low Dilution
	Availability of ventilation						
	Good	Fair	Poor	Good	Fair	Poor	Good, fair or poor
Continuous	Non-hazardous (Zone 0 NE)[a]	Zone 2 (Zone 0 NE)[a]	Zone 1 (Zone 0 NE)[a]	Zone 0	Zone 0 + Zone 2[c]	Zone 0 + Zone 1	Zone 0
Primary	Non-hazardous (Zone 1 NE)[a]	Zone 2 (Zone 1 NE)[a]	Zone 2 (Zone 1 NE)[a]	Zone 1	Zone 1 + Zone 2	Zone 1 + Zone 2	Zone 1 or zone 0[c]
Secondary[b]	Non-hazardous (Zone 2 NE)[a]	Non-hazardous (Zone 2 NE)[a]	Zone 2	Zone 2	Zone 2	Zone 2	Zone 1 and even Zone 0[d]

[a] Zone 0 NE, 1 NE or 2 NE indicates a theoretical zone which would be of negligible extent under normal conditions.

[b] The Zone 2 area created by a secondary grade of release may exceed that attributable to a primary or continuous grade of release; in this case, the greater distance should be taken.

[c] Zone 1 is not needed here. I.e. small Zone 0 is in the area where the release is not controlled by the ventilation and larger Zone2 for when ventilation fails.

[d] Will be Zone 0 if the ventilation is so weak and the release is such that in practice an explosive gas atmosphere exists virtually continuously (i.e. approaching a 'no ventilation' condition).

'+' signifies 'surrounded by'.

Availability of ventilation in naturally ventilated enclosed spaces is commonly not considered as good.

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6. Extent of the zone

The extent of the hazardous area or region where flammable gas may occur depends on the release rate and several other factors such as gas properties and release geometry and surrounding geometry.

Figure D.1 may be used as a guide to determine the extent of hazardous area for various forms of release.

Which line to choose depends on the form of the release and the substance properties.

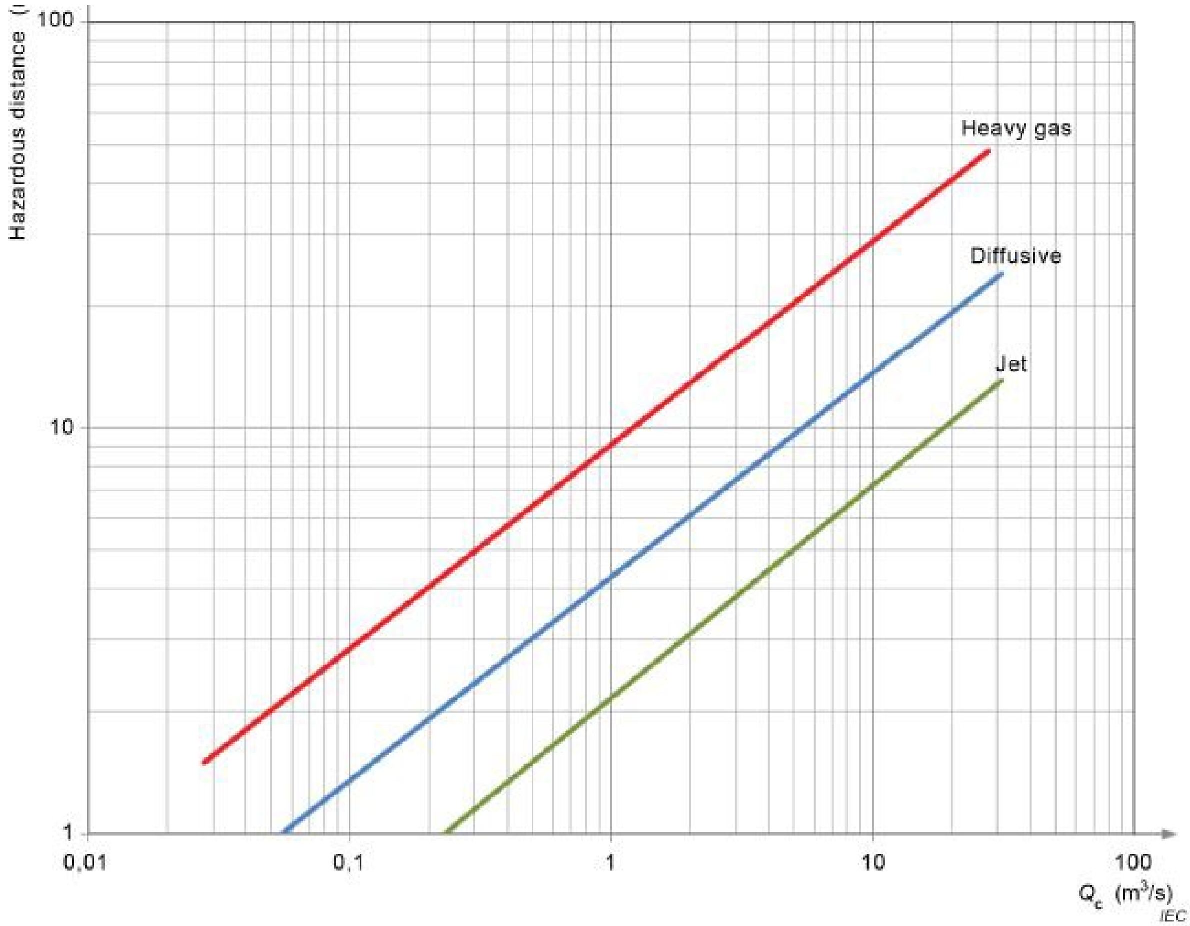

Figure D.1 – Chart for estimating hazardous area distances

There is a cut-off in the graph for heavy gases at a 1,5 mtr radius and for jet and diffuse releases the cut-off is 1 mtr radius.

Hazcalc

In order to simplify all the calculations and assessments, Hazcalc can be used. This is an online calculation model, which is based on scenarios, and fully compliant with the current European standard EN-IEC 60079-10-1.

All figures and graphs are implemented in the software, even as a substance database. Assessment reports can be printed as pdf and be downloaded in Excel format.

For more information visit hazcalconline.com/software or view the tool via a demo version app.hazcalc.com/register.