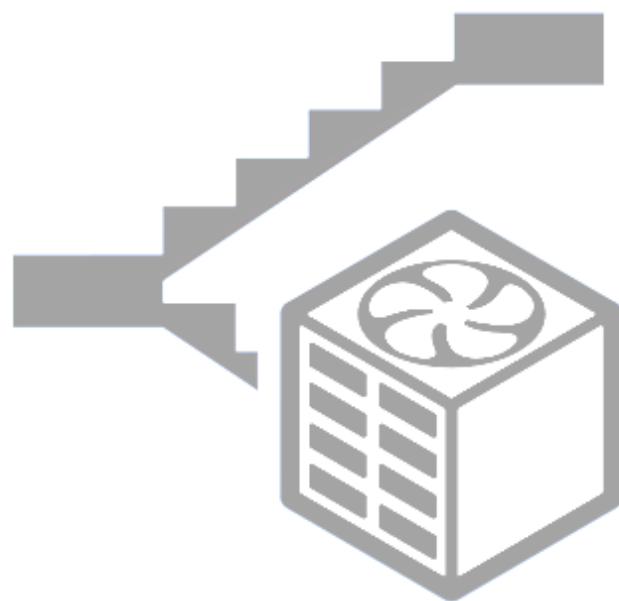# CYPEFIRE
Pressure Systems

User guide

Design of pressure differential systems in accordance with the European EN 12101-6 code.

Contents

1 **Basic concepts**

1.1 Overview

Thank you for choosing CYPE and CYPEFIRE Pressure Systems. CYPEFIRE Pressure Systems is a tool developed to carry out the installation of an overpressure stairwell system, in accordance with EN 12101-6.

The application has the class of systems A, B, C, D and E, found in the above-mentioned regulations, in order to develop the calculations necessary to accomplish the overpressure.

The application's objective is to calculate all of the air leaks/escapes that the different elements (stairwell, protected lobbies and/or lifts) produce in an overpressure system in each one of the necessary scenarios. The sum of all these leaks in each scenario will define the flows needed to maintain the pressure in the stairwell, lobby and/or lift, with respect to the rest of the building.

1.2 Initial configuration and starting a project

This section of the manual will show how to begin a project and how to begin using CYPEFIRE Pressure Systems.

Start by downloading the latest version of CYPEFIRE Pressure Systems from
BIMserver.center (https://bimserver.center/en/store/cypefire_pressure_systems).
In order to do this you will need an account with **BIMserver.center**.

The first step is to open CYPEFIRE Pressure Systems. Then, connect to BIMserver.center in the top right corner and, if necessary, login following the indicated steps. Once you have logged in you will be able to begin working.

To continue working on a previous project, select **File manager** and find the desired project. On the other hand, to begin a new project select **New…,** chose where to save the file and give it a name and a description. Next a screen from BIMserver.center will appear, and here is where you can create a new BIM project selecting **Create a new project**, or connect this new project with a previous project in the BIMserver.center. To do this, click on **Select project**. A list will appear with all of your projects- select the correct one and click on **Accept**.

The programme will load the selected project and any files associated with it. Next, you can select the files that you want to import for the simulation, as well as the architectural model. Upon clicking accept, the selected configuration will load and the programme's main interface will open with your model loaded.

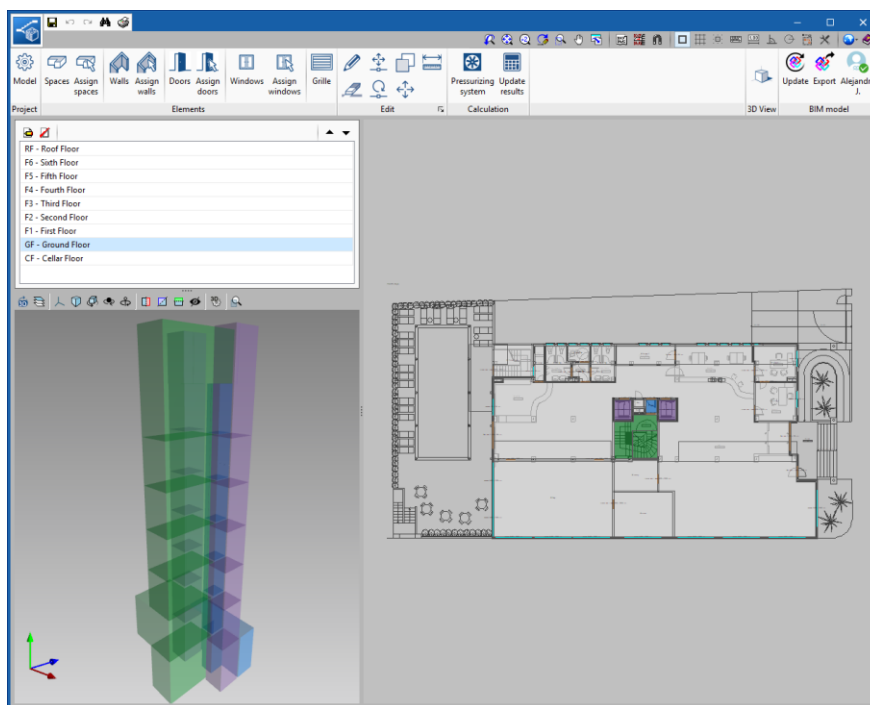Image 1. CYPEFIRE Pressure Systems interface

1.3 Interface

In the CYPEFIRE Pressure Systems interface you will find 4 main sections into which it is divided: the main toolbar (1), the navigation window for current floor plans (2), 3D view of the model, if there is one (3) and a 2D interface for the introduction of elements (4). Each section is highlighted in the images below.
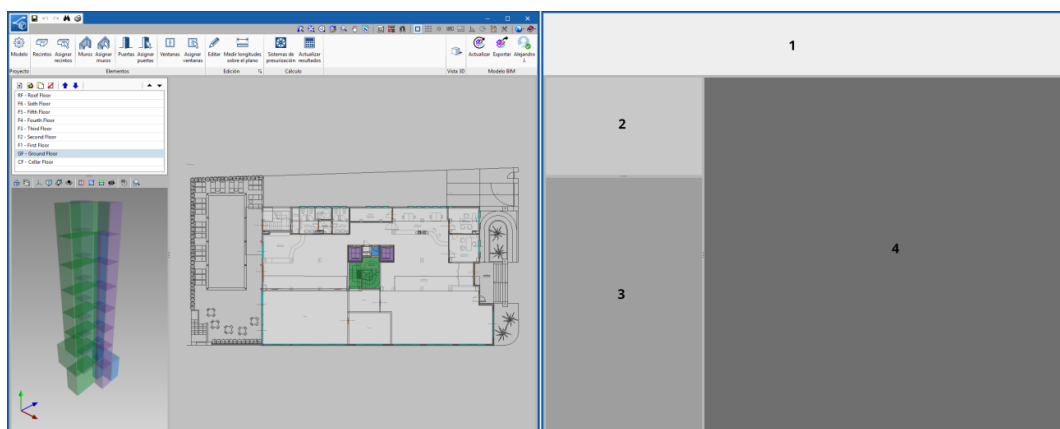

Image 2. Interface sections
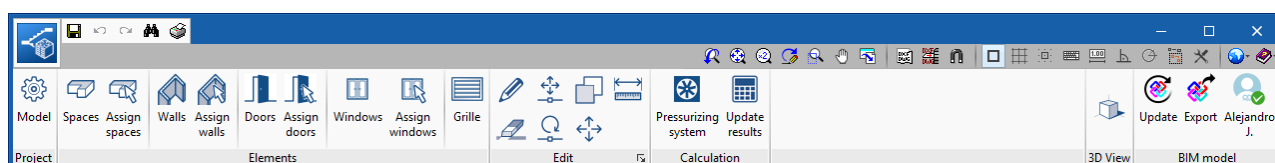
1.3.1 *Main toolbar*

Image 3. Toolbar options

The toolbar contains the main tools to control the configuration of the overpressure stairwell system. Here, you can edit the characteristics of the walls, doors and windows according to regulations, edit and carry out measurements on the plan and create a pressurisation system based on the BIM model.

The selection panel is used to modify/introduce data for the selected element in the project tree. It is possible to edit elements in the list, add new elements, delete or reorder them using the blue arrows.

1.3.2 *Floor plans*

In the floor plan section you can navigate around the model, selecting the floor in which you want to use the tools that the program has, in order to introduce a stairwell pressurisation system.

1.3.3 *3D view*

In the lower left window of the application there is the option to view in 3D the BIM model on which you are working. Here you can see the model in its current state. You can refresh the model to update any changes that you have made, filter the layers, change the orientation and create sections using cuts. To navigate using the 3D view, the controls are very similar to other CYPE programs. To move the model, hold down the mouse wheel. To rotate the model, hold down the left or right button on the mouse. To zoom, simply turn the mouse wheel.

Image 4. 3D view of the model

2 Configuration

Below follows an explanation of how to configure the main elements that affect the calculation of a stairwell over pressurisation system.

2.1 Doors

The doors in an overpressure system are usually responsible for the biggest percentage of airflow loss rate produced in this type of installation. The leaks from the doors can take place in pressurised spaces (from the stairwell in the protected lobby or towards the lift), or between the staircase and the accommodation areas.

With the tool **Assign doors,** that is located in the application's main toolbar, the user is able to configure the doors on the BIM model according to the type assigned to them, or alternatively directly on the programme interface selecting each one of them.

In accordance with EN 12101-6, depending on the door's leakage area they can be:

- Single-leaf door that opens into a pressurised space

- Single-leaf door opening outwards from a pressurised space

- Double-leaf doors

- Lift landing door

Table A.3 — Air leakage data from doors

Type of door	Leakage area m^2
Single-leaf opening into a pressurized space	0,01
Single-leaf opening outwards from a pressurized space	0,02
Double-leaf	0,03
Lift landing door	0,06

Image 5. Data of air leaks via the doors

2.2 Windows

Air leakage through windows is less than through doors, and normally they will only be installed in external-facing staircases.

Just like doors, windows follow the same criteria to assign their properties. As stated in the stairwell overpressure code, the types of windows according to their airflow leakage are:

- Pivoted, no weather stripping

- Pivoted, and weather stripped

- Sliding

Table A.4 — Air leakage data from windows

Type of window	Crack area m^2 per m length
Pivoted, no weather stripping	$2,5 \times 10^{-4}$
Pivoted, and weather stripped	$3,6 \times 10^{-5}$
Sliding	$1,0 \times 10^{-4}$

Image 6. Data of air leaks via the windows

2.3 Construction elements

Finally, there is air leakage produced by construction elements. These losses are produced by leakage paths that exist in these types of elements (slabs, partitions and facades).

These air leakages may seem insignificant for their values according to the regulations, but in overpressure systems of a moderate volume it can make a big difference between taking them into account or not.

Table A.5 — Air leakage data for walls

Construction element	Wall tightness	Leakage area ratio A_{LW}/A_{Wall}
Exterior building walls (including construction cracks, cracks around windows and doors)	Tight	$0{,}7 \times 10^{-4}$
	Average	$0{,}21 \times 10^{-3}$
	Loose	$0{,}42 \times 10^{-3}$
	Very loose	$0{,}13 \times 10^{-2}$
Internal and stair walls (including construction cracks, but not cracks around windows and doors)	Tight	$0{,}14 \times 10^{-4}$
	Average	$0{,}11 \times 10^{-3}$
	Loose	$0{,}35 \times 10^{-3}$
Lift well walls (including construction cracks, but not cracks around windows and doors)	Tight	$0{,}18 \times 10^{-3}$
	Average	$0{,}84 \times 10^{-3}$
	Loose	$0{,}18 \times 10^{-2}$

Table A.6 — Air leakage data for floors

Construction element	Wall tightness	Leakage area ratio A_{LF}/A_{Floor}
Floors (includes construction cracks and cracks around penetrations)	Average	$0{,}52 \times 10^{-4}$

Image 7. Data of air leaks via construction elements

2.4 Settings

In order to assign the properties seen in the previous points there are different methods.

First of all, when starting a new Project in CYPEFIRE Pressure Systems and importing a BIM model, a panel will appear (like in Image 8) on the application's interface. Before starting the project, in this panel you will be able to assign each element according to its characteristics and also indicate which model spaces are representative of the stairwell pressurisation system (Stairs, protected lobbies and lifts).
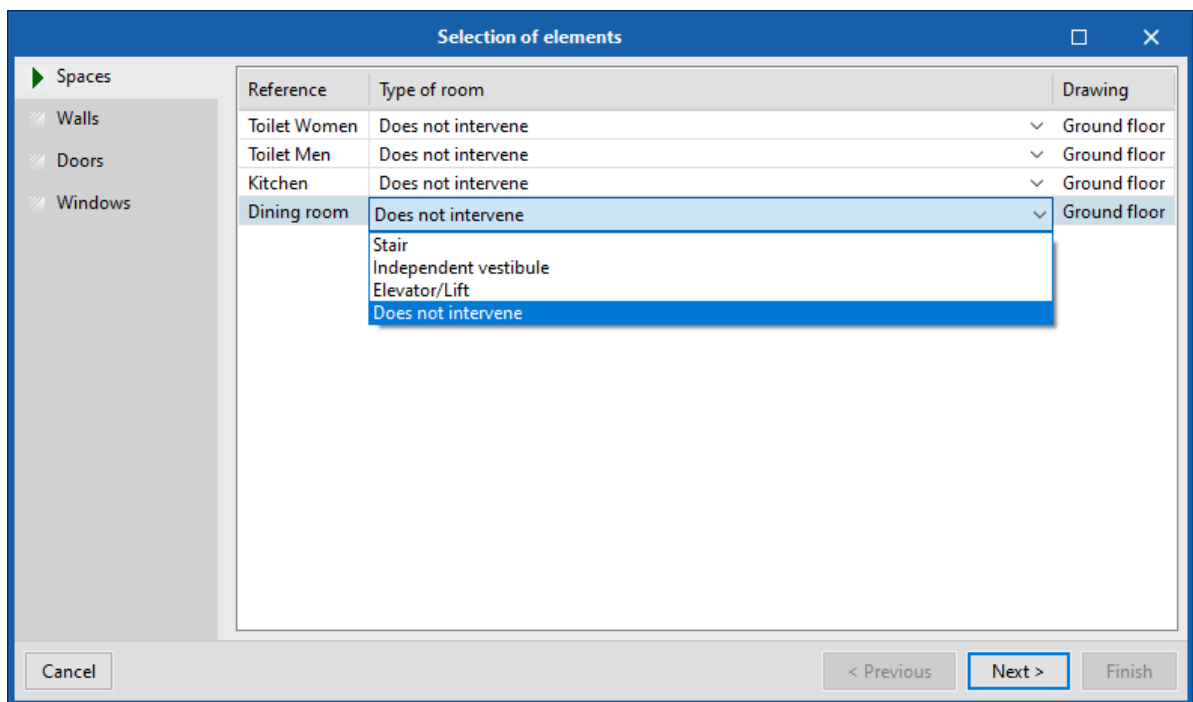
Image 8. Configuration of the spaces imported from the BIM model

Once the Project has been started there is always the possibility to return and edit this panel from the main toolbar, as was shown previously.

Once you have selected the normative values that you wish to apply, there is also a tool on the programme interface that allows you to select the elements to which you would like to apply these values.

This tool can be very useful in the case of applying air leakage data to the doors, which can have a different value according to their layout in the project.
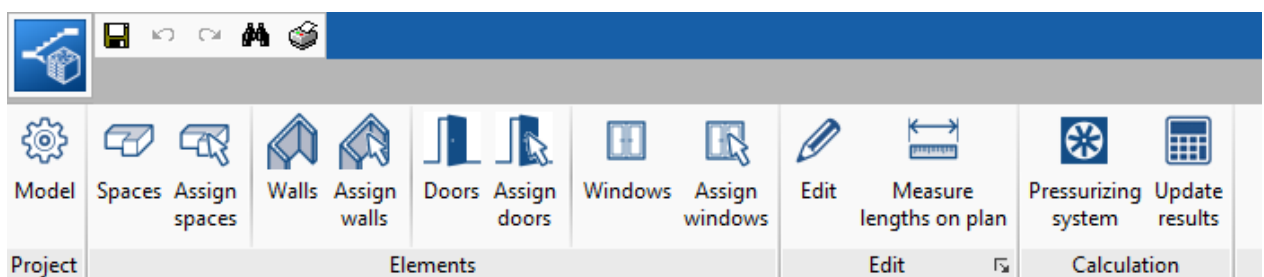

Image 9. Tools to assign normative values to the interface

3 Introduction of an over pressure system

Once the import of all the elements from the BIM model has been completed, you can begin introducing the overpressure stairwell system.

You can find this utility in the toolbar. In Image 10 you can see what this panel looks like.

To begin working you have to introduce a reference and a description of the system, as well as select the class of system and state if the lobby and lift (if you have included them) are pressurised or not.

The classes of system define the calculations that need to be carried out, which criteria to apply according to regulations and also the values that have to be used to apply the criteria.
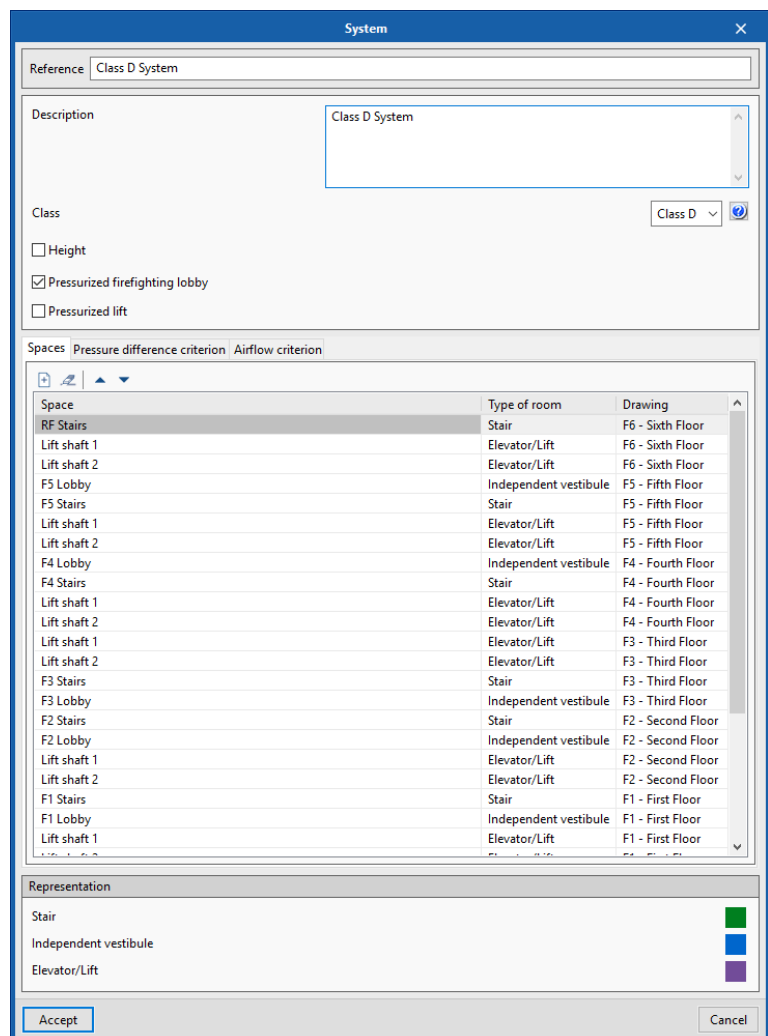

Image 10. Edit window for a pressurisation system

In Table 1 you can see a summary of the class of systems' design parameters according to the regulation.

	Use	Pressure difference criterion with closed doors	Pressure difference criterion	Airflow criterion
Class A	It is assumed that the building will not be evacuated, unless it is threatened by the fire.	✔	✘	✔ v: 0,75 m/s
Class B	The class B system is used to reduce as much as possible the chance of smoke pollution during evacuation and extinction.	✔	✘	✔ v: 2,0 m/s
Class C	It is based on the idea that all of the occupants will be evacuated at the same time. **E.g. Offices**	✔	✔	✔ v: 0,75 m/s
Class D	This class assumes that the occupants of the building may be sleeping, for which it will take longer. **E.g. Hotels**	✔	✔	✔ v: 0,75 m/s
Class E	This system is used in buildings where the occupants will be evacuated by stairs or in phased evacuation. **E.g. Hospitals**	✔	✔	✔ v: 0,75 m/s
		P. Stairwell: 50 Pa P. Lift: 50 Pa P. Lobby: 45 Pa	Stairwell: 10Pa	

Table 1. Table summarising the main features of each class of system

3.1 Tab - Spaces

The first tab that appears in the overpressure stairwell system is spaces.

In this tab you need to introduce all of the spaces that belong in the system, and that previously have been classified as:

- Staircase

- Protected lobby

- Lift

3.2 Tab – Pressure difference criterion

The second tab that appears in the overpressure stairwell system is pressure difference criterion.

In this tab you can indicate which doors, out of all the spaces marked in the previous tab, will be open when calculating the pressure difference criteria. According to the pressure difference on both sides of the open door, depending on the type of system calculated, and on the area of the open door, there will be an airflow leakage which will have to be overcome in order to maintain the pressure difference inside the staircase.
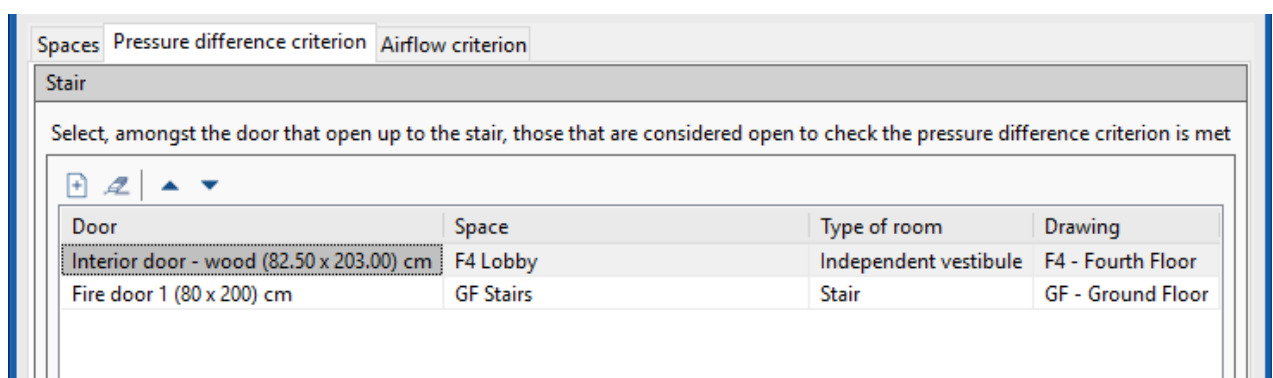

Image 11. Tab – Pressure difference criterion

3.3 Tab – Airflow criterion

Finally, there is the airflow criterion tab. Just as in the previous tab, the doors that will be open need to be marked in order to apply this calculation.
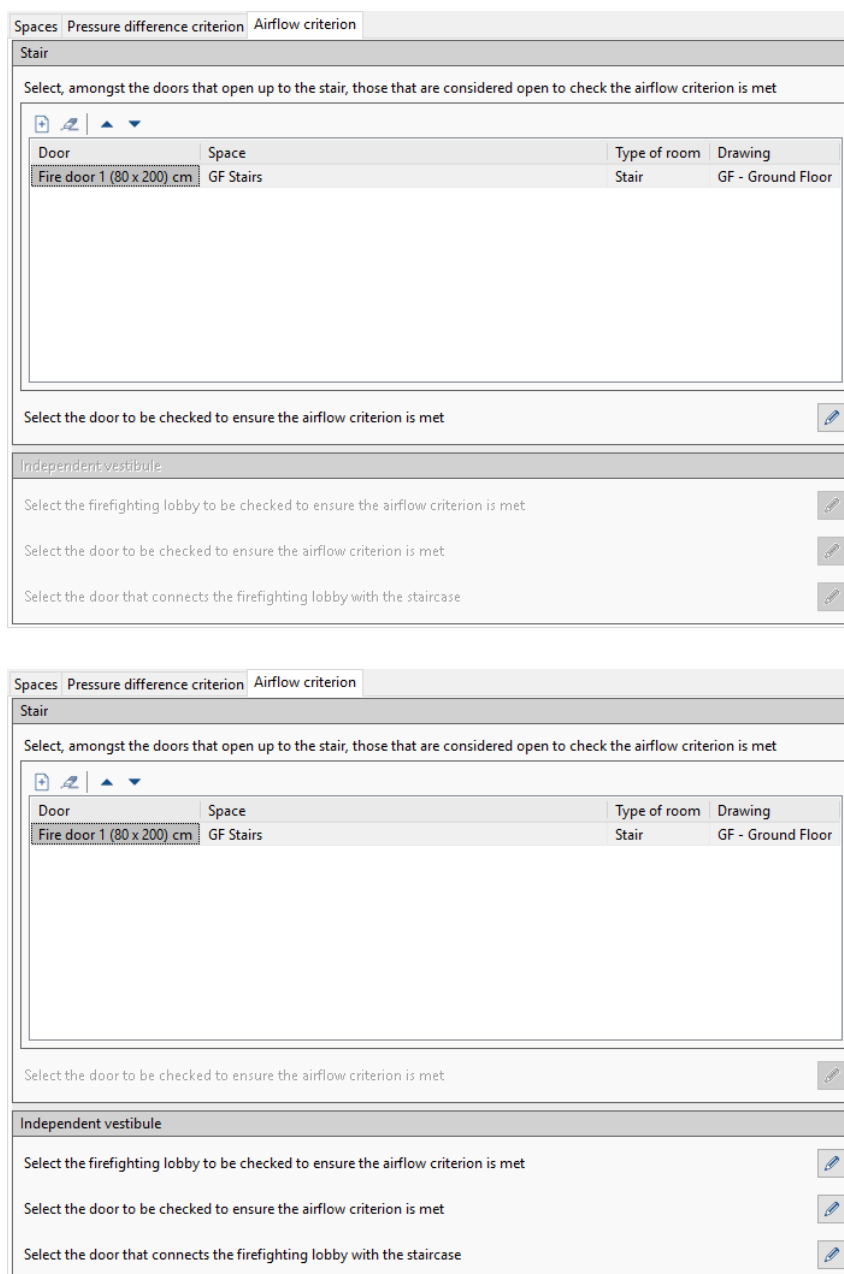

Image 12. Tab – Airflow criterion

This tab may include two aspects, as shown in Image 12, depending on if there is a **protected lobby** included in the calculated pressure difference system.

The top image shows a pressurisation system that does not have a protected lobby. As such, the only available options are to include the doors that will be open to see if the criterion is met, and selecting the door to which the airflow criterion applies.

In the bottom image you can see a pressurisation system that does include a protected lobby. Here, no option appears to chose the door on which to apply the airflow criterion, given that first of all you have to indicate in which of the protected lobbies the criteria will be applied, and then the doors need to be indicated- both the open door between the lobby and the staircase, and the door to which the airflow criterion will apply.

The doors that will be selected as open for the criterion are introduced into the system in the same way.

3.4   Airflow grille

Once the creation of the pressurisation system has been finalised the grilles need to be introduced. They will function as air supply points to the staircase, the protected lobbies and the lift shaft, if they have been included.

In accordance with EN 12101-6, these grilles must fulfil the following requirements:

- **Staircase:** For staircases that are less than 11m high, only one air supply point is needed. For staircases higher than 11m there needs to be air supply points separated by no more than three floors between them.

- **Protected lobby:** Every lobby must have an air supply point.

- **Lift:** For the lift shaft there needs to be an air supply point up to 30m high.

4 Calculation model

After introducing all the elements and updating the results, click on **Model,** where you will find the fundamental equations that regulate the calculation of an overpressure system.

Here, you will find the overpressure systems that have been previously generated through the assistant, and you will also have the possibility of manually introducing overpressure systems.

In relation to the manual introduction of an overpressure system, the interface that the software offers allows you to individually define each one of the elements (doors, windows, lift doors or construction elements) that determine losses in a stairwell pressurisation system. As such, the only thing you need to do in order to use this method is to introduce each one of the parameters necessary to define the pressurisation system.

The aim of this _user guide_ is not to explain in detail how to manually input the data, but rather to provide the necessary tools so that once an overpressure system has been introduced you can revise the data and make the required modifications.

Every time that **Update results** is selected in the main toolbar, all the data from the BIM model will be transferred. If you wish to change the parameters introduced and you do not want it to update the results, you must lock the _padlock_ that appears to the right of the reference in each system, as shown in Image 13.

Once the _padlock_ has been locked any changes made in the system introduction window will not be imported- nor new doors opened in one of the criteria, changes to the surfaces of doors, the number of windows etc. If you want to update new results, all you have to do is **unlock** the _padlock_ and **click on update results**, but the data that has been manually introduced or modified will be lost.

Therefore, it is recommended that before manually inputting or changing data to work upon a finished model that is not liable to change, to avoid losing information and repeating the process.
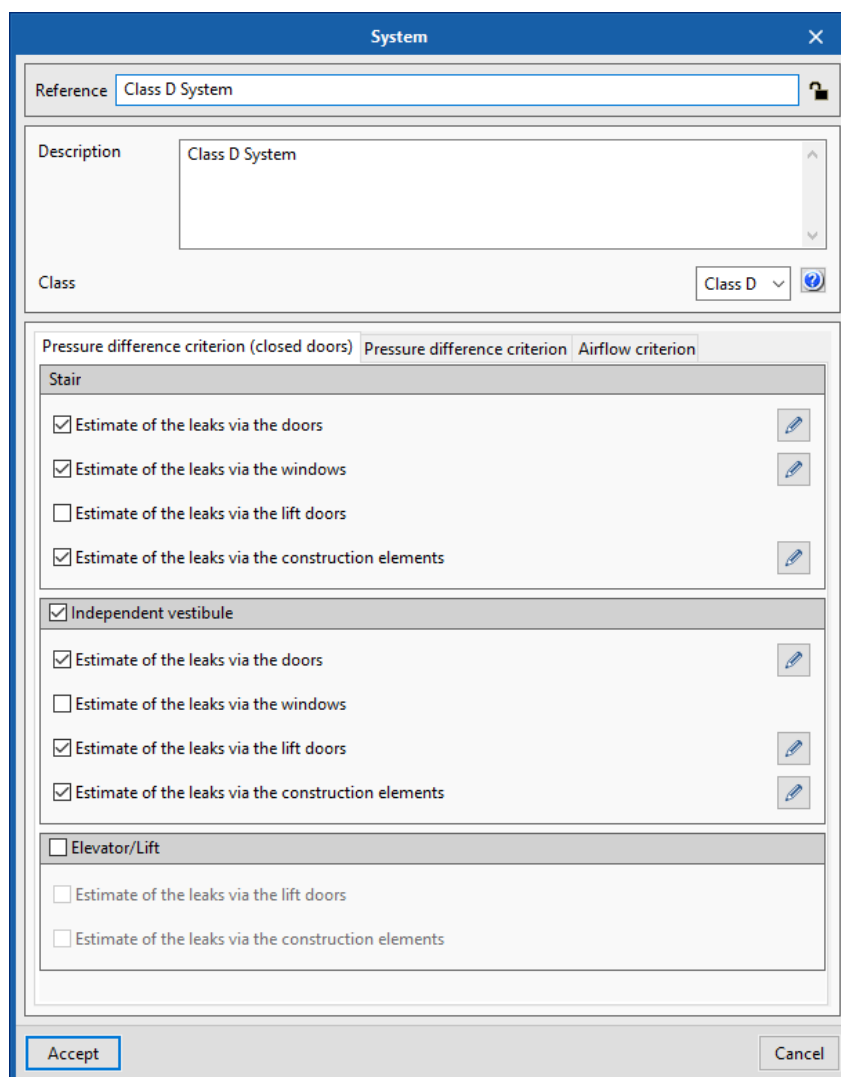
Image 13. Pressure difference criterion locked for Class A

4.1 Pressure difference criterion (Closed doors)

This criterion needs to be calculated for all of the class of systems. The visual aspect of this criterion, just as the other criterion mentioned below in this guide, are all very similar, differing only in some aspects.

Image 13 shows the importation of a stairwell and a pressurised lobby. By accessing any of the options for Stairs (doors, windows, lift doors or construction elements) a list of all the elements of this type will be shown that the software has interpreted from the BIM model. Furthermore, if you click on each one of them, the main parameters will be shown-element leakage area and pressure differential across the same **Doors** and **Windows**, and also the Leakage Area ratio for the **Structural elements**.

As is shown in Image 14 the application calculates for each element, according to its position, what the pressure differential is on both sides of the same element, depending on if the lobby is pressurised or not, if there is a lift etc.
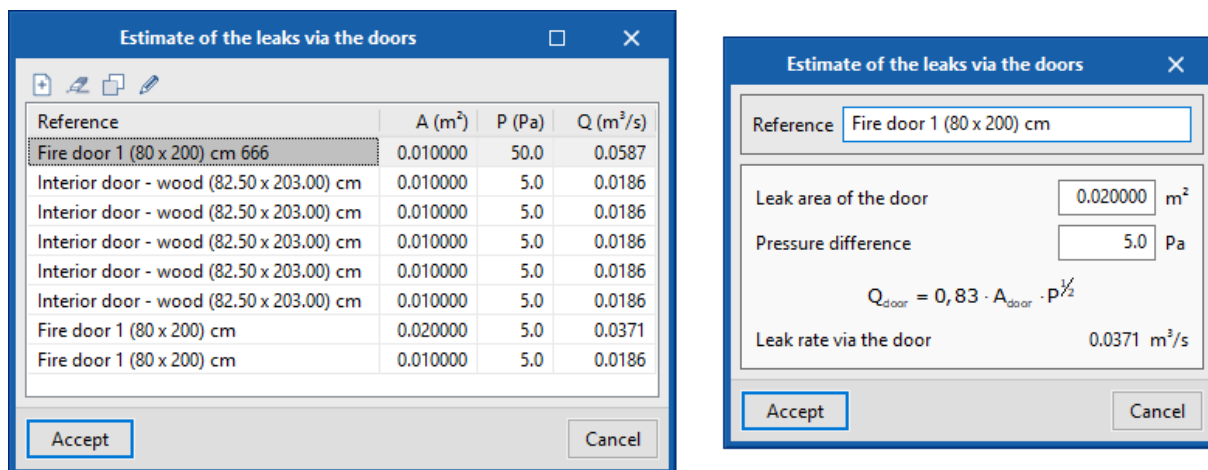

Image 14. Closed doors for the pressure difference criterion with all the doors closed

The process that you can see in Image 14 is repeated for each element (Doors, windows, Lift doors or construction elements) and for each space type (Stair, protected lobby and lift).

4.2 Pressure difference criterion

For the calculation of this criterion as well as that of the parameters seen in the previous criterion, the doors that will be open need to be included in order to analyse this case.

As it was shown in **Section** 3.2 how to introduce the open doors from the BIM model, here their parameters will be interpreted in order to carry out the calculation. In this tab in the **Stairs** section, this new calculation element has been added and we can revise and modify its parameters (Image 15Image 15).
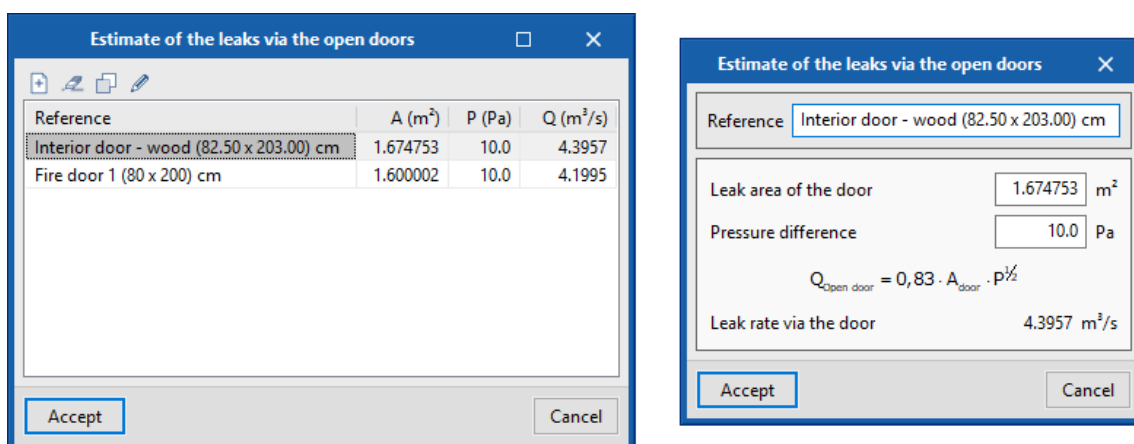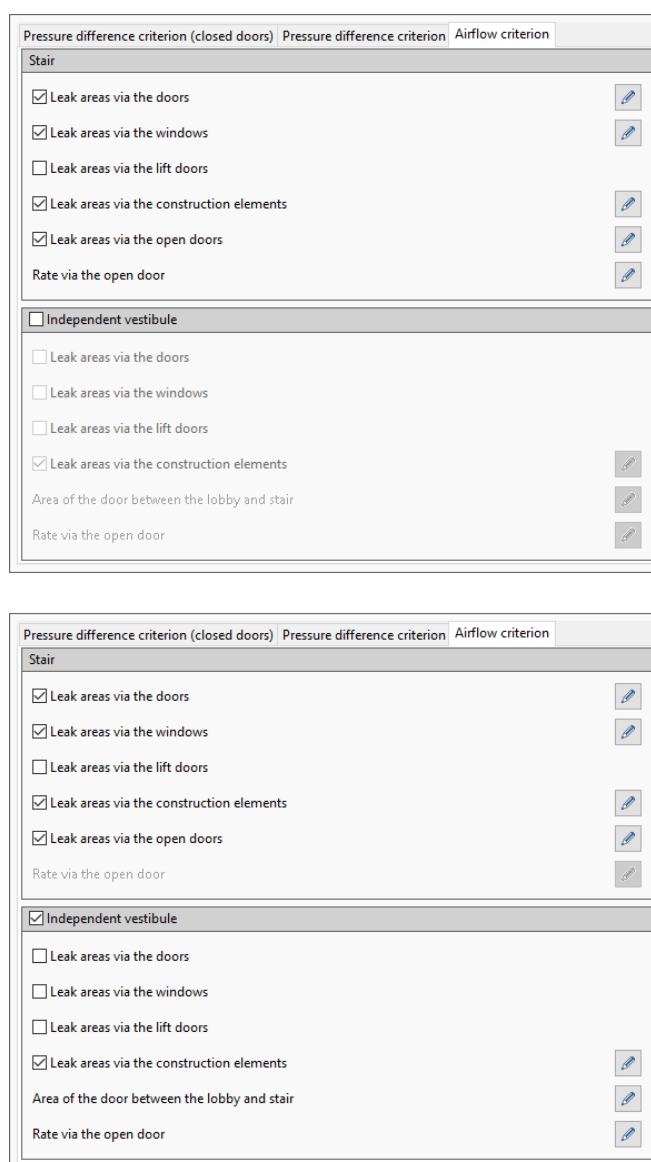

Image 15. Open doors for the pressure difference criterion

4.3 Airflow criterion

Finally, the airflow criterion is the most characteristic, as you can observe in Image 17. Just as in **Section** 3.3, depending on if there is a protected lobby or not some parts of the panel will appear blocked.

Image 16. Airflow criterion with and without a protected lobby

For this criterion the only data needed to carry out the calculation are the leakage areas of each one of the elements for the doors, Windows, lift doors, and the leakage area ratio and the area for the construction elements.

Moreover, in the selected open door to which the airflow criterion will be applied, the speed of the flow will also be added. For the other open doors the area of this element will be introduced, and not the leakage area.

5 **Results**

Finally, you can access the calculation results from the main toolbar, as demonstrated in Image 17.

Image 17. Access to the report generated by CYPEFIRE Pressure Systems.

The application's justification report provides information about all of the calculated pressurisation systems, offers a summary of the class of system, the geometric configuration and, lastly, a breakdown of each one of the air leakage rates by element (doors, windows, lift doors, construction elements and open doors) of each calculated criteria.

At the end of the document the total air leakage rates for each criterion calculated are shown, after the respective safety margins have been applied.
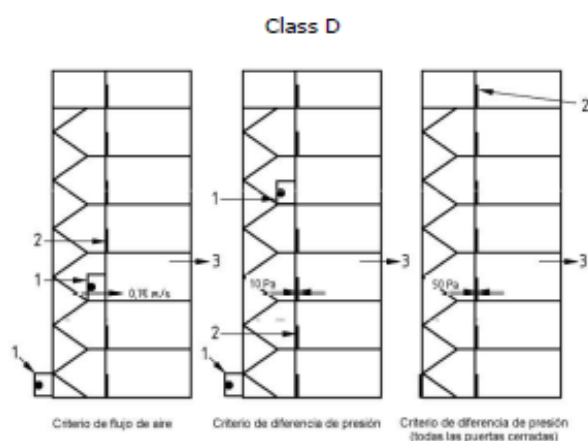
From the results obtained in the calculated criteria you can measure the fan(s) needed to completely supply the overpressure stairwell system.

EN 12101-6

Class D System
Class D System

Data of the differential pressure system

Class D

Criterio de flujo de aire   Criterio de diferencia de presión   Criterio de diferencia de presión (todas las puertas cerradas)

No. of doors that communicate with the stair	8
No. of windows that communicate with the stair	6
Existence of firefighting lobbies at the staircase accesses	Yes
Existence of a lift	No

Pressure difference criterion (closed doors)

Stair		Independent vestibule	
Leak rates via the doors	0.2072 m³/s	Leak rates via the doors	0.5568 m³/s
Leak rates via the windows	0.0144 m³/s	Leak rates via the windows	-
Leak rates via the lift doors	-	Leak rates via the lift doors	0.6681 m³/s
Leak rates via the construction elements	0.131 m³/s	Leak rates via the construction elements	0.0502 m³/s

Pressure difference criterion

Stair		Independent vestibule	
Leak rates via the doors	0.0262 m³/s	Leak rates via the doors	0.9496 m³/s
Leak rates via the windows	0.0053 m³/s	Leak rates via the windows	-
Leak rates via the lift doors	-	Leak rates via the lift doors	0.6681 m³/s
Leak rates via the construction elements	0.0586 m³/s	Leak rates via the construction elements	0.0502 m³/s
Leak rates via the open doors	8.5952 m³/s		

Airflow criterion

Stair		Independent vestibule	
Leak areas via the doors	0.07 m²	Leak areas via the doors	-
Leak areas via the windows	0.0015 m²	Leak areas via the windows	-

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Image 18. Justification report of CYPEFIRE Pressure Systems.

Contact

The configuration of a project, navigating through the user interface, the design inside the software and achieving results based on the design will become evident after completing this CYPEFIRE Pressure Systems user guide. If you still have questions or need more information, please visit our website or contact CYPE's technical support.

CYPE Ingenieros
Avda. de Loring, 4
03003 Alicante - Spain
Tel. (+34) 965 92 25 50
cype@cype.com

CYPE Italia
Tel. (+39) 06 94 803 504
Tel. (+39) 06 94 800 227
supporto.italia@cype.com

North America & United Kingdom Contact:
USA (+1) 202 569 8902
UK (+44) 20 3608 1448
support@cype.com

**CYPE em Portugal
(TOP Informática, Lda.)**
Tel. (+351) 253 209 430
geral@top-informatica.pt

CYPE France
Tel. (+33) 2 30 96 1744
Fax (+33) 2 22 44 2508
cype.france@cype.com