



# User Manual Hazcalc

Version: Final 2.1

28-8-2021

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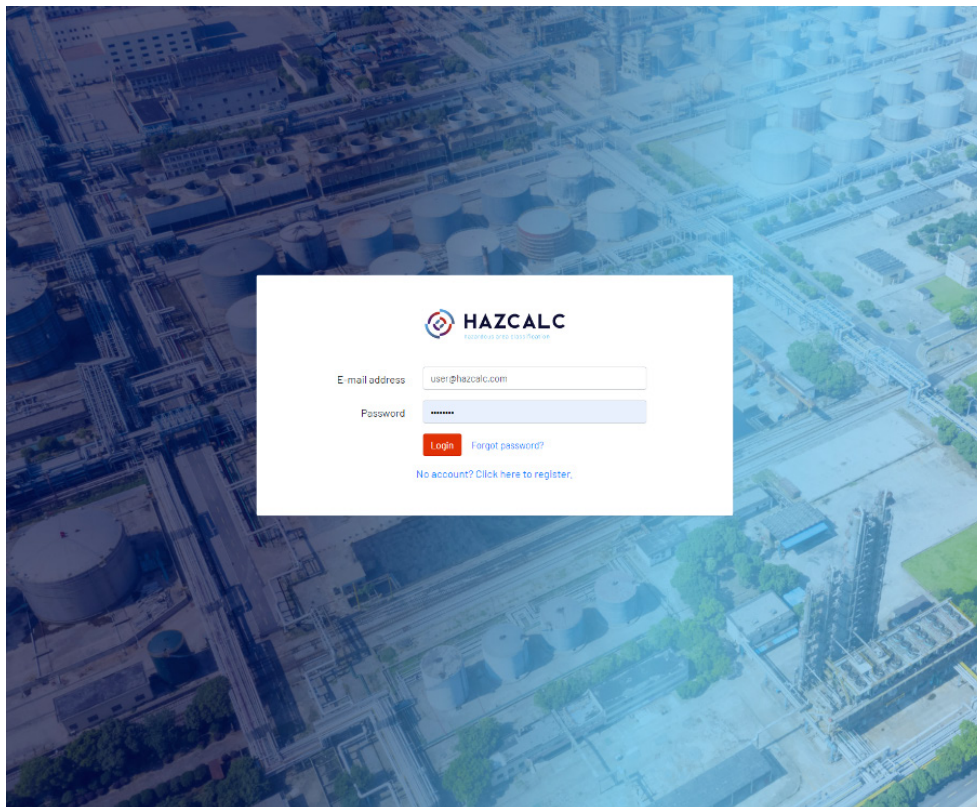
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# 1. Introduction

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 interpretation 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.

Hazcalc B.V.  
Stobbenakker 32  
7391 LZ Twello  
Netherlands



### 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

#### 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

#### 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  
**Critical 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

#### 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!

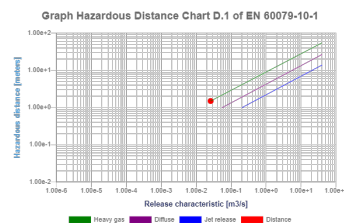
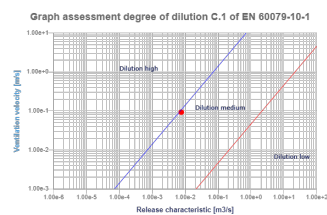
#### Advice

Add advice can be added here!



**Liquid density @ 20°C** 790 kg/m3  
**Universal Gas Constant, R** 8314 (J/kmol/K)

**Ambient temperature, Ta** 293 °K  
**Temperature medium, Tm** 293 °K  
**Density of the gas, pg** 1.92 kg/m3  
**Used formula** B6 and B7



Hazardous Area Classification according to IEC 60079-10-1:  
Spill of ethanol of 2 m2

Page 1

#### 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 appearance for clients, e.g. picture and company logo print on report;
- fully compliant to IEC 60079-10-1, both 2015 and the 2020 version..

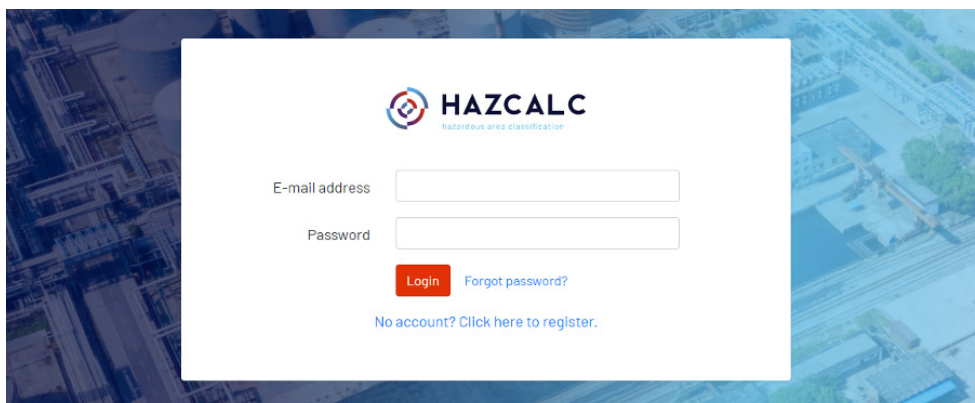
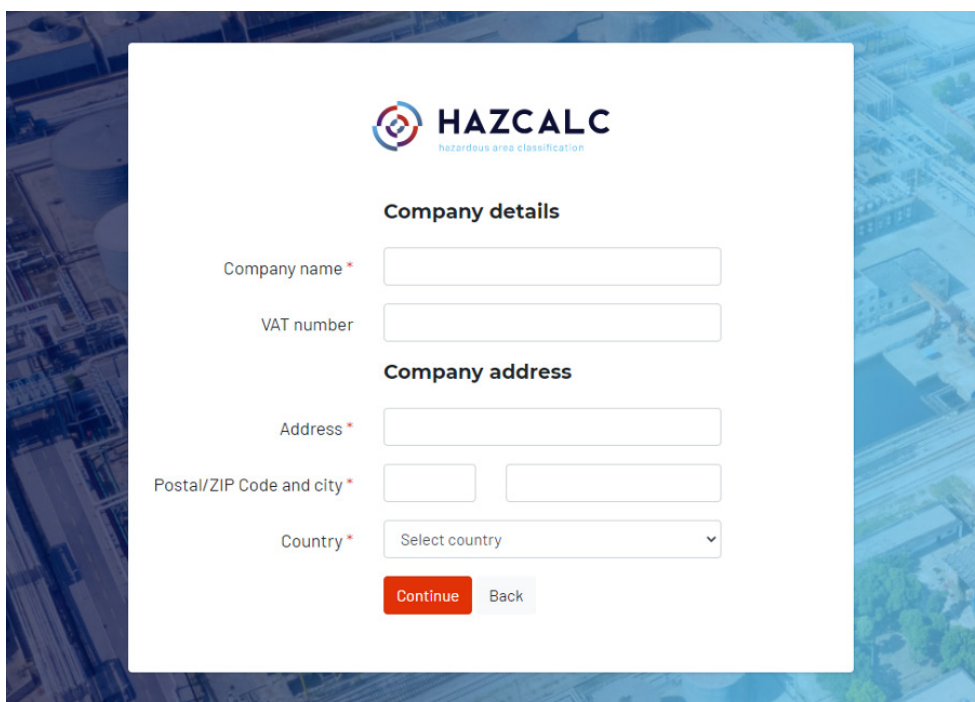
### 1.3 Engineering purposes

The tool can be 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 screenshot shows the login interface for HAZCALC. At the top is the HAZCALC logo with the tagline "hazardous area classification". Below the logo are two input fields: "E-mail address" and "Password". A red "Login" button is positioned below the password field, with a blue link "Forgot password?" to its right. At the bottom of the form, there is a blue link that reads "No account? Click here to register." The entire form is centered on a white background, which is overlaid on a blue-tinted aerial image of an industrial facility.The screenshot displays the registration form for HAZCALC. It begins with the HAZCALC logo and tagline. The form is divided into two main sections: "Company details" and "Company address". Under "Company details", there are input fields for "Company name" (marked with a red asterisk) and "VAT number". The "Company address" section includes an "Address" field (marked with a red asterisk), a "Postal/ZIP Code and city" section with two adjacent input fields (both marked with red asterisks), and a "Country" dropdown menu (marked with a red asterisk and showing "Select country"). At the bottom of the form are two buttons: a red "Continue" button and a grey "Back" button. The form is presented on a white background over a blue-tinted aerial industrial image.

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!





### Company details

Company name Hazcalc.com

### Company address

Address Hazardous area Road 999

Postal/ZIP Code and city 87643 Hazloc

Country GB

### User details

First Name \*

Middle Name

Last Name \*

E-mail Address \*

Password \*

Your password should be at least 8 characters long.

Confirm Password \*

Telephone

Country \* Select country ▼

Timezone \* Select timezone ▼

Create account

Back

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

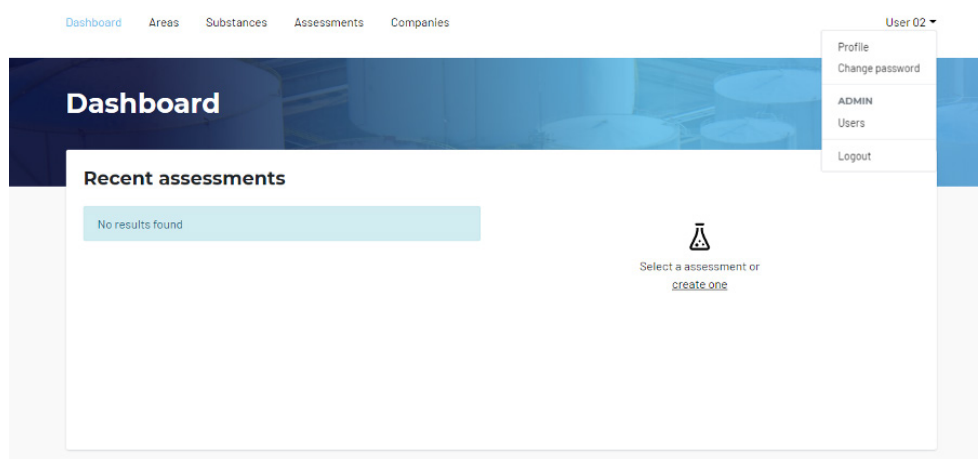
So now you are able to use the benefits of Hazcalc, so login with your email address and password.

## 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 explitley buying a full enabled account.

With a demo account the full possibilities of Hazcalc can be experienced. 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](https://hazcalc.com).

### 2.3.1 Single user account

A single user account is an account that strictly 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).

Dashboard Substances Companies Areas Assessments Hazcalc 01 ▼

### Dashboard

Create assessment

#### Welcome to Hazcalc!

This web-application provides an easy and fast assessment of possible hazardous areas in relation to explosion safety. The application is fully compliant with the IEC 60079-10-1 standard, as well both for version 2015 and for the new version 2020.

#### Help

A help function is fully integrated within every step of the assessment. A User Manual is also available for download.

#### Tutorials

More example assessments are available within the User Manual and the use of the application is also explained in the FAQ section on our website hazcalc.com. Several tutorial videos are available on our Youtube channel.

#### Recent assessments

Spill of ethanol of 2 m2  
24 november 2020 11:39

Show Edit

Select an assessment or [create one](#)

### 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.

Dashboard Substances Companies Areas Assessments Hazcalc 01 ▼

### Substances

Create substance

Search Filter ▼

Name	Alternative name	CAS	
(1-Methylethyl) benzene (= Cumene) <b>Default</b>	(= Isopropyl benzene)(= 2-Phenyl propane)	98-82-8	Show Duplicate
(Chloromethyl) oxirane (= Epichlorohydrin) <b>Default</b>	(= 1-Chloro-2,3-epoxypropane)(= 2-Chloropropylene oxide)	106-89-8	Show Duplicate
(Chloromethyl)benzene (= Benzyl chloride) <b>Default</b>	alpha-Chlorotoluene)(= Toly chloride)	100-44-7	Show Duplicate
(n)-Heptane(mixed isomers) <b>Default</b>		142-82-5	Show Duplicate

### 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.

**Create new substance**

**Substance**

Name

CAS Number

☐ **Flammable gas**  
Check this if the substance is a flammable gas.

**Properties**

Rel. density  Molmass  kg/kmol

Water = 1

Flashpoint  °C Vapour pressure @ 20°C  mbar

Vapour pressure @ 20°C  kPa Vapour pressure @ 20°C  Pa

LEL  vol% LFL  vol/vol

Rel. vapor density  Cp [J/kg/K]  J/kg/K

Air = 1

Boiling point  °C MOT  °C

Similar conductivity  pS/m MOE  mJ

Gas group

T-class

**Comments**

Comments

[Cancel](#) [Create substance](#)



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.

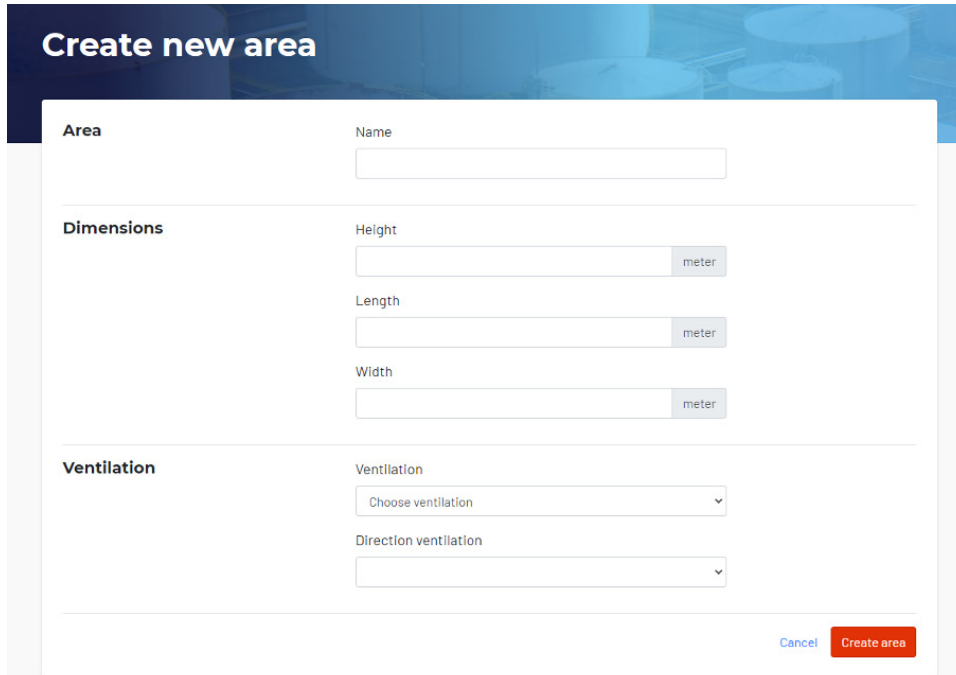
The screenshot shows a web form titled "Create new company" with a blue header. The form is divided into three sections: "Company", "Address", and "Contact".

- Company section:** Contains a "Name" field with the text "Testcompany 1" entered.
- Address section:** Contains an "Address" field, a "Postcode" field, a "City" field, and a "Country" dropdown menu.
- Contact section:** Contains "Name", "Phone", and "E-mail" fields.

At the bottom right of the form, there are two buttons: a blue "Cancel" button and a red "Create company" button.

### 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:

##### Sideways long:

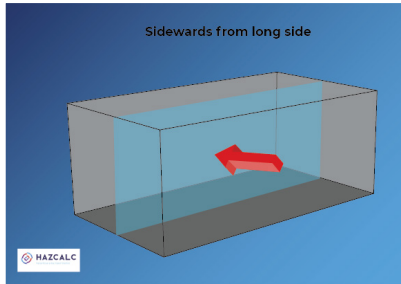


Figure 1, Area with sideways airflow from the long side

##### Sideways short:

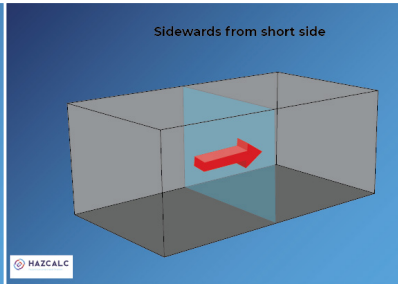


Figure 2, Area with sideways airflow from the short side

##### Upwards:

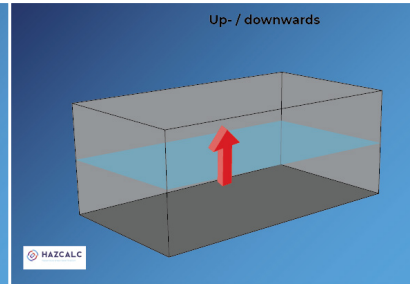
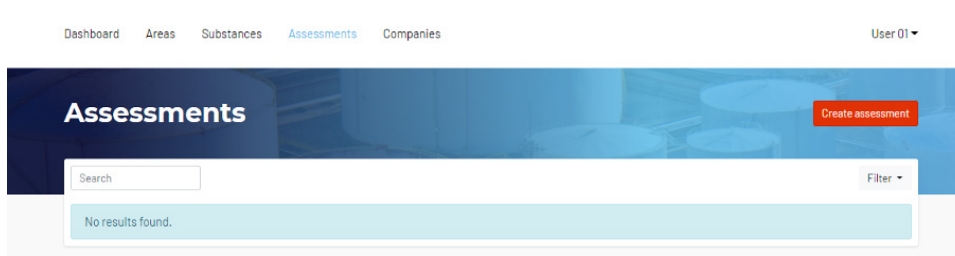


Figure 3, Area with up- or downwards airflow

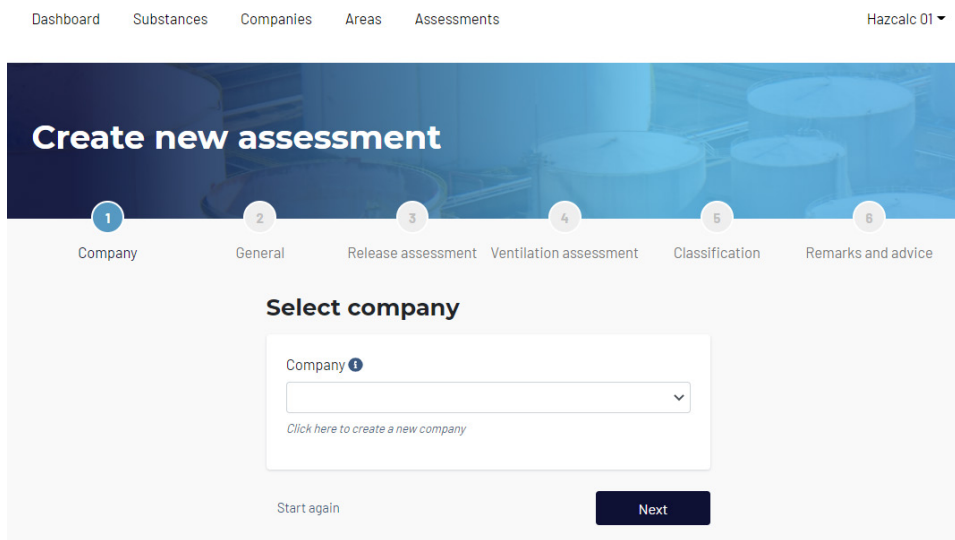
Based on this input the model automatically calculates the cross sectional area across the space under consideration and uses that value for calculating the average air velocity through the area. As mentioned, this value can still be overridden at the appropriate places within the model.

## 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

Dashboard Areas Substances Assessments Companies User 01 ▼

## Create new assessment

### Test assessment

1 Company 2 **General** 3 Release assessment 4 Ventilation assessment 5 Classification 6 Remarks and advice 7 Report

#### General assessment details

Description  
Test assessment

Location of release  
Outside

Substance ⓘ  
Aceton (67-64-1)  
[Click here to create a new substance](#)

Type of release  
Atmospheric

Image  
Click here or drag an image to upload.

Back Next

#### 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

Dashboard Areas Substances Assessments Companies User 01 ▼

## Create new assessment

### Test assessment

1 Company

2 General

3 Release assessment

4 Ventilation assessment

5 Classification

6 Remarks and advice

7 Report

#### Release assessment

Ambient temperature ⓘ  °K

Temperature medium ⓘ  °K

#### Atmospheric Release

Liquid pool size  m<sup>2</sup>

Estimation increase airspeed ⓘ  m/s

Back Next

#### 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	<p>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 Assessment).</p> <p>The k-factor is a safety factor attributed to the Lower Flammable Limit, typically between 0,5 and 1,0.</p> <p>A lower value however can also be used. This leads to a higher release characteristic and thus a more conservative approach.</p>
----------	---

#### 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	<p>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 Assessment).</p> <p>The k-factor is a safety factor attributed to the Lower Flammable Limit, typically between 0,5 and 1,0.</p> <p>A lower value however can also be used. This leads to a higher release characteristic and thus a more conservative approach.</p>
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#### Vapour pressure

Speed of the release [m <sup>3</sup> /hr]	Add the flow rate of the liquid that is pumped or 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)	<p>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: <a href="https://webbook.nist.gov/chemistry/#">https://webbook.nist.gov/chemistry/#</a> can be used for making calculations with the Antoine formula.</p>
---------------------------------------	---

K-factor	<p>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 Assessment).</p> <p>The k-factor is a safety factor attributed to the Lower Flammable Limit, typically between 0,5 and 1,0.</p> <p>A lower value however can also be used. This leads to a higher release characteristic and thus a more conservative approach.</p>
----------	---



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	<p>Cross section of the opening (hole), through which the fluid is released (m<sup>2</sup>)/</p> <p>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.</p> <p><b>Be aware that under-estimation of this release opening leads to underestimation of the risk.</b></p>
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	<p>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 Assessment).</p> <p>The k-factor is a safety factor attributed to the Lower Flammable Limit, typically between 0,5 and 1,0.</p> <p>A lower value however can also be used. This leads to a higher release characteristic and thus a more conservative approach.</p>



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	<p>Cross section of the opening (hole), through which the fluid is released (m<sup>2</sup>)/ 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.</p> <p><b>Be aware that under-estimation of this release opening leads to underestimation of the risk.</b></p>
Z	<p>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.</p>
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	<p>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 Assessment).</p> <p>The k-factor is a safety factor attributed to the Lower Flammable Limit, typically between 0,5 and 1,0.</p> <p>A lower value however can also be used. This leads to a higher release characteristic and thus a more conservative approach.</p>



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



Figure 5, air velocity measurement with an anemometer

The air velocity for dilution must be entered. Two scenarios are available:

- **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.

Mechanical Ventilation Capacity	2330.00 m3/h
Ventilation rate	5.28 times/hr
Cross Section Space	63.90 m2
Air velocity for dilution (calculated average)	1.01e-2 m/s

Air velocity for dilution (override) ⓘ

m/s

Release characteristic 1.62e-3 m3/s

So within this field the average calculated air velocity can be overridden. 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 (m<sup>3</sup>/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 efficiency 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

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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 (m<sup>3</sup>/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	<p>The efficiency of the ventilation has only to be entered for indoor situation where the background concentration has to be assessed.</p> <p>For outdoor situations this chapter (background concentration) and field (efficiency of the ventilation) does not show up.</p> <p>The efficiency of the ventilation (factor f in the IEC standard) stands for the efficiency of the ventilation within the room related to the average background concentration within the room.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p><b>Tip:</b> For local air extraction systems the efficiency can be set to 1.</p>
Safety Factor	<p>With reference to the <b>2020 version</b> 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 <math>100\% - 25\% = 75\%</math> of the Lower Flammable Concentration. With a Safety Factor of 10%, the Release Characteristic is calculated with 90%LFL.</p> <p>When using this factor, one will see that this factor can be critical when the red dot in the graphs is near to the blue or red line, so that another dilution class must be applied.</p>

---

### 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.

---



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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

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 then 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-hazardous (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-hazardous (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
Secondaryb	Non-hazardous (Zone 2 NE)a	Non-hazardous (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 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 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.

### Classification

Type of hazard ⓘ

Zone

Density relative to air

vapour/gas is heavier than air

Type of release ⓘ

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

- an unimpeded jet release with high velocity;
- a diffusive jet release with low velocity or a jet that loses its momentum due to the geometry of the release or impingement on nearby surfaces;
- 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 substances 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,  $Q_c$ , on the horizontal axis, was defined as the Release characteristic  $Wg/\rho_g \times k \times LFL$ .

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

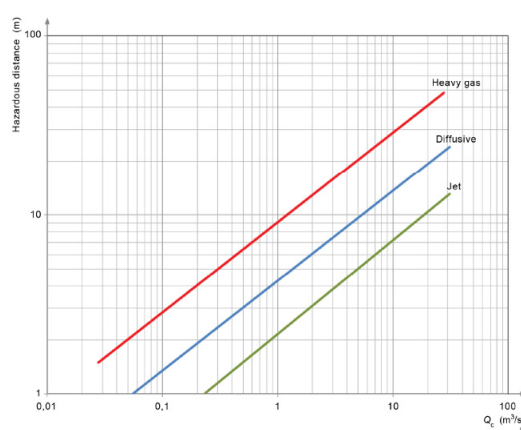


Figure D.1 – Chart for estimating hazardous area distances

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.

#### 4.1.7 Finish

Click Finish to save the assessment. The total assessment 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 8, remarks and Advice fields

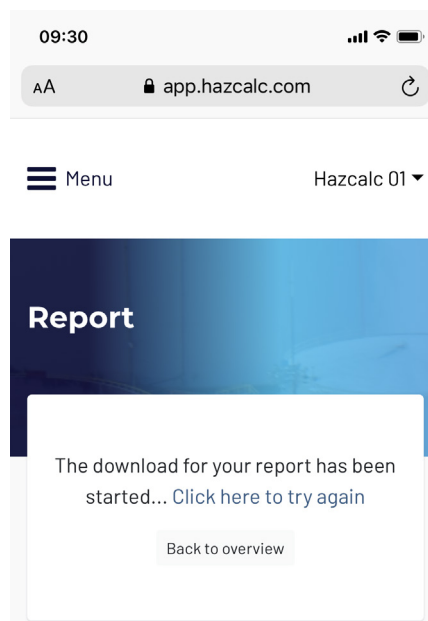


Figure 9, Click here to try again on mobile IOS Devices

## 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

### Release-assessment

**Type of release** Pressurized  
**Atmospheric pressure, Pa** 101325 Pa (1.00 bara)  
**Pressure in system, Pa** 35101325 Pa (350.00 barg)  
**Cp** 13861 J/kg/K  
 **$\gamma$**  1.42  
**Critical pressure, Pc** 193167 Pa  
**Cd** 0.99  
**Mass release rate of the gas, Wg** 5.45e-4 kg/s  
**Volumetric gas release rate, Qg** 6.48e-3 m<sup>3</sup>/s  
**K-factor** 0.25  
**Release characteristic** 6.48e-1 m<sup>3</sup>/s

### Ventilation assessment

**Area length, width and height** 15.00 x 3.00 x 3.00 mtr  
**Ventilation capacity** 15000 m<sup>3</sup>/h  
**Volume** 135.00 m<sup>3</sup>  
**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  
**Critical 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.



**Universal Gas Constant, R** 8314 (J/kmol/K)

**Ambient temperature, Ta** 293 °K  
**Temperature medium, Tm** 293 °K  
**Leak-opening, S** 2.50e-8 m<sup>2</sup>  
**Compressibility factor, Z** 1.00  
**Velocity of the released gas is** sonic/choked release  
**Density of the gas,  $\rho_g$**  8.40e-2 kg/m<sup>3</sup>  
**Used formula** B4

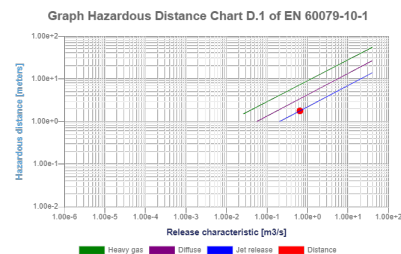
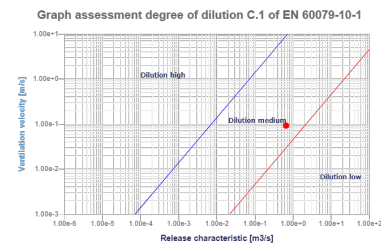


Figure 10, Example report from Hazcalc

## 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 following formula:

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

C = concentration in air in mg/m<sup>3</sup>

M = relative molecular mass

p = vapour pressure in mbar @ temperature T

T = Temperature in Kelvin

Together with the filling rate in m<sup>3</sup>/hr the mass release rate of (saturated) gas out of the tank opening is calculated. This is a conservative approach 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](http://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](mailto: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 m<sup>2</sup> 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

Ventilation Capacity: 1500 m3/hr

Direction of ventilation: sideways long

Ventilation measurements are not performed.

Step 1) Add a company, you can choose the name

Step 2) Add the area with the parameters 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



## 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

### 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

### 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  
Critical 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

### 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

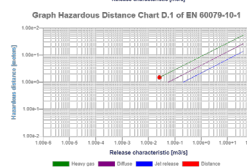
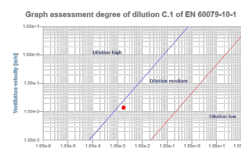
Your remarks can be added here!

### Advice

Add advice can be added here!

Liquid density @ 20°C: 790 kg/m3  
Universal Gas Constant, R: 8314 (J/kmol/K)

Ambient temperature, Ta: 293 °K  
Temperature medium, Tm: 293 °K  
Density of the gas, pg: 1.92 kg/m3  
Used formula: B6 and B7



## 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

Ventilation Capacity: 1500 m<sup>3</sup>/hr

Direction of ventilation: sideways long

Ventilation measurements are not performed.

Step 1) Add a company, you can choose the name

Step 2) Add the area with the parameters 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. Select  $S = 0,025 \text{ mm}^2$ ,  $Z = 1,0$ ,  $C_d = 0,99$  and don't use  $C_p$  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, select "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



### Hazardous Area Classification: Leaking flange Hydrogen release @ 350 bar

Company: Hazchem  
Assessment: Leaking flange Hydrogen release @ 350 bar  
Location of release: bar  
Area name: Inside  
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  
Atmospheric pressure, Pa: 101325 Pa (1.00 bara)  
Pressure in system, Pa: 35101325 Pa (350.00 barg)  
Cp: 13861 J/kg/K  
 $\gamma$ : 1.42  
Critical pressure, Pc: 193167 Pa  
Cd: 0.99  
Mass release rate of the gas, Wg: 5.45e-4 kg/s  
Volumetric gas release rate, Qg: 6.48e-3 m<sup>3</sup>/s  
K-factor: 0.25  
Release characteristic: 6.48e-1 m<sup>3</sup>/s

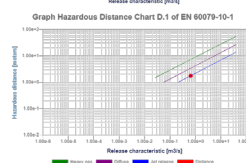
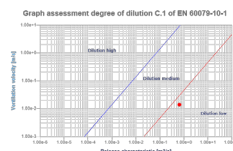
Ambient temperature, Ta: 293 °K  
Temperature medium, Tm: 293 °K  
Leak-opening, S: 2.50e-8 m<sup>2</sup>  
Compressibility factor, Z: 1.00  
Velocity of the released gas is: sonic/choked release  
Density of the gas, pg: 8.40e-2 kg/m<sup>3</sup>  
Used formula: B4

#### Ventilation assessment

Area length, width and height: 10.00 x 5.00 x 3.00 mtr  
Ventilation capacity: 1500 m<sup>3</sup>/h  
Volume: 150.00 m<sup>3</sup>  
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  
Critical 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

#### 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

Ventilation Capacity: 1500 m<sup>3</sup>/hr

Direction of ventilation: sideways long

Ventilation measurements are not performed.

- Step 1) Add a company, you can choose the name
- Step 2) Add the area with the parameters 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 m<sup>3</sup>/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 B.V.  
Stobbenakker 32  
7391 LZ Twello  
Netherlands



### Hazardous Area Classification: Filling an IBC with acetone @ flow of 100 ltr/min

**Company** Hazchem  
**Assessment** Filling an IBC with acetone @ flow of 100 ltr/min  
**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/m<sup>3</sup>  
**Universal Gas Constant, R** 8314 (J/kmol/K)

#### Release-assessment

**Type of release** Vapor pressure  
**Pressure in system, Pa** 101325 Pa  
**Speed of gas release** 6 m<sup>3</sup>/hr  
**Calculated saturated vapour concentration in casing** 546594 mg/m<sup>3</sup>  
**Maximum concentration in casing, ppm** 226267 ppm  
**Freight of gas out of casing, Wg** 9.11e-4 kg/s  
**Volumetric gas release rate, Qg** 3.77e-4 m<sup>3</sup>/s  
**K-factor** 0.5  
**Release characteristic** 3.02e-2 m<sup>3</sup>/s

**Ambient temperature, Ta** 293 °K  
**Temperature medium, Tm** 293 °K  
**Density of the gas, ρg** 2.42 kg/m<sup>3</sup>  
**Molair volume** 24.0 dm<sup>3</sup>  
**Max concentration in casing, vol%** 22.6 vol%  
**Used formula** See, manual and info-button

#### Ventilation assessment

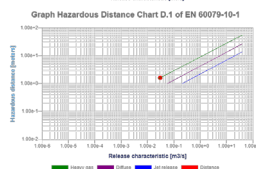
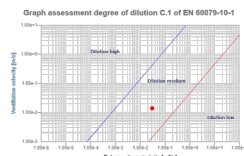
**Area length, width and height** 10.00 x 5.00 x 3.00 mtr  
**Ventilation capacity** 1500 m<sup>3</sup>/h  
**Volume** 150.00 m<sup>3</sup>  
**Ventilation rate** 10.00 times/hr  
**Air velocity for dilution** 1.39e-2 m/s  
**Dilution class** Medium dilution  
**Availability ventilation** Fair  
**Efficiency ventilation** 3

**Critical concentration, Xcrit** 6.25e-3 vol/vol  
**Background concentration, Xb** 2.72e-3 vol/vol  
**Result** background concentration < critical concentration, so

**Resulting dilution class** Medium dilution

#### Classification of area

**Type of release source** Continuous  
**Resulting dilution class** Medium dilution  
**Zone** Zone 0 + Zone 2  
**Density of gas relative to air** vapour/gas is heavier than air  
**Type of release** Heavy gas  
**Radius zone area** 1.61 mtr  
**Temperature class** T1  
**Gas group** IIA



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 efficiently extract the vapours a minimum flow of the extraction system should be equal to the volumetric flow rate but a higher rate should be advised to dilute the gases more. For example to 25%LEL:  $C \text{ [vol\%]}/100 / (\text{LEL}/100 / (100/25\text{LEL})) = 22,6/100 / (2,1/100 / (100/25)) = 43 \text{ times} \times \text{flow (6 m}^3/\text{hr)} = 258 \text{ m}^3/\text{hr}.$

# 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

Ventilation Capacity: 1500 m<sup>3</sup>/hr

Direction of ventilation: sideways long

Ventilation measurements are not performed.

Step 1) Add a company, you can choose the name

Step 2) Add the area with the parameters 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 m<sup>3</sup>/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



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

### 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  
Atmospheric pressure, Pa 101325 Pa (1.00 bara)  
Pressure in system, Pa 105325 Pa (0.04 bara)  
Cp 2210 J/kg/K  
γ 1.31  
Critical pressure, Pc 186063 Pa  
Cd 0.99  
Mass release rate of the gas, Wg 1.80e-5 kg/s  
Volumetric gas release rate, Qg 2.70e-5 m<sup>3</sup>/s  
K-factor 1  
Release characteristic 6.14e-4 m<sup>3</sup>/s

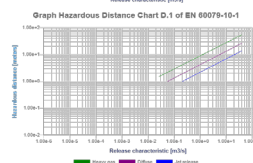
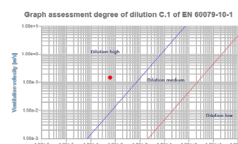
Ambient temperature, Ta 293 °K  
Temperature medium, Tm 293 °K  
Leak-opening, S 2.50e-7 m<sup>2</sup>  
Compressibility factor, Z 1.00  
Velocity of the released gas is subsonic/non-choked release  
Density of the gas, pg 6.67e-1 kg/m<sup>3</sup>  
Used formula B3

### 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



### 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 mm<sup>2</sup>, 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 secondary 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



## 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		
Relative vapour density (air = 1)	3.67		
Release-assessment			
Type of release	Liquid		
Atmospheric pressure, Pa	101325 Pa (1.00 bara)		
Pressure in system, Pa	401325 Pa (3.00 barg)		
Cd	0.99		
Density of the liquid, ρl	860 kg/m3		
Release rate liquid, W	5.62e-3 kg/s		
Percentage direct evaporation	10%		
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		
Critical concentration, Xcrit	1.75e-3 vol/vol		
Background concentration, Xb	9.17e-4 vol/vol		
Result	background concentration < critical concentration, so <span>OK</span>		
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 heavier than air		
Type of release	Heavy gas		
Radius zone area	1,5 mtr		
Temperature class	T1		
Gas group	IIA		

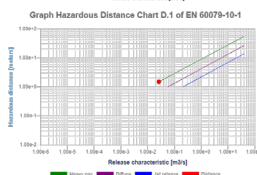
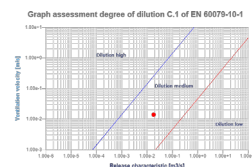
Liquid density @ 20°C	860 kg/m3
Universal Gas Constant, R	8314 (J/kmol/K)
Ambient temperature, Ta	293 °K
Temperature medium, Tm	293 °K
Leak-opening, S	2.50e-7 m2
Density of the gas, ρg	4.42 kg/m3
Volumetric release rate liquid, W	7 ml/s
Time until leak of 200 ml (appr. 1 glass)	31 sec
Used formula	B1

Graph assessment degree of dilution C,1 of EN 60959-2

This graph plots Ventilation rate [m³/h] on the y-axis (log scale from 0.001 to 1000) against Release characteristic [m³/s] on the x-axis (log scale from 1.00e-5 to 1.00e-1). Two diagonal lines represent 'Dilution high' and 'Dilution medium'. A red dot representing the release characteristic is located between these two lines, indicating a 'Medium dilution' class.

Graph Hazardous Distance Chart D,1 of EN 60959-2

This graph plots Release rate [kg/s] on the y-axis (log scale from 1.00e-2 to 1.00e+2) against Release characteristic [m³/s] on the x-axis (log scale from 1.00e-5 to 1.00e-1). It includes curves for 'Hazardous gas', 'Diffuse', 'Off-axis', 'Off-axis', and 'Off-axis'. A red dot representing the release rate and characteristic is located near the 'Hazardous gas' curve, indicating a 'Hazardous gas' class.



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

Within the report you can see that the time until a leakage of 200 ml (1 glass) liquid occurs within approx. 31 seconds, so a spill of 1 ltr (ca 1m<sup>2</sup>) occurs within approx. 2,5 min. That scenario should be assessed again according to example 1.



