

EASE Evac

Version 2



Developed by
AFMG Ahnert Feistel Media Group

www.afmg.eu

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1 Introduction to EASE Evac

The following chapters will introduce you to the multiple features of EASE Evac. It will guide you through the modeling of rooms and arranging loudspeakers, provide information about calculation parameters and result types, and describe the various possibilities of viewing, exporting and reporting the result.

1.1 Overview

EASE Evac provides an intuitive tool for designing acoustic mass notification and voice address concepts in a room, hall or building complex. The 3D simulation software calculates the distribution of direct sound pressure levels as well as total sound pressure levels, the signal-to-noise ratio (SNR) and speech intelligibility (STI, ALCons, CIS). The latter calculations are based on statistical room acoustics.

The scientific background of EASE Evac derives from the long-term research and development in conjunction with the programming of EASE, the professional electro- and room acoustic simulation software developed by Ahnert Feistel Media Group (AFMG).

EASE Evac offers various alternatives for entering the room. The import of images, AutoCAD DXF-format or Trimble SketchUp files as well as EASE room models simplifies the building of rooms with a complex layout. Several tools enable a quick modeling from scratch. Projects can consist of more than one room, each with its own room acoustic, defined by entering the reverberation time or assigning wall materials with their absorption coefficient to the surfaces of the room.

Wall- and ceiling-mounted loudspeakers, horns or sirens can be added to the model and may be positioned individually. Alternatively, the auto-arrange functions will quickly ‘install’ a vast number of ceiling loudspeakers in a user-defined grid. Sound source data is given in the EASE GLL format, AFMG’s primary loudspeaker file format. GLL data files are created and supplied by manufacturers of loudspeakers and other sound devices. Alternatively, the software module EASE SpeakerLab, another product of AFMG, provides the facilities to create a GLL presuming the necessary data such as the sound source’s balloon measurements are available.

Based on the room and the sources defined, the propagation of sound is simulated. Mappings on horizontal and vertical cutting planes visualize the calculation results. These results are shown as broadband or frequency dependent mappings with user-defined frequency ranges between 1/3 octave and 3 octaves, absolute or relative values, and A-weighted or non-weighted. Noise levels can be accounted for in the speech intelligibility calculation. Both mappings and statistic distribution graphs present the following results:

- Direct sound pressure level
- Total sound pressure level
- Signal-to-noise ratio
- STI

- ALCons
- CIS

For detailed examination, the frequency response graph shows the frequency dependent pressure levels at user defined positions in the room.

EASE Evac is a product of Ahnert Feistel Media Group. Located in Berlin, Germany, AFMG is a worldwide leader in software for the pro-audio industry and has created the industry standards EASE and EASERA software for acoustic simulation and measurement as well as their related products EASE Focus, AFMG SysTune, EASE Address, AFMG Reflex, AFMG SoundFlow and EASE SpeakerLab. AFMG works closely with leading university faculties, manufacturers, and design clients to apply the latest developments in acoustical research and computer technology. For more information, including the latest news and forum posts, visit <https://afmg.eu>.

1.2 System Requirements

Minimum Software Requirements

- Microsoft Windows Vista (Service Pack 1), Windows 7, Windows 8, Windows 10 and Windows 11
- Adobe Acrobat Reader 4.0 (or later)
- Microsoft .NET Framework v 4.0, which can be downloaded from the link below

<http://www.microsoft.com/downloads/details.aspx?displaylang=en&FamilyID=9CFB2D51-5FF4-4491-B0E5-B386F32C0992>

To run the AFMG License Manager, that is needed to register EASE Evac in order to use it, Microsoft .NET Framework 2.0 must be installed on the computer. It can be downloaded here:

<https://www.microsoft.com/en-US/download/details.aspx?id=21>

Please note that Microsoft .NET Framework 2.0 is installed separately from and independently of version 4.0. You will need both to use EASE Evac.

For the Trimble SketchUp import function to work correctly, the Microsoft Visual C++ 2005 Redistributable Package (Service Pack 1) needs to be installed:

<http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=14431>

It will normally be installed automatically by the EASE Evac program installer.

Minimum Hardware Requirements

- 4 GB RAM
- 800 x 600 display resolution (1024 x 768 or higher recommended display resolution)
- 1.5 GHz processor speed or higher
- Multiple processors (cores) are supported and recommended

1.3 Installation & License Registration

Installing and licensing EASE Evac requires very little effort. An overview of the process is described below. See Appendix B where the process is covered in detail.

1. Install the EASE Evac software package (Also install the AFMG Licence Manager if not already installed)
2. Install the EASE Evac User Certificate
3. Start the AFMG Licence Manager, select EASE Evac, then download a licence
4. Start EASE Evac

1.3.1 Initial Start-Up of EASE Evac

After the installation and licensing have completed successfully you can launch EASE Evac using the desktop icon or the Windows Start menu. The software is located in the AFMG folder. If you should experience problems with EASE Evac at any time later, please try starting the software with its default settings. This option is available as a command from the Windows Start menu.



Upon start-up, the software will prompt you with the question if you would like to sign up for the AFMG newsletter in order to be informed about program updates and other AFMG news. We strongly recommend subscribing to the newsletter. It contains the latest details of what is happening at AFMG as well as update notifications for our software.

You may subscribe by either pressing **YES** on the initial dialog window or by selecting the command **SIGN UP FOR NEWS** from the **HELP** menu. This will take you to the AFMG registration website where you may enter personal details as needed and choose which news you would like to receive.

1.4 User Interface

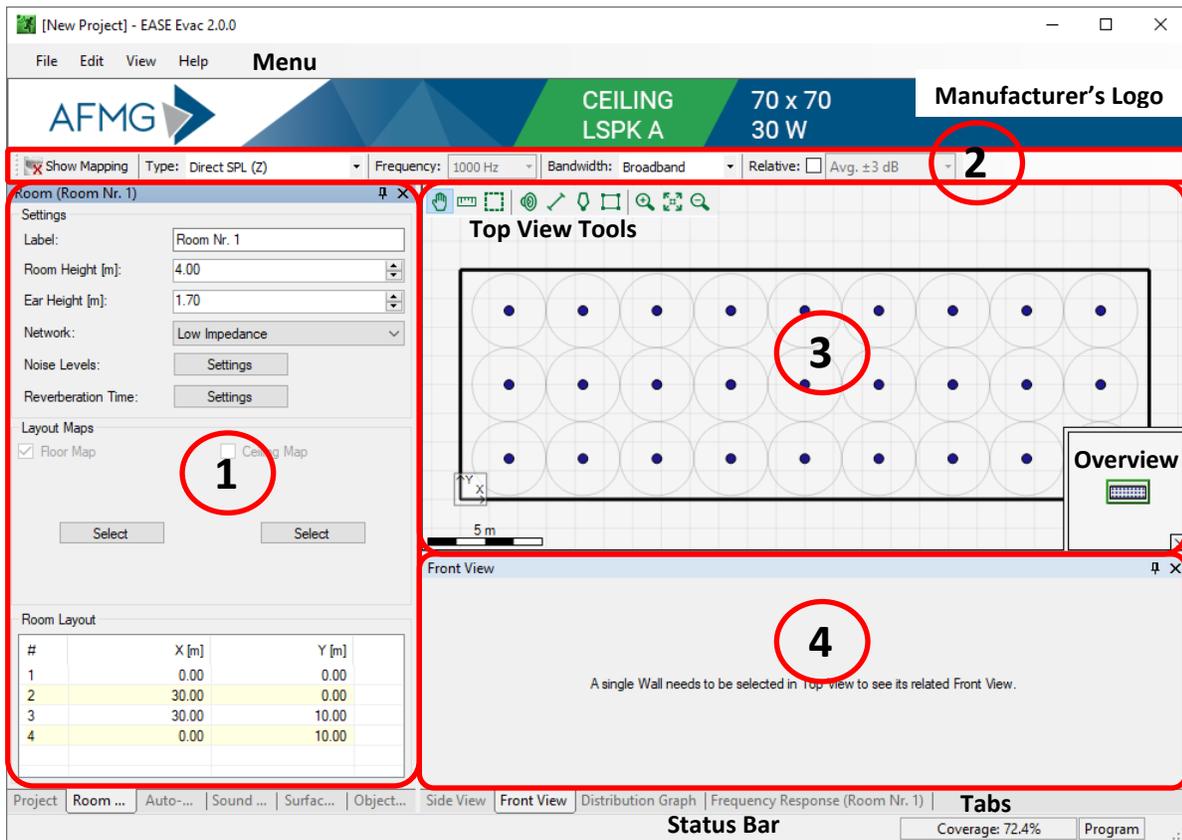


Figure 1.1 – EASE Evac program window

The Graphical User Interface (GUI) has been designed for an intuitive definition of rooms and sound source layout concepts as well as a comprehensive display of the results. The GUI consists of four main window sections and several menu, tool, selection and tab bars. The following paragraphs will summarize their functions and features.

The **Menu** bar on top of the GUI contains the sub menus for general program functions like opening, saving, exporting a project, changing the view and selecting one of the help facilities. The **FILE > OPTIONS** menu allows setting default display and calculation parameters.

The **Manufacturer’s Logo** section displays the manufacturer’s logo of the sound sources currently used in the project and the type of the currently selected sound source, e.g., loudspeaker.

Section 1 (Left): Properties Window

Properties of the project, rooms, sound sources, surfaces and objects are defined in this section. The tabs at the bottom enable the selection of the active property window.

Section 2 (Top): Mapping Toolbar

The Mapping Toolbar controls the start of the mapping procedure and the parameters of the mapping display as well as the distribution graph and the frequency response. For example, absolute sound pressure levels can be displayed with different bandwidths (1/3, 1, 3 octaves or broadband) and center

frequencies (100 Hz – 10000 Hz), variations relative to the average are shown within a tolerance of ± 1 , 2, 3 dB or larger values.

Section 3 (Upper Right): Top View Window

The Top View window summarizes all functions that concern the horizontal plane. It is used to design the layout of the rooms, arrange and aim the ceiling loudspeakers, insert receivers for frequency response displays, define section planes for vertical result displays and show the horizontal mapping results. The toolbar of the Top View contains the necessary tools. The pan icon  is a general-purpose tool for moving, selecting and modifying items. The cursor’s appearance changes according to the current function. Additionally, the toolbar includes zoom functions. The Overview section in the lower right of the Top View simplifies the navigation especially in large projects with several rooms.

Section 4 (Lower Right): Vertical View and Result Window

This section comprises all functions concerning the vertical planes and section views. The Front View shows the wall that is currently selected in the Top View window. Wall-mounted sound sources may be placed on the selected wall. The Side View window displays a wall-mounted loudspeaker or shows the vertical mapping, when a section plane is selected in the Top View window. Additionally, the distribution graph and the frequency response at receiver positions are visualized in this section. The active display depends on the tab selected in the bottom area below this window.

The **Status Bar** at the very bottom of the program window shows the coverage of the current loudspeaker design, the active input signal as well as cursor coordinates and mapping values after calculations. Potential design problems are indicated by warnings.

Several options can be accessed by context menus. These will be explained in the following chapters together with the sections and functions that are equipped with context menus.

1.5 Customizing the Appearance of the User Interface

In order to adjust the program appearance to your requirements, all window sections can be resized and closed individually. To resize a section, place the cursor between adjacent sections. The cursor will change to a resize cursor. Hold down the left mouse button and drag the section boundary either up/down or left/right to resize the sections as needed.

The window sections can be closed with the  button and reopened with the VIEW menu. The exception is the Top View window which cannot be closed.

All windows have a push-pin button , except for the Top View. These push-pins hold the display section in place within the EASE Evac program window. Clicking the push-pin will unpin it from the program window. The display section will now be represented by a tab to the side or bottom of the program window as shown to the right. The display section may be made visible temporarily by moving the mouse over the tab. When the mouse is moved away from the display section, it will once again be hidden. To make the display section remain visible, simply click the push-pin to hold it in position.

In addition, all sections and windows can be repositioned, again with the exception of the Top View window. A left click on the title bar of a section or a tab will produce a shaded square as shown in Figure 1.2 while holding the left mouse button.

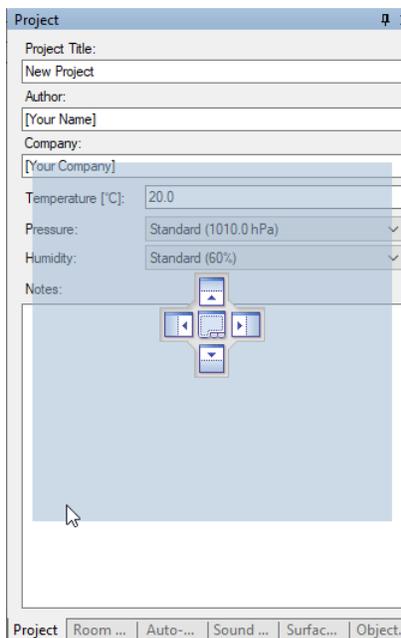
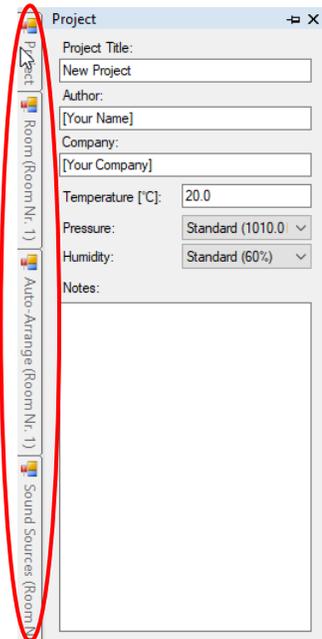


Figure 1.2 – Facilities to reposition sections and windows

Releasing the left mouse button will create a new window independent of the program window for all windows except the Top View window. Holding the mouse button and dragging the square to another window section will produce the display position icon shown in the top part of Figure 1.2. The Top View window will only show this icon in its own section. The section or window indicated by the shaded square may now be placed at the same position as the section with the display position icon by dragging it to the middle part of the display position icon. Tabs in the bottom line indicate the sections with more than one window. These are used to select the active window of the sections.



Alternatively, the window may be positioned on the right, left, top or bottom of the section by dragging the shaded square to the corresponding arrow icon. This will divide the section into two parts with both windows visible.

If the shaded square is dragged into one of the display position fields, its future position is indicated by a shaded field corresponding with the window shape after releasing the left mouse button.

All user created layouts can be stored and recalled. Select **VIEW > STORE CURRENT LAYOUT...** and type a name to save your layout. To recall it at any time, select the corresponding item in the **VIEW** menu. Use the items **VIEW > REMOVE WINDOW LAYOUT** and **VIEW > REPLACE WINDOW LAYOUT** to edit your custom layouts. Note that at any time you may reset the window layout to its default state with the **VIEW > RESET LAYOUT** menu item.

1.6 Shortcut List

There are several shortcut keystroke combinations available to optimize the use of the GUI. A complete listing of these is provided in the tables below for quick reference.

In this text, *LMB* will be used to indicate a press of the left mouse button and *RMB* for the right mouse button.

Left click and *right click* are used for a click with the LMB or RMB, respectively.

The *context menu* is a popup menu that can be opened with a RMB click on the particular element of the user interface.

Drag or *click and drag* will describe the procedure where the LMB is held down while the cursor is moved to a different location in order to reposition items.

1.6.1 Program Shortcuts

Shortcut	Description
F1	Help Index
F4	Properties of selected wall, sound source, etc.

F5	Show Mapping
F9	Options
F10 0 Home	Scale to fit (Full View) in Top, Front or Side View window
F11	Zoom to Next Room
F12	Zoom to Previous Room
Ctrl+1-9 (Room Number)	Activate Room
Ctrl+A	Save Project As
Ctrl+B	Enable Pan Mouse Mode
Ctrl+C	Copy active item in Top, Front or Side View window
Ctrl+D	Show Distribution Graph
Ctrl+F	Show Frequency Response
Ctrl+M	Enable Select Mouse Mode
Ctrl+N	New Project
Ctrl+O	Open Project
Ctrl+P	Create Report
Ctrl+R	Open RT Window
Ctrl+S	Save Project
Ctrl+V	Paste active item in Top, Front or Side View window
Ctrl+Y	Redo
Ctrl+Z	Undo
Alt+F4	Exit Program
Ctrl+Alt+R	Add Default Room
Ctrl+Shift+R	Reset Layout
Ctrl+Shift+S	Export Main Picture
- PageDown	Zoom Out in Top, Front or Side View window
+ PageUp	Zoom In in Top, Front or Side View window
P D	Pan (Drag) in Top or Front View window
T	Measure distance in Top View window
M	Select (Mark) in Top View window
L	Add Sound Source in Top or Front View window
C	Add Section Plane (Cutting Plane) in Top View window
S	Add Receiver (Seat) in Top View window
R	Add Room in Top View window
Ctrl+I	Open Noise Settings
Ctrl+F1-12	Recall custom layouts from 1 to 12

1.7 Trouble Shooting

Here are some additional hints for trouble shooting your software configuration if you encounter technical problems:

- If you cannot start EASE Evac, make sure you have correctly installed all of the files. Please refer to the installation instructions and verify that you have performed all of the installation steps properly.
- If EASE Evac worked before, but it does not start anymore or shows strange errors, do the following: From the Windows Start menu, start EASE Evac using the link `PROGRAMS > AFMG > EASE EVAC (START WITH DEFAULT SETTINGS)`. This will discard the last application settings and start like a fresh installation.
- Visit the website of AFMG, your distributor and our public forum located at www.afmg-network.com. Also verify that you have installed the latest version of the software. You will find information about updates and other useful tools under <https://www.afmg.eu/en/ease-evac>.

If you still cannot run EASE Evac, please create a status report: From the Windows Start menu select the menu item `PROGRAMS > AFMG > CREATE STATUS REPORT`. After that, please contact AFMG or your software distributor and send them this report along with a detailed description of the error you have encountered.

1.8 Disclaimer

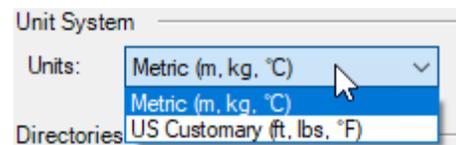
Disclaimer: All results provided by EASE Evac are only accurate within the accuracy of the input data and the computational model. Herewith AFMG explicitly excludes any legal liability regarding the calculation results of EASE Evac or any other AFMG software product.

2 Building a Room: A Quick-Start

There are a several room design alternatives and advanced procedures including the surface material definition for adjusting the reverberation time, the insertion of room and wall objects, and the management of several rooms in the same project. These will be explained in chapter 4 (Room Acoustic Design) and chapter 6 (Advanced Room Building Procedures). The task of this chapter is an introduction to the general building procedures in order to enable a fast progression to the main purpose of EASE Evac, the design and validation of mass notification sound systems.

Note that although the Top, Front and Side Views have a 2D appearance, the rooms are 3D shapes with floor, wall and ceiling surfaces. There are no limits concerning the number of walls, but the walls are straight and have the same height throughout the room. Consequently, the floor outline is the same as the ceiling outline.

It may be necessary to adjust the unit system and language before starting the model. The `FILE > OPTIONS > ENVIRONMENT` dialog enables the selection the units, either metric or US customary. You can also open the Options dialog at any time by pressing the Function Key 9 (F9).



2.1 Room Modeling Facilities

If EASE Evac is started with the default setting (`PROGRAMS > AFMG > EASE EVAC (START WITH DEFAULT SETTINGS)`), a default room (30 x 10 m) appears in the Top View window and the `PROJECT` tab is active on the left side. The default room already includes ceiling loudspeakers, indicated by the blue points with the coverage visualized by their circles (Initial settings for the default project and default room can be made in `FILE > OPTIONS > PROJECT DEFAULTS`, see chapter 8.5.)

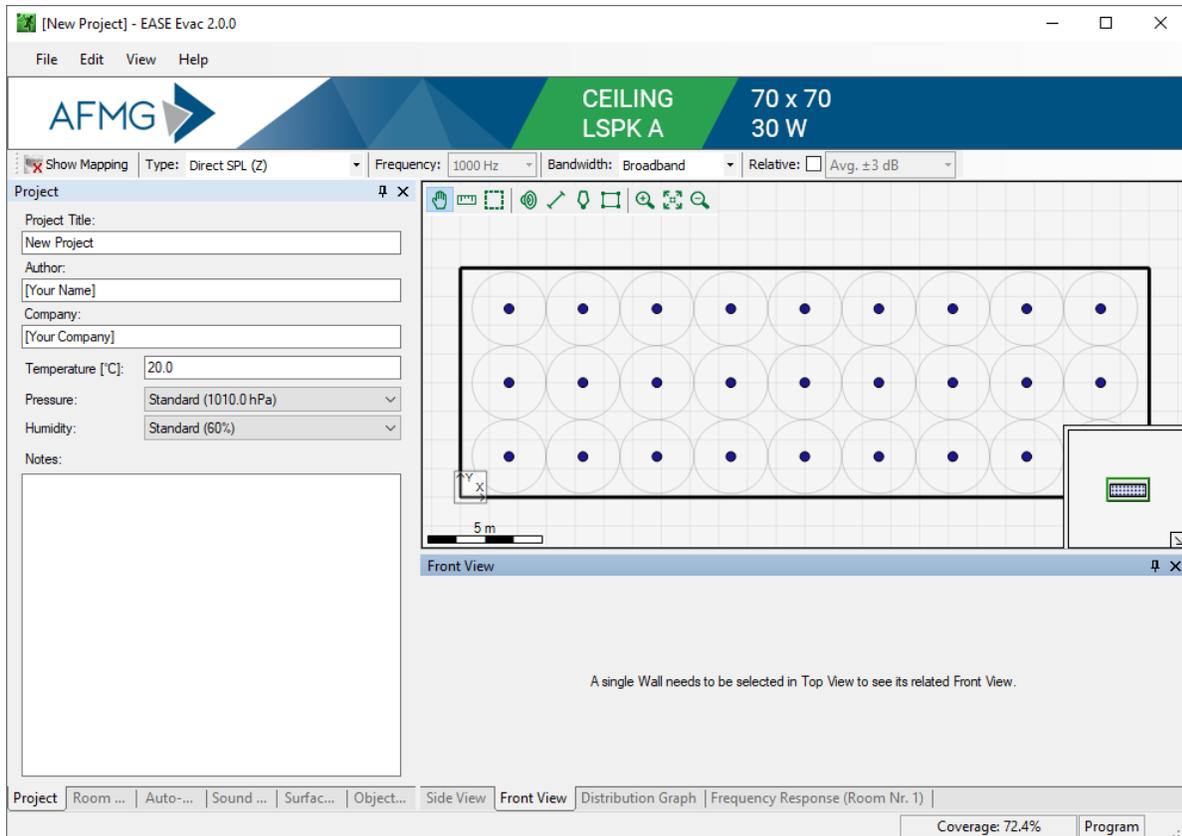


Figure 2.1 – Default program window

2.1.1 Project Tab

The **PROJECT** tab contains general information about the project. Project details like the **PROJECT TITLE**, **AUTHOR**, **COMPANY** and **NOTES** with additional information may be entered into the associated fields. The properties of air (**TEMPERATURE**, **PRESSURE**, **HUMIDITY**) can be altered as well.

2.1.2 The Room Tab

The **ROOM** tab includes all settings relevant for the room. This paragraph will explain the settings concerning the modeling of the room, the others like **NETWORK**, **NOISE LEVELS** and **REVERBERATION TIME** will be topics of the corresponding chapters.

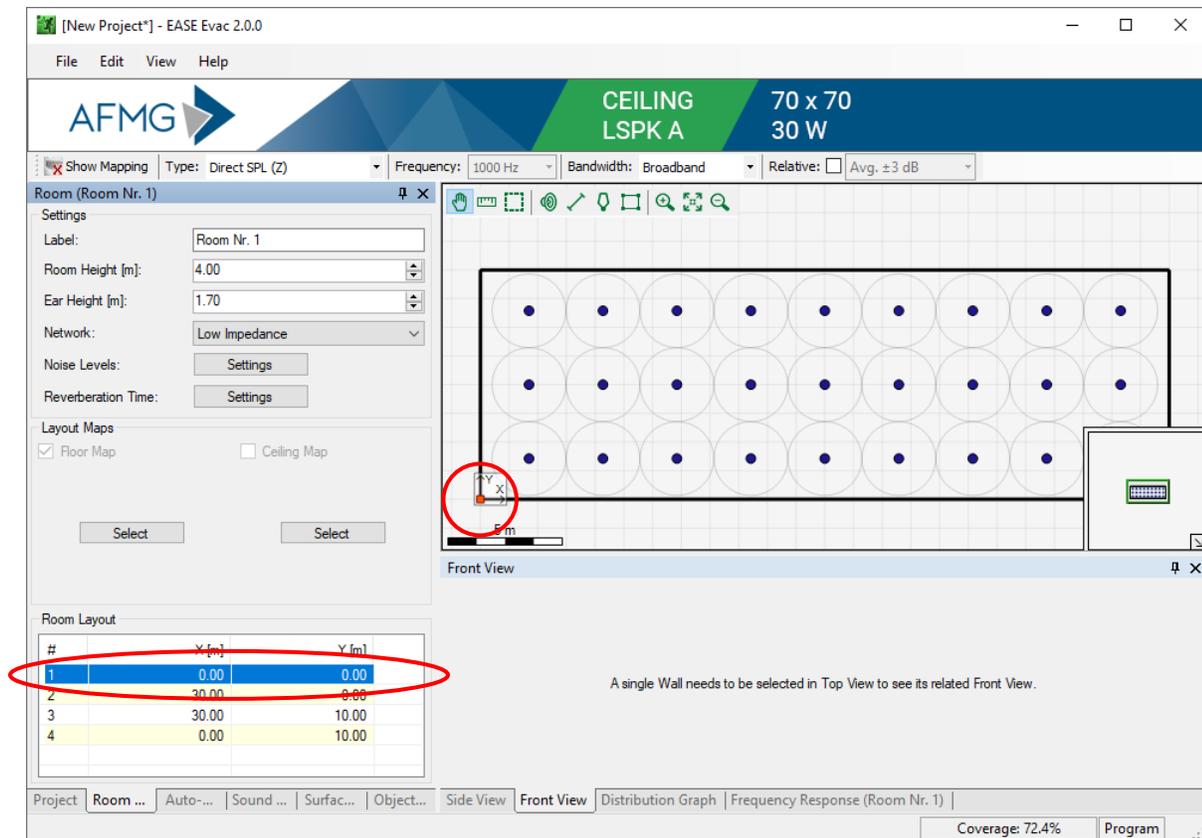


Figure 2.2 – The Room tab

Each room of a project has a LABEL, the default is Room Nr.1. You may enter an appropriate label into the associated field. The ROOM HEIGHT determines the overall height. Models in EASE Evac incorporate only floor and ceiling on one level as well as straight walls. Therefore, the height cannot vary in a room. The EAR HEIGHT defines the height of the virtual listening plane that is automatically inserted above the floor. The floor has the z coordinate 0, the virtual listening plane has the z coordinate defined by EAR HEIGHT. All mappings will be calculated for this listening plane.

Hint: Ear height for people sitting down is normally estimated at 1.2 m. Ear height for standing people is normally estimated at 1.7 m.

The room’s x and y coordinates are shown under ROOM LAYOUT. There are two types of vertices in the Top View window, the main vertices and the auxiliary vertices. The main vertices define the start and end point of a straight wall and are listed in the ROOM LAYOUT table. The auxiliary vertices are automatically inserted between any two main vertices and enable the adjustment of the room shape.

To change the vertex position, PAN is activated in the Top View toolbar by a click on the  button. In this mode, the cursor will change into a hand with index finger whenever the cursor is positioned on an item, e.g., a vertex or a wall. If a main vertex is selected by a LMB click, the vertex is indicated by a red square and its coordinates are marked grey in the ROOM LAYOUT table as shown in Figure 2.2. A click on

an auxiliary vertex will change it into a main vertex and it will appear in the ROOM LAYOUT table. The wall will be cut into two parts at the position of the new main vertex and each part will automatically get a new auxiliary vertex. The position of the vertices is changed by dragging with the LMB. Alternatively, the vertex position can be typed into the coordinate fields of the layout table. The up-and-down arrows can be used as well.

In order to change the room’s display position in the Top View window, drag with the LMB on the background of the window. The cursor hand will change to a closed hand as long as the LMB is held. The origin of the room relative to other rooms can be changed by dragging one of the walls in the same manner. In this case the cursor hand will change to a move symbol as long as the LMB is held.

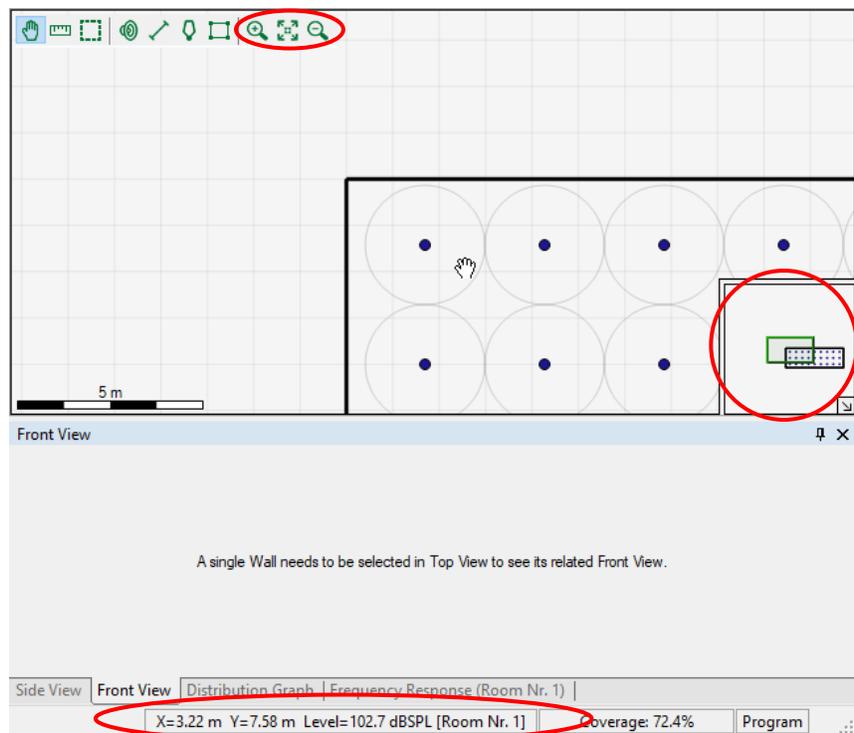
Both the Top View and the Room Layout table have context menus that include a DELETE function. In addition, the layout context menu contains the ADD NEW VERTEX ABOVE, ADD NEW VERTEX BELOW and SET AS ROOM ORIGIN functions. The latter will change the room origin, indicated by the  symbol, to the position of the selected vertex. It is often useful to adjust the room origin when working on the basis of CAD drawings that already have a coordinate system.

#	X [m]	Y [m]
1	0.00	0.00
2	30.00	0.00
3	0.00	10.00
4	30.00	10.00

Room Layout context menu options:

- Delete
- Set as Room Origin
- Add New Vertex Above
- Add New Vertex Below

The toolbar of the Top View window includes the zoom icons    (ZOOM IN / SCALE TO FIT / ZOOM OUT) to adjust the room position. The Overview in the bottom right corner indicates the section of the room currently displayed in the Top View window. This feature is especially useful for keeping the overview in large projects with several rooms.



The Status bar at the bottom displays the x and y coordinates at the cursor position.

The room may be built by manually entering all vertices. However, if a floor or ceiling drawing or image of the room exists, the importing the drawing simplifies the room building process.

2.2 Import of Layout Maps

A quick modeling approach for existing rooms begins with importing the floor and/or ceiling layout maps. The import procedure differs slightly depending on the import file format. Compatible file formats are images (*.png, *.jpg, *.gif, *.bmp, *.tif, *.tiff), AutoCAD (*.dxf), Trimble SketchUp (*.skp) and EASE room model (*.frd) files. The EASE Evac import function supports all of the current versions of DXF (up to DXF 2010) and SketchUp (up to v8) files.

A click on the  button, for either the LAYOUT MAPS > FLOOR MAP or LAYOUT MAPS > CEILING MAP, will open a Windows file dialog to select the drive, path, and file.

Note that the layout maps only provide a background image used to build the room. You need to use the drawing tools in EASE Evac to recreate all of the room geometry, because the import procedure does not translate the layout directly. The floor and ceiling layout of the room are equally useful because a room may contain only vertical walls. Therefore, it is usually sufficient to import a floor or a ceiling layout map. However, if a ceiling includes components like ventilation openings, beams or lighting systems, it may be convenient to import a ceiling map in addition to a floor map in order to prevent conflicts between sound sources and those components.

2.2.1 Import of Images

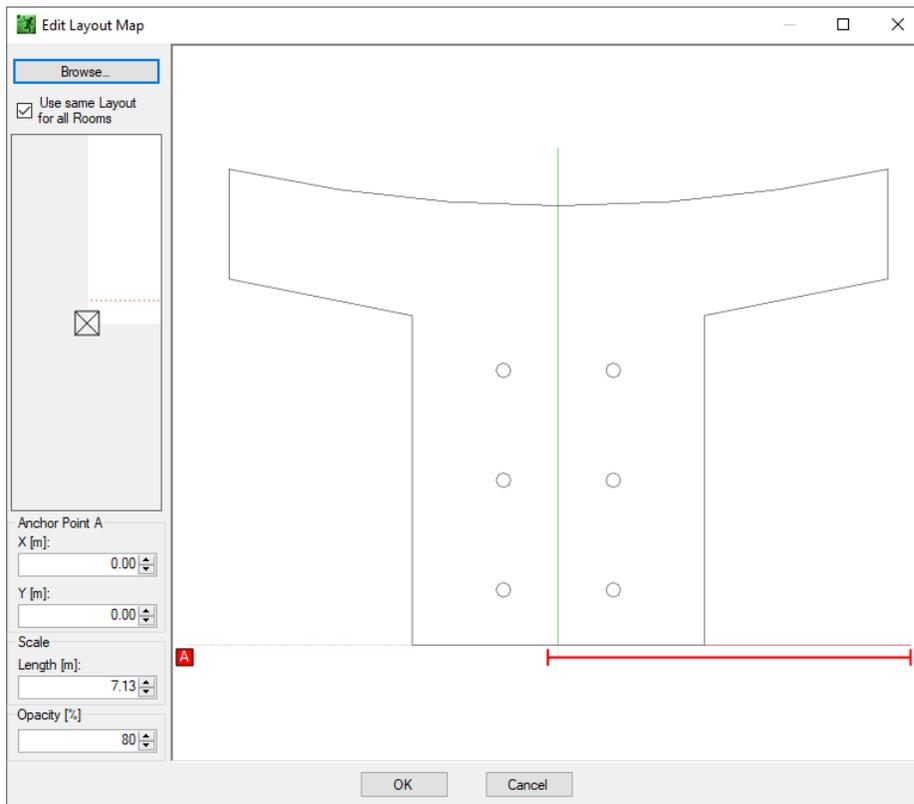


Figure 2.3 – Import dialog for images

The assignment of the imported image to floor or ceiling depends on the **SELECT** button choice on the **ROOM** tab. The button **BROWSE...** reopens the Windows dialog for the import of the layout map. If **USE SAME LAYOUT FOR ALL ROOMS** is checked the layout image will be shared between all rooms. Uncheck this box if you have a separate drawing for each room. Note that the amount and the size of the images will affect the project file size.

The small drawing on the left shows the details of the drawing on the right at the position of the cursor. It makes it easier to position the anchor point **A** and the scale line precisely in the drawing.

The scaling of the drawing is defined by the distance between the end points of the scale line. The first step is to position the end points at appropriate locations in the drawing. Click on each of the two points and drag it to the desired position. The cursor will change to a pointing hand during the dragging. Enter the distance between the end points into the **SCALE LENGTH** field.

After that, move the anchor point **A**. Click on **A** and drag the point to the desired position. Enter the coordinates of **ANCHOR POINT A** into the associated **X** and **Y** fields on the left side.

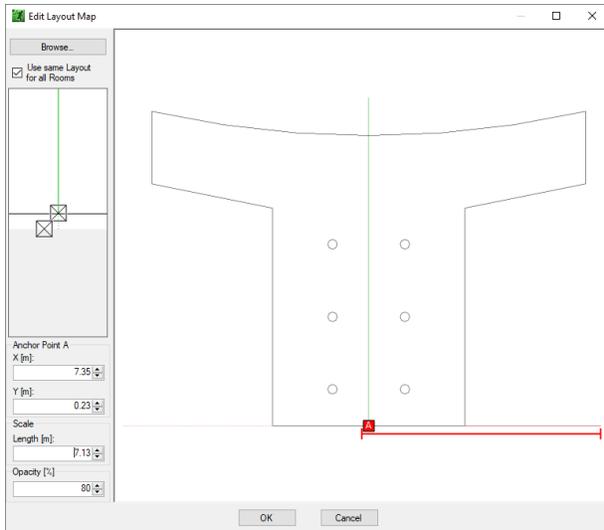


Figure 2.4 – Edit Layout Map dialog after adjusting anchor point A

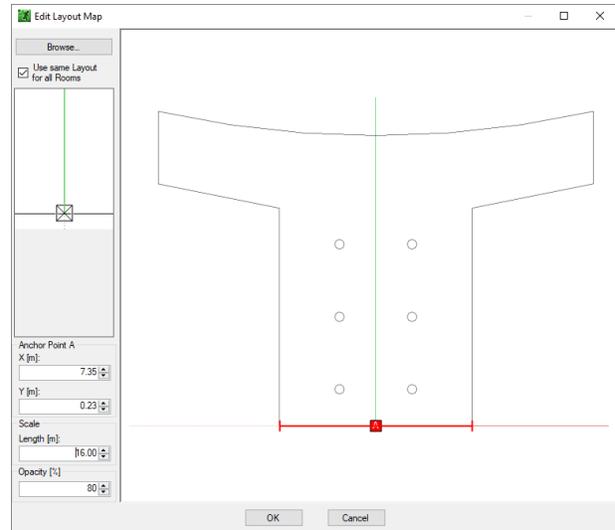


Figure 2.5 – Edit Layout Map dialog after adjusting the scale line and entering coordinates and length

The **OPACITY** of the drawing in the Top View window may be adjusted now or later. The higher the **OPACITY** the more pronounced are the lines of the drawing in the Top View window.

OK will load the drawing into the Top View window; **CANCEL** will discard the import process.

2.2.2 Import of CAD, SketchUp or EASE drawings

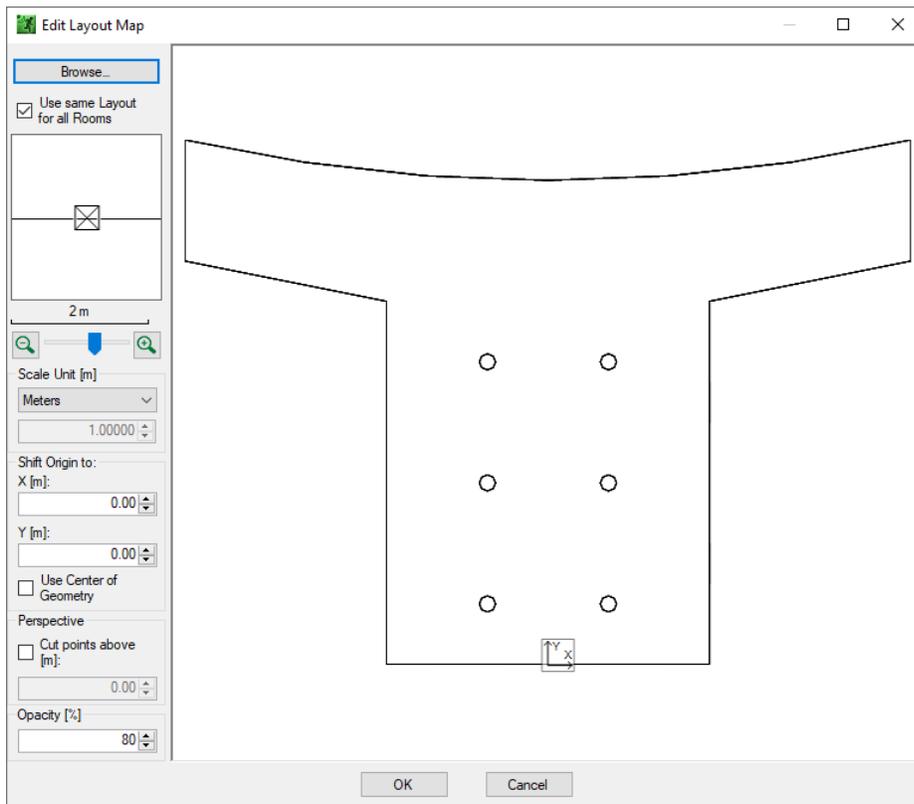


Figure 2.6 – Import dialog for CAD, SketchUp and EASE drawings

The assignment of the imported drawing to floor or ceiling depends on the **SELECT** button choice on the **ROOM** tab. The button **BROWSE...** reopens the Windows dialog for the import of the layout map. If **USE SAME LAYOUT FOR ALL ROOMS** is checked the layout image will be shared between all rooms. Uncheck this box if you have a separate drawing for each room. Note that the amount and the size of the drawings will affect the project file size.

The small drawing on the left shows the details of the drawing on the right at the position of the cursor. The zoom of the detail drawing can be adjusted with the  sliding bar. It makes it easier to define the origin of the drawing precisely.

For DXF drawing files the **SCALE UNIT** can also be defined. Select one of the items in the list to select the unit used in the drawing file. This setting will define how the coordinates of the imported room are scaled upon import. Select **CUSTOM** in order to enter a user-defined scaling factor. Since SKP and EASE drawing files carry their unit of definition with them the **SCALE UNIT** function is not available for these file formats.

The origin, indicated by the  symbol, is equivalent to the origin of the imported drawing. In order to shift it, the coordinates of the new origin are entered under **SHIFT ORIGIN TO**. Alternatively, it can be

moved automatically to the center by activating `USE CENTER OF GEOMETRY`, or it can be manually dragged on the map with the mouse. You may also use the command `USE THIS POSITION AS ORIGIN` from the context menu to move the origin to the current mouse location.

`CUT POINTS ABOVE` (floor map) or `CUT POINTS BELOW` (ceiling map) will insert a horizontal cut. All items above or below are removed. This may improve the overview, especially if a 3D drawing includes a lot of items that are not relevant for the room modeling or if a ceiling and a floor map are derived from the same 3D drawing.

The `OPACITY` of the drawing in the Top View window may be adjusted now or later. The higher the `OPACITY` the more pronounced are the lines of the drawing in the Top View window.

`OK` will load the Drawing into the Top View window; `CANCEL` will discard the import process.

2.2.3 Room Shape Adaptation after Import

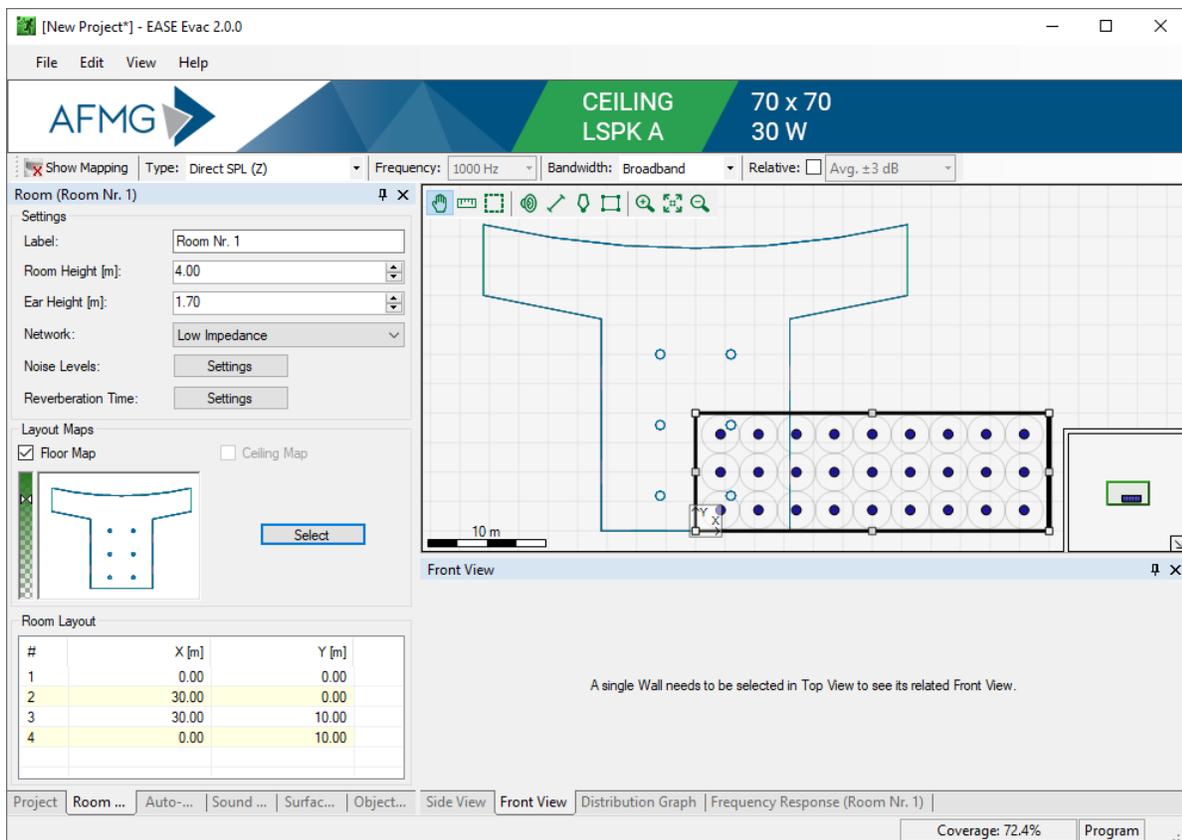
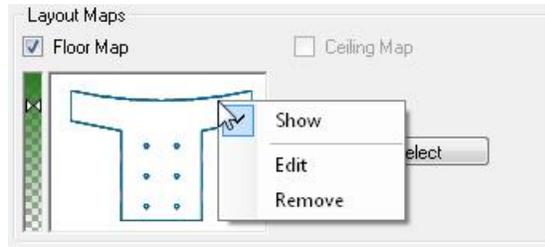


Figure 2.7 – Top View window after the import of an image or drawing

The slider in the LAYOUT MAPS section allows the adjustment of the drawing opacity in order to achieve the optimal balance between the layout drawing and the room outlines in the Top View window.

Each of the LAYOUT MAPS thumbnails includes a context menu. SHOW activates the display of the layout map in the Top View window. EDIT reopens the Edit Layout Map dialog for modifications. REMOVE deletes the layout map from the project.



In order to adapt the shape of the default room to the drawing, drag each vertex to the desired position. The status bar at the bottom of the program window specifies the coordinates at the cursor position during the dragging as shown in Figure 2.8. Alternatively, the coordinates are defined in the ROOM LAYOUT list. A combination of both is probably the fastest approach, first dragging the vertices approximately to the correct position and then correcting the coordinates in the ROOM LAYOUT list. But in many cases, accurate coordinates may not be available or may not be needed for a quick overview.

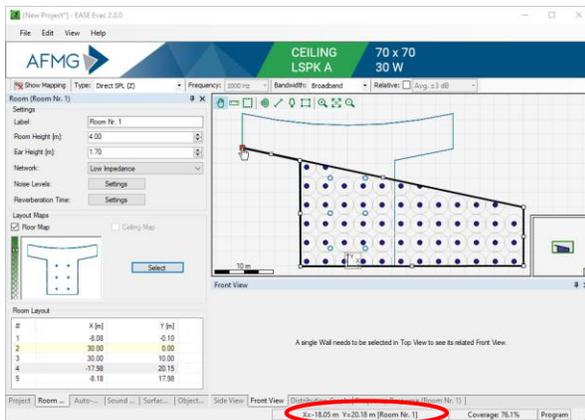


Figure 2.8 – Manually adjustment of the vertices

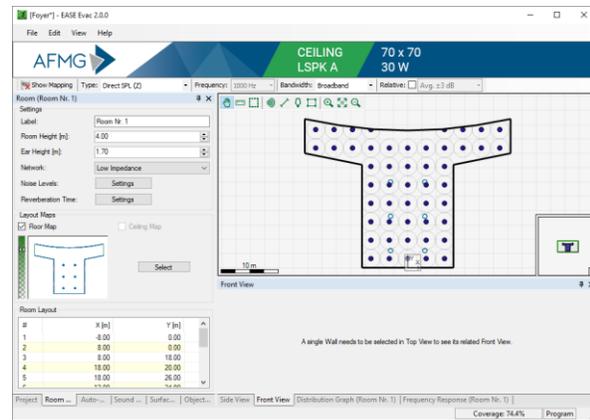
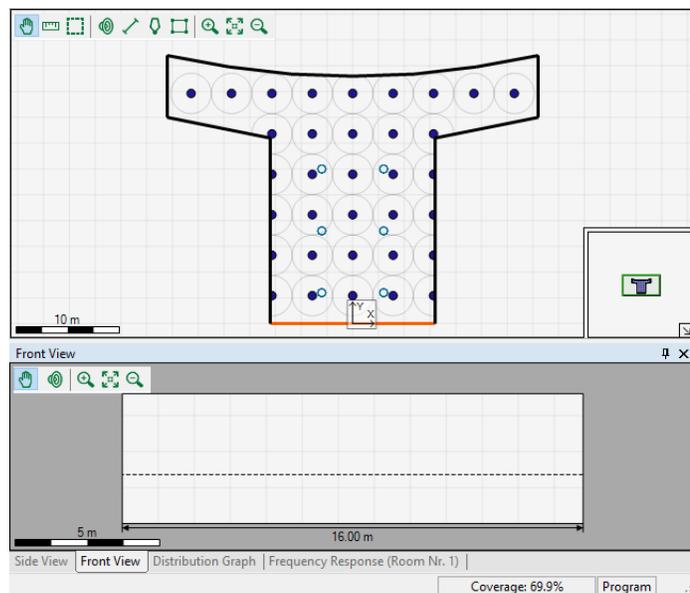


Figure 2.9 – Room shape after adjusting all vertices

If the height has not been defined yet, it should be entered in ROOM HEIGHT before the project is saved. In this example it is set to 4.5 m.

In order to see the wall elevation, activate the FRONT VIEW tab and click on a wall. The selected red wall is visualized in the Front View window.

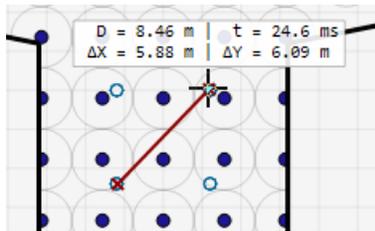
The dashed line indicates the height of the listening plane. This parameter is adjusted



by the `EAR HEIGHT` setting discussed earlier.

2.2.4 Measuring Distances and Delays

When building a room or when looking at a project it is often of interest to see the dimensions of the room, verify the spacing of some elements or measure the distance between two points of interest. For this purpose, the  icon in the Top View window can be used. Click on the button or press the shortcut T to activate the measurement mode.



In order to take measurements, left-drag anywhere on the drawing. By pressing the LMB the starting point for the measurement is defined. The end point is at the current mouse location as long as the LMB is held. For a new measurement just release the LMB and left-drag again.

While dragging a rectangular box is shown that displays four quantities: the distance D , the delay time T , the offset in X direction ΔX and the offset in Y direction ΔY .

2.2.5 Drawing Accuracy

Regarding the accuracy of the room drawing, please note that EASE Evac is designed for the quick evaluation of a mass notification sound system. It is normally not necessary to model the walls to the accuracy of a millimeter or to the tenth of an inch. As a rule of thumb for medium size rooms, geometrical details with dimensions greater than 1 m should be included in the drawing, but smaller objects and wall structures should be ignored. For very large and very small venues this limit should be adapted accordingly. Most rooms should not require more than 20-30 vertices. If your number of vertices is significantly above that number, you can probably simplify the drawing by omitting some details.

In any case, the accuracy of the room drawing is only of importance for shadowing effects and for room acoustic considerations, such as regarding total sound pressure levels and speech intelligibility. If you are just concerned with direct sound pressure levels, e.g., when designing a ceiling speaker layout in a non-reverberant room, you will not need an accurate room drawing for acoustic investigations at all.

Regarding the error introduced with respect to the room acoustic calculation, please note that it will practically only depend on the floor area omitted or added for the purpose of simplification or faster drawing. If the sum of this area is well below 5%, the room acoustic calculation will normally not be affected significantly.

2.3 Saving and Opening a Project

The project with the new room can either be saved with the same name and in the same directory with `FILE > SAVE (CTRL+S)` or a new name and directory is assigned with `FILE > SAVE AS... (Ctrl+A)`. The latter will open a Windows file dialog to select the drive and path as well as enter the name. The file extension for EASE Evac projects is *.evc.

The project file contains all data of the project, including the sound source data files (GLL), surface materials and room objects. However, all database items such as materials or sound sources are organized in subfolders. If a folder or file used by the project is not found while loading the project, EASE Evac will open an import dialog in order to copy the data from the project file to the local database. Refer to chapter 7.1 for further information.

It is recommended to switch off the  button before a new project is created with `FILE > NEW PROJECT (CTRL+N)` or an existing one is opened with `FILE > OPEN... (CTRL+O)`. Otherwise, the calculation will start automatically. A new project will always include the default room. Settings related to the default room can be made using `FILE > OPTIONS > PROJECT DEFAULTS`, see 8.5.

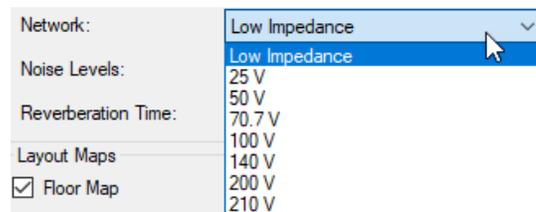
3 Designing the Sound System

In EASE Evac each sound source in the room, e.g., a loudspeaker or a horn, consists of two kinds of data:

- The first type of data relates to the properties of a particular sound source relative to another one, such as the location, orientation or gain. These properties can be understood as settings that are made by the user and that are specific to the sound source and to the room.
- The second kind of data relates to the underlying model number or series, the so-called type of the sound source. This includes data like the sensitivity, the rated opening angle, the directional radiation pattern and the impedance which are assumed to be the same for all sound sources of the same type. These properties normally cannot be changed by the user.

In EASE Evac each type of sound source is defined by a separate GLL data file that includes all of the latter data. GLL files are either provided by a manufacturer or created with EASE SpeakerLab, which is a separate software package by AFMG. The EASE Evac software ships with some exemplary ceiling- and wall-mounted loudspeakers. New types of sound sources can be added to the database of the software using the menu item `FILE > IMPORT SYSTEM DEFINITIONS...` AFMG also provides a database of GLL files online. You can open the website in a browser by selecting the menu item `HELP > DOWNLOAD SYSTEM DEFINITIONS.....` See section 3.3.1 for more details.

The `AUTO-ARRANGE` and `SOUND SOURCES` tabs provide the functions to insert and adjust the sound sources. An exception is the configuration of the `NETWORK` on the `ROOM` tab. The `NETWORK` setting defines if a room uses a low-impedance network or a constant-voltage network, such as 70 V or 100 V.



3.1 Automatic Insertion of Sound Sources

Especially large room designs with regularly spaced ceiling loudspeakers or horns benefit from the `AUTO-ARRANGE` function. Furthermore, it enables a quick arrangement of sound sources in order to get a preliminary assessment of the loudspeaker design suitability, before the system design is fine-tuned and optimized.

After activating the `AUTO-ARRANGE` tab, the checkbox `AUTOMATICALLY ARRANGE SOUND SOURCES` has to be selected before the auto-arrange functions are available. Auto-arrange will be switched off automatically, if any loudspeaker position is changed manually.

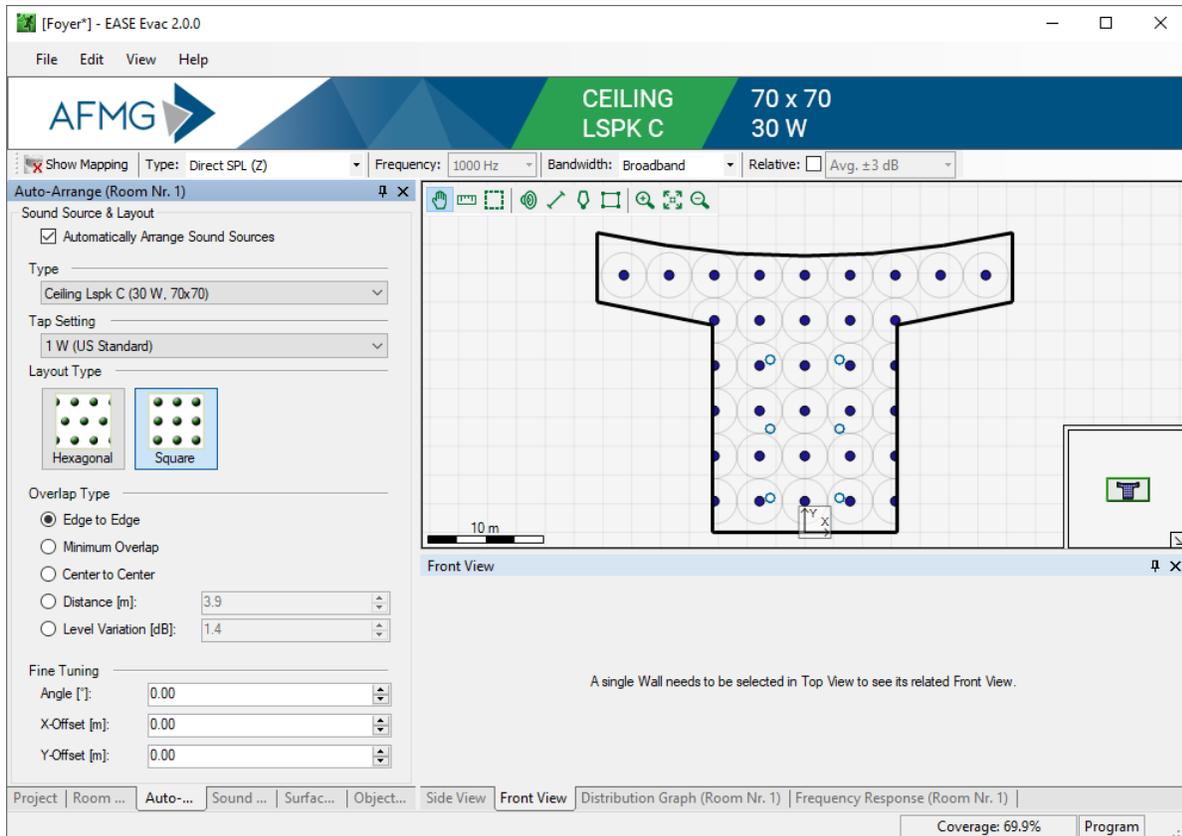
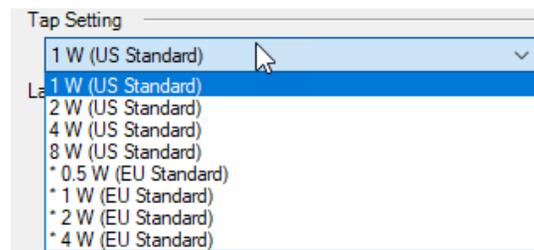


Figure 3.1 – The Auto-Arrange tab

Several parameters control the auto-arrangement. The **TYPE** of sound source is selected in the topmost drop-down list. Based on that selection, the Manufacturer’s Logo section shows the loudspeaker type as well as the creator of the GLL. When auto-arrange is active, only one type of sound source can be used in each room, but the type of each sound source may be changed later manually in the Sound Sources window. The types available correspond to the GLL files available in the system definitions folder of EASE Evac.

Note: New types can be added by selecting the corresponding GLL file using the menu item **FILE > IMPORT SYSTEM DEFINITIONS...** (section 3.3.1).

GAIN defines a global gain setting for all sound sources of the room. This option is only available if the Room supports a low-impedance network. In a constant-voltage network the **TAP SETTING** can be adjusted instead. It defines a global transformer tap setting for all sound sources of the room.



Note: Only those tap settings will be available in the selection list that are defined in the GLL and do not exceed the maximum power rating of the sound source for the given network voltage. Tap settings which are defined for a different network voltage but are compatible are indicated by a star *.

LAYOUT TYPE determines the type of grid used to arrange the sound sources. In a HEXAGONAL grid, each sound source has six direct neighbors. A hexagonal grid provides a higher density of sources and more even coverage but it is more difficult to build in practice. In a SQUARE grid, each sound source has four direct and four diagonal neighbors. A square grid is simple to build in practice but it does not provide the uniformity of a hexagonal grid.

The OVERLAP TYPE determines the distance between individual sources. Greater density of loudspeakers corresponds to more even coverage and higher redundancy in evacuation applications. Lower density corresponds to smaller quantities of loudspeakers and therefore more cost-effective solutions.

With the EDGE TO EDGE type the circles indicating the rated opening angle of the sources are adjacent to each other. This layout is often sufficient for installations where the sound system has only subordinate importance, like the play-back of ambient music in a hotel lobby.

With the MINIMUM OVERLAP type the area is entirely covered but with the minimum of overlapping area. This layout is often a good compromise between the quality of coverage and the quantity of loudspeakers needed.

With the CENTER TO CENTER type any spot of the area is nominally covered by at least two loudspeakers. This is a preferred layout for applications with high safety standards.

DISTANCE allows the user to set the spacing of loudspeakers manually.

LEVEL VARIATION defines the maximum level variation over the ideal grid. The loudspeakers are spaced accordingly. Note that this calculation is only an approximation. It may differ from the actual level variation in a given room, particularly at its edges.

The FINE TUNING options adjust the loudspeaker configuration relative to the Room’s boundary, either by shifting it or by rotating it. ANGLE rotates the grid by the entered angle. Figure 3.2 shows the arrangement with a rotated square grid. X-OFFSET shifts the grid in the X direction by the entered distance. Y-OFFSET Shifts the grid in the Y direction by the entered distance. Figure 3.3 shows an arrangement with an X and Y offset.

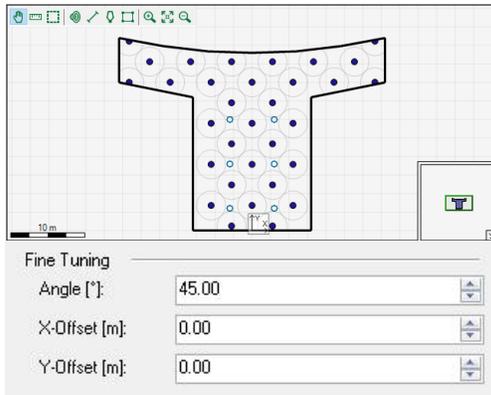


Figure 3.2 – Auto-Arranged sources with a rotated grid

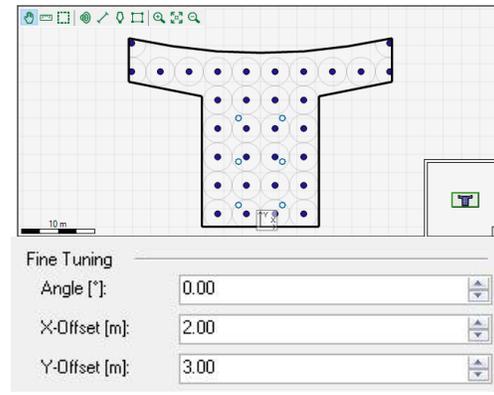


Figure 3.3 – Auto-Arranged sources with X and Y offset

The Status bar indicates the overall **COVERAGE** of the active sound system design. It states the relative coverage as a percentage based on the rated opening angle of each loudspeaker and the resulting coverage of the listening area. By default, the status bar also shows a **LEVEL** value for the direct sound pressure level at the position of the mouse cursor.

3.2 Direct Sound

A direct sound calculation may now reveal the quality of the coverage and thereby the necessity of general improvements. It will enable a quick comparison of different sound source layout concepts before much effort is put into detailed enhancements like optimizing the coverage at the room boundaries.

Direct sound calculations in EASE Evac only model the sound propagation along the line of sight between sound source and the receive location [1]. This calculation also accounts for shadowing effects. Therefore, listening areas and receiver positions that are shadowed by a wall from the perspective of a particular loudspeaker will receive no direct sound from that loudspeaker in the model. Note also, that by definition the direct sound signal does not include any reflections or reverberation. Use the total sound pressure level quantity (section 4.2) to investigate the combination of direct sound and reverberant sound field.

The calculation is started with a click on the button. At first the results are shown with a low resolution. Then the calculation process will continue automatically at higher resolutions until the final Mapping resolution is reached. The default target resolution is medium; it can be adjusted under **FILE > OPTIONS > MAPPING**. The bar in the bottom right corner of the Top View window indicates the time required for the calculation.

The color legend that corresponds to the color scale used for the mapping is shown on the right. The icon toggles the visibility status between show and hide. By default, the color scale of the mapping is

adjusted automatically. If a different scaling is required it can be altered under **FILE > OPTIONS > MAPPING** as well.

The results are displayed in the Top View window as shown in Figure 3.4.

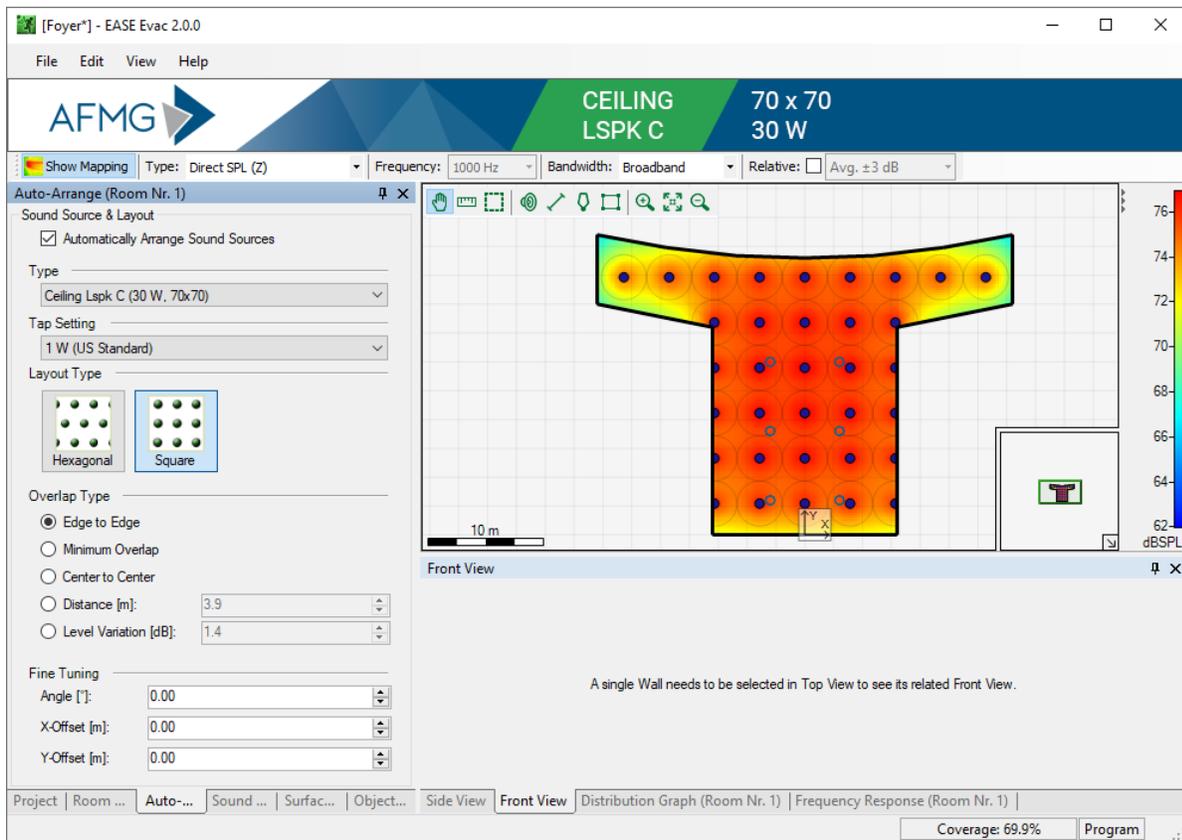


Figure 3.4 – Direct SPL Mapping in the Top and Side View window.

The Status bar displays the value at the current cursor position. In order to achieve a presentable graphic display for documentation the opacity slider in the Layout Map section may be used to hide the layout map.

3.2.1 Section Planes

The results can also be shown in the Side View window if either a single source or a **SECTION PLANE** is selected in the Top view window. A **SECTION PLANE** for the display of vertical mappings is inserted by selecting the  icon in the toolbar, positioning the cursor on the starting point of the desired section plane and dragging the cursor to the end point of the section plane. Several section planes can be added in the Top View window. Only one section plane can be active for the vertical mapping display in the Side View window at a time. The active section plane is orange, the inactive ones are blue. For selecting

a section plane, activate the **PAN** icon and the hand will show an index finger when moved over a section plane. A click on the section plane activates it.

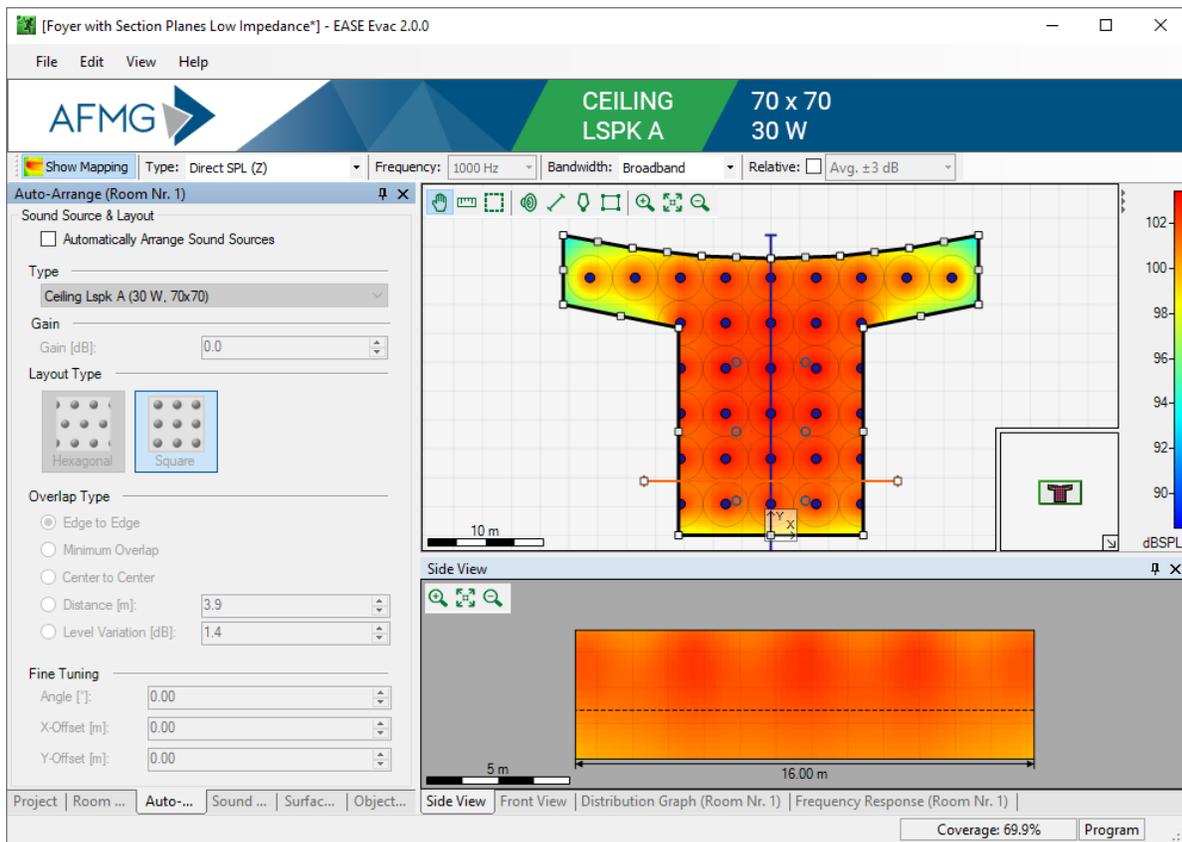


Figure 3.5 – The Side View shows the mapping at the active red section plane

3.2.2 Mapping Parameters

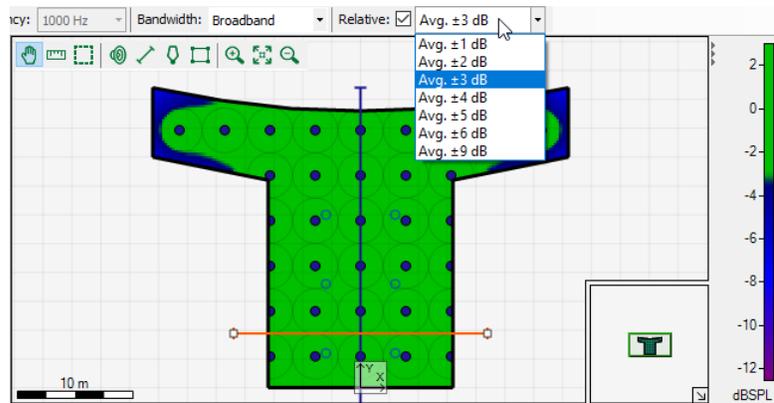
The default **BANDWIDTH** is set to **BROADBAND** and the **TYPE** is **DIRECT SPL (Z)**. Consequently, the first mapping shows the broadband sum direct sound pressure level over all 1/3 octave bands from 100 Hz to 10000 Hz with no weighting.

In addition to the calculation with no (zero = Z) weighting, sound levels can be displayed with an A-weighting. This corresponds to a weighting that takes the frequency-dependent sensitivity of the human hearing system into account. Humans are more sensitive to the mid-range frequencies around 250 Hz to 4 kHz than to very low and very high frequencies. Many regulations request sound level values with an A-weighting. If **DIRECT SPL (A-WEIGHTED)** is selected for **TYPE** the A-weighted values are shown.

When considering frequency ranges, EASE Evac always calculates the sum value over the bandwidth, i.e., the 1/3 octave levels of the selected bandwidth are added. This enables the comparison with measurements as well as with calculation results from EASE, AFMG’s advanced acoustic design software

package. **BROADBAND** takes all 1/3 octave bands from 100 Hz to 10000 Hz into account. Alternatively, the sum of 1/3, 1 or 3 octave wide bands with the mid frequency selected in **FREQUENCY** can be visualized.

In addition to the absolute level displays the relative deviation from the average can be displayed by selecting the **RELATIVE** check box. EASE Evac will calculate the average level and the mapping will indicate only the deviation from that average with the tolerance according to the setting in the drop-down list to the right of **RELATIVE**. Listening



locations within the tolerance will be shown in green, whereas mapping points outside of the limits will be indicated by red or blue colors. This function gives a quick overview of the coverage evenness. The tolerance can be set to values between ± 1 dB and ± 9 dB.

Note that the mappings always display the sum values. Consequently, the broadband sum level is higher than the sum levels of the 1/3, 1 or 3 octave bands. The levels also depend on the input signal. This parameter can be set under **FILE > OPTIONS > CALCULATION PARAMETERS**. By default, it is set to the broadband signal according to IEC 60268-1 which corresponds to the frequency spectrum of average program material. This setting is a good starting point for most investigations. See section 8.4 for more details.

All calculations are performed in one go. Therefore, the change of calculation parameters does not require any calculation time. Theoretically, the other calculation types such as total sound pressure level or speech intelligibility (STI) can be visualized as well. However, due to their high dependency on the room acoustics they do not provide a valid prediction because the acoustic parameters of the room have not been defined yet. See Section 4 below on Room Acoustic Design for further information.

3.2.3 Distribution Graph

The Distribution Graph can be activated by a click on the `DISTRIBUTION GRAPH` tab.

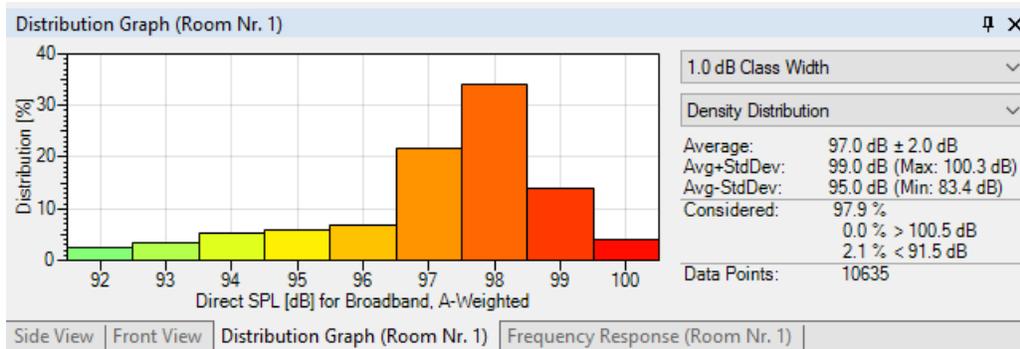
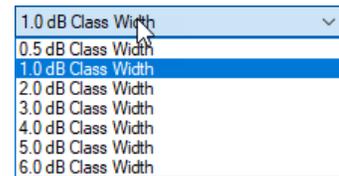


Figure 3.6 – Distribution Graph

This window shows statistical information about the sound level distribution over the listening plane. Simply put, this type of graph allows investigating the relative amount of mapping points that have a certain level, for example, 35% may show a level of 98 dB +/- 0.5 dB.



The parameter `CLASS WIDTH` determines the scaling of the x-Axis. A `CLASS WIDTH` of 1.0 dB, for example, will round all values to full dB values and will show the distribution percentage in 1 dB steps. `AVERAGE` shows the average level and the standard deviation. `AVG+STDDEV` displays the mean level plus the standard deviation. The maximum level value over the entire listening area is shown in parentheses. Equally, the mean level minus the standard deviation is presented by `AVG-STDDEV`. The minimum level value over the entire listening area is shown in parentheses. `CONSIDERED` indicates the relative number of data points considered in the graph. The rest is beyond the lower and upper limit of the graph. The calculations are performed for a certain amount of data points depending on the selected resolution. The number of points used in the current calculation is listed after `DATA POINTS`. As explained earlier, the resolution can be set under `FILE > OPTIONS > MAPPING > QUALITY`.

By default, the distribution graph shows a `DENSITY DISTRIBUTION`. It can be switched to a `CUMULATIVE DISTRIBUTION` which represents the sum (or integral) over the density distribution. It provides information about the minimum level that is guaranteed for a certain part of the covered area. For example, a direct sound pressure level of 92.7 dB may be achieved for 95% of the area but a level of 95.7 dB is established for only 80% of the area (see Fig. 3.7). The lowest level of the distribution is achieved at all mapping points and therefore has a percentage of 100%. In contrast, the highest levels will have a fairly low percentage because they are measured at only a few mapping locations.

Notice that for all mapping types except for ALCons higher values are considered better which is why the sum is calculated towards lower values. For ALCons the sum of the cumulative distribution is established towards higher values because for ALCons lower values are generally better.

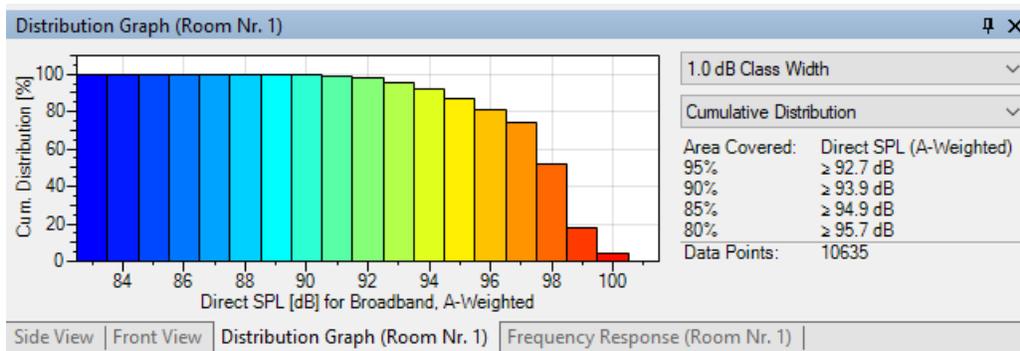
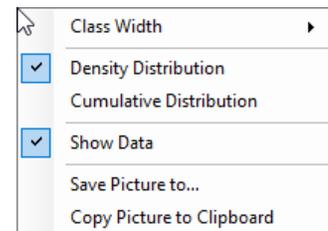


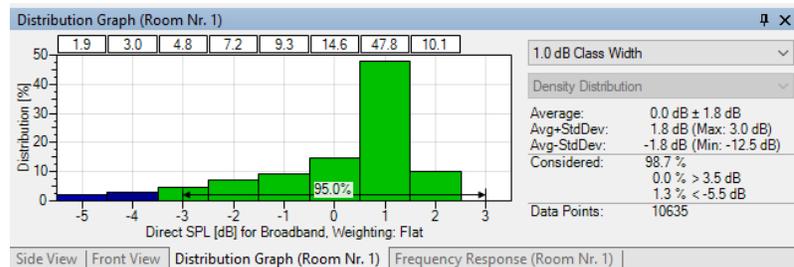
Figure 3.7 – Cumulative Distribution

A double LMB click on the graph background will hide the data column on the right side. The data will be shown again with another double click on the graph or via the context menu function `SHOW DATA`. The context menu also enables the change of the `CLASS WIDTH` even if the data is hidden. It also allows exporting pictures as explained in chapter 5.1.



A left click on any of the bars will add the corresponding percentage value above the graph. Another left click will hide it.

The Distribution Graph is especially suitable for the evaluation of the coverage evenness if the mapping is set to relative. The graph shows obviously the deviation distribution and additionally specifies the percentage of values at the bottom.



The range depends on the tolerance set in the Mapping Toolbar.

For example, a typical requirement for a sound system is that 90% of the listening area is within +/- 3 dB of the average level. This can be instantly verified using the Distribution Graph by switching to `RELATIVE` mapping, setting the tolerance to +/- 3 dB, choosing a `CLASS WIDTH` of 1.0 dB and reading off the percentage value displayed on top of the line with arrows that extends from -3 on the left to +3 on the right.

The Distribution Graph is only available after a calculation and when the `SHOW MAPPING`  button is activated. The values shown depend on the settings of the Mapping Toolbar.

3.3 Manual Insertion of Sound Sources

The `SOUND SOURCES` tab allows the manual insertion of ceiling and wall loudspeakers and other sources as well as the individual adjustment of all sound sources in the room. It is recommended to deactivate the calculation by a click on `SHOW MAPPING`  button. Otherwise, the calculation will start anew with every modification of a sound source.

3.3.1 Import of Sound Source Types (System Definitions)

At the beginning of this chapter, we explained that each sound source in the model refers to a type of sound source that defines the essential acoustic properties of the source and that is given by a GLL file. In the software this GLL file is more abstractly called a System Definition.

New types, that is, System Definitions, can be added to the program’s database at any time. Use the menu command `FILE > IMPORT SYSTEM DEFINITIONS...` to open a Windows file dialog for the selection of GLL files to be added. A public set of system definitions is hosted on AFMG’s website. It can be accessed most easily via the menu item `HELP > DOWNLOAD SYSTEM DEFINITIONS`.

GLL files can be loaded into EASE Evac as long as they are not array, cluster or column type loudspeakers. Also, their rated opening angles must be defined in the GLL data files.

It is generally recommended to have loaded only those system definitions from brands or manufacturers that are to be used. As there are many system definitions available, having a large range of files in the program’s database can slow down the start-up of the software.

If necessary, the directory for the GLL files can be set on the `ENVIRONMENT` page by selecting `FILE > OPTIONS`. Switching between different folders can be particularly useful when working with different brands one at a time.

The system definitions of the sound sources are found in (`C:\Users\Public\Documents\AFMG\AFMG Evac\System Definitions`) after a default installation.

3.3.2 General Settings and Adjustments

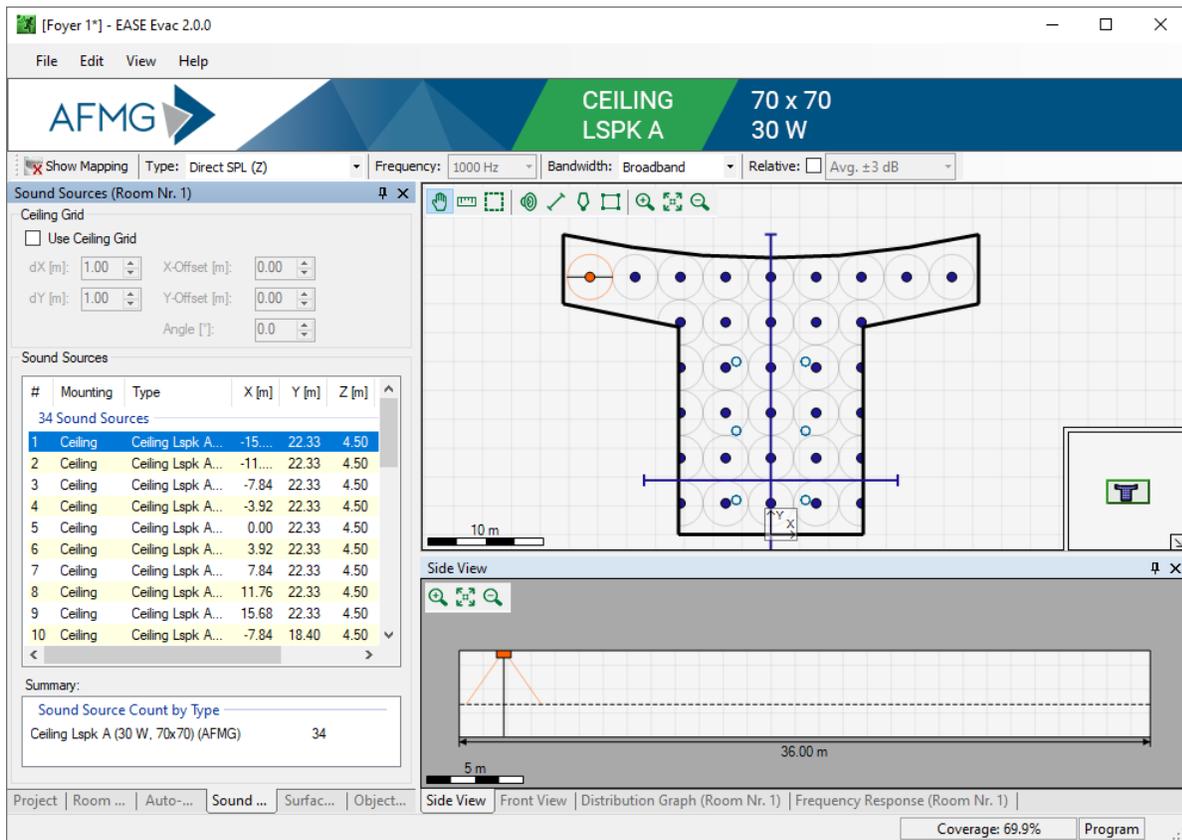


Figure 3.8 – The Sound Sources tab

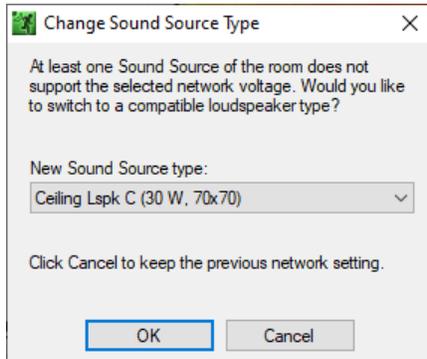
This window includes the **SOUND SOURCES** table where the **MOUNTING**, **TYPE**, **X**, **Y** and **Z** coordinate of each source are listed and each source can be muted individually. A click on the number or mounting of a sound source will select the row, the selected source is then highlighted by an orange dot and circle . The context menus of the table and of the Top View Window provide the functions **DELETE** for deleting the current source and **PROPERTIES (F4)** for opening the Sound Source Properties window for the selected sound source.

The mounting height of the sound sources can be specified individually for each sound source by altering the **Z** coordinate. This sets the height of the sound source above the ground. The projected coverage circle depends on the relative height of the source above the listening plane and the rated opening angle of the source. Note that when you change the room height after ceiling-mounted sources have already been inserted, the **z** coordinate of the sound source will be changed automatically because the program keeps the mounting distance relative to the ceiling constant.

If a low impedance network is selected on the **ROOM** tab the **GAIN** can be set individually. In a constant-voltage network the tap settings can be adjusted for each sound

Summary:	
Power consumption	
Summed power consumption	4 W
Sound Source Count by Type	
Ceiling Lspk C (30 W, 70x70) (AFMG)	34

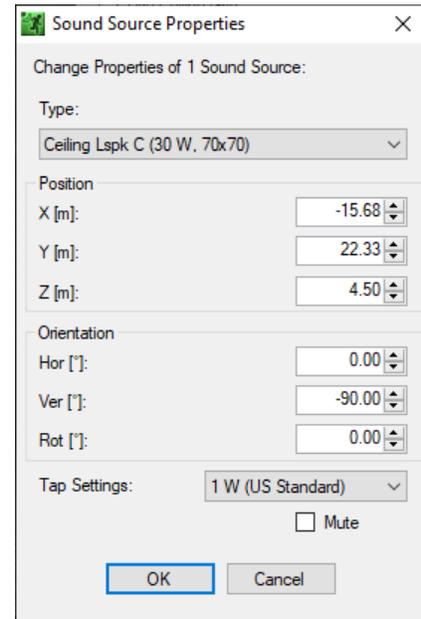
source. For constant-voltage networks the SUMMARY section includes the overall POWER CONSUMPTION of the loudspeakers in the room. The calculation is based on the selected transformer settings, the current network voltage as well as the setting for the crest factor. It also includes the compensation for an assumed line loss of 2 dB or about 60%.



Note that all sound sources in the room must support the selected network. Therefore, changing the NETWORK may require changing the type of some sources and cause the appearance of the Change Sound Source Type window shown on the right. A compatible sound source needs to be chosen in order to enable a change of the settings. Similarly, some tap settings may become unavailable for the newly selected network. The software will indicate this by a warning and switch the source to the closest available tap setting.

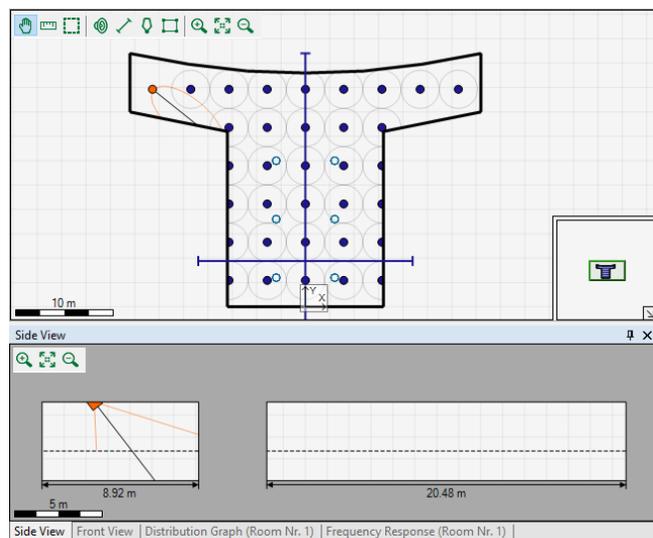
The Sound Source Properties window enables the configuration of one or multiple sound sources in the model. It allows the selection of a different type, the modification of the position as well as the orientation.

If the Side View is active, the sound source is shown in this window as well. To change the orientation, the horizontal (HOR), vertical (VER) and rotational (ROT) angles are either typed into the associated field or the cursor is placed over the main beam in the graphic displays and modified by dragging the beam to the desired angle. While dragging, the cursor is changed into a double arrow. The Side View displays the walls from the perspective of the sound source.

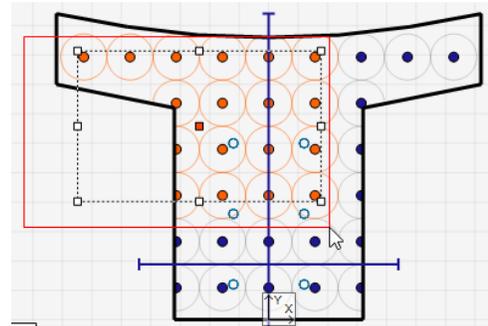


All sound source parameters can be modified directly in the table after a click on the associated field, except for the number and mounting fields.

Dragging with the LMB allows the repositioning of the selected sound sources in the graphic displays. While dragging, the cursor is changed into a cross with arrows.



In order to change the properties of several sound sources at the same time, multiple sources can be selected in the table or graphic display. The latter is done either by holding Ctrl and clicking on the sources or by activating the  button in the toolbar and selecting an area of sources by dragging with the LMB. The selection is indicated by an orange circle around each source as well as a frame with white handles around the selection. If more than one sound source is selected, the Side View disappears.



The white handles of the frame enable the repositioning of all selected sources by positioning the cursor over the square handle in the middle and dragging the whole selection. The white square handles around the border of the frame allow changing the spacing of the sources by narrowing or widening the frame.

To manually insert ceiling loudspeakers the `USE CEILING GRID` function simplifies the regular spacing of the sound sources. When the grid is enabled, all source locations will be forced to the next available grid position. The grid is especially useful if certain construction conditions require a specific spacing of the sound sources, for example a ceiling with acoustic tiles or fixed mounting possibilities.

The `DX` field defines the spacing of grid points in X direction and `DY` determines the spacing of grid points in Y direction. `X-OFFSET` shifts the ceiling grid in the X direction relative to the Room’s origin. `Y-OFFSET` shifts the ceiling grid in the Y direction relative to the Room’s origin. `ANGLE` rotates the ceiling grid by an angle relative to the Room’s origin.

3.3.3 Adding Ceiling Loudspeakers

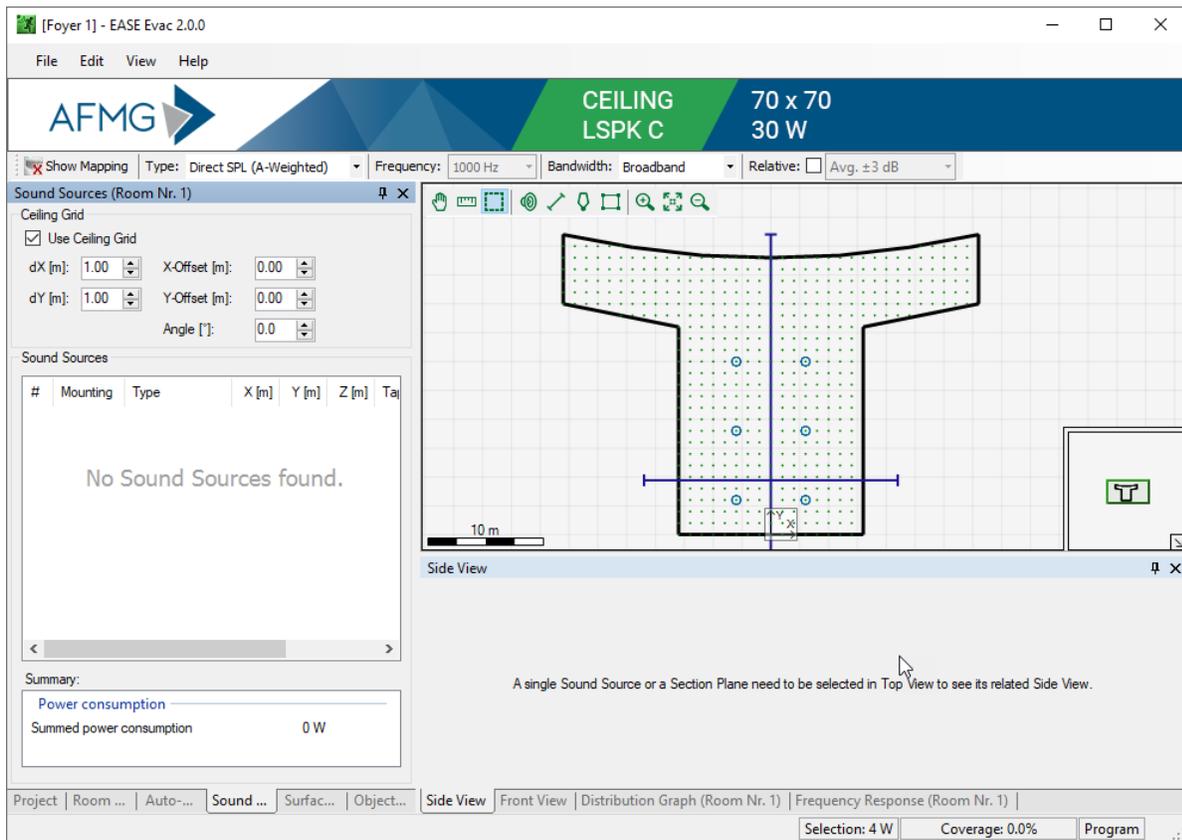
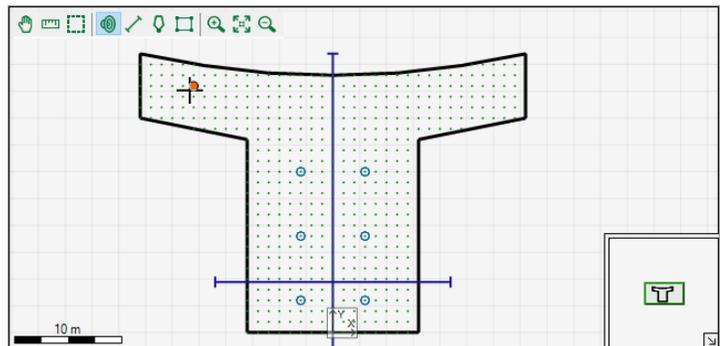


Figure 3.9 – Top View window with ceiling grid

Ceiling-mounted sound sources can be added manually using several functions in the Top View.

The  icon enables the insertion of sound sources in the graphic display. If the icon is active the cursor changes into a cross with an orange dot. Every click will add a source at the cursor position as long as the  icon is active.

In order to zoom the drawing, the    icons (ZOOM IN / SCALE TO FIT / ZOOM OUT) provide the required tools.



The **COPY** and **PASTE** function of the context menu of the sound source offers an effective method to insert several sources with the same properties. **COPY** will copy the source including the settings for the orientation and **PASTE** will insert the source with a given offset.

When the mouse cursor is located over a Room, sound sources can also be inserted using the **ADD SOUND SOURCE** command from the context menu. This is a very quick and easy way to insert sources where the coverage is too thin.

3.3.4 Adding Wall Loudspeakers

The **Front View** tab provides the tools for adding wall-mounted sound sources. The first step is to choose the wall with the prospective source position. The wall in the **Top View** window that is highlighted in orange is the one that is shown in the **Front View** window.

The  icon enables the insertion of sound sources in the graphic display. If the icon is active the cursor changes into a cross. Every click will add a sound source at the cursor position as long as the  icon is active.

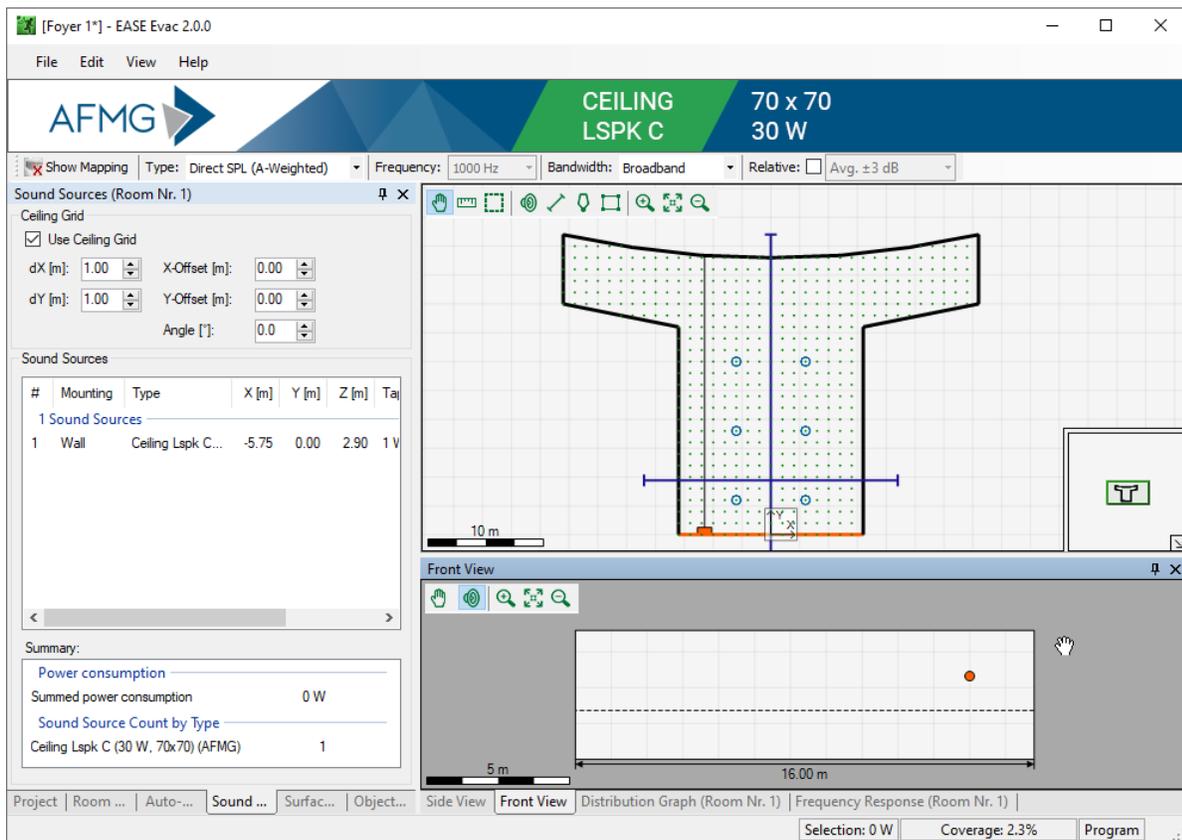
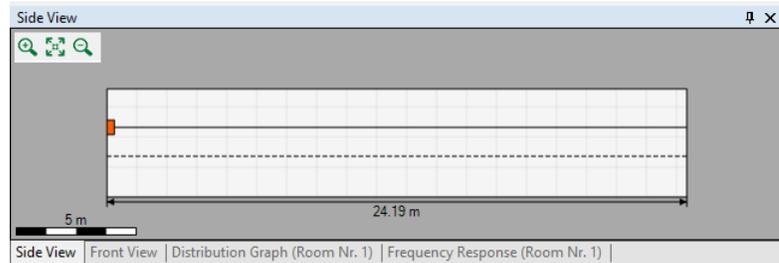


Figure 3.10 – The Front View window shows the orange marked wall with one wall loudspeaker.

In order to zoom the drawing, the  icons (ZOOM IN / SCALE TO FIT / ZOOM OUT) provide the required tools.

The orientation of the source is set in the Sound Source Properties window (context menu or F4). The orientation of the selected source is visualized in the Side View window as well.



The COPY and PASTE function of the context menu of the sound source offers an effective method to insert several sources with the same properties. COPY will copy the source including the settings for the orientation and PASTE will insert the source with a given offset.

In the Front View, when the mouse cursor is located over the wall, sound sources can also be inserted using the ADD SOUND SOURCE command from the context menu.

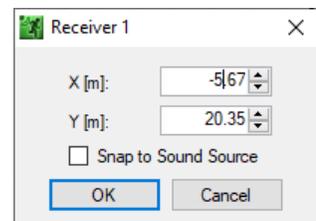
3.4 Frequency Response

Sound systems that are used for voice announcements are rated primarily according to their broadband output level and the speech intelligibility at the receive location. In this case, the frequency response of the system plays a secondary role. However, if the same system should reproduce program material and music as well, the spectral balance of the received signal becomes more important for the listening impression.

In EASE Evac, the frequency response can be investigated at specific positions in the Room using the Frequency Response window. To define these positions, RECEIVERS need to be inserted in the Top View window.

In order to add receivers, the  icon must be activated in the Top View window. The cursor changes into a cross and receivers are inserted at the location of the cursor by a click on the background. The height of the receivers equals the EAR HEIGHT defined previously on the ROOM tab.

The Receiver properties dialog accessed via the context menu allows entering the receiver coordinates. Dragging a receiver symbol in the Top View window will also alter the position. While dragging, the actual coordinates are indicated in a box at the cursor position. When selected, the switch SNAP TO SOUND SOURCE puts the receiver at the x/y location of the closest ceiling-mounted sound source.



The Frequency Response graph shows the sound pressure level in dB over frequency, either absolute or relative to a selected reference receiver. For the latter the reference receiver must be defined by a LMB click on the corresponding receiver icon in the Frequency Response window. The graph is changed back to absolute levels by another click on the reference receiver. Frequency response curves can also be set invisible. Right-click on the receiver icon in the upper right of the Frequency Response window to hide the receiver. Right click again to make the curve visible again.

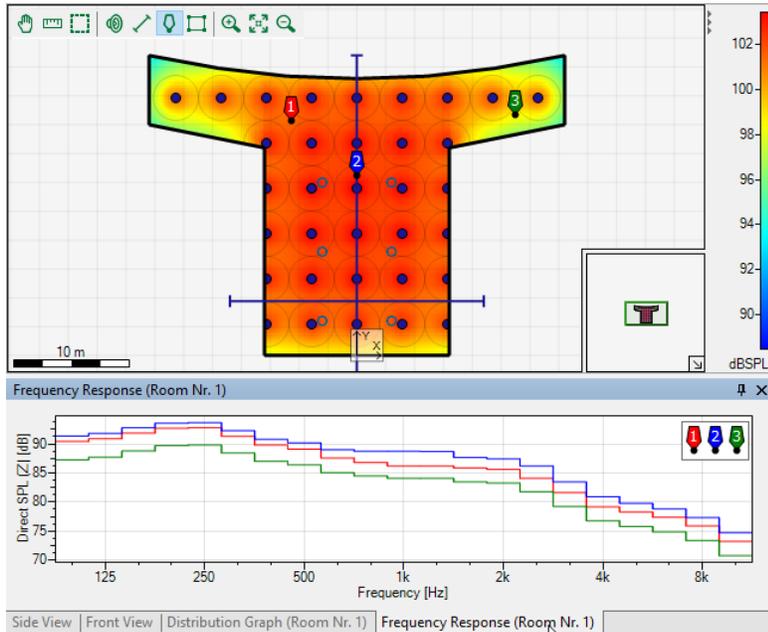


Figure 3.11 – Absolute direct SPL frequency response at three receiver positions

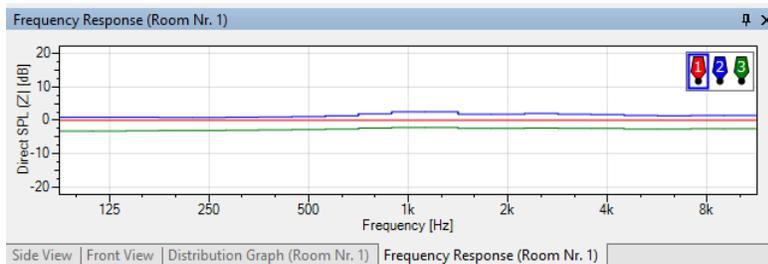


Figure 3.12 – Relative direct SPL frequency response with receiver number 1 as reference

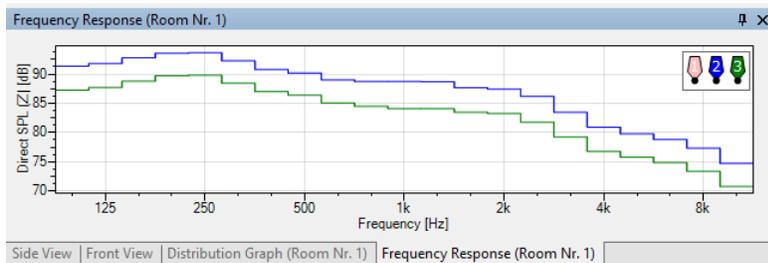


Figure 3.13 - Direct SPL frequency response with first receiver hidden.

The graph depends on the `TYPE` selection in the Mapping Parameters bar. It is available for Direct SPL, Total SPL and S/N Ratio but not for STI, ALCons and CIS.

A click on the level axis opens the Options window (`FILE > OPTIONS > FREQUENCY RESPONSE` or `F9`) to adjust the scaling of the graphs.

The frequency response also depends on the input signal. The input signal can be set under `FILE > OPTIONS > CALCULATION PARAMETERS > INPUT SIGNAL TYPE`. The different alternatives are explained in chapter 8.4

3.5 Evaluation of Direct Sound Result

One of the most important quality criteria for sound reinforcement systems is a smooth frequency response over the whole frequency range. If the sound reinforcement system is not able to play back the original signal without modification due to an uneven frequency response, the reinforced sound will not equal the original anymore and audible alteration can corrupt the reception. The playback of music especially requires a smooth frequency response. The modification of speech can also result in an unnatural, less intelligible sound. EASE Evac provides an efficient tool for inspecting frequency responses at different positions in order to assess these quality criteria.

However, the main purpose of evacuation systems is the intelligible reproduction of emergency announcements everywhere in the room. This implies a uniform coverage with a sufficient signal-to-noise ratio. In this case, neutrality of the sound reinforcement is of secondary importance as long as the intelligibility is not deteriorated by the modification of the sound.

Therefore, coverage and sound pressure level are essential quality criteria for evacuation systems. All areas should be equally covered and the sound level has to be well above the noise in order to have no influence on the intelligibility.

Coverage and level depend on the type and quantity of loudspeakers. More loudspeakers with a narrower spacing increase the level. An equal coverage requires loudspeakers in remote areas like corners. Furthermore, evacuation system regulations may require redundancy in order to ensure that a certain amount of failures will not result in an unintelligible reproduction of emergency announcements. Nevertheless, more loudspeakers will increase the costs.

In order to design an optimal sound system concept taking both costs and quality into account, the important criteria for the specific applications need to be defined. This includes:

- **Quality criteria concerning the frequency response:**

It may be more cost-effective to install high quality / more expensive 2-way ceiling loudspeakers if music will be reproduced as well as emergency announcements than the installation of two separate sound systems.

- **Coverage and redundancy:**

National and international regulations determine the requirements concerning the coverage and redundancy of evacuation systems in certain applications.

- **Signal-to-noise level:**

Higher signal levels do not automatically increase the intelligibility. On the contrary, the speech intelligibility decreases beyond a certain level (Total SPL 80 dB(A)). Nevertheless, the level has to be well above the noise level (10-15 dB) in order to minimize its negative influence on the speech intelligibility. Therefore, the knowledge of the noise level is essential in order to achieve the optimal sound level under given conditions.

EASE Evac provides all the tools for inspecting frequency responses, the coverage and the signal-to-noise level in order to enable the designer to find the optimal trade-off between costs and quality. Comparison between different loudspeaker types and concepts can be quickly performed and effectively visualized, offering a solid foundation for discussions and decisions concerning the most suitable concept for a particular application.

Note: Although signal-to noise and speech intelligibility ratings are based on the total SPL, the direct SPL gives a far more detailed impression of the coverage.

3.6 Computation Accuracy

At the end of this chapter about sound system design and direct sound evaluation some remarks should be made about the accuracy of the simulation. As with all calculation programs the quality of the result depends on the quality of the input data. This means that errors and uncertainties included in the loudspeaker data, room geometry and calculation setup as well as the assumptions made in the modeling engine will propagate through the calculation algorithm and establish an uncertainty in the result. When using the program, you should at least be aware of the basic assumptions made and avoid potential pitfalls.

In particular, it should be emphasized that EASE Evac includes a lot of input information in the calculation of the direct sound level at the receive location [1]. The most important elements are:

- Sensitivity, impedance, directional characteristics and further parameters of loudspeakers and other sound devices. These data are subject to the measurement accuracy, to the data resolution and to potential errors during the conversion of raw measurement data to the final GLL file as well as to the manufacturing deviation between samples of the same type [2], [3].
- Attenuation of the amplitude of the propagating sound wave by the propagation medium air based on the temperature, humidity and pressure parameters. This is subject to the applicability and accuracy of the physical model used in EASE Evac, namely the ISO 9613-1 standard [4].

- Shadowing effects caused by non-convex room boundaries. The accuracy of the shadowing calculation in listening areas is affected by the exact placement of sound source and receiver as well as the precise definition of the side walls of the room.

As a rule of thumb, in controlled environments the average error of direct field predictions may be as low as 1 dB and is seldom larger than 3 dB. In complex environments the average deviation may be as high as 6 dB. If significantly larger errors occur, these are usually due to erroneous loudspeaker data or measurement errors made on site.

It should also be stated that EASE Evac does not account for a number of different effects that influence the propagation and reception of the sound wave as well [1], [5]. These include in particular:

- Movement of air, such as convection cells caused by ventilation systems. This effect can mostly be neglected in practice.
- Diffraction of sound around edges and columns. This phenomenon happens particularly at low frequencies where the wave length is large compared to the dimension of the obstacle. Speech intelligibility calculations that focus on the mid frequency range will normally not be affected significantly.
- Coherent summation of sound sources. EASE Evac assumes that all sound sources exhibit a random phase relationship compared to each other. This means that their combined sound pressure levels are computed by summing the sound power of each source. However, at low frequencies and depending on the type of speaker and environment, the phase relationship may be rather constant and therefore more coherent. This can cause higher levels or cancellations at the receive location. Since this effect is limited to the low frequency range its influence may be neglected for speech intelligibility calculations.
- Differences between loudspeakers and horns. This software version of EASE Evac treats all sound sources like loudspeakers even though the adjustment of the output levels of horns or sirens may not be possible or limited. When using the software, you should therefore only select gain settings according to the specification of the device. Other settings may not be available in practice.
- Directionality of the receiver. In EASE Evac calculation results are derived in a manner that is comparable to a measurement with an omni-directional microphone. Measurements with hand-held sound level meters or a directional microphone may provide different results.

Some of these effects can be accounted for by using EASE, the professional electro- and room acoustic simulation software developed by AFMG. But since they are normally negligible for evacuation systems, they are not available in EASE Evac.

For the sake of clarity, it should be underlined that the direct sound calculation by definition does not take into account any sound re-radiated by the surfaces of the room, that is, reflections, echoes or reverberation. This often leads to deviations when comparing Direct SPL data from EASE Evac with on-site measurements where a simple level reading without proper time windowing will include a large amount of reverberant energy or at least a floor or side wall reflections.

4 Room Acoustic Design

The acoustic properties of the room have an essential impact on the transmission of music and speech from the sound system to the listener; this is particularly true for speech intelligibility. That is why EASE Evac is not only concerned with the layout of the sound sources and their SPL coverage but must also account for the room itself.

Among a number of different acoustic characteristics, the reverberation time (RT, RT60) is one of the most important quantities to describe the response of the room to its excitation by the sound system [6]. In simple words, the RT is a quantitative measure for how long sound energy radiated into the room stays in the room until it is eventually absorbed by the surfaces and the air. The RT is measured in seconds and can be roughly described by how long you can hear echoes and reverberation in a room after clapping your hands.

Rooms with a short reverberation time create far better conditions for intelligible speech reproduction than rooms with long reverberation times. In order to compute speech intelligibility figures, EASE Evac allows either entering the reverberation time of the room if it is known, e.g., from measurements or estimates, or calculating it from the geometrical characteristics of the room and the acoustic properties of the room’s surface materials. If speech intelligibility is a concern, it is therefore crucial to expand the EASE Evac model from a simple drawing and loudspeaker layout to a full room-acoustic model.

4.1 Reverberation Time

EASE Evac uses statistic room acoustic methods to calculate the total SPL, SNR and speech intelligibility [6], [7], [8], [9]. This means that certain assumptions are made regarding the acoustic properties of the room (see 4.5). Based on these assumptions, it is sufficient to define only the reverberation time of the room. It is not obligatory to assign materials with their specific absorption coefficients to each surface in order to calculate the reverberation time. This paragraph will describe the adjustment of the reverberation time if the reverberation time is known, e.g., after measurements, or can be estimated realistically. The paragraph 4.4 will explain the assignment of surface materials in order to estimate the reverberation time if it is not known.

The **ROOM** tab includes the **Reverberation Time: Settings** button to open the Edit Reverberation Time dialog (Ctrl+R). The reverberation time of the active room is shown in the left table and in the right graph.

The **STATISTICAL CALCULATION** is based on the equation of Eyring including the air absorption:

$$T_{Eyring} = 0.163 \cdot \frac{V}{\alpha_{Air} \cdot 4V - S \cdot \ln(1 - \alpha)}$$

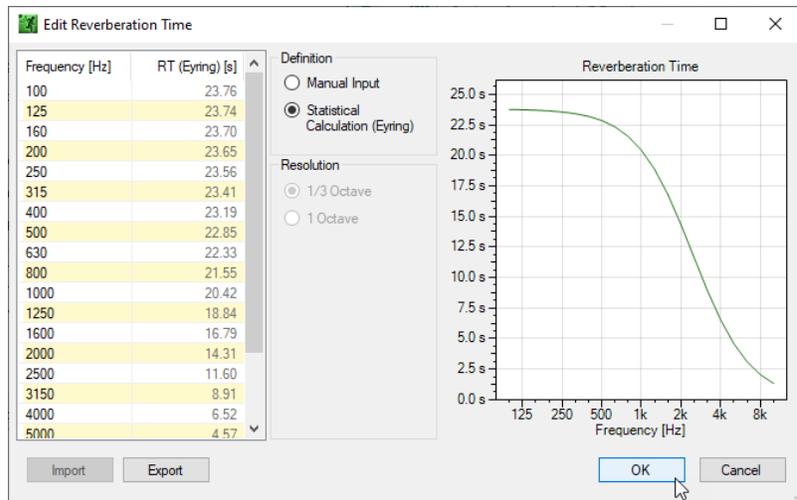
0.163 = factor in s/m

V = room volume in m³

α_{Air} = absorption coefficient of air

α = average absorption coefficient of the acoustically effective surface area

S = acoustically effective surface area in m²



Without any adjustments to the default model, the reverberation time is high because all surfaces are assumed to be highly reflective, i.e., have an absorption coefficient of 0.01.

In order to alter the values, select **MANUAL INPUT** and then set the resolution (**1/3 OCTAVE** or **1 OCTAVE**). You may now enter the reverberation time manually into the associated fields for each frequency or import a reverberation time file (*.exr). **IMPORT** opens a Windows file dialog for the selection of the RT file. EASE Evac includes a database with predefined RT files. After a default installation they are found in (C:\Users\Public\Documents\AFMG\AFMG Evac\RT Files). **EXPORT** opens a Windows file dialog to save the current RT to a file.

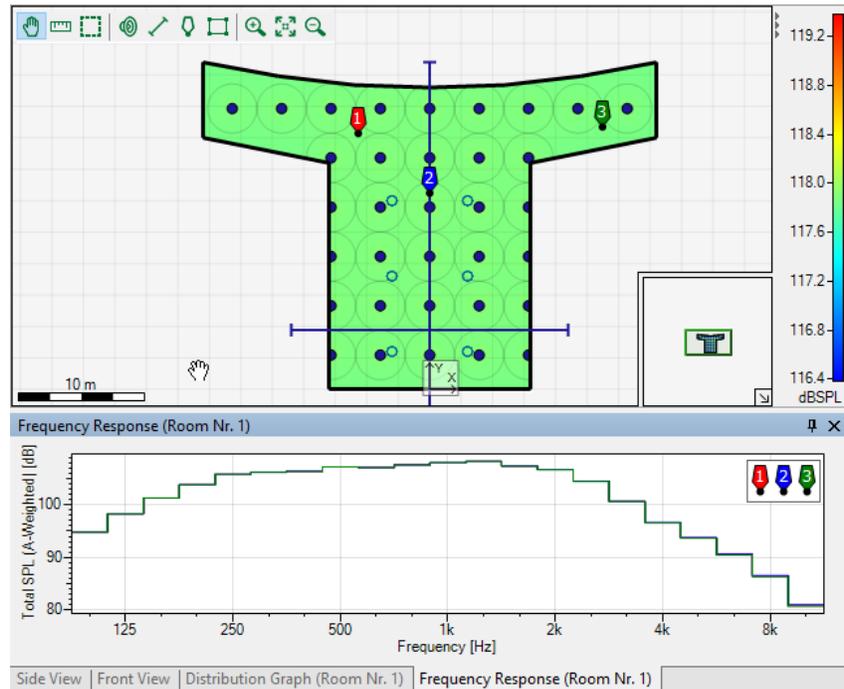
Low reverberation times providing for good speech intelligibility are usually found in small rooms as well as in medium-sized rooms with acoustic treatment. Typical examples are studios, lecture halls, and conference rooms which have RTs on the order of 0.5 to 1.5 s. Spaces that are intended for the reproduction of music, also usually require slightly longer reverberation times to enhance the spatial impression of the room. Theaters, churches and multi-purpose halls mostly have 1 to 2 s of RT and occasionally more. Acoustically “hard” spaces and large venues such as stadiums, cathedrals and railway stations can have reverberation times of 4 s and above. In these cases, it requires careful and accurate design work to establish a satisfactory level of speech intelligibility at all.

4.2 Total SPL and Signal / Noise

The total SPL is the sum of the direct SPL and the diffuse field SPL where the statistical room acoustics used assumes a uniform diffuse sound field in the room. Therefore, the diffuse field SPL can be derived from the room volume and the reverberation time.

Select either **TOTAL SPL (Z)** (unweighted) or **TOTAL SPL (A)** (A-weighted) as the mapping **TYPE** to display the corresponding levels in the Top View and Side View windows. This will also switch the Distribution Graph and Frequency Response windows to the corresponding graphs.

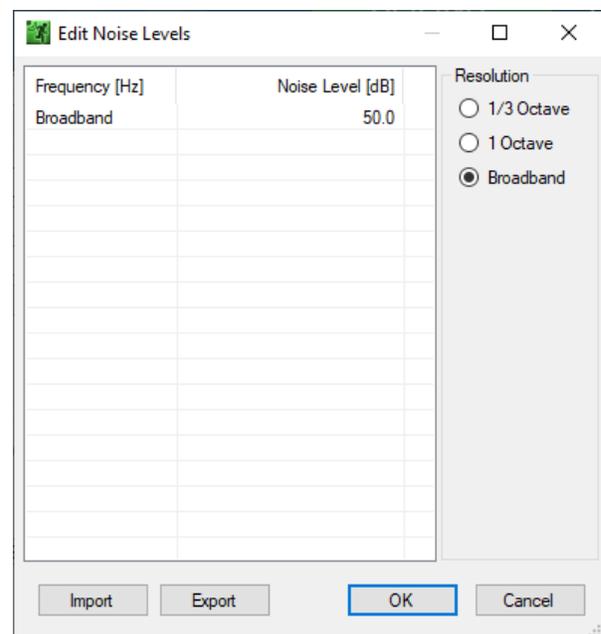
Total SPL Mappings and the Distribution Graph depend on the setting of the **FREQUENCY** and the **BANDWIDTH** in the Mapping Parameter bar. The relative deviation from the average with the tolerance according to the setting for **RELATIVE** can be visualized as well.



If the total sound pressure level is known, the calculation of the signal-to-noise ratio (SNR) requires only the definition of the noise level. The **ROOM** tab includes the facilities **Noise Levels:** **Settings** to open the **EDIT NOISE LEVEL** dialog (Ctrl+I).

A broadband value or the frequency dependent noise values in **1/3 OCTAVE** or **1 OCTAVE** resolution can be entered. Alternatively, the **IMPORT** button opens a Windows file dialog for the selection of a Noise file (*.exn).

EASE Evac includes a database with predefined noise files as specified by various standards such as NR, NC and RNC. After a default installation these files can be found in

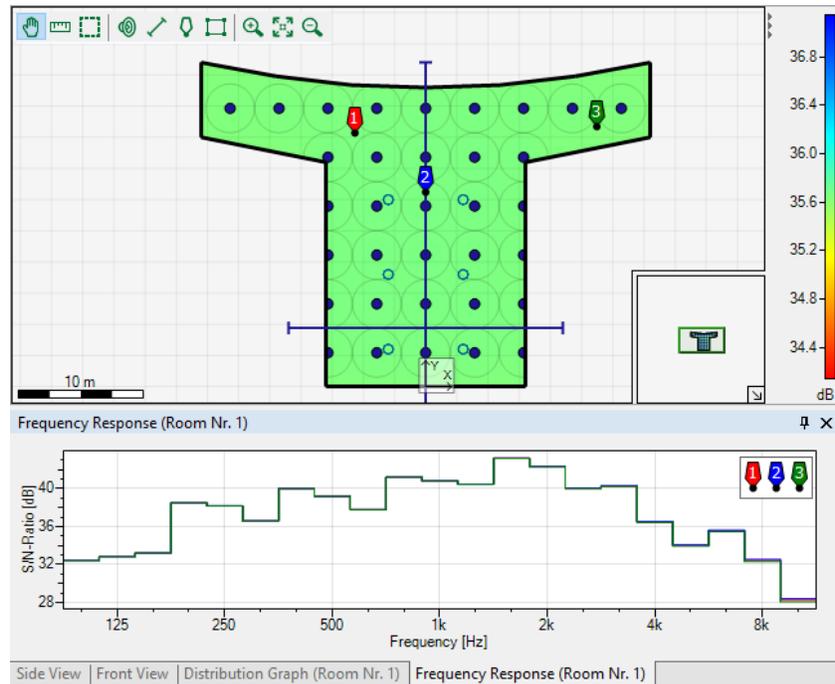


(*C:\Users\Public\Documents\AFMG\AFMG Evac\Noise Files*). EXPORT opens a Windows file dialog to save the current noise level setting to a file.

Whenever the noise level is changed, the calculation starts anew. The noise levels are considered in the speech intelligibility results.

If the S/N RATIO mapping type is selected, the difference between signal and noise will be shown in the mappings and in the graphs as well.

The SNR can be considered a simple indicator for good signal transmission. But although good speech intelligibility will require a high SNR, a high SNR does not necessarily mean good speech intelligibility. Particularly in rooms with high reverberation times, such as 4 to 8 seconds or above, the total sound pressure level will be high as well and may exceed the noise level significantly. However, large amounts of late reverberant energy (indicated by the high RT) affect speech intelligibility in a detrimental way. The best indicator for high speech intelligibility is the combination of good SPL coverage, a short reverberation time and a high SNR. It is not enough to consider one of these figures alone.



4.3 Intelligibility

The speech intelligibility is one of the most important criteria for the rating of voice alarm evacuation systems and voice address systems. Three internationally established parameters for the rating of the speech intelligibility can be calculated with EASE Evac. These are

- The Speech Transmission Index (STI), a value between 0 and 1 where higher is better.
- The Articulation Loss of Consonants (ALCons), a value between 0% and 100% where lower is better.
- The Common Intelligibility Scale rating (CIS), a value between 0 and 1 where higher is better.

The Common Intelligibility Scale is part of the standard IEC 60268-16: 2020 [10]. It summarizes and compares all common rating parameters. STI values can be converted into CIS values with the following equation:

$$CIS = 1 + \lg(STI)$$

An STI value of 0.5 corresponds to a CIS value of 0.7. The IEC 60268-16:2020 standard states that an STI value of 0.46 should be considered as the lower limit for voice address systems and a value of 0.50 as the target value.

The relationship between STI and ALCons can be expressed as follows:

$$STI = 0.9482 - 0.1845 \cdot \ln(AL_{cons} \%)$$

A STI value of 0.5 corresponds to an ALCons value of 11%.

In order to associate the numerical value with a subjective impression, STI and CIS can be rated as summarized in the following table:

STI Value	CIS	Rating
0.75 – 1	0.88 - 1	excellent
0.60 – 0.75	0.78 – 0.88	good
0.45 – 0.60	0.65 – 0.78	fair
0.30 – 0.45	0.48 – 0.65	poor
0 – 0.30	0 – 0.48	bad

The mapping as well as the distribution graph shows the speech intelligibility STI, ALCONS or CIS values dependent on the TYPE selection in the Mapping Parameters bar.

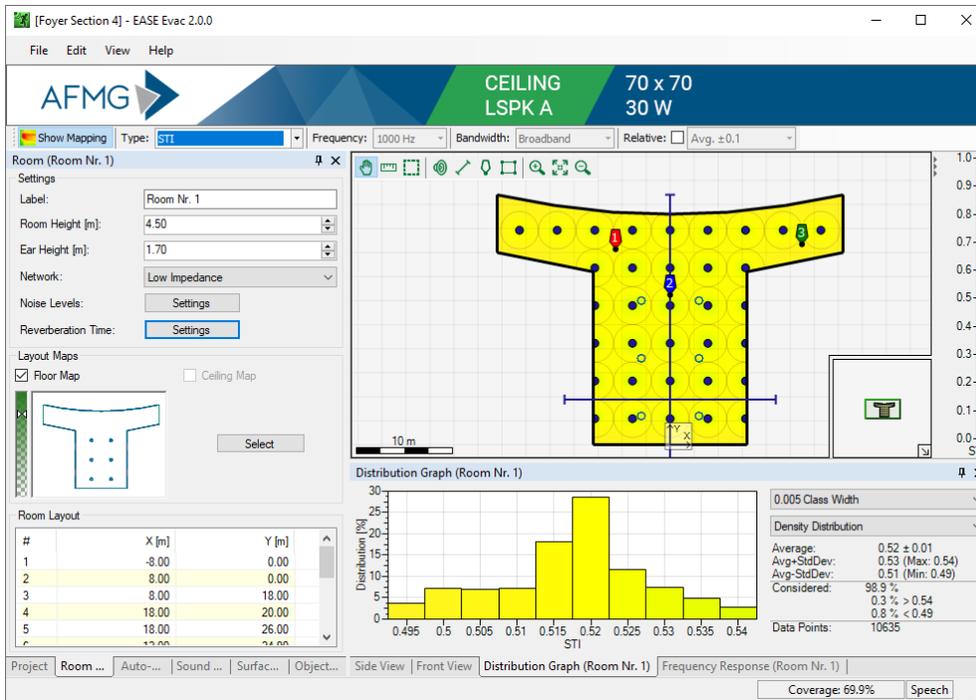


Figure 4.1 – STI mapping and distribution graph

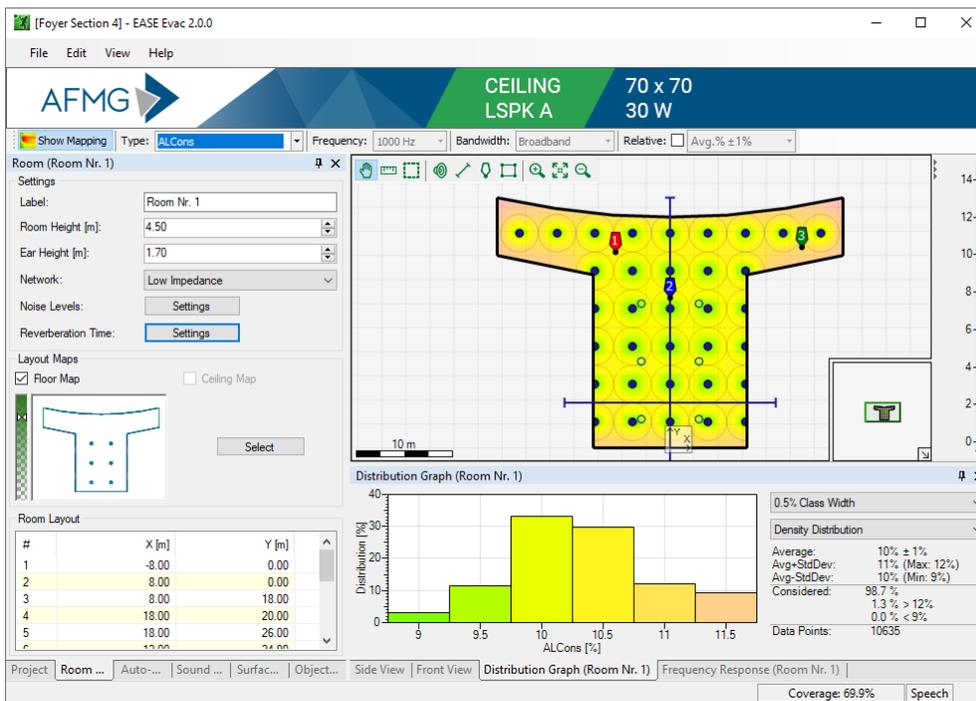


Figure 4.2 – ALCons mapping and distribution graph

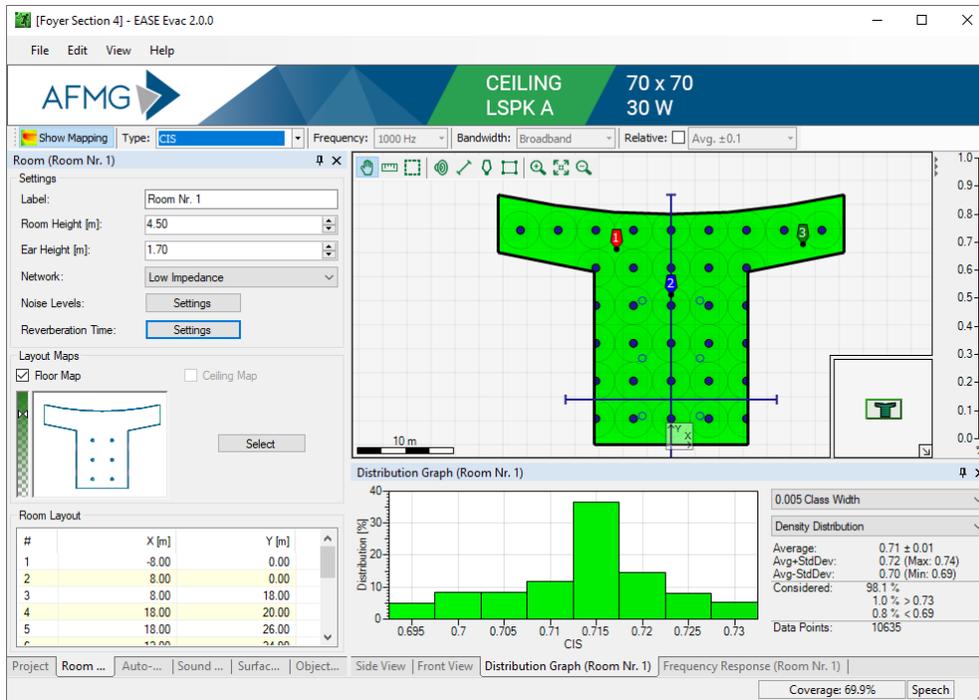


Figure 4.3 – CIS mapping and distribution graph

Relative deviations of the values can be visualized as well. Note that the Frequency Response window will not show any of the speech intelligibility figures since they are purely broadband quantities.

In addition to the rating above, one can state that STI values of 0.7 and higher are seldom reached in practice in large or acoustically difficult spaces. A good recording studio may provide STI values larger than 0.7 whereas lecture halls, conference rooms and other spaces dedicated to speech communication will normally range between 0.6 and 0.7. Most other rooms will be below a value of 0.6. Acoustically challenging environments will barely reach an STI of 0.5; that is why requirements are sometimes lowered to a value as low as 0.45. Speech intelligibility in venues with an STI that is less than 0.45 will generally be bad and may present a severe obstacle to hearing-impaired and foreign listeners for recognizing the announcement at all.

We also denote that the intelligibility value, whether STI, CIS or ALCons, is normally understood as an average over the entire reception zone. In most cases, project requirements ask for a target value that is only considered as met when the average of the intelligibility value reduced by its standard deviation is still higher than the threshold. For example, if a minimum STI value of 0.5 is required, the requirement is satisfied for an average value of 0.55 if the standard deviation is less than or equal to 0.05. Similarly, it may be required that an STI value of at least 0.45 is achieved for at least 85% of the considered area.

4.4 Assigning Surface Materials

The reverberation time can be calculated based on the material and absorption coefficient of each surface. The **SURFACES** tab enables the assignment of materials to each surface. The table on the left lists all surfaces, their material and their size. As long as no material for a surface is specified the **MATERIAL** type is (DEFAULT: HARD WALL), even if a general reverberation time was defined in the **EDIT REVERBERATION TIME** dialog. This default setting means that the absorption coefficients are set to 0.01 which corresponds to a highly reflective surface.

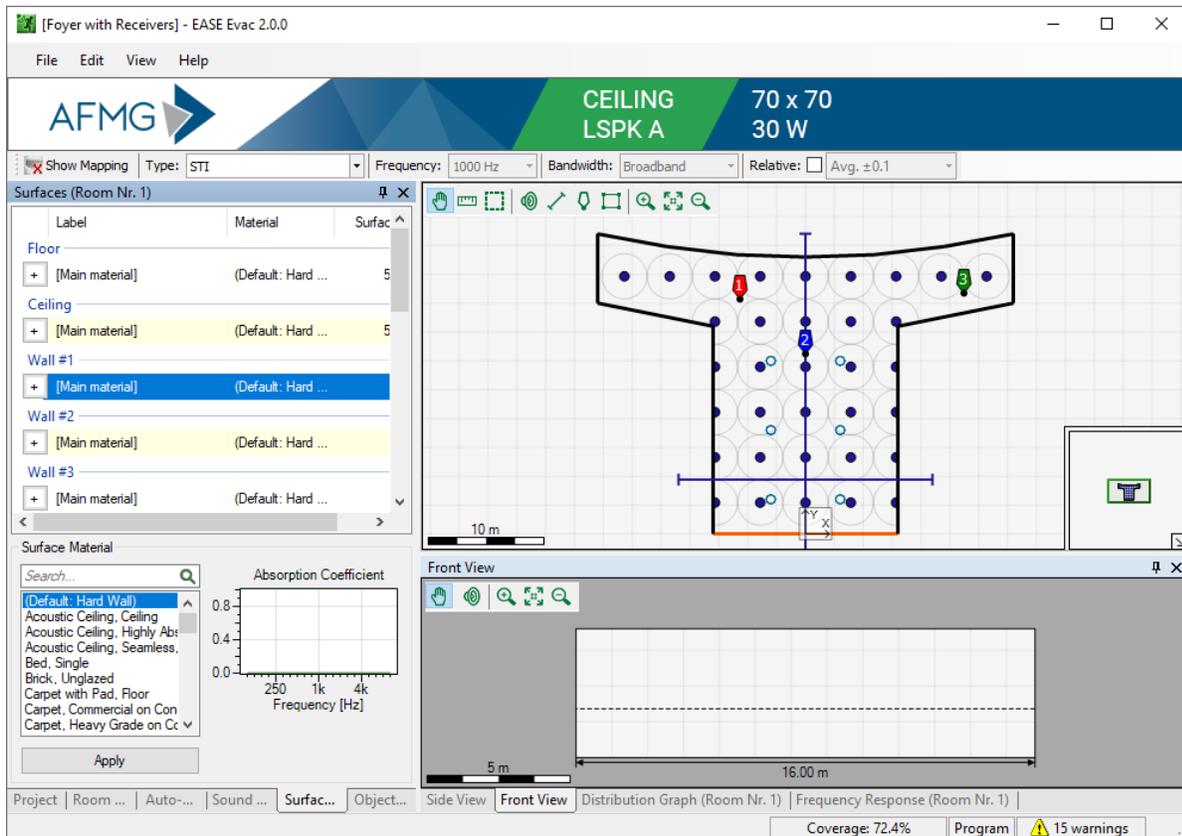
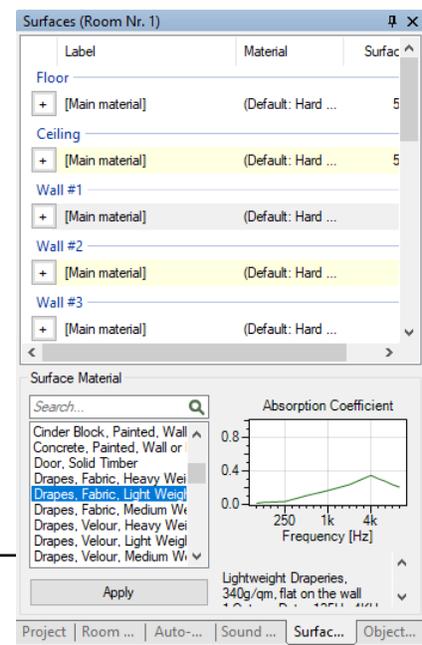


Figure 4.4 – The Surfaces tab

The first surfaces in the list are the floor and the ceiling. In order to change the material of ceiling, floor or wall, it should be selected either in the table or the Top View window. The active wall is highlighted in orange in the Top View window. Multiple material areas in the table are selected by holding the Ctrl or Shift key and clicking on the label. Multiple walls in the Top view window are selected by holding the Ctrl key and clicking on the walls.

The material list in the bottom left corner shows the material database. After a default installation the database can be found in



(*C:\Users\Public\Documents\AFMG\AFMG Evac\Materials*). See below for more information about adding material files to the database.

The graph in the bottom right corner shows the absorption coefficients of the selected material. A small value indicates a reflective material whereas a high value indicates an absorbing material. For example, concrete does not absorb sound very well and thus has an alpha value of about 0.05 to 0.1. In contrast, acoustic ceiling tiles absorb sound well, particularly in the mid and high frequencies, and therefore have alpha values of 0.5 and more. Most absorptive materials have a higher absorption coefficient for the high frequency range than for the low frequency range. Additional information about the selected material is given below the graph.

After the selection of one or more surfaces and their material click on **APPLY** to assign the material. This will also update all calculation results automatically, such as mappings and graphs.

In order to add an area with a different material to a wall, for example, to simulate glass doors in a concrete wall, a click on the + button will add an area. The area name, material and size can be defined. One main surface may include several different areas.



Material areas can be copied and pasted using the context menu or the shortcuts Ctrl+C and Ctrl+V. They can also be cut and pasted or deleted.

Generally, not every small item on the wall, floor or ceiling should be modeled. As a rule of thumb, a new material area should be defined if the corresponding surface contributes about 1% or more to the overall surface area of the room. This also applies to areas that are not contiguous, such as many small windows. If the combined surface area is significant, it should be taken into account. Since the EASE Evac model is not concerned with the exact 3D placement of the area you may also combine material areas distributed over one or multiple walls into a single entry with the corresponding overall surface area.

Internally, each type of surface material is described by a data file in the EASE material file format (*.mat). Generally, EASE material files are created using the Material Database program of EASE 4. In addition, multi-layer wall structures can be simulated using the AFMG SoundFlow software and exported as .mat files.

New materials can be added to the program’s database at any time. Use the menu command **FILE > IMPORT SURFACE MATERIALS...** to open a Windows file dialog for the selection of .mat files to be added. If necessary, the directory for the .mat files can be changed on the **ENVIRONMENT** page by selecting **FILE > OPTIONS**. Switching between different folders can be particularly useful when working on projects from countries that use different standard building materials, such as the US and Germany.

4.5 Computation Accuracy

In chapter 3.6 we already discussed various aspects related to the accuracy of the simulation of the direct sound field. Naturally, these apply in the same manner to the calculation of the total sound field as well as to the intelligibility figures. But the room acoustic modeling has some implications on its own which shall be discussed here.

4.5.1 Diffuse Sound Field

As explained in the previous sections of chapter 4, the room acoustic algorithms of EASE Evac are based on a statistical approach [6], [7], [8], [9]. This means that the reverberation in the room can be described by a diffuse sound field, where the sound level is the same everywhere (homogeneity) and there are no preferred propagation directions (isotropy). The characteristic quantity describing the strength of this field is the reverberation time.

Once the reverberation time is known, the total sound pressure level and the speech intelligibility can be estimated by combining the diffuse field with the direct sound. This approach is quite elegant, involves only a limited amount of input data and calculations can be performed quickly. However, there are disadvantages, as well.

By estimating the reverberation, that is, the arrival of reverberant energy over time at the receiver, only based on the assumption of a diffuse field, discrete reflections are excluded by definition. Single reflections of high amplitude are a two-sided knife; they may increase speech intelligibility when arriving early, that is, within a few milliseconds after the direct sound, but they may also decrease speech intelligibility when arriving late, e.g., several tenths of a second, and can be recognized as a distinct echo.

However, considering these effects requires significant efforts both with respect to building the model as well as to the calculation time needed. Such investigations involve ray tracing algorithms that are normally only necessary in acoustically challenging environments and in large venues. They usually must be performed when the sound system to be installed is fairly expensive. In contrast, EASE Evac is a tool that is dedicated to assist in a quick analysis and verification of evacuation systems in relatively simple spaces.

4.5.2 Calculation of Reverberation Time

If the reverberation time of a venue is unknown, it can be estimated using Eyring’s approach (section 4.1). This theoretical model requires knowledge about the volume of the room, the acoustically effective surface area and the absorption coefficient averaged over this area. The actual 3D data of the room geometry is not needed.

In order to fulfill the underlying diffuse field assumption certain conditions regarding the room geometry and the distribution of surface materials must be met. This includes in particular that:

- The room is approximately convex and does not consist of several weakly coupled spaces. A coal mine with a number of linked, long tunnels is an example of where the Eyring equation will not work well. That is because the reverberant sound field must normally be well-coupled between all locations in order to be roughly homogenous and isotropic.
- If the surface materials do not have approximately similar absorption coefficients, the surface areas with highly absorptive and highly reflective materials should be roughly mixed in space. For example, a large rectangular ballroom with highly absorbing carpet and acoustic ceiling but concrete side walls can be only roughly approximated by Eyring’s approach. This is because sound energy will circulate for a longer time in the horizontal domain than in the vertical domain and will therefore dominate the reverberant field at late times.

In practice, most rooms satisfy these criteria well enough so that the statistical approach implemented in EASE Evac allows for a reliable first analysis. If required, detailed investigations can be performed with an advanced room acoustic software package like EASE [12].

In addition to the above aspects, it should also be mentioned that the accuracy of the average absorption coefficient plays a role as well. A potential uncertainty is introduced by the fact that the user has to choose the right material from a database which may not even include that specific surface material but only a similar version. Another source of error is of course, the accuracy of the measurement that was made to acquire the absorption coefficient data.

4.5.3 Speech Intelligibility

In EASE Evac, speech intelligibility is computed using the solution published by Steeneken and Houtgast, e.g., [9]. Their work served also as the basis for the IEC 60268-16 standard [10], [11], that defines how STI is measured and calculated. The current version of EASE Evac implements the 2020 revision of IEC 60268-16 [10] completely including the corrections for ambient noise, hearing threshold and level masking. EASE Evac also supports the speech signal spectrum as defined by the standard. To enable it, select `SPEECH` under `OPTIONS > CALCULATION PARAMETERS > INPUT SIGNAL TYPE > SPECTRUM`. For STI calculations this spectrum should typically be used.

Finally, it should be emphasized that even though the STI has turned out to be a very robust and effective acoustic characteristic, it may not always correlate directly with the subjective impression. Among many things this is due to the fact that the STI according to IEC 60268-16 does not account for the linearity of the frequency response and for the ability of the human listener to use two ears in combination with mental post-processing instead of an omni-directional microphone.

4.5.4 Design Goals

The foregoing statements have been made in order to make you aware of the research and depth behind the algorithms used by EASE Evac as well as EASE. As stated earlier, the results provided by the software can only be as accurate as the input data and the modeling algorithms used. It is therefore recommended that any modeling project should include a safety margin in the design.

Based on practical experience, the best high-resolution models will only be accurate compared to actual on-site measurements within an average STI value of +/- 0.02. This means that rougher models will normally require a safety margin of 0.05 to 0.1, sometimes even more. Even though most results in reality turn out to be slightly better than the simulation results, keep in mind to not design exactly to the point of the required STI value but to leave some room for the details not accounted for.

5 Documentation and Export

There are several procedures to export pictures and models in order to document the room configuration, sound system concept and calculation results.

5.1 Exporting Pictures

The context menus of the Top View, Side View, Front View, Distribution Graph and Frequency Response windows are dedicated to export section details such as drawings, graphs and mappings. The pictures can be saved as Windows Bitmap (*.bmp), JPEG (*.jpg), Portable Network Graphics (*.png) or Tagged Image File (*.tif). The drive, path, and name are selected in a Windows file dialog that is shown after selecting **SAVE PICTURE TO...** from the context menu.



Drawings, graphs and mappings can also be copied to the Clipboard for inserting them into various text, picture and spreadsheet programs like Microsoft Word or Excel with the paste (CTRL+V) command. For this purpose, use the context menu command **COPY PICTURE TO CLIPBOARD**.

The **FILE** menu provides the **SAVE PICTURE FROM** function for exporting the current display of the Top View, Front View, Side View, Distribution Graph or Frequency Response window as well.



5.2 Creating a Report

The menu command **FILE > CREATE REPORT...** (Ctrl+P) will open the Report Settings window. In this window adjustments can be made about which information about the project should be included in the report.

On the one hand, data about each room can be added or omitted, such as the geometry (**ROOM LAYOUT**), the walls and materials assigned to them (**SURFACES**), the objects defined in the room (**OBJECTS**), the current RT (**REVERBERATION TIME**), the list of loudspeakers (**SOUND SOURCES**) as well as the list of **RECEIVERS**.

On the other hand, up to five more mappings can be automatically generated and included. To do that, click on **ADD** and then select the **TYPE**, **FREQUENCY** and **BANDWIDTH** for the map to be added to the report. Corresponding distribution data will be appended automatically.

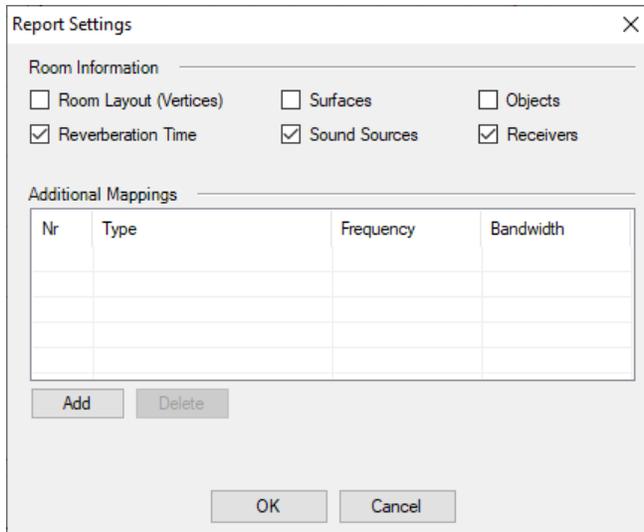
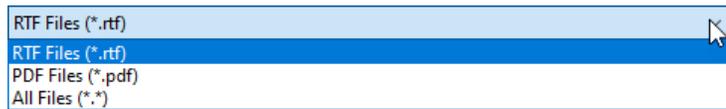


Figure 5.1 – Report Settings window with default parameters

After confirming the Report Settings window with OK a Windows file dialog is shown to select the drive, path and name of the report document. The default name is the project name. The report can be created as a Portable Document Format (*.pdf) or Rich Text Format (*.rtf) file, the latter being directly editable in many word processors like Microsoft Word.



By default, the report consists of the project information including a summary of the sound sources and a layout overview as well as of information about each room including the room layout, reverberation time, loudspeaker concept, currently displayed calculation results in the Top View, Distribution Graph and Frequency Response window. A sample report is shown in Appendix A.

5.3 Export to EASE, DXF or SketchUp

FILE > EXPORT ACTIVE ROOM... allows exporting the currently active room model to EASE (*.frd), a CAD program (*.dxf) or Trimble SketchUp (*.skp). The function will open a Windows file dialog to select the drive, path, and name as well as the export format. The DXF files will have the DXF 2000 format and the SketchUp files the SketchUp 6 format. The export includes the material information of each surface. The EASE model includes the sound sources as well. If case drawings exist in the GLL data files the source positions are indicated by these case drawings after the export to a CAD program or SketchUp.



The following figures show the models after the export:

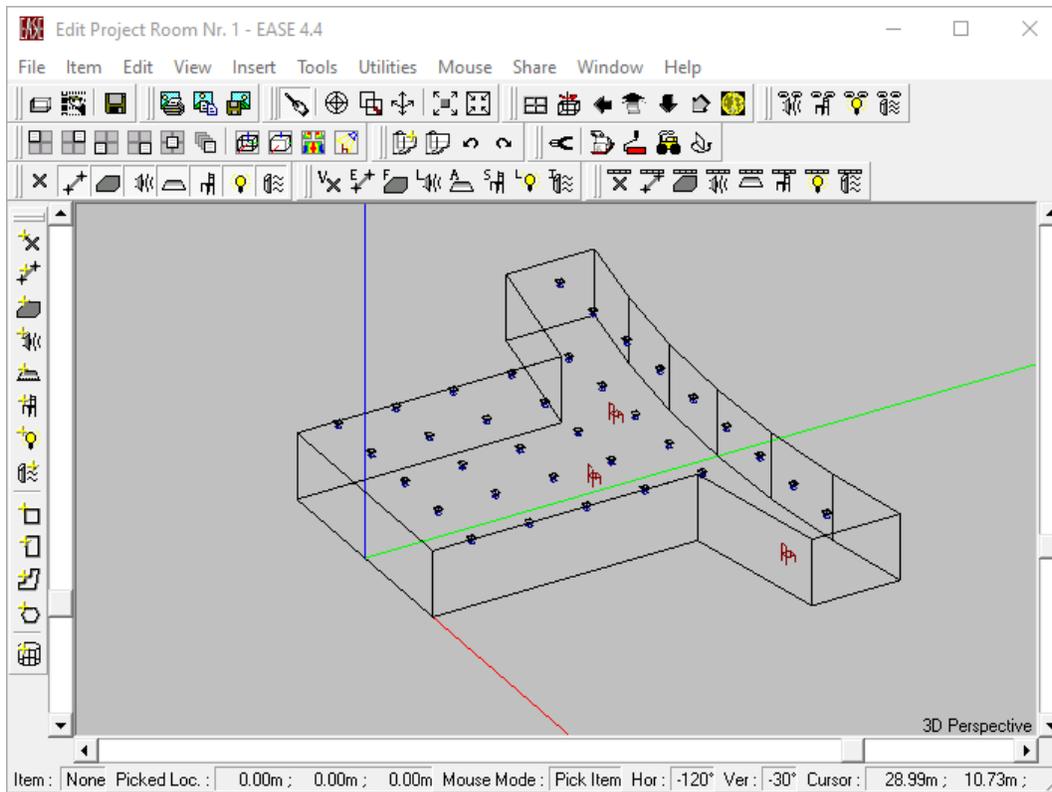


Figure 5.2 – Model after export in EASE 4

Regarding data export to EASE, the material file format (.mat) is the same in EASE Evac and EASE. Therefore, the surface materials including their absorption coefficients are imported into EASE according to the definition in the SURFACES tab of EASE Evac. No further adjustments are necessary. However, note that the EASE project refers directly to the material data files in the EASE Evac database directory. The same is true for the GLL data files. To transfer the EASE project to another computer, it has to be saved as a packed project from within EASE first.

Also note that material areas as well as objects are only defined by their surface area and material type in EASE Evac. This is sufficient for the statistical room acoustics calculations. The export function will generate corresponding 3D drawings for both material areas and objects, but you will have to adjust their position in the room using the software platform you exported to.

5.3.1 Comparing Calculation Results between EASE Evac and EASE 4

At some point of time, you may want to compare calculation results between EASE Evac and EASE 4. Because EASE offers a much larger set of calculation options than EASE Evac, the programs have to be configured so that the simulation parameters match. In order to compare calculation results of EASE and EASE Evac the program settings need to be adjusted as follows:

EASE Evac:

- OPTIONS > CALCULATION PARAMETERS: Set INPUT SIGNAL TYPE to PINK NOISE (AES2 / EASE 4.x).
- OPTIONS > CALCULATION PARAMETERS: Set CALCULATION ACCURACY to HIGH RESOLUTION (SLOW).

EASE:

- EDIT ROOM > ROOM DATA: Set LEVEL DEFINITION to PINK NOISE / SUM LEVELS.
- In EDIT ROOM > ROOM DATA, only EYRING RT or a user-defined RT should be used.
- Standard Mapping should be used as the only calculation method.
- For STI and ALCons comparisons, NOISE MASKING must be on (last tab of Evaluation window), SIGNAL MASKING must be on and STI MALE must be selected. The 2020 edition of the IEC 60268-16 standard must be select as well.

Moreover, make sure that you are using exactly the same room model with the same materials and loudspeakers. Note that the export function converts tap settings in EASE Evac into dB gain settings in EASE 4 because EASE does not directly support constant-voltage networks. Also make sure that your mapping parameters are the same, especially the bandwidth setting.

In most cases, there will still be slight SPL deviations for the two lowest and highest 1/3rd octave bands. This is due to the different ways that EASE and EASE Evac handle the frequency response outside of the main range of 100 Hz to 10 kHz. However, differences should be 2 dB or less and should not affect STI and similar calculations significantly.

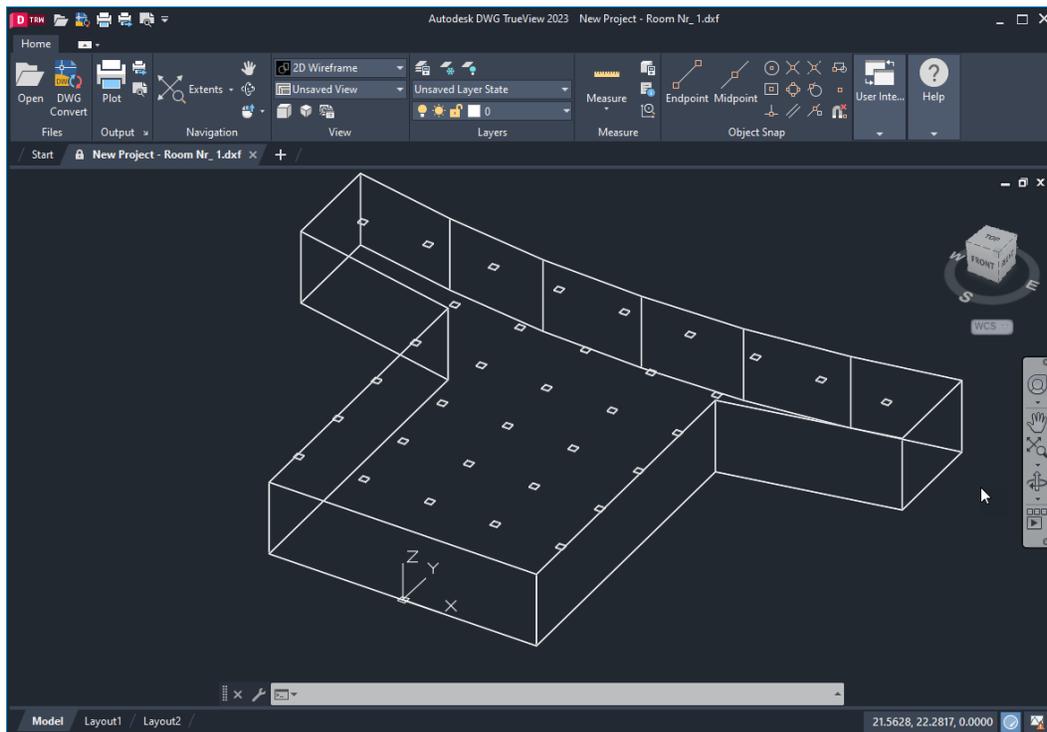


Figure 5.3 – Model after export in Autodesk DWG TrueView

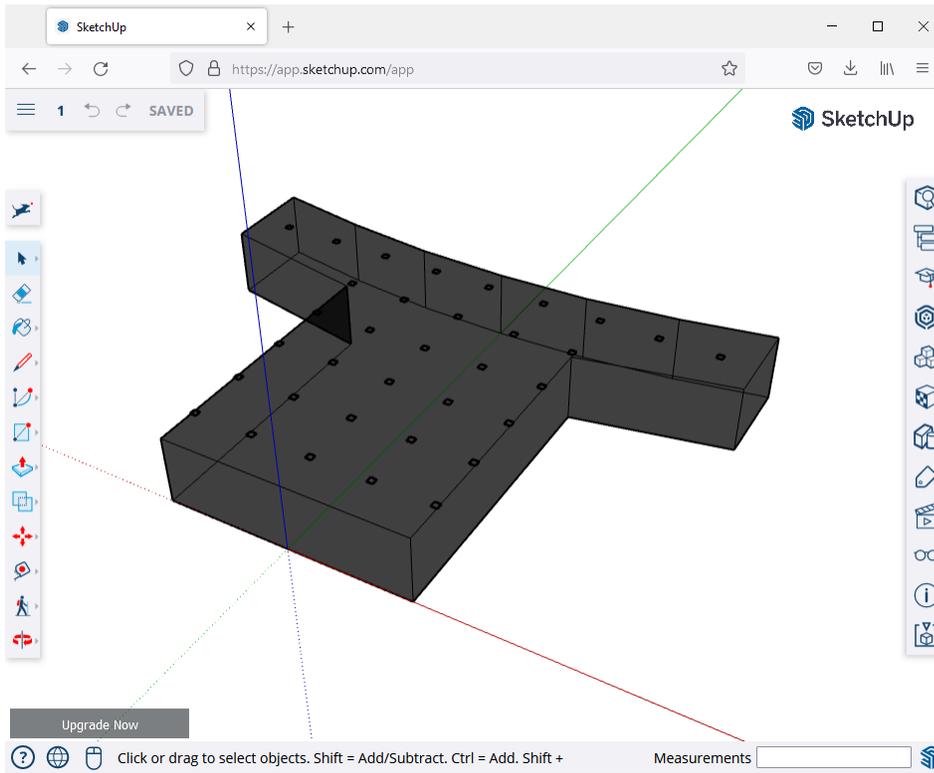


Figure 5.4 – Model after export in Trimble SketchUp

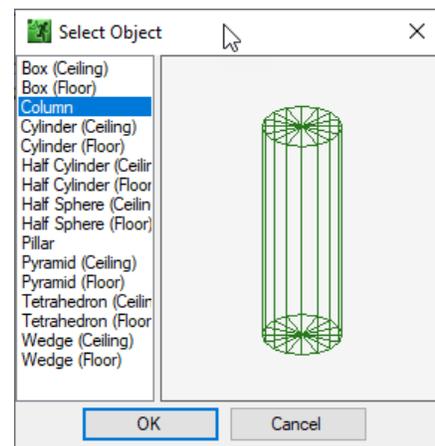
6 Advanced Room Building Procedures

EASE Evac offers a number of advanced room building facilities. These include the possibility of inserting objects and managing several rooms in a single project.

6.1 Inserting Objects

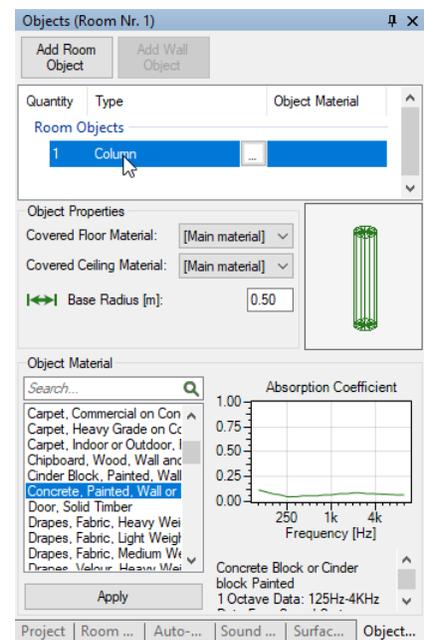
The **OBJECTS** tab facilitates the insertion of objects. There are two different kinds of objects. Room objects such as columns are attached to the ceiling or to the floor. In contrast, wall objects are only attached to a side wall. In order to insert objects in the room, use the button **ADD ROOM OBJECT** at any time or use **ADD WALL OBJECT** when a wall is selected in the Top View window.

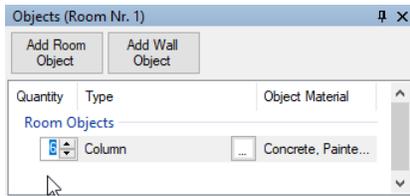
A click on **ADD ROOM OBJECT** opens the **SELECT OBJECT** dialog for choosing the shape. Objects that extend over the full room height, like columns, as well as ceiling and floor objects, like half spheres, are available in the selection. Objects with room height will cover an area of both the floor and the ceiling. The other objects will only cover either a floor or a ceiling area. The surface areas covered by the object will not be considered in the room RT calculations. Click **OK** to add the object to the room.



The next step is the definition of the **OBJECT PROPERTIES**. The settings that can be adjusted depend on the object type. If a column is inserted, the radius can be defined. Floor or ceiling objects require the definition of the object height as well. Below, the section **OBJECT MATERIAL** enables the selection of the surface material for the object. See section 4.4 for details of this process. **APPLY** will assign the selected material to the object. The object surfaces facing into the room and their surface material will then be considered in the RT calculation.

In the **OBJECT PROPERTIES** section, the particular **CEILING MATERIAL** and /or **FLOOR MATERIAL** that is covered by the object can be set. If there are multiple material areas defined, this selection allows specifying which one is covered. In this example, the column has a radius of 0.4 m. Therefore, the area covered at the floor and ceiling has a size of 0.5 m². Consequently, the surface area of the wall and ceiling surface is reduced by 0.5 m² in the RT calculation.



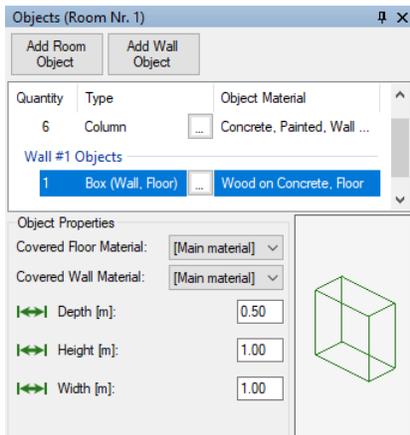
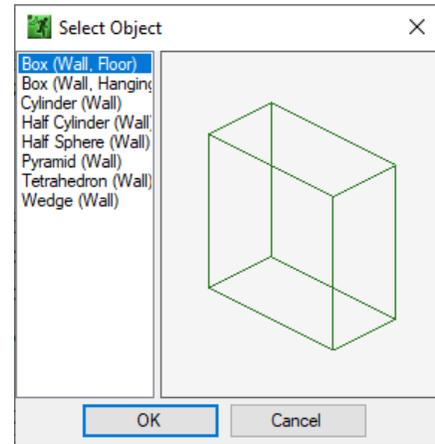


In order to add several objects of the same kind, the **QUANTITY** in the first list column can be modified.

The ... button will reopen the **SELECT OBJECT** dialog to allow altering the object **TYPE**.

If a wall is selected in the Top view window, the **ADD WALL OBJECT** button is enabled. Wall objects like shelves are added with the same procedure as room objects.

The wall object will cover the surface of the wall. If a box has a height of 1 m and a width of 1 m the resulting area of 1 m² that is covered by the object will be subtracted from the wall surface and not be considered in the RT calculation. Instead, the object surfaces facing into the room (sides and front of the box) and their material type will be considered in the RT calculation.



Note that it is not necessary to include every small object of the original room in the model. As a rule of thumb, there is no need to insert objects with less than 1% of the room’s volume or surface area. Exceptions are a room with a high reverberation time and reflective surfaces that possess highly absorbing materials or a room with many similar small objects that represent a significant surface area or volume when considered combined.

6.2 Creating and Managing Projects with Several Rooms

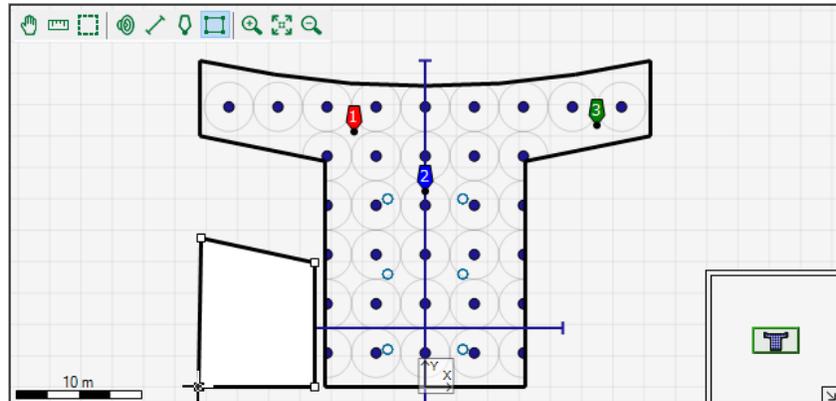
In general, an evacuation system includes sound sources in several rooms. Therefore, EASE Evac allows the creation and management of several rooms in one project.

6.2.1 Adding Rooms to a Project

There are two different ways to add a new room. Either the menu command **EDIT > ADD DEFAULT ROOM** will add a default room to the project or the  tool button is activated in the Top View window and the room is inserted using the mouse.

The first procedure will add a 30 x 10 m room to the project. In order to align the shape to a certain layout the vertices can be modified as explained in chapter 2.2.3.

The second procedure needs the **ADD ROOM**  tool icon to be activated. The cursor changes into a cross and every click in the Top View window will add a vertex until the first vertex is selected again. The closed room will be indicated by an opaque white area.



By default, the room origin will be set to the first/last inserted vertex. It can be altered in the Room Layout table with a click on the vertex of interest and selecting the **SET AS ROOM ORIGIN** function in the context menu. Another way to change the room origin is using the context menu in the Top View window. The command **MOVE ROOM ORIGIN TO** allows moving the origin to a given X/Y location. The command **COPY ROOM ORIGIN FROM...** allows selecting the X/Y location of the origin of another room as the new origin.

When auto-arrange is on, sound sources will be added automatically. In order to create further rooms, the building procedures can be performed again as described above.

6.2.2 Managing Multiple Room Projects

Each room has its own room tab for setting the room properties like **LABEL**, **ROOM HEIGHT**, **EAR HEIGHT**, **NETWORK**, etc. The data that is displayed depends on the room that is currently active. The active room is selected by a click on the room area in the Top View window if the **PAN** tool icon is activated or via the **EDIT** menu.

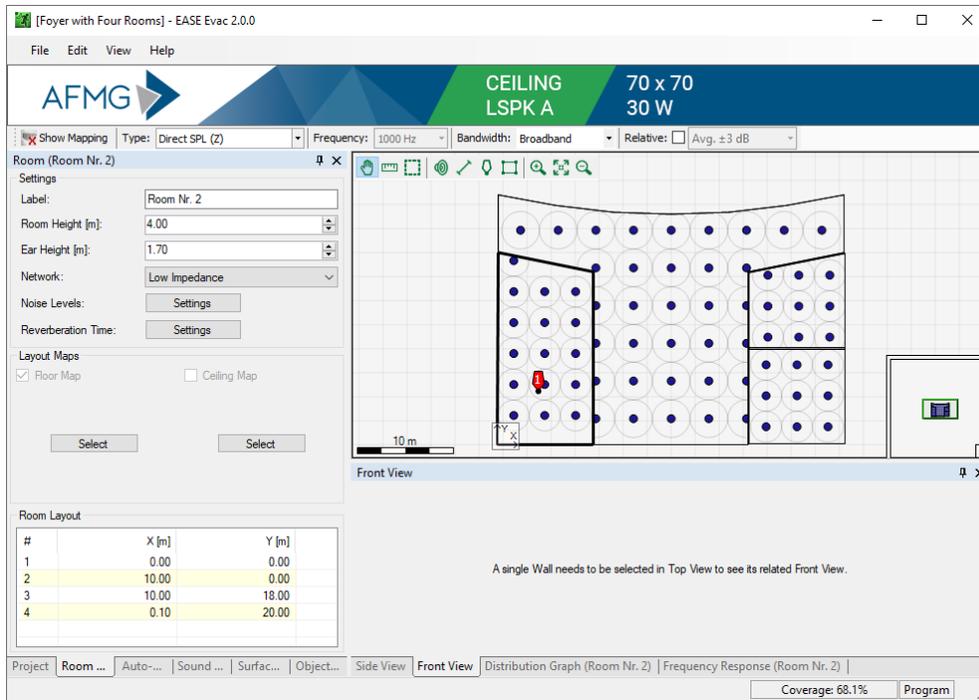
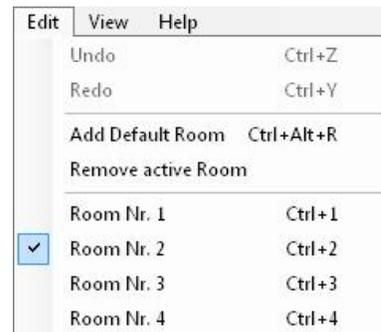


Figure 6.1 – Project with four rooms

The **EDIT** menu includes a list of all rooms. If a room is selected in the **EDIT** menu or by using the shortcut **Ctrl+(Room Number)** the **Top View** window will zoom into the room and the room labels will be shown briefly. The room labels will be shown permanently if the setting **PERMANENT ROOM LABELS** is selected under **OPTIONS > DISPLAY OPTIONS/GRID**. Back in the **EDIT** menu, **REMOVE ACTIVE ROOM** deletes the active room.



The menu functions **VIEW > ZOOM TO NEXT ROOM (F11)** and **ZOOM TO PREVIOUS ROOM (F12)** allow switching the view quickly between rooms.

All properties and parameters are set individually for each room. Therefore, each room has its own **ROOM**, **AUTO-ARRANGE**, **SOUND SOURCES**, **SURFACES** and **OBJECTS** tab. Note that the captions of all windows relating to room-specific data show the label of the active room in parentheses.

With respect to **LAYOUT MAPS**, note that it is possible to have a separate background image for each room or to load a global image which is shared among all rooms. See also section 2.2.

Calculations are performed for all rooms of the project at the same time. The **Top View** window will show the results of all rooms, but the **DISTRIBUTION GRAPH** and the **FREQUENCY RESPONSE** window will display the individual results of the selected room, only.

A report will include all rooms, showing the room properties and calculation results individually for each room.

7 Menu Bar Functions and Warnings

The following paragraphs summarize the functions of the **FILE**, **EDIT**, **VIEW** and **HELP** menus. Exceptions are the functions and settings of **FILE > OPTIONS** that will be explained in chapter 8.

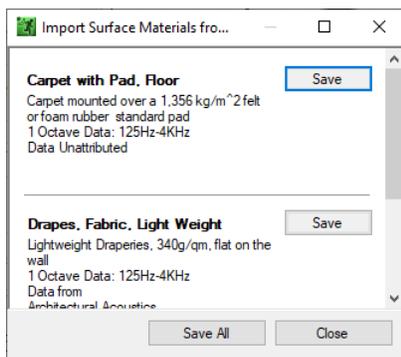
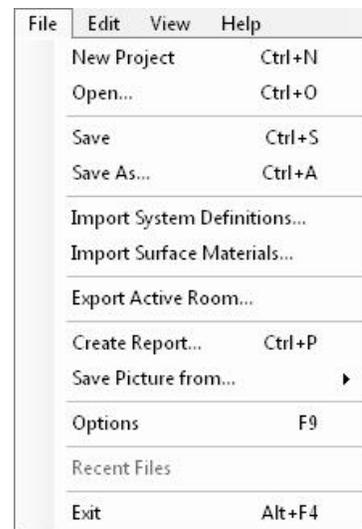
In the status bar, EASE Evac indicates design inconsistencies by warnings. These will be explained at the end of this chapter.

7.1 Functions of the File Menu

NEW PROJECT (Ctrl+N) opens a new project with the default room. Initial settings for the default project and for the default room can be made in **OPTIONS > PROJECT DEFAULTS** (see section 8.5).

The project with the new room can either be saved with the same name and in the same directory with **FILE > SAVE** (CTRL+S) or a new name and directory are assigned with **FILE > SAVE AS...** (Ctrl+A). The latter will open a Windows file dialog to select the drive and path as well as to enter the name. The file extension of EASE Evac Projects is *.evc.

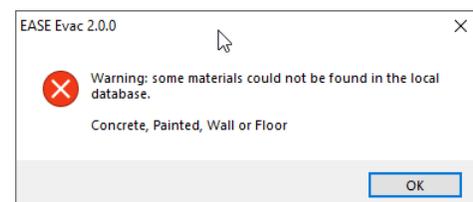
The project file contains all data of the project, including the sound source data files (GLL), surface materials and room objects. It is not necessary to take specific care when saving projects in order to ensure that all project data is available when the project file is opened on other computers with EASE Evac.



However, all database items for materials, sound sources and objects are organized in subfolders. If a file used by the project is not found while loading the project, EASE Evac will open an Import dialog in order to copy the data from the project file to the local database. The dialog for the import of surface materials is shown on the right as an example. The list shows those material files that are included in the project but are not available in the appropriate subfolder on the local PC. **SAVE** will add the material to the program’s database of surface materials. **SAVE ALL** will add all

materials at once.

CLOSE will close the dialog. If there are still some surface materials missing, a warning will list the definitions not available in the local database. Surfaces referencing materials



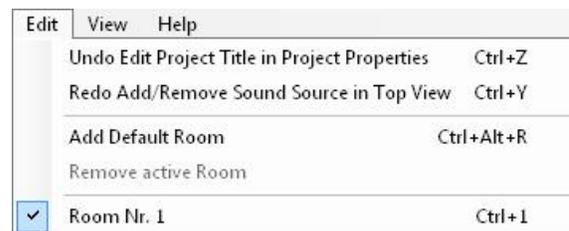
that are not imported will be set to the default material (NONE).

In order to import missing database items after opening a project or add new database items during the modeling process the functions `IMPORT SYSTEM DEFINITIONS...` and `IMPORT SURFACE MATERIALS...` provide the facilities to select the appropriate files using a Windows file dialog (see also sections 3.3.1 and 4.4).

The documentation and export functions of the `FILE` menu are discussed in chapter 5. The `RECENT FILES` menu item is visible only after the start with default settings. Later any recently opened project files are listed in this section.

7.2 Functions of the Edit Menu

Every step of the modeling and sound system design process can be cancelled or restored using the menu commands `EDIT > UNDO` (Ctrl+Z) or `EDIT > REDO` (Ctrl+Y).



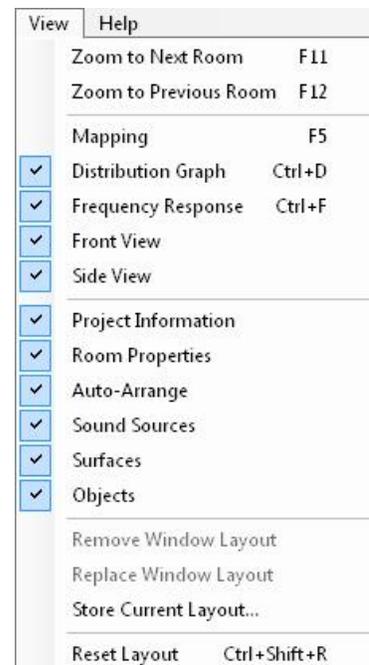
`ADD DEFAULT ROOM` adds a new room to the project.

`REMOVE ACTIVE ROOM` deletes the active room. Details about these functions as well as the Room selection are described in chapter 6.2.

7.3 View Options

The `VIEW` menu includes the facilities to adjust the program window. `ZOOM TO NEXT ROOM` (F11) shows the room with the next room number in the Top View window. `ZOOM TO PREVIOUS ROOM` (F12) displays the room with the previous room number.

The `MAPPING` (F5), `DISTRIBUTION GRAPH` (Ctrl+D) and `FREQUENCY RESPONSE` (Ctrl+F) menu items are equipped with shortcuts for a quick enabling and disabling of the windows. All other windows can be switched on and off in the `VIEW` menu as well. Disabled windows are not available in the bottom area.



The program layout can be stored and recalled. **STORE CURRENT LAYOUT** opens the dialog to label the layout. After one layout was stored, the menu items **REMOVE WINDOWS LAYOUT** and **REPLACE WINDOWS LAYOUT** as well as the direct recall of the stored layouts by their labels are enabled.



RESET LAYOUT will set the program window back to the default appearance.

7.4 Help Menu

A click on **USER’S GUIDE** will open this manual. Clicking on **QUICK START** will display a document that gives a very short introduction into the use of EASE Evac. Further help and information facilities are provided by the AFMG Software Newsletter and the EASE Evac website. If the computer is connected to the internet, a click on **SIGN UP FOR NEWS** will automatically open the AFMG Newsletter Registration with your standard browser or the **EASE EVAC WEBSITE** with a click on the corresponding menu item. The menu item **DOWNLOAD SYSTEM DEFINITIONS** will open a subpage of the EASE Evac website where a database of GLL files is provided. After downloading the files, they can be added to the program’s database using the **FILE > IMPORT SYSTEM DEFINITIONS...** menu command.

ABOUT EASE EVAC activates a window with information about the current program and license version as well as the license validity.

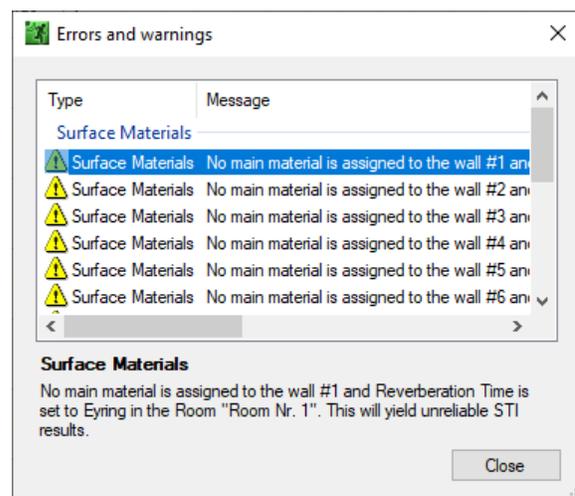
7.5 Warnings

If there are design inconsistencies in the project, warnings will be shown in the status bar

 16 warnings. They indicate the following problems;

- The reverberation time is set to Eyring, mapping is set to intelligibility, S/N or Total SPL and some surfaces or objects do not have a material assigned.
- The number of speakers in auto-arrangement reaches a threshold, defined in the Options window.
- A sound source is located outside of a room.

A left click on the warning icon in the status bar opens a list with the specific warnings.



8 General Settings with Options

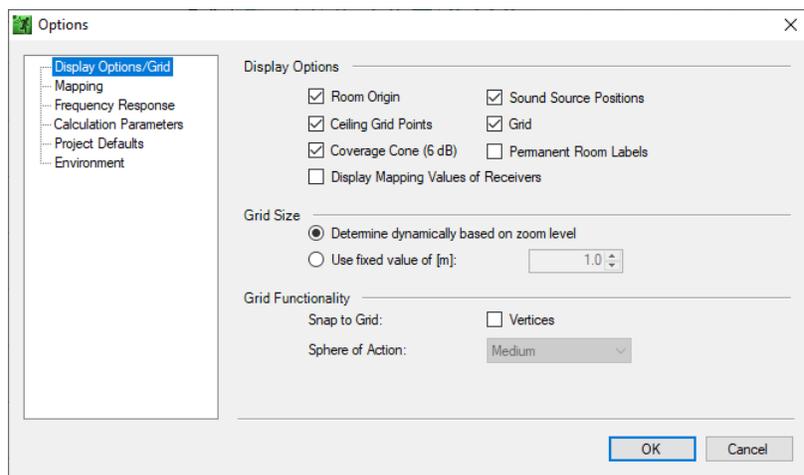
General program settings like default display options, calculation parameters, project defaults and units are defined with the **FILE > OPTIONS** dialogs (F9). The settings are grouped in six dialog pages.

Changes will be applied if the options dialog is closed with **OK**. **CANCEL** will discard the changes.

8.1 Display Options/Grid

The **DISPLAY OPTIONS/GRID** dialog page defines the settings of the Top View window.

In the **DISPLAY OPTIONS** section a number of different items can be enabled or disabled for display in the Top View window. This includes the icon for the **ROOM ORIGIN**, the blue dots indicating **SOUND SOURCE POSITIONS**, the locations of the **CEILING GRID**



POINTS, the background lines of the **GRID**, the circles in the Top View that indicate the **COVERAGE CONE** of each sound source based on the GLL’s rated coverage angle, the display of **PERMANENT ROOM LABELS** and of **MAPPING VALUES** at the receiver locations.

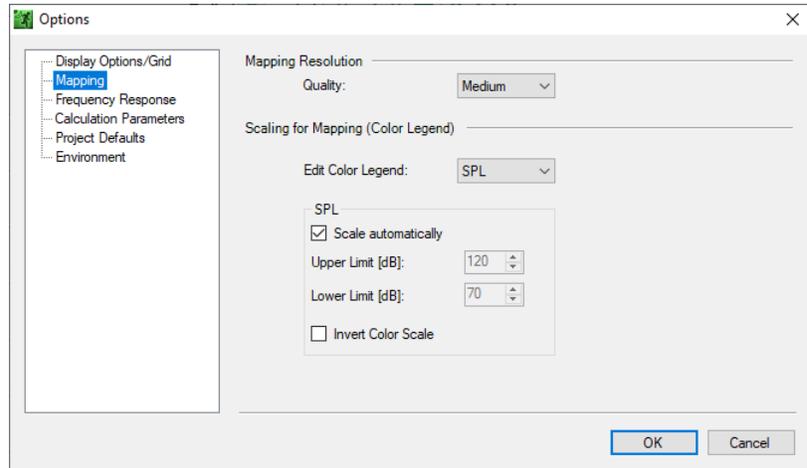
The **GRID SIZE** can either be automatically adapted to the current view with **DETERMINE DYNAMICALLY BASED ON ZOOM LEVEL** or keep the fixed spacing defined with **USE FIXED VALUE OF**.

Selecting the switch **SNAP TO GRID** allows Vertices to be moved to the next grid point automatically, when inserted or moved by mouse. **SPHERE OF ACTION** determines the distance between a vertex insert location and the grid point it will snap to.

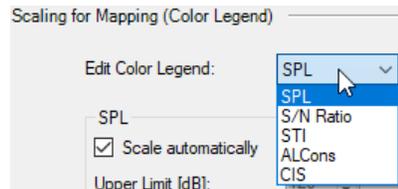
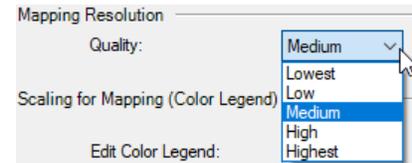
8.2 Mapping

The **MAPPING** plot in EASE Evac is calculated dynamically. The calculation is performed for several levels of spatial accuracy - mapping resolutions - automatically one after the other. This **QUALITY** selection list determines the resolution of the final level.

For example, at the lowest quality the final level will be reached quickly but the resolution will be low. In contrast, the highest quality will provide a very high resolution at the final level, but it will take quite long to finish. Five levels are available for selection. **MEDIUM** will have approximately a three times higher resolution than **LOWEST**. **HIGHEST** will have approximately a three times higher resolution than **MEDIUM**.



This option is particularly useful to adjust the mapping speed at which individual levels are reached to the individual computer’s performance.



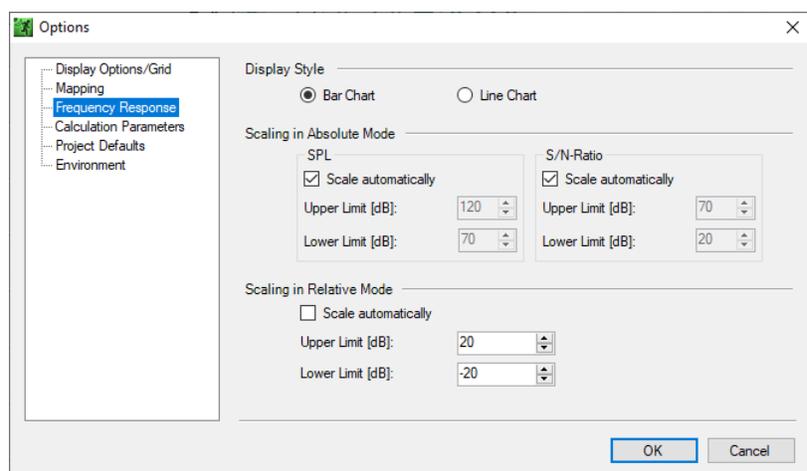
SCALING FOR MAPPING (COLOR LEGEND) allows the definition of different color scales for each mapping type. If the **SCALE AUTOMATICALLY** checkbox is selected, the color range is automatically adapted to the range of computed values for the given mapping type. Alternatively, the **UPPER LIMIT** and **LOWER LIMIT**

of the color scale can be set to fixed values for each mapping type. Selecting **INVERT COLOR SCALE** reverses the color scale regarding the association of lower and higher values to the colors of blue and red, respectively.

8.3 Frequency Response

The section **DISPLAY STYLE** allows the definition of the Frequency Response display, either as a **BAR CHART** or **LINE CHART**.

In **ABSOLUTE MODE** all levels (**SPL** and **S/N RATIO**) are shown as absolute dB values. For a better display, the default for the absolute graph is automatically adjusted, based on the range of



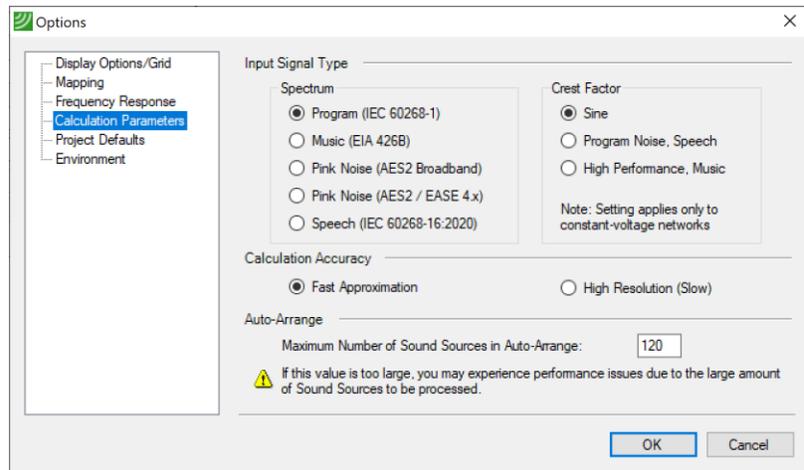
values. **SCALE AUTOMATICALLY** performs the automatic adjustment of the Y axis. If the checkbox is not selected the **UPPER LIMIT** determines the highest dB value for the Y axis. The **LOWER LIMIT** sets the lowest dB value for the Y axis.

In **SCALING IN RELATIVE MODE**, all levels are shown as dB values relative to the selected receiver position. For better comparison, the default for the relative graph is set to a fixed range of levels. If **SCALE AUTOMATICALLY** is selected, the software automatically adjusts the Y axis of the graph based on the range of levels. If the checkbox is not selected, the **UPPER LIMIT** determines the highest dB value for the Y axis, the **LOWER LIMIT** sets the lowest dB value for the Y axis.

8.4 Calculation Parameters

The **INPUT SIGNAL TYPE** > **SPECTRUM** determines the input level for the acoustic calculation as a function of frequency. Because the mapping results are displayed in absolute sound pressure levels they depend on the type of input signal to the system.

Here a choice of common, standardized signals is provided:



- The **PROGRAM (IEC 60268-1)** signal is a broadband test signal as defined by the IEC 60268-1 standard. The spectral shape is similar to typical program material and relatively close to pink noise. This is the default as the signal covers a broad range of applications and is not as unnatural as pure pink noise.
- The **MUSIC (EIA 426B)** signal is a broadband signal as defined by the EIA 426B standard. The spectral shape is derived from the average of many pieces of different music.
- The **PINK NOISE (AES2 BROADBAND)** signal is a broadband test signal as defined by the AES2 standard. The spectral shape is pink noise band-passed at 20 Hz and 20 kHz.
- The **Pink Noise (AES2 /EASE 4.x)** signal is similar to the broadband AES2 signal but it is limited to the rated bandwidth of each sound source. This setting is not a typical configuration for signals distributed through voice announcement systems and is normally only needed for detailed comparisons with EASE.
- The **SPEECH (IEC 60268-16:2020)** signal is a broadband signal with emphasis on the speech bands as defined by the STI standard. The spectral shape is representative for the frequency spectrum of talking male speakers. This option should typically be selected for STI calculations.

Note that the maximum output level of a sound source also depends on the kind of input signal.

In the main window the currently selected INPUT SIGNAL TYPE is shown in the status bar:

Coverage: 81,0% Speech  19 warnings ... Clicking on the label will open this page of the Options window.

The INPUT SIGNAL TYPE > CREST FACTOR allows adjusting the level of the input signal for constant voltage networks. The SINE setting assumes that the transformer supplies the loudspeaker with power according to the tap setting’s nominal rating. At this input level, the loudspeaker output is equal to its maximum SPL. However, in practice the crest factor of a real-world input signal has to be considered. The PROGRAM NOISE, SPEECH setting assumes a crest factor of 12 dB, the HIGH PERFORMANCE, MUSIC setting assumes as crest factor of 18 dB. When activated, the input levels of the sound sources in the model are decreased accordingly, relative to the SINE setting by 9 dB and 15 dB, respectively. In other words, these settings take into account a realistic headroom at the input and accordingly reduce the loudspeaker’s continuous SPL output.

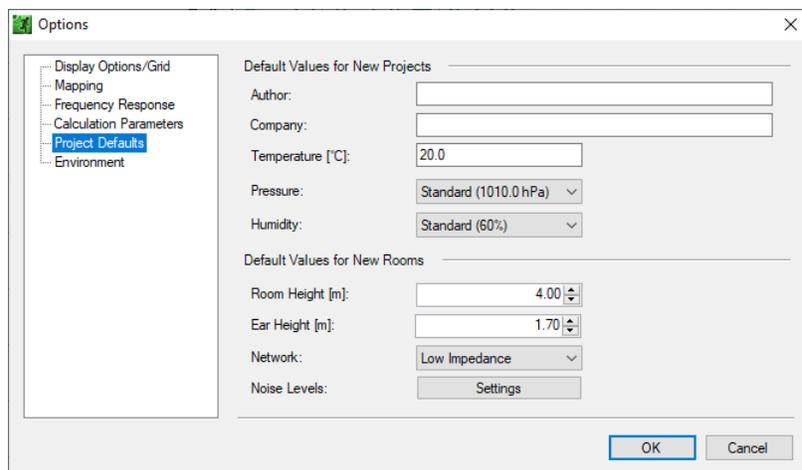
CALCULATION ACCURACY defines the internal frequency resolution for the acoustic calculations. The setting FAST APPROXIMATION uses 1/3rd octave bands over the bandwidth of the device. For most applications of EASE Evac this resolution is sufficient. However, it may deviate from regular EASE results by 0.5 or 1 dB. The setting HIGH RESOLUTION (SLOW) uses the high-resolution data as available in the GLL. This is the same resolution as used in standard EASE calculations.

AUTO-ARRANGE sets the MAXIMUM NUMBER OF SOUND SOURCES IN AUTO-ARRANGE. The default setting is 120 which means that the auto-arrange function will add a maximum of 120 sound sources to the model. If the number of sources is too high, the calculation performance may be decreased.

8.5 Project Defaults

The DEFAULT VALUES FOR NEW PROJECTS are defined in this dialog. It enables the definition of a default name for the AUTHOR and COMPANY.

The dialog allows the modification of the environmental parameters as well. The default air TEMPERATURE is 20 °C. The default air PRESSURE is 1010 hPa. The default air HUMIDITY is 60%.



The screenshot shows the 'Options' dialog box with the following settings:

- Default Values for New Projects:**
 - Author:
 - Company:
 - Temperature [°C]:
 - Pressure:
 - Humidity:
- Default Values for New Rooms:**
 - Room Height [m]:
 - Ear Height [m]:
 - Network:
 - Noise Levels:

Buttons: OK, Cancel

DEFAULT VALUES FOR NEW ROOMS determine the ROOM HEIGHT, i.e., the ceiling height, and the EAR HEIGHT, i.e., the vertical offset of the listening plane for the mappings above the ground floor. The mounting height of the sound sources can differ from the ceiling height.

Hint: Ear height for people sitting down is normally estimated at 1.2 m. Ear height for standing people is normally estimated at 1.7 m.

The setting for NETWORK defines if a new room uses a low-impedance network or a constant-voltage network, such as 70 V or 100 V, by default. Note that a warning will be displayed by the program if there is no sound source in the database that supports a constant-voltage network.

A click on the SETTINGS button for NOISE LEVELS opens the EDIT NOISE LEVELS window (section 4.2) in order to define the default values for ambient noise in dB for a new Room.

8.6 Environment

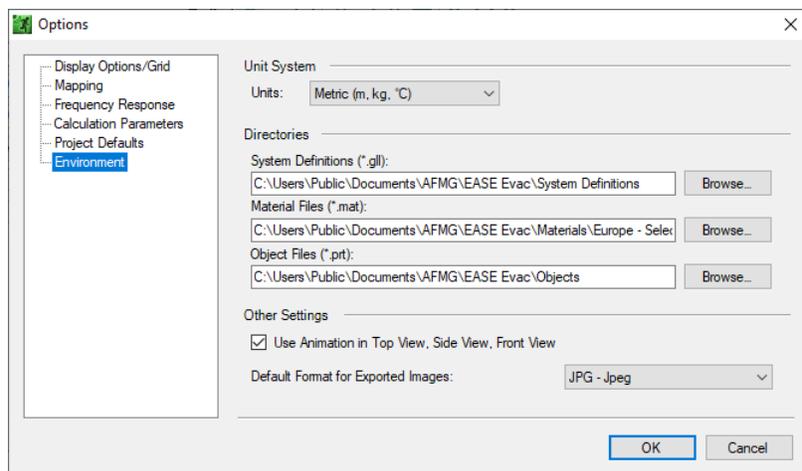
The setting UNIT SYSTEM allows the selection of the UNITS that are used in the program. It determines the unit system, either metric units (m, kg, °C) or US customary units (ft, lb, °F). Note that you will need to close the OPTIONS window before the new settings are applied.

Database paths are defined under DIRECTORIES.

SYSTEM DEFINITIONS (*.GLL) defines the directory where the program searches for system definitions, i.e., GLL files. Use the BROWSE... button to change this location. The Browse dialog will automatically open when the program starts and no system definitions are found at this location. This applies to MATERIAL FILES (*.MAT) and OBJECT FILES (*.PRT) as well.

The setting USE ANIMATION IN TOP VIEW, SIDE VIEW, FRONT VIEW is selected by default and provides a smooth visual transition when the view is zoomed or scaled. This option can be switched off in order to improve the working speed.

The selection DEFAULT FORMAT FOR EXPORTED IMAGES defines the default file format for saving pictures.



9 References

- [1] L. Kinsler, A. Frey, A. Coppens, and J. Sanders, *Fundamentals of Acoustics*, 4th ed. (Wiley, New York, 2000).
- [2] S. Feistel, W. Ahnert, *Modeling of Loudspeaker Systems Using High-Resolution Data*, J. Audio Eng. Soc., vol. 55, pp. 571-597 (2007 July/August).
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- [4] ISO 9613-1:1993, *Acoustics -- Attenuation of sound during propagation outdoors -- Part 1: Calculation of the absorption of sound by the atmosphere*
- [5] P. M. Morse, K. U. Ingard, *Theoretical Acoustics*, 1st ed. With errata page (Princeton University Press, Princeton, 1986).
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- [7] W. Ahnert, F. Steffen, *Sound Reinforcement Engineering, Fundamentals and Practice*, 1st ed. (E&FN Spon, London, 2000).
- [8] D. Davis, E. Patronis, *Sound System Engineering*, 3rd ed. (Focal Press, Burlington, 2006).
- [9] H.J.M. Steeneken, T. Houtgast, R. Plomp, *Predicting Speech Intelligibility in Rooms from the Modulation Transfer Function*, *Acustica*, vol. 46, pp. 60-72 (1980).
- [10] IEC 60268-16:2020, *Sound system equipment - Part 16: Objective rating of speech intelligibility by speech transmission index*
- [11] IEC 60268-16:2011, *Sound system equipment - Part 16: Objective rating of speech intelligibility by speech transmission index*
- [12] EASE software, <http://www.afmg.eu>.

Appendix A. Sample EASE Evac Report

Foyer



[Your Name]
[Your Company]

Sunday 31 July 2022

Project Information

Title:	Foyer
Author:	[Your Name]
Company:	[Your Company]
Notes:	- Ceiling Height 4.5 m - With Section Planes - With Receivers - Noise Level => RNC-70 - Reverberation Time => RT-1
Temperature:	20.0°C
Pressure:	Standard (1010.0 hPa)
Humidity:	Standard (60%)
Input Signal Spectrum:	Program (IEC 60268-1)
Input Signal Crest Factor:	Pink Noise, Speech
Calculation Accuracy:	Fast Approximation
STI Standard:	IEC 60268-16 (2020)

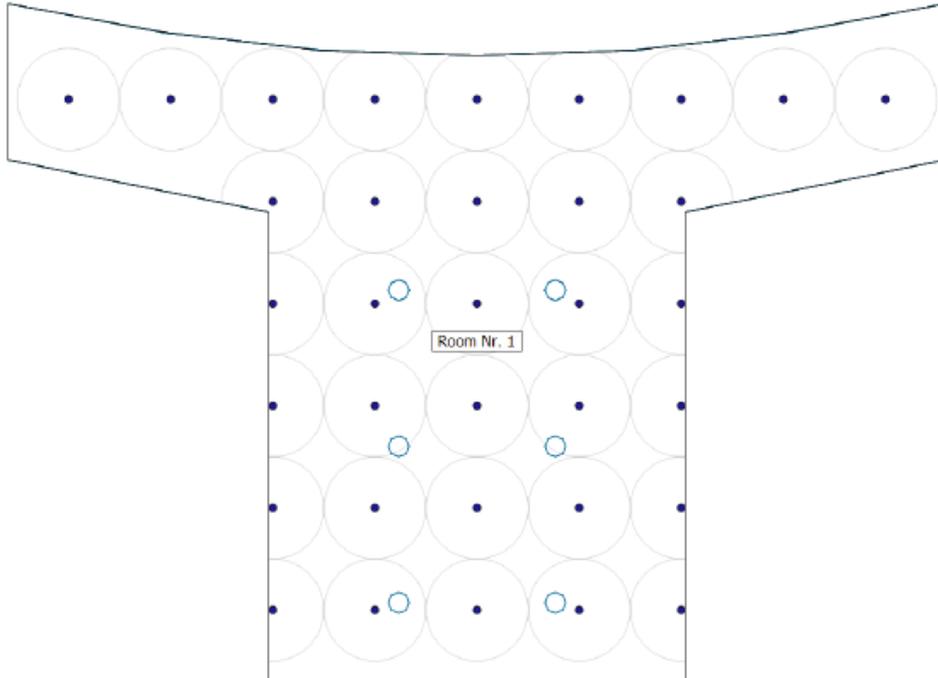
Sound Sources Summary

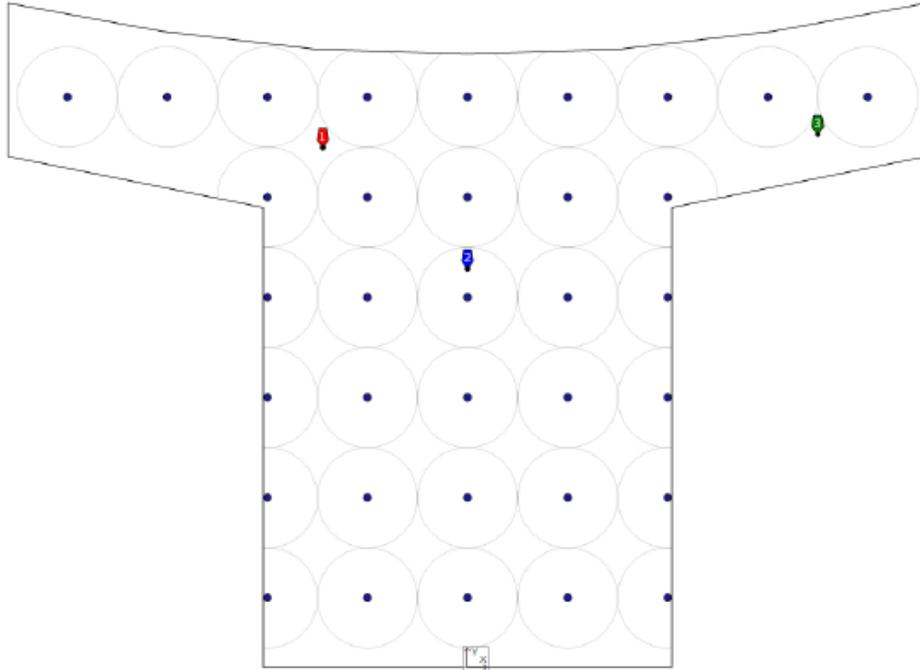
Quantity	Type
34	Ceiling Lspk A (30 W, 70x70) (AFMG)



EASE Evac

Layout Overview



Room: Room Nr. 1

Label:	Room Nr. 1
Room Height:	4.50 m
Dimensions (WxD):	36.00 m x 26.00 m
Volume:	2291.4 m ³ (net: 2291.4 m ³)
Surface Area:	1561.5 m ² (net: 1561.5 m ²)
Ear Height:	1.70 m

Sound Sources Summary

Quantity	Type
34	Ceiling Lspk A (30 W, 70x70) (AFMG)

Reverberation Time

Frequency Band [Hz]	Reverberation Time (Manual)
125	1.20 s
250	1.00 s
500	1.00 s
1000	1.00 s
2000	1.00 s

EASE Evac

4000	0.84 s
8000	0.68 s

Sound Sources

Nr.	Mounting	Type	X [m]	Y [m]	Z [m]	Hor [°]	Ver [°]	Gain [dB]
1	Ceiling	Ceiling Lspk A (30 W, 70x70)	-15.68	22.33	4.50	0.0	-90.0	0.0
2	Ceiling	Ceiling Lspk A (30 W, 70x70)	-11.76	22.33	4.50	0.0	-90.0	0.0
3	Ceiling	Ceiling Lspk A (30 W, 70x70)	-7.84	22.33	4.50	0.0	-90.0	0.0
4	Ceiling	Ceiling Lspk A (30 W, 70x70)	-3.92	22.33	4.50	0.0	-90.0	0.0
5	Ceiling	Ceiling Lspk A (30 W, 70x70)	0.00	22.33	4.50	0.0	-90.0	0.0
6	Ceiling	Ceiling Lspk A (30 W, 70x70)	3.92	22.33	4.50	0.0	-90.0	0.0
7	Ceiling	Ceiling Lspk A (30 W, 70x70)	7.84	22.33	4.50	0.0	-90.0	0.0
8	Ceiling	Ceiling Lspk A (30 W, 70x70)	11.76	22.33	4.50	0.0	-90.0	0.0
9	Ceiling	Ceiling Lspk A (30 W, 70x70)	15.68	22.33	4.50	0.0	-90.0	0.0
10	Ceiling	Ceiling Lspk A (30 W, 70x70)	-7.84	18.40	4.50	0.0	-90.0	0.0
11	Ceiling	Ceiling Lspk A (30 W, 70x70)	-3.92	18.40	4.50	0.0	-90.0	0.0
12	Ceiling	Ceiling Lspk A (30 W, 70x70)	0.00	18.40	4.50	0.0	-90.0	0.0
13	Ceiling	Ceiling Lspk A (30 W, 70x70)	3.92	18.40	4.50	0.0	-90.0	0.0
14	Ceiling	Ceiling Lspk A (30 W, 70x70)	7.84	18.40	4.50	0.0	-90.0	0.0
15	Ceiling	Ceiling Lspk A (30 W, 70x70)	-7.84	14.48	4.50	0.0	-90.0	0.0
16	Ceiling	Ceiling Lspk A (30 W, 70x70)	-3.92	14.48	4.50	0.0	-90.0	0.0
17	Ceiling	Ceiling Lspk A (30 W, 70x70)	0.00	14.48	4.50	0.0	-90.0	0.0
18	Ceiling	Ceiling Lspk A (30 W, 70x70)	3.92	14.48	4.50	0.0	-90.0	0.0
19	Ceiling	Ceiling Lspk A (30 W, 70x70)	7.84	14.48	4.50	0.0	-90.0	0.0
20	Ceiling	Ceiling Lspk A (30 W, 70x70)	-7.84	10.56	4.50	0.0	-90.0	0.0
21	Ceiling	Ceiling Lspk A (30 W, 70x70)	-3.92	10.56	4.50	0.0	-90.0	0.0
22	Ceiling	Ceiling Lspk A (30 W, 70x70)	0.00	10.56	4.50	0.0	-90.0	0.0
23	Ceiling	Ceiling Lspk A (30 W, 70x70)	3.92	10.56	4.50	0.0	-90.0	0.0
24	Ceiling	Ceiling Lspk A (30 W, 70x70)	7.84	10.56	4.50	0.0	-90.0	0.0
25	Ceiling	Ceiling Lspk A (30 W, 70x70)	-7.84	6.64	4.50	0.0	-90.0	0.0
26	Ceiling	Ceiling Lspk A (30 W, 70x70)	-3.92	6.64	4.50	0.0	-90.0	0.0
27	Ceiling	Ceiling Lspk A (30 W, 70x70)	0.00	6.64	4.50	0.0	-90.0	0.0
28	Ceiling	Ceiling Lspk A (30 W, 70x70)	3.92	6.64	4.50	0.0	-90.0	0.0
29	Ceiling	Ceiling Lspk A (30 W, 70x70)	7.84	6.64	4.50	0.0	-90.0	0.0
30	Ceiling	Ceiling Lspk A (30 W, 70x70)	-7.84	2.72	4.50	0.0	-90.0	0.0
31	Ceiling	Ceiling Lspk A (30 W, 70x70)	-3.92	2.72	4.50	0.0	-90.0	0.0
32	Ceiling	Ceiling Lspk A (30 W, 70x70)	0.00	2.72	4.50	0.0	-90.0	0.0
33	Ceiling	Ceiling Lspk A (30 W, 70x70)	3.92	2.72	4.50	0.0	-90.0	0.0

Sunday 31 July 2022

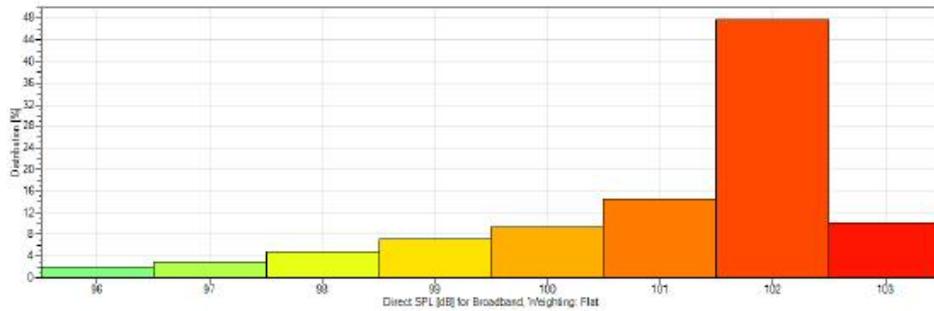
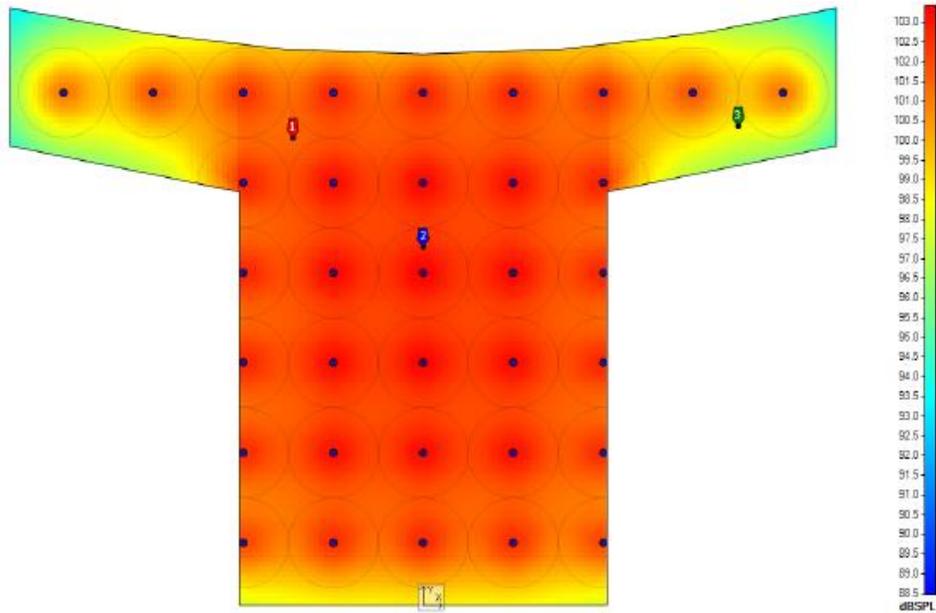
4/6

EASE Evac

34	Ceiling	Ceiling Lspk A (30 W, 70x70)	7.84	2.72	4.50	0.0	-90.0	0.0
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Mapping and Distribution

Direct SPL, Broadband



Average:	101.0 dB ±1.8 dB
Average + Std. Dev.:	102.8 dB
Average - Std. Dev.:	99.2 dB
Max. Value:	103.4 dB
Min. Value:	88.5 dB
Data Points:	10635

Area Covered:	Direct SPL
95%	≥97.1 dB

Sunday 31 July 2022

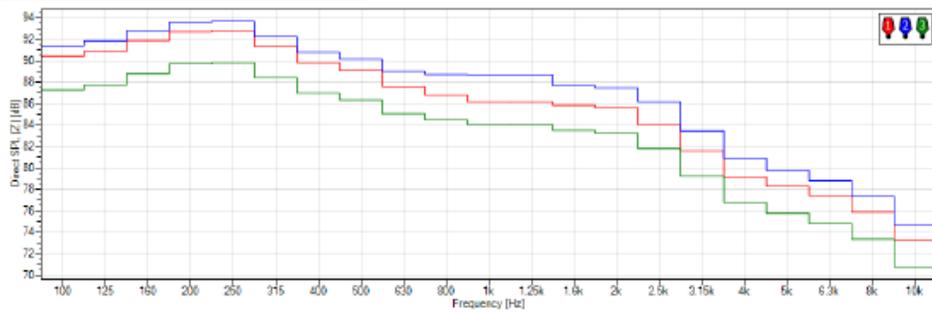
5/6

EASE Evac

90%	≥98.3 dB
85%	≥99.1 dB
80%	≥99.7 dB

Receivers

	X [m]	Y [m]
Receiver 1	-5.67	20.35
Receiver 2	0.00	15.60
Receiver 3	13.72	20.87



Appendix B. EASE Evac Installation and Licensing

B.1 Installation Instructions

B.1.1 Microsoft .NET Framework 4.0

Please note that you need to have .NET Framework 4.0 installed before installing EASE Evac:

<http://www.microsoft.com/downloads/details.aspx?displaylang=en&FamilyID=9CFB2D51-5FF4-4491-B0E5-B386F32C0992>

B.1.2 EASE Evac Startup

First, please run the Setup file to begin the EASE Evac Startup application. Follow the instructions on the screen to install both EASE Evac and the AFMG Licence Manager.

B.1.2.a EASE Evac

This will create a folder for the program and place an EASE Evac icon on the Windows Desktop. The default location for this folder is (*C:\Program Files\AFMG\EASE Evac*) for 32-bit and (*C:\Program Files (x86)\AFMG\EASE Evac*) for 64-bit.

B.1.2.b AFMG Licence Manager

This will create a folder for the program and place an AFMG Licence Manager icon on the Windows Desktop. The default location for this folder is (*C:\Program Files\AFMG\AFMG Licence Manager*) for 32-bit and (*C:\Program Files (x86)\AFMG\AFMG Licence Manager*) for 64-bit.

B.1.3 EASE Evac User Files

Finally, run the EASE Evac User Certificate Setup file. Select **TYPICAL** to install with the preferred settings. This will make the software Licence available to all users of this computer. Select **CUSTOMIZE** to change this preset to a different location. The installer will then create a folder for the licence files and allow the AFMG Licence Manager installed above to register a Licence for the software.

B.1.4 Licensing the Software

EASE Evac is licensed via AFMG Licence Manager. It can be opened using the desktop icon or the Windows Start menu. After it has opened, just click on EASE Evac and then on **DOWNLOAD LICENCE**. Wait a few seconds for the confirmation message and it is done.



B.2 Licensing Instructions

B.2.1 Online Licensing

To further improve your comfort we have created a Licensing web application to run on our web server. It allows you to easily download an EASE Evac Licence via internet (being online with your EASE Evac computer assumed). This means the software sends the computer's reference information to our web application, which creates Licence information on our server. This information is then automatically downloaded and installed. So with a single button push on `DOWNLOAD LICENCE` you can unlock EASE Evac.

By subscribing to the Licence agreement you are entitled to install the program on one computer. After that installation, additional Licences must be purchased. Please see AFMG or your distributor for prices.

If you intend to uninstall EASE Evac from the original computer then please upload the Licence information from that computer by clicking on `UPLOAD LICENCE`. This will allow you to download this Licence again and then unlock EASE Evac on a different computer.

B.2.2 Licensing by File

You should only use this option if you are not able to use the online Licensing functions.

B.2.2.a Reference File

The Reference File is a file generated by the AFMG Licence Manager program and placed in the *My Documents* folder. This file is different for each installation. If you have more than one computer each will have its own Reference File. To order a Licence you must send the Reference File to AFMG (support@afmg.eu) by E-Mail.

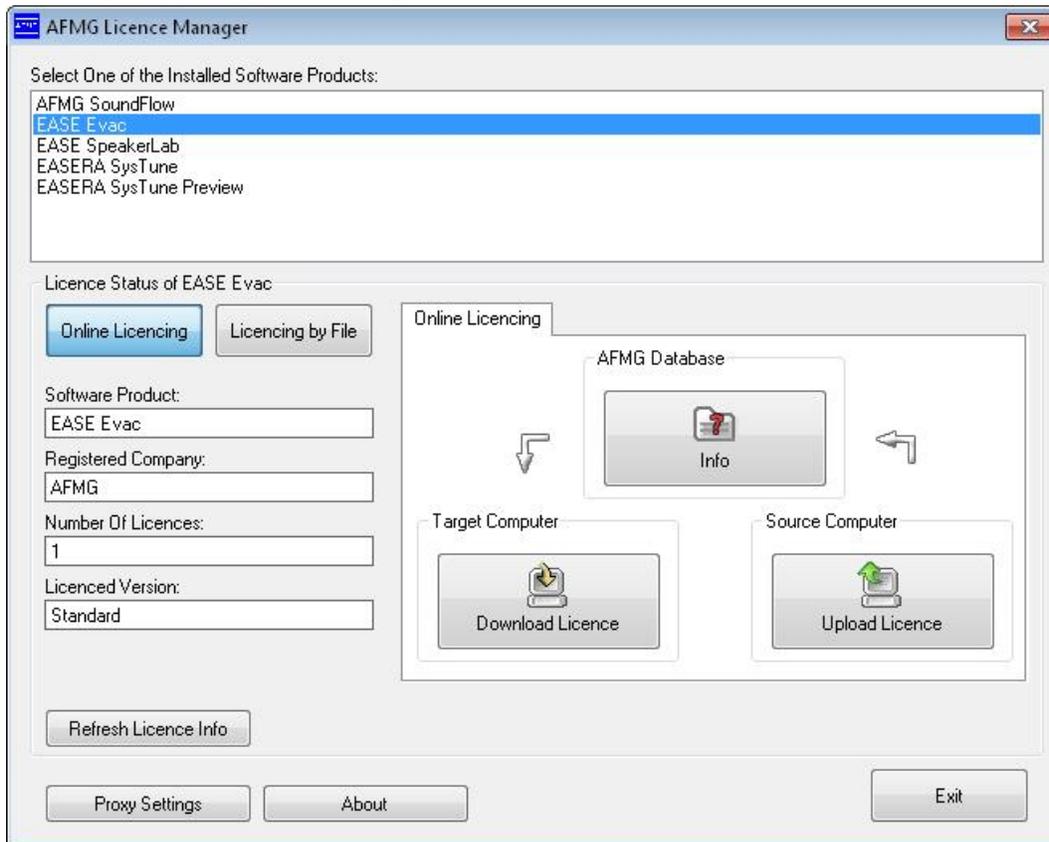
B.2.2.b Licence File

The Licence File is a file generated by AFMG, which is linked to the Reference File. The Licence File is supplied to you by E-Mail. Loading this file into the AFMG Licence Manager with `INSTALL LICENCE` unlocks the particular EASE Evac version purchased.

If you intend to uninstall EASE Evac from the original computer then remove the Licence information from that computer before by using the `TERMINATION. TERMINATE LICENCE` creates a Termination File which you must send to AFMG (support@afmg.eu) by E-Mail. This will allow you to order a new Licence for the terminated one and unlock EASE Evac on a different computer or computers. There can be only one operational program at the same time without additional Licences.

B.3 AFMG Licence Manager Program

This program allows the Licensing of EASE Evac.



- **PROXY SETTINGS:** Opens the Proxy Server Configuration window. It allows adjusting proxy server settings for online Licensing through a proxy server. See also:

Proxy Server Configuration Window

- **ABOUT:** Shows information about the currently installed AFMG Licence Manager.
- **EXIT:** Closes the AFMG Licence Manager window.

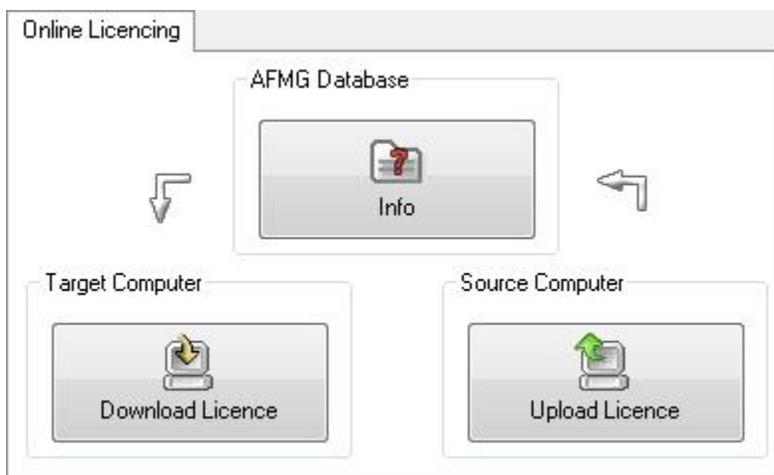
B.3.1 Licence Status

- **ONLINE LICENSING:** Shows the Online Licensing tab in the right part of the AFMG Licence Manager.
- **LICENSING BY FILE:** If it is not possible for you to be online with your computer an EASE Evac Licence can be ordered via email instead. To do that, generate a reference file and send this file to AFMG (support@afmg.eu). As a response you will receive a Licence file from AFMG which is needed to unlock EASE Evac.

This button enables three tabs in the right part of the AFMG Licence Manager labeled **LICENCE**, **TERMINATE**, and **IMPORT/EXPORT**. See below for instructions on how to use these tabs.

- **SOFTWARE PRODUCT:** This field shows the AFMG software product selected for Licensing.
- **REGISTERED COMPANY:** This field shows the company name for which the installed Licence is registered.
- **NUMBER OF LICENCES:** This field shows how many Licences are available on this computer.
- **LICENCED VERSION:** This field shows which software version is unlocked.
- **REFRESH LICENCE INFO:** Reloads the Licence information.

B.3.2 Online Licensing



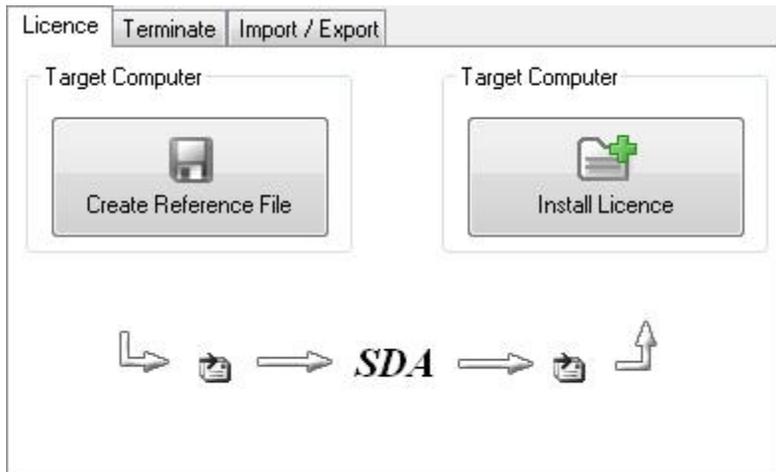
- **INFO:** Checks the EASE Evac Licence database on the AFMG web server and downloads information about the user registration, the purchased version and the number of Licences still available.
- **DOWNLOAD LICENCE:** Downloads one Licence from the AFMG web server. With EASE Evac it is not possible to have more than one licence on the computer.

- **UPLOAD LICENCE:** Terminates all available Licences. The Licences will be uploaded to the AFMG web server and will be available for new downloads later. If you intend hard disk manipulations or to buy a new computer you should use this procedure to prevent a Licence being lost. It just means a Licence backup for a certain time. After this procedure EASE Evac will reset to an unlicensed mode.

B.3.3 Licensing by File

B.3.3.a Licensing by File – Licence Tab

This tab allows a Licence to be installed on this computer. You should only use this option if this computer is not online and a Licence download is not possible.



- **CREATE REFERENCE FILE:** Creates a Reference File (*.erf format) to send to AFMG. To use the command:
 - Click on **CREATE REFERENCE FILE**.
 - This opens a **SAVE REFERENCE FILE** window after a confirmation message.
 - Use the **SAVE IN** portion of the window to select the folder where you would like to save the Reference File.
 - Click on the **SAVE** button.

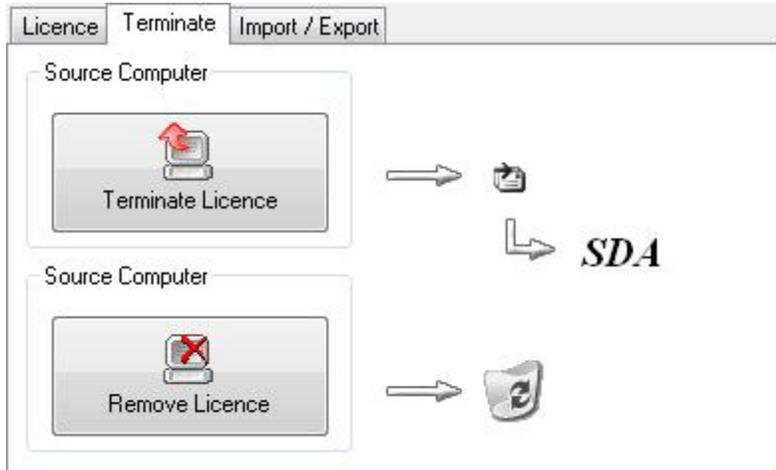
After saving the file, a "Send Email now?" prompt appears. Click on **YES TO** automatically send a Licence order with the reference file as an attachment using an installed email client (e.g. MS Outlook or MS Outlook Express) to AFMG. It is also possible to save the file and to mail it later attached to a Licence order to AFMG.

- **INSTALL LICENCE:** Click to load a Licence File (*.elf format) and install a Licence for EASE Evac. To use this command: Click on **INSTALL LICENCE**.
 - This opens an **OPEN LICENCE FILE** window.
 - Use the **LOOK IN** portion of the window to find the folder containing the Licence File.
 - Click on the Licence File name.
 - Click on the **OPEN** button.

If the reference signature in the Licence File matches this computer, the Licence will be installed. The Licence information and parameters will be shown in the Licence Status frame.

B.3.3.b Licensing by File – Terminate Tab

This tab allows a Licence to be uninstalled or removed from this computer. You should only use this option if this computer is not online and a Licence upload is not possible.



- **TERMINATE LICENCE:** Creates a Termination File (*.etf format) to send to AFMG. To use the command:
 - Click on **TERMINATE LICENCE**.
 - This opens a **SAVE TERMINATION FILE** window after a confirmation message.
 - Use the **SAVE IN** portion of the window to select the folder where you would like to save the Termination File.
 - Click on the **SAVE** button.

After saving the file, a "Send Email now?" prompt appears. Click on **YES** to automatically send the termination file as an attachment using installed email client (e.g. MS Outlook or MS Outlook Express) to AFMG. It is also possible to save the file and to mail it later to AFMG. There it will be verified and if it is correct you can order a replacement Licence any time for the terminated one. After this procedure EASE Evac will be reset to an unlicensed mode.

- **REMOVE LICENCE:** Click to remove all traces of the Licence on this computer.

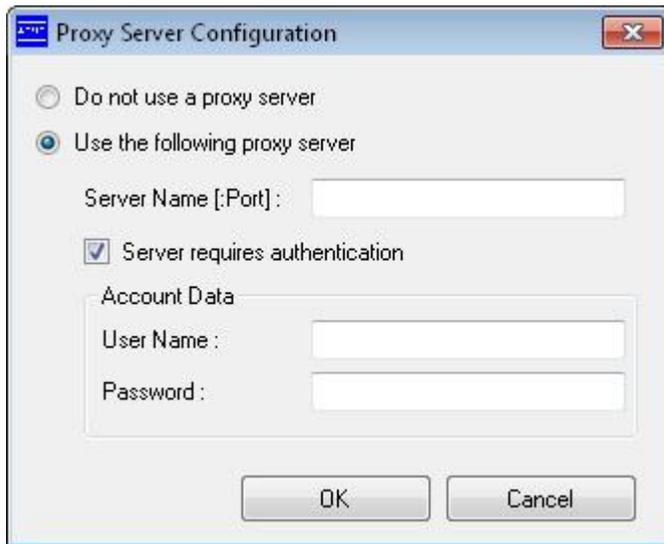
Note: Be very careful with this button! All Licence information will be deleted from the computer. This option should only be used in case of general Licensing problems due to software or hardware errors. Please contact AFMG before using this command or your EASE Evac Licence may be lost completely.

B.3.3.c Licensing by File – Import / Export Tab

This functionality is not supported by EASE Evac.

B.3.4 Proxy Server Configuration Window

If you are running EASE Evac in a secured intranet, access to the internet for online Licensing may be blocked by a firewall, depending on your network’s configuration. Configuring AFMG Licence Manager to use the local proxy server on your network may resolve this issue. If you are unsure of the appropriate proxy server settings, please consult your network administrator.



USE THE FOLLOWING PROXY SERVER

- **SERVER NAME [:PORT] :** Proxy server name or IP address and port number for internet access.
- **SERVER REQUIRES AUTHENTICATION:** Check if the proxy server needs an additional authentication.
- **ACCOUNT DATA:** USER NAME and PASSWORD to authenticate on the proxy server.
- **OK :** Accepts configuration settings and closes the window.
- **CANCEL :** Discards configuration settings and closes the window.