User Manual Hazcalc

Version: Final 2.2

08-02-2022

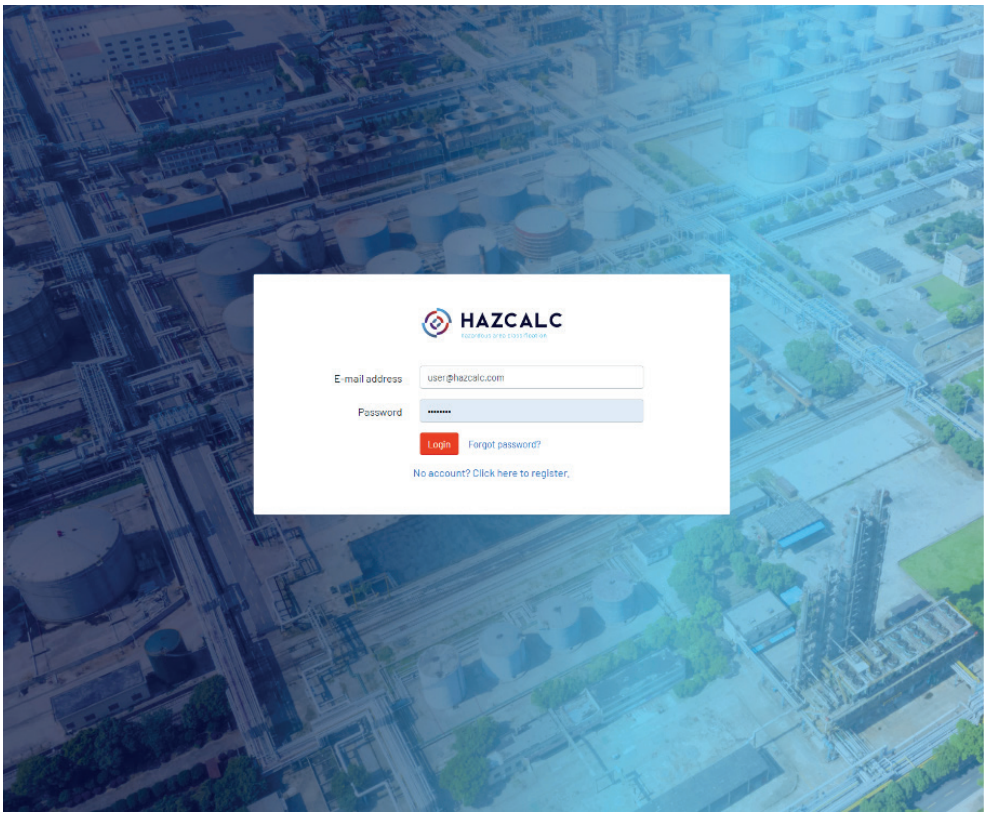
HAZCALC

Content

1. Introduction

Thank you for using Hazcalc!

Hazcalc is a platform for assessing hazardous areas for flammable gases and liquids in relation to explosion safety. We started developing Hazcalc during our work as an Atex consulting company for hazardous areas.



During that time we often assessed existing workplaces and new installations, such as container skids and process installations, on hazardous areas. Among the methods that you can use for that, we often used the methods as described in the IEC standards; for gas atmospheres the IEC 60079-10-1. During the use of that standard, we developed an Excel worksheet, so that assessments could be performed in an easy way. We kept on developing and finetuning that worksheet, as we came to the point that we realised ourselves: why not sharing that useful tool with others?

We decided to develop a web-based platform where user can assess potentially hazardous areas in an easy and controlled way.

However, we succeed in developing a user-friendly tool, one has always keep the following in mind:

1. Using the tool always leads to a result, but how representative is the result in relation to the assessed situation?
2. To evaluate scenario's the user must have knowledge of the content of the European Standard.
3. However we developed quite an intuitive tool, the tool does not replace the content of the standard IEC 60079-10-1.
4. The use of the tool goes "hand in hand" with the use and inter pretation of IEC 60079-10-1.

1.1 Competence of users

The tool should preferably be used by sufficient competent persons, e.g. persons who have knowledge on assessing hazardous areas and have knowledge of the IEC 60079-10-1 standards. Its preferable, but not mandatory, to execute assessment by sufficiently competent persons or let sufficiently competent persons control executed assessments. Users are always self-responsible for the content and accuracy of their assessments.

1.2 Possibilities

What kind of assessments can be done with this tool? We implemented various calculation methods in it. First of all, most of the relevant calculations that are within the IEC 60079-10-1 standard (version 2015 and 2020), such as:

Calculation of release rates:
- Calculation of the releases rate of liquids;
- Calculation of the release rate of gases or vapours;
- Calculation of the release rate of evaporative pools.

Beside that we added some useful features to the tool:
- Calculation of the release rate of filling containers or tanks with liquids;
- Manually insert of calculated release rates with other methods.

For all forms of release, the hazardous areas can be assessed by:

Evaluation of the dilution of released substances:
- Calculation of the average air velocity within a room;
- Override the calculated ventilation velocity for dilution manually;
- Insert the ventilation velocity for outdoor situations;
- Calculation of the background concentration for indoor situations;
- Automated classification of the dilution class;
- Automated plotting of the dilution class within a graph.

Classification of hazardous area:
- Automated classification of hazardous area's based on inserted values;
- Automated calculation of the size of hazardous area's;
- Automated calculation of the size of hazardous areas by extrapolation;
- Automated plotting of the size of hazardous areas within a graph.

Storage and Report

All assessments are stored in a personal or business account (with one or multiple users). The assessments with all relevant parameters can be printed or stored in an Acrobat PDF report.

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HAZCALC
hazardous area classification

Hazardous Area Classification: Spill of ethanol of 2 m2

Company	Hazchem
Assessment	Spill of ethanol of 2 m2
Location of release	Inside
Area name	Production room 1

Substance properties

Substance name	Ethanol (= Alcohol)
CAS-number	64-17-5
Molmass	46.10 kg/kmol
Flashpoint	12 °C
Vapour pressure @ Tmedium	5.90 kPa
LFL [vol/vol]	0.031 vol/vol
Relative vapour density (air = 1)	1.59
Liquid density @ 20°C	790 kg/m3
Universal Gas Constant, R	8314 (J/kmol/K)

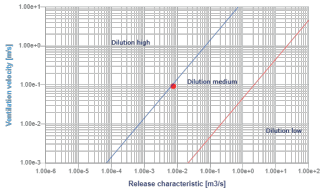
Release-assessment

Type of release	Atmospheric (2015)
Size of the liquid pool	2 m2
Calculated average air velocity in area	9.26e-2 m/s
Estimated local air velocity over pool	1.00e-1 m/s
Total airvelocity of fluid, Uw	1.93e-1 m/s
Mass release rate of the gas, Wg	1.13e-4 kg/s
Volumetric gas release rate, Qg	5.93e-5 m3/s
K-factor	0.25
Release characteristic	7.61e-3 m3/s
Ambient temperature, Ta	293 °K
Temperature medium, Tm	293 °K
Density of the gas, ρg	1.92 kg/m3
Used formula	B6 and B7

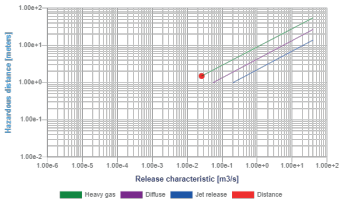
Ventilation assessment

Area length, width and height	15.00 x 3.00 x 3.00 mtr
Ventilation capacity	15000 m3/h
Volume	135.00 m3
Ventilation rate	111.11 times/hr
Air velocity for dilution	9.26e-2 m/s
Dilution class	Medium dilution
Availability ventilation	Fair
Efficiency ventilation	3
Crtitical concentration, Xcrit	7.75e-3 vol/vol
Background concentration, Xb	4.27e-5 vol/vol
Result	background concentration < critical concentration, so OK
Resulting dilution class	Medium dilution

Graph assessment degree of dilution C.1 of EN 60079-10-1



Graph Hazardous Distance Chart D.1 of EN 60079-10-1



Classification of area

Type of release source	Secondary
Zone	Zone 2
Density of gas relative to air	vapour/gas is heavier than air
Type of release	Heavy gas
Radius zone area	1,5 mtr
Temperature class	T2
Gas group	IIB

Comments

Your remarks can be added here!

Advice

Add advice can be added here!

1.2.5 Benefits of Hazcalc

The main benefits of using Hazcalc are:

- time saving due to e.g. integrated substance database, automated calculations, copy functions and reporting function (single and batch reporting);
- less faults compared to manual calculations with e.g. Excel;
- professional apearance for cliënts, e.g. picture and company logo print on report;
- fully compliant to IEC 60079-10-1, both 2015 and the 2020 version..

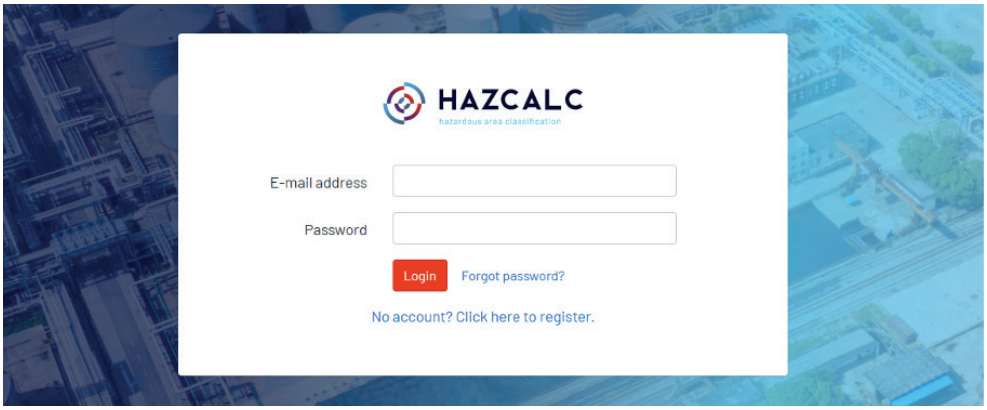
1.3 Engineering purposes

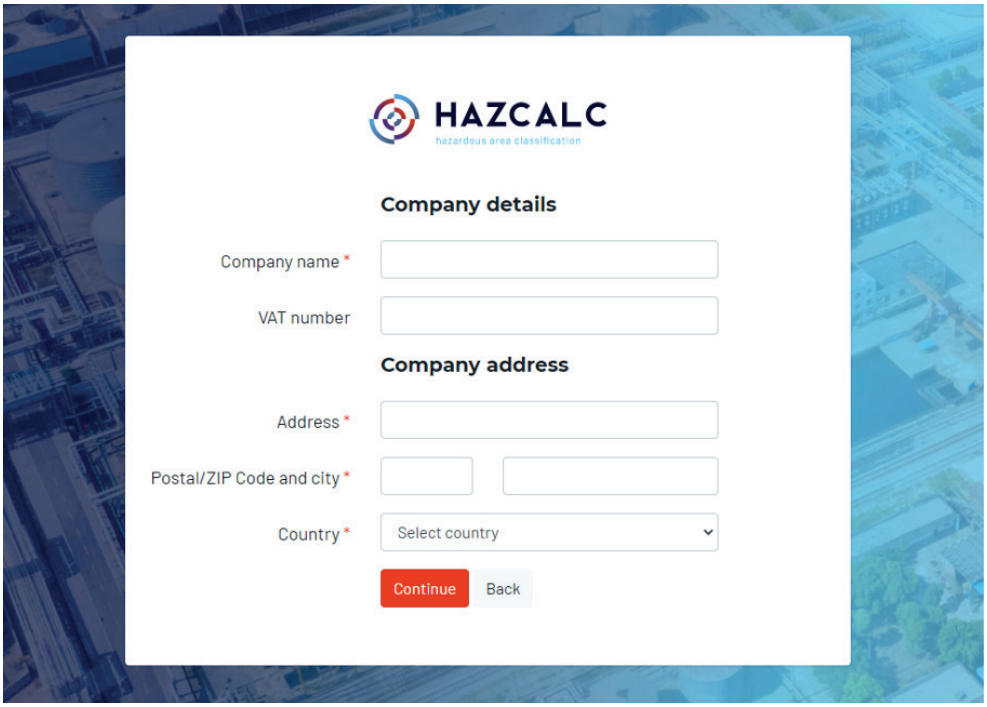
The tool can useful for engineering purposes. Assessment can be made to evaluate the area dimensions and ventilation requirements in relation to the hazardous area to be applied. The pre-conditions to achieve a less hazardous area can be determined and calculations can be made to calculate the maximum concentration of substances within ducting.

2. Accounts

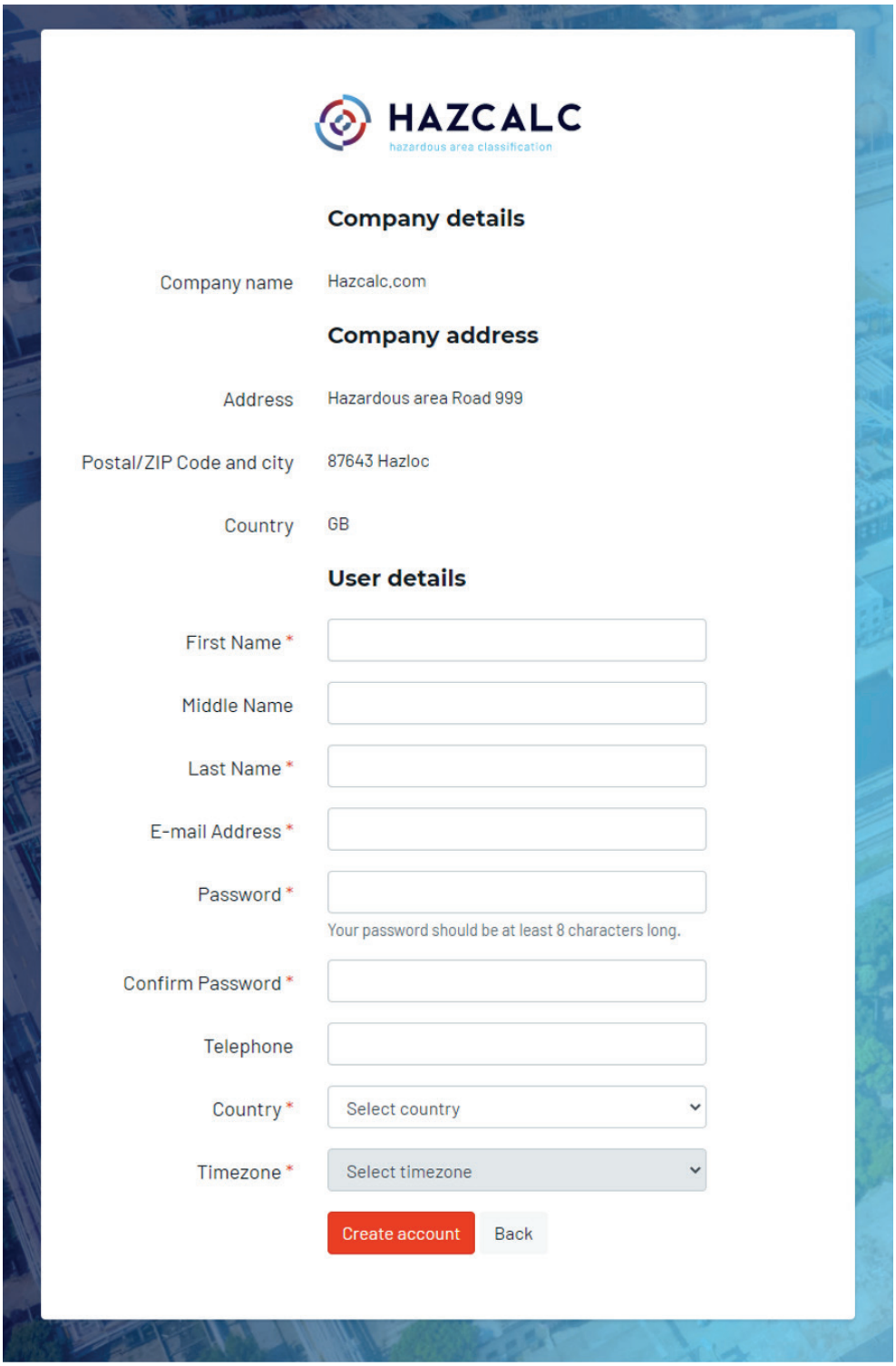
2.1 Creating an account

The use of the tool is only possible by creating an account so that one can login within the platform.





The creation of an account is possible for business users. First of all the company credentials must be added, also when one wants to try the demo version!



After creation of an account, the account must be verified by clicking the link in the automated email that you received.

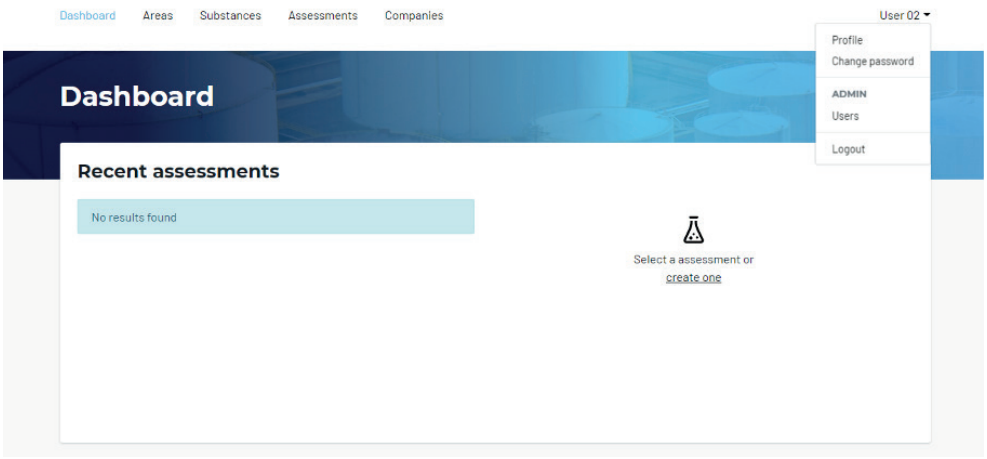
So now you are able to user the benefits of Hazcalc, so login with your email address and password.

2.2 Demo account

After creating an account, a 2-week trial of Hazcalc starts! This is free of charge and after the 2-week demo the tool is automatically blocked. See it is not need to cancel any subscription at this time. No charging occurs, only after explitely buying a full enabled account.

With a demo account the full possibilities of Hazcalc can be expierenced. In the report however a demo watermark will show up.

After the 2 week trials ends, Hazcalc is automatically blocked and no assessments can be made. However, made assessments can still be seen, printed and downloaded.



2.3 Paid user account

During the use of the demo version or after expiring of the demo version a full license can be purchased. This can be done within the profile settings of your account. We offer multiple user plans. More information on our user plans are on our website hazcalc.com.

2.3.1 Single user account

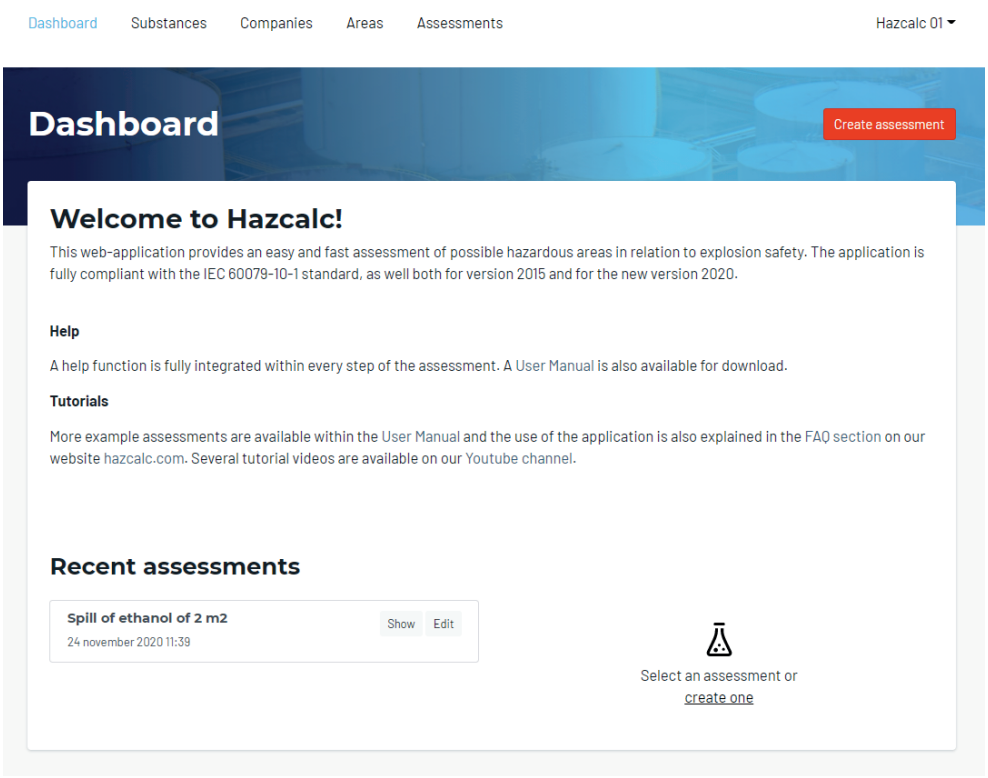
A single user account is an account that stricktly belongs to the user who made the account.

2.3.2 Multiple users account

A multiple user account is a bussiness account with more than 1 user. This gives high flexibility because users can be removed and added by a company-administrator and the company-administrator is able to login as a specific user.

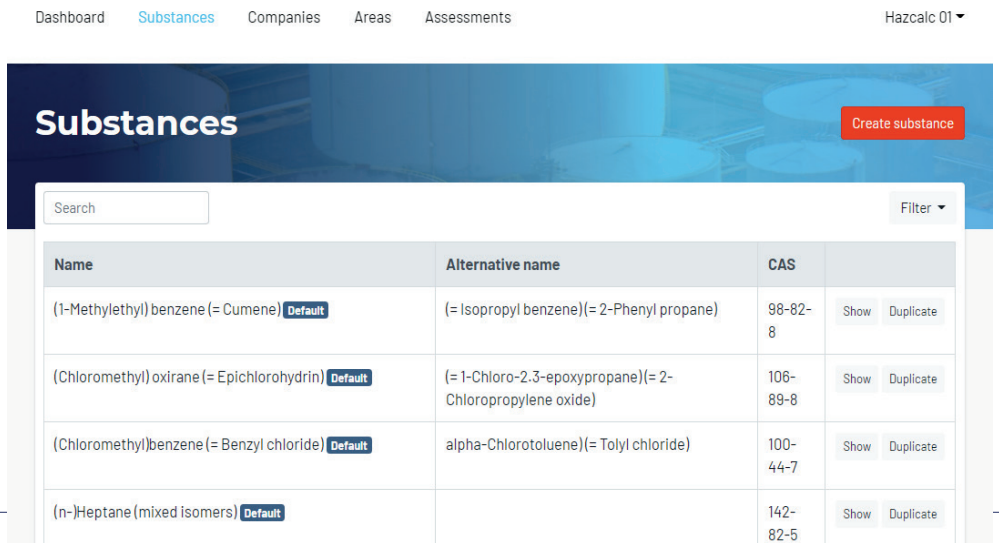
3 Structure of the application

After login the Dashboard screen is opened with presented all resent assessments (or empty for new users).



3.1 Substances

A default database of more than 250 substances is integrated within the application. These substances come from the IEC 60079-20-1 standard (Explosive Atmospheres - Part 20-1: Material characteristics for gas and vapour classification - Test methods and data). These substances cannot be edited or removed.



3.1.1 Selecting and checking

In General:
Always check the data of the substance that you use within the assessment. When you want to use other parameters, you have to add a new substance with the parameters that are applicable for the assessment. Default substances cannot be edited.

The pre-defined vapour pressure however can always be overridden at the appropriate places within the assessment.

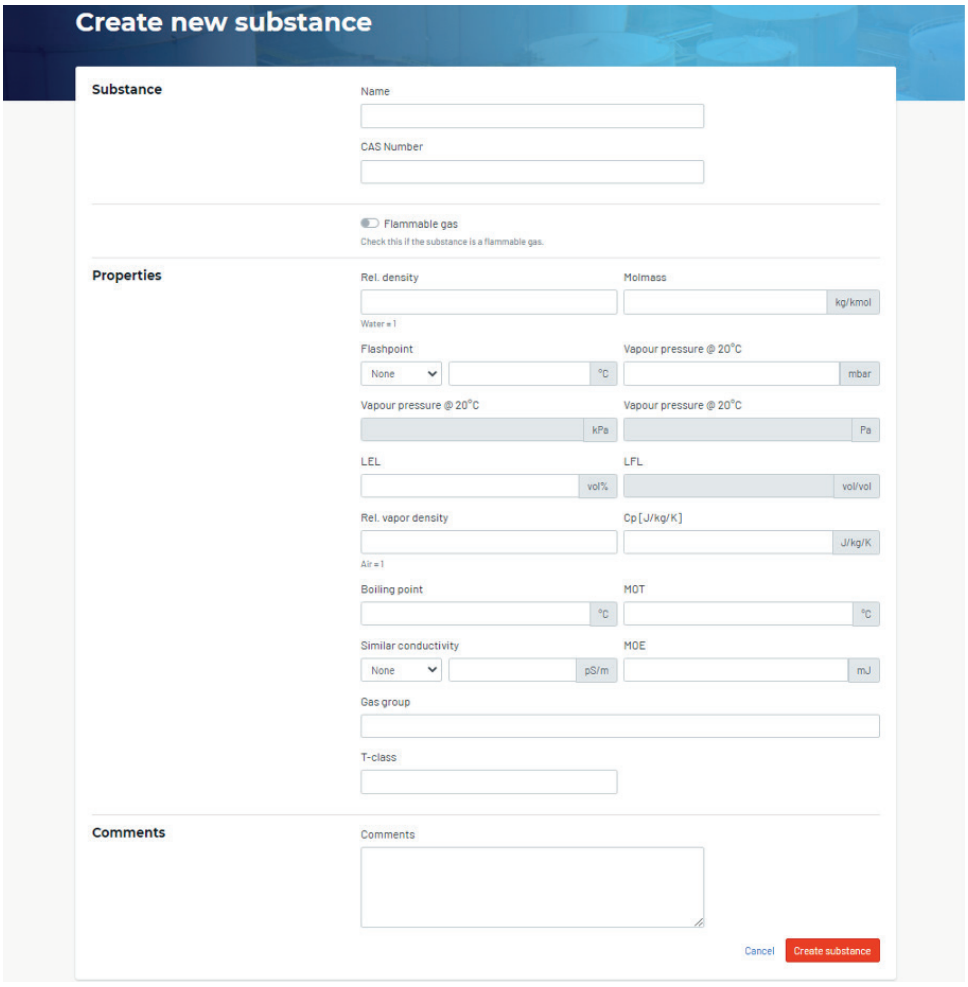
3.1.2 Manual adding substances

When the substance is not within the pre-defined substance database, new substances can be added by the user. These user defined substances are only available within the account of the user that added the new substance.

For adding new substances we recommend the following data sources:

1. GESTIS Substance Database: https://www.dguv.de/ifa/gestis/gestis-stoffdatenbank/index-2.jsp
2. NIST Chemistry WebBook: https://webbook.nist.gov/chemistry/#

Other data sources can also be used.



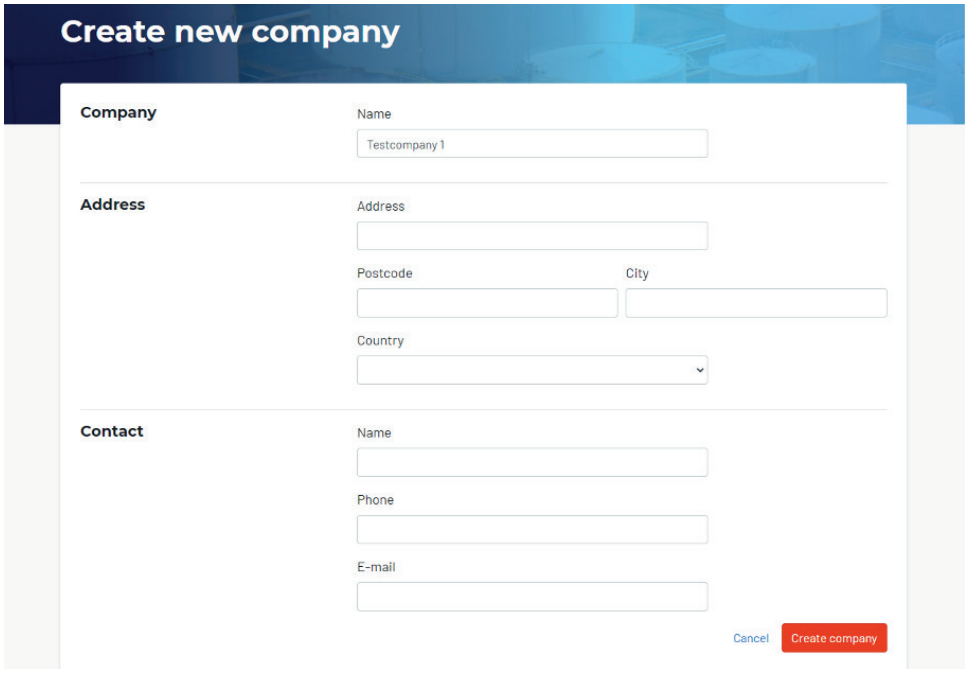
Mandatory* parameters are:

- Name
- Molmass
- Vapour pressure @ 20 °C (only for liquids)
- LEL
- Rel. vapor density
- Only for flammable gas: Cp

After entering the data click “create substance” to add the substance to the database! The substance can now be selected within the assessment.

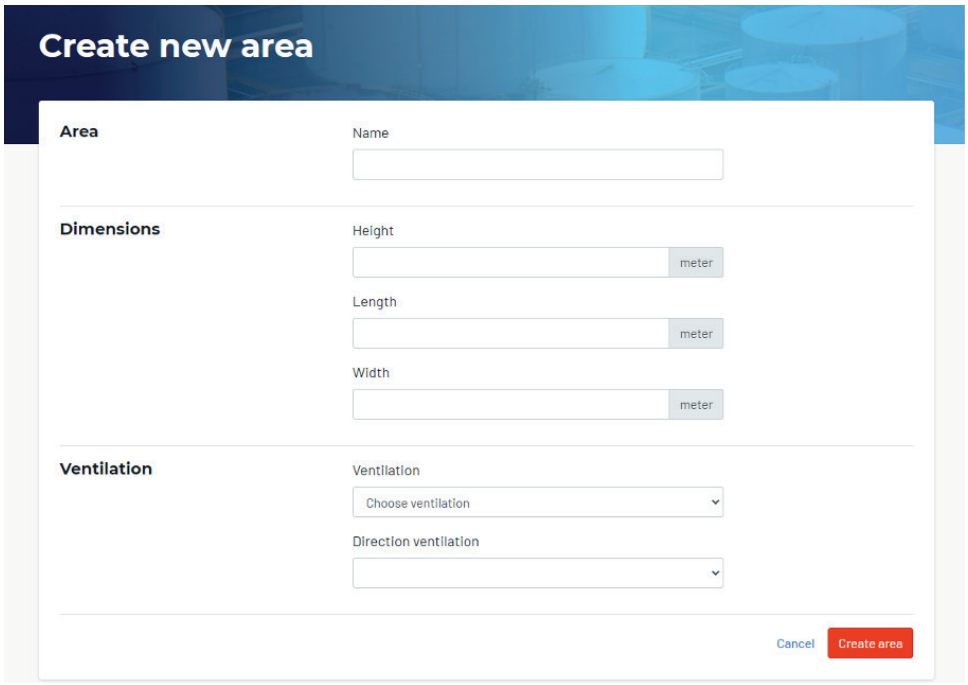
3.2 Companies

Before starting an assessment the related company must be added to the application. Mostly it is the company where the assessment is related to, like a client or customer or your own workplace. Only the company name is mandatory, but also all other fields can be filled in.



3.3 Areas

For assessment of indoor situations, areas must be added to the system.



3.3.1 Name and dimensions

The name of the area must be specified and the dimensions of the area must be specified.

When an area is not a rectangle, but maybe round or in other forms, specify the average length, width and height! These dimensions are used for automated calculation of the air velocity and ventilation rate. But in areas that are not a rectangle, the air velocity within the area under consideration must be and can be, manually overridden within the assessment!

3.3.2 Ventilation

The type of ventilation within the area must be specified here:

1. Mechanical
2. Natural
3. Mechanical + Natural

For each type of ventilation the ventilation capacity must be added. For mechanical ventilation capacity, check the installation manuals or perform ventilation measurements. For natural ventilation capacity check the IEC 60079-10-1 standard for calculation purposes or perform ventilation measurements.

Be sure that the ventilation properties are added well, because these parameters are quite significant within the model. However, the air velocity can also be overridden within the model at the relevant positions.

For automated calculation of the air velocity one has to choose the direction of the ventilation. In this way an average air velocity through a cross-sectional area of the room will be calculated. Manual override of this calculated value is also still possible at the relevant positions within the model.

Direction of ventilation

Select the most appropriate direction of the ventilation according to these pictures:

Sidewards long:

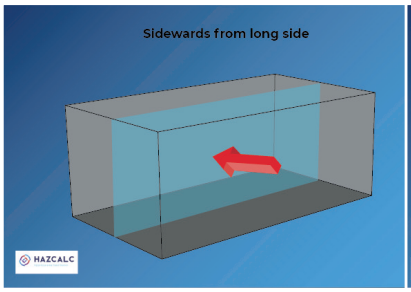


Figure 1, Area with sidewards airflow from the long side

Sidewards short:

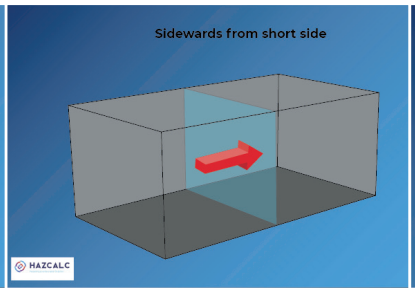


Figure 2, Area with sidewards airflow from the short side

Upwards:

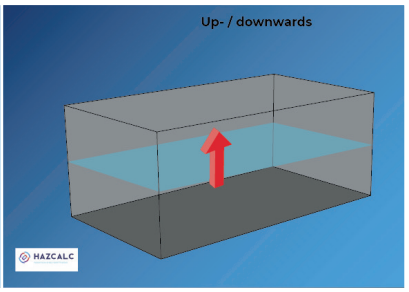
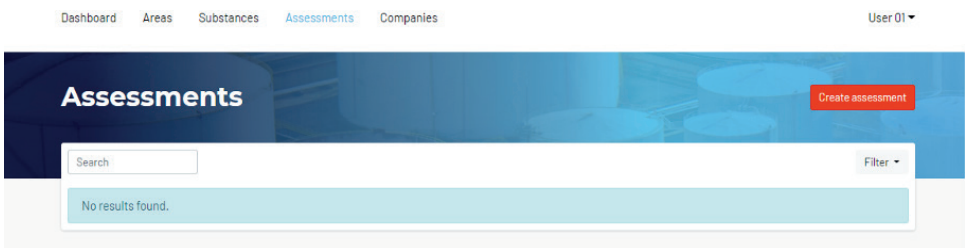


Figure 3, Area with up- or downwards airflow

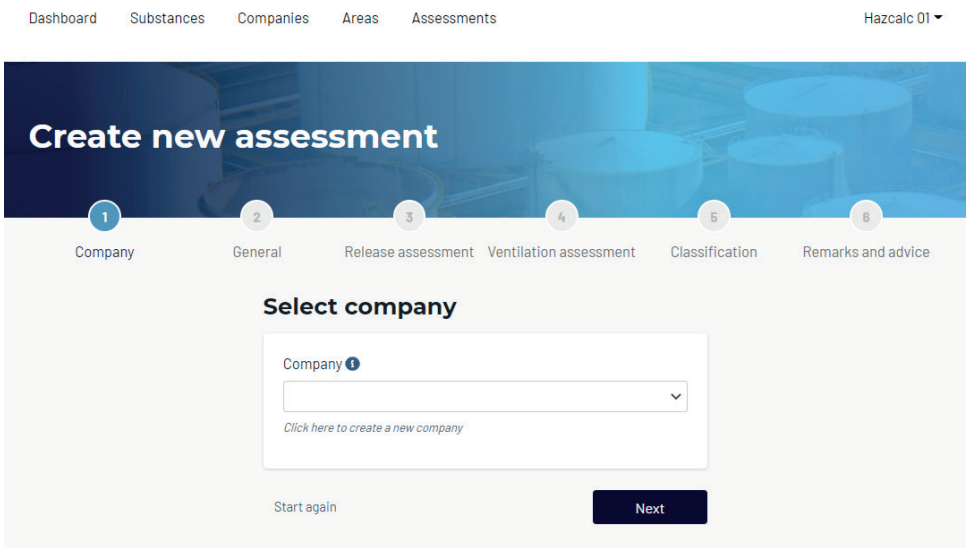
Based on this input the model automatically calculates the cross sectional area across the space under considoration and uses that value for calculating the average air velocity through the area. As mentioned, this value can still be overridden at the appropriate places within the model.

4 How things work!

After entering the applicable substances, companies and areas, a new assessment can be performed by clicking “Create assessment”



After clicking “Create Assessment” the following screen shows up:



4.1 Assessment in 7 steps

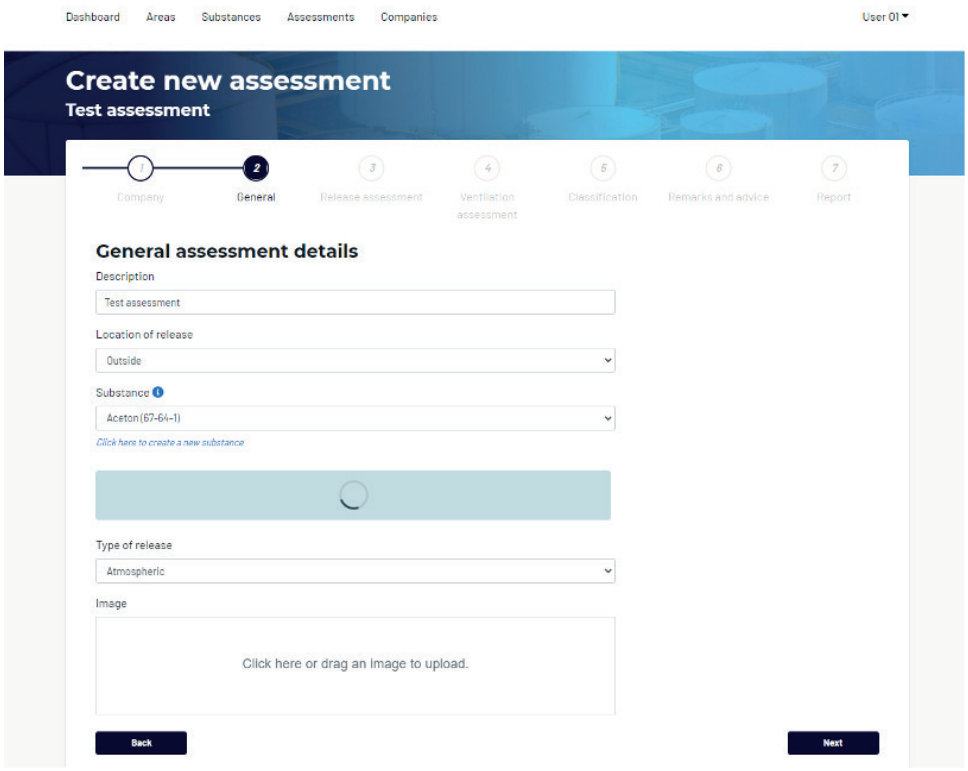
Here you can see that an assessment is divided in 7 steps:
1. Select company
2. General
3. Release assessment
4. Ventilation assessment
5. Classification
6. Remarks and Advice
7. Report

Each step in de assessment-process can be followed up by clicking next.

4.1.1 Select Company

First of all a company must be selected. Mostly it is the company where the assessment is related to, like a client or customer or your own workplace. When no company can be selected, one has to add a new company first (see chapter 3.2).

4.1.2 General assessment details



Description

Here one can give a short description of the assessment to be executed.

Location of release

One can select the location of release. For indoor locations, the area must be specified and selected (see chapter 3.3 when the area is not in the list).

Substance

The substance can be selected from the list.
All the relevant data is automatically loaded within the blue fields.

Type of Release

At last one has to choose the type of release. With the several types of release the “vapour release rate” must be calculated. The “vapour release rate” stands for the amount of substance (in time) in gaseous form that releases from the source.

When the substance is a liquid one can choose the following types of release:

1. Atmospheric 2015
Choose this option when the gaseous release rate of an evaporative pool must be calculated. With this option the formulas of IEC 60079-10-1 version 2015 are used.

2. Atmospheric 2020
Choose this option when the gaseous release rate of an evaporative pool must be calculated. With this option the formulas of the IEC 60079-10-1 version 2020 are used.

3. Manual
Choose this option when the gaseous release rate is calculated with formulas that are not within the IEC 60079-10-1 standard. The result of that calculation can be add manually.

4. Vapour pressure
Choose this option when the gaseous release rate out of a container, that is filled up with flammable liquids, must be calculated. This is done by using the saturated vapour pressure at the actual medium temperature. The saturated vapour concentration can be calculated with these parameters. The saturated vapour pressure at a certain temperature is the highest concentration within an enclosed space. Based on that concentration and the flow rate of the substance the worst-case quantity of saturated air, displaced by the liquid, coming out of the container can be calculated.

5. Liquid
Choose this option when the liquid release out of an enclosed space must be calculated, e.g. flanges in a piping for transport of liquids. Based on the pressure difference and leak-opening the liquid release rate will be calculated. A percentage of the liquid that evaporates immediately can be entered, to calculate the gaseous release rate.

When the substance is a flammable gas one can choose the following types of release:

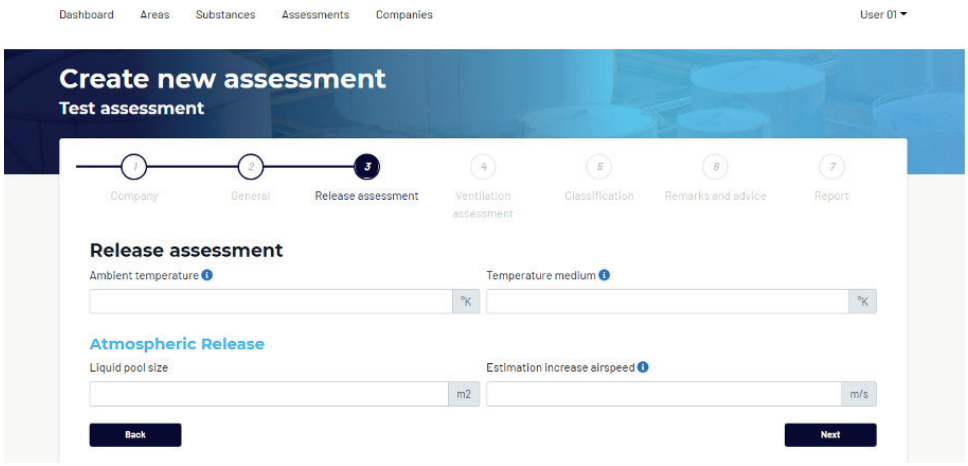
1. Pressurized
Choose this option when the gaseous release out of an enclosed system must be calculated, e.g. flanges in a piping for transport of gases. Based on the pressure difference and leak-opening, the gaseous release rate will be calculated.

2. Manual
Choose this option when the gaseous release rate is calculated with formulas that are not within the IEC 60079-10-1 standard. The result of that calculation can be add manually.

3. Liquid
Choose this option when a the evaporation of a liquified gas out of an enclosed space must be calculated. Based on the pressure difference and leak-opening the liquid release rate will be calculated. A percentage of the liquid that evaporates immediately can be entered, to calculate the gaseous release rate.

Image
An image (max. 10 MB) can be uploaded for displaying in the assessment-report.

4.1.3 Release Assessment



General	
Ambient medium	The temperature of the room or area under consideration.
Temperature medium	The temperature of the medium under consideration.
Atmospheric release	
Liquid pool size	When liquids are spilled or dripping out of an enclosure, an evaporative pool on the floor will be formed. Estimate the maximum size of that pool. This can be done e.g. by the size of a drip tray that is used or by the maximum time/size before a spill is discovered. **Be aware that under-estimation of the size of the pool leads to underestimation of the risk.**
Estimation increase air velocity  Figure 4, air velocity measurement with an anemometer	Based on the values entered when creating an area (see chapter 3.3) the average air velocity within the room is calculated. This can be an underestimation of the actual air-velocity across the liquid pool. E.g. local fans of motors or other type of equipment can locally lead to a higher air velocity. The gaseous release rate from the pool depends for a large amount on the used air velocity: the higher the air velocity, the higher the gaseous release rate will be. So within this field a correction on the average calculated air velocity can be made. This can be done by performing measurements of the air velocity above the pool or by an estimation. As a reference one can use the following thoughts: an air velocity of appr. 0,10 m/s can be felt by workers and often leads to complaints. **Be aware that under-estimation of the air velocity across the pool leads to underestimation of the risk.**

K-factor	The k-factor must be selected for calculating the Release Characteristic. The use of the k-factor is removed with version 2020 of the IEC 60079-10-1. Hazcalc was updated in june 2021, when a Safety Factor was introduced to the IEC 60079-10-1:2020 version model. (in step 4 Ventilation Assesment). The k-factor is a safety factor attributed to the Lower Flammable Limit, typically between 0,5 and 1,0. A lower value however can also be used. This leads to a higher release characteristic and thus a more conservative approach.
Manual release	
We / Wg	Add evaporation rate of liquids (We) or mass release rate of gas (Wg) manually. This option is available for calculations made that are not available within IEC 60079-10-1.
K-factor	The k-factor must be selected for calculating the Release Characteristic. The use of the k-factor is removed with version 2020 of the IEC 60079-10-1. Hazcalc was updated in june 2021, when a Safety Factor was introduced to the IEC 60079-10-1:2020 version model. (in step 4 Ventilation Assesment). The k-factor is a safety factor attributed to the Lower Flammable Limit, typically between 0,5 and 1,0. A lower value however can also be used. This leads to a higher release characteristic and thus a more conservative approach.
Vapour pressure	
Speed of the release [m3/hr]	Add the flow rate of the liquid that is pumped of transported in the enclosure (like an IBC or vessel). The displaced air comes with the same flow rate out of the fill-opening of the enclosure.
Pressure in casing [Pa]	Specify the pressure within the casing. Normally 101325 Pa.
Vapour pressure at Tmedium (override)	The standard vapour pressure at 20 °C can be overridden here when the temperature of the medium is higher or lower than 20°C. Use data sources on the internet for reference values. The NIST Chemistry WebBook: https://webbook.nist.gov/chemistry/# can be used for making calculations with the Antoine formula.
K-factor	The k-factor must be selected for calculating the Release Characteristic. The use of the k-factor is removed with version 2020 of the IEC 60079-10-1. Hazcalc was updated in june 2021, when a Safety Factor was introduced to the IEC 60079-10-1:2020 version model. (in step 4 Ventilation Assesment). The k-factor is a safety factor attributed to the Lower Flammable Limit, typically between 0,5 and 1,0. A lower value however can also be used. This leads to a higher release characteristic and thus a more conservative approach.

Liquid release	
Atmospheric pressure [bara]	Fill in the atmospheric pressure; normally 1 bar absolute.
Pressure in system [barg]	Fill in the pressure within the enclosed system. Check manometers (bar gauge) for reference values.
S	Cross section of the opening (hole), through which the fluid is released (m2)/ Specify the release opening. See table B.1 in IEC 60079-10-1 for suggested hole cross sections for secondary grades of release. See also the help function within the application. **Be aware that under-estimation of this release opening leads to underestimation of the risk.**
Cd	Specify the value of Cd, discharge coefficient (dimensionless) which is a characteristic of the release openings and accounts for the effects of turbulence and viscosity, typically 0,50 to 0,75 for sharp orifices and 0,95 to 0,99 for rounded orifices.
Percentage evaporation	Fill in the percentage of the liquid that evaporates immediately after release. Normally this is an estimation. Be aware that under-estimation of this percentage leads to underestimation of the risk.
K-factor	The k-factor must be selected for calculating the Release Characteristic. The use of the k-factor is removed with version 2020 of the IEC 60079-10-1. Hazcalc was updated in june 2021, when a Safety Factor was introduced to the IEC 60079-10-1:2020 version model. (in step 4 Ventilation Assesment). The k-factor is a safety factor attributed to the Lower Flammable Limit, typically between 0,5 and 1,0. A lower value however can also be used. This leads to a higher release characteristic and thus a more conservative approach.

Normally ambient temperatures above and under reference levels of 20°C (293 °C), have negligible effect on the explosion properties of the flammable substances.

Always check the data of the substance that you use within the assessment. When you want to use other parameters, you have to duplicate the default substance before values can be edited. Or add a new substance with the parameters that are applicable for the assessment. Default substances cannot be edited.

The pre-defined vapour pressure however can be overridden at the appropriate fields.

Pressurized release	
Atmospheric pressure	Fill in the atmospheric pressure; normally 1 bar absolute.
Pressure in system	Fill in the pressure within the enclosed system. Check manometers (bar gauge) for reference values.
S	Cross section of the opening (hole), through which the fluid is released (m2)/ Specify the release opening. See table B.1 in IEC 60079-10-1 for suggested hole cross sections for secondary grades of release.See also the help function within the application. **Be aware that under-estimation of this release opening leads to underestimation of the risk.**
Z	Compressibility factor (dimensionless) The compressibility factor for ideal gases is 1,0. For the real gases, the compressibility factor takes values below or above 1,0 depending on type of the gas concerned, the pressure and the temperature. For low to medium pressures, Z =1,0 can be used as a reasonable approximation and may be conservative. For higher pressures, e.g. above 50 bar, and where improved accuracy is required the real compressibility factor should be applied. The values for compressibility factor can be found in data books for gas properties.
Cd	Specify the value of Cd, discharge coefficient (dimensionless) which is a characteristic of the release openings and accounts for the effects of turbulence and viscosity, typically 0,50 to 0,75 for sharp orifices and 0,95 to 0,99 for rounded orifices.
k-factor	he k-factor must be selected for calculating the Release Characteristic. The use of the k-factor is removed with version 2020 of the IEC 60079-10-1. Hazcalc was updated in june 2021, when a Safety Factor was introduced to the IEC 60079-10-1:2020 version model. (in step 4 Ventilation Assesment). The k-factor is a safety factor attributed to the Lower Flammable Limit, typically between 0,5 and 1,0. A lower value however can also be used. This leads to a higher release characteristic and thus a more conservative approach.

Normally ambient temperatures above and under reference levels of 20°C (293 °C), have negligible effect on the explosion properties of the flammable substances.

Always check the data of the substance that you use within the assessment. When you want to use other parameters, you have to duplicate the default substance before values can be edited. Or add a new substance with the parameters that are applicable for the assessment. Default substances cannot be edited.

The pre-defined vapour pressure however can be overridden at the appropriate fields.

Pressurized release (2)	
Cp (override)	Specific heat at constant pressure (J/kg K). This value depends on the temperature of the medium. So with higher medium temperatures, the specific heat can be adjusted here. Use data sources on the internet for reference values. The NIST Chemistry WebBook: https://webbook.nist.gov/chemistry/# can be used by making correction based on interpolation.

Normally ambient temperatures above and under reference levels of 20°C (293 °C), have negligible effect on the explosion properties of the flammable substances.

Always check the data of the substance that you use within the assessment. When you want to use other parameters, you have to duplicate the default substance before values can be edited. Or add a new substance with the parameters that are applicable for the assessment. Default substances cannot be edited.

The pre-defined vapour pressure however can be overridden at the appropriate fields.

4.1.4 Ventilation Assessment

Within the ventilation assessment the degree of dilution of the flammable gases / vapours in the atmosphere (calculated within the release assessment in the previous step) are assessed.
The principle is that a high degree of dilution of gases / vapours leads to a lower concentration of the flammable substances in the atmosphere; thus a lower potential risk. A lower degree of dilution however, leads to less dilution of gases/ vapours and thus to a higher potential risk.

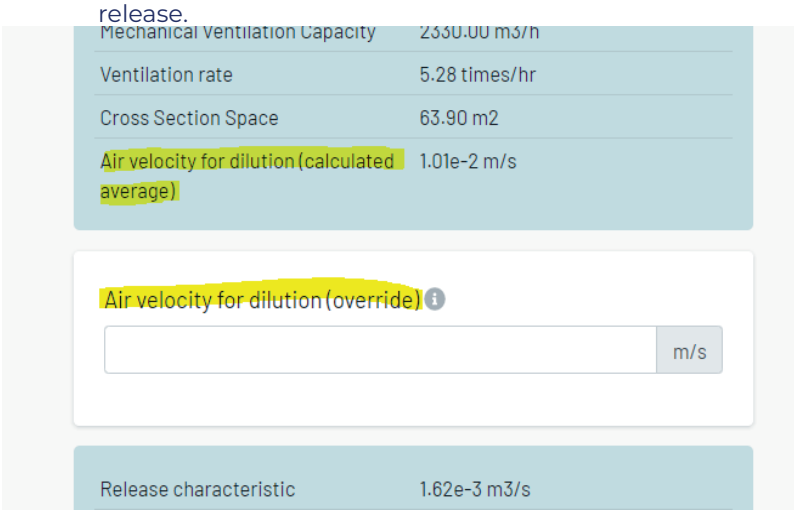
The degree of dilution is equal to the air velocity near the source of release. The higher the air velocity, the more dilution of vapours and gases. The lower the air velocity, the less dilution. The air velocity near the source of release is compared with the characteristic of the release.
The characteristic of the release is the ratio between the calculated evaporation rate of liquids or the release rate of gases and a percentage (k-factor) of the Lower Flammable Limit.

The following fields must be entered within the ventilation assessment:

Ventilation Assessment	
Airvelocity for Dilution	The air velocity for dilution must be entered. Two scenarios are available:

Figure 5, air velocity measurement with an anemometer

- **Indoor situations:**
  For indoor situations the area is specified with ventilation properties. Based on these values the average air velocity within the room is calculated. This can be an underestimation of the actual air-velocity for dilution within the room and near the source of release.



So within this field the average calculated air velocity can be overrided. This can, preferably being done, by performing measurements of the air velocity near the source of release.

Be aware that over-estimation of the air velocity near the source of release leads to underestimation of the risk!

- **Outdoor situations:**
  Fill in the air velocity near the source of release. Table C.1 of the IEC 60079-10-1 gives an indication for outdoor ventilation velocities. See also the help function near the field.

Ventilation Assessment	
Background Concentration	For indoor situations, also another factor must be calculated: the background concentration. The background concentration within an area may never reach the critical concentration. The critical concentration is specified as 25% of the Lower Flammable Limit of a substance. This can be explained by the following example: a high air velocity within the vicinity of the source of release can be achieved by a local ventilator. The air velocity can be extremely high there, so locally the flammable substances will be diluted with a high grade. Over time however, the average concentration of flammable substances within the room can, in case of a low ventilation capacity (m3/hr) of the room, rise to a dangerous level. In that case the grade of dilution is set to low, and a potential high risk can be present. For assessing the background concentration the following field must be entered:
Efficiency ventilation	The efficiency of the ventilation has only to be entered for indoor situation where the background concentration has to be assessed. The efficiency of the ventilation (factor f in the IEC standard) stands for the efficiently of the ventilation within the room related to the average background concentration within the room. The efficiency of the ventilation within the room is classified as a number from 1 to 5: 1 stands for efficiently mixing of the air within the total area under consideration and 5 stands for very inefficient mixing. The factor is used for assessing the background concentration within the area under consideration. This concentration may not be higher than a predefined (and arbitrary) percentage of the LFL, e.g. the value at which a gas detector is set to alarm. Within Hazcalc this value is fixed at 25% of the LFL. When the background concentration exceeds the critical concentration (25% of the LFL), the degree of dilution is automatically set to low, which then automatically overrules the outcome of the assessment of the degree of dilution. **Tip:** For local air extraction systems the efficiency can be set to 1.

Background concentration for indoor situations

For indoor situations, also another factor must be calculated: the background concentration. The background concentration within an area may never reach the critical concentration. The critical concentration is specified as 25% of the Lower Flammable Limit of a substance.

This can be explained by the following example: a high air velocity within the vicinity of the source of release can be achieved by a local ventilator. The air velocity can be extremely high there, so locally the flammable substances will be diluted with a high grade. Over time however, the average concentration of flammable substances within the room can, in case of a low ventilation capacity (m3/hr) of the room, rise to a dangerous level. In that case the grade of dilution is set to low, and a potential high risk can be present.

For assessing the background concentration the following field must be entered:

Efficiency of the ventilation	The efficiency of the ventilation has only to be entered for indoor situation where the background concentration has to be assessed. For outdoor situations this chapter (background concentration) and field (efficiency of the ventilation) does not show up. The efficiency of the ventilation (factor f in the IEC standard) stands for the efficiently of the ventilation within the room related to the average background concentration within the room. The efficiency of the ventilation within the room is classified as a number from 1 to 5: 1 stands for efficiently mixing of the air within the total area under consideration and 5 stands for very inefficient mixing. The factor is used for assessing the background concentration within the area under consideration. This concentration may not be higher than a predefined (and arbitrary) percentage of the LFL, e.g. the value at which a gas detector is set to alarm. Within Hazcalc this value is fixed at 25% of the LFL. When the background concentration exceeds the critical concentration (25% of the LFL), the degree of dilution is automatically set to low, which then automatically overrules the outcome of the assessment of the degree of dilution. **Tip:** For local air extraction systems the efficiency can be set to 1.
Safety Factor	With reference to the 2020 version of the IEC -standard, a safety factor was introduced within Hazcalc. This Safety Factor is an extra factor that can be applied for assessing the Ventilation. The applied factor is a safety factor in relation to the Lower Flammable Limit, e.g. when a safety factor of 25% is applied, the Release Characteristic is calculated based on a LFL of 100%-25% = 75% of the Lower Flammable Concentration. With a Safety Factor of 10%, the Release Characteristic is calculated with 90%LFL. When using this factor, one will see that this factor can be critical when the red dot in the graphs in near to the blue or red line, so that another dilution class must be applied.

4.1.5 Classification

The classification of hazardous areas is determined by the result of all the input from the previous steps together with the type of release source (type of hazard) and the type of release.

Type of release source

The source at which a substance is released has to be classified as type of release source. The following types of release source are applicable:

- Continuous source of release;
- Primary source of release;
- Secondary source of release.

These types of release are defined as (within IEC 60079-10-1):

Continuous grade of release	which is continuous or is expected to occur frequently or for long periods Examples are: a. The surface of a flammable liquid in a fixed roof tank, with a permanent vent to the atmosphere. b. The surface of a flammable liquid which is open to the atmosphere continuously or for long periods. Note: in some national standards a percentage of the working time or operational time of the installation is set as a “rule of thumb”: more than 10% of the duration of an activity or more than 10% of the operational time of the installation.
Primary grade of release	release which can be expected to occur periodically or occasionally during normal operation Examples are: a. Seals of pumps, compressors or valves if release of flammable substance during normal operation is expected. b. Water drainage points on vessels which contain flammable gases or liquids, which may release flammable substance into the atmosphere while draining off water during normal operation. c. Sample points which are expected to release flammable substance into the atmosphere during normal operation. d. Relief valves, vents and other openings which are expected to release flammable substance into the atmosphere during normal operation Note: in some national standards a percentage of the working time or operational time of the installation is set as a “rule of thumb”: between 0,1 and 10% of the duration of an activity or between 0,1 and 10% of the operational time of the installation.

Secondairy 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 Examples are: a. Seals of pumps, compressors and valves where release of flammable substance during normal operation of the equipment is not expected. b. Flanges, connections and pipe fittings, where release of flammable substance is not expected during normal operation. c. Sample points which are not expected to release flammable substance during normal operation. d. Relief valves, vents and other openings which are not expected to release flammable substance into the atmosphere during normal operation Note: in some national standards a percentage of the working time or operational time of the installation is set as a "rule of thumb": less than 0,1% of the duration of an activity or less than 0,1 % of the operational time of the installation.

The hazardous area is than automatically classified by the following scheme:

	Effectiveness of ventilation						
	High dilution			Medium dilution			Low dilution
	Availability of ventilation						
Grade of release	Good	Fair	Poor	Good	Fair	Poor	Good, Fair, Poor
Continuous	Non-hazar-dous (Zone 0 NE)a	Zone 2 (Zone 0 NE)a	Zone 1 (Zone 0 NE)a	Zone 0	Zone 0 + Zone 2	Zone 0 + Zone 1	Zone 0
Primary	Non-hazar-dous (Zone 1 NE)a	Zone 2 (Zone 1 NE)a	Zone 2 (Zone 1 NE)	Zone 1	Zone 1 + Zone 2	Zone 1 + Zone 2	Zone 0 or Zone 0c
Secon-dairyb	Non-hazar-dous (Zone 2 NE)a	Non-hazar-dous (Zone 2 NE)a	Zone 2	Zone 2	Zone 2	Zone 2	Zone 0 and even Zone 0c

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

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

c 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).

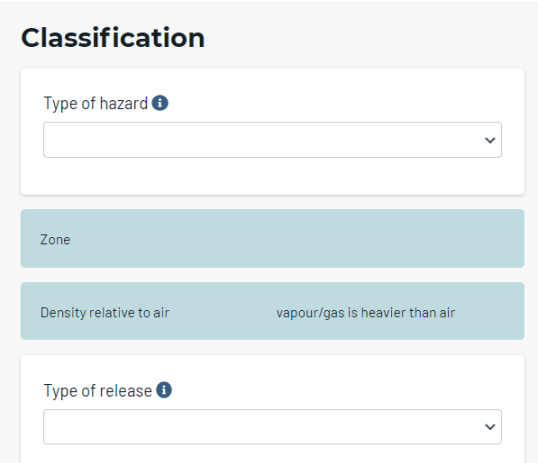
'+' Signifies 'surrounded by'

Availability of ventilation in naturally ventilated enclosed spaces shall never be considered as good.

Extend of the hazardous area

The extent of the hazardous zone 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 in the standard may be used as a guide to determine the extent of hazardous zones for various forms of release.



The appropriate line from the graph should be selected based on the type of release as either:

a. an unimpeded jet release with high velocity;
b. a diffusive jet release with low velocity or a jet that loses its momentum due to the geo metry of the release or impingement on nearby surfaces;
c. heavy gases or vapours that spread along horizontal surfaces (e.g. the ground).

Possible guidance on selecting the type of release

Type	Should be selected when:
Jet	Assessing pressurized gas systems.
Diffuse	Assessing (low) pressurized gas systems and liquid evaporation
Heavy	Assessing (low) pressurized gas systems and liquid evaporation from sub-stances that are heavier than air (e.g. substances with a relative density higher than 1,2).

·In IEC 60079-10-1:2015 the Volumetric release characteristic of the source, Qc, on the horizontal axis, was defined as the Release characteristic Wg/ρg x k x LFL.

Further the graph is exact the same is in IEC 60079-10-1:2020. Within Hazcalc the graph from the 2020 version is used.

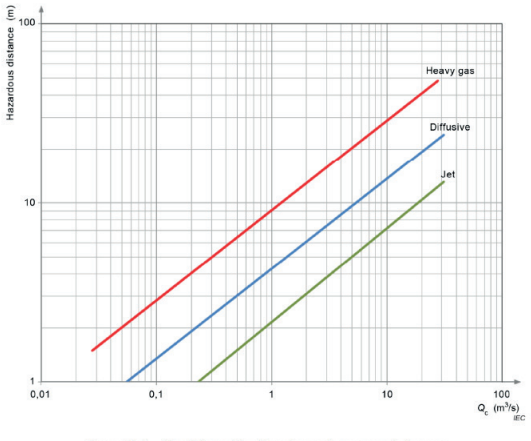


Figure D.1 – Chart for estimating hazardous area distances

Figure 6, chart D.1 from IEC 60079-10-1:2020

The curves are based on a zero background concentration and are not applicable for indoor medium and low dilution situations (see C.3.6.1).

The chart represents a rough approximation for some large-scale situations but would not be reliable on a small scale level. Where a zone of negligible extent (NE) is suggested then the use of this chart is not applicable.

Extrapolation of the curves beyond the chart area shown in Figure 7, should not be undertaken. IEC 60079-10-1 standard is quite clear to that.

Figure 7, mobile PID / LEL measurement for additional assessment

Extrapolation of the graph is however still possible with Hazcalc. When extrapolating, it must always be done in combination with further examination. This examination can be done by e.g. additional concentration measurements with a mobile PID or LEL detector. Be aware that these detectors have a low accuracy, so apply an extra safety zone when additional measurements are done. In situations where additional measurements are not possible (e.g. secondary sources of release out of flanges), extrapolation should not be applied.

Than it is better to apply other methods for determination of the extents of the hazardous area. See IEC 60079-10-1 for more guidance.

4.1.6 Remarks, Advice

Within these two fields some comments can be made and an advice can be given on which hazardous area and which extent of the hazardous area should be applied.

The fields are not mandatory but can give more explanation about the basic principles or starting points, thoughts and considerations that are applicable on the assessment.

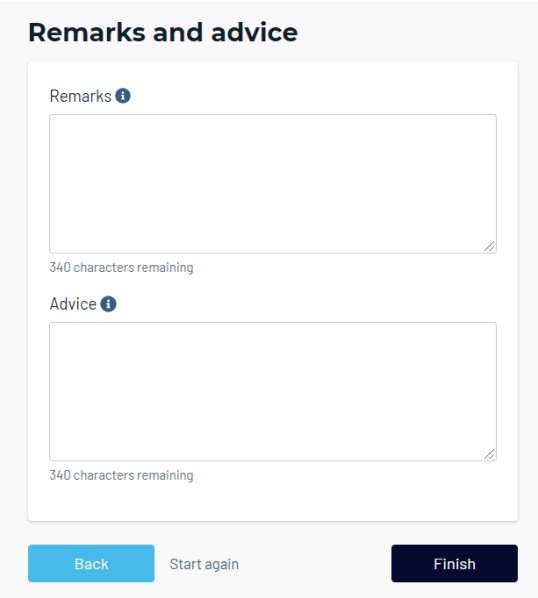


Figure 8, remarks and Advice fields

4.1.7 Finish

Click Finish to save the assessment. The total assesment is displayed on screen now, so control of all the values is easy.

4.1.8 Report

The assessment can be printed as an Acrobat PDF file with the Report button.

A full example report is shown in Fig. 10.

Multiple assessments can be printed in one report by selecting the assessments on the “Assessments page and select Report.

On IOS Devices one must click on “Click here to try again”in order to open the pdf on screen.

TIP: When printing multiple assessments at once, the assessments are ordered by the description. So to order assessments in the appropriate way one should consider renaming the assessments and starting with e.g. [1] Assessment one, [2] Assessment two, [3] Assessment three, etc.

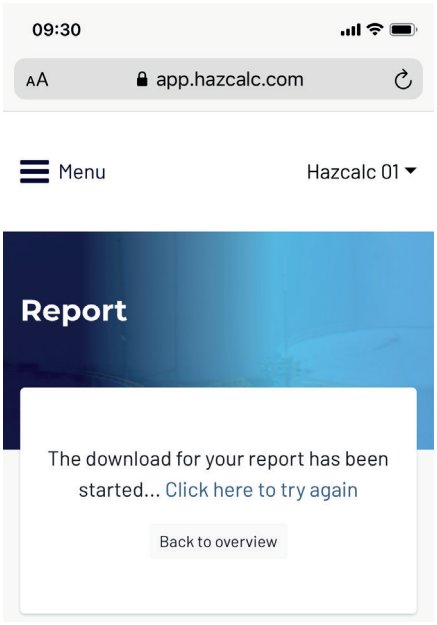


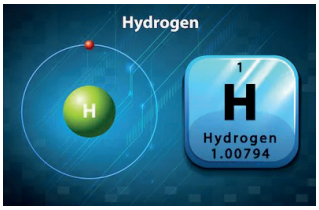
Figure 9, Click here to try again on monile IOS Devices

Hazcalc B.V.
Stobbenakker 32
7391 LZ Twello
Netherlands

HAZCALC
hazardous area classification

Hazardous Area Classification: Leaking flange Hydrogen release @ 350 bar

Company	Hazchem
Assessment	Leaking flange Hydrogen release @ 350 bar
Location of release	Inside
Area name	Production room 1



Substance properties

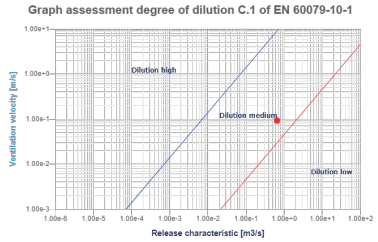
Substance name	Hydrogen
CAS-number	1333-74-0
Molmass	2.02 kg/kmol
Flashpoint	flammable gas
Vapour pressure @ Tmedium	flammable gas
LFL [vol/vol]	0.040 vol/vol
Relative vapour density (air = 1)	0.07
Universal Gas Constant, R	8314 (J/kmol/K)

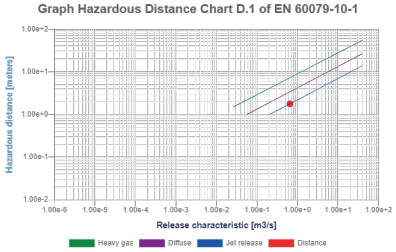
Release-assessment

Type of release	Pressurized	**Ambient temperature, Ta**	293 °K
Atmospheric pressure, Pa	101325 Pa (1.00 bara)	**Temperature medium, Tm**	293 °K
Pressure in system, Pa	35101325 Pa (350.00 barg)	**Leak-opening, S**	2.50e-8 m2
Cp	13861 J/kg/K	**Compressibility factor, Z**	1.00
γ	1.42	**Velocity of the released gas is**	sonic/choked release
Critical pressure, Pc	193167 Pa	**Density of the gas, ρg**	8.40e-2 kg/m3
Cd	0.99	**Used formula**	B4
Mass release rate of the gas, Wg	5.45e-4 kg/s		
Volumetric gas release rate, Qg	6.48e-3 m3/s		
K-factor	0.25		
Release characteristic	6.48e-1 m3/s		

Ventilation assessment

Area length, width and height	15.00 x 3.00 x 3.00 mtr
Ventilation capacity	15000 m3/h
Volume	135.00 m3
Ventilation rate	111.11 times/hr
Air velocity for dilution	9.26e-2 m/s
Dilution class	Medium dilution
Availability ventilation	Fair
Efficiency ventilation	3
Crtitical concentration, Xcrit	1.00e-2 vol/vol
Background concentration, Xb	4.67e-3 vol/vol
Result	background concentration < critical concentration, so OK
Resulting dilution class	Medium dilution





Classification of area

Type of release source	Secondary
Zone	Zone 2
Density of gas relative to air	vapour/gas is lighter than air
Type of release	Jet
Radius zone area	1.77 mtr
Temperature class	T1
Gas group	IIC

Comments

Swagelok couplers are used.

Advice

Apply a zone 2 with a radius of 2 meters around release sources. Apply a ventilation system with ventilation opening on the top of the room. Make the ceiling smooth such that there are no unventilated areas (blind spots) within the room where there can be a build up of hydrogen. Ventilate the room with overpressure from ground level.

Figure 10, Example report from Hazcalc

HAZCALC

5. Edit Assessments

On the assessment page, all the assessments are stored. Useful features here are the filter options to display only certain sets of assessments, e.g. to compare certain assessments and its results.

5.1 Showing Assessments

By clicking on show the report of the assessment is shown.

5.2 Editing Assessments

By clicking edit, the selected assessment can being edited. This can be done by clicking on the appropriate chapter, changing the values and clicking next and in step 7 on Finish.

Be aware that with editing an assessment, the assessment must be saved by clicking on “Finish” within step 7. Only then, the changes made, are saved.

5.3 Deleting Assessment

By clicking delete the selected assessment will be deleted from the database.

5.4 Copy Assessment

By clicking copy, the selected assessment will be copied. The name will be added with the suffix copy_xx. This option is very useful for quick adding or comparison of e.g. identical situations where only the substance changes, or what the effects are of more ventilation in a given circumstance.

6. Used formulas

The formulas used for the calculations are mainly based on the formulas stated in the IEC 60079-10-1 standards. However, for the “Vapour Pressure” type of release a formula is used from another source.

With the “vapour pressure” release the mass release rate of gas out of a container of tank during filling of tank container/tank with liquid. The vapour pressure of that liquid is used to calculate the saturated vapour concentration within the container with the follwing formula:

$$C = \frac{M}{22{,}4} \cdot \frac{p}{1013} \cdot \frac{273}{T} \cdot 10^6$$ where

C = concentation in air in mg/m3
M = relative molecul mass
p = vapour pressure in mbar @ temperature T
T = Temperature in Kelvin

Together with the filling rate in m3/hr the mass release rate of (saturated) gas out of the tank opening is calculated. This is a concervative approuch of the actual situation and thus the risk. The actual concentration will be lower, but hard to measure with e.g. a LEL measuring device which stops at appr. 100%LEL.

7. Frequently Asked Questions

Answers about the use of the tool can be found under the Frequently Asked Questions section on the website www.hazcalc.com/faq. Also several examples of scenario assessments are available on the website.

When appropriate answers are not listed in the FAQ, a ticket for guidance can be sent to us from your user account. We will answer that ticket as soon as possible.

8. Development

Hazcalc will stay under continuous development. So tips, tricks and recommendations are welcome. These can be sent to info@hazcalc.com

9. Examples

For the maximum return of investment, several examples of assessments are included within this manual:

Example 1:	Spill of 1 m2 of ethanol within an production facility
Example 2 :	Leaking of a flange of a pressurized gas system with hydrogen
Example 3 :	Filling an IBC with acetone at a flow rate of 100 ltr/min
Example 4 :	Leaking flange of a biogas system (40 mbarg) in outdoor situation
Example 5 :	Leaking of a pump seal for xylene in an indoor situation

Example 1 Spill of 1 m2 ethanol indoors

Area parameters:
Length : 10 mtr
With: 5 mtr
Height: 3 mtr
Ventilation: Mechanical
Ventlation Capacity: 1500 m3/hr
Direction of ventilation: sidewards long

Ventilation measurements are not performed.

Step 1) Add a company, you can choose the name
Step 2) Add the area with the paremeters specified above
Step 3) Start an Assessment for an indoor situation and select the area and the substance from the database and choose as Type of Release: “Atmospheric”
Step 4) Set the temperatures to 20°C, liquid pool size to 1 m2 and estimation increase airspeed to 0,1 m/s
Step 5) Don’t use the dilution override and set the efficiency of the ventilation to moderate (3) and set the availability to “Fair”
Step 6) Select a secondary release source and since the gas is heavier than air choose : “Heavy Gas”
Step 7) Click next, followed by “Finish” and print the report

The result should be this report:

Hazcalc B.V.
Stobbenakker 32
7391 LZ Twello
Netherlands

HAZCALC
hazardous area classification

Hazardous Area Classification: Spill of ethanol of 1 m2

Company	Hazchem
Assessment	Spill of ethanol of 1 m2
Location of release	Inside
Area name	Production room 1

Substance properties

Substance name	Ethanol (= Alcohol)
CAS-number	64-17-5
Molmass	46.10 kg/kmol
Flashpoint	12 °C
Vapour pressure @ Tmedium	5900.00 Pa
LFL [vol/vol]	0.031 vol/vol
Relative vapour density (air = 1)	1.59
Liquid density @ 20°C	790 kg/m3
Universal Gas Constant, R	8314 (J/kmol/K)

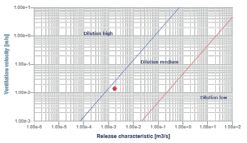
Release-assessment

Type of release	Atmospheric
Size of the liquid pool	1 m2
Calculated average air velocity in area	1.39e-2 m/s
Estimated local air velocity over pool	1.00e-1 m/s
Total airvelocity of fluid, Uw	1.14e-1 m/s
Mass release rate of the gas, Wg	1.05e-4 kg/s
Volumetric gas release rate, Qg	5.49e-5 m3/s
Release characteristic	1.76e-3 m3/s
Ambient temperature, Ta	293 °K
Temperature medium, Tm	293 °K
Density of the gas, ρg	1.92 kg/m3
Used formula	B6 and B7

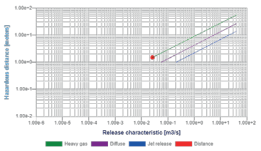
Ventilation assessment

Area length, width and height	10.00 x 5.00 x 3.00 mtr
Ventilation capacity	1500 m3/h
Volume	150.00 m3
Ventilation rate	10.00 times/hr
Air velocity for dilution	1.39e-2 m/s
Dilution class	Medium dilution
Availability ventilation	Fair
Efficiency ventilation	3
Crtitical concentration, Xcrit	7.75e-3 vol/vol
Background concentration, Xb	3.95e-4 vol/vol
Result	background concentration < critical concentration, so OK
Resulting dilution class	Medium dilution

Graph assessment degree of dilution C.1 of EN 60079-10-1



Graph Hazardous Distance Chart D.1 of EN 60079-10-1



Classification of area

Type of release source	Secondary
Zone	Zone 2
Density of gas relative to air	vapour/gas is heavier than air
Type of release	Heavy gas
Radius zone area	1,5 mtr
Temperature class	T2
Gas group	IIB

Comments

Your remarks can be added here!

Advice

Add advice can be added here!

Example 2 Leaking of a flange of a pressurized gas system with hydrogen

Area parameters:
Length : 10 mtr
With: 5 mtr
Height: 3 mtr
Ventilation: Mechanical
Ventlation Capacity: 1500 m3/hr
Direction of ventilation: sidewards long

Ventilation measurements are not performed.

Step 1) Add a company, you can choose the name
Step 2) Add the area with the paremeters specified above
Step 3) Start an Assessment for an indoor situation and select the area and the substance from the database and choose as Type of Release: “Pressurized”
Step 4) Set the temperatures to 20°C, Atm. pressure to 1 bar and Pressure in system to 350 bar. Se lect S = 0,025 mm2, Z = 1,0, Cd = 0,99 and don’t use Cp override. Set the k-factor to 0,25.
Step 5) Don’t use the dilution override and set the efficiency of the ventilation to moderate (3) and set the availability to “Fair”
Step 6) Select a secondary release source and since the gas comes out of the release source under pressure, slect “Jet release””
Step 7) Click next, followed by “Finish” and print the report

The result should be this report:

Hazcalc B.V.
Stobbenakker 32
7391 LZ Twello
Netherlands

HAZCALC
hazardous area classification

Hazardous Area Classification: Leaking flange Hydrogen release @ 350 bar

Company	Hazchem
Assessment	Leaking flange Hydrogen release @ 350 bar
Location of release	Inside
Area name	Production room 1

Substance properties

Substance name	Hydrogen
CAS-number	1333-74-0
Molmass	2.02 kg/kmol
Flashpoint	flammable gas
Vapour pressure @ Tmedium	flammable gas
LFL [vol/vol]	0.040 vol/vol
Relative vapour density (air = 1)	0.07
Universal Gas Constant, R	8314 (J/kmol/K)

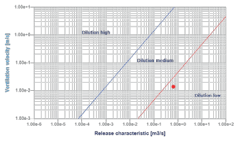
Release-assessment

Type of release	Pressurized	**Ambient temperature, Ta**	293 °K
Atmospheric pressure, Pa	101325 Pa (1.00 bara)	**Temperature medium, Tm**	293 °K
Pressure in system, Pa	35101325 Pa (350.00 barg)	**Leak-opening, S**	2.50e-8 m2
Cp	13861 J/kg/K	**Compressibility factor, Z**	1.00
γ	1.42	**Velocity of the released gas is**	sonic/choked release
Critical pressure, Pc	193167 Pa	**Density of the gas, ρg**	8.40e-2 kg/m3
Cd	0.99	**Used formula**	B4
Mass release rate of the gas, Wg	5.45e-4 kg/s		
Volumetric gas release rate, Qg	6.48e-3 m3/s		
K-factor	0.25		
Release characteristic	6.48e-1 m3/s		

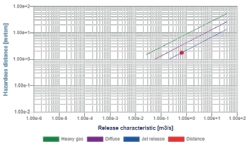
Ventilation assessment

Area length, width and height	10.00 x 5.00 x 3.00 mtr
Ventilation capacity	1500 m3/h
Volume	150.00 m3
Ventilation rate	10.00 times/hr
Air velocity for dilution	1.39e-2 m/s
Dilution class	Low dilution
Availability ventilation	Fair
Efficiency ventilation	3
Crtitical concentration, Xcrit	1.00e-2 vol/vol
Background concentration, Xb	4.67e-2 vol/vol
Result	background concentration > critical concentration, so Not OK
Resulting dilution class	Low dilution

Graph assessment degree of dilution C.1 of EN 60079-10-1



Graph Hazardous Distance Chart D.1 of EN 60079-10-1



Classification of area

Type of release source	Secondary
Zone	Zone 1 and even Zone 0
Density of gas relative to air	vapour/gas is lighter than air
Type of release	Jet
Radius zone area	1.77 mtr
Temperature class	T1
Gas group	IIC

Example 3 Filling an IBC with acetone at a flow rate of 100 ltr/min

Area parameters:
Length : 10 mtr
With: 5 mtr
Height: 3 mtr
Ventilation: Mechanical
Ventlation Capacity: 1500 m3/hr
Direction of ventilation: sidewards long

Ventilation measurements are not performed.

Step 1) Add a company, you can choose the name
Step 2) Add the area with the paremeters specified above
Step 3) Start an Assessment for an indoor situation and select the area and the substance from the database and choose as Type of Release: “Vapor Pressure”
Step 4) Set the temperatures to 20°C, and speed of gas release to 6 m3/hr (=100 ltr/min), pressure in casing to 101325 Pa and don’t use vapor pressure override Set the k-factor to 0,5.
Step 5) Don’t use the dilution override and set the efficiency of the ventilation to moderate (3) and set the availability to “Fair”
Step 6) Select a continuous release source and since the gas comes out of the release source and is a heavy gas, select “Heavy gas””
Step 7) Click next, followed by “Finish” and print the report

The result should be this report:

HAZCALC

Hazcalc B.V.
Stobbenakker 32
7391 LZ Twello
Netherlands

HAZCALC
hazardous area classification

Hazardous Area Classification according to IEC 60079-10-1:2015: [3] Example 3 Filling an IBC with acetone at a flow rate of 100 ltr/min - copy

Company	Hazchem
Assessment	[3] Example 3 Filling an IBC with acetone at a flow rate of 100 ltr/min - copy
Location of release	Inside
Area name	Production room 1

Substance properties

Substance name	2-Propanone (= Acetone) (= Dimethyl ketone)
CAS-number	67-64-1
Molmass	58.08 kg/kmol
Flashpoint	< -20 °C
Vapour pressure @ Tmedium	24.60 kPa
LFL [vol/vol]	0.025 vol/vol
Relative vapour density (air = 1)	2.00
Liquid density @ 20°C	790 kg/m3
Universal Gas Constant, R	8314 (J/kmol/K)

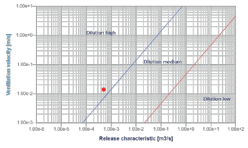
Release-assessment

Assessment according to	Edition 2015
Type of release	Vapor pressure
Pressure in system, Pa	101325 Pa
Speed of gas release	0.1 m3/hr
Calculated saturated vapour concentration in casing	546035 mg/m3
Maximum concentration in casing, ppm	226151 ppm
Freight of gas out of casing, Wg	1.52e-5 kg/s
Volumetric gas release rate, Qg	6.28e-6 m3/s
K-factor	0.5
Release characteristic	5.03e-4 m3/s
Ambient temperature, Ta	293 °K
Temperature medium, Tm	293 °K
Density of the gas, ρg	2.41 kg/m3
Molair volume	24.1 dm3
Max concentration in casing, vol%	22.6 vol%
Used formula	See, manual and info-button

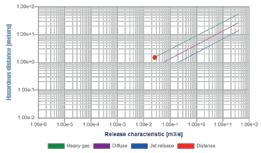
Ventilation assessment

Area length, width and height	5.00 x 10.00 x 3.00 mtr
Ventilation capacity	1500 m3/h
Volume	150.00 m3
Ventilation rate	10.00 times/hr
Air velocity for dilution	1.39e-2 m/s
Dilution class	High dilution
Availability ventilation	Fair
Efficiency ventilation	3
Critical concentration, Xcrit	6.25e-3 vol/vol
Background concentration, Xb	4.52e-5 vol/vol
Result	background concentration < critical concentration, so OK
Resulting dilution class	High dilution

Graph assessment degree of dilution C.1 of EN 60079-10-1



Graph Hazardous Distance Chart D.1 of EN 60079-10-1



Classification of area

Type of release source	Continuous
Resulting dilution class	High dilution
Zone	Zone 2 (Zone 0 NE)
Density of gas relative to air	vapour/gas is heavier than air
Type of release	Heavy gas
Radius zone area	1,5 mtr
Temperature class	T1
Gas group	IIA

Comments

Vapour release flow from IBC = filling rate of the fluid

Advice

Apply a zone 2 with a radius of 1,5 mtr around the filling opening. Reduce the zone by applying local air extraction at the filling point. The zone can possibly be reduced to non-hazardous around the opening.

The calculations show that the max. concentration within the casing is 22,6 vol%. The advise here should be to apply a local extraction system which extract the vapours directly from the release source. To effin-ceintly extract the vapours a minium flow of the extraction system should be equal to the volumetric flow rate but a higher rate should be adviced to dilute the gases more.

For example to 25%LEL:

C [vol%]/100/(LEL/100/(100/25LEL)) =

22,6/100/(2,1/100/(100/25))=

43 times x flow (0,1 m3/hr) =

4,3 m3/hr.

Example 4 Leaking flange of a biogas system (40 mbarg) in outdoor situation

Area parameters:
Length : 10 mtr
With: 5 mtr
Height: 3 mtr
Ventilation: Mechanical
Ventlation Capacity: 1500 m3/hr
Direction of ventilation: sidewards long

Ventilation measurements are not performed.

Step 1) Add a company, you can choose the name
Step 2) Add the area with the paremeters specified above
Step 3) Start an Assessment for an indoor situation and select the area and the substance from the database and choose as Type of Release: “Liquid”
Step 4) Set the temperatures to 20°C, and speed of gas release to 6 m3/hr (=100 ltr/min), pressure in casing to 101325 Pa and don’t use vapor pressure override Set the k-factor to 0,5.
Step 5) Don’t use the dilution override and set the efficiency of the ventilation to moderate (3) and set the availability to “Fair”
Step 6) Select a continuous release source and since the gas comes out of the release source and is a heavy gas, select “Heavy gas””
Step 7) Click next, followed by “Finish” and print the report

Hazcalc B.V.
Stobbenakker 32
7391 LZ Twello
Netherlands

HAZCALC
hazardous area classification

Hazardous Area Classification: Leaking of a flange in piping with biogas @ pressure 40 mbarg

Company	Hazchem
Assessment	Leaking of a flange in piping with biogas @ pressure 40 mbarg
Location of release	Outside

Substance properties

Substance name	Methane
CAS-number	74-82-8
Molmass	16.04 kg/kmol
Flashpoint	flammable gas
Vapour pressure @ Tmedium	flammable gas
LFL [vol/vol]	0.044 vol/vol
Relative vapour density (air = 1)	0.56
Universal Gas Constant, R	8314 (J/kmol/K)

Release-assessment

Type of release	Pressurized	**Ambient temperature, Ta**	293 °K
Atmospheric pressure, Pa	101325 Pa (1.00 bara)	**Temperature medium, Tm**	293 °K
Pressure in system, Pa	105325 Pa (0.04 barg)	**Leak-opening, S**	2.50e-7 m2
Cp	2210 J/kg/K	**Compressibility factor, Z**	1.00
γ	1.31	**Velocity of the released gas is**	subsonic/non-choked release
Critical pressure, Pc	186063 Pa	**Density of the gas, ρg**	6.67e-1 kg/m3
Cd	0.99	**Used formula**	B3
Mass release rate of the gas, Wg	1.80e-5 kg/s		
Volumetric gas release rate, Qg	2.70e-5 m3/s		
K-factor	1		
Release characteristic	6.14e-4 m3/s		

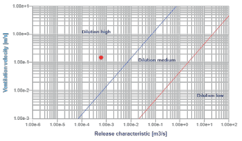
Ventilation assessment

Air velocity for dilution	1.50e-1 m/s
Dilution class	High dilution
Availability ventilation	Fair

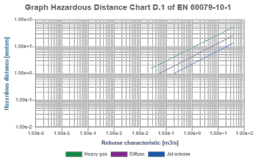
Classification of area

Type of release source	Secondary
Zone	Non-hazardous (Zone 2 NE)
Density of gas relative to air	vapour/gas is lighter than air
Type of release	Diffuse
Radius zone area	N/A
Temperature class	T1
Gas group	IIA

Graph assessment degree of dilution C.1 of EN 60079-10-1



Graph Hazardous Distance Chart D.1 of EN 60079-10-1



Comments
Your remarks!

Advice
Your Advice!

Example 5 Leaking of a pump seal for xylene (mixture) in an indoor situation

Step 1) Add a company, you can choose the name
Step 2) Start an Assessment for an outdoor situation and select the substance (Xylene mixture) from the database and choose as Type of Release: “Liquid”
Step 3) Set the temperatures to 20°C, atmospheric pressure to 1 bara and the pressure within the system to 3 barg. Select S = 0,25 mm2, set Cd to 0,99. Set percentage of direct evaporation tp 10%. Set the k-factor to 1.
Step 4) Don’t use the dilution override and set the efficiency of the ventilation to moderate (3) and set the availability to “Fair”.
Step 5) Select a secondairy release source and select a Heavy gas, since the vapors are heavier than air.
Step 6) Click next, followed by “Finish” and print the report .

The result should be this report:

Hazcalc B.V.
Stobbenakker 32
7391 LZ Twello
Netherlands

HAZCALC
hazardous area classification

Hazardous Area Classification: Leaking of a pump seal for xylene in an indoor situation

Company	Hazchem
Assessment	Leaking of a pump seal for xylene in an indoor situation
Location of release	Inside
Area name	Production room 1

Substance properties

Substance name	Xylene (mixture)		
CAS-number	1330-20-7		
Molmass	106.17 kg/kmol		
Flashpoint	25 °C		
Vapour pressure @ 20°C	0.80 kPa		
LFL [vol/vol]	0.007 vol/vol	**Liquid density @ 20°C**	860 kg/m3
Relative vapour density (air = 1)	3.67	**Universal Gas Constant, R**	8314 (J/kmol/K)

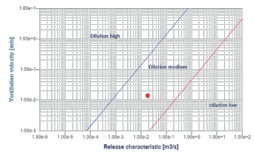
Release-assessment

Type of release	Liquid	**Ambient temperature, Ta**	293 °K
Atmospheric pressure, Pa	101325 Pa (1.00 bara)	**Temperature medium, Tm**	293 °K
Pressure in system, Pa	401325 Pa (3.00 barg)	**Leak-opening, S**	2.50e-7 m2
Cd	0.99	**Density of the gas, ρg**	4.42 kg/m3
Density of the liquid, ρl	860 kg/m3	**Volumetric release rate liquid, W**	7 ml/s
Release rate liquid, W	5.62e-3 kg/s	**Time until leak of 200 ml (appr. 1 glass)**	31 sec
Percentage direct evaporation	10%	**Used formula**	B1
Evaporation rate of liquid, We	5.62e-4 kg/s		
Volumetric evaporation rate, Qg	1.27e-4 m3/s		
K-factor	1		
Release characteristic	1.82e-2 m3/s		

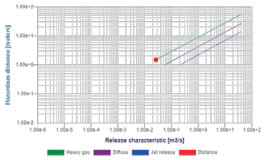
Ventilation assessment

Area length, width and height	10.00 x 5.00 x 3.00 mtr
Ventilation capacity	1500 m3/h
Volume	150.00 m3
Ventilation rate	10.00 times/hr
Air velocity for dilution	1.39e-2 m/s
Dilution class	Medium dilution
Availability ventilation	Fair
Efficiency ventilation	3
Crtitical concentration, Xcrit	1.75e-3 vol/vol
Background concentration, Xb	9.17e-4 vol/vol
Result	background concentration < critical concentration, so OK
Resulting dilution class	Medium dilution

Graph assessment degree of dilution C.1 of EN 60079-10-1



Graph Hazardous Distance Chart D.1 of EN 60079-10-1



Classification of area

Type of release source	Secondary
Zone	Zone 2
Density of gas relative to air	vapour/gas is heavier than air
Type of release	Heavy gas
Radius zone area	1,5 mtr
Temperature class	T1
Gas group	IIA

Based on this input a zone 2 with an extent of 1,5 mtr aroud the leak soure (flange) must be applied.

Within the report you can see that de time untill a leakage of 200 ml (1 glass) liquid occurs within appr. 31 seconds, so a spill of 1 ltr (ca 1m2) occurs within appr. 2,5 min. That scenario should be assessed again acording to example 1.