Cadna A®

State-of-the-art
noise prediction software

Reference Manual

Release 4.1

DataKustik

Greifenberg 2010

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Chapter 1 - Introduction

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CadnaA is a software program for the calculation and the assessment of noise and air pollution. The program fulfills the requirements for professional experts.

The software calculates and predicts the noise immission in the neighborhood of:

- commercial and industrial sites,
- sports and leisure facilities,

and of traffic systems like

- road and railways,
- airports and landing strips, or
- any other noisy facilities.

CadnaA is suitable for noise prediction in local studies as well as for detailed analyses of mapping noise scenarios in large cities (option **CadnaA**-XL). Powerful features include incredible screen displays, handling and output of graphical grids and the use of scanned bitmap plans (option **CadnaA**-BMP). **CadnaA** enables automatic optimization of barriers and the automatic allocation of noise quota (option **CadnaA**-BPL). Aircraft noise in the vicinity of airports, landing strips and related facilities is calculated with the additional option **CadnaA**-FLG.

The option **CadnaA**-APL („Air Pollution“) extends the range of application to the calculation, the assessment, and the presentation of air pollutants distribution.

Basic to all, **CadnaA** has the ability to import and export data from and to third-party software (e.g. ArcView, MapInfo, DXF, or from databases via the ODBC-interface).

The sound level during pass-by's with time history and auralization of moving sources, the different 3D-views of your project when moving through, the PCSP (Program Controlled Segmented Processing) to accelerate calculation of large projects, the groups and the ObjectTree are just some highlights of **CadnaA**.

1.1 Structure of CadnaA-documentation

The range of documentation provided with the **CadnaA**-software consists of the following parts:

Document	**Contents**
Introduction to **CadnaA**	installation, editing of objects, modes of calculation, modeling industrial, road, and railway noise, basic import features & grouping concept, Modify Objects & context menu actions/commands, **CadnaA**-options
CadnaA-reference manual (present manual)	detailed description of all dialogs and their options (sources, obstacles, topography, immission), configuration dialog, import/export, graphics/bitmaps, tables & libraries, project organization
CadnaA-manual „Attributes, Variables, and Keywords“	listings of object attributes, variables & keywords, handling of string operations, operators & functions, protocol abbreviations

Structure of this manual

The reference manual contains the documentation and description of all **CadnaA**-features, excluding the installation procedure, the input and the editing of objects, and the actions/commands on the dialog **Modify Objects** and on the context menu. Those features are explained in the introductory manual besides an introduction to all modes of calculation and all noise types.

Chapter 2 describes for each source type all available options on the corresponding object dialog, including short examples if necessary. The subchapters for each source type (industry, road, railway) start by a chapter explaining input data independent from the selected standard, followed by standard-specific explanations.

☝ Due to numerous standards and guidelines implemented in **CadnaA**, and with respect to the possible revision of national procedures between two software releases, **DataKustik** cannot guarantee in any case the actuality of the specifications given. Particularly, the specifications cannot substitute buying and studying the original paper. Indications on the official supplier can be found in the references (chapter 1.4 "Literature").

In chapter 3 to 4, the reference manual treats all obstacles including the topography.

In chapter 5 all types of noise evaluation in **CadnaA** are described. This includes: the receiver point, the area of designated, the horizontal and the vertical grid as well as the building evaluation. This chapter treats also the features of the option XL as there are, e.g.: the map of conflicts, the grid evaluation, the ObjectScan, and the population density.

Chapter 6 presents the principles of calculation applied in **CadnaA,** particularly with respect to the configuration settings.

The chapter 7 covers the handling of all import formats available in **CadnaA**.

Chapter 8 treats the use of a digitizing board for the input of object geometry.

The chapters 9 and 10 describe all available objects and procedures for producing a graphic output in **CadnaA**, as well as the features for import and scaling of external bitmaps.

Chapter 11 explains the features of the object's tables while chapter 12 covers their application within the local and global libraries.

The chapter 13 deals with the output of report files (for example in tabular form) or as a graphic printout using the **CadnaA**-PlotDesigner. This covers also the export of geo-referenced projects to GoogleEarth™.

Chapter 14 deals with all aspects of project organization, such as: the groups and variants, the ObjectTree, the multi-threaded calculation and the batch-processing using PCSP (Program Controlled Segmented Processing).

1.2 New Features of CadnaA 4.1

The list of new features in **CadnaA**, release 4.1, is subdivided into the following sections:

- calculation/configuration
- **CadnaA**-objects
- further new features/miscellaneous
- import
- export
- **CadnaA**-options
- bug fixing

Calculation| Configuration

- Nordic Prediction Method, Railway: calculation of maximum levels for LmaxF (in addition to LmaxM)
- new Swiss parking lot guideline implemented (SN 640 578:2006-07, Lärmimmissionen von Parkierungsanlagen - Berechnung der Immissionen)
- Austrian railway guideline ONR 305011, edition 2009, implemented (now using propagation model accord. to ISO 9613)
- new French guideline for road noise NMPB 2008 implemented
- Concawe & Harmonoise: via keyword CALCCONF several attributes for meteorology specifiable (wind speed and direction, stability class)
- QSI-statistics: now applicable to „Points on Iso-Lines“

CadnaA-Objects

Road/Traffic Light

- object "Crossing w/ Traffic Light": deviating distances and penalties (up to 25 m: + 2 dB, up to 50 m: + 1 dB); will be applied with STL86+ or SonRoad selected (Switzerland)

Building Noise Map & Facade Points

- dialog **Building Noise Map**: new option "Use rounded values"

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Further new features

- new library-object **Color Palette** (menu **Tables|Libraries (local/global)**: Color palettes can be assigned to the evaluation parameters via dialog **Grid|Appearance** or to object types via dialog **Appearance** (**Options** menu) for the graphic representation.
- dialog **Grid|Appearance** (horizontal and vertical grids): new button "Apply"
- dialog **Options|Appearance**: option "Show Object type" is now saved
- dialog **ObjectTree**: status of ObjectTree-structure is saved to file
- dialog **ObjectTree**: new buttons for „Expand“ and „Collapse“ of ObjectTree-structure being displayed
- dialog **PlotDesigner** (Caption Preview): as before (save structure, Expand/Collapse)
- dialog **Group** shows indents as on dialog **ObjectTree**

Miscellaneous

- new keyword #(GLK, stw): exports the storey selection for the Building Noise Map
- new keyword #(RST, dx) dy, z: exports the settings for grids
- new attribute DISP_TEXT ("displayed text"): text of labels which has been generated using an assignment can be converted into „plain“ text
- dialog **Group**: location and size is saved only restart

Import

- ODBC-import: failing ODBC-connection can be reset (hold CTRL-key depressed while selecting the command **Database|Definition**)
- geo-referenced ERS-files (Bitmaps) can be imported using option BMP (from ERDAS ER Mapper)

Export

- KML-export to GoogleEarth now with optional export of object attributes (option BMP)

CadnaA-Options

- BMP: geo-referenced ERS-files (Bitmaps) can be imported using option BMP (from ERDAS ER Mapper)
- BMP: KML-export to GoogleEarth now with optional export of object attributes
- CALC: **Batch-Only** menu available to select batch directory
- FLG: fill the geometry of air routes up to a radius of 25000 m
- FLG: new option "Military Designation" for airports (in conjunction with ICAN/AzB08)
- FLG: export of AzB08-noise contours as txt-file
- FLG: evaluation of maximum levels for aircraft noise, evaluation parameter „FlgStat D/E/N“ (arousal reaction accord. to *Griefahn* and DLR)
- FLG: threshold level with predefined number of exceedances available within the evaluation of maximum levels
- FLG: new evaluation parameter „SigmaFlgStat D/E/N“ (standard deviation of arousals)
- FLG: QSI-AzB enables now years to be assigned within the Sigma-statistics
- FLG: epsilon values (correction factors for sigma-calculation) extended by 2 to 5 years
- FLG: KML-export of air routes and radar tracks

Bug Fixing

- no crash when copying the ResultTable
- Pass-By: considers now self-screening option
- CRTN: condition that a reflector must be at least 1.5 m above the road’s surface is now considered.

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1.3 Notations

The following table comprises all types of notations used in the **CadnaA**-documentation.

`setup`	text to be typed in
RETURN, CTRL, DEL	keyboard keys
CTRL+v	key combinations
	(e.g.: hold down the CTRL-key while typing the letter v)
down arrow key	arrow keys
	(move cursor to left/right/up/down)
Program Files/Datakustik	directories
Grid|Appearance, 3D-Special	menus and commands
„Geometry“, „TransLoss“	buttons in dialogs and other options in dialogs
double-click, double-clicking	Instructs you to rapidly press and release the left mouse button twice.
•	The focal point requires an action or a sequence of actions.
☝	remark or comment
🗁 Examples\ 04_Topography\HP.cna	reference to file on the **CadnaA**- CD. Used the indicated file path to open the file.

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1.4 Literature

Standards, Guidelines, and Reports

International

/1/ Concawe-report no. 4/81, „The propagation of noise from petroleum and petrochemical complexes to neighbouring communities“, (Ref.AT 931), CONCAWE, Den Haag May 1981

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/4/ Development of the HARMONOISE Point-To-Point MODEL, Prediction of Excess Attenuation in Outdoor Noise Propagation, presentation slides by Dirk van Maercke/CSTB, presented at Meeting Norwegian Acoustical Society, Kristiansand, 08.09.2006.

/5/ ECAC DOC 29: European Civil Aviation Conference Document 29, „Report on Standard Method of Computing Noise Contours around Civil Airports“, 2nd edition, 1997

/6/ ISO 3744 Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering method in an essential free field over a reflecting plane

/7/ ISO 9613, Acoustics - Attenuation of sound during propagation

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outdoors,
Part 1 (1993-06): Calculation of the absorption of sound by the atmosphere,
Part 2 (1996-12): General method of calculation,
ISO International Organization for Standardization, Geneva (CH)

/8/ ISO 717: Acoustics - Rating of sound insulation in buildings and of building elements,
Part 1: Airborne sound insulation (ISO 717-1:1996)
Part 2: Impact sound insulation (ISO 717-2:1996);
ISO International Organization for Standardization, Geneva (CH)

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/11/ EN 12354: Building Acoustics - Estimation of acoustic performance of buildings from the performance of products,
Part 1 (1999): Airborne sound insulation between rooms;
Part 2 (1999): Impact sound insulation between rooms
Part 3 (1999): Airborne sound insulation against outdoor sound

Germany

/12/ RLS90, Richtlinien für den Lärmschutz an Straßen (Guidelines for Noise Control at Roads, in German); Der Bundesminister für Verkehr, Abteilung Straßenbau, Ausgabe 1990, Verkehrsblatt 44 (1990)

/13/ Richtlinien für die Anlage von Straßen RAS (Guidelines for the construction of roads, in German), Teil: Querschnitte RAS-Q Ausgabe 82, Forschungsgesellschaft für Strassen- und Verkehrswesen, Arbeitsgruppe Strassenentwurf

/14/ Richtlinien für die Anlage von Straßen RAS (Guidelines for the construction of roads, in German), Teil: Querschnitte RAS-Q 96, Forschungsgesellschaft für Strassen- und Verkehrswesen, Arbeitsgruppe Strassenentwurf

/15/ Rechenbeispiele zu den Richtlinien für den Lärmschutz an Straßen RBLärm-92 (Calculation Examples concerning the Guidelines for Noise Control at Roads, in German), Der Bundesminister für Verkehr Abteilung Straßenbau, Ausgabe 1992

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27. Dezember 2008 (BGBl. I S. 2980)

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Chapter 2 - Sound Sources

General Sources

Sound sources, the emission of which is described based on the sound power level are called "general sources". In **CadnaA**, the emission of general sources (such as point, line, and area sources) can be described by single number ratings (sound power level PWL in dB(A)) or by spectra (linear, or with A-, B-, C- or D-weighting) and for the three time periods Day/Evening/Night separately. When both emission types are present within a project, both are included in the calculation at the same time. Within a spectral calculation the sound pressure level or any other evaluation parameter (see chapter 6.2.5) at the receiver point is calculated as a spectrum (linear or A-, B-, C- or D-weighted) and as a sum level in dB(A).

Spectra are entered in the local or global libraries (see chapter 12.1), and are referred to in the edit dialog of the source by entering their ID (see manual „Introduction to **CadnaA**“).

Parametric Sources

The emission parameter of „parametric sources“ is not the sound power level, but several source type specific parameters. For example, the following sources are parametric sources:

- road (see chapter 2.4)
- railway (see chapter 2.6)
- parking lot (see chapter 2.7)
- crossing with traffic lights (see chapter 2.5)
- tennis point of service (see chapter 2.3)

Those source types require to specify an emission parameter which is specific to the standard/guideline or, for example the overall traffic count, the percentage of heavy vehicles, the type of road surface, and the traffic speed where the emission parameter is calculated from.

The input figures can be specified for the three time periods Day/Evening/Night even when the selected standard just provides only one or two time periods.

The input of objects is explained in the manual „Introduction to **CadnaA**“.

2.1 Industrial Sources

The general source types, such as point, line and area sources (horizontal and vertical), are used to model a variety of noise sources including also the building radiation. Moreover, they may receive an individual directivity (see chapter 2.2).

When applying these sources to mode the sound radiation from buildings the object snap is activated in order to place them in front of the building's facade at a distinct distance (see chapter 9.4). This prevents from the source being placed inside the building.

see chapter 2.1.1 "Common Input Data" for detailed information on the common parameters of the general sound sources.

Point Source 

A point source is entered at the position of the mouse pointer with a mouse click at the desired location. The point source is represented by a cross.

Point sources are noise sources whose dimensions are small in comparison to the distance to the receiver points. Examples are ventilation openings, pumps, motors, and people shouting.

Line Source 

Line sources are modelled as open polygons. Line sources have one dimension only, while the dimensions in the other two orthogonal dimensions are small compared with the distance to the receiver points. Examples are pipelines, conveyor belts, and traffic routes on a factory site.

Upon calculation, **CadnaA** subdivides the line source in a two-step procedure. First, the line source is subdivided into sections being screened and sections not being screened by any obstacles lying between the receiver and the sub-source (see chapter 6.1.3 "Projection at extended Sound Sources"). In a second step, the distance between the receiver and each section is determined and a further subdivision is required if the section length exceeds the minimum distance criterion.

Area Source

Area sources are modelled as closed polygons. They are noise sources extending in two dimensions while the third dimension perpendicular to its area is small in relation to the receiver distance.

CadnaA subdivides upon calculation the area sources into sufficiently small sub-areas. In the centre of each sub-source a point source with the appropriate partial sound power is placed. This procedure results in a fine grid of point sources, the total emission of which represents the area source.

horizontal Area Source

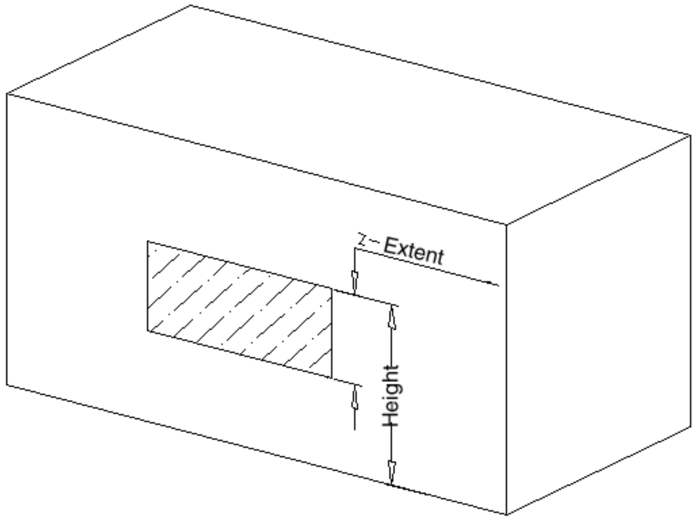
Horizontal area sources are inserted by entering their horizontal projection.

Examples of area sources are parking lots (see chapter 2.7), sports facilities, and even entire industrial or commercial areas.

vertical Area Source

Vertical area sources are inserted by entering their horizontal projection as an open polygon line.

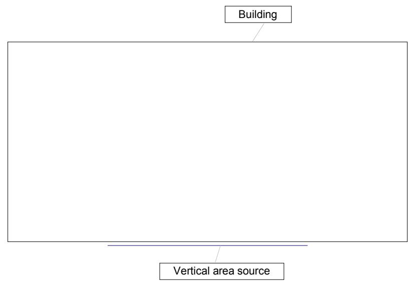
Upon calculation, **CadnaA** subdivides the area source in a two-step procedure. First, the area source is subdivided into partial areas being screened and partial areas not being screened by any obstacle lying between the receiver and the source (see chapter 6.1.3 "Projection at extended Sound Sources"). Then, in the second step, the distance between the receiver point and each partial area is determined and a further subdivision is required if the largest dimension of a partial area exceeds the minimum distance criterion.



Geometric definition of the vertical area source

In order to enter a window (as illustrated above) as a sound-radiating area, enter a vertical area source as a polygon line in xy-plane at a short distance in front of the facade. For a clear distinction, a distance of approximately 0.05 m is used. This distance is automatically set via the dialog **Object Snap** (**Options** menu) prior to the input of the vertical area source (see chapter 9.4 "Object Snap")

2



Vertical area source in front of a facade

On the edit dialog of the vertical area source specify the position of the top edge via button **Geometry**. As with any other object, this height may be defined as relative or absolute value, or with respect to the roof of a building. The latter is particularly convenient when entering e.g. ventilators placed onto a roof. The lower edge of the vertical area is specified as „z-dimension“ downwards from the top edge. More complicated outlines of vertical sound-radiating areas can be approximated by several rectangular areas.

Upon calculation, the vertical area source is replaced by a series of line sources with a spacing of 1 m. These are subdivided into sections as described above.

☝ The subsequent chapters are specific for each standard or guideline available in **CadnaA**. These specifications do not represent a copy of the standardized procedures, rather the way they are implemented.

2.1.1 Common Input Data

On the dialogs **Point Source**, **Line Source**, **Area Source** and **vertical Area Source** the following values and settings govern the resulting sound power level:

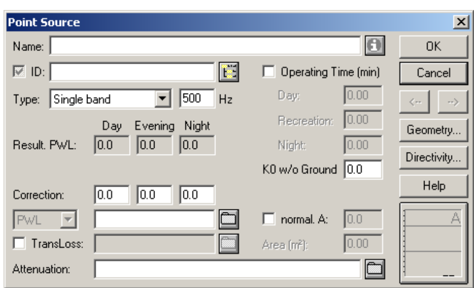
- Type
- Hz
- Correction
- PWL, PWL’, PWL’’, PWL-Pt
- TransLoss
- Attenuation
- Area (m²)
- normalized A

The sound power level is calculated from these parameters and displayed for the time periods Day/Evening/Night.

Lw-Type

Depending on the source type the emission can be specific for the following „types“ of sound power levels (attribute „LWTYP“):

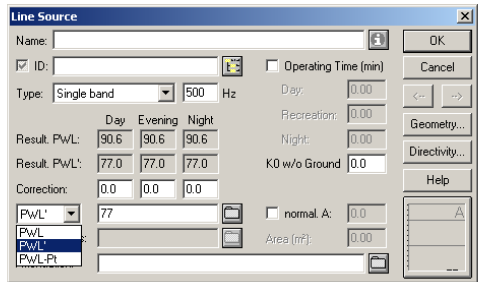
- with point sources: by the sound power level PWL in dB(A),



Dialog **Point Source**

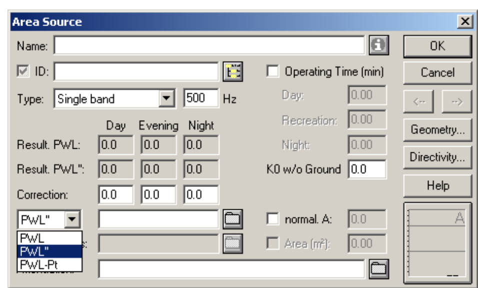
2

- with line sources: by the sound power level PWL in dB(A), by the sound power level per unit length PWL’ in dB(A), or by the sound power level PWL-Pt of a moving point source (default setting: PWL'),



Dialog **Line Source** with list box „LWTYP“ opened

- with area sources: by the sound power level PWL in dB(A), by the sound power level per unit area PWL’’ in dB(A), or by the sound power level PWL-Pt of a moving point source (default setting: PWL’’).



Dialog **Area Source** (horizontal) with list box „LWTYP“ opened

The input box to the right of the list box for the emission type (attribute LWTYP) may contain a single number, a reference to a spectrum, or a combination of both, or even an equation.

Type

Via list box „Type“ it can be switched between „Single band“ and „Spectrum“.

Single band / Frequency (Hz)

With selection „Single band“ the sound power level entered under PWL, PWL’, PWL’’, or PWL-Pt is considered as the A-weighted total level. In this case, for frequency dependant propagation parameters (e.g. air absorption) the resulting values is calculated for the frequency specified. Default frequency value is 500 Hz (see ISO 9613-2, section 1 /7/).

Spectrum

With selection „Spectrum“ the sound power level entered under PWL, PWL’, PWL’’, or PWL-Pt is considered as A-weighted level per octave band. In this case, the displayed sound power level PWL („Result. PWL“ in dB(A)) results from adding 10 lg 9 = 9,5 dB for 9 octaves.

Alternatively - and this is the common procedure in conjunction with using spectra - instead of a figure an ID-code of the respective spectrum is entered or selected.

Example for „Spectrum“

- Enter the local library (see Chapter 12 - Libraries) via **Tables|Libraries (local)|Sound Levels** the following sound power spectra:

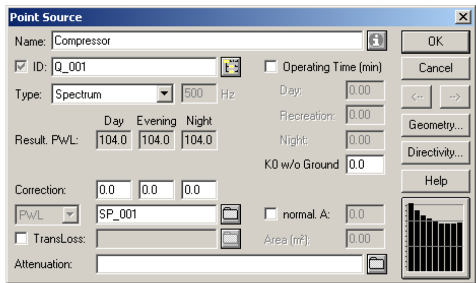
Name	ID	Type	Oktave Spectrum (dB)												Source
			Weight.	31.5	63	125	250	500	1000	2000	4000	8000	A	lin	
Kompressor 1	SP_001	Lw		133.9	120.7	110.6	103.1	97.7	94.5	93.3	93.5	95.6	104.0	134.1	
Kompressor 2	SP_002	Lw		87.0	88.0	89.0	91.0	90.0	89.0	86.0	84.0	95.6	97.1	99.7	

- On the point source’s dialog select for „Type“ the option „Spectrum“ for spectral calculation.
- Enter the ID-code „SP_001“ of compressor 1 into the box PWL. This refers to that spectrum.
- The text sequence SP_001 may either be entered via the keyboard or be selected from the local library by clicking the file selector symbol, subsequently selecting the first data set and clicking OK.

- Access to the global libraries as achieved by clicking the file selector symbol while keeping the SHIFT-key depressed.

- Upon selection of a spectrum from the <u>global</u> library the data set is copied automatically to the local library while its ID-code is transferred to the PWL-input box of the source dialog.

In this example, after having selected the compressor spectrum the resulting A-weighted sound power level (Result. PWL) and the spectrum shape are displayed, the latter in the lower right corner of the dialog **Point Source**.



Dialog **Point Source** with referencing to spectrum-ID SP_001

- Now, upon clicking again to the file selector symbol and selecting a different spectrum, the former reference will be replaced by the new one.

In case a second spectrum should be added energetically to the first one, considering the rules of level summation, press the CTRL-key prior to selection of the second spectrum. This causes the second spectrum to be entered with the operator ++ in front being the symbol for energetic level summation (for further operators see the **CadnaA**-manual „Attributes, Variables, and Keywords“, chapter 6.2 "Operators and Functions").

This summation formula can also be entered via the keyboard. During typing the red text indicates that the formula is not complete or cannot be evaluated, respectively.

- Formulas in the input box „PWL“ are restricted to 15 characters.

2

Spectrum Monitor

The spectrum monitor at the bottom right corner of the source dialog displays the frequency spectrum in from of bars. Clicking the diagram cycles among no weighting (i.e. linear) and A-, B-, C- or D-weighting. With this switching the emission of the source remains.

Result. PWL

When the sound power level per unit length PWL, is entered for a line source or the sound power level per unit area PWL'' is entered for an area source, the total sound power level resulting from the dimensions of that source is displayed here (excluding the correction for operating time and the directivity index K0/DΩ). This sound power level is used as the emission characteristic of the source within the calculation of sound propagation.

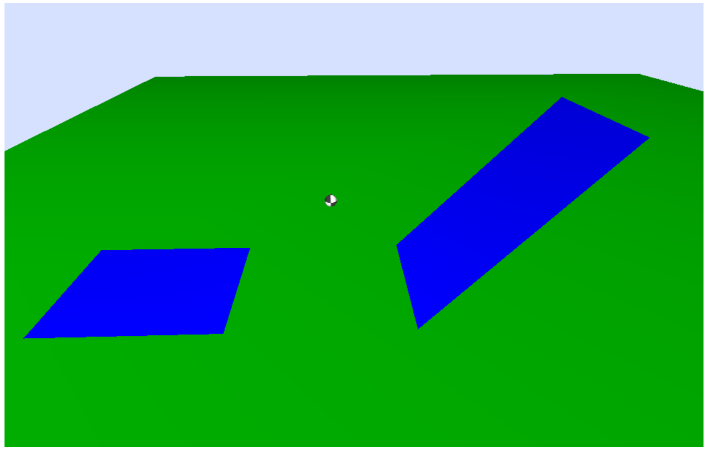
As the height of the terrain at the polygon points of the source is not known when the values are entered, this total sound power level refers, with relative heights, to the horizontal projection of the source. Consequently, this will not be correct for inclined line or area sources. Upon calculation, however, the absolute heights at the polygon points is updated and the correct total sound power level is determined.

Inclined Sources

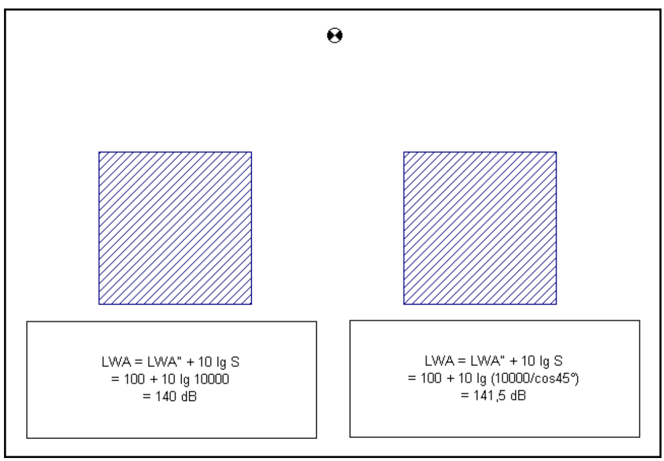
When entering the sound power level per unit length or unit area for inclined line or area sources, the heights of which are given as relative coordinates, the total value displayed for „Result PWL“ is not yet correct as the increased radiating area due to the incliniation of the source is not considered so far. However, this will the case when the dialog is closed and reopened.

Example:
inclined area source

2



Plane area source and inclined area source (by 45 degrees),
both having the same 2D-ground plane



Resulting sound power level of a plane area source (left) and of a
by 45° inclined area source (right), both having the same 2D-ground plane

Correction

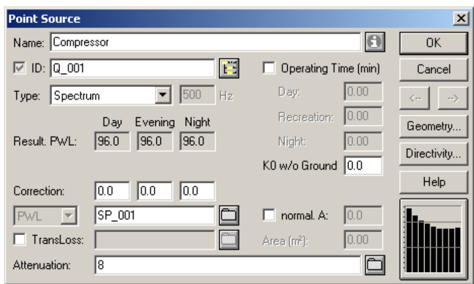
To consider different emissions for the time periods Day, Evening, and Night specify a correction for each of these periods. The correction entered will be added to the sound power level.

Attenuation

Via the „Attenuation“ box a value can be entered which will be considered as an additional damping of the source’s emission. Furthermore, attenuation spectra from the local and global libraries can be referenced. The entered or referenced attenuation will be subtracted from the sound power level.

Example

After the compressor (with PWL=104 dB(A)) of the recent example a silencer with an additional attenuation of 8 dB is installed.



Dialog **Point Source** with an attenuation of 8 dB

- Enter in box „Attenuation“ the figure 8, resulting in a sound power level („Result. PWL“) of 96 dB(A).

Applying Equations

The attenuation input box may also receive complex formulas or the ID of a spectrum.

☝ Formulas for „Attenuation“ are restricted to 63 characters.

For example, several attenuations may attenuate the sound power radiated (e.g. pipe elbows, changes in cross section, fittings, and silencers). This sum of attenuations may be described by, e.g.: 8+4+3.5+2.

2

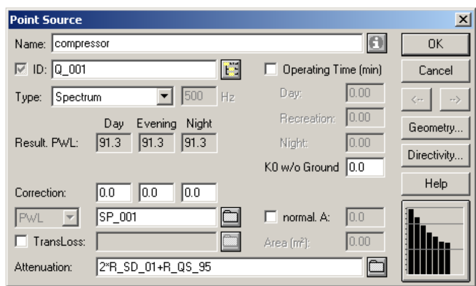
Of course, the total attenuation could be entered by a single figure directly, but the specification as a sum illustrates more obviously the individual attenuations contributing and also will be listed in the respective column of the source table. The line offers to enter even more complex formulas, such as: ((8+4+3.5+2)++23)-19.

As described for other input boxes, ++ stands for the energy-equivalent (or level) addition, and -- for the level subtraction (see also **CadnaA**-manual „Attributes, Variables, and Keywords“, see chapter 6.2 "Operators and Functions").

Referencing Attenuations

Furthermore, arbitrary damping spectra from the local or global library (see Chapter 12 - Libraries) can be referenced via the input box „Attenuation“.

In the subsequent figure, the attenuation spectra of two changes in cross section and a silencer are combined:



Combined attenuations on dialog **Point Source**

Sound Power of a moving Point Source PWL-Pt

The line or the horizontal area source may be used to model the emission of a moving point source (emission type option: PWL-Pt).

2

When using a line source, the sound power level of the point source, the number of events per hour Q (number of pass-bys) and the speed (in km/h) have to be specified. The resulting sound power level PWL and the sound power level per unit length PWL' calculate from:

$$PWL = PWL_{Pt} + 10\lg\frac{Q}{(h^{-1})} + 10\lg\frac{l}{(m)} - 10\lg\frac{v}{(km/h)} - 30\ dB$$

$$PWL' = PWL_{Pt} + 10\lg\frac{Q}{(h^{-1})} - 10\lg\frac{v}{(km/h)} - 30\ dB$$

With area sources, the sound power level of the point source and the number of events Q are required. The resulting sound power level PWL and the sound power level per unit area PWL'' calculate from:

$$PWL = PWL_{Pt} + 10\lg\frac{Q}{(h^{-1})}$$

$$PWL'' = PWL_{Pt} + 10\lg\frac{Q}{(h^{-1})} - 10\lg\frac{S}{(m^2)}$$

Example

see manual „Introduction to **CadnaA**", chapter 6.2 "Internal Driveways and Areas"

normalized A

With this checkbox „normal. A" activated and a number entered, a constant K in dB is subtracted from or added to the frequency-band levels resulting from the specified PWL in order to obtain this value for the total A-weighted sound power level. This option enables the application of normalized spectra (with a total sum level of 0 dB) the final emission value of which is specified be entering the respective value in input box „norm. A".

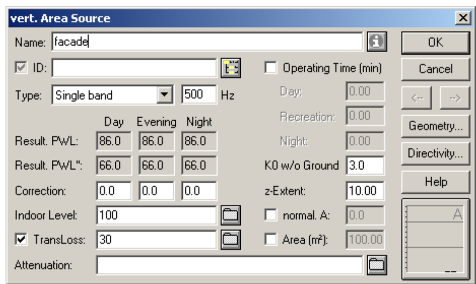
2

Transmission Loss

All types of general sources described above can be applied to model the sound radiation from buildings. In order to specify the radiated sound power based on the (diffuse) interior level SPL activate the option „TransLoss“. Subsequently, the emission type (Lw-type) switches to „Interior Level“.

Enter an interior level and in the box „TransLoss“ a single number rating (weighted sound reduction index R_w or STC) or the ID-code of a sound reduction index spectrum. All techniques for the selection of spectra from the libraries and the handling of user-defined formulas apply as before.

☝ Formulas in the input box „TransLoss“ are restricted to 15 characters.



Dialog **vertical Area Source** (radiating area S=100 m²),
Transmission Loss specified by a single number rating

The resulting sound power level PWL is (S_0=1 m²):

- for spectral sources (S_0=1 m²):

$$L_{wA} = L_{pA} - R(f) - 6\ dB + 10\lg\frac{S}{S_0}$$

- for sources based on the A-weighted sound power level (S_0=1 m²):

$$L_{wA} = L_{pA} - R_w - 4\ dB + 10\lg\frac{S}{S_0}$$

☝ The calculation follows the rules given in the VDI guideline 2571 (edition 8.1976) /32/. With this it assumed: $R_A = R_w - C = R_w - 2$ dB (with the spectrum adaptation term C according to ISO 717-1 /8/).

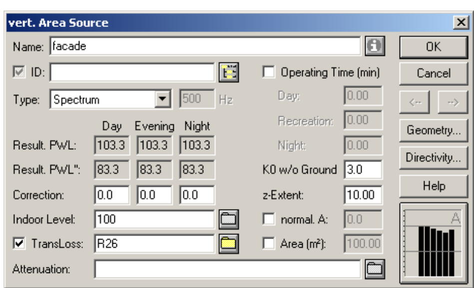
When the option „TransLoss“ is activated and the transmission loss is zero a value of zero has to be entered. Within this box being empty no radiated sound power results.

Additionally, with point and area sources an area (m²) has to be entered in the respective box as this value is not available from the object’s geometry data (see the subsequent section).

Example for spectral Sound Reduction Index

- Select for the sound insulation of the facade in the previous example the spectrum „steel sheet with trapezoidal corrugations 45 mm“ from the global library (menu **Tables|Libraries (global)|Sound Reduction** (ID: R26).
- To this end, click on dialog **vertical Area Source** with the SHIFT-key depressed on the file selector symbol to the right of the input box „TransLoss“.
- Select the spectrum with ID „R26“ and click OK.
- Switch the emission type from „Single band“ to „Spectrum“.

The sound power level and its spectrum as resulting from the input data is displayed.



Dialog **vertical Area Source** (radiating area S=100 m²),
Transmission Loss specified by referencing a sound reduction spectrum

2

Area (m²)

With point and line sources a radiating area has to specified when modelling sound radiation based on the indoor level. To this end, click the check box, and enter the relevant area. With horizontal or vertical area sources are respective value is required just when the actual radiating area differs from the geometrical area of the area source.

Example

The sound radiation from a glazed facade within a heavy outer wall is modelled by a vertical area source in front of the entire wall. In order to ignore the radiation from the heavy parts of the facade just the area of the actual glass facade is entered.

When the option „Area (m²)" is not activated, **CadnaA** considers the entire area source as derived from the object's geometry in the calculation.

☝ Check for the value of „Result. PWL". As long as it is zero, parameters are still missing, for instance, with calculations based on the indoor level either the area or the sound reduction index/TL.

The length (m) of the line source and the area of the area source (m²) can be checked via the dialog **Geometry**. For a vertical area source - drawn from two polygon points - this value is zero as this area entered refers to the horizontal projection (2D-area). Instead, the area of vertical area sources can be seen after a calculation in the box „Area (m²)" on the edit dialog.

The length of a line-like object can be specified in an exact way (see manual „Introduction to **CadnaA**", context menu command „Specify Length"). and chapter 3.1.4 "Generate a Building" in this manual.

Operating Time

By default, the option „Operating Time" is deactivated. Consequently, no operating time correction is applied. In this case, the specified sound emission is emitted permanently during the entire reference time interval (see chapter 6.2.4). The penalties as entered on tab „Reference Time" (**Calculation|Configuration** menu) are only applied for so-called combined evaluation parameters (such as Lden, Lde, Ldn, Len, see chapter 6.2.5).

When this option is activated the time intervals as specified for „Day/ Recreation(Evening)/Night" are the effective operating times of the source being considered within the calculation. In this case, the time correction results from the operating time/s specified and the respective reference times of each time period (menu **Calculation|Configuration**, tab „Reference Time"). This procedure offers sufficient flexibility for any kind of assessment.

see also:

- Special Reference Time for Industry, see chapter 6.2.4 "Reference Time Tab"
- Compatibility Mode for Industry, see chapter 6.2.5 "Evaluation Parameter Tab".

2

K0 without Ground

solid angle correction K_0 (dB) accord. to VDI 2714 /33/ or the directivity index D_Ω accord. to ISO 9613 /7/

The excess level in the direction of sound radiation due to reflecting surfaces close to the source can be accounted for by a global correction, the solid angle correction K_0 or the directivity index D_Ω. Since the ground reflection is already accounted for within the calculation according to ISO 9613-2, just the remaining reflecting surfaces are to be considered when determining the value of K_0 (thus called „K0 without Ground“, i.e. ignoring the ground).

Examples for K_0 / DΩ

Source Location	K0 / DΩ without Ground (dB)
Source at any height above the ground (solid angle: 2π)	0
Source at any height above the ground in front of a wall (solid angle: π)	3
Source at any height above the ground in a corner (solid angle: π/2)	6

In case of K_0 or DΩ > 0 the reflection from the building itself (i.e. reflector near the source) must not be included as the excess level is already accounted for by the correction K_0 resp. DΩ. In order to maintain the building’s reflective properties for all other sound sources the „Minimum Distance from Source to Reflecting Object“ specified via menu **Calculation|Configuration**, tab „Reflection“ (see chapter 6.2.8), has to be larger than the distance of the source in front of the facade (e.g. 0.5 m).

see chapter 4.1 "Object’s Geometry", section "Roof"

2.1.2 ISO 9613

Beyond the source characteristics as specified in chapter 2.1.1 "Common Input Data" no further parameters are to be considered with the application of this standard.

☝ The national editions of ISO 9613 may state further application notes (e.g.: /7/ /49/).

2.1.3 Nordic Prediction Method 1996

Beyond the source characteristics as specified in chapter 2.1.1 "Common Input Data" no further parameters are to be considered with the application of this standard.

2.1.4 Ljud från vindkraftverk

2

Beyond the source characteristics as specified in chapter 2.1.1 "Common Input Data" no further parameters are to be considered with the application of this standard.

2.1.5 BS 5228

Beyond the source characteristics as specified in chapter 2.1.1 "Common Input Data" no further parameters are to be considered with the application of this standard.

2.1.6 Harmonoise

Beyond the source characteristics as specified in chapter 2.1.1 "Common Input Data" no further parameters are to be considered with the application of this standard.

2.1.7 Concawe

Beyond the source characteristics as specified in chapter 2.1.1 "Common Input Data" no further parameters are to be considered with the application of this standard.

2

2.1.8 Further Procedures for Industrial Noise

Information on the following standards or guidelines for industry can be found in the German version of the **CadnaA**-reference manual:

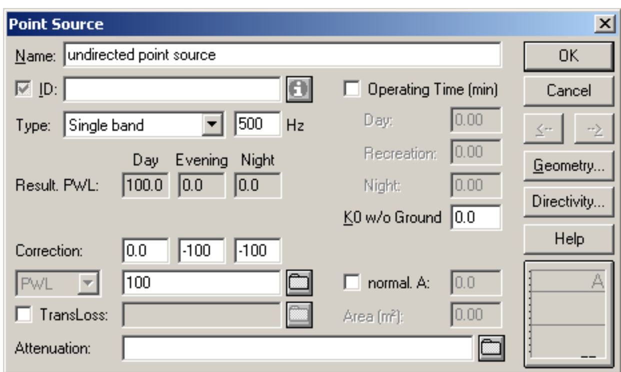
- VDI 2714/2720 (Germany)
- DIN 18055 (1987, Germany)
- OEAL 28 (1987, Austria)

2.2 Directional Sound Radiation

Not all sound sources radiate sound uniformly in all directions. There is, for example, a directivity of the radiated sound for power-plant chimneys, which depends on the exhaust velocity of the gas and its temperature. But there are many other examples, such as the ground run-up of aero engines in a test facility, or the blow-off from valves, where the sound pressure level is not the same for all directions and not only a function of the distance.

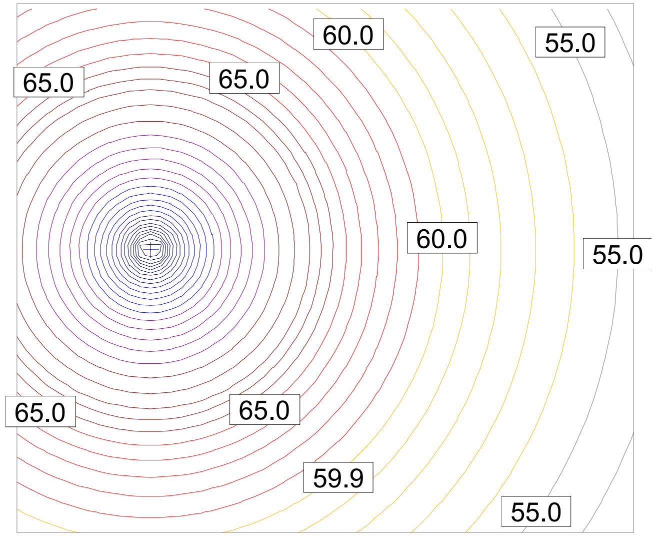
In order to account for this fact, directional sound radiation was integrated into **CadnaA**, both in a general way and for specific source types.

When a point source is specified, the pertinent option button in the edit source dialog lets you assign a directivity to that source.



Point Source Edit Dialog

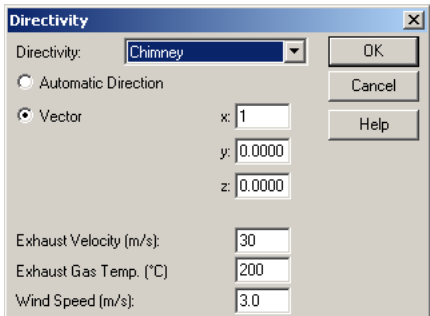
Performing a grid calculation with the inputs shown in the dialog above will produce the following graphic.



Omnidirectional radiation from a point source

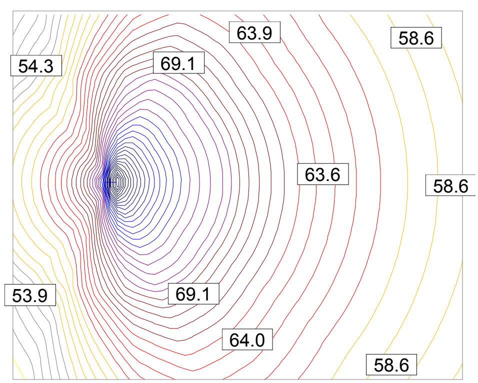
2.2.1 Sound Radiation from Chimneys or Stacks

Chimney mouth directivity is integrated according to an older publication /38/. After clicking the button „Directivity“ on the dialog **Point Source** specify the principal axis of sound radiation as the positive x axis (x/y/z = 1/0/0) and select the directivity of a chimney. Specify an exhaust gas velocity of, e.g. 30 m/s, and a temperature of 200 degrees.



Dialog for the calculation of the directivity of a power-plant chimney

With all other data of the point source left unchanged, the following graphic will result from the calculation.

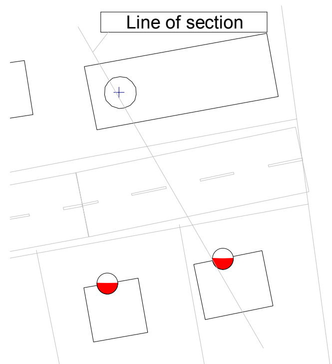


Radiation pattern of chimney tilted to the horizontal plane - parameters as above

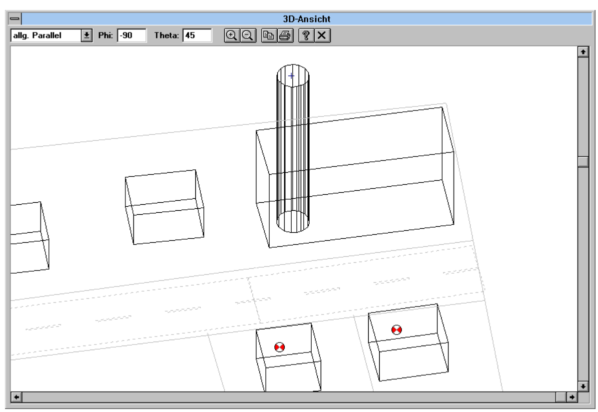
2

In practice, the point source will be positioned at the centre of the cross section chimney of the outlet, and the principal direction of radiation will be the normal vector on this outlet cross section, pointing upwards, (x/y/z = 0/0/1). If no vector is defined, the flow upwards is automatically chosen.

For the following simplified scenario, the chimney outlet is assumed to be at a height of 30 m.



Horizontal projection with residential buildings and power plant with 30-m chimney



Oblique view of the (simplified) power plant and chimney

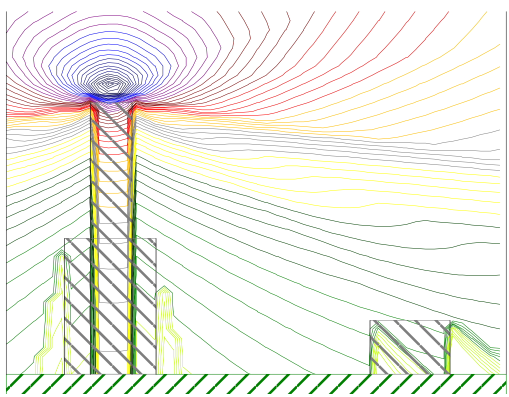
2

As the chimney directivity pattern includes the screening by the chimney itself. It would, therefore, be wrong to attach this directivity to a point source when this point source is screened by the chimney cylinder in addition. Thus, the shielding by the cylinder shall be suppressed when the predefined chimney directivity pattern is used.

For example, to model a chimney of 30 m height proceed as follows:

- Enter a cylinder with radius and height of the chimney and define it to be reflective if necessary.
- Enter a point source in the center of the cylinder (chimney) with the height of 0.01 m less than the cylinder's height. So, that the point source is placed inside (dialog **Geometry**).
- On menu **Calculation|Configuration**, tab „Industry“ activate the option „Source in Building/Cyl. do not shield“ (see chapter 6.2.9).
- Select the default directivity pattern „Chimney“ from the dialog P**oint Source**, button „Directivity“ and enter the corresponding parameters.

Now enter a height of 40 m for the auxiliary-polygon line of the cross section as illustrated above. For the sectional view thus generated, perform a grid calculation (see chapter 5.3.6) with a grid spacing of 1 m to obtain the level distribution in this plane which is caused by the chimney.



Level distribution around the chimney in the vertical plane

2

Radiation Characteristics of Chimneys

Simplified determination of the radiation characteristics of chimneys and cooling towers for specified conditions (according to VDI 3733, July 1996 and /38/. This approach is valid with the following conditions:

- diameter of the outlet $d_{i\,m}$ = 5...7m;
- wind speed $W_L \cong 3ms^{-1}$;
- with emission medium: CO_2 and temperature T_F = 473...773K;
- with emission medium: water vapor and temperature T_F = 308K.

The angle δ calculates as follows::

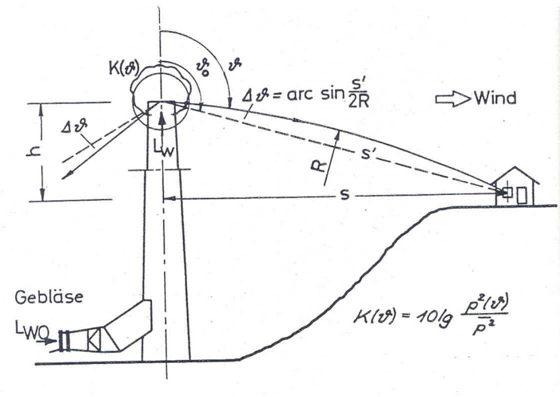
$$\delta = 90° + arc\tan(h \times s^{-1}) - arc\sin\left(\sqrt{h^2 + s^2} \times 10^{-4}\right) - arc\tan((W_L \times T_F)(W_F \times T_L)^{-1})$$

Directivity Index K_δ

δ	f in Hz							
	63	125	250	500	1 k	2 k	4 k	8 k
30°	2,0	2,5	2,5	3,6	3,0	2,0	2,0	2,0
45°-60°	4,0	4,8	3,2	4,1	4,8	4,8	4,8	4,8
75°	1,0	1,5	1,5	1,5	0,8	0,5	0,5	0,5
90°	-2,0	-2,5	-3,0	-3,5	-4,8	-5,6	-5,6	-5,6
105°	-4,0	-5,5	-7,0	-9,0	-10,0	-10,6	-10,0	-10,0
120	-5,0	-7,5	-9,2	-11,5	-15,2	-19,8	-20,0	-20,0

The used equation characters signify (see also the following figure):

- h source height relative (relative to the receiver) [in m]
- sdistance receiver source axis (z-coordinate) [in m]
- W_L downwind speed [in ms^{-2}]
- T_F temperature of the emission medium [in K]
- W_F exit speed of the emission medium [in ms^{-2}]
- T_L ambient temperature [in K]

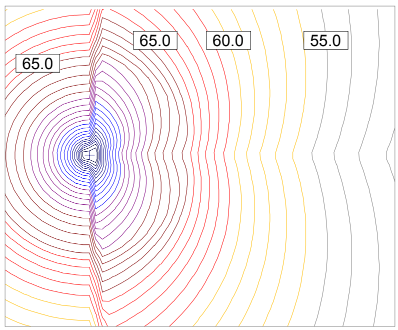


Situation sketch for the sound emission of chimneys /38/

2

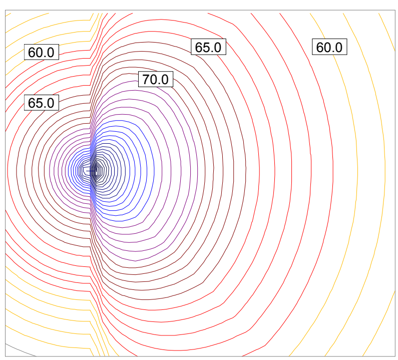
2.2.2 Sound Radiation from Elements & Openings

According to the Austrian Guideline OEAL 28 /48/, a (frequency-independent) directivity can be assigned to building elements and openings. When selecting the directivity for sound-radiating elements according to OEAL 28 for a point source the calculation will result in the following radiation pattern (into direction x/y/z = 1/0/0).



Radiation from elements according to OEAL

The next figure illustrates the radiation from openings according to OEAL.

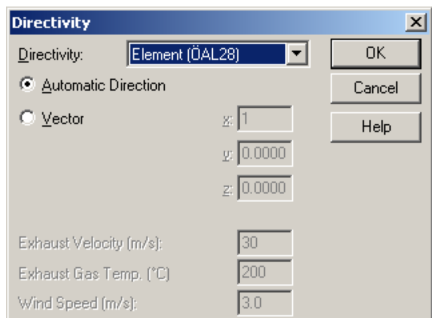


Radiation from openings according to OEAL

In practice, the two types of sources mentioned last are located on the outside of buildings. To select the correct reference direction for the sound radiation on the **Directivity** dialog, leave the default setting **Determine Direction Automatically (Nearest Building)** activated, as illustrated below.

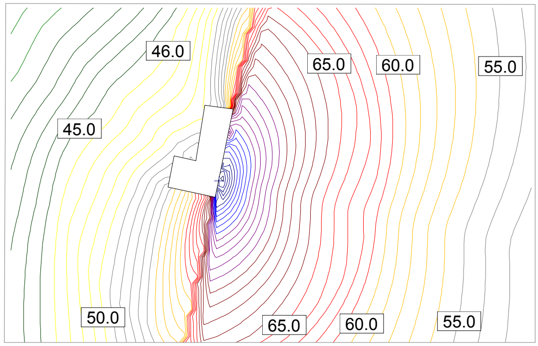
Now if you position a point source next to a building facade (an object snap of approximately 6 pixels specified under **Options|Object Snap** will be helpful), **CadnaA** automatically determines the direction of radiation perpendicular to the facade at this point.

For the 6 m high, L-shaped building in the figure after the next one, the level distribution is thus obtained without further adjustments.



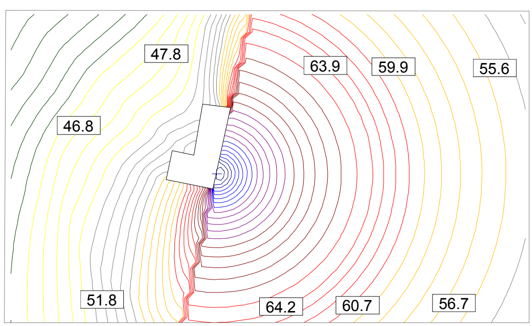
Automatic determination of the direction of radiation
for sound-radiating elements and openings according to ÖAL

2



Level distribution calculated for elements according to OEAL using automatic determination of the direction of radiation (the sound power effectively radiated is precisely the same as for the other grid calculations)

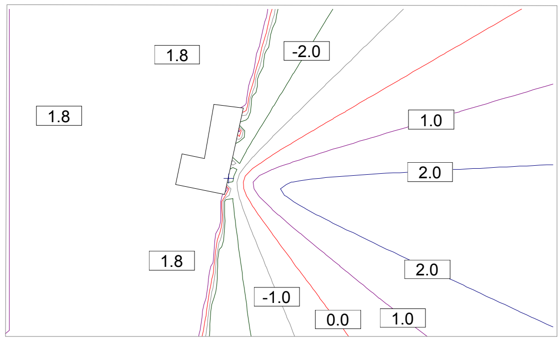
You can easily assess the effect of different specifications on the calculated level distributions. The next figure, for example, illustrates the result of a grid calculation where no directivity has been assigned to the point source simulating the sound-radiating element. In this case, the level distribution results exclusively from the intrinsic shielding effect of the building.



Calculated level distribution caused by the sound-radiating element, when the directivity according to ÖAL has been deactivated (i.e. an omnidirectional radiation)

2

As the position of the level boxes has not been changed, the levels exactly show the difference between the two methods. When the numerical difference of the two level distributions in the two scenarios above is calculated, the lines of equal difference clearly show the essential differences.



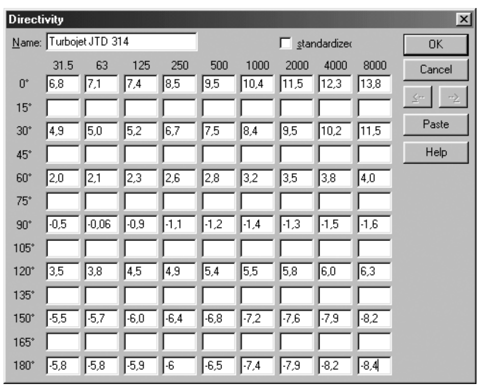
Lines of equal level difference between omnidirectional sound radiation and sound radiation according to ÖAL

This example illustrates how the grid arithmetic in **CadnaA** can be applied to investigate the level differences due to this predefined directivity pattern.

2.2.3 Frequency-dependent Directivity

To use any directivity that is taken from measurements or from literature, a very general and flexible concept is integrated. In **Tables|Library (local)|Directivity** for each directivity pattern a new line can be inserted. Double click on this line opens a matrix form with frequency-columns and lines spaced 15 degrees. This form allows to define an axial symmetrical directivity pattern, that is sufficient in most cases. A general description would require the directivity index in each frequency band independence of two angles. With „Name“ a string is entered, which can be referred to in the „PWL“ input line of any point-, line- or area source during calculation.

The form allows to enter the directivity indices for all octave bands from 31.5 Hz to 8000 Hz in angular increments of 15 degrees. If values are only available for larger increments, use the DEL key to delete the zeros for the 15-degree-increments where no such values are available. **CadnaA** will then fill in these values by interpolation.

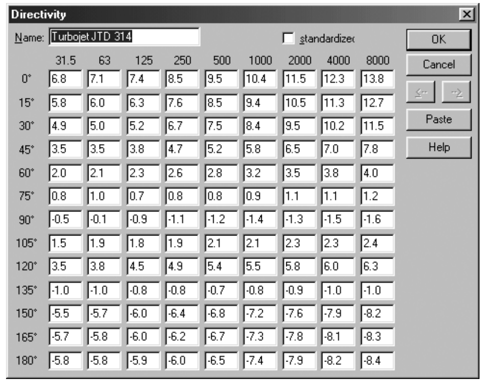

Directivity
Name: Turbojet JTD 314
standardized
OK
Cancel
Paste
Help

	31.5	63	125	250	500	1000	2000	4000	8000
0°	6,8	7,1	7,4	8,5	9,5	10,4	11,5	12,3	13,8
15°									
30°	4,9	5,0	5,2	6,7	7,5	8,4	9,5	10,2	11,5
45°									
60°	2,0	2,1	2,3	2,6	2,8	3,2	3,5	3,8	4,0
75°									
90°	-0,5	-0,06	-0,9	-1,1	-1,2	-1,4	-1,3	-1,5	-1,6
105°									
120°	3,5	3,8	4,5	4,9	5,4	5,5	5,8	6,0	6,3
135°									
150°	-5,5	-5,7	-6,0	-6,4	-6,8	-7,2	-7,6	-7,9	-8,2
165°									
180°	-5,8	-5,8	-5,9	-6	-6,5	-7,4	-7,9	-8,2	-8,4

Frequency-dependent directivity indices in increments of 30 degrees. The values for the intermediate angles are deleted.

When you close the dialog above by clicking OK and open it again, the missing values are added in the empty fields automatically by **CadnaA**.

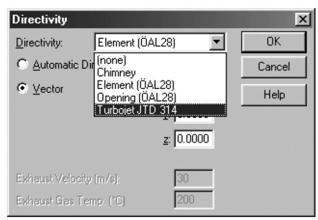
2



	31.5	63	125	250	500	1000	2000	4000	8000
0°	6.8	7.1	7.4	8.5	9.5	10.4	11.5	12.3	13.8
15°	5.8	6.0	6.3	7.6	8.5	9.4	10.5	11.3	12.7
30°	4.9	5.0	5.2	6.7	7.5	8.4	9.5	10.2	11.5
45°	3.5	3.5	3.8	4.7	5.2	5.8	6.5	7.0	7.8
60°	2.0	2.1	2.3	2.6	2.8	3.2	3.5	3.8	4.0
75°	0.8	1.0	0.7	0.8	0.8	0.9	1.1	1.1	1.2
90°	-0.5	-0.1	-0.9	-1.1	-1.2	-1.4	-1.3	-1.5	-1.6
105°	1.5	1.9	1.8	1.9	2.1	2.1	2.3	2.3	2.4
120°	3.5	3.8	4.5	4.9	5.4	5.5	5.8	6.0	6.3
135°	-1.0	-1.0	-0.8	-0.8	-0.7	-0.8	-0.9	-1.0	-1.0
150°	-5.5	-5.7	-6.0	-6.4	-6.8	-7.2	-7.6	-7.9	-8.2
165°	-5.7	-5.8	-6.0	-6.2	-6.7	-7.3	-7.8	-8.1	-8.3
180°	-5.8	-5.8	-5.9	-6.0	-6.5	-7.4	-7.9	-8.2	-8.4

Frequency-dependent directivity indices with interpolated values

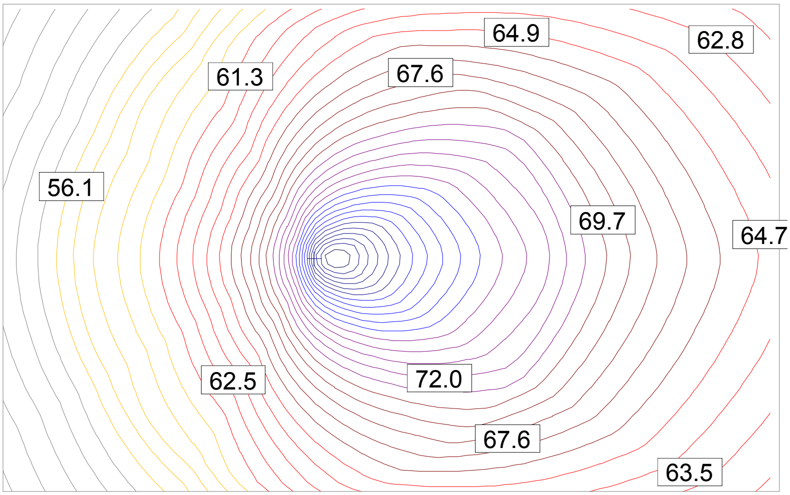
Now we can assign to a point-, line- or area source a previously specified frequency-dependent directivity by selecting its name from the list box **Directivity**.



A specified directivity can be selected by clicking its name on the list

2

In the example, the calculation will result in the level distribution shown below.



Level distribution resulting from the selected directivity

When the calculation is performed for an receiver point, the directivity index calculated on the Directivity dialog is added to the sound power level.

Normalized Directivity

With the option „normalized“ activated, the correction is increased or reduced by a constant factor for all directions so as to leave the sound level specified on the edit dialog of the source unchanged although this directivity is taken into account. This enables you to enter directly the octave band sound pressure levels that you have measured on a half circle with the source as pivot.

Paste

Clicking the „Paste“ button on the edit dialog **Directivity** on menu **Tables|Library (local)|Directivity** will paste data in ASCII-format via the clipboard into the dialog. Directivities having a comma as decimal separator will, however, also be accepted when pasting.

ASCII-format: Cells separated by TAB stops, lines separated by carriage RETURNs.

Import of directivities via ODBC

Directivities can also be imported via the ODBC-connection (see chapter 7.3). To this end, select from the dialog **File|Database|Definition** the object type „Directivity“ (at the end of the list).

The attribute of the directivity index with structure „Sxxx_yyyy“, where:

- xxx: angle 0 to 180 degrees
- y: frequency 31 to 8000 Hz

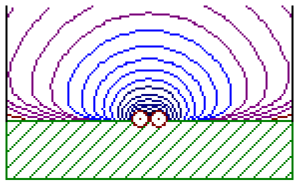
Example: S000_31 or S180_8000)

2.3 Tennis Point of Serve

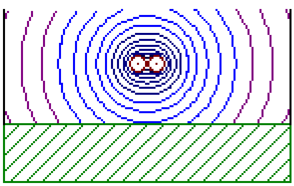
This type of noise source applies in Germany only because the emission is related to a special time weighting (maximum level in time intervals of 5 seconds, the so-called „Taktmaximalpegel“).

2.4 Roads

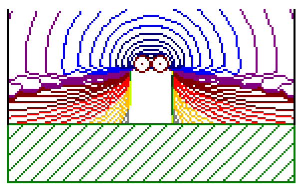
The sound source „Road“ is radiating to all sides as long as the option „Self-Screening“ is not activated (see chapter 2.4.1 "Common Input Data", section "Self-Screening").



Radiation from sound source „Road“,
relative height 0 m (for RLS-90)



Radiation from sound source „Road“,
relative height 10 m,
option „Self-Screening“ **deactivated**



Radiation from sound source „Road“,
relative height 10 m,
option „Self-Screening“ **activated**

The object „Road“ may have different values at each polygon point for the following parameters:

- the road’s cross section or width (see chapter 2.4.1, section "Specification of Road Width")
- the lateral slope (see chapter 2.4.1), and
- the height (see chapter 4.1).

2

The command **Parallel Object** (see manual „Introduction to **CadnaA**“) on the context menu of a road enables to generate barriers, embankments, or contour lines at a specified distance parallel to the road’s axis or to generate station marks into the direction of the road using the command **Generate Station** (see manual „Introduction to **CadnaA**“).

Commands on the context menu of the object „Road“

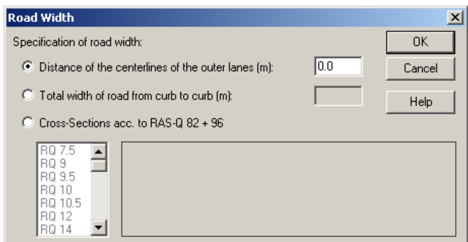
The parameters of a road are entered in edit mode on the dialog **Road** that opens when double-clicking on the road’s centre line.

☝ The subsequent chapters are specific for each standard or guideline available in **CadnaA**. These specifications do not represent a copy of the standardized procedures, rather the way they are implemented.

2.4.1 Common Input Data

Specification of Road Width

When clicking the file selector symbol to the right of the input box „SCS/ Dist. (m)“ in the dialog **Road** the dialog **Road Width** is displayed enabling to enter, either the distance of the centre lines of the outer lanes (location of the noise sources), or the total width of the road from curb to curb (in m). Alternatively, the predefined cross sections can be selected.



Distance of the outer lanes

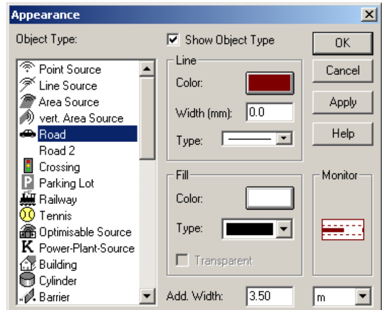
The road width represented on the screen corresponds to the entered width only in case the additional width (at the curb) is set to 0 m (see below, section "Display real Width of Roads"). In this case, the borders of the object „Road“ represent the centre lines of the outer lanes (noise sources).

Total width of road from curb to curb

The road width displayed on screen does <u>not</u> correspond to the entered width because a default distance of 1.75 m is presumed between the centre lines of the outer lanes to the curb. Therefore, a road with a total width of e.g. 10 m from curb to curb has a distance of 10 - (2*1,75) = 6,5 m between the centre lines of the outer lanes.

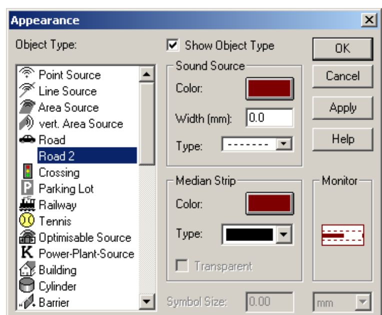
Display real Width of Roads

On menu **Options|Appearance** the additional width between the emission lines and the curb can be defined globally (object type „Road“). The value entered represents the sum of the curb’s distance left/right. Mark the object „Road“ and enter the required additional width.



Menu **Options|Appearance**, object type „Road“:
globally defined additional width (default value: 3.5 m)

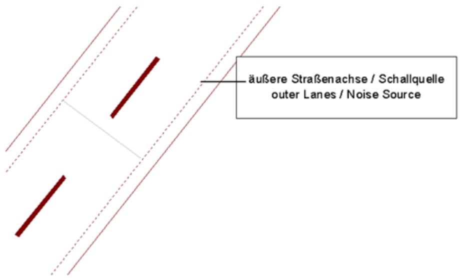
Via the object type „Road2“ type and color of the centre lines of the outer lanes (sound sources) can be defined. The defined appearance for object types **Road** and **Road2** concern all roads in a global way.



Menu **Options|Appearance**, object type „Road2“:
appearance of the sound source

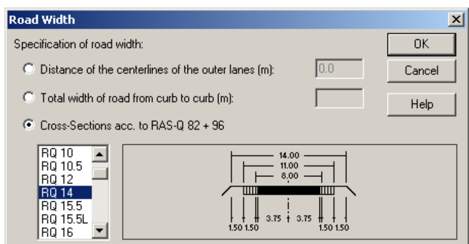
☝ The centre line of the object „Road“ will always be displayed as a centre line, irrespective whether the real road has a single or several lanes in each direction (e.g. highway).

2



Road with additional width: emission lines and curbs

Standard Cross Section (SCS)



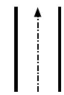
The standardized cross sections can be selected from the list with the mouse and clicking OK. The standardized cross sections result from the following German standards:

- Richtlinien für die Anlage von Straßen RAS, Teil: Querschnitte RAS-Q, Ausgabe 1982 /13/ und 1996 /14/, Forschungsgesellschaft für Straßen- und Verkehrswesen, Arbeitsgruppe Straßenentwurf, Köln.
- Entwurfshinweise für planfreie Knotenpunkte an Straßen der Kategoriengruppe B, RAS-K-2-B, Ausgabe 1995 /16/.
- Aktuelle Hinweise zur Gestaltung planfreier Knotenpunkte außerhalb bebauter Gebiete, AH-RAL-K-2, Ausgabe 1993 /17/.

Examples for Roads

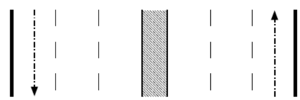
In the subsequent section some examples are given for the input of roads.

Example 1: Single Lane Road



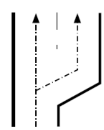
For a single-lane road, enter 0 in the input box „Standard Cross Section/ Distance“ on the dialog **Road** or, if 0 is displayed as the default value, leave it unchanged. In this case just a single emission line exists.

Example 2: Multi-lane Road



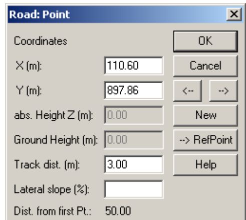
For a multi-lane road, enter either the distance between the centre lines of the outer lanes, or select the appropriate predefined cross section. For example, when selecting the standard cross section „a6ms“ according to RAS-Q 82 /13/, a distance of 24.75 m results between the centre lines of the two outer lanes. This corresponds to the road width displayed on the screen (with an additional width of 0 m).

Example 3: Road widening from 1 to 2 Lanes



In order to alter the distance of the outer lanes or the lateral slope along a road, each polygon point is edited individually via the dialog **Geometry** (see chapter 4.1). Proceed as follows.

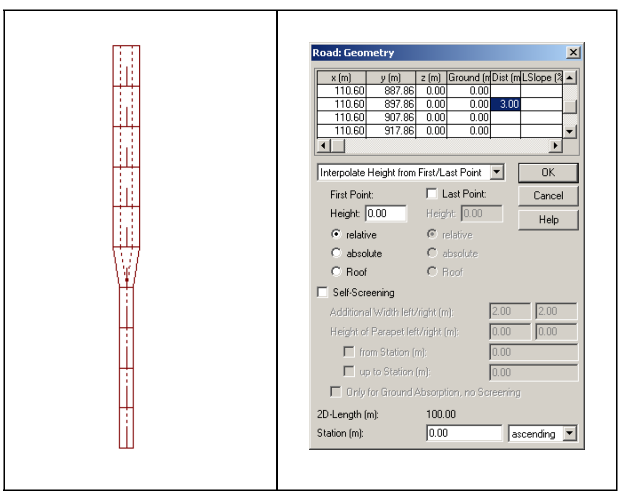
- Open the dialog of the respective road.
- Click the button „Geometry“ and double-click into a row of the geometry list.



Dialog **Road: Point**

- On the dialog **Road: Point**, enter the appropriate values for the distance between the axis' of the outer lanes.
- Access the next or previous polygon point via the arrow buttons.

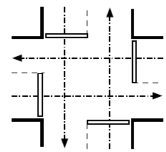
Via the button „New" a new point is inserted. The road's polygon point being edited is flashing on the screen. In order to see this, the dialog box may have to be moved apart. To keep the road width constant in the direction of geometry, it does not require to edit every polygon as the entered distance is kept until it is changed at a further point.



Widening of a road from 1 to 2 lanes

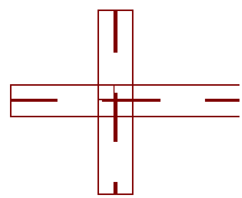
Example 4: Crossing with continuous lanes

The next example shows a crossing with continuous lanes.



In **CadnaA**, just enter the two intersecting roads. In case the traffic densities of the four combining road sections are different, it needs to model this road crossing from four road sections joining in the middle of the crossing.

☝ Regarding the use of traffic lights see chapter 2.5.



Even when two road sections each are supposed to join in the middle of the crossing, the straight through-lanes are entered first and can be split afterwards.

Splitting of Roads into Sections

Option 1: Open the context menu by clicking on the centre line of the road with the right mouse button. Selecting the command **Break Lines** from the context menu splits the crossing roads right in the middle. This can be checked by clicking on the split road selecting just a half of it. Subsequently, by clicking one of the split road sections, select the command **Break Lines** once again, the non-split road will be split.

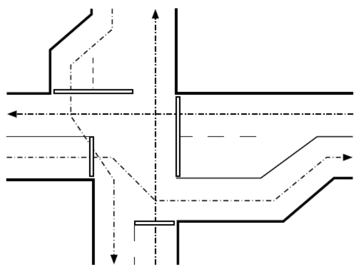
☝ Deactivate other objects - if any - being intersected by the roads in order not to be split as well.

If this is the case, and the other objects shall not to be split, proceed as follows.

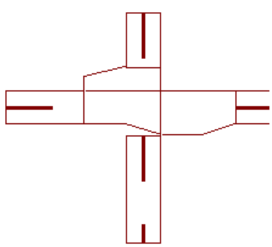
Option 2: Instead of using the crossing roads as intersection lines for splitting, draw an auxiliary line - for example, a line source or an auxiliary polygon - on top of the centre line of the road to be split, and apply the command **Break Lines** from the context menu of this auxiliary line in order to split the road. Then, delete the auxiliary line. After splitting of the roads, different parameters such as traffic densities can be defined for the individual road sections.

for further options see the manual „Introduction to **CadnaA**".

Example 5: Crossing with Filter Lane



This example is a combination of the scenarios already dealt with. At the transitions from the two-lane roads to the crossing and within the area of the crossing, the lanes are modelled from roads with a road width of zero. These are followed by two-lane roads in all four directions.



Any other geometry may be derived from those examples.

2

Lateral Slope

On the dialog **Road: Point**, the lateral slope can be defined - besides the outer lanes' distance - from point to point (via button „**Geometry**" of the road).

The lateral slope refers to the outer lanes' axis which is rotated around the road's centre line. A positive value lifts the outer right lane, a negative value the outer left lane. „Right" and „left" refer to the initial point when looking towards the final point.

☝ The entered slope holds also for all subsequent points into the direction of geometry. A new value needs to be entered only when the lateral slope changes again at a further point. Starting from this point, this new value holds again for all subsequent points.

Emission in dB(A)

The sound emission of a road is characterized by an emission level which is usually specific to the standard or guideline applied. This value is either entered directly or derived from road specific parameters for the selected road standard or guideline (see subsequent chapters specific to each standard/guideline).

Traffic Density

Counts, MDTD

Average daily traffic density (normally: vehicles per 24 hours): This is the number of vehicles passing a section of the road per day, averaged over the entire year.

Exact Count Data

When the option „Precise Counts" is activated, the relevant hourly traffic density M (in vehicles/hour) for the periods Day|Evening|Night and the mean proportion of trucks p in % can be entered (vehicles with a gross mass > 2800 kg as percentage of the relevant traffic density).

Road Type

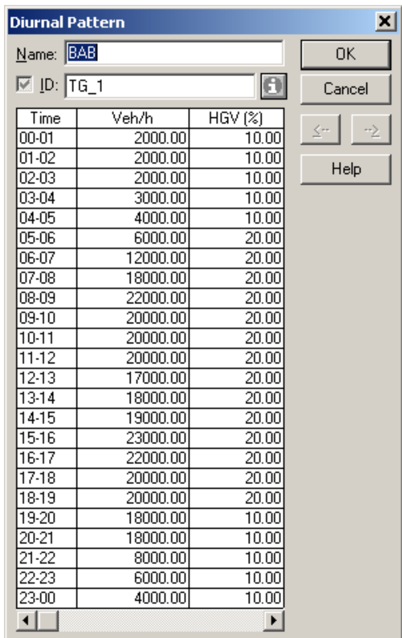
With the option „Counts" selected, this list box enables to select the road type according to the selected standard. Based on this classification, default values for the hourly traffic density and for the proportion of trucks are used.

Diurnal Pattern

To calculate the noise indicators L_{den} and L_n according to the EC-Directive /106/ the diurnal patterns for each road are required. The diurnal pattern enables to assign the respective traffic counts to the three time periods. Diurnal patterns for each road type can be entered into the global or the local library (see chapter 12.1).

Examples\
02_Sources\
Road\DiurnalPattern.cna

Open the file **DiurnalPattern.cna** in **ExamplesExamples\02_Sources\Road** on your CD.



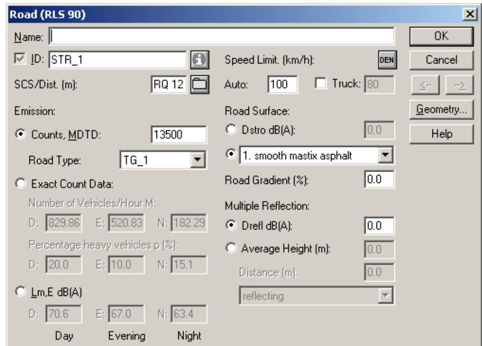
Time	Veh/h	HGV (%)
00-01	2000.00	10.00
01-02	2000.00	10.00
02-03	2000.00	10.00
03-04	3000.00	10.00
04-05	4000.00	10.00
05-06	6000.00	20.00
06-07	12000.00	20.00
07-08	18000.00	20.00
08-09	22000.00	20.00
09-10	20000.00	20.00
10-11	20000.00	20.00
11-12	20000.00	20.00
12-13	17000.00	20.00
13-14	18000.00	20.00
14-15	19000.00	20.00
15-16	23000.00	20.00
16-17	22000.00	20.00
17-18	20000.00	20.00
18-19	20000.00	20.00
19-20	18000.00	10.00
20-21	18000.00	10.00
21-22	8000.00	10.00
22-23	6000.00	10.00
23-00	4000.00	10.00

Dialog **Diurnal Pattern** (menu **Tables|Libraries (local** or **global)**)

To address this diurnal pattern to a specific road it has to be referenced via the list box **Road Type** on the road's dialog. By default, the road types according to the selected guideline for road noise are available. In case diurnal patterns are available from the library, these will be listed at the

2

end of the list. In this example, the diurnal pattern with the ID-code "TG_1" is selected.



When calculating the noise indicators L_{den} for roads the assignment of the daily hours to the time periods Day|Evening|Night and the respective time penalties apply (**Calculation|Configuration** menu, tab „Reference Time“, see chapter 6.2.4).

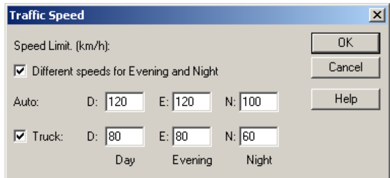
Speed Limit (km/h)

This is the maximum speed, in km/h, permissible on the relevant road section for autos and trucks. This speed is taken into account according to the selected standard for autos and trucks. The default value for trucks is the same for cars. In case a different speed limit applies for trucks, activate the check box „Truck“ and enter the speed limit for trucks.

Information on the minimum and maximum speeds for each road noise standard is given in the subsequent chapters.

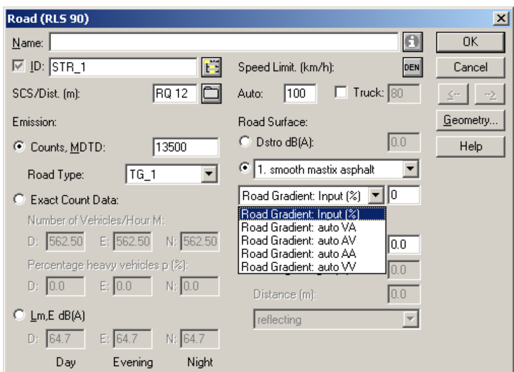
Button DEN

When clicking the symbol DEN speed limits can be entered separately for autos and trucks and for the time periods Day|Evening|Night.



Road Gradient (%)

The road gradient in % can either be entered by the user or calculated automatically, respecting the individual height profile of the road. The available options are selectable from the list box „Road Gradient“.



Dialog **Road** with list box „Road Gradient“

Road Gradient auto

With selection of „Road Gradient: auto“ the gradient of roads made of several road sections is calculated automatically. In this case, the displayed emission value (e.g. $L_{m,E}$ with RLS-90) does not consider any gradient correction (also, not the tabulated emission value on menu **Tables|Sources|Road**). The gradient correction, however, is calculated for each road section automatically and considered within the calculation of propagation.

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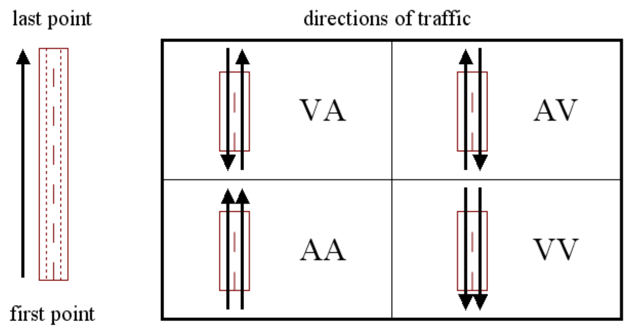
Select from the list box „Road Gradient“ into which direction the traffic flows on the two outer lanes. The abbreviations VA, AV, AA and VV designate the traffic direction on the outer lanes, as seen from the first to the last point of the road (see figure below).



Road geometry and traffic directions

The letter „A“ and „V“ can be understood as arrowheads. For example, in case of traffic direction VA the traffic flow is - seen from the first point of the road - on the left outer lane into the opposite direction of the geometry points and on the right outer lane into the direction of the geometry points.

☝ The type of road gradient can also be specified by using the attributes STEIG and STEIG_AUTO (see **CadnaA**-manual „Attributes, Variables, and Keywords“).

Calculate Road Gradient

When selecting the command **Calc Gradient of Roads** from the **Tables|Miscellaneous** menu, **CadnaA** calculates the average gradient in % for all active roads based on their z-coordinates and the digital terrain model. The result is displayed and used as road gradient.

2

☝ Because the value applies for the entire road, the gradient is calculated from the height difference of the first and the last point <u>of the road’s entire length</u>. Otherwise, the road has prior to be broken into pieces (by the command **Break into Pieces**, with the option „Split at Polygon Points“) before calculating the gradient.

The gradient calculation using the command **Tables|Miscellaneous|Calc Gradient of Roads** occurs for <u>all</u> active roads simultaneously. In case this is not intended, deactivate those roads which are to be excluded from the gradient’s calculation and reactivate them afterwards.

Dialog Geometry

Source Height

The height entered in the dialog **Geometry** is the surface height of the road. Depending on the selected standard for road noise the source height (e.g. 0.5 m with RLS-90) is added for calculation. Thus, the road’s z-coordinate is always the surface height.

Self-Screening

When the option „Self-Screening“ on the dialog **Geometry** is activated the road is just radiating into the upper half sphere. For the lower half sphere a screening effect occurs for all receivers below the road surface. This feature enables to define inclined roads, either upwards or downwards, by allocating the height above (relative) ground or an absolute height to every point of the road, and by defining an additional width (e.g. considering sidewalks etc.). Since the option „Self-Screening“ is available, the use of the object „Bridge“ became superfluous (see chapter 3.4).

When selecting a predefined cross-section (see chapter 2.9.1) the respective additional width referring to the entire road profile is copied to the input boxes "Additional Width". This feature faciliates the consideration of ground absorption for the entire road width (see chapter 6.2.7).

2

Additional Width left/right

By default, the road width as displayed by **CadnaA** results from the sum of the width between axis of the outer lanes and the additional width as defined on dialog **Options|Appearance** (see also 2.9.1 Specification of Road Widths, default value: 3.5 m).

With the self screening-option activated, the actual road width can be specified by entering an additional width > 0 m. The additional width can be defined separately for either side of a road. A specified additional width overwrites the additional width as defined on dialog **Options|Appearance** (see also 2.9.1 Specification of Road Widths). These additional width is also displayed in the plan view and on the 3D-special view.

Height of Parapet left/right

In addition, parapets (e.g. parallel barriers) for the self-screening road can be defined, either on one or both sides by entering a height left/right > 0 m. The parapets are treated as fully absorbing on either sides. This characteristic cannot be changed. Absorbing or reflecting barriers without or with cantilever can be defined just by using the object „Barrier“ (see chapter 3.3).

The following requirements and properties are to be respected:

- In any case, the additional width has to be > 0 m.
- The screens defined via option „Self-Screening“ are a characteristic of the road and are not displayed in the 2D-graphics, but just on the 3D-Special view.
- Barriers defined via option „Self-Screening“ will just screen the own source (road), but not the noise from other kinds of sources.

Station from/up to

This option enables to restrict the length of the barrier along the road’s axis with reference to the stationing. In this case, the barrier is just generated for the range „from-up to“.

This option is particularly useful when modelling bridges in order to suppress the diffraction around the edge of the road sections (road width) at bridgeheads.

2

For the automatic assignment two attributes are available:

- station start: SSCR_ST_B
- station end: SSCR_ST_E

Only for Ground Absorption, no Screening

With this option being activated, the additional width entered will not cause any screening effect, but will just be considered when calculating ground absorption. This requires, however, that the respective option on the configurations is checked (dialog **Calculation|Configuration**, tab „Ground Absorption“, option „Roads/Parking Lots are reflecting G=0“, see chapter 6.2.7). With this option activated the speed of calculation may increase considerably due to the omission of barrier calculation.

The self-screening effect of the road’s surface - including parallel barriers, if any - just refers to the respective road itself. Thus, the parallel barriers (parapets) defined via „Self-Screening“ are not seen by other sources.

2

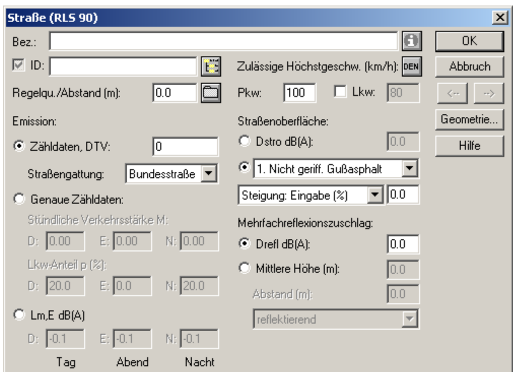
2.4.2 RLS-90

Emission Parameter

The emission parameter according to RLS-90 is the mean level $L_{m,E}$ at 25 m distance from the road's axis of an infinite straight road with free sound propagation /12/:

$$L_{m,E} = L_m + D_v + D_{StrO} + D_{Stg}$$

where
L_m: mean level at 25 m distance
D_v: speed correction
D_{StrO}: correction for road surface
D_{Stg}: correction for road gradient



Dialog **Road** (for RLS-90)

Emission Level Lm

The mean level L_m calculates from:

$$L_m = 37.3 + 10\lg\left[M * (1 + 0.082 * p)\right]$$

where
M: hourly traffic, i.e. mean number of vehicles of hour
Note - For multi-line roads the hourly traffic is split by 50/50 for each lane.
p: portion of trucks in % (trucks with a maximum mass of more than 2800 kg)

2

MDTD - RLS-90

Specifying the „Mean Daily Traffic Density“ (MDTD, veh/24h) calculates the emission level $L_{m,E}$ depending on the road type based on the hourly traffic data M (veh/h) and the truck portion p (%) according to the table below.

accord. to RLS-90, table 3:

Attribute Value STRGATTNR	Road Type	daytime (6-22 h)		nighttime (22-6 h)	
		M (veh/h)	p (%)	M (veh/h)	p (%)
0	Motorway	0.06 DTV	25	0.014 DTV	45
1	Federal Road	0.06 DTV	20	0.011 DTV	20
2	Ordinary Road	0.06 DTV	20	0.008 DTV	10
3	Local Road	0.06 DTV	10	0.011 DTV	3

MDTD - VBUS

With the options „Strictly accord. to RLS-90“ deactivated and the option „Calculation accord. to VBUS“ activated (both on tab „Road“, menu **Calculation|Configuration**) the following hourly traffic data M (veh/h) and the truck portion p (%) will be used /100/:

Attribute Value STRGATTNR	Road Type	Day (6-18 h)		Evening (18-22 h)		Night (22-6 h)	
		M (veh/h)	p (%)	M (veh/h)	p (%)	M (veh/h)	p (%)
0	Motor-way	0.062 DTV	25	0.042 DTV	35	0.014 DTV	45
1	Federal Road	0.062 DTV	20	0.042 DTV	20	0.011 DTV	20
2	Ordinary Road	0.062 DTV	20	0.042 DTV	15	0.008 DTV	10
3	Local Road	0.062 DTV	10	0.042 DTV	6.5	0.011 DTV	3

2

Source Geometry

The height entered in the dialog **Geometry** is the height of the road's surface. The source height is 0.5 m above the road's center line or above of the center lines of the outer lanes.

Speed Limit (km/h)

The minimum speed according to RLS-90 is 30 km/h for all types of vehicles. The speed limits are 130 km/h for autos and 80 km/h for trucks. In case a speed below 30 km/h is entered, 30 km/h is applied instead. With a speed limit > 130 km/h a speed of 130 km/h for autos and of 80 km/for trucks is used.

The speed correction D_v calculates from:

$$D_v = L_{car} - 37.3 + 10\lg\left[\frac{100 + \left(10^{0.1D} - 1\right)p}{100 + 8.23p}\right]$$

with

$$L_{car} = 27.7 + 10\lg\left[1 + \left(0.02v_{car}\right)^3\right]$$

and

$$D = L_{truck} - L_{car} \text{ where } L_{truck} = 23.1 + 12.5\lg v_{truck}$$

where
v_{car}: speed limit for autos/cars ($30 <= v_{car} <= 100$ km/h)
v_{truck}: speed limit for trucks ($30 <= v_{car} <= 80$ km/h)
L_{car}, L_{truck}: mean level L_m for a one auto/car or truck per hour
p: proportion of heavy vehicles (in %)

Road Surface

The correction for different road surfaces D_{StrO} can be entered or selected from the list box providing the road surface types of RLS-90. To this, at first the corresponding option button has to be activated. By default, the road surfaces listed in a following table are available.

accord to RLS-90, table 4, and amendment (Rundschreiben Straßenbau Nr. 14/1991, Ed.: BMV):

Attribute Value STRONR *)	Road Surface	D_{StrO} in dB(A) at a speed of			
		< 40 km/h	< 50 km/h	<= 60 km/h	> 60 km/h
1	smooth mastic asphalt, asphalt concrete or blinded mastic asphalt	0	0	0	0
2	concrete or corrugated mastic asphalt	1	1,5	2	2
3	pavement with a smooth surface	2	2,5	3	3
4	other pavements	3	4,5	6	6
5	concrete according to ZTV Beton 78 with steel broom stroke	-	-	-	1
6	concrete according to ZTV Beton 78 with steel broom stroke and with smoothing tool	-	-	-	-2
7	asphalt concrete <= 0/11 and blinded mastic asphalt 0/8 and 0/11 without grit	-	-	-	-2
8	open-pore asphalt covering layers containing at least 15 % of voids, when new, with 0/11 grain size	-	-	-	-4
9	open-pore asphalt covering layers containing at least 15 % of voids, when new, with 0/8 grain size	-	-	-	-5

Notes:
1. For low-noise road surface materials which have proved to provide a lasting noise reduction due to recent technological developments in structural engineering, different D_{StrO} corrections may be taken into account.
2. The corrections for rows 5 to 9 apply just to roads outside towns with a speed limit > 60 km/h.
3. The classes for the speed limit have been rearranged for software design reasons.

*) By the attribute value STRONR=0 selects the numerical input of D_{StrO}.

2

Gradient (%)

The road gradient can be entered in % or be calculated automatically, depending on the z-heights of the road. On the dialog Road the list box „Road Gradient" offers different options (see chapter 2.4.1, section "Road Gradient (%)").

$D_{Stg} = 0.6 \cdot |g| - 3$ for |g| > 5%

$D_{Stg} = 0$ for |g| <= 5%

Correction for Multiple Reflections

First-order reflections are to be taken into account by first-order mirror sound sources according to RLS-90. When the option „Strictly according to RLS-90" on the tab „Road" (**Calculation|Configuration** menu, see Chapter 6.3.11) is activated, this occurs automatically. This is also the case if a different order of reflection is specified on the tab „Reflection" (see Chapter 6.3.9). A calculation without any reflections can be engaged only by deactivating the option „Strictly according to RLS-90" and specifying no order of reflection (i.e. zero).

With building rows on both sides of a road, the resulting excess level has to be accounted for by an additional correction for multiple reflections which depends on the average height of the buildings left/right and on the distance among them. According to RLS-90 a correction for multiple reflections applies only when percentage of gaps between the buildings is less than 30%.

Drefl

This is the excess sound level due to multiple reflections. When this option is activated a correction (in dB) for multiple reflections can be entered.

Alternatively, the correction is calculated from the average height of the buildings on each side of the road, and the average distance (in m) between the buildings on both sides of the road according to:

- between reflecting buildings (percentage of gaps < 30%):

$$D_{refl} = 4 * h_{Beb} / d_{Beb} \leq 3.2\ dB$$

- between absorbing buildings:

$$D_{refl} = 2 * h_{Beb} / d_{Beb} \leq 1.6\ dB$$

- between highly absorbing buildings:

$$D_{refl} = 0\ dB$$

Average Height (m) average height of the buildings (attribute HBEB)

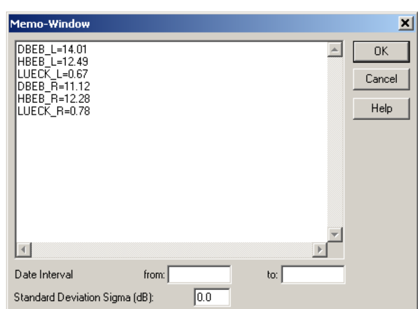
Distance (m) average distance between the buildings (attribute ABST)

Absorption absorption of the buildings (reflecting, absorbing or highly absorbing).

Calc Width of Roads

The command **Calc Width of Roads** (**Tables|Miscellaneous** menu) calculates the average height, the average distance and the proportion of gaps between buildings parallel to the roads. The results are stored in string variables stored on the dialog **Memo-Window** of the corresponding road..

DBEB_L; DBEB_R	average distance between the buildings (left/right)
HBEB_L; HBEB_R	average height of the buildings (left/right)
LUECK_L; LUECK_R	percentage of gaps (left/right)



Dialog **Memo-Window** with the corresponding string variables after using the command **Calc Width of Roads**.

By copying those values to the respective input boxes on dialog **Road** the Correction for Multiple Reflections can be evaluated using **CadnaA** (see subsequent example).

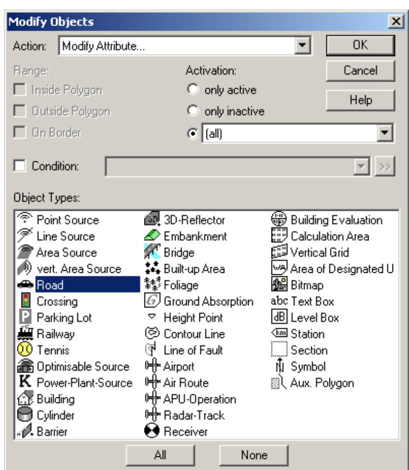
Examples\
05_Immissions\
Option XL\
XL_01.cna

- Open the file XL_01.cna on your CD.
- Select the command **Calc Width of Roads** (from **Tables|Miscellaneous** menu)

Example

First, the calculated average height of the buildings is copied to the input box „Average Height (m)“ on the dialog **Road**. To achieve this, the values of the string variables HBEB_L (average height, left) and HBEB_R (average height, right) are used. Both values are summed up and divided by 2. Proceed as follows:

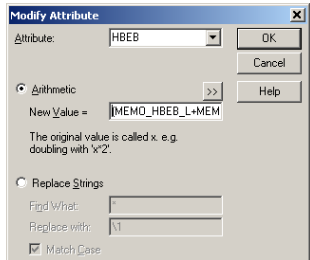
- Click with the right mouse onto the white area of the screen and select from the context menu the command **Modify Objects**.
- On the dialog **Modify Objects** specify the action „Change Attribute“ for the object type „Road“ and confirm by OK.



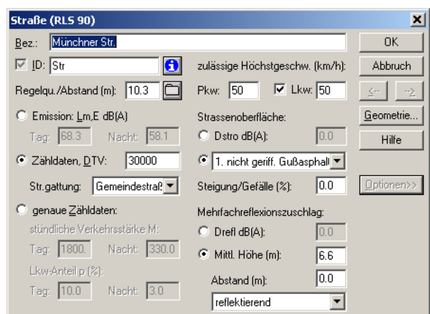
2

- On the subsequent dialog select the attribute HBEB, activate „Arithmetic“ and enter the following expression:

  (MEMO_HBEB_L+MEMO_HBEB_R)/2



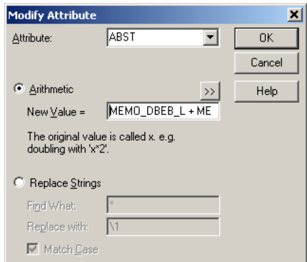
- When confirming by OK the calculated value is copied to the box „Average Height (m)“ on the dialog **Road**.



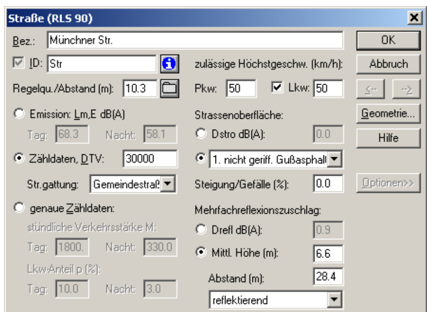
Still, the distance between the buildings (DBEB) has to be copied as well.

- Select from the dialog **Modify Attribute** the attribute ABST and enter following formula:

  MEMO_DBEB_L + MEMO_DBEB_R



Now, **CadnaA** calculates from the entered data the correction for multiple reflections.



As already said, whether the correction for multiple reflections applies or not depends whether the proportion of gaps is smaller than 30%.

- In order to consider this in **CadnaA**, reselect on the dialog **Modify Objects** the action **Modify Attribute** for object type „Road“.
- On dialog **Modify Attribute** select the attribute DREFL and enter the following formula (with option „Replace Strings“):

  iif(max(MEMO_LUECK_L,MEMO_LUECK_R)<0.3,DREFL,0)

2

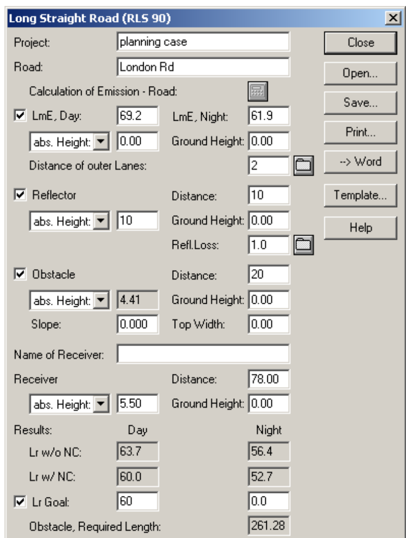
☝ This expression means in words: If the maximum value of the string variables MEMO_LUECK_L and MEMO_LUECK_R is smaller than 0.3 (= 30%) keep the value of DREFL, otherwise, replace it by zero (see also manual „Attributes, Variables, and Keywords“, chapter 6.2 "Operators and Functions").

After confirming the dialog with OK the option „Drefl“ is activated and the proportion of gaps entered if the condition above is fulfilled. Otherwise, Drefl= 0 dB and no correction of multiple reflections is applied.

Long Straight Road

Using the command **Long Straight Road** from the context menu of a road (or from the menu **Tables|Miscellaneous**) enables to perform an approximative calculation of the receiver level along roads complying with the requirements of RLS-90, section 4.4.1 („infinite long straight road“). This calculation cannot be used in combination with the other calculation methods from RLS-90 (segmented road sections).

When selecting the command **Long Straight Road** a dialog is displayed calculating the sound emission levels $L_{mE,Day}$ and $L_{mE,Night}$ as well as the receiver levels $L_{r,Day}$ and $L_{r,Night}$. Both receiver levels are calculated when entering the relevant parameters.

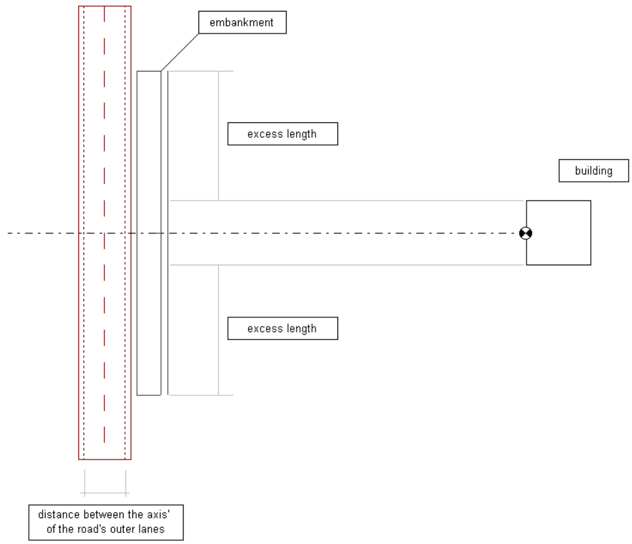


Dialog **Long Straight Road** (accord. to RLS-90)

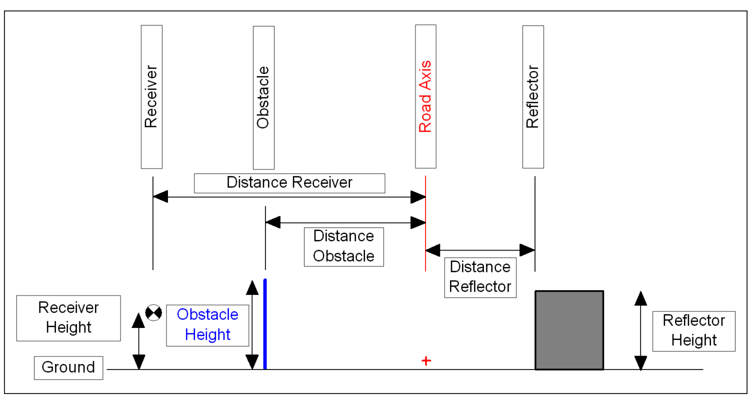
2

The relevant distances and object heights are shown in the following figures.

ground plan:



sectional view:



Lm,E Day/Night

In case the emission of the road where the context menu command **Long Straight Road** has been selected is specified already, the respective emission levels $L_{m,E}$ for Day/Night are displayed.

The calculator symbol enables to alter the emission data via the dialog **Road**.

Alternatively, after activation of the check box, the emission level $L_{m,E}$ for Day/Night can be entered.

Road Width/ Standard Cross Section

In the latter case, the road width or the standard cross section are specified on the dialog.

relative/absolute Height

The object heights (for road, reflector, obstacle, and receiver point) can be specified as relative or absolute heights.

Calculate Height of Obstacle

Using this form, the height of a barrier (obstacle) can be calculated when a limiting value has be entered in box „Lr Goal".

Excess Length

Here, the required excess length of the screening obstacle is displayed. This additional length in direction of the road to both sides - counted from the perpendiculars of the obstacle to the road line - is required at least in order to ensure that the calculated receiver levels are met.

Save/Open

Via the button „Save" the calculation results can be saved and be loaded via the button „Open". The file extension used is *.lgs.

Print

The form will be printed using the definitions of the selected template file to the connected printer.

Export

This button exports the form using the definitions of the selected template file as a RTF-file, e.g for MS-Word.

Template

A template file can be selected specifying the output format (file suffix *.rtf). The template files delivered with **CadnaA** are stored in the directory **templates** in the **CadnaA**-installation directory. To create your own template file, copy an existing template file and alter the text and the format definitions as required. The variable names can be obtained from the provided template files.

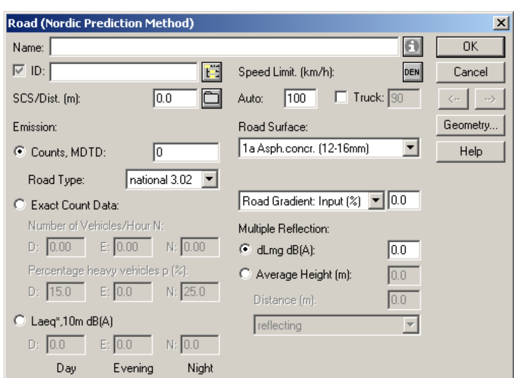
2.4.3 Nordic Prediction Method 1996

According to Nordic Prediction Method (NPM) for road traffic noise (TemaNord 1996:525) two types of evaluation parameters are calculated /64/:

- the A-weighted equivalent continuous sound pressure level $L_{A,eq}$ and
- the A-weighted maximum sound pressure level L_{AFmax}.

As the equivalent continuous level $L_{A,eq}$ is calculated per day (24 h) no specific day- or nighttime values exist. However, NPM states that any other period could be assessed as well using $L_{A,eq}$ provided the traffic data refers to this period. In contrary, a separate procedure is applied to calculate the maximum level L_{AFmax}.

☝ In **CadnaA**, the emission level $L_{Aeq*,10m}$ stated in the dialog **Road** refers to the A-weighted equivalent continuous sound pressure level $L_{A,eq}$ as emission parameter, additionally corrected for the road surface and for the road gradient. When calculating the A-weighted maximum sound pressure level L_{AFmax} the emission parameter stated is still the emission level $L_{Aeq*,10m}$.



Dialog **Road** (for Nordic Prediction Method)

2

Emission Level $L_{A,eq}$

The A-weighted equivalent continuous sound pressure level $L_{A,eq}$ at 10 m distance from the road's axis of an infinite straight road with free sound propagation calculates from the sound exposure levels for each vehicle category (light and heavy traffic) according to /64/:

- level for light traffic:

$$L_{Aeq,10m}(light) = L_{AE,10m}(light) + 10\lg\frac{N(light)}{T}$$

- level for heavy vehicles (m > 3500 kg):

$$L_{Aeq,10m}(heavy) = L_{AE,10m}(heavy) + 10\lg\frac{N(heavy)}{T}$$

and for both contributions:

$L_{Aeq,10}$ (mixed) = $L_{Aeq,10}$ (light) ++ $L_{Aeq,10}$ (heavy)

where ++ represents the energetic sum.

The sound exposure levels for each category result from:

- light traffic:

v >= 40 km/h: $L_{AE,10m} = 73.5 + 25\lg\frac{v}{50}$ dB(A)

30 <= v < 40 km/h: $L_{AE,10m} = 71.1$ dB(A)

- heavy vehicles (m > 3500 kg):

50 km/h <= v <= 90 km/h: $L_{AE,10} = 80.5 + 30\lg\frac{v}{50}$ dB(A)

30 <= v <= 50 km/h: $L_{AE,10m} = 80.5$ dB(A)

and $L_{AE,10m}(v <= 30\ km/h) = L_{AE,10m}(v = 30\ km/h)$

Emission Level L_{AFmax}

The A-weighted maximum sound pressure level is calculated applying a standard deviation of the emission levels resulting in an emission level exceeded by 5% of the vehicles. The arithmetic mean level $\overline{L_{AF\max 5\%,10m}}$ considering the standard deviation calculates from:

2

- for light traffic:

v >= 30 km/h: $\overline{L_{AF\max 5\%,10m}} = 69 + 30\lg\frac{v}{50} + 9e^{-0.7\frac{v}{50}}$ dB(A)

- for heavy vehicles (m > 3500 kg):

v > 50 km/h: $\overline{L_{AF\max 5\%,10m}} = 75 + 30\lg\frac{v}{50} + 16.4e^{-0.9\frac{v}{50}}$ dB(A)

v <= 50 km/h: $\overline{L_{AF\max 5\%,10m}} = 81.7$ dB(A)

and $L_{AF\max,10m}(v <= 30\ km/h) = L_{AF\max,10m}(v = 30\ km/h)$

☝ In case the A-weighted maximum sound pressure level is calculated the **CadnaA** protocol still shows the results for L_{eq} calculation and thus does not apply.

2

MDTD

The „Mean Daily Traffic Density“ (MDTD, vehicles/24h) does not exist in NPM as an input parameter for traffic data. Nevertheless, this feature is provided by **CadnaA** applying the road types of the Austrian road noise standards RVS 3.02 /52/ and RVS 4.02 /53/. The respective data is given in the tables below.

from RVS 4.02, tables 1 and 2:

Attribute Value STRGATTNR	Road Type	Day (6-19 hrs)		Evening (19-22 hrs)		Night (22-6 hrs)	
		N (veh/h)	p (%)	N (veh/h)	p (%)	N (veh/h)	p (%)
2	national road	0.060 * MDTD	10	0.036 * MDTD	15	0.014* MDTD	25
3	local road	0.064 * MDTD	10	0.029 * MDTD	10	0.010 * MDTD	10
4	main road	0.062 * MDTD	10	0.035 * MDTD	5	0.011 * MDTD	10
5	service road	0.062 * MDTD	5	0.041 * MDTD	2	0.009 * MDTD	2

from RVS 3.02, tables 1 and 2:

Attribute Value STRGATTNR	Road Type	Day (6-22 hrs)		Night (22-6 hrs)	
		N (veh/h)	p (%)	N (veh/h)	p (%)
0	local 3.02	0.065 * MDTD	10	0.007 * MDTD	5
1	national 3.02	0.065 * MDTD	15	0.013 * MDTD	25

where
N: number of vehicles per hour
p: percentage of heavy vehicles

☝ Speed correction in RVS refers, as it does in NPM, to 50 km/h.

For the percentage of light/heavy trucks it holds for both (see RVS 3.02, tab. 3 and RVS 4.02, tab. 3):

Road Type	Percentage of Heavy Vehicles	
	light trucks (%)	heavy trucks (%)
national (4.02 & 3.02)	25	75
local (4.02 & 3.02)	90	10
main road	60	40
service road	95	5

Source Geometry

The height entered in the dialog **Geometry** is the height of the road surface. The source height is 0.5 m above the road's center line or above the center lines of the outer lanes.

Speed Limit (km/h)

According to NPM the real speed is used in the prediction, not the indicated speed limit. When the real speed is, however, not available the „posted speed" should be used instead.

Road Surface

In **CadnaA**, different road surface correct the emission level already, even when NPM originally states this correction to be a part of the propagation model.

The following table lists the types of road surfaces and their respective level corrections.

road surface corrections according to NPM, Annex A, Table A1:

Attribute Value STRONR	Road Surface	Correction in dB(A) for a certain % of heavy vehicles							
		0-60 km/h			61-80 km/h			80-130 km/h	
		0-5	6-19	20-100	0-5	6-19	20-100	0-5	6-100
1	1a Asph.concr. (12-16mm)	ref	ref	ref	ref	ref	ref	ref	ref
2	1b Asph.concr. (12-16mm)	0	0	-1	-2	-1	-1	-2	-2
3	2a Asph.concr. (8-10mm)	0	0	0	-1	0	0	-1	-1
4	2b Asph.concr. (8-10mm)	-1	-1	-1	-2	-1	-1	-2	-2
5	3a Mastic asph. (12-16mm)	0	0	0	1	0	0	1	0
6	3b Mastic asph. (12-16mm)	0	0	0	1	0	0	1	0
7	4a Mastic asph. (8-10mm)	-1	-1	0	-1	-1	-1	-1	-1
8	4b Mastic asph. (8-10mm)	-2	-1	0	-2	-2	-1	-2	-2
9	5 Chipped asphalt (BCS)	1	0	0	2	1	0	2	1
10	6a Chip seal Y1 (16-20mm)	1	0	0	2	1	0	2	1
11	6b Chip seal Y1 (16-20mm)	2	1	0	3	1	0	2	1
12	7a Chip seal Y1 (10-12mm)	0	0	0	0	0	0	0	0
13	7b Chip seal Y1 (10-12mm)	0	0	0	0	0	-1	0	0
14	8a Chip seal Y1 (6-9mm)	0	0	0	-1	0	0	-1	0
15	8b Chip seal Y1 (6-9mm)	-1	0	0	-1	-1	-1	-1	-1
16	9a Chip seal Y2 (16-20mm)	0	0	0	1	0	-1	0	0
17	9b Chip seal Y2 (16-20mm)	1	0	0	1	0	-2	0	0
18	10a Chip seal Y2 (10-12mm)	0	0	0	0	0	-1	0	-1
19	10b Chip seal Y2 (10-12mm)	0	0	0	0	-1	-2	0	-1
20	11a Porous asph. (14-16mm)	0	0	0	-1	-1	-1	-1	-1
21	11b Porous asph. (14-16mm)	--1	-1	0	-1	-1	-1	-1	-2
22	11c Porous asph. (14-16mm)	-2	-2	-2	-2	-2	-3	-2	-3
23	12a Porous asph. (8-12mm)	0	0	0	-1	-1	-1	-2	-2
24	12b Porous asph. (8-12mm)	-1	-1	-1	-2	-2	-2	-3	-3
25	12c Porous asph. (8-12mm)	-3	-3	-3	-4	-4	-5	-5	-5
26	13 Cem.concr. (20-80mm)	2	1	1	2	2	2	2	2
27	14 Cem.concr. (12-18mm)	1	1	1	2	2	2	2	2
28	15 Cem.concr.,ground	-1	-1	-1	-2	-2	-2	-1	-1
29	16 Paving Stones	3	3	2	5	4	3	5	4
30	17 Cement block pavement	0	0	0	0	0	0	0	0

Gradient (%)

In **CadnaA**, a varying road gradient corrects the emission level already, even when NPM originally states this correction to be a part of the propagation model.

The correction for the road gradient ΔL_{st} (in dB) results from:

$$\Delta L_{st} = \frac{2G}{100} + \frac{3G}{100} \lg(1 + p)$$

where
G: gradient in ‰ (10‰=1%)
p: proportion of heavy vehicles (in %)

In **CadnaA**, the road gradient is specified in % instead.

☝ When calculating the A-weighted maximum sound pressure level L_{AFmax} no gradient correction is applied.

Correction for Multiple Reflections

NPM provides an overall correction for multiple reflection in side streets where the noise impact results from a main street (section 2.6.9 of part 2 of /64/). As this correction alters the normal distance correction it is part of the propagation model and, thus, not part of the emission model. However, the correction ΔL_{ms} can be entered manually on the dialog **Road**, for parameter „Drefl“, with activating the configuration option „Calc exactly one Reflection Order“ (see chapter 6.2.10.2). When applying the correction for multiple reflections the maximum number of reflections calculated using image sources should be restricted to the first order.

When the option „Average Height“ is selected (with option „Calc exactly one Reflection Order“ still activated) the correction for multiple reflections is calculated from the average height, the distance and the reflecting properties of the buildings according to RLS-90 (see chapter 2.4.2, section "Correction for Multiple Reflections").

2.4.4 NMPB 1996

Emission Parameter

2

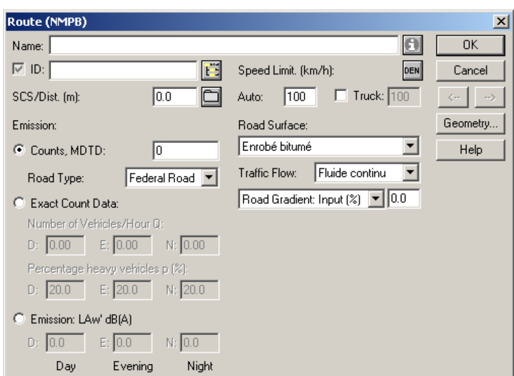
The emission parameter in NMPB-1996 („Nouvelle Méthode de Prévision du Bruit“) is the A-weighted sound power level per octave band $L_{Aw,i}$ of a point-like sub-source S_i in dB(A) /66/. This level calculates from:

$$L_{Aw,i} = 10\lg\left(10^{(E_{VL}+10\lg Q_{VL})/10} + 10^{(E_{PL}+10\lg Q_{PL})/10}\right) + 20\,dB + 10\lg l_i + R(i)$$

where
E_{VL}: sound power level of the light vehicles, in dB(A)
Q_{VL}: traffic number of the light vehicles (max. mass m < 3500 kg), in veh/h
E_{PL}: sound power level of the heavy vehicles, in dB(A)
Q_{PL}: traffic number of the heavy vehicles (max. mass m >= 3500 kg), in veh/h
l_i: length of the sub-source S_i, in m
R(i): octave values of the reference spectrum for road noise, in dB(A)
i: running number of octave

In **CadnaA**, the overall traffic flow Q (in vehicles/hour) and the percentage of heavy vehicles p% is to be specified instead. The relation between those figures and the ones above are:

$$Q = Q_{VL} + Q_{PL} \quad \text{and} \quad p\% = \frac{Q_{PL}}{Q}$$



Dialog **Road** (for NMPB 96)

2

Emission Parameter LwA'

The emission parameter displayed on the dialog **Road** is A-weighted total sound power level per unit length $L'_{Aw,i}$ in dB(A) according to the modified equation:

$$L'_{Aw,i} = 10\lg\left(10^{(E_{VL}+10\lg Q_{VL})/10} + 10^{(E_{PL}+10\lg Q_{PL})/10}\right) + 20\ dB + \psi \quad \text{in dB(A)}$$

☝ This value includes the correction for the vehicle type, the type of traffic flow, the correction of road gradient and the road surface correction ψ (see below).

Reference Spectrum

The values R(i) of the weighting spectrum are listed in the following table:

i	Frequency (Hz)	R(i) in dB(A)
1	125	-14
2	250	-10
3	500	-7
4	1000	-4
5	2000	-7
6	4000	-12

2

Emission Level E

The emission level E is taken from the following diagram:

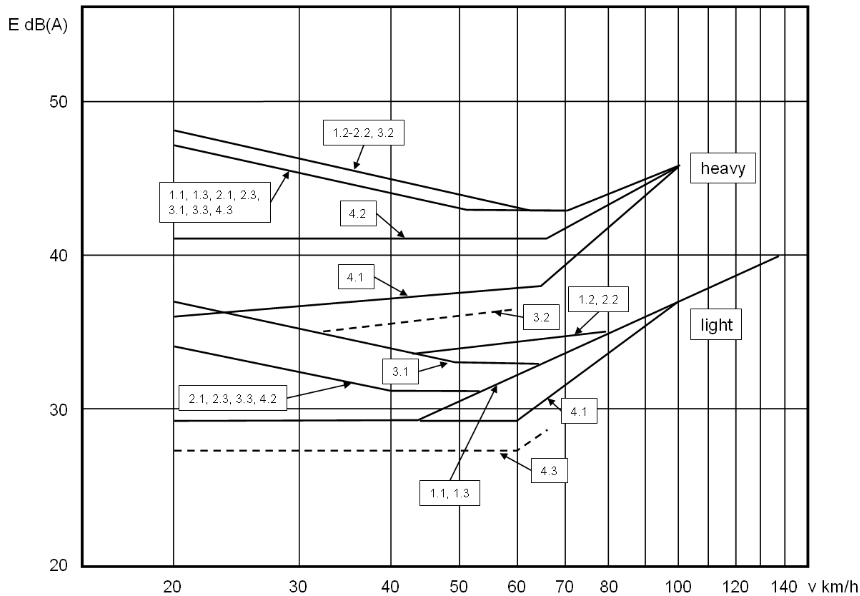


Diagram for NMPB-specific emission parameter E (approximative)

Legend (road gradient g%):

	Horizontal (-2% < g < 2%)	Monté (g > 2%)	Descente (g < -2%)
Fluide continu	1.1	1.2	1.3
Pulsé non différencié	2.1	2.2	2.3
Accéléré	3.1	3.2	3.3
Décéléré	4.1	4.2	4.3

This diagram considers:

- two types of vehicles (light and heavy)
- four types of traffic flows (fluide continu, pulsé non différencié, accéléré, décéléré),
- three types of road gradient (horizontal, montée, descente) and
- the traffic speed for light and heavy vehicles.

2

MDTD

The „Mean Daily Traffic Density" (MDTD, vehicles/24h) does not exist in NMPB as an input parameter for traffic data. Nevertheless, this feature is provided by **CadnaA** applying the road types of the German road noise standard RLS-90 /11/ in conjunction with VBUS /100/. The respective data for the hourly traffic data M (veh/h) and the truck proportion p (%) is given in the next table.

Attribute Value STRGATTNR	Road Type	Day (6-18 h)		Evening (18-22 h)		Night (22-6 h)	
		Q (veh/h)	p (%)	Q (veh/h)	p (%)	Q (veh/h)	p (%)
0	Motor-way	0.062 * MDTD	25	0.042 * MDTD	35	0.014 * MDTD	45
1	Federal Road	0.062 * MDTD	20	0.042 * MDTD	20	0.011 * MDTD	20
2	Ordinary Road	0.062 * MDTD	20	0.042 * MDTD	15	0.008 * MDTD	10
3	Local Road	0.062 * MDTD	10	0.042 * MDTD	6.5	0.011 * MDTD	3

Source Geometry

The height entered in the dialog **Geometry** is the height of the road's surface. The source height is 0.5 m above the road's center line or above of the center lines of the outer lanes.

Speed Limit (km/h)

The minimum speed according to NMPB is 20 km/h for all types of vehicles. The maximum speeds are 140 km/h for autos and 100 km/h for trucks. For higher speeds a speed of 140 km/h for autos and of 100 km/for trucks is used. In case a speed below 20 km/h is entered, 20 km/h is applied instead.

Road Surface

With NMPB, the correction for different road surfaces is already included in the emission level E. By default, the road surfaces listed in the following table are available (types „EC“ resulting from /99/).

Attribute Value STRONR	Road Surface	Spectrum Type applied	road surface correction ψ in dB at a speed of		
			<= 60 km/h	<= 100 km/h EC: <= 80 km/h	<= 130 km/h
1	Enrobé bitumé	1	0		
2	Enrobé drainant	2	0	0-3,5 *)	3,5
3	Chaussée cloutée	1	2		
4	Béton lisse	1	0		
5	Béton strié	1	3		
6	Pavés (en ville)	1	3		
101	EC: Porous surface	1	-1	-2	-3
102	EC: Smooth asphalt	1	0		
103	EC: Cement concrete	1	2		
104	EC: Smooth texture Paving	1	3		
105	EC: Rough texture Paving	1	6		

spectrum type 1: road spectrum (see previous section „Reference Spectrum“)
spectrum type 2: spectrum for „Enrobé drainant“ (see below)

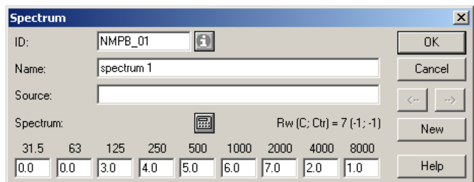
*) correction linearly increasing from 0 dB for 50 to 3,5 dB for 100 km/h

Spectrum for road surface „Enrobé drainant“ (for ψ = 3,5 dB(A)) :

i	Frequency (Hz)	R(j) in dB(A)
1	125	0
2	250	0
3	500	0
4	1000	0,5
5	2000	5,5
6	4000	7

User-defined Road Surfaces

With NMPB selected, additional road surfaces can be defined by the user. Open the local library for sound reduction indices (menu **Tables|Libraries (local)|Sound Reduction Indices**) and enter a new line via the table's context menu. For a sound reduction index spectrum to be selectable as a road surface correction, the ID has to start with the text sequence: NMPB_X, where X is a two digit integer number (e.g. NMPB_01, not NMPB_1). The entered name will be shown at the end of the default list of road surfaces.



Example: user-defined road surface spectrum

Gradient (%)

The road gradient can be entered in % or be calculated automatically, depending on the z-heights of the road.

For information on the different options offered in the list box „Road Gradient" of the dialog **Road** see chapter 2.4.1 "Common Input Data", section "Road Gradient (%)", for details.

Correction for Multiple Reflections

There is no global correction available in NMPB-96 to correct for multiple reflections. However, **CadnaA** enables to restrict the calculation using image sources to the 1st order of reflection and to correct for multiple reflections according to RLS-90 /12/.

see chapter 6.2.10.3 "NMPB 1996" and chapter 2.4.2 "RLS-90"

2.4.5 CRTN

The evaluation parameter in CRTN („Calculation of Road Traffic Noise“) is the level L10 (for 18 hours) in dB(A) which is defined based on the level L10 hourly in dB(A) /69/. The level L10 (1h) is the level just exceeded in 10% of the time within one hour. The L10 (18h) is the arithmetic average of all values L10 (1h) between 6:00 and 24:00 hours (total 18 values).

Emission Parameter

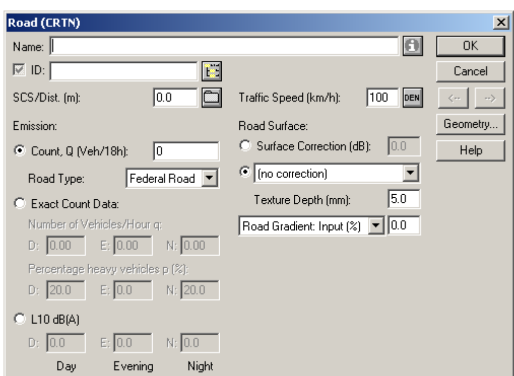
The emission parameter displayed on the dialog **Road** in **CadnaA** is L10 which is calculated from the following equations depending on what option at „Emission“ is selected:

$$L_{10}(1h) = 42.2 + 10\lg q \quad \text{or} \quad L_{10}(18h) = 29.1 + 10\lg Q \quad \text{in dB(A)}$$

where the number of vehicles per hour q calculates from the 18h-count Q (see CRTN, charts 2 and 3):

$$q = 10^{-\frac{13.1}{10}} * Q \quad \text{or approximately} \quad q = Q/20.417 \; .$$

This assumes a basic speed of v=75 km/h, a percentage of heavy vehicles (HGV) of p%=0, and a road gradient of G=0%.



Dialog **Road** (for CRTN)

Specification of Emission

2

MDTD & Road Type

The „Mean Daily Traffic Density“ (MDTD, vehicles/24h) does not exist in CRTN as an input parameter for traffic data. Nevertheless, this feature is provided by **CadnaA**. Two options are available (see list box „Road Type“ on dialog **Road**):

1. Specification of the percentage of heavy goods vehicles (HGV, with an unladen mass > 1525 kg) in the range from 0% to 95%, applying the equation for q (as above). In this case, the resulting emission levels L10 are equal for all three daily time periods D/E/N.

☝ The attribute STRGATT enables to switch between different settings for the proportion of heavy vehicles by using the following string (where xx represents the proportion of heavy vehicles as a available from the list box „Road Type“): HGVxx (e.g. HGV50)

2. Specification of one of the road types from the German road noise standard RLS-90 /11/. The respective data for the hourly traffic data q (veh/h) and the truck proportion p(%) is given in the next table. In this case, the hourly count q for Day calculates from the 18h-count Q as specified by CRTN while for Night the distribution in RLS-90 is used. Thus, just the daytime level is in accordance with CRTN.

Attribute Value STRGATTNR	Road Type	Day (6-22 h)		Night (22-6 h)	
		q (veh/h)	p (%)	q (veh/h)	p (%)
0	Motorway	$q = Q/20.417$	25	0.014 Q	45
1	Federal Road	$q = Q/20.417$	20	0.011 Q	20
2	Ordinary Road	$q = Q/20.417$	20	0.008 Q	10
3	Local Road	$q = Q/20.417$	10	0.011 Q	3

Exact Count Data

This option enables to enter hourly traffic data q and percentage of heavy vehicles p% for the three time periods Day/Evening/Night.

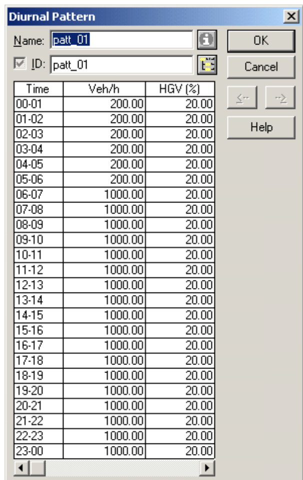
☝ This data can also be imported via ODBC (see chapter 7.3).

Specifying L10

The emission level L10 can be entered directly. In this case, the corrections (for speed, road type etc.) are not applied.

Diurnal Patterns

Furthermore, diurnal patterns can be used in **CadnaA** to specify road emission. Diurnal patterns are introduced via the local libraries on the **Tables** menu.



Diurnal Pattern

Subsequently, the ID of the pattern will be available from the lower end of the list box „Road Type“ on the dialog **Road**.

As long as the option "Use Non Standard Reference Time D/E/N" on dialog **Calculation|Configuration**, tab „Road“, is deactivated the data from 6 to 24 hours of the selected pattern will be used to calculate the level L10 (i.e. ignoring the traffic figures from 0 to 6 hours).

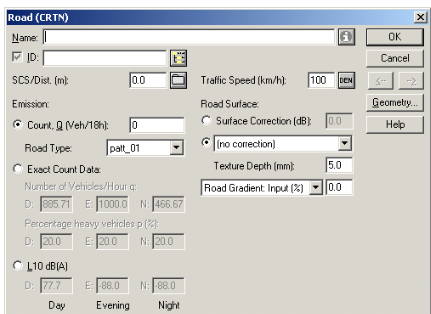
☝ In this case, the figures displayed for the hourly traffic q are not correct as they refer to the entire pattern (from 0 to 24 hours).

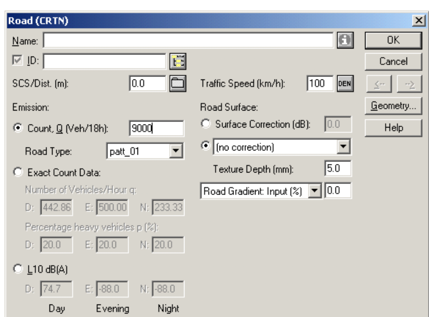
2

With counts Q being 0 (Zero) the pattern will be used as entered for calculation of emission. When entering a value for $Q_{entered}$ the hourly values $q_{applied}$ of the pattern will be corrected according to:

$$q_{applied} = Q_{entered}(18h) * \frac{q_{pattern}}{Q_{pattern,6-24h}(18h)}$$

For the pattern above the result for L10,18h (displayed for D, while results for E and N not being relevant) will be the same when entering 18000 for Q results as with entering 0 (Zero). Entering the half amount (9000/18 h) will reduce the entire counts of the diurnal pattern to half of the values entered (see figures below).

<table>
<tr>
<td>
</td>
<td>Example 1:

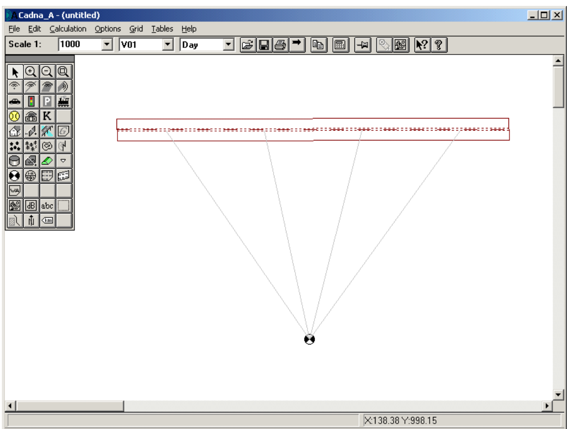
road pattern with
24000 veh./24h or
18000 veh./18 h
selected,
input of Q=0 considers
18000 veh./18 h</td>
</tr>
<tr>
<td>
</td>
<td>Example 2:

road pattern with
24000 veh./24h or
18000 veh./18 h
selected,
input of Q=9000 considers
9000 veh./18 h</td>
</tr>
</table>

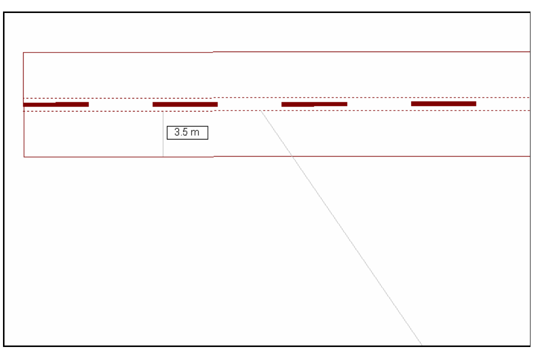
With the option "Use Non Standard Reference Time D/E/N" activated see chapter 6.2.10.4 "CRTN".

Road & Source Geometry

According to CRTN, paragraph 4, the source of traffic noise (emitting line source) has to be taken 0.5 m above the road surface level and 3.5 m inwards from the nearside of the road's edge (curb). This definition, however, refers to a situation with just receivers on one side of the road. In **CadnaA**, source lines are generated on either side of the road as the procedure should be applicable also to more complex scenarios with receivers on either side of the road or with grid calculations.



CRTN-road with two emission lines (curb-to-curb distance 8 meters), radiation occurs just from the source line being closer to the receiver (option „Generate Rays“ activated on dialog **Receiver**)

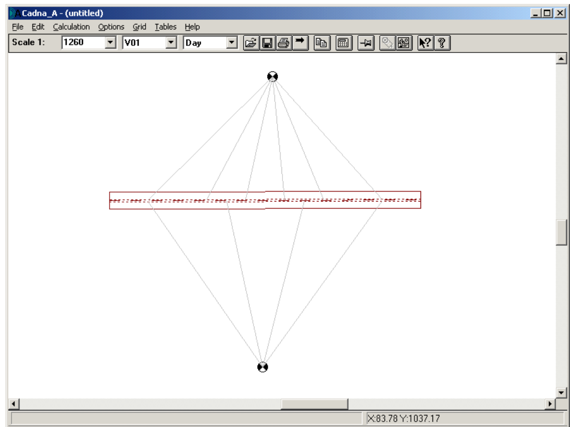


close-up: ray is extending from the near source line, source position is 3.5 meters inwards from the road's curb

2

The distance from the source line to the curb has no influence on the emission of the road, i.e. just enabling to identify the location of the road's curb in relation to the source position. The default distance of 3.5 m is specified on the **Options** menu, **Appearance** (see chapter 2.4.1 "Common Input Data", section "Specification of Road Width").

With receivers on either sides of the road both emission lines radiate.



Radiation by a CRTN-road with two receivers on either side
(curb-to-curb distance 8 meters)

Speed Correction

The following speed correction applies:

$$\Delta_{pV} = 33\lg\left(V + 40 + \frac{500}{V}\right) + 10\lg\left(1 + \frac{5p}{V}\right) - 68.8 \quad dB(A)$$

where
V is the road type specific traffic speed (see table 6.1 in CRTN /69/, in km/h

p is the percentage of heavy vehicles, calculated according to: $p = \frac{100f}{q} = \frac{100F}{Q}$

f is the hourly flow of heavy vehicles
F is the 18-hour flow of heavy vehicles

☝ Despite the limitation of chart 4 in CTRN, **CadnaA** applies this speed correction for any speed, also below 20 km/h and above 130 km/h.

2

Road Surface

The following road surface types are available from the list on dialog **Road** (besides the option „no correction“):

- Impervious, concrete
- Impervious, bituminous
- Pervious

The road surface corrections for roads with a traffic speed v>75 km/h are:

- for impervious concrete surfaces: $\Delta_{TD} = 10\lg(90 \cdot TD + 30) - 20 \quad dB(A)$
- for impervious bituminous surfaces: $\Delta_{TD} = 10\lg(20 \cdot TD + 60) - 20 \quad dB(A)$

where TD is the texture depth in mm. If the speed V<75 km/h it applies:

- for impervious bituminous road surfaces: $\Delta_{TD} = -1\, dB(A)$
- for pervious surfaces: $\Delta_{TD} = -3.5\, dB(A)$

Gradient (%)

The road gradient can be edited manually by selecting "Input (%)" or be calculated automatically from the height points of the road polygon. This feature enables for a single road to calculate the gradient correction for each road section separately (for more details see chapter 2.4.1 "Common Input Data", section "Road Gradient (%)"). **CadnaA** applies the correction according to CRTN chart 6 for positive and negative gradients G:

$\Delta_G = 0.3\, G \quad dB(A)$ with G gradient in %

☝ Furthermore, the traffic speed V on roads with gradients has to be reduced by ΔV in accordance with CRTN, chart 5. This speed reduction is not accounted for by **CadnaA** automatically. Instead, always the entered speed is used for the speed correction.

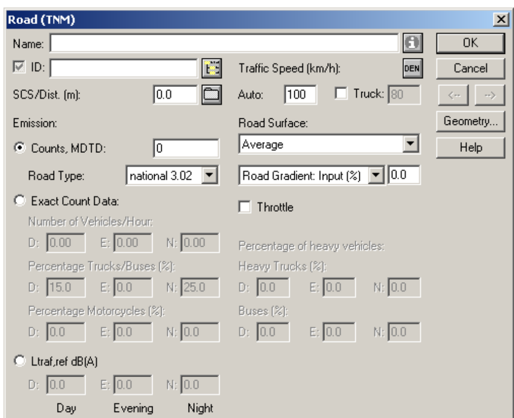
2.4.6 TNM

Note - The Federal Highway Administration Traffic Noise Model (FHWA TNM™) is protected by U.S. copyright laws. The noise prediction methodology used in **CadnaA** has been designed to be consistent with the FHWA TNM™, however, **CadnaA** has not been tested, evaluated, or approved for use by any Agency of the U.S. Government.

Emission Parameter

The emission parameter in TNM („Traffic Noise Model“) is the A-weighted level $L_{traf,ref}$ in dB(A) at a distance of 50 ft. (15.24 m) perpendicular to the axis of a road with infinite length with absorbing flat ground /76/.

In TNM, emission is based on A-weighted levels (expressed in energy form), while sound level computations use one-third octave-band data, converted to A-weighted levels for display and output.



Dialog **Road** (for TNM)

Vehicle Categories

The vehicle categories and their definitions available in TNM are listed in the subsequent table.

☝ For the time being, **CadnaA** does not allow for user-defined vehicle categories.

2

TNM-vehicle categories	Definition
autos	all passenger cars (2 axles, 4 tires), gross mass < 4500 kg (< 9900 lb)
medium trucks	cargo vehicles (2 axles, 6 tires), 4500 kg < gross mass < 12000 kg (9900 lb < m < 26400 lb)
heavy trucks	all cargo vehicles with 3 and more axles, gross mass > 12000 kg (> 26400 lb)
buses	all vehicles (2 or 3 axles) designated for transportation of 9 or more passengers
motorcycles	all vehicles with 2 or 3 tires with an open-air driver and/or passenger compartment

Emission Scheme

The emission for each category, pavement type and throttle setting, is represented by 17 constants (2*7+3=17, resulting in 17*(5*4*2)= 680 constants in total) applying the following equations.

The radiated energy E_A is:

$$E_A(s_i) = (0.6214 \cdot s_i)^{A/10} \cdot 10^{B/10} + 10^{C/10} \quad ,$$

converted to A-weighted levels per third-octave band:

$$L_{emis,i}(s_i, f) = 10 \lg E_A + \sum_{j=1}^{7} \left(X_1 + 0.6214 \cdot X_2 \cdot s_i \right) \cdot \lg f^{\,j-1}$$

with

$$\left(X_1; X_2 \right) = \left\{ \left(D_1; D_2 \right), \left(E_1; E_2 \right), \ldots, \left(J_1; J_2 \right) \right\}$$

where
s_i speed of vehicle type i (in km/h)
A1...J1, A2...J2constants (see table 5 in /77/)
f frequency (in Hz)

Converted back to its energy form:

$$E_{emis}(s_i, f) = 10^{L_{emis,i}/10}$$

The emission level $L_{traf,ref}$ is not displayed in the TNM 2.5 software. Instead, the emitted energy E for each vehicle category can be exported to a csv-file using the procedure described in the box below.

Exporting spectra of energy parameter E from TNM 2.5 software:
1 - locate the file *tnm.ini* in *C:\ WINDOWS*
2 - open the file and add the section:
...
[Diagnostics]
emission=1
...
3 - with each TNM-calc run a file *emit.csv* is written besides the *.dat and *.idx files
4 - *emit.csv* lists the energy parameter E for each category and sub-source type
5 - sum E for all categories and sub-source types gives after conversion $L_{traf,ref}$

Specification of Emission

MDTD

CadnaA offers to introduce traffic data based on Mean Daily Traffic Data (MDTD), though not available in the original TNM. In this case, the number of vehicles per hour and the percentage trucks/buses is calculated according to the specifications in the Austrian road noise standards RVS 3.02 /52/ and RVS 4.02 /53/.

☝ For details (and tables) on the traffic count (veh/h) and proportion of heavy vehicles (%) for each type of road see chapter 2.4.3 "Nordic Prediction Method 1996", section "MDTD".

In this case, the percentages of motorcycles and of heavy trucks and buses are, however, 0% for all road types as those vehicles types are not considered in the Austrian road noise standards RVS 3.02 and 4.02.

2

Exact Counts

This option enables to introduce the five TNM-specific vehicle types, comprising autos (cars), medium trucks, heavy trucks, buses, and motorcycles. As traffic data in TNM is specified in absolute figures for each vehicle type, while **CadnaA** uses - as the majority of road noise standards do - a scheme based on hourly overall traffic and percentage, the following transformations apply to convert absolute figures:

CadnaA-input data	calculates from TNM-input data according to ...
number of vehicles/ hour	$n_{Autos} + n_{Medium\ Trucks} + n_{Heavy\ Trucks} + n_{Buses} + n_{Motorcycles} = n_{tot}$
Percentage of Trucks/Buses (%)	$(n_{Medium\ Trucks} + n_{Heavy\ Trucks} + n_{Buses}) / n_{tot} * 100\%$
Percentage of Motorcycles (%)	$n_{Motorcycles} / n_{tot} * 100\%$
- Percentage of heavy vehicles: Heavy Trucks (%)	$n_{Heavy\ Trucks} / (n_{Medium\ Trucks} + n_{Heavy\ Trucks} + n_{Buses}) * 100\%$
- Percentage of heavy vehicles: Buses (%)	$n_{Buses} / (n_{Medium\ Trucks} + n_{Heavy\ Trucks} + n_{Buses}) * 100\%$

☝ A scheme using hourly traffic and percentages has the advantage that overall traffic figures can be changed without altering the traffic mix.

File on CD — Examples\02_Sources\Road\Road\Calc CadnaA-figures from TNM-figures.xls

Ltraf,ref dB(A) — direct input of $L_{traf,ref}$ in dB(A)

Diurnal Pattern — see chapter 2.4.1 "Common Input Data", section "Diurnal Pattern"

Source Geometry

Depending on vehicles type, sub-sources are located at different heights (at 0.1 m for tire, 1.5 m (5 feet) for engine, and 3.66 m (12 feet) for stack, all above ground).

☝ A height of 0.1 m for the tire source as in TNM 2.5 software is used, while the TNM 1.0 documentation states a height of 0.0 m instead.

2

Speed Correction

Traffic speed can be specified for "Autos" and - if activated - for "Trucks" separately (in km/h). The speed limit entered for "Autos" will be considered as limit for autos and motorcycles, while the speed limit entered for "Trucks" - if any - will be considered for medium and heavy trucks, and for buses. With the limit entered just for "Autos" (i.e. "Trucks" deactivated) the value applies to all types of vehicles (no intrinsic speed limit for trucks). The DEN-selector enables to define speed limits for each daily period individually (for autos and trucks separately).

☝ Accelerating ramps and flow control devices are not available in **CadnaA** for the time being.

Road Surface

The following TNM-specific road surface types are available:

- Average (of DGAC and PCC)
- DGAC: dense-graded asphaltic concrete
- OGAC: open-graded asphaltic concrete
- PCC: Portland cement concrete

☝ FHWA states that the „average pavement type shall be used in the FHWA TNM for future noise level prediction unless a highway agency substantiates the use of a different pavement type for approval by the FHWA.“

Road Gradient (%)

The road gradient is <u>not</u> considered by **CadnaA** when calculating TNM-specific emission for the time being.

Throttle

TNM has two kinds of operating conditions causing a different emission: „cruise throttle“ and „full throttle“. With the option „Throttle“ activated the respective road will be considered as a full throttle road.

2.4.7 Czech Method

Emission Parameter

The emission parameter according to the Czech Method is the A-weighted equivalent continuous sound pressure level $L_{Aeq,7.5m}$ at a reference distance of 7.5 m from the center line of the outer lane of an infinite straight road with free sound propagation /81/.

Emission Level LAeq,7.5m

The mean level $L_{Aeq,7.5m}$ calculates from:

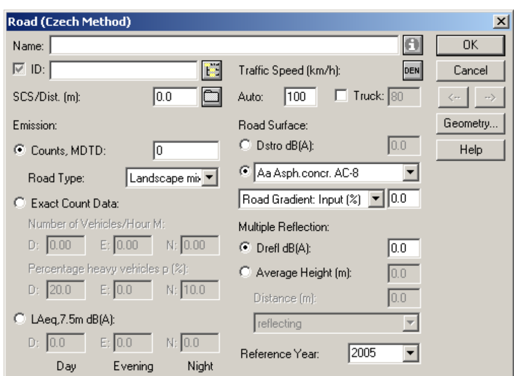
$$L_{Aeq,7.5m} = 10\lg X - 10.1 \quad \text{in dB(A)}$$

with the correction X:

$$X = F_1 \cdot F_2 \cdot F_3$$

where

- the factor F_1 expresses the influence of the speed of the traffic flow and the percentage of the lorries,
- the factor F_2 expresses the influence of the road gradient (slope), and
- the factor F_3 expresses the influence of the road pavement.



Dialog **Road** (for Czech Method)

2

The factor F_1 is calculated separately for daytime (6-22 h) and nighttime (6-22 h) according to:

$$F_1 = n_{OA} \cdot F_{vOA} \cdot 10^{L_{OA}/10} + n_{NA} \cdot F_{vNA} \cdot 10^{L_{NA}/10}$$

where

n_{OA} average traffic flow per hour of the cars (Day or Night)

n_{NA} average traffic flow per hour of the lorries and buses (Day or Night)

F_{vOA} speed dependence of the equivalent sound pressure level on the traffic flow consisting from the cars only (see below)

L_{OA} A-weighted sound pressure level of the passenger cars for the year under consideration, given in the table in section „Particular Years“ (see below)

F_{vNA} speed dependence of the equivalent sound pressure level on the traffic flow consisting from the lorries and buses only (see below)

L_{NA} A-weighted sound pressure level of the lorries and buses for the year under consideration, given in the table in section „Particular Years“ (see below)

F_{vOA} is given by: $F_{vOA} = 3.59 \cdot 10^{-5} \cdot v^{0.8}$ for v <= 60 km/h

$F_{vOA} = 2.70 \cdot 10^{-7} \cdot v^{2}$ for v > 60 km/h

F_{vNA} is given by: $F_{vNA} = 1.50 \cdot 10^{-2} \cdot v^{-0.5}$ for v <= 60 km/h

$F_{vNA} = 2.45 \cdot 10^{-4} \cdot v^{0.5}$ for v > 60 km/h

Particular Years

Particular sound pressure level L_{OA} (in dB) for cars, and L_{NA} (in dB) for trucks and buses for years 1995-2005 are given in the next table.

Year	level L_{OA} cars, dB(A)	level L_{NA} trucks and buses, dB(A)
1995	77.9	85.4
1996	77.4	84.7
1997	76.8	84.0
1998	76.2	83.3
1999	75.6	82.4
2000	74.9	81.4
2001	74.8	81.1
2002	74.6	80.9
2003	74.4	80.7
2004	74.3	80.4
2005	74.1	80.2

Specification of Emission

MDTD

Specifying the „Mean Daily Traffic Density“ (MDTD, veh/24h) calculates the emission level $L_{Aeq,7.5m}$ depending on the road type based on the hourly traffic data M (veh/h) and the truck proportion p (%) according to the table below.

Attribute Value STRGATTNR	Road Type	daytime (6-22 h)		nighttime (22-6 h)	
		M *1) **(veh/h)**	**p** *2) **(%)**	**M** *1) **(veh/h)**	**p** *2) **(%)**
0	Motorway	0.0563 DTV (=0.9/16)	25	0.0125 DTV (=0.1/8)	12.5
1	Landscape mixed	0.0581 DTV (=0.93/16)	20	0.0087 DTV (=0.7/8)	10
2	Settlement mixed	0.06 DTV (=0.96/16)	20	0.005 DTV (=0.04/8)	10
3	Recreational	0.0606 DTV (=0.97/16)	10	0.0038 DTV (=0.03/8)	3

*1) $M = n_{OA} + n_{NA}$

*2) $p = n_{OA}/(n_{OA} + n_{NA}) * 100\%$

Exact Count Data

Any number of vehicles per hour M and other proportions of trucks p% can be specified when selecting this option.

$L_{Aeq,7.5m}$

for direct input of the emission level

Diurnal Patterns

see chapter 2.4.1 "Common Input Data", section "Diurnal Pattern"

Speed Limit (km/h)

The speed correction in **CadnaA** is based on the speed entered (whether it complies with an actual speed limit or not).

2

Source Geometry

The height entered in the dialog **Geometry** is the height of the road's surface. The source height is 0.5 m above the road's center line or above the center lines of the outer lanes.

Road Gradient (%)

The factor F_2 expresses the influence of the slope s on the level $L_{Aeq,7.5m}$ (see subsequent table).

One-way road				Two-ways road	
Inclining		Declining			
%	F_2	%	F_2	%	F_2
s < 1	1.00	s <= 6	1.0	s < 1	1.00
1 <= s < 2	1.12	s > 6	2.5	1 <= s < 2	1.06
2 <= s < 3	1.25			2 <= s < 3	1.13
3 <= s < 4	1.42			3 <= s < 4	1.21
4 <= s < 5	1.60			4 <= s < 5	1.30
5 <= s < 6	1.79			5 <= s < 6	1.40
s = 6	2.00			s = 6	1.50
s > 6	2.50			s > 6	2.50

Road Surface

The factor F_3 expresses the influence of the road pavement on the level $L_{Aeq,7.5m}$. The correction for different road surfaces D_{StrO} (in dB) can be entered or selected from the list box (for speeds > 50 km/h). By default, the road surfaces listed in a following table are available.

For speeds < 50 km/h, the factor F_3=1.0 for all types of asphalt concrete and concrete pavements. For the same speed range the factor is F_3=2.0 for the small set pavings and F_3 = 4.0 for the set pavings.

2

Attribute Value STRONR	Pavement Category	Road Surface	Factor F_3
1	Aa	Asphalt concrete - AC-8 Asphalt concrete continuously graded	1.0
2	Ab	Gap-graded asphalt concrete for very thin layers ACVTL-11 (e.g. type RUMAC)	1.0
3	Ac	Stone mastic asphalt SMA-11 or another asphalt with grading up to 11 mm (e.g. type ULM)	1.1
4	Ad	Asphalt concrete AC-16HE with the use of modified bitumen	1.1
5	Ae	Cold micro surfacing with grading up to 8 mm (e.g. type GRIPFIBRE)	1.2
6	Ba	Concrete pavement with texture with towed jute	1.2
7	Bb	Concrete pavement with negative transverse roughness	1.2
8	Bc	Concrete pavement with fine transverse roughness	1.5
9	Ca	Small set paving (surface course)	2.0
10	Cb	Set paving (surface course)	4.0

Correction for Multiple Reflections

Multiple reflections within an urban road can be corrected for by the correction for multiple reflections according to RLS-90. This enables to reduce the order of refections considered by image sources (see chapter 6.2.8 "Reflection Tab").

see chapter 2.4.2 "RLS-90", section "Correction for Multiple Reflections" for details

2.4.8 SonRoad

Emission Parameter

According to the Swiss road noise model „SonRoad“ the A-weighted sound power level L_{wA} in dB(A) emitted by the two vehicle types autos and trucks calculates from /80/:

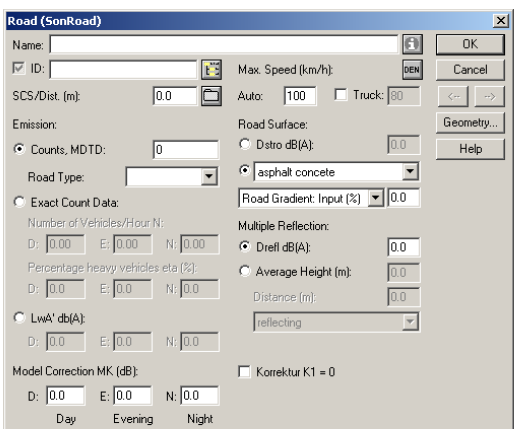
- for autos:

$$L_{wA,autos} = 28.5 + 10\lg\left(10^{0.1(7.3+35\lg v+\Delta_{BR})} + 10^{0.1\left(60.5+10\lg\left(1+\left(\frac{v}{44}\right)^{3.5}\right)+\Delta_S\right)}\right) + \Delta_{BG}$$

- for trucks:

$$L_{wA,trucks} = 28.5 + 10\lg\left(10^{0.1(16.3+35\lg v+\Delta_{BR})} + 10^{0.1\left(74.7+10\lg\left(1+\left(\frac{v}{56}\right)^{3.5}\right)+\Delta_S\right)}\right) + \Delta_{BG}$$

where
v: speed of autos or trucks, in km/h
Δ_{BR}: correction for roll noise component on road surfaces (tabulated, see below), in dB(A)
Δ_{BG}: correction for total noise component on road surfaces (tabulated, see below), in dB(A)
Δ_S: gradient correction, in dB(A)



Dialog **Road** (for SonRoad)

2

In SonRoad, emission is based on A-weighted sound power levels, while the calculation of propagation occurs in one-third octave-bands, in **CadnaA** converted to octave band levels and A-weighted levels.

The A-weighted sound power per unit length L'_{wA} in third-octave bands results from:

$$L'_{wA} = 10\lg\left(\sum_{j=0}^{23}\left(\frac{N_{autos}}{v_{autos}}10^{0.1(L_{wA,autos}+Y_j)} + \frac{N_{trucks}}{v_{trucks}}10^{0.1(L_{wA,trucks}+Y(j))}\right)\right) - 30\ dB + MK + K_1$$

where
N_{autos}, N_{trucks}: number of autos/trucks per hour
v_{autos}, v_{trucks}: speed of autos/trucks, in km/h
Y(j): third-octave values of the reference spectrum (see below), in dB(A)
j: running number of third-octave

Reference Spectrum

The values X(j) represent the A-weighting spectrum. As the emission data was measured on hard ground the final spectrum Y(j) results.

i	Frequency (Hz)	X(j) in dB(A)	Y(j) in dB(A)
1	100	-20	-24.3
2	125	-20	-24.3
3	160	-18	-22.3
4	200	-16	-20.2
5	250	-15	-19.1
6	315	-14	-17.9
7	400	-13	-16.6
8	500	-12	-15.1
9	630	-11	-13.4
10	800	-9	-10.3
11	1000	-8	-7.6
12	1250	-9	-6.6
13	1600	-10	-7.5
14	2000	-11	-10.9
15	2500	-13	-14.5
16	3150	-15	-15.5
17	4000	-16	-15.1
18	5000	-18	-18.7

2

Specification of Emission

MDTD

CadnaA offers to introduce traffic data based on Mean Daily Traffic Data (MDTD), though not available in SonRoad originally. In this case, the number of vehicles per hour N and the percentage trucks/buses eta (%) is calculated for the road type „Switzerland“ according to the specifications in the Swiss road noise standard STL-86 /55/.

Road Type	Day (6-22 h)		Night (22-6 h)	
	N (veh/h)	Eta (%)	N (veh/h)	Eta (%)
Switzerland	0.058 MDTD	10	0.009 MDTD	5

Exact Counts

This option enables to enter the five hourly traffic figures N and percentage of heavy vehicles eta (%) for the time periods D/E/N.

L'wA dB(A)

direct input of L'_{wA} in dB(A)

Diurnal Pattern

see chapter 2.4.1 "Common Input Data", section "Diurnal Pattern"

Model Correction MK

The model correction MK can - as already available for STL86 /55/ - be entered for each road and time periods D/E/N individually.

Level Correction K1

The level correction K_1 is a low traffic correction according to:

$$K_1 = \begin{cases} -5 & : \quad N < 31.6 \\ 10\lg\left(\frac{N}{100}\right) & : \quad 31.6 \leq N < 100 \\ 0 & : \quad N > 100 \end{cases}$$

where N: total number of vehicles per hour

Speed (km/h)

The speed correction in **CadnaA** is based on the speed entered (whether it complies with an actual speed limit or not).

Source Geometry

The source height in SonRoad is 0.45 m above ground.

Road Surface

The table below lists the road surface corrections for the total noise (Δ_{BG}) and for the roll noise (Δ_{BR}).

Surface Type	Δ_{BG} **dB(A)**	Δ_{BR} **dB(A)**
asphalt concrete AC 8,11,16 (also AB 10,11,16)	0	0
concrete (depending on age and condition)	+2	0
porous asphalt PA 8,11 (formerly drain asphalt DRA 10,11) for speeds v > 70 km/h	-4	0
mastic asphalt MA 8,11,16 (formerly GA)	0	0
rough asphalt AC MR 8,11 (formerly also Macro-Rugeux MR 6,11)	-1	0
surface treatment OB 3/6	0	0
surface treatment OB 6/11	+1	0
stone mastic asphalt SMA 6	-1	0
stone mastic asphalt SMA 8,11	0	0
chipped mastic asphalt SPA 6,8,11	0	0
asphalt concrete TA 10	0	0
asphalt concrete TA 16	+1	0
pavement (Note - Larger individual spread is likely.)	0	+6

Road Gradient (%)

A positive road gradient g (i.e. uphill) results in the level correction:

$$\Delta_S = 0.8 \cdot g \quad \text{for g > 0\%}$$

Roads with negative slope (i.e. downhill) receive no correction.

Correction for Multiple Reflections

Multiple reflections within an urban road can be corrected for by the correction for multiple reflections according to RLS-90. This enables to reduce the order of refections considered by image sources (see chapter 6.2.8 "Reflection Tab").

2

see chapter 2.4.2 "RLS-90", section "Correction for Multiple Reflections" for details

2.4.9 NMPB 2008

2

Emission Parameter

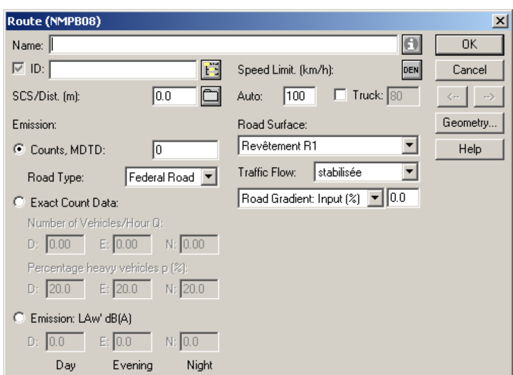
The emission parameter in NMPB-2008 /67/ is the A-weighted third-octave sound power level per unit length and per vehicle in dB(A). This level calculates from /68/:

$$L_{W/m}(j) = 10\lg\left(10^{(L_{W/m/VL}+10\lg Q_{VL})/10} + 10^{(L_{W/m/PL}+10\lg Q_{PL})/10}\right) + R(j)$$

where
$L_{W/m/VL}$: sound power level per unit length of the light vehicles, in dB(A)
Q_{VL}: hourly traffic of the light vehicles (max. mass m < 3500 kg), in veh/h
$L_{W/m/PL}$: sound power level per unit length of the heavy vehicles, in dB(A)
Q_{PL}: hourly traffic of the heavy vehicles (max. mass m >= 3500 kg), in veh/h
R(j): third-octave values of the reference spectrum for road noise, in dB(A)
j: running number of octave

In **CadnaA**, the overall traffic flow Q (in vehicles/hour) and the percentage of heavy vehicles p% is to be specified instead. The relation between those figures and the ones above are:

$$Q = Q_{VL} + Q_{PL} \quad \text{and} \quad p\% = \frac{Q_{PL}}{Q}$$



Dialog **Road** (for NMPB 2008)

Emission Parameter LwA'

The emission parameter displayed on the dialog **Road** is the A-weighted total sound power level per unit length L'_{Aw} in dB(A) according to:

$$L'_{wA}(j) = 10\lg\sum_{j=1}^{18} 10^{0.1\cdot L_{W/m}(j)} \quad \text{in dB(A)}$$

Traffic Data

The noise emission is calculated from traffic data based on the daily periods Day (6-22 h) and Night (22-6 h). The day may be subdivided into two further periods: 6-18 h and 18-22 h. The emission is estimated according the following specifications depending on:

- the „Mean Daily Traffic Density“ (MDTD, veh/24h) or the „trafics moyens journaliers annuels“ (TMJA, veh/24 h),
- the daily time period,
- the number of lanes (for urban and inter-urban roads).

In any case, the emission is limited to the emission caused by a so-called „maximum traffic flow“ situation („émission sonore maximale du flot“).

MDTD (TMJA)

Specifying the „Mean Daily Traffic Density“ (MDTD, veh/24h) or „trafics moyens journaliers annuels“ (TMJA, veh/24 h) calculates the emission level depending on the road type selected.

NMPB 2008, table 2.2, specifies TMJA-ranges in combination with ranges of the percentage of heavy vehicles %PL:

<table>
<tr><td rowspan="2">Road Type</td><td>TMJA</td><td colspan="2">%PL</td><td rowspan="2">%HPS</td><td rowspan="2">%TV daytime</td><td rowspan="2">%TV nighttime</td></tr>
<tr><td>veh/day</td><td>daytime (6-22 h)</td><td>nighttime (22-6 h)</td></tr>
<tr><td>Voiries structurantes urbaines</td><td>17000 to 217000</td><td>5 to 20%</td><td>5 to 35%</td><td>7,5 to 9,5</td><td colspan="2">-</td></tr>
<tr><td>Voiries urbaines intersecteurs</td><td rowspan="2">2500 to 25000 (Île-de-France: 50000)</td><td colspan="2" rowspan="2">0 to 5%</td><td rowspan="2">6,5 to 9,5</td><td rowspan="2">85 to 95%</td><td rowspan="2">15 to 5%</td></tr>
<tr><td>Voiries urbaines de secteurs</td></tr>
</table>

2

As this table does not establish a strict relation with respect to the three road types, the road types from the German VBUS /100/ are taken instead in **CadnaA** (see chapter 2.4.2 "RLS-90", section "MDTD - VBUS").

Speed Correction

The maximum speed is 130 km/h for autos, and 100 km/h for trucks.

NMPB 2008 states that the speed of autos is equivalent to the indicated maximum speed of a road while the maximum speed of trucks are depending on road type. In **CadnaA**, however, the speed of trucks has to edited by the user as these road types do not combine with the road types for used for MDTD/TMJA.

Road Type	**Speed of Trucks PL (km/h)**
highway interconnection	90
speed lane, urban	90
road with separated carriage ways	85
road with single carriage ways	80
in agglomerations	indicated speed

Reference Spectrum

The values R(j) of the weighting spectrum are listed in the following table:

third-octave band center frequency (Hz)	100	125	160	200	250	315	400	500	630
draining road surface	-22	-22	-20	-17	-15	-12	-10	-8	-9
non-draining road surface	-27	-26	-24	-21	-19	-16	-14	-11	-11

third-octave band center frequency (Hz)	800	1000	1250	1600	2000	2500	3150	4000	5000
draining road surface	-9	-10	-11	-12	-13	-16	-18	-20	-23
non-draining road surface	-8	-7	-8	-10	-13	-16	-18	-21	-23

2

Source Description

For each vehicle category, the emission (sound power level per unit length) consists of two components:

$$L_{W/m/veh} = 10\lg\left(10^{0.1 \cdot Lr_{\_W/m}} + 10^{0.1 \cdot Lm_{\_W/m}}\right)$$

where
$Lr_{\_W/m}$: rolling noise, due to tire-road interaction, called „roll noise“
$Lm_{\_W/m}$: mechanical sources of the vehicles, called „engine noise“

Roll Noise

The roll noise component for three types of road surface (R1, R2, R3) is given in the next table:

Attribute Value STRONR	Road Surface Category	Speed Range v (km/h) Autos (VL)	Speed Range v (km/h) Trucks (PL)
		20 <= v <= 130	20 <= v <= 100
1	R1	53,4 + 21 log (v/90)	61,5 + 20 log (v/80)
2	R2	55,4 + 20,1 log (v/90)	63,4 + 20 log (v/80)
3	R3	57,5 + 21,4 log (v/90)	64,2 + 20 log (v/80)

Engine Noise

With engine noise the following effects influence the radiated noise:

- traffic flow condition, five different situations apply:

  - stabilisée,
  - accélération,
  - décélération,
  - troncons de démarage,
  - troncons d'arrêt.

- road gradient, three different situations apply:

  - horizontal (gradient <= 2% absolute),
  - increasing (gradient 2 to 6%),
  - decaresing (gradient -2 to -6%)

Gradients larger to 6% (absolute) do not increase the correction.

☝ For the time being, the respective equations for all engine noise situations are not stated here.

2

Source Geometry

The height entered in the dialog **Geometry** is the height of the road's surface. The source height is 0.05 m (5 centimeters) above the road's center line or above of the center lines of the outer lanes.

Correction for Multiple Reflections

There is no global correction available in NMPB-2008 to correct for multiple reflections. However, **CadnaA** enables to restrict the calculation using image sources to the 1st order of reflection and to correct for multiple reflections according to RLS-90 /12/.

see chapter 6.2.10.8 "NMPB 2008" and chapter 2.4.2 "RLS-90"

2.4.10 Further Procedures for Road Noise

2

☝ Information on the following standards or guidelines for road noise can be found in the German version of the **CadnaA**-reference manual:

- RVS 4.02 (Austria)
- StL-86 (Switzerland)
- DIN 18055 (1987, Germany)

2.4.11 Air Pollution according to MLus-92

CadnaA enables you to calculate air pollution caused by road traffic according to a national German procedure, called MLuS 92, edition 1996 /41/.

The calculation of air pollution according to the MLuS 92 in **CadnaA** is similar to noise calculation according to the method "Long Straight Road". By clicking on a road with the right mouse button you can select from the opening context menu the command **Air Pollution**. On the dialog, all the relevant parameters of this road have been automatically transferred to the respective input boxes.

REMARK: For the time the dialog has not been translated into English.

An alternative is to open the edit box via **Tables|Miscellaneous|Air Pollution**. In this case you would have to enter via the keyboard the relevant parameters like MDTD, truck-percentage and so on.

Values in red indicate an infringement or an incorrect entry.

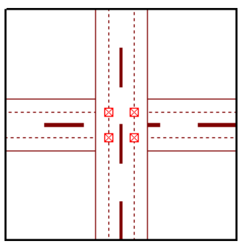
2.5 Crossings with Traffic Lights

The majority of standards for road noise do no offer to model road crossings controlled by traffic lights. The only two standards defining a correction depending on distance are RLS-90 /12/ and the Swiss „Guide-line for Road Noise, advice paper No. 0637“ /58/.

Calculation according to RLS-90

The correction for road crossings controlled by traffic lights according to RLS-90 is applied with for all road noise guidelines and standards implemented in **CadnaA, besides** STL86+ /54//55/ and SonRoad /61/, provided that the object „Crossing w/ Traffic Light“ is used at all in the model.

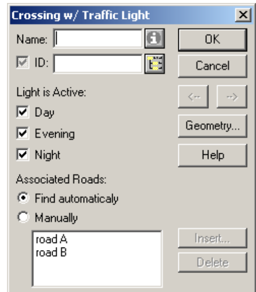
In RLS-90, the location of the object „Crossing“ in the model does <u>not</u> comply with its physical location, but is the imaginary intersection point of the respective emission lines (which is a hatched line, by default).



In the model, the object „Crossing“ is located at the imaginary intersection point/s of the respective emission lines

Select the object „Crossing“ from the toolbox and insert it at the first imaginary intersection point of the outer lanes of roads. In order to make use of all parameters set for the first traffic light also for subsequent traffic lights specify all relevant parameters on dialog **Crossing**. When entering the next object „Crossing“ the parameters specified for the first traffic light will be adopted for all subsequent ones.

2



Light is active

When allocating a traffic light to a crossing or junction, the penalty according to RLS-90, section 4.2, table 2, is added to the receiver level automatically taking into account at what time, day, evening or night, the traffic light is active.

distance d of the receiver from the closest intersection of emission lines	correction K (dB)
<= 40 m	3
40 < d <= 70 m	2
70 < d <= 100 m	1
> 100 m	0

The correction K is applied only once (at multiple crossings with traffic lights).

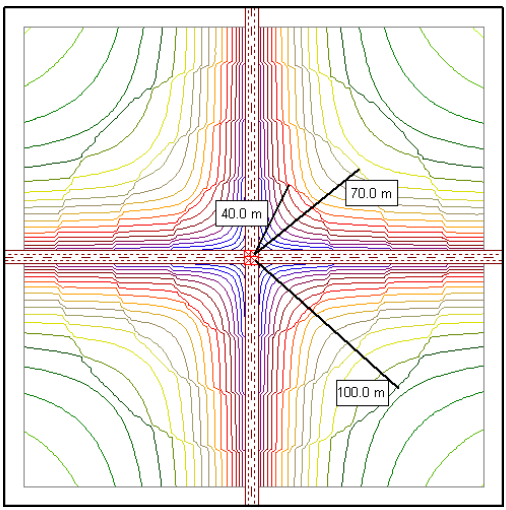
The check boxes enable to specify traffic light's activity separately for daytime, evening and night-time. In the graphics, an active traffic light is indicated by a cross within the square.

Associated Roads

Any road lying within at a distance < 20 m to the traffic light's position will be allocated to this crossing in the calculation, and will be listed on the list box „Associated Roads“. The option „Find Automatically“ is activated by default.

To allocate a road to a crossing with traffic lights, enter at least a single active receiver and start the calculation by clicking the pocket calculator icon.

Example



Road crossing with traffic lights: Grid showing the correction with limiting distances according to RLS-90

2

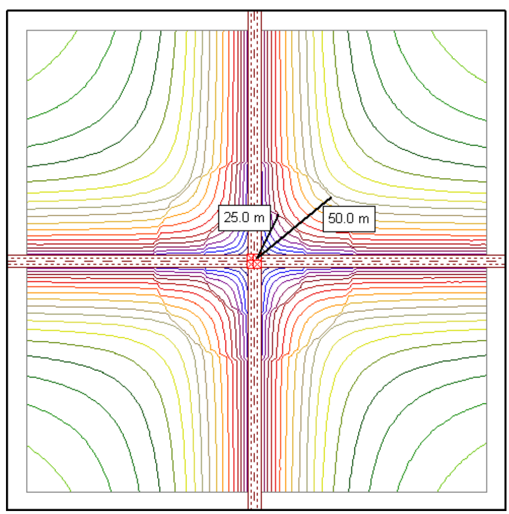
Calculation according to SN 640 578

The correction according to Swiss „Guideline for Road Noise, advice paper No. 0637“ /58/ is considered only if the road noise standards STL86+ /53/ /54/ or SonRoad /60/ are selected and the object „Crossing“ is used.

distance d of the receiver from the closest intersection of emission lines	correction (dB)
< 25 m	2
25 <= d < 50 m	1
d >= 50 m	0

Furthermore, all remarks as given for RLS-90 hold, especially, with the option „Find Automatically“ being activated (default setting) the distance condition < 20 m to the traffic light’s position is used to decide whether a road is being listed in „Associated Roads“ or not.

Example

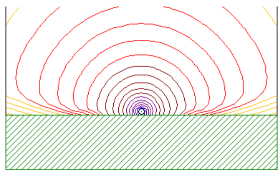


Road crossing with traffic lights: Grid showing the correction with limiting distances according to the Swiss „Guideline for Road Noise“

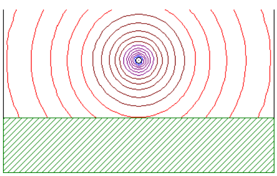
2.6 Railways

The sound source „Railway" is radiating to all sides unless the option „Self-Screening" is not activated (see chapter 2.4.1 "Common Input Data", section "Self-Screening").

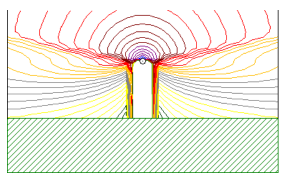
The railway object may have different heights at each polygon point (see chapter 4.1). The source is located at the top edge of the rail (railhead) with a relative height of 0.6 m by default.



Radiation from sound source „Railway",
relative height 0.6 m



Radiation from sound source „Railway",
relative height 10.6 m,
option „Self-Screening" **deactivated**



Radiation from sound source „Railway",
relative height 10.6 m,
option „Self-Screening" **activated**,
additional width L/R 2 m each

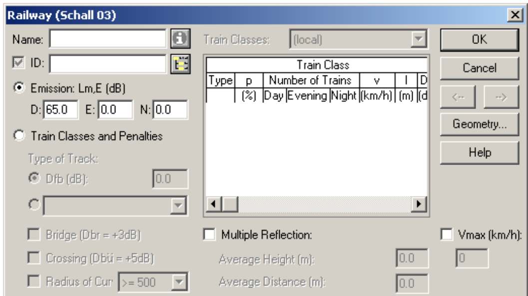
The command **Parallel Object** (see manual „Introduction to **CadnaA**") on the context menu of a railway enables to generate barriers, embankments, or contour lines at a specified distance or to generate station marks into the direction of the road using the command **Generate Station** (see manual „Introduction to **CadnaA**").

The parameters of a railway are entered in edit mode on the dialog **Railway** that opens when double-clicking on the railway's centre line.

☝ The subsequent chapters are specific for each standard or guideline available in **CadnaA**. These specifications do not represent a copy of the standardized procedures, rather the way they are implemented.

2.6.1 Common Input Data

Dialog Railway



Dialog **Railway** (here for Schall-03 as an example)

On the dialog **Railway** it can be selected whether the emission shall be specified using the guideline-specific emission parameter or (e.g. $L_{m,E}$ for Schall 03) or based on the number of trains for the guideline-specific train classes.

Emission

Emission Parameter

With the option „Emission“ selected values of the guideline-specific emission parameter for daily periods Day/Evening/Night (D/E/N) can be entered.

☝ Whether all three time periods are relevant depends on the selected guideline for railway noise (see chapter 6.2.11 "Railroad Tab").

Train Classes and Penalties

With this option activated the number of trains for the guideline-specific train classes can be selected from a list (so-called „List of Trains“). In this case, **CadnaA** calculates the resulting emission level from the input data automatically (see guideline-specific chapters).

2

There are two alternatives to define a list with number of trains:

1. By editing the local table on the dialog **Railway**. To this end, select the option „(local)“ from the list box.
2. By referencing an existing list with number of trains available from the **Tables** menu, **Libraries (local)|Number of Trains**. To this end, select the name of the train list from the list box.

Number of Trains

Editing a local list

Use the context menu commands to insert new lines to the local train list.

Editing the local table is useful only when just a single railway section is concerned. In practice, a railway track has to be split into several sections due to changing parameters relevant for emission (such as track type or bridge penalty). With a local train list this would mean that with any small change (e.g. in the numbers of trains) each individual section would have to be reedited. To avoid this effort a list with number of trains is defined and referenced via the box „List of Trains“ for all relevant railway sections.

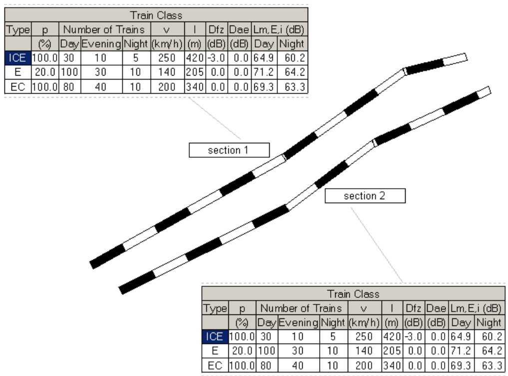
Library Number of Trains

Via the table **Numbers of Trains (Tables** menu, **Libraries (local)**) a table listing the number of trains for all railway classes travelling on a railway track can be compiled. To achieve this reference is established to the railway classes available from the local or global library (menus **Tables|Libraries (global)|Railway Classes** or **Tables|Libraries (local) |Railway Classes**). Subsequently, this list with number of trains is referenced on dialog **Railway** by selecting its name.

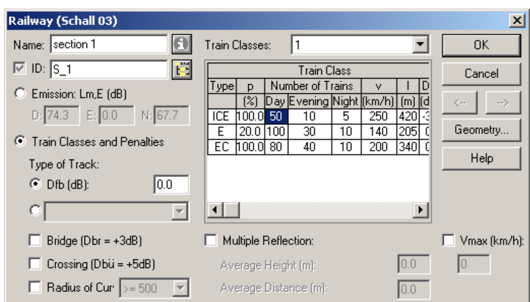
This procedure has - compared with a local train list - the advantage that any changes in the table with the train numbers have to be edited once only, but will effect all railway section referencing that list, no matter whether the changes occurs via the table **Railway** (on the **Tables|Sources** menu) or via the list of trains in the edit dialog on dialog **Railway**. In either case, the change will be addressed to all railway sections referencing this list of trains.

Example

In the subsequent example, two railway sections are referencing to the local list with number of trains „1“.

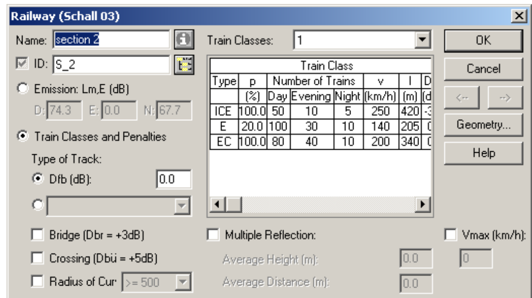


Now, on dialog **Railway** of section 1 the number of trains for the first train class („ICE“) is changed from 30 to 50 trains.

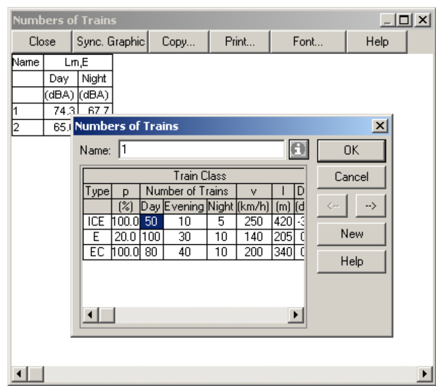


Upon closing the dialog by OK the change will be also become relevant to railway section 2 which is referencing this train list as well.

2



This change will also concern the train list „1“ in the local library.



In case the change would have been made to that train list „1“ via the local library, all railway sections referencing this list would have been concerned by this change.

Edit Boxes for Railway Classes

The input boxes for each train class within the train list depends on the selected guideline for railway noise and will be explained in the following guideline-specific chapters.

Import Number of Trains

Lists with Number of Trains can be imported and exported (**File** menu, command **Import** and. **Export**).

see chapter 7.2.13 "Import / Export of Numbers of Trains"

and regarding import operations:

chapter 8.2 "Creating & Addressing Lists with „Number of Trains“" in the manual „Introduction to **CadnaA**“ (including an example)

Purging Tables with Number of Trains

When files containing train lists are imported, those train lists will be appended to the existing train lists. In order to prevent the list from increasing in length, select the command **Purge Tables** from the **Tables| Miscellaneous** menu to update this list with number of trains. Subsequently, all train lists not being referenced by any railway section will be deleted.

Dialog Geometry

Source Height

The height entered in the dialog **Geometry** corresponds with the rail's top edge. The default value is 0.6 m (relative height).

Self-Screening

When the option „Self-Screening“ on the dialog **Geometry** is activated the railway is just radiating into the upper half sphere. For the lower half sphere a screening effect occurs for all receivers below the railroad's surface. This feature enables to define inclined railway lines, either upwards or downwards, by allocating the height above (relative) ground or an absolute height to every point of the railway, and by defining an additional width (e.g. considering sidewalks etc.). Since the option „Self-Screening“ is available, the use of the object „Bridge“ became superfluous (see chapter 3.4).

Additional Width left/right

With the self screening-option activated, the actual width of the railway line can be specified by entering an additional width > 0 m. The additional width can be defined separately for either side of a railway line.

2

The graphical representation of the object „Railway“ (also on 3D Special View) does not consider the additional width (so, being different from the object „Road“). The specified additional width will, however, be considered upon calculation. The same holds in the same way for the additional parapets left/right.

Parapet left/right

In addition, parapets (e.g. parallel barriers) for the self-screening road can be defined, either on one or both sides by entering a height left/right > 0 m. The parapets are treated as fully absorbing on either sides. This characteristic cannot be changed. Absorbing or reflecting barriers without or with cantilever can be defined just by using the object „Barrier“ (see chapter 3.3).

The following requirements and properties are to be respected:

- In any case, the additional width has to be > 0 m.
- The screens defined via option „Self-Screening“ are a characteristic of the railway and are not displayed in the 2D-graphics, but just on the 3D-Special view.
- Barriers defined via option „Self-Screening“ will just screen the own source (railway), but not the noise from other kinds of sources.

Stationing from/to

This option enables to restrict the length of the barrier along the railway’s axis with reference to the stationing. In this case, the barrier is just generated for the range „from-up to“.

This option is particularly useful when modelling bridges in order to suppress the diffraction around the edge of the railway sections at bridgeheads.

For the automatic assignment two attributes are available:

- station start: SSCR_ST_B
- station end: SSCR_ST_E

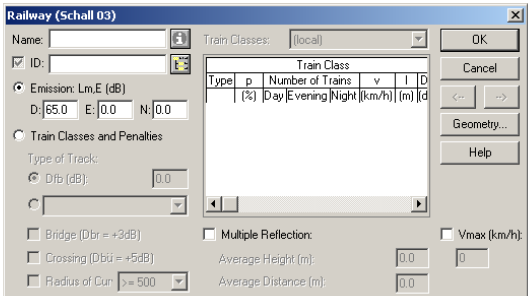
only for Ground Absorption

With this option being activated, the additional width entered will not cause any screening effect, but will just be considered when calculating ground absorption. This requires, however, that the respective option on the configurations is checked (dialog **Calculation|Configuration**, tab „Ground Absorption“, option „Roads/Parking Lots are reflecting G=0“, see chapter 6.2.7). With this option activated the speed of calculation may increase considerably due to the omission of barrier calculation.

The self-screening effect of the road’s surface - including parallel barriers, if any - just refers to the respective road itself. Thus, the parallel barriers (parapets) defined via „Self-Screening“ are not seen by other sources.

2

2.6.2 Schall 03



Dialog **Railway** (for Schall03)

Emission Level

The emission parameter according to Schall 03 is the mean level $L_{m,E}$ at 25 m distance and at 3.5 m height above the rail's top edge from the railway line's axis with free sound propagation /18/. It calculates from (sum of all relevant train classes i):

$$L_{m,E} = 10\lg\left[\sum_i 10^{0.1*(51+D_{Fz}+D_D+D_l+D_v+D_{Ae})}\right] + D_{Fb} + D_{Br} + D_{Bü} + D_{Ra}$$

where D_{Fz}: correction for the type of train
D_D: correction for the type of brakes
D_l: correction for train length
D_v: correction for the speed
D_{Ae}: correction for aerodynamics
D_{Fb}: correction for track type
D_{Br}: correction for bridges
$D_{Bü}$: correction for level/grade crossings
D_{Ra}: correction for curves

The basic value of 51 dB(A) is the mean level at 25 m distance and at 3.5 m height above the rail's top edge for a single train per hour with a length of 100 m, a speed of 100 km/h, and for 100% of the vehicles with disc brakes.

2

Type of Train

Abbreviation	Type of Train	D_{Fz} (dB)
ICE	InterCity Express	-3
EC	EuroCity / InterCity	0
IR	Interregio	0
D	passenger train	0
E	local train	0
N	commuter train	0
S	S-Bahn (multiple unit)	0
SB	S-Bahn Berlin	0
SH	S-Bahn Hamburg	0
SRR	S-Bahn Rhein-Ruhr	0
G	Freight Train (distant)	0
GN	Freight Train (local)	0
U	underground/subway	2
STR	tram	3
TR1	Transrapid 07/1	0
TR2	Transrapid 07/2	-1

Type of Brakes

$$D_D = 10 \lg (5 - 0.04 \, p)$$

where p: percentage of vehicles with disc brakes referring to the train length (including locomotive/s)

Train Length

$$D_l = 10 \lg (0.01 \, l)$$

where l: sum of all trains of train class i per hour

Speed

$$D_v = 20 \lg (0.01 \, v)$$

where v: speed (track or loco max. speed) in km/h

Aerodynamics

$$D_{Ae} = 0 \text{ dB for } v <= 250 \text{ km/h}$$

$$D_{Ae} = 1 \text{ dB for } 250 \text{ km/h} < v <= 300 \text{ km/h}$$

see /20/

Track Correction

Attribute Value FBNR	Type of Track	D_{Fb} (dB)
1	Lawn formation - Tramway	-2
2	Ballast - Wooden sleepers	0
3	Ballast - Concrete sleepers	2
4	Concrete Track - no absorption	5

Bridges

$D_{Br} = 3$ dB

Level/Grade Crossings

$D_{Bü} = 5$ dB

Curves

Radius of Curves r	D_{Ra} (dB)
r < 300 m	8
300 m <= r < 500 m	3
r >= 500 m	0

Correction for Multiple Reflections

With high-rise building structures lateral to the railway track a correction for multiple reflections can be considered based on the their distance and their mean height.

In **CadnaA**, the correction for multiple reflections is calculated according to RLS-90 (see chapter 2.4.2 "RLS-90", section "Correction for Multiple Reflections").

v_{max}

When specifying a track-relevant maximum speed v_{max} the train speed will be adjusted if necessary. In the calculation the smaller of both values is used.

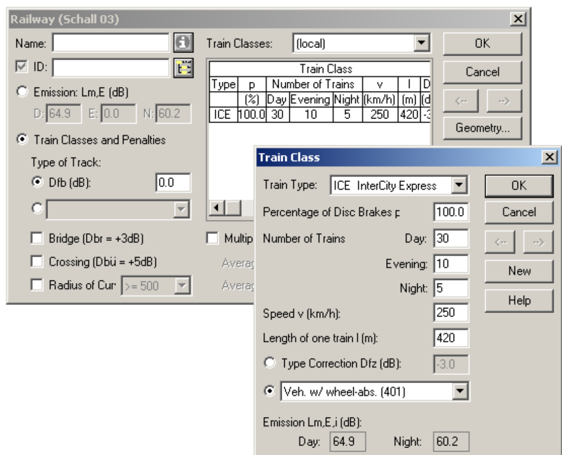
Train Classes and Penalties

2

With this option activated, the types of trains and train classes, numbers of trains and corrections, can be edited locally, or an existing list with number of trains can be selected. **CadnaA** will automatically calculate the emission level from the specified values.

☝ In the following, the procedure to edit a local train list (with numbers of trains) is described. To enter a train list in the local library, see chapter 2.6.1 "Common Input Data", section "Number of Trains".

Local Train List



Train Type

The train type is selected from the list **Train Types** on the **Library (global)|Railway Group** (also called „Train Classes“). By this selection all relevant parameters, such as train length and speed or percentage of disc brakes, are specified.

Number of Trains Day/Evening/Night

Numbers of trains for Day and Night (for Schall 03). In case the amount is given by trains per hour, this values have to be multiplied by 16 to obtain the figure for Day and by 8 for Night.

☝ For calculations according to VBUSch /101/ the Evening period is relevant as well (D/E/N = 12/4/8 h).

relevant speed of trains of the respective train class (in km/h) *Speed*

length l of a train of the respective train class (in m) *Train Length*

By the type correction D_{fz} the effect of different kinds of vehicles is accounted for /18/ /19/. Alternatively, the train type is selectable from a list of train types. *Type Correction*

Type of Vehicle	D_{Fz} (dB)
Vehicle w/ wheel-absorbers (401)	-3
Vehicle w/ disc brakes (403...)	-2
Vehicle w/ disc brakes (Bx)	-1
Subway	2
Tram	3
other	0
Transrapid 07/1	0
Transrapid 07/2	-1

The emission level $L_{m,E,i}$ for a train class resulting from the specified parameter is displayed here. *Emission $L_{m,E,i}$ (dB)*

see chapter 2.6.1 "Common Input Data", section "Number of Trains" **Library with Number of Trains**

2

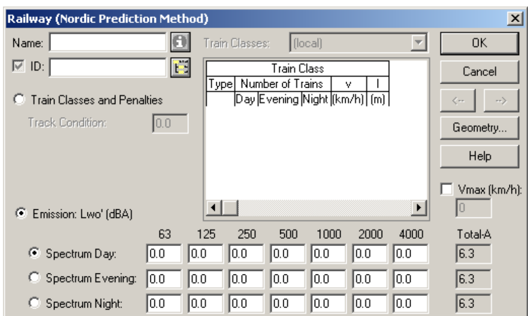
2.6.3 Nordic Prediction Method 1996

Evaluation Parameters

According to Nordic Prediction Method (NPM) for railway traffic noise (TemaNord 1996:524) two evaluation parameters are calculated /63/:

- the A-weighted equivalent continuous sound pressure level $L_{A,eq}$ and
- the A-weighted maximum sound pressure levels L_{maxM} (energy average over train length) or L_{maxF} (highest level with „Fast“ meter setting).

As the equivalent continuous level $L_{A,eq}$ is calculated per day (24 h) no specific day- or nighttime values exist. In contrary, a separate procedure is applied to calculate the maximum level L_{AFmax}.



Dialog **Railway** (for Nordic Prediction Method)

Emission Level L'wo

The emission parameter for L_{eq}-based evaluations is the A-weighted sound power level per unit length L'_{wo} /63/:

$$L'_{wo} = a \cdot \lg\left(\frac{v}{100}\right) + 10\lg\left(l_{24h}\right) + b + \Delta L_c$$

where a,b: constants depending on train type and frequency
v: train speed, in km/h
l_{24h}: total passing train length within 24 hours, in m
ΔL_c: track correction, in dB

Emission Level L’wt

The emission parameter for max-level evaluations is the A-weighted sound power level per unit length L'_{wt} /63/:

$$L'_{wt} = a \cdot \lg\left(\frac{v}{100}\right) + 10\lg v + 43.8 + b + \Delta L_c$$

where a,b: constants depending on train type and frequency
v: train speed, in km/h
ΔL_c: track correction, in dB

see also chapter 6.2.11.2 "Nordic Prediction Method (1996)"

Track Condition

In case the option „Train Classes and Penalties“ is selected the track condition can be entered manually. The track correction ΔL_c is also used to correct the emission level for joints, crossings, and bridges.

Type of Track	**ΔL_c (dB)**
ballasted tracks with continuously welded rails on concrete or wooden sleepers	0
rails with joints	3
10 m track length for each unit of switches and crossings	6
partial track length on a bridge without ballast	6
partial track length on a bridge with ballast	3

☝ **CadnaA** provides no list box for track conditions as NPM states ranges of the track correction, rather than distinct values.

Source Position

The source heights with respect to the octave band centre frequency are listed on the following table (approximative):

Partial Source	**Octave band centre frequency (Hz)**						
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**
Rails							
Wheels							
Engine etc. (Diesel power trains)							
Curve screech							
Carriages, wagon (primarily goods trains)							
Braking							
Source Position on the track centre line (meters above rail head)	**2**	**1.5**	**0.8**	**0.3**	**0.4**	**0.5**	**0.6**

v_{max} (km/h)

When specifying a track-relevant maximum speed v_{max} the train speed will be adjusted if necessary. In the calculation the smaller of both values is used.

Train Types

2

In **CadnaA**, the following train types are available from the global library (**Tables** menu, **Libraries (global)|Railway Groups**).

Abbreviation	Train Class Name
Npas	N-Pass El
Ngoo	N-Goods El
Nb65	N-B65 Pass El
Nb70	N-B70 Pass El
Nb69	N-B69 Pass El
Sx2	S-X2 Pass El Concr
Spas	S-Pass El Concr
Spaw	S-Pass/W El Wood
Sx10	S-X10 Pass El Concr
Sgod	S-GoodsDi Diesel Concr
Sgoo	S-Goods El Concr
Fsm	F-Sm Pass El Concr
Fsr1	F-Sr1 Pass El Concr
Fgoo	F-Goods mEl Wood
Rgoo	R-Goods mEl Concr
B71t	BM 71 El today maint
B72t	BM 72 El today maint
B73t	BM 73 El today maint
B71i	BM 71 El improved maint
B72i	BM 72 El improved maint
B73i	BM 73 El improved maint
B93D	BM 93 Di
SL79	SL 79 Leddtrikk
Tban	T-bane
T2k	T-2000
X31	X31/32 Contessa
X52	X52-53 Regina
Y31	Y31 Itino

☝ In case those railway groups are not listed on the **Tables** menu, import the library „Train Classes“ from Type „Default“ into the global library.

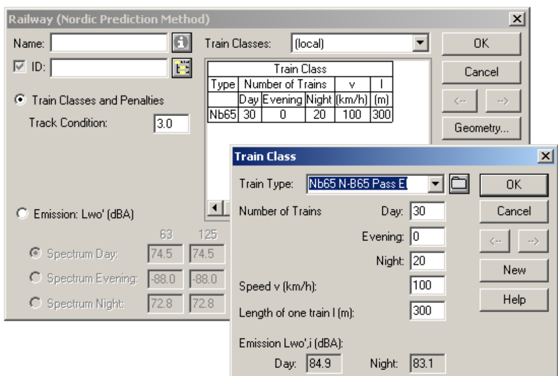
2

Train Classes and Penalties

With this option activated, the types of trains and train classes, numbers of trains and corrections, can be edited locally, or an existing list with number of trains can be selected. **CadnaA** will automatically calculate the emission level from the specified values.

☝ In the following, the procedure to edit a local train list (with numbers of trains) is described. To enter a train list in the local library, see chapter 2.6.1 "Common Input Data", section "Number of Trains".

Local Train List



Train Type

The train type is selected from the list **Train Types** on the **Library (global)|Railway Group** (also called „Train Classes“). By this selection all relevant parameters are specified.

Number of Trains Day/Evening/Night

Numbers of trains for Day/Evening/Night. With the same numbers of trains for D/E/N the same power level $L'_{wo,i}$ results.

Speed v (km/h)

relevant speed of trains (in km/h)

Train Length (m)

length l of the respective train class (in m)

Emission $L_{m,E,i}$ (dB)

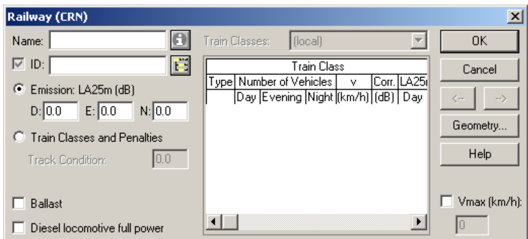
The emission level (sound power per unit length) $L'_{wo,i}$ for a train class resulting from the specified parameter is displayed here.

Library with Number of Trains

see chapter 2.6.1 "Common Input Data", section "Number of Trains"

2.6.4 CRN

The evaluation parameter in CRN („Calculation of Railway Noise“) is the level $L_{Aeq,18h}$ in dB(A) /70/.



Dialog **Railway** (for CRN)

Emission Parameter

The emission parameter in CRN is the A-weighted continuous sound pressure level $L_{Aeq,25m}$ at a distance of 25 m from the nearside railhead. It calculates from the base line sound exposure level SEL in dB(A) at that distance by:

- for rolling railway vehicles (electric locos, cars and wagons):

$$SEL_{vehicle} = 31.2 + 20\lg v \quad \text{in dB(A)}$$

- for diesel locomotives (full power):

$$SEL_{vehicle} = 112.6 + 10\lg v \quad \text{in dB(A)}$$

and for N number of identical vehicles:

$$SEL_{tot} = SEL_{vehicle} + 10\lg N \quad \text{in dB(A)}$$

2

This results in the two levels L_{Aeq} for Day and Night:

$$L_{Aeq,18h} = SEL_{tot} - 48.1 + 10\lg N_{day} \quad \text{in dB(A)}$$

$$L_{Aeq,6h} = SEL_{tot} - 43.3 + 10\lg N_{night} \quad \text{in dB(A)}$$

where N_{day}: number of trains during daytime (6 to 24 hours)
N_{night}: number of trains during daytime (0 to 6 hours)

Track Condition

In case the option „Train Classes and Penalties“ is selected the track correction can be entered manually.

Type of Track	**correction (dB)**
continuously welded rail	
- on concrete	0
- on wooden sleepers	0
jointed track, points and crossings	+2.5
slab track	+2
concrete bridges and viaducts	+1
steel bridges	+(4 to 9)

☝ For the time being, **CadnaA** provides no list box for CRN-specific track corrections.

v_{max} (km/h)

When specifying a track-relevant maximum speed v_{max} the train speed will be adjusted if necessary. In the calculation the smaller of both values is used.

Geometry

The source height in CRN is the height of nearside railhead. For diesel locomotives at full power, however, it is at 4 m above the nearside railhead.

Train Types & Type Corrections

In **CadnaA**, the following types of train and type corrections are available.

☝ The data of the CRN-specific train classes is not available via the local or global libraries, but coded internally.

Abbr.	Train Class Name	Corr. dB(A)	Abbr.	Train Class Name	Corr. dB(A)
Mk1	British Rail MkI	14.8	C33	Class 33	14.8
Mk2	British Rail MkII	14.8	C37	Class 37	16.6
GwEx	Gatwick Express	16.7	C43	Class 43	18
C421	Class 421 EMU	10.8	C47	Class 47	16.6
C422	Class 422 EMU	10.8	C56	Class 56	16.6
LUnA	London Undergr-A Stock	12.9	C59	Class 59	16.6
LUnT	London Undergr-Tube stock	7.1	C60	Class 60	16.6
Mk3	British Rail MkIII	6	C73	Class 73	14.8
Mk4	British Rail MkIV	6	C86	Class 86	14.8
C319	Class 319 EMU	11.3	C87	Class 87	14.8
C465	Class 465 EMU	8.4	C90	Class 90	14.8
C466	Class 466 EMU	8.4	C91	Class 91	14.8
C165	Class 165 DMU	7	C20F	Class 20 Full Power	0
C166	Class 166 DMU	7	C31F	Class 31 Full Power	0
MML	Manchester Metrolink LRV	15.8	C33F	Class 33 Full Power	0
SYST	South Yorkshire Supertram	14.9	C37F	Class 37 Full Power	0
2XTW	2 axle tank wagon	12	C43F	Class 43 (HST) Full Power	0
4XTW	4 axle tank wagon	15	C47F	Class 47 Full Power	0
MGRC	Merry Go Round Coal Hopper	8	C56F	Class 56 Full Power	0
FL	Freightliner	7.5	C59F	Class 59 Full Power	0
C20	Class 20	14.8	C60F	Class 60 Full Power	0
C31	Class 31	16.6			

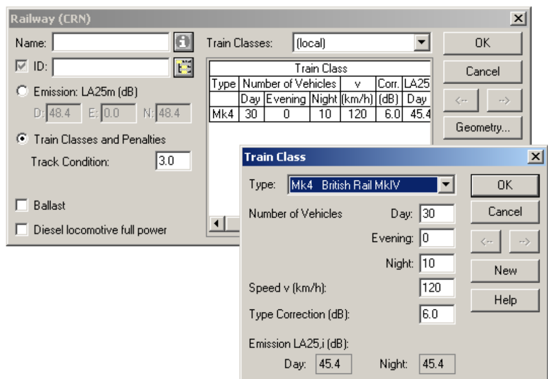
2

Train Classes and Penalties

With this option activated, the types of trains and train classes, numbers of trains and corrections, can be edited locally, or an existing list with number of trains can be selected. **CadnaA** will automatically calculate the emission level from the specified values.

☝ In the following, the procedure to edit a local train list (with numbers of trains) is described. To enter a train list in the local library, see chapter 2.6.1 "Common Input Data", section "Number of Trains".

Local Train List



Train Type The train type is selected from the list „Type". By this selection all relevant parameters are specified.

Number of Vehicles numbers of trains for Day/Evening/Night

Speed v (km/h) relevant speed of trains (in km/h)

Type Correction (dB) type correction for this train type

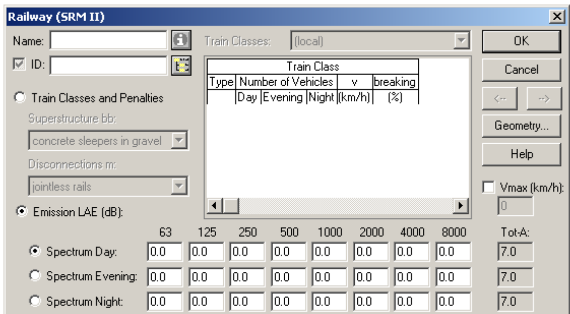
Emission $L_{A25,i}$ (dB) The emission level $L_{A25,i}$ for train class i resulting from the specified parameter is displayed here.

Library with Number of Trains see chapter 2.6.1 "Common Input Data", section "Number of Trains"

2

2.6.5 SRM II

The Dutch calculation method SRM II („Standaardrekenmethode 2“) calculates in octave band width and splits up the source into maximally 5 sub-sources at different heights depending on the type of train /74/.



Dialog **Railway** (for SRM II)

Already within the calculation of emission, the portions of braking or not braking trains are distinguished. The emission level in octave band i is calculated by:

$$L_{E,i}^{h} = 10\lg\left(\sum_{c=1} n \cdot 10^{E_{nb,i,c}^{h}/10} + \sum_{c=1} n \cdot 10^{E_{br,i,c}^{h}/10} \right) \quad \text{in dB(A)}$$

where

n is the number of train categories using the railway line under consideration,

$E_{nb,i,c}^{h}$ is the emission term for non-braking units for train in each train category (c = 1 to n), in octave band i,

$E_{br,i,c}^{h}$ is the emission term for braking units for train in each train category (c = 1 to n), in octave band i,

and at assessment height h (h = {0; 0.5; 2; 4; 5} m, dependent on the train category).

2

The emission terms E calculate from:

- for braking trains:

$$E^h_{br,i,c} = a^h_{br,i,c} + b^h_{br,i,c} \log V_{br,c} + 10 \lg Q_{br,c} + C_{bb,imc} \quad \text{in dB(A)}$$

- for non-braking trains:

$$E^h_{nb,i,c} = a^h_{i,c} + b^h_{i,c} \log V_c + 10 \lg Q_c + C_{bb,imc} \quad \text{in dB(A)}$$

where:

$a^h_{i,c}$, $b^h_{i,c}$:	emission terms for train category c in non-braking conditions, for octave band i, at height h
$a^h_{br,i,c}$, $b^h_{br,i,c}$:	emission terms for train category c in braking conditions, for octave band i, at height h
Q_c:	mean number of non-braking units of the railway vehicle category concerned
$Q_{br,c}$:	mean number of braking units of the railway vehicle category concerned
V_c:	mean speed of passing non-braking railway vehicles
$V_{br,c}$:	mean speed of passing braking railway vehicles
bb:	type of track/condition of the railway tracks
m:	estimation of the occurrence of track disconnection
$C_{bb,i,m}$:	correction for to track discontinuities and rail roughness

Train Classes

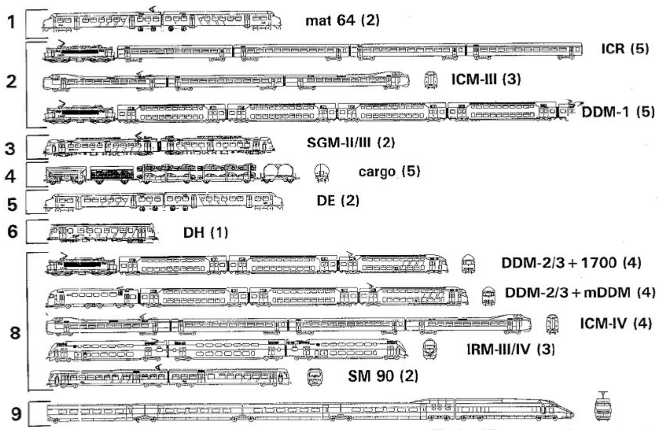
The existing categories that are provided in the Dutch emission database are primarily differentiated by propulsion system and wheel brake system as follows:

Category	Train description
1	Block braked passenger trains
2	Disc braked and block braked passenger trains
3	Disc braked passenger trains
4	Block braked freight trains
5	Block braked diesel trains
6	Diesel trains with disc brakes
7	Disc braked urban subway and rapid tram trains
8	Disc braked InterCity and slow trains
9	Disc braked and block braked high speed trains
10	Provisionally reserved for high speed trains of the ICE-3 (M) (HST East) type

Train Units

2

The next figure shows side views of the train categories and specifies the number of individual units. One unit of any given category determines the sound emission. In the case of the trains drawn, the locomotives, carriages or cars act as individual units. In case of integrated trains, the connected sections are regarded as a single unit.



SRM II-specific train categories (in brackets: number of units)

☝ In SRM II calculation method, the modification of the predefined train classes with regard to a real train composition with deviating train length or number of cars/locos, can just be corrected by using the number of trains n within the periods D/E/N, but not by modifying the train length itself. The train length is not an editable parameter in SRM II.

2

Emission Indices a, b

category		octave band with centre frequency [Hz]							
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
	index code	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	a	20	55	86	86	46	33	40	29
	b	19	8	0	3	26	32	25	24
2	a	51	76	91	84	46	15	24	36
	b	5	0	0	7	26	41	33	20
3	a, v < 60 km/h	54	50	66	86	68	68	45	39
	a, v >= 60 km/h	36	15	66	68	51	51	27	21
	b, v < 60 km/h	0	10	10	0	10	10	20	20
	b, v >= 60 km/h	10	30	10	10	20	20	30	30
3 motor	a, v < 60 km/h	72	88	85	51	62	54	25	15
	a, v >= 60 km/h	72	35	50	68	9	71	7	-3
	b, v < 60 km/h	-10	-10	0	20	10	20	30	30
	b, v >= 60 km/h	-10	20	20	10	40	10	40	40
4	a	30	74	91	72	49	36	52	52
	b	15	0	0	12	25	31	20	13
5	a, v < 60 km/h	41	90	89	76	59	58	51	40
	a, v >= 60 km/h	41	72	89	94	76	58	51	40
	b, v < 60 km/h	10	-10	0	10	20	20	20	20
	b, v >= 60 km/h	10	0	0	0	10	20	20	20
5 diesel	a	88	95	107	113	109	104	98	91
	b	-10	-10	-10	-10	-10	-10	-10	-10
6	a, v < 60 km/h	54	50	66	86	68	68	45	39
	a, v >= 60 km/h	36	15	66	68	51	51	27	21
	b, v < 60 km/h	0	10	10	0	10	10	20	20
	b, v >= 60 km/h	10	30	10	10	20	20	30	30
6 motor	a, v < 60 km/h	72	88	85	51	62	54	25	15
	a, v >= 60 km/h	72	35	50	68	9	71	7	-3
	b, v < 60 km/h	-10	-10	0	20	10	20	30	30
	b, v >= 60 km/h	-10	20	20	10	40	10	40	40
7	a	56	62	53	57	37	36	41	38
	b	2	7	18	18	31	30	25	23
8	a	31	62	87	81	55	35	39	35
	b	15	5	0	6	19	28	23	19

2

Emission Indices for category 9

category		octave band with centre frequency [Hz]							
		63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
	index code	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
railcar									
9, 0 m	a	7	14	57	52	57	66	47	71
	b	27	28	12	18	18	15	21	5
9, 2 m	a	9	10	1	41	8	17	0	23
	b	26	28	36	22	37	34	39	24
9, 4 m	a	5	11	13	56	-27	-19	-37	-12
	b	27	28	31	15	50	47	53	36
9, 5 m	a	11	18	28	28	-50	-41	-84	-34
	b	25	26	25	25	59	56	73	45
pushed/pulled units									
9, 0 m	a	3	10	57	50	53	62	43	67
	b	27	28	12	18	18	15	21	5
9, 2 m	a	3	10	57	46	47	55	37	61
	b	27	28	12	18	18	15	21	5
9, 4 m	a	1	8	54	40	40	49	30	54
	b	27	28	12	18	18	15	21	5
9, 5 m	a	3	10	54	0	0	0	0	0
	b	27	28	12	0	0	0	0	0

Braking Correction

octave band i	$C_{brake.i.c}$(in dB)			
	cat = 1, 4, 5	**cat =2**	**cat = 7**	**cat = 3, 6, 8, 9**
1	-20	-20	-8	-20
2	-20	-20	-7	-20
3	-20	-20	-20	-20
4	-2	0	-20	-20
5	2	1	-20	-20
6	3	2	-20	-20
7	8	5	-20	-20
8	9	5	-5	-20

cat: Train Category

2

Superstructure bb (Track Condition)

The correction factor $C_{bb,i}$ as a function of structures above station compounds or railway track condition (bb) and octave band (i) is:

octave band i	$C_{bb,i}$ (in dB)							
	bb=1 concrete sleepers in gravel	bb=2 wooden sleepers in gravel	bb=3 gravel	bb=4 blocks	bb=5 blocks and gravel	bb=6 contr. rail fixation	bb=7 contr. rail fixation + gravel	bb=8 poured in railway lines
1	0	1	1	6	6	-	6	5
2	0	1	3	8	8	-	1	4
3	0	1	3	7	8	-	0	3
4	0	5	7	10	9	-	0	6
5	0	2	4	8	2	-	0	2
6	0	1	2	5	1	-	0	1
7	0	1	3	4	1	-	0	0
8	0	1	4	0	1	-	0	0

Besides the track condition a roughness correction is applied which is a function of track disconnections. The wheel roughness depends on the type of brake system as a function of the wavelength (radiated frequency is speed related).

☝ The model of roughness correction applied in SRM II is not dealt with in detail within this chapter for the time being.

Disconnections

The following types of disconnections are available:

- jointless rails
- rails with joints
- 2 switches per 100m
- > 2 switches per 100m

Speed (km/h)

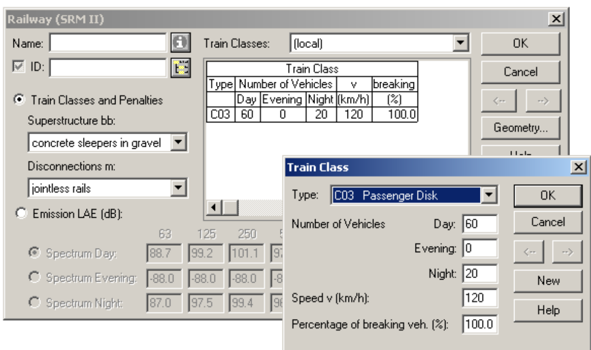
SRM II indicates the following maximum speeds per category:

category	1	2	3	4	5	6	7	8	9	10
v [km/h]	140	160	140	100	140	120	100	160	300	330

These train type specific speed limits are, however, not implemented in **CadnaA** for the time being.

When specifying a track-relevant maximum speed v_{max} the speed will be adjusted if necessary. In the calculation the smaller of both values is used.

Local Train List



Train Type

The train type is selected from the list **Train Types** on the **Library (global)|Railway Group** (also called „Train Classes“). By this selection all relevant parameters are specified.

Number of Trains Day/Evening/Night

Numbers of trains for Day and Night. For calculations for mixed evaluation parameters (such as L_{den}) see chapter 6.2.11.4 "SRM II".

Speed v (km/h)

relevant speed of trains (in km/h)

Percentage of breaking vehicles

percentage of all vehicles of a train category to be considered as braking vehicles

☝ The emission level L_{AE} is not displayed in the dialog **Train Class**, but on the dialog **Railroad** (as not all correction factors are known with the dialog **Train Class**).

Library with Number of Trains

see chapter 2.6.1 "Common Input Data", section "Number of Trains"

2.6.6 NMPB-Fer 1996

> Note - No printed guideline is available describing the NMPB-method applied in France to railway traffic. This method, called „NMPB-Fer“, is a calculation procedure implemented only into the former French sound propagation software MITHRA using a data set on emission data from the French national railway institution SNCF. For the time being, there is no detailed documentation on the NMPB-Fer algorithm available here.

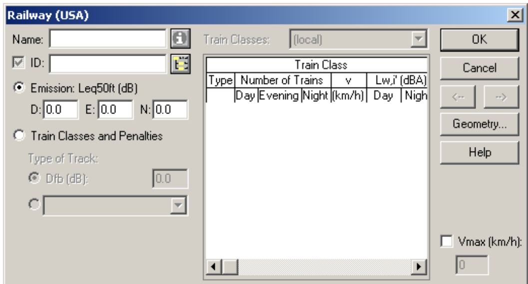
☝ The emission data for calculation according to NMPB-Fer is available from a file provided to customers separately.

for import of NMPB-Fer specific train classes see also:

chapter 7.2.14 "Special Formats"

2

2.6.7 FTA / FRA



Dialog **Railway** (for FTA/FRA)

Emission Level

The emission parameter according to FTA/FRA is the A-weighted equivalent continuous sound pressure level $L_{eq,50ft}$ at 50 feet (15.24 m) distance from the railway's axis /78//79/. For a single train class, it calculates from the sound exposure level $SEL_{i,50ft}$ in dB(A) of sub-source i:

$$SEL_{i,50\,ft} = \left(SEL_{ref}\right)_i + 10\lg\left(\frac{len}{len_{ref}}\right)_i + K\lg\left(\frac{v}{v_{ref}}\right)_i$$

where SEL_{ref}: reference sound exposure level for sub-source i
len: length of train or car/loco, in ft. (internally converted to m)
len_{ref}: reference length for sub-source i, in ft. (internally converted to m)
K: speed factor
v: speed, in mph (internally converted to km/h)
v_{ref}: reference speed for sub-source i, in mph (internally converted to km/h)

The total level SEL_{tot} for all sub-sources n of a single train class is:

$$SEL_{tot} = 10\lg\left(\sum_{i=1}^{n} 10^{SEL_i/10}\right)$$

The level $L_{eq,50ft}$ for a single type of train results from (per hour):

2

$$L_{eq,50\,ft} = SEL_{tot} + 10\lg\frac{N}{3600} + C_{Throttle} + C_{Track}$$

where N: number of trains per hour
$C_{Throttle}$: throttle correction (for FTA-sources only)

with the throttle correction $C_{Throttle}$ (T: throttle setting):

$$C_{Throttle} = \begin{cases} 0 & for\ T < 6 \\ 2(T-5) & for\ T \geq 6 \end{cases}$$

The total level $L_{eq,50ft,tot}$ for all train types j on a track is:

$$L_{eq,50\,ft,tot} = 10\lg\left(\sum_{j=1}^{m} 10^{L_{eq,50\,ft,j}/10}\right)$$

Track Correction

Attribute Value FBNR	Type of Track	C_{Track} (dB)
1	(normal)	0
2	jointed track	5
3	embedded track on grade	3
4	aerial structure w/ slab track	4

v_{max} (km/h)

When specifying a track-relevant maximum speed v_{max} the speed will be adjusted if necessary. In the calculation the smaller of both values is used.

Type of Trains

The table on the next page lists all FTA/FRA-train types. The following abbreviations for the sub-source types apply:

Abbreviation	Type of Sub-Source
HSWH	High Speed, Wheel-Rail Interaction
HSPR	High Speed, Propulsion
HSAE	High Speed, Wheel Region - Aerodynamic High Speed, Train Nose - Aerodynamic High Speed, Pantograph - Aerodynamic
LOCO	locomotive source
CAR	all other types of vehicles (cars, coaches)
HORN	warning horns

Type of Trains (cont.)

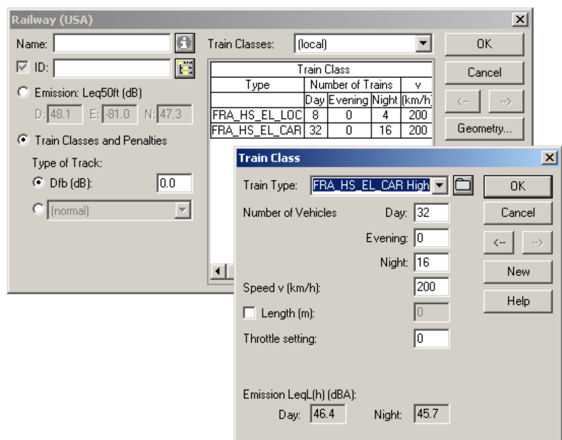
Application	Type	Name	Source Height (ft)	Source Height (m)	SEL_{ref} dB(A)	len_{ref} (m)	v_{ref} (km/h)	Speed Factor K	Source Type
FRA	HS_EL_LOC	HighSpeed Electric Locomotive	1	0.30	85	193.2	144.8	28	HSWH
			3	0.91	75	21.3	144.8	15	HSPR
FRA	HS_EL_CAR	HighSpeed Electric Car	1	0.30	85	193.2	144.8	28	HSWH
FRA	HS_FF_LOC	HighSpeed Fossil Fuel Locomotive	1	0.30	85	193.2	144.8	20	HSWH
			10	3.05	83	22.3	32.2	10	HSPR
FRA	HS_FF_CAR	HighSpeed Fossil Fuel Car	1	0.30	85	193.2	144.8	20	HSWH
FRA	HS_EMU_LOC	HighSpeed EMU Locomotive	1	0.30	91	193.2	144.8	20	HSWH
FRA	HS_EMU_CAR	HighSpeed EMU Car	1	0.30	91	193.2	144.8	20	HSWH
FRA	VHS_EL_LOC	VeryHighSpeed Electric Loc	1	0.30	91	193.2	145	20	HSWH
			5	1.52	89	193.2	289.7	60	HSAE
			10	3.05	89	22.3	289.7	60	HSAE
			12	3.66	86	22.3	32.2	0	HSPR
			15	4.57	86	-	289.7	60	HSAE
FRA	VHS_EL_CAR	VeryHighSpeed Electric Car	1	0.30	91	193.2	145	20	HSWH
			5	1.52	89	193.2	289.7	60	HSAE
FRA	FRA_CONV_FRE_LOC	Conventional Freight Locomotive	10	3.05	97	27.4	64.4	10	LOCO
FRA	FRA_CONV_FRE_CAR	Conventional Freight Car	1	0.30	100	609.6	64.4	20	CAR
FRA	FRA_CONV_PASS_LOC	Conventional Passenger Loco	10	3.05	94	18.2	64.4	10	LOCO
FRA	FRA_CONV_PASS_CAR	Conventional Passenger Coach	1	0.30	94	152.4	64.4	20	CAR
FRA	FRA_HORN	Horn	12	3.66	114	-	0	0	HORN
FTA	FTA_COMM_LOC_DE	Conv. Commuter Locomotive, Diesel-Electric	8	2.44	92	-	80.5	-10	LOCO
FTA	FTA_COMM_LOC_EL	Conv. Commuter Locomotive, Electric	2	0.61	90	-	80.5	-10	LOCO
FTA	FTA_COMM_DMU	Conv. Commuter Diesel Multiple Unit	2	0.61	85	-	80.5	-10	LOCO
FTA	FTA_COMM_HRN	Conv. Commuter Horn	12	3.66	110	-	0	0	HORN
FTA	FTA_COMM_CAR	Conv. Commuter Car	1	0.30	82	-	80.5	20	CAR
FTA	FTA_AGT_ST	Conv. AGT - Steel Wheel	2	0.61	80	-	80.5	20	LOCO
FTA	FTA_AGT_RU	Conv. AGT - Rubber Wheel	2	0.61	78	-	80.5	20	LOCO
FTA	FTA_HORN	Horn	12	3.66	113	-	-	0	HORN

Train Classes and Penalties

With this option activated, the types of trains and train classes, numbers of trains and corrections, can be edited locally, or an existing list with number of trains can be selected. **CadnaA** will automatically calculate the emission level from the specified values.

☝ In the following, the procedure to edit a local train list (with numbers of trains) is described. To enter a train list in the local library, see chapter 2.6.1 "Common Input Data", section "Number of Trains".

Local Train List



Train Type

The train type is selected from the list **Train Types** on the **Library (global)|Railway Group** (also called „Train Classes“). By this selection all relevant parameters, such as train length and speed or percentage of disc brakes, are specified.

Number of Trains Day/Evening/Night

Numbers of trains for Day and Night. In case the amount is given by trains per hour, this values have to be multiplied by 15 to obtain the figure for Day and by 9 for Night (for FTA/FRA).

Speed v (km/h)

relevant speed of trains (in km/h)

Train Length (m)

length l of the respective train class (in m)

As locos and cars are different train classes in FTA/FRA, an entire train consists, normally, of at least two types of train classes. Regarding the input of the length, however, both classes - locos and cars - have to be distinguished.

Example 1: A steel-wheeled electric train with 2 power cars and 8 passenger coaches is defined using the FRA-railway group "VHS Very High-Speed" and the following traffic data:

- number of trains: 60 during Daytime (4 trains per hour)

In this case, the length entered for locos as well as for cars corresponds to either default lengths (check box "Length" on dialog "Train Class" is deactivated). So, the number of vehicles to be entered for each category is:

- number of locos: 120 during Daytime (8 per hour)
- number of cars: 480 during Daytime (32 per hour)

Example 2 corresponds with example 1 regarding the number of trains. The number of vehicles, however, is entered in a different way.

As the noise emitted by the pantograph of the locos is linked to the number of locos, the two locos in each train cannot be entered as a single source of type FRA_VHS_EL_LOC while doubling its length. This would lead to a wrong emission as the pantograph's aerodynamic emission is per vehicle and not per length. So, the service numbers for locos have to be kept.

For the cars, however, the 8 passenger coaches per train could be counted as a single unit with a length of 8 * car length (8 * 18.59 m = 148.72 m). In this case, the number of locos and car compositions passing by are:

- number of locos: 120 during Daytime (8 per hour)
- number of cars: 60 during Daytime (4 per hour)

Both ways to specify the emission lead to the same emission level.

2

Throttle setting

The FTA-model applies a correction for the throttle setting with diesel-powered locos and Diesel Multiple Units (DMUs) only (see table 6-4, FTA-report). In **CadnaA**, throttle setting is applied to all sources of type LOCO instead. Consequently, the user has to ensure that the throttle is zero for all other FTA-loco-types besides the two mentioned above.

Emission $L_{m,E,i}$ (dB)

The emission level $L_{eqL(1h)}$ for a train class resulting from the specified parameter is displayed here.

Library with Number of Trains

see chapter 2.6.1 "Common Input Data", section "Number of Trains"

2.6.8 Further Procedures for Railway Noise

☝ Information on the following standards or guidelines for railroad noise can be found in the German version of the **CadnaA**-reference manual:

- ONR 305011 (Austria)
- DIN 18005 (1987, Germany)
- Semibel (Switzerland)
- Schall 03 (200X, Germany)

2.6.9 Train Class Libraries

Global Library

The global library for train classes (via **Tables|Libraries (global)|Railway Groups**) provides the emission data of various guideline-specific train classes with their parameters.

This library is accessed when editing a local train list (with numbers of trains) on the dialog **Railway**, but also when compiling a train list in the local library (**Tables|Libraries (local)|Numbers of Trains**). This global library of train classes can be edited and enlarged by the user. As with any global library, it is available in any **CadnaA**-project without any further import operation.

Train Classes (global)

OK | Cancel | --> Local Lib. | Copy... | Print... | Font... | Help

Train Class						
Application	Type	Name	p	v	l	Dfz
			(%)	(km/h)	(m)	(dB)
Schall 03	ICE	InterCity Express	100	250	420	-3.0
Schall 03	EC	EuroCity / InterCity	100	200	340	0.0
Schall 03	IR	Interregio	100	200	205	0.0
Schall 03	D	D/FD-Zug	30	160	340	0.0
Schall 03	E	Express	20	140	205	0.0
Schall 03	N	Nahverkehrszug	20	120	150	0.0
Schall 03	S	S-Bahn (Triebzug)	100	120	130	0.0
Schall 03	SB	S-Bahn Berlin	100	100	70	0.0
Schall 03	SH	S-Bahn Hamburg	100	100	130	0.0
Schall 03	SRR	S-Bahn Rhein-Ruhr	100	120	120	0.0
Schall 03	G	Freight Train (Long Dist.)	0	100	500	0.0
Schall 03	GN	Freight Train (Short Dist.)	0	90	200	0.0
Schall 03	U	Subway	100	80	80	2.0
Schall 03	STR	Tram	100	60	25	3.0
Schall 03	TR1	Transrapid 07/1	0	400	150	0.0
Schall 03	TR2	Transrapid 07/2	0	400	150	-1.0
Schall 03 200X	HGV_TK	HGV-Triebkopf, FzKat1	0	0	0	0.0
Schall 03 200X	HGV_MS	HGV-Mittel/Steuerwagen, FzKat2	0	0	0	0.0
Schall 03 200X	HGV_TZ_1	HGV-Triebzug, FzKat3, 1System	0	0	0	0.0
Schall 03 200X	HGV_TZ_2	HGV-Triebzug, FzKat3, 2 Systeme	0	0	0	0.0
Schall 03 200X	HGV_TZ_3	HGV-Triebzug, FzKat3, 3 Systeme	0	0	0	0.0
Schall 03 200X	HGV_NZ_411	HGV-Neigezug, FzKat4 BR 411	0	0	0	0.0
Schall 03 200X	HGV_NZ_470	HGV-Neigezug, FzKat4 ETR 470	0	0	0	0.0
Schall 03 200X	SBAHN_WS	S-Bahn FzKat5 Wellensch.	0	0	0	0.0
Schall 03 200X	SBAHN_RS	S-Bahn FzKat5 Radsch.	0	0	0	0.0
Schall 03 200X	DTZ	Diesel-Triebzug im Nahverkehr FzKat6	0	0	0	0.0
Schall 03 200X	ELOK_KB	E-Lok, FzKat7 Klotzbremse	0	0	0	0.0
Schall 03 200X	ELOK_SB	E-Lok, FzKat7 Scheibenbremse	0	0	0	0.0
Schall 03 200X	DLOK	D-Lok, FzKat8	0	0	0	0.0
Schall 03 200X	RZW_KB	Reisezugwagen, FzKat9 Klotzbremse	0	0	0	0.0
Schall 03 200X	RZW_SB	Reisezugwagen, FzKat9 Wellenscheibenbremse	0	0	0	0.0

Table **Train Classes** (or Railway Groups) from the global library

2

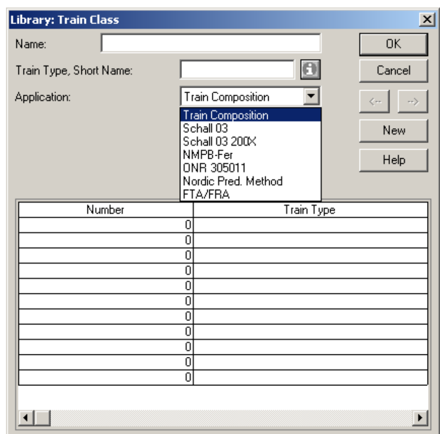
Local Library

In order to use a global train class in a project the respective data sets have to be copied to the local library first. Alternatively, the train classes are selectable from the global library via list box „Train Type“ on dialog **Railway:Train Class**.

This depends, however, on the calculation guideline selected as some calculation methods just use the global train classes (Schall03, Schall03 200X, SRMII, ONR 305011, Nordic Prediction Method, Railr. FTA/FRA) while for others the global train classes have to be copied to the local library (NMPB-Fer). For further guidelines the guideline-specific train classes are just coded in **CadnaA** internally and can, therefore, not be edited (e.g. Semibel, CRN, SRM II).

Inserting a new train class

In order to define a new train class insert a new line into the local or global library (via the context menu command **Insert before/after**). With a double-click on the new row the edit dialog of the new train class opens.



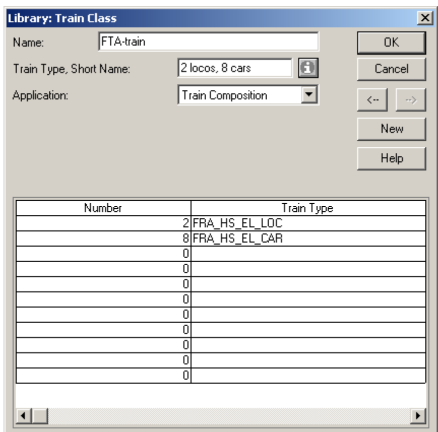
Application

Depending on the guideline selected the dialog will be adjusted. The option „Application“ is in fact a filter. Are the existing data records assigned to e.g. Schall 03, these train classes are available from the list box on the dialog **Railway:Train Class**, when Schall 03 has been selected on the dialog **Calculation |Configuration**, tab „Country“.

Train Composition

Some calculation methods for railway noise offer to set up user-defined trains composed of locomotives and wagons/cars (e.g. ONR 305011, Schall 03 200X, NMPB-Fer, FTA/FRA). When the option „Train Composition“ is selected from the list box, user-defined trains can be edited using the existing train types/classes.

In the list of the train composition enter the number and the train type (Type) of the train classes available from the library of train classes. Double click in column „Train Type“ and select the train class from the dialog **Train Composition**.



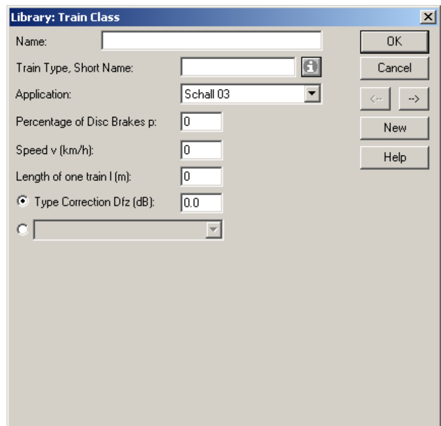
Train composition for FTA/FRA:
train composed of 2 locos and 8 cars

Enter also a name and a short name for train type. When selecting this train composition via the dialog **Railroad** the entered short name/name will be displayed on the list box „Train Type“. A train composition may consist of 11 lines (data sets) at the most.

Application Schall 03

With the application of Schall 03 the following input data is required to define a new train class:

- Name and Short Name
- Percentage of Disc Brakes p (%)
- Speed v (km/h)
- Length of one (single) train l (m)
- Type Correction D_{fz} (dB), alternatively selectable form the list box.



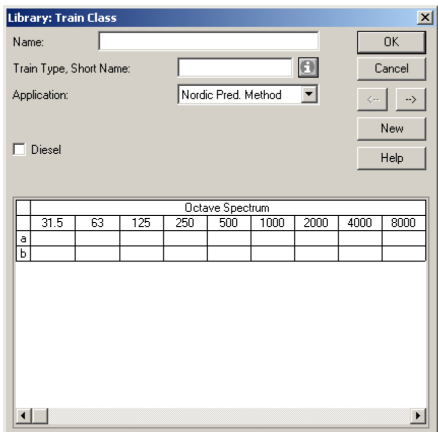
Dialog **Library:Train Class**: new train class for Schall 03

Application Nordic Prediction Method

Nordic Prediction Method requires spectra of parameters a and b to define a new train class. The following input data is required to define a new train class:

- Name and Short Name
- Diesel engine yes/no
- octave band spectrum for parameters a and b

To enter the spectrum click into the respective cell of the table.

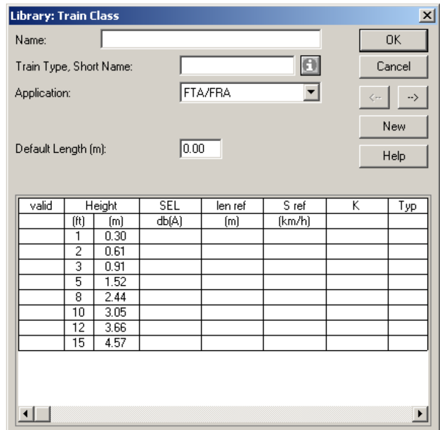


Dialog **Library:Train Class**: new train class for Nordic Prediction Method

2

Application FTA/FRA

FTA/FRA requires to define sub-sources for a new train class at a single or several heights. In this case, in column „valid“ a letter x is entered to activate that respective row. Type space to deactivate a row.



Dialog **Library:Train Class**: new train class for FTA/FRA

Emission model

Besides the sound exposure level SEL the FRA/FTA-emission model considers:

- default length (m), used for length correction
- reference length len_ref (m), used for emission correction
- reference speed S_ref (km/h) and speed factor K
- sub-source type (see below)

Source Heights

The FRA-source heights for all types of sub-sources result from tables 5-2 and E-1 in the FRA-report. As the source height specified for horns from either tables differ (12 vs. 13 ft), just the height of 12 ft has been considered in the emission table.

As far as source height with FTA-source heights are concerned, **CadnaA** applies a height of 12 ft for horns, of 8 ft for diesel-electric-locos and 2 ft for all other types of sources (see table 6-5 in the FTA-report). The horns as point sources do not require a default length.

Default Source Lengths

The default source length for FRA-train classes is the physical length of each vehicle (loco, car/wagon), irrespective what reference length len_ref is used to specify the source emission. As FTA-report evaluates the emission per car/loco this value is not relevant in this case.

Source Types

The following source types are used (see FRA-report, tables 5-2 and E-1, and FTA-report, table 6-4):

HSWH	High Speed Source - Wheel-Rail Interaction
HSPR	High Speed Source - Propulsion
HSAE	High Speed Source - Aerodynamic (with different heights)
LOCO	locomotive source
CAR	all other types of vehicles (cars, coaches)
HORN	warning horns

Application for further guidelines

The editing of new train classes for the following guidelines is described just in the German version of the **CadnaA**-reference manual:

- Schall 03 200X
- ONR 305011

2

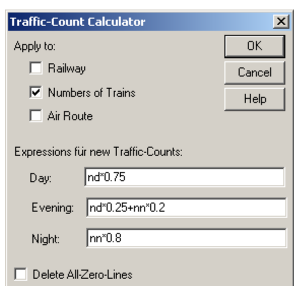
2.6.10 Traffic-Count Calculator

The **Traffic-Count Calculator** dialog on the **Tables|Miscellaneous** menu enables to redistribute the actual numbers of trains or of flight movements (i.e. traffic counts) for the time periods Day/Evening/Night.

Especially with calculations according to the EC-Directive on Environmental Noise the prevailing numbers of trains or flights for Day and Night may be redistributed to the three time periods Day/Evening/Night. The variables for the traffic counts of the three time periods are: nd for Day, ne for Evening, and nn for Night.

The redistribution can be applied to:

- all activated objects „Railway“,
- all lists for „Numbers of Trains“ (and consequently for all objects „Railway“ referencing a respective train list), and
- all activated objects „Air Route“.



Example

In the example above, the actual traffic counts of the local train lists for Day and Night will be redistributed, resulting in Evening counts being 25% of the Day, plus 20% of the Night. Therefore, the original traffic counts are reduced for the Day to 75% and for the Night to 80%.

2

Option „Delete All-Zero-Lines“

When this option is active, all data sets of the selected object type/s containing no data (empty or zero lines) will be deleted upon the next recalculation. This option ensures that non-valid traffic data (e.g. from import operations) is kept and exported afterwards.

2.7 Parking Lots

The sound emission of parking lots can be calculated according to:

- RLS-90 /12/,
- Parking Lot study, Bavarian Environmental Agency (LfU) 1993 /44/,
- Parking Lot study, Bavarian Environmental Agency (LfU) 1995 precise /42/, approximative /43/,
- Parking Lot study, Bavarian Environmental Agency (LfU) 2003 /45/,
- Parking Lot study, Bavarian Environmental Agency (LfU) 2007 /46/,
- Swiss standard SN 640 578:2006-07 /57/.

The sound immission or propagation is calculated:

- according to RLS-90 for public parking lots or
- according to the selected industry standard for commercial parking lots.

Edit Dialog Parking Lot

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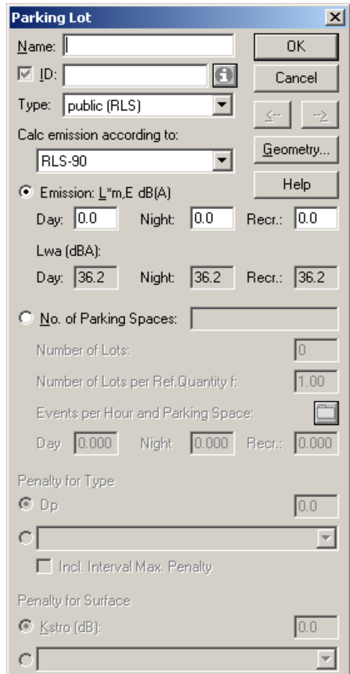


Calc emission according to: From the list box, select the method to be used for the calculation of the sound emission.

RLS-90 Guidelines for Noise Control at Roads (RLS-90); published by the German Federal Ministry of Transport, Dept. for Road Construction, Ed. 1990, Traffic Gazette 44 (1990) [in German]

LfU-Study 1993 Parking Lot Study, study concerning sound emission from parking lots, scrap yards and bus terminals, 1993 edition, issue 89, collection of publications by the Bavarian Ministry for Environmental Protection (LfU), Munich [in German]

LfU-Study 1995 precise Hendlmeier, W.: "Noise control at parking lots and underground car parks", clause 12.2: Precise calculation method (for parking lots where the distribution of traffic between the parking spaces can be estimated with sufficient precision), Bavarian Ministry for Environmental Protection, Depts. 2/4 and 2/5, November 1994 [in German]

When calculating according to this method, the traffic paths within the parking lot have to be modelled additionally calculating the emission according to RLS-90.

LfU-Study 1995 approximate

Hendlmeier, W.: "Noise control at parking lots and underground car parks", clause 12.3: Approximate calculation method (for parking lots where the distribution of traffic between the parking spaces cannot be estimated with sufficient precision), Bavarian Ministry for Environmental Protection, Depts. 2/4 and 2/5, November 1994 [in German]

No traffic paths within the parking lot have to be entered separately as this is already considered in the emission data of the parking lot.

LfU-Study 2003

In the 4th edition of the LfU-study /45/ more detailed information about vehicle movements have been included. The number of events are referred to the number of parking spaces and to further quantities depending on the type of lot. Additionally, two different procedures for the calculation of the noise emission by parking lots on flat ground are described.

In **CadnaA**, both procedures are implemented, the so-called "combined evaluation" (normal case) and the "separate evaluation" (special case).

combined evaluation

By the combined evaluation the emission caused by the transit traffic is accounted for approximately by the parameter KD. This increase just depends on the number of parking spaces ng or any other specified reference quantity n (e.g. per bed for hotels; per 10 m² area for restaurants or stores). The Bavarian Environmental Protection Agency (LfU Bayern) has straighten out upon request that the parameter K_D is to be calculated for all kinds of parking lots based on the number of parking spaces ng or any other specified reference quantity n, although the study just refers to the variable ng.

separate evaluation

By the separate evaluation the emission resulting from parking movements and from search resp. transit traffic is accounted for separately. In the calculation of the noise emission the parameter K_D is not applied. Thus, search and transit traffic has to be accounted for by modelling the road lines separately (e.g. according to RLS-90).

2

LfU-Study 2007

In the 6th edition of the LfU-Parking Lot Study /46/ the reference parameters 1 parking space, 1 m² net-area, or 1 bed are used. In case the reference parameter „absolute“ is selected the overall number of movements per hour is applied. In principle, both existing evaluation procedures - the combined evaluation (including transit traffic) and the separate evaluation (excluding transit traffic) - have been kept.

LfU-Study 2007, *combined evaluation*

With the combined evaluation (normal case) the calculation of the transit traffic correction K_D has been modified compared with the 3rd edition. The new relation holds for all types of parking lots independently from the number of parking spaces. The equation for KD as in the 3rd edition resulted in too high K_D-values for parking lots with more than 150 spaces.

LfU-Study 2007, *separate evaluation*

The separate evaluation applies the same kind of correction for impulse noise characteristics („Interval Max. Penalty“) as with the separate evaluation (special case).

SN 640 578:2006-07

The standard provides sound power levels per parking event and per hour for parking lots of the following uses: „Berufsverkehr“ (rush-hour traffic), Park and Ride, „Dienstleistungsunternehmen“ (service providers), „Einkaufsverkehr“ (shopping traffic/stores), „Freizeitaktivitäten“ (leisure activities), „Anwohner und Besucher“ (residents and visitors), „Warte- und Bereitstellungsräume“ (queuing/provision zones), „Weitere“ (other). Besides the first three uses, the emission of all others includes the noise due to door and trunk lid slamming. Alternatively, the emission for parking lots used by cars, truck or motorcycles only are provided. The calculation of the receiving level contains besides the parking noise itself also the noise resulting from search traffic. Transit traffic is to be modelled using the object „Road“.

Emission
L*m,E in dB(A)

The sound emission of a parking lot due to parking traffic is characterized by the emission level $L^*_{m,E}$. This is the time-averaged level in a free field at a distance of 25 m from the centre of the parking lot, assuming that the total emission originates from this single point.

Emission LwA in dB(A)

Alternatively, the sound power level LwA (PWL) can be entered. The sound power level is the emission characteristic as applied by the numerous LfU-studies. **CadnaA** displays always both emissions values.

Reference Quantity, Numbers B and f

Upon selection of the LfU-study 2007 the reference quantity is entered into this text box. In box „Number of Reference Quantities B" the number of individual parking spaces, or the area, or the number of beds is entered. For parking lot types according to LfU-study 2007 without a default reference quantity („absolute") entered a value of 1 (one) for B.

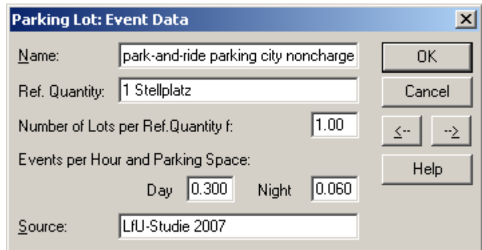
Events

Events per hour and parking space for day, night, and recruitment time (evening). You may enter the values or adopt them from a table with predefined numbers of events for different parking spaces. To open this table, click the file selector symbol. The highlighted data record is copied by clicking the **OK** button.

Library Parking Lot Events

The table **Number of Events** (Parking Lot Movements) is edited either via the edit dialog **Parking Lot** or via the menu **Tables|Libraries (global)|Parking Lot Events**. Data sets are stored globally and, thus, are available upon each restart of **CadnaA**.

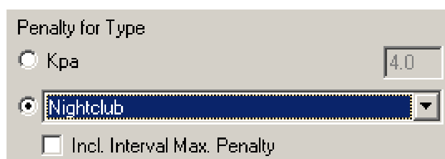
When defining new parking lot types the input box „Ref. Quantity" any text information can be typed in. Now, specify the number of parking spaces per reference quantity and the events (movements) per hour and parking space. The figure entered for the daytime will be applied to the recruitment time as well.



Penalty
Dp dB(A)

The correction Dp dB(A) - accord. to RLS-90 - or Kpa - accord. to LfU-studies - is a correction for different types of parking lots. This correction is added to the default sound power level.

In order to edit the correction for different types of parking lots activate the option *Dp* or *Kpa* respectively. Alternatively, you can select a f parking lot type from the list box (after activation of this option).



Type of Parking Lot

Upon selection of a parking lot type from the list box - e.g. Nightclub - the corrections suggested in the selected study are adopted.

Interval Max. Penalty

With this option activated - provided a LfU-study is selected - a further correction for impulse noise Ki depending on the type of parking lot is considered. The value displayed is the sum of (Kpa + Ki).

Correction for Road Surface

For the combined evaluation according to LfU-study 2007 a penalty (correction) for the type of road surface can be considered (direct input or selection from the list box).

Operating time (min)

For industrial parking lots (list box „Type“, calculation of propagation accord. to industry standard selected) the operating time within the three time intervals day/night/recruitment time (evening) can be entered. These operation times (in minutes) refer to the reference times D/E/N as been specified on dialog **Configuration|Reference Time** (see chapter 6.2.4 "Reference Time Tab"). With the check box „operating time“ deactivated a constant emission is assumed.

2.8 Pass-by Levels for Roads, Railways, and Line Sources

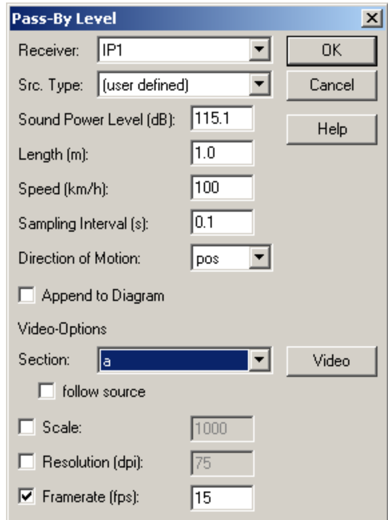
For roads, railways, and other line-like sources **CadnaA** enables to calculate according to the selected standard the time history of the sound pressure level that would result from a single vehicle or other source with a specified emission travelling along that line.

Generating this level characteristic allows you to check very effectively, e.g.,

- whether the effect of a noise-control device, such as a barrier, would be sufficient for all affected partial areas,
- which noise reduction may be expected by providing a reflecting building facade with absorbent cladding, or
- by which amount the sound pressure level resulting from single motor vehicles travelling by is reduced if, e.g., a zone with a speed limit of 30 km/h is established in an ordinary inner-city street.

With the right mouse key we click the command **Pass-By Level** from the context menu of the line object.

☝ The command **Pass-By Level** in the context menu of a line source is only available if a receiver point is inserted.



Dialog for calculation of the time history at a receiver point
as a vehicle is passing by on a road.

The possible specification depends on the object type used for the command **Pass-By Level,** such as road, railway or general line source.

Source Type

User-defined

By selecting „User-defined“ from the list box „Source Type“ you can enter your own data for all relevant parameters.

Light or Heavy

When selecting „light“ or „heavy“ from the list box „Source Type“ the sound power level cannot be entered, but will be determined from the speed (km/h). The sound power level for roads is determined according to RLS 90 when the selected standard does specify a respective procedure.

Train list

The entered train types (see chapter 2.12.2 "Train Classes and Penalties") from the list box „Source Type“ in case of the line source **Railway**.

Sound Power Level and Speed

The following table lists the average sound power levels for passenger cars and trucks as a function of speed used as the emission value as prescribed by RLS-90 for a specific speed.

	Speed, in km/h				
	30	50	80	100	120
Passenger car	92.5	97	103	106.4	109.4
Truck	105.5	110.5	115.1		

Sound power levels, in dB(A), of individual vehicles, as a function of speed

Accordingly, a sound power level of 97 dB(A) can be entered for a passenger car driving at 50 km/h. Of course, it would be possible to automatically assign this value, but other values may have to be assumed in some situations.

Sample Time

Both, the sampling time and the speed determine the section lengths through which the fictitious vehicle or the source moves from one location to the next. A sampling time of 1 s may be sufficient to check for the required calculation time, a value of 0.1 s may be appropriate to represent a level record showing all level variations due to shielding and reflections.

Driving direction negative/positive

The direction of traffic can be specified with respect to the direction in which the road was inserted. „Positive“ means the driving direction is from the first to the final point of the geometry and „negative“ vice versa.

Append to Diagram

By the option „Append to Diagram“ activated several pass-bys can be simulated consecutively.

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Example

Keep the dialog **Pass-by Level** open and mark once again the same object or a different one with the right mouse button and select again **Pass-By Level** from the context menu. Mark the option „Append to Diagram“ and for the driving direction select „negative“ instead of „positive“ or vice versa depending on what you have selected before.

Pass-By Diagram

If we drag the Y-axis in the dialog **Pass-by Level** in a horizontal direction then the vehicle symbol in the graphic will also move along the line source/road/railway. Another alternative is to choose a value from the **Animation** menu. The pass-by then runs with the selected speed.

Auralisation

Hardware requirement: sound card and loudspeaker or headphones

On the menu **Auralization|Properties** the saved sound file of the relevant process is opened after selection of a sound type in the list box and is reproduced - regarding volume - according to the calculated time history of the pass-by level.

3D-Auralisation

By the option „3D-Auralization“ the Doppler effect - when switching from approach to departure (by „Direction of Motion“ - will be simulated in a realistic way.

Listening direction at Receiver Point

Automatically to source: viewing directly towards the source (with the shortest distance)

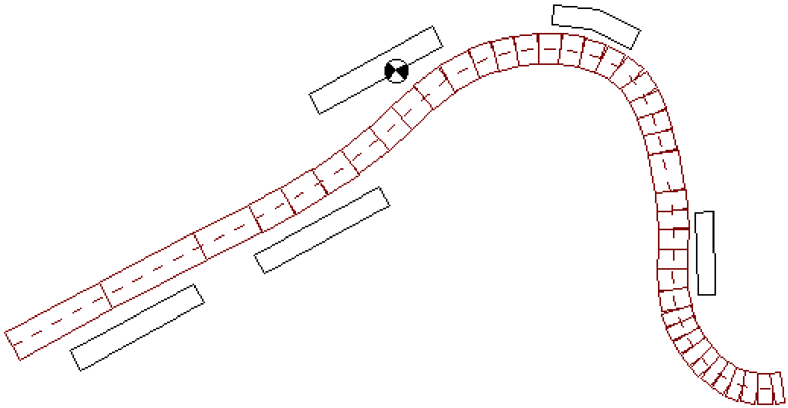
Direction (°): view at the given angle towards the source, relative to the x-axis

Calibration: Select the desired volume from the list box and adjust the corresponding playback on your audio device.

Example Pass-By

Examples\02_Sources\Road\Pass-By.cna

- Test the **Pass-By** with a simple arrangement as in the following figure.



Simple arrangement of a road, buildings and a receiver point IP1.

- Open the context menu by clicking the road axis with the right mouse key and select the command **Pass-By Level**.
- From the list box „Receiver“ select the desired receiver for which the pass-by level shall be calculated - in our example IP1.
- In the next box „Source Type“ select „light“.
- Adjust the sampling interval to 0.1 s.
- After confirmation with OK the diagram opens with the calculated level’s time history. The calculation time depends on the complexity of the project.

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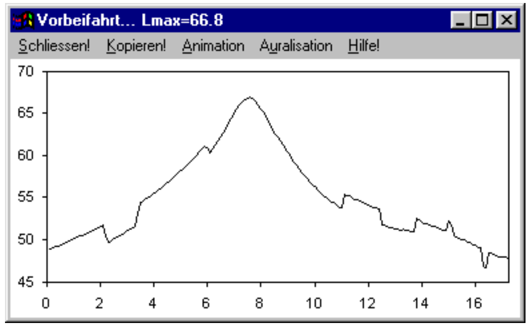

For a light vehicle calculated level time-history

- Now move the mouse cursor in the diagram and press the left mouse button. On this position a vertical cursor line appears, whose time and sound pressure level is indicated in the upper dialog bar and a symbol (black box) indicates the vehicle's position on the road in the graphic, in the driving direction on the road.
- When dragging the cursor line horizontally ins the diagram the vehicle's symbol will move along the road. We can also choose a value from the **Animation** menu.

Regarding the vehicle's position relative to the location of buildings reflections (increases in level) and shielding effects (reductions in level) can be realized by respective level changes.

Copy the Level's Time History

The level's time history can be copied to the clipboard to be pasted into other software (e.g. like MS-Excel or MS-Word), either as sequences of numbers or as a chart.

- Therefore, activate the Level-Time diagram on dialog **Pass-by Level** by clicking onto it. The upper dialog bar gets highlighted. Now copy to the clipboard by clicking the „Copy“ button (or by pressing the c-key).
- Paste the data into the other software and confirm either graphic or

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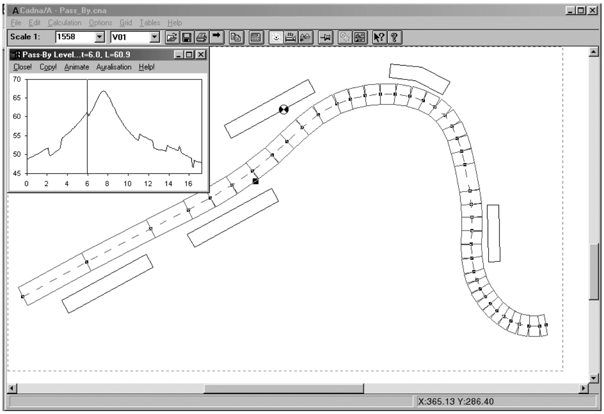
text.



Indicating the vehicle on the road with a symbol (black box) and in the diagram with a vertical cursor line

- Test further pass-by possibilities.
- Vary the reflection of single buildings by switching them on and off alternately and watching the effect on the level’s time history.

2

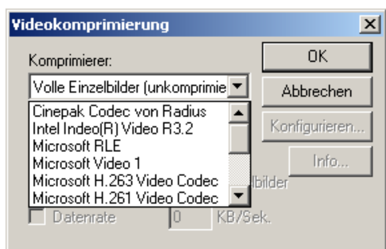
This diagram also facilitates the optimization of barriers, because the effect of a modification can be assessed immediately. Beyond the mere consideration of time-averaged levels, the pass-by feature offers a tool which enables to examine and visualize the effects of level-reducing measures on the actual level.

Video

The pass-by can be recorded as a video in AVI-format for replay using any standard video software (such as Windows Media Player).

Click the button „Video“ to configure the recording options. Select the desired section either the whole limits or a user-defined section. The user-defined section requires a name in order to select it from the corresponding list. For a test, we recommend to define a smaller user-defined section that it does not require too much recording time.

To record a video, a respective compression algorithm (video codec) has to be specified after having entered a file name.



List of Video Codecs
(example, actual options depend on system and
German dialog due to German WIndows system)

A list of video codecs available on your system is displayed. Select and configure the selected codec accordingly. After confirming with OK the pass-by is calculated and recorded.

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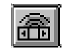
2.9 Optimized Area Sources

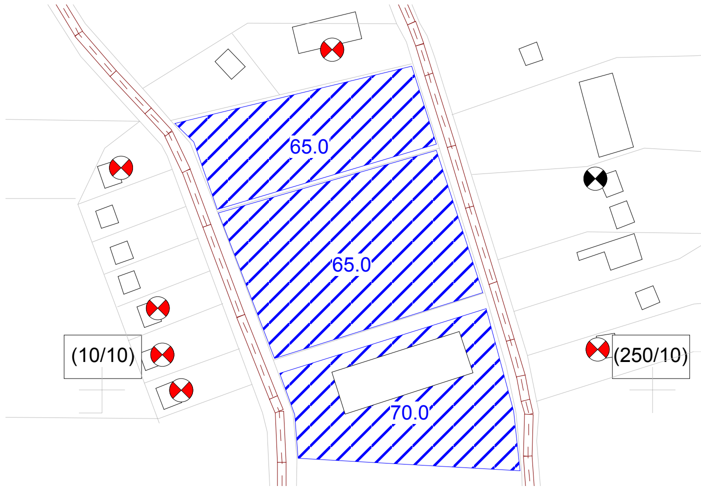


This source type is available with **option BPL** only.

REMARK: BPL stands for „Back-Ttacing of Power Levels“

Clicking this icon allows you to specify the boundary of a maximized area source. The source is characterized by the following features.

- The method for the calculation of sound propagation is done as it was for the general area source (see chapter 2.1), i.e. the area is split into partial areas taking into account its distance from the receiver point and possible shielding objects. The partial areas are replaced by point sources.
- When determining noise quotas using **Maximized Area Sources** you should generally activate the option so that shielding objects within do not affect the emission of area sources. This option is available for any area source. (see chapter 6.2.9 **Calculation|Configuration|Industry|Src. in buildings/Cylinders do not shield**.)
- The edit dialog can be switched from day-time to night-time. The entry of either the area-related sound power level PWL’’ or the total sound power level PWL refers to the respective time.
- By the other entries in the bottom part of the dialog, the **Maximized Area Sources** differs from a general area source. These entries support the maximization with respect to the allocation of noise quotas.



Noise Allotment

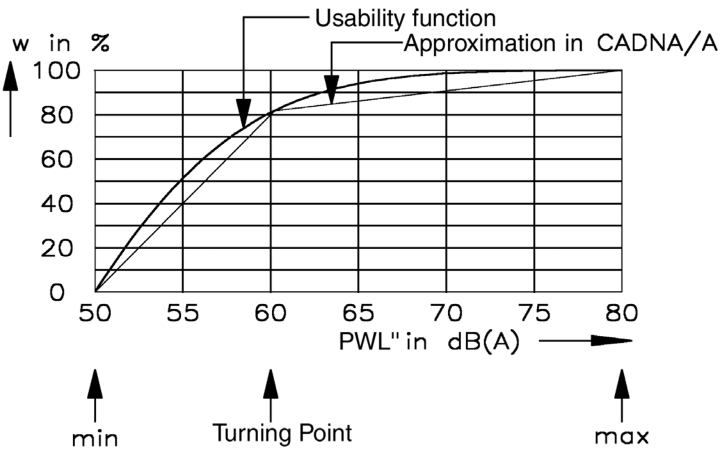
The procedure of noise allotment is explained below.

If immission-sensitive residential areas are situated in the vicinity of a planned trade or industrial area the latter is so partitioned as to provide individual areas with different maximum permissible emissions. These permissible emission values are determined under the condition that:

- the relevant immission limits for the neighborhood are complied with in any case, and
- the intended use of the individual areas is prevented or restricted in the least possible way

This generally is called **noise allotment**. **CadnaA** supports this in an extremely flexible manner using the **Maximized Area Source**, without forcing the user to follow a particular program-inherent philosophy of maximization.

In order to achieve this, a usability function is assigned to each partial area.



Usability Function

It assigns an area-related usability in % to each area-related sound power level. The fact that the gradient of the curve decreases as the emission values increase shows that a further increase in the permissible emission cannot be exploited due to the intended use. On the other hand, the usability decreases excessively when a particular emission required for the intended use is further reduced.

Thanks to this concept /85/ the individual requirements of planning concerning institutions and parties can be accounted for in the maximization. The usability function of **CadnaA** is approximated by two lines. This requires three emission values for each partial area as a basis for the maximalisation.

PWL’’ max	is the maximum exploitable emission (depending on the branch of industry - value may be up to 80 dB(A) for industries with permanent truck traffic)

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PWL'' min	is the minimum required emission [determined on the basis of the absolutely necessary noise-relevant processes - e.g. a 10-minute truck ride across an area of 1,000 m^2 results in 55 dB(A).]
PWL Turning Point	is the emission value where the gradient of the usability function changes. Below the turning point level, a 1-dB reduction results in a stronger reduction in usability than a 1-dB increase in the range above, and enhances the usability. Here we should enter the value that should be "retained" in the maximization.

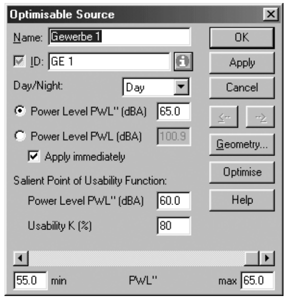
The usability specified at the turning point determines the curve and thus the "maximizing strategy".

Common data for industrial areas::

PWL'' min	57 dB(A)
Turning Point	80 % / 60 dB(A)
PWL'' max	65 dB(A)

The bottom part of the edit dialog for the **Optimized Area Source** contains a slider control serving to select an emission value within the range from min to max like the current value which is displayed in the dialog above. For a first test, push the slider to the extreme right, thus selecting the maximum emission value.

2



Calculation

The most critical receiver points are entered with their relevant standard immission levels as customary. Clicking the calculator icon on the icon bar starts the calculation. If no receiver point turns red for either day or night, the standard levels are complied with in spite of the maximum values which were assumed - in this case it is not necessary to reduce emission values.

In the calculation, all sources existing in the project - roads, railways, industry or even air-traffic noise - are taken into account as the initial immission. The individual or group (see chapter 14.1) deactivation, or deactivation of entire types of noise sources allows you to generate and analyse any scenario for large limits.

The procedure described so far is the same as for the calculation of ordinary area sources.

Manual Maximization

If red color shows that the standard levels have been exceeded at individual receiver points, the emission from the partial areas with the strongest influence on the relevant point are reduced in steps.

CadnaA does not require a new calculation for each step. Double-clicking the respective partial area and shifting the position of the slider will show you the resulting change of receiver points in the graphic - practically on-

2

line. Depending on the desired strategy the emission values can be reduced until compliance with the standard levels is ensured at all receiver points.

☝ Follow this procedure separately for day-time and night-time.

Automatic Maximization

Selecting **Optimized Area Sources** on the **Calculation** menu will result in an automatic, iterative reduction of the emission values by **CadnaA**. It is always the reduction of emission resulting in the smallest decrease of the area-related usability according to the concept explained above which is carried out in this step-by-step procedure.

With

Si	area in m² of the ith partial area
wi	area-related usability in % of the ith partial area

the total usability is

$$w = \frac{\sum w_i \bullet S_i}{\sum S_i}$$

Its value is displayed at the beginning and the end of the maximization.

The result calculated by **CadnaA** need not be the best if further aspects, not accessible to the above usability function, are to be considered. In this case, the automatic optimization is a suitable starting point, whereas manual modifications of the emission values using the slider (see above: Manual Maximization) allow you to further adapt the scenario in the desired way.

When the maximization has been completed and fixed, the **Optimized Area Source** can be converted to an general area source (see manual „Introduction to **CadnaA**"). This is particularly useful where large data stocks are to be supplemented for noise immission maps.

See also:
see chapter 6.2.13 "Optimizable Source Tab"

2

Chapter 3 - Obstacles

3

In **CadnaA**, the following types of objects cause a screening effect in the calculation of propagation, depending on the standard or guideline selected for each noise type:

- building,
- cylinder,
- barrier,
- bridge,
- embankment,
- ground absorption area,
- built-up areas and foliage,
- 3D-reflector.

The following types of obstacles may also have reflecting properties:

- building,
- cylinder,
- barrier,
- 3D-reflector.r.

Reflection Properties

In order to specify the reflectivity of the surfaces of obstacles three options are available in **CadnaA**.

No Reflection

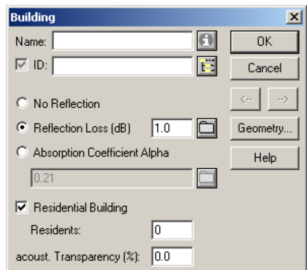
No reflection is calculated for this object. This is the default setting.

The subsequent options require that on dialog **Calculation|Configuration**, tab „Reflection“ (see chapter 6.2.8) at least the reflection order 1 has been selected.

3

Reflection Loss

Enter the reflection loss in dB due to reflection or click the file selector symbol to select from a predefined list of surface classifications (resulting from RLS-90, table 7 /12/)..



Dialog **Building**: specifying the reflection loss

Absorption Coefficient Alpha

With this option activated, a single-number value, a formula, or the reference to an absorption coefficient spectrum (see chapter 12.1 Local and Global Libraries) can be specified.

3.1 Building

Buildings are objects with vertical walls and an arbitrary closed polygon as base. The rectangular shape can be forced. The roof is not considered a reflecting or shielding object. (If necessary, enter a barrier, the top edge of which is defined by the roof top.)

Reflections at the outer surfaces of the building will be taken into account according to the mirror sound source method if this option has been selected under **Calculation|Configuration** (see chapter 6.2.8).

Sources will be shielded if the are lying within the building because their facades are be taken into account as barriers. We can determine this by activating or deactivating the option **Sources in Buildings/Cylinders do not shield** on the tab **Industry** in **Calculation|Configuration** (see chapter 6.2.9 "Industry Tab").

The heights of a building is entered as customary in the edit dialog, under **Geometry** (see chapter 4.1).

Deactivate Point Objects in Buildings

With the function **Deactivate Point Objects in Buildings** (**Tables|Miscellaneous**) you can deactivate point like objects (e.g. height points, point sources) which are within the building base. That maybe sometime useful after a third-party program’s import. Now, you can easily delete the deactivated objects using the command **Modify Object** (see manual „Introduction to **CadnaA**“).

For further information concerning buildings:

- Object „Building", see manual „Introduction to **CadnaA**"
- Acoustical Transparency see chapter 3.1.1
- Generate Building, see chapter 3.1.4
- command **Force Rectangle** on the context menu, see manual „Introduction to **CadnaA**"
- command **Orthogonalize** on the context menu, see manual „Introduction to **CadnaA**"
- Barriers, see chapter 3.3
- Object snap, see chapter 5.1
- Snap Point on Building Facade, see chapter 3.1.3
- Building Evaluation, see chapter 5.4
- Building Noise Map, see chapter 5.4.1
- Import Building Height Points, see chapter 7.2.16

3.1.1 Acoustic Transparency (%)

Application

The object „**Building**“ may receive a characteristic called „acoustic transparency“ in % by entering a respective value being larger than zero. This feature enables to model more or less open structures, e.g., an arrangement of pipes, tanks and other technical equipment penetrated by sound. This is modelled using the object „**Building**“ with a transparency value addressed.

3

Industrial Sources

When the transparency is larger than zero, the calculation of the screening effect considers that the object (partially) transparent. This feature, however, applies to point, line and area sources only in conjunction with the procedures according to VDI 2714/2720 or ISO 9613-2.

Effect

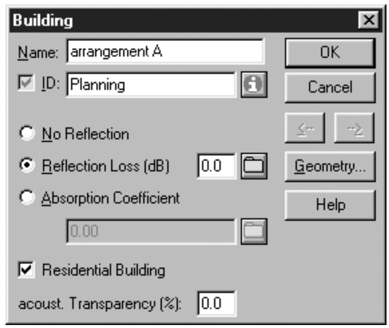
The calculation procedure is as follows:

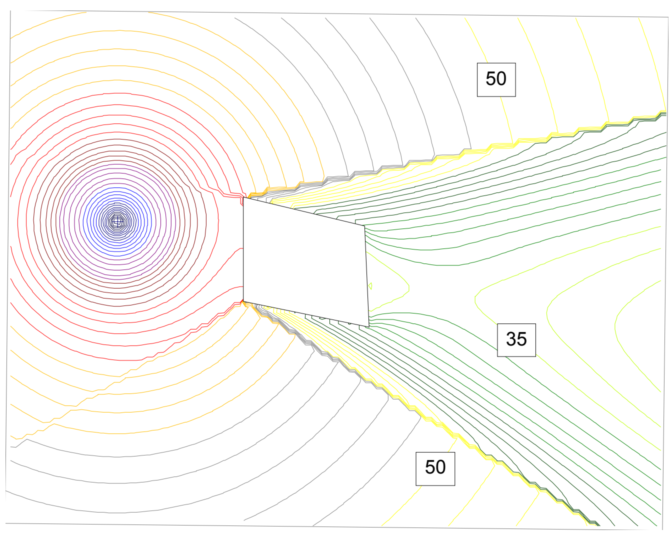
- At first we check, which of these objects influence the diffraction calculation according to the „ribbon band method“.
- If the sound energy at the receiver point is reduced by dE according to the screening calculation, then with a collective transparency of X % the energy (X/100)*dE is added to the sound energy calculated with transparency zero.
- The total degree of transmission for many buildings is the product of all single transmission factors.
- At the receiver point two sound contributions are added energetically. The first contribution is the diffracted sound over and if necessary around the arrangement and is calculated as for objects not acoustically transparent.
- The second contribution is calculated as direct sound energy, not taking into account the shielding objects, but multiplying this energy value by the resulting transmission factor defined above.
- With direct sound contribution E_{dir} and the resulting transmission factor τ, this second contribution is $E_{dir} * \tau$.

☝ This procedure was implemented due to user demands. It is not described in any standard or guideline. The depth of an object with transparency has no impact on the calculation result. The value of the acoustic transparency is considered to be the same for all directions.

Example, Case 1

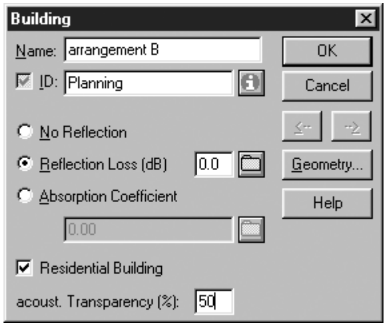
The acoustic transparency of the building is 0 %:

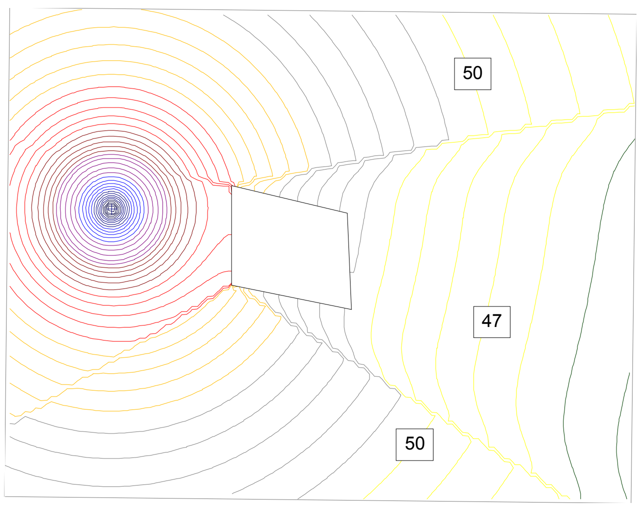




Example, Case 2

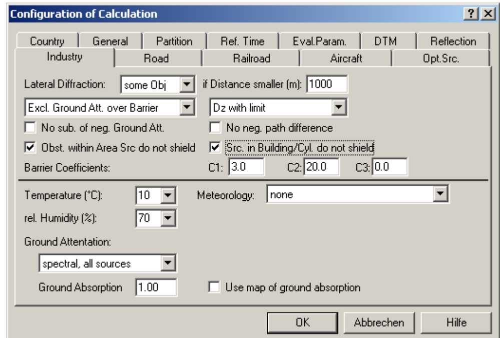
The acoustic transparency of the building is 50 %:





Sources in Building/Cylinder do not shield

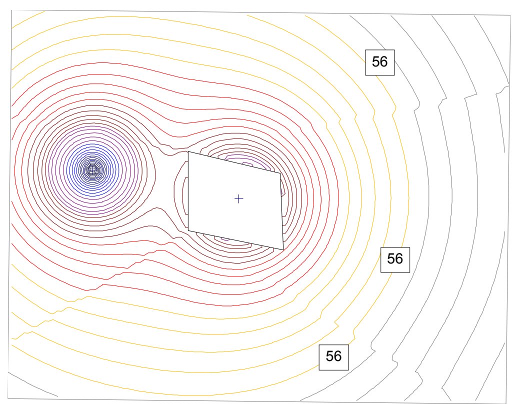
If this option is activated in **Calculation|Configuration**, tab „Industry“ the general sources as point, line and area sources can be placed within the building plan. The building, in which the sources are placed, does not effect the emission of these sources. For other sources and receiver points outside the building a shielding calculation will be taken into account according to the selected configuration.



Application

With this option the radiation out of almost open structures can be carried out. So a plant, consisting of open bundles of pipelines, can be modeled as a house with a predefined transparency considering each specific sound radiating valve as a point source.

Example

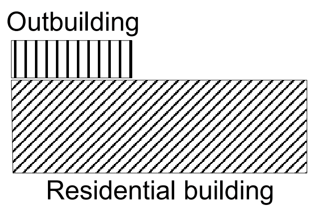


3.1.2 Residential and Outbuilding

Residential and Outbuilding

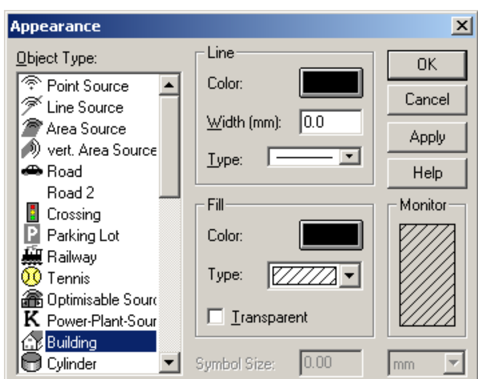
3

A building can be labelled a "***Residential Building***" (default setting). If "***Residential Building***" is not marked in the edit dialog, the building in question is an outbuilding. Residential buildings and outbuildings are thus automatically marked by different hatchings. Furthermore, only residential buildings are considered in the automatic determination of the population density (XL module, see chapter 5.5.4).



Residential buildings and outbuildings have different hatchings

Specify the appearance of the hatching as shown on the dialog below (**Options|Appearance**, see chapter 9.6)



Appearance dialog

Residents: For documentation you can enter the real number of residents and with the option **XL** you can use this value for further calculations.

3

3.1.3 Snap Point to Building Facade

The command **Snap Point to Facade** in the **Context Menu** of the marked object or in the **Context menu|Change Objects** enables you to locate objects (e.g. point, line or area source or receiver point etc.) at a defined distance in front of building facades after they have been inserted.

Distance Points-Facade

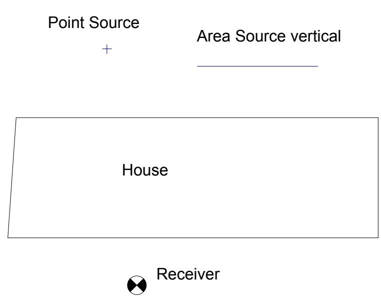
The objects are attached to the facade with the distance defined in the edit box **Distance Points-Facade**.

Snap Radius

The operation is applied for all points with a distance smaller than the **snap radius**.

This could be necessary, e.g.,

- if objects have been inserted without activated **Object Snap** (see chapter 9.4) but shall have a defined distance to the facade
- if objects have been placed inside a building inadvertently - they are moved and located with the defined distance outside the building or
- if points have been imported from external sources



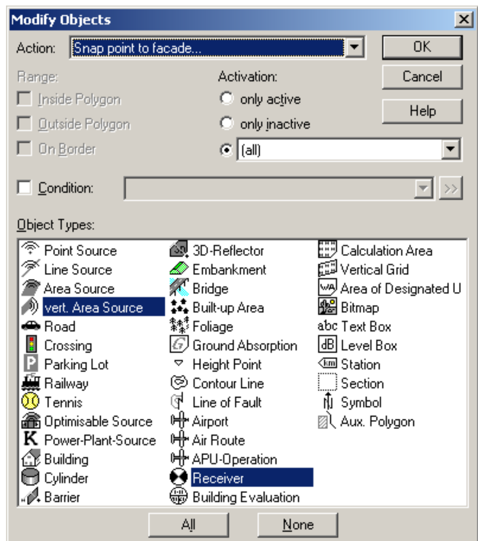
Initial situation: House with a point source, a vertical area source and a receiver point. These objects shall be dragged in front of the facade with a distance of 0,05 m.

Examples\
03_Obstacles\
SnapePointFacade.cna

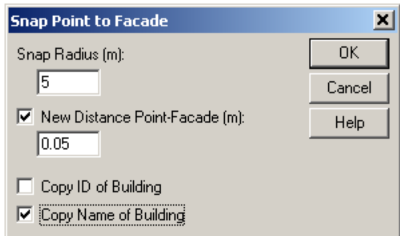
3

In the shown example objects are located near a building. The receiver point and the vertical area source shall be dragged to the building facade with a distance of 0,05 m

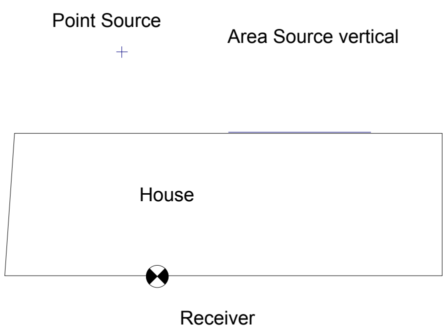
- click with the right mouse key on a free area in your graphics
- choose from the **Context Menu|Modify Objects|Action: Snap Point to Facade**
- mark the **vertical area source** and the **receiver point** as shown in the following picture and confirm with **OK**.



The receiver point and the vertical area source are snapped to the building facade.



With activated option Copy **ID/Name** of building the contents of these fields is copied into the corresponding fields of the objects snapped.



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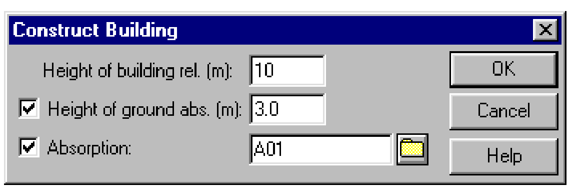
3.1.4 Generate a Building

To insert a building whose roof and four facades radiate sound, use the command **Generate Building** on the context menu (see manual „Introduction to **CadnaA**").

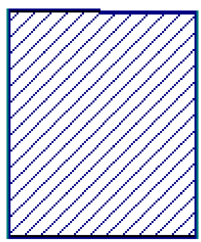
- First, insert a area source in the shape of the horizontal projection of the building (see chapter 2.1)
- 
- Switch to the edit mode and double-click the area source. This opens the edit dialog.
- Activate the **Sound Reduction** option, and enter an indoor level, either directly or with reference to a spectrum. Enter all further parameters for this source, and click **OK** to close the dialog.
- Then click the area source with the right mouse button and select **Generate Building** from the context menu.

In the **Generate Building** dialog, you can enter the parameters for the height of the building and, if required, the height of the terrain at the base of the building, and an absorption coefficient - either a single-number value or a reference to a spectrum (see chapter 12.1 Local and Global Libraries).

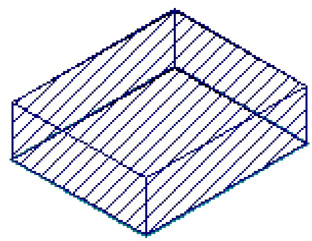


When all boxes are completed and the dialog has been closed by clicking **OK**, **CadnaA** generates

1. a building with a specified height – 10 m in this example,
2. the appropriate number of vertical area sources whose parameters are adopted from the first area source, at a distance of 0.05 m in front of the building walls, and a horizontal area source at 0.05 m above the roof (if necessary, adjust the parameters via **Tables|Sources|Vert. Area Sources**);
3. a surrounding contour line (see chapter 4.2) with the absolute height as entered.



Horizontal projection



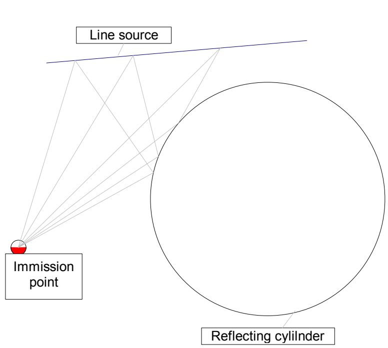
3D-View

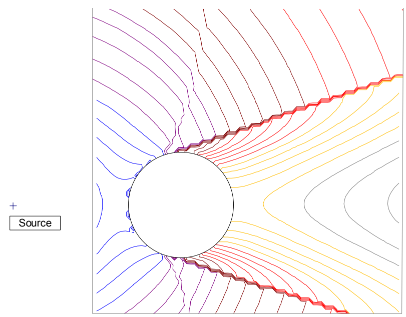
3.2 Cylinder

A **Cylinder** can - like a building - shield and/or reflect. It is defined with two points.

- The first point defines the central point and
- the second point the radius through its distance to the first point.

The height is entered, as customary, in the edit dialog under **Geometry** (see chapter 4.1**)**.





Rays reflected by the cylinder

Lines of equal sound levels

Sources inside the cylinder are shielded because the walls are considered barriers. This standard effect can be switch off by activating the option **Sources in Buildings/Cylinder do not shield** (see chapter 6.2.9).

3.3 Barrier Types

Reflections at the outer surfaces of a barrier are taken into account according to the mirror sound source method if

1. a reflection > 0 is selected (see chapter 6.2.8) and
2. a barrier is defined as reflecting by entering a **Reflection Loss** or, alternatively, an **Absorption Coefficient Alpha** in the edit dialog.

The standard setting of a barrier is **No Reflection**. But we can define a **Reflection Loss** or an **Absorption Coefficient Alpha** for the left and/or right side of a barrier. Left and right refer to the view from the initial point to the final point of a barrier's polygon points.

Strict provisions are made by RLS-90 /12/ concerning the neglecting of lateral diffraction and of ground attenuation in the calculation of the shielding effect. For all other sources you may define on the tab **Calculation|Configuration|Industry** (see chapter 6.2.9) to what extent lateral diffraction shall be taken into account and, if necessary, you may modify the barrier coefficients.

see also:

chapter 3.3.1 Floating Barrier

chapter 3.3.2 Barrier with special Crowning

chapter 3.5.1 Automatically Optimize Noise Barriers

3.3.1 Floating Barrier

The **CadnaA** object **Barrier** was modified to also include barriers on bridges.

The **Floating Barrier** option is available in the edit dialog **Barrier**. If this option is activated, the height of the barrier from its bottom to top edges can be entered in the z dimension box, in addition to the height specified in the **Geometry** dialog. If the height of the barrier (i.e. the relative height of its top edge) is, e.g. 10 m, and 3 m have been entered as its z dimension, the bottom edge is 7 m above the ground.

Such a barrier whose bottom edge does not rest on the ground has the following properties:

1. The shielding effect is calculated as customary for each ray hitting the actual barrier surface, considering all three propagation paths (over, under and laterally around the barrier), if necessary.
2. Rays passing underneath the barrier's edge are not attenuated. This effect is therefore calculated correctly.
3. Diffraction around the bottom edge is – currently – not taken into account.
4. Reflections of rays hitting the barrier's surface are calculated according to the principle of mirror image source, if necessary. This allows you to calculate the increase in level caused by, e.g., large indicator boards and similar items.

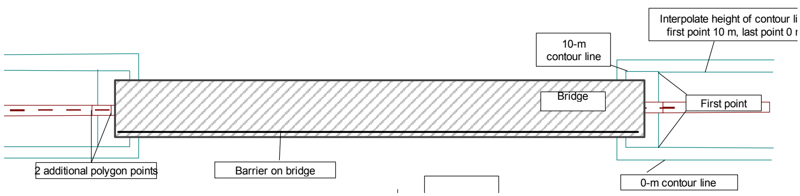
☝ If a barrier is installed on a bridge (see below), the height of the barrier section on the bridge must be entered as either

- the height of the top edge above the base plate of the bridge, and the „Building Height“ button in the **Geometry** dialog must be activated - that means 3 m in our example - and the same value must be entered for the z dimension after „Floating Barrier“ has been activated, or

- the height of the top edge as an **absolute** value – thus 13 m in our example. The z dimension remains the same (3 m).

☝ In both cases, further polygon points must be inserted (see manual "Introduction to **CadnaA**") for the barrier where it intersects contour lines.

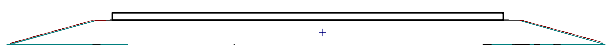
The barrier is calculated correctly in both cases.



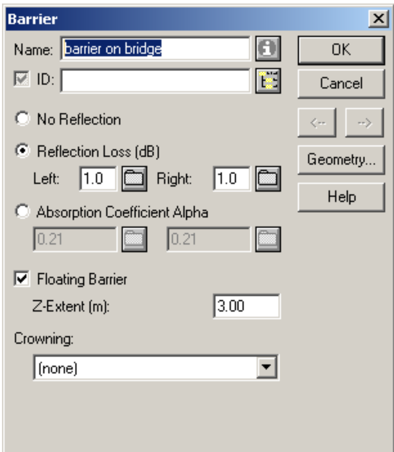
Inserting a barrier on a bridge

Examples\
03_Obstacles\
Bridge.cna

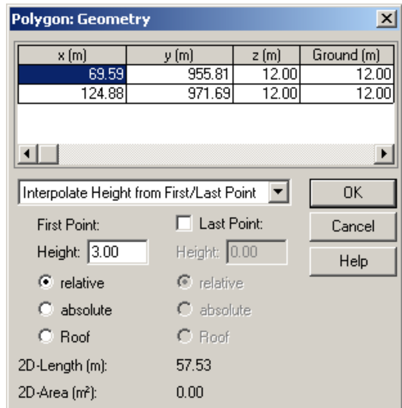
- In the two dialogs below enter the height of a reflecting barrier as 3 m above bridge level .



3-m-high barrier on a bridge in the 3-D front view

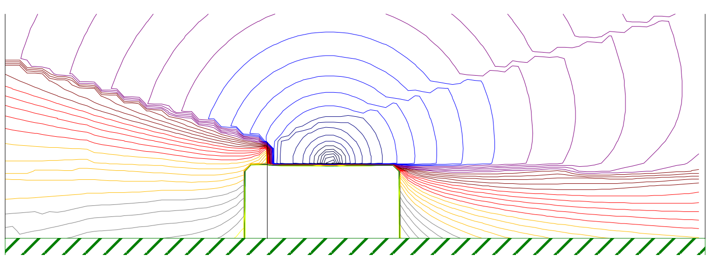


Activate Floating Barrier in the edit dialog



Specify the barrier height above the bridge by selecting the building roof option.

If the cross-section view of the noise map is calculated, the level distribution is as illustrated below. The distortion of the lines of an equal sound level in the top right hemisphere - which is due to the reflection at the barrier - and the shielding effect of the 3-m-high barrier on the left side of the bridge - can be clearly seen.

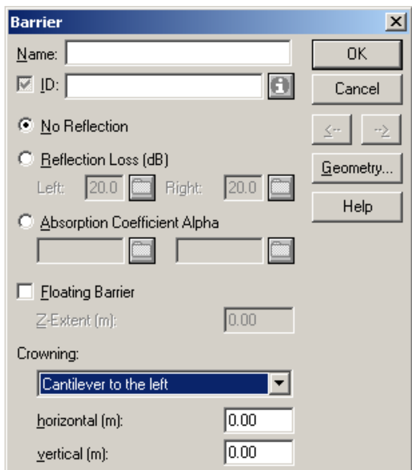


Sound level distribution in a vertical plane for a road on a bridge with a barrier

see chapter 2.4.1 "Common Input Data", section "Self-Screening"

3.3.2 Barrier with special Crowning

Also barriers with special crowning can be edited and calculated in **CadnaA**, depending on the calculation standard selected. In this case, activate the desired crowning in the list box „Crowning".



normal Crowning

A barrier crowning with the attribute „(normal)" is valid for all calculation methods. The upper edge of the barrier's polygon is taken into account as diffraction edge in the calculation. The screening algorithm of the selected calculation method is applied.

Cantilever

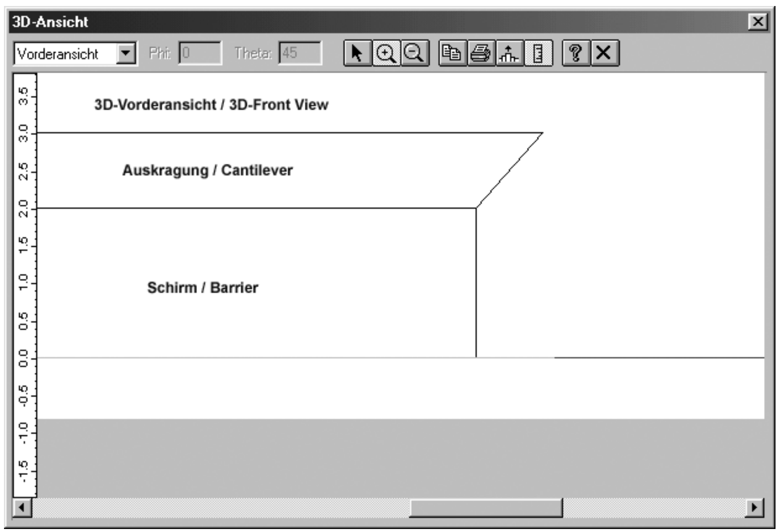
The crowning with the attribute „Cantilever" is valid for the following standards:

- ISO 9613.
- RLS90, and
- Schall03.

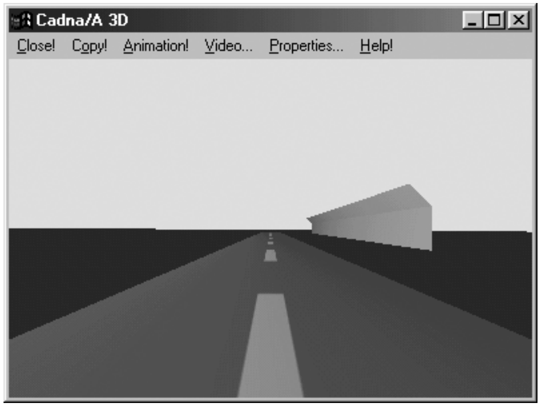
Insert a corresponding value for the horizontal and vertical extension of the cantilever. The barrier height in the dialog **Geometry** is, as with the upright barriers, the height of the diffracting upper edge.

If the barrier's height is specified as 3 m in the dialog **Geometry** and the cantilever horizontal and vertical as 1 m, each a barrier is constructed as displayed in the following image.

By selecting „left" or „right" the cantilever points to the corresponding side according to the first polygon point entered when looking toward the final polygon point. The cantilever is displayed graphically as a dotted line.



Barrier with cantilever displayed in 3D front view



Barrier with cantilever in 3D special view

☝ The sloped area of the cantilever is supposed to be completely absorbed in each case.

T-shaped

Barriers with crowning attribute „T-shaped“ are valid for all calculation methods with "Mithra-compatibility" checked.

The value for the width has to be between 0,85 and 1,5 m then a T-shaped crowning is created with a bar of this total width centrically born on of the top edge of the entered polygon (in 3D special displayed).

Cylindric

Barriers with crowing attribute „Cylindric“ are valid for all calculation methods with "Mithra-compatibility" checked.

After entering a value for the diameter between 0,60 and 1,00 m a cylindric crowning is created with the upper central line of the top edge of the entered polygon (in 3D special displayed).

see chapter 6.2.2 "General Tab": Mithra-compatibility

Application

With regard to the practical application of barriers with cantilever the following situations apply:

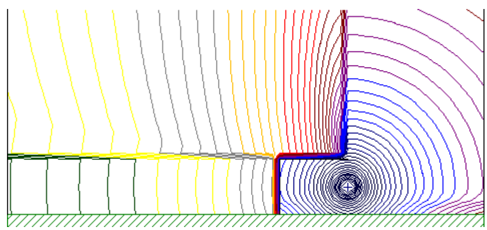
- source below the cantilever,
- source outside of the cantilever.

3

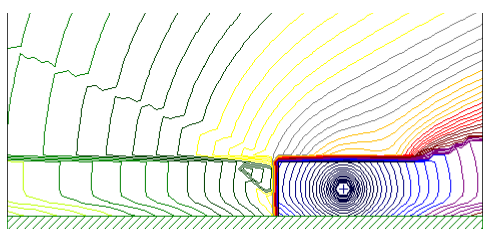
Source below the cantilever

In order to calculate these situations correctly, the shortest ray path must be found starting from the source around the cantilever's edge to the receiver point. The method applied will retrieve the shortest path difference for a single barrier in the entire space. Regardless of the receiver point's location, one or two diffracting edges are taken into account. As mentioned already, the sloping surface of the cantilever is considered to be full absorbing. This feature enables to model porches or galleries alongside of roads with their lower surfaces being absorbing.

Example: point source and barrier with cantilever



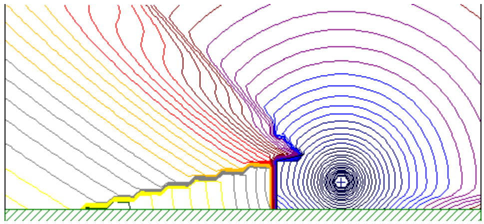
Vertical Grid: point source directly below the cantilever's edge



Vertical Grid: point source below the cantilever (Dz without limit)

Source outside of the cantilever

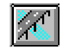
The same procedure is applied with sources below the cantilevered part. The levels are valid for single barriers within the entire space.



Vertical Grid: point source outside of the cantilever

3

3.4 Bridge



The object "bridge" represents a horizontal plate causing diffraction from sources located below or above. This object was the only way in former releases of **CadnaA** to model a screening plate lifted above the ground.

Due to the option „Self-Screening" of the objects „Road" and „Railway" the object „Bridge" became dispensable for modeling of bridge plates (see section „Self-screening" of roads, chapter 2.4, and of railways, chapter 2.6).

CadnaA's 3-D view of a bridge

The object „Bridge“ has the following properties:

- The bridge is a horizontal plate being a closed polygon. All sound rays not intersecting the bridge remain unaffected.
- When a sound ray by a source lies above the bridge plate intersects the plate the diffraction is calculated for receiver points not directly below the bridge's plate.
- For sound rays from sources lying below the bridge intersecting the plate to receiver points above the bridge the diffraction is calculated due to the bridge's edge.
- Diffraction into the space below the bridge is not considered. Therefore, resulting levels below the bridge are irrelevant!
- The bridge plate is assumed to have a plane surface being parallel to the reference plane regardless of the terrain's contour.
- The height of the bridge is always taken from the <u>first</u> polygon point (dialog **Bridge|Geometry**). Heights entered for further polygon points are not relevant.
- The bridge plate is considered as if it were a building's roof. When the bridge's height attribute is set to „Roof“ (dialog **Bridge|Geometry**) the height above the bridge's level is entered.
- On the vertical grid or on the cross section the bridge plate is not displayed.

The sound diffracted downwards from roads or railway lines on top of the bridge are calculated correctly considering the diffraction around the bridge's edges. Rays passing below the bridge causing an immission on the opposite side are considered automatically.

Due to the „floating barrier“-option even barriers on a bridge can be modeled (see chapter 3.3.1 "Floating Barrier").

see also:

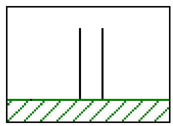
file „Entering a bridge.pdf“ on your CD

Examples\
03_Obstacles\
Entering a bridge.pdf

3

3.5 Embankment

An embankment with crest of a specified width has a shielding effect due to diffraction around its two top edges. For the calculation of the insertion loss D_E, these two edges are considered as one non-reflecting double barrier. In the sectional view (see chapter 9.12), the embankment is therefore represented by these two barriers.



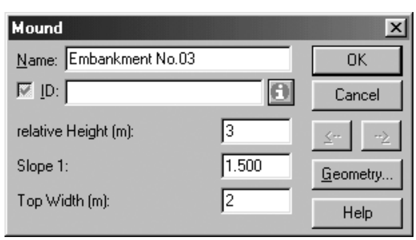
Display of the embankment's cross section

There are two ways to insert an embankment:

1. manual insertion using the toolbox icon, or
2. using the command **Parallel Object** on the dialog **Modify Objects** or on the context menu (see manual "Introduction to **CadnaA**").

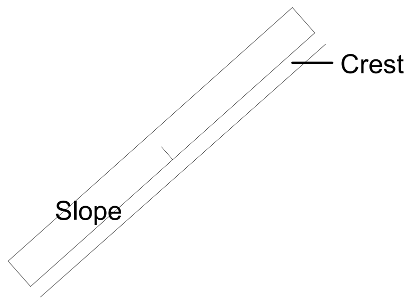
To insert an embankment proceed as follows:

- Click the toolbox icon „Embankment“.
- Enter the line for the base of the embankment using the mouse.
- Switch to edit mode and double-click the base line to open the embankment' edit dialog.



- Enter the appropriate parameters.

Upon closing the dialog by clicking **OK**, the embankment is shown with its slope.



2-D view of the embankment

relative height

The **relative height** in the dialog **Embankment** describes the upper edge of the embankment and the height in the **Geometry** dialog the height of the base.

Slope

If the slope is positive, the sloped side will be drawn to the right, as seen along the base line in the direction of insertion, otherwise to its left.

The **Parallel Object** command from the context menu allows you to insert an embankment running parallel to a road by specifying the distance.

Conversion into barrier

When converting embankments into barriers (e.g. after a barrier optimization) the height attribute HREL of the embankment is written automatically to the attribute HA of the barrier (see chapter 11.13 "Convert to" in the manual „Introduction to **CadnaA**“).

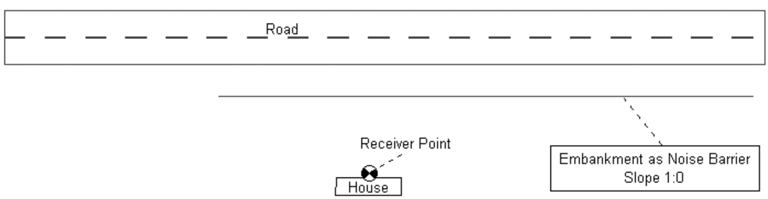
see also: chapter 3.5.1 Automatically Optimize Noise Barriers

3.5.1 Automatically Optimize Noise Barriers

CadnaA is able to determine autonomously the required height of a noise protection wall/barrier which is needed to obey given maximum levels by means of iterative calculation.

☝ Because of the object's structure, for such an optimization we have to use the object **Embankment** and **n o t** the object **Barrier**.

The following simple example shows the course of events:

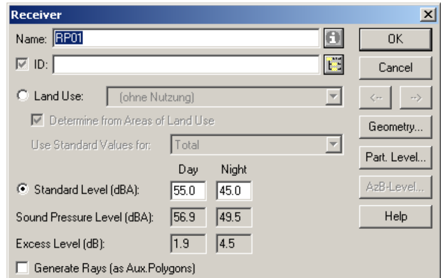


Road with a Noise Barrier and a Receiver Point

The represented road exceeds the permitted value at the receiver point. Therefore a noise barrier shall be constructed in the given position in such a way that the permitted value is not exceeded.

☝ To perform an optimizing calculation it is **absolutely necessary** to assign the relevant maximum value as **Standard Level (dBA)** to the receiver points. It is of no significance if you enter the maximum value directly or have it determined out of the type of land use. (In that case, do not forget to insert an area of **Designated Land Use**, see chapter 5.2.1)

3

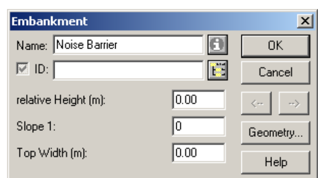


To perform an optimizing calculation the relevant maximum value must be assigned to the receiver points

The object „Embankment“ must be given

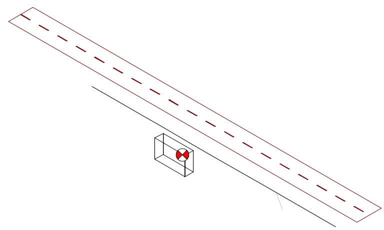
- a slope of 1:0 and
- a top width of 0

☝ Do not enter a value for height - this is what **CadnaA** is supposed to determine.

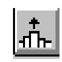


To opitmize the height of the Noise Barrier automatically in the edit dialog **Embankment** all values have to be zero.

In the next step we subdivide the noise barrier with the **Break into Pieces** command from the context menu of the Embankment. In the example 10 sections of identical size have been formed. Now select an appropriate view in the menu **Options|3D-View**, e.g., isometric.

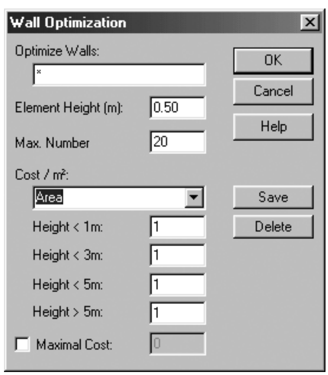


Options|3-D-View|Isometric

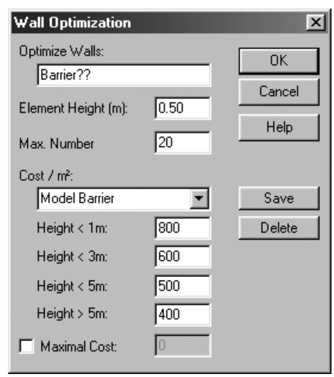


In the symbol bar of this dialog you can find the symbol **Optimize Barrier**.

After clicking, the parameter dialog will open and we can define our strategy of optimization.



Settings A



Settings B

Both dialogs show examples for possible settings.

In the upper text box a pattern similar to the group definition can be entered by which only the walls with identical **ID** codes will be integrated into the optimizing calculation. On the left hand side only the activated

Embankments are integrated, on the right hand side only the **Embankments** with the string „Barrier“ plus two additional characters.

With every step of the calculation a barrier section is raised by the value given in „element height“. The longer the calculation takes the shorter the subdivided elements are and the lower the value of the element’s height is. The result of multiplying **Element height** by **Maximum number of elements** is the upper limit for the height of the barrier.

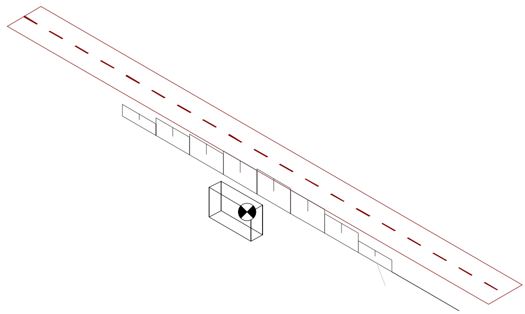
In the following combo box you can select the name „area“ or enter any other name, e.g., the product name of a noise barrier. In the first case the value 1, in the four subsequent boxes, will remain unchanged and optimization is executed in a way that the entire surface of the noise protection wall is minimized. With the setting A the further sample calculation is executed.

The setting B in the right figure takes into consideration the fact that the costs per square-meter can depend on the height of the noise barrier because costs for a foundation have to be apportioned and because, with the increasing height of the wall, greater wind pressures will have to be withstood. Optimizing is then executed in a way that will minimize the total cost.

Please note that the combo box **cost/m²** must **not** be left without an entry.

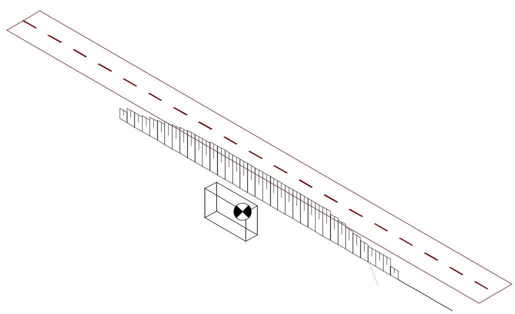
The cost schedule of a noise barrier can be saved/deleted with the corresponding buttons. A saved cost schedule, valid for all projects, will be at your disposal in the combo box.

After the setting A has been confirmed, the optimizing calculation will begin.



Subdivision of the noise barrier into sections of 10m each - Calculation with the setting B

An element width of 3m leads to the following representation:



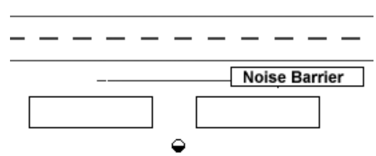
Subdivision of the noise barrier into sections of 3m each - Calculation with setting A

CadnaA first checks if the maximum value (**Standard Level (dBA)**) has been exceeded at the maximum height of all wall elements - in this case a message box will pop up. After the corresponding modification of the configuration the calculation will be restarted.

☝ Please note that with optimizing barriers all settings of the program will be considered. This is valid for projection, reflection and consideration of all activated elements. Owing to the large number of steps of calculation it is always advisable to deactivate all objects that have no effect on the result. Another alternative is to cut the relevant part out of the entire project - the optimized wall will then be imported into the project.

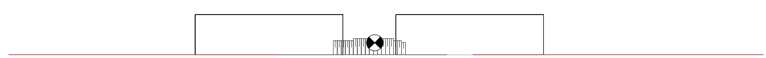
Examples\03_Obstacles\OptimizeBarrierGap.cna

In the following example a noise barrier will be positioned in the given location in front of a gap in a way that a maximum value, given for the receiver point behind the gap, can be maintained.



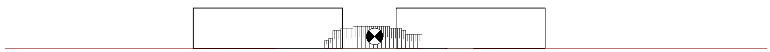
Initial Situation

In this case the wall is subdivided into 42 elements with a width of 1 m. This leads to a contour of the upper edge of the wall as shown in the graphic below. Calculation was executed strictly according to RLS90 with buildings considered as non-reflecting.



Optimizing a barrier with calculation strictly according to RLS90

Now calculation is repeated with buildings considered as reflecting, and integration of reflections up to the 5th order are included. Inclination will also be considered in deviation from the regulations of RLS90. This is appropriate because the represented situation can only be dealt with insufficiently by following the RLS90. As the result shows, a much higher wall would be necessary to meet this non-trivial situation.

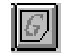


Optimizing a barrier with a 5th order reflection

With the optimization of barriers **CadnaA** is able to perform an efficient positioning of noise protection facilities.

3

3.6 Ground Absorption Areas



As a default setting for the object **ground absorption area** the ground attenuation will be taken into account according to the chosen guideline.

Upon clicking the **Ground Absorption** icon on the toolbox, enter the borderlines of the area. The ground absorption is specified in the edit dialog (opened by double-clicking on the borderline of the area).

For areas to which no such area has been assigned to, the global settings will apply as defined under **Calculation|Configuration**, tab „Ground Absorption“.

According to ISO 9613-2 clause 7.3.1 a ground attenuation will be taken into account frequency-dependent by default.

But you may also calculate simplified frequency-independent according to equation (10) clause 7.3.2. In this case a self-contained ground attenuation will be taken into account deviant from the real soil conditions.

In **CadnaA** you can define to calculate both - frequency-independent (simplified) or frequency-dependent (see **Configuration**, tab „Industry“)

☝ A height entered in the dialog Geometry of the object **Ground Absorption Area** is without any effect.

Where areas overlap the one entered last - so to say the one on top - determines the characteristics of the overlapping region. It is possible to assign an arbitrary color to such areas with specified ground absorption under **Options|Appearance**.

A list of these entered areas can be found under **Tables|Obstacles|Ground Absorption.**

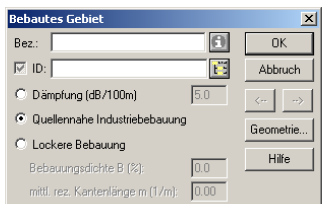
In case there are defined a lot of areas with special ground absorption you should activate the option „Use Map of Ground Absorption“ to save calculation time (see **Calculation|Configuration|Tab Ground Abs.**)

3.7 Built-Up Areas and Foliage

Built-Up Areas

Built-up areas are defined by a closed polygon and by its height (on dialog **Geometry**). The resulting attenuation due to built-up areas depends on the guideline selected for the respective type of source.

With calculation according to VDI 2714 or ISO 9613-2 the attenuation due to built-up areas is taken into account for areas as defined. When calculating traffic noise with the setting „strictly according to RLS90“ or „strictly according to Schall03“, however, no attenuation occurs with built-up areas (tabs „road“ and „Railroad“ on dialog **Calculation|Configuration**).



Dialog **Built-Up Area**

Calculation according to VDI 2714

According to VDI-guideline 2714, section 6.4.2, the attenuation of built-up areas D_G for single sources and for propagation through scattered buildings (i.e. no extending building facades):

$$D_G = (m * B * s_G - D_{BM})\ \text{dB} \geq 0\ \text{dB}$$

where

- m: average reciprocal length of edges in 1/m
- B: area coverage (of buildings) in %
- s_G: length of sound path through the built-up area in m
- D_{BM}: attenuation due ground & meteorology in dB

With single buildings the average reciprocal length of edges is 0.1 m^{-1} at maximum. With scattered halls smaller values for m apply.

The length of sound ray s_G through the built-up area is evaluated for a curve radius of 5000 m from source to receiver. Enter the average height of buildings with the area in dialog **Built-Up Area|Geometry**.

According to VDI-guideline 2714 the sum $D_{BM}+D_D+D_G$ is limited to a maximum value of 15 dB (D_D: attenuation due to foliage).

By entering values it can be checked which attenuation of built-up areas D_G results. The application of the object **Built-Up Area** is useful where the geometry of individual objects is not available. Otherwise, the object **Building** should be used.

Calculation according to ISO 9613-2

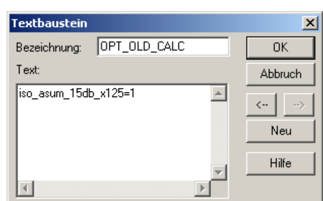
According to ISO 9613-2, annex A.3, the attenuation due to housing $A_{Hous,1}$ results from:

$$A_{Hous,1} = 0.1 * B * d_B \text{ dB}$$

where: - B: area coverage in % $\left(= \frac{\text{total building area}}{\text{total area}} \right)$

- d_B: length of sound path through the built-up area in m

The attenuation due to housing $A_{Hous,1}$ is limited to 10 dB according to ISO 9613-2. The sum of attenuations $A_{gr}+A_{fol}+A_{hous}$, however, is nit limited to 15 dB - as in VDI 2714. Using a text block with the name OLD_OPT_CALC this limitation can be engaged (text to be entered: iso_asum_15db_x125=1).



☝ The contribution of $A_{Hous,2}$ according to ISO 9613-2, annex A.3, is not considered by **CadnaA**.

Foliage

Woods („foliage“) are defined by a closed polygon and by its height (on dialog **Geometry**). The resulting attenuation due to foliage depends on the guideline selected. In the following, the procedures according to VDI 2714, ISO 9613-2, and Schall03 are explained.

Calculation according to VDI 2714

According to VDI-guideline 2714, section 6.4.2, the attenuation due to foliage D_D calculates from:

for A-weighted levels: $$D_D = 0.05\, dB/m * s_D$$

for spectra: $$D_D = \left[0.006\left(\frac{f}{Hz}\right)^{1/3§}\right] dB/m * s_D$$

with s_D: length of sound path through the foliage in m.

The length of sound ray s_D through the foliage is evaluated for a curve radius of 5000 m from source to receiver. Enter the average height of buildings with the area in dialog **Foliage|Geometry**. The resulting attenuation just holds for permanent (leaves !) and dense woods (i.e. with dense undergrowth).

Calculation according to ISO 9613-2

According to ISO 9613-2, annex A.2, attenuation due to foliage calculates from:

$A_{fol} = D_f * d_f$

with d_f: length of sound path through the foliage in m.

with the attenuation D_f as on the next table:

path length d_f (m)	octave band center frequency (Hz)	63	125	250	500	1k	2k	4k	8k
10 <= d_f <= 20	attenuation (dB)	0	0	1	1	1	1	2	3
20 <= d_f <= 200	attenuation (dB/m)	0,02	0,03	0,04	0,05	0,06	0,08	0,09	0,12

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Calculation according to Schall03

The procedure corresponds with the calculation in guideline VDI 2714 for A-weighted levels.

When performing exclusively road noise calculation according to RLS90 no attenuation due to foliage is considered.

3.8 3D-Reflector

3D-Reflector

The object 3D-Reflector models a plane reflector freely orientated in space. The 3D-reflector is a screening surface where the shortest deviation path between source-receiver governs the screening effect. Lateral screening and 1st order reflections are considered. In addition, individual edges of the 3D-reflector can be excluded from the calculation of lateral screening (see paragraph *Exclude Edges*). This option allows to restrict the screening at an edge e.g. at adjoining buildings.

The reflector's surface has to be plane. When polygon points not forming a plane have been entered a quadratic averaging is used to generate a plane surface. However, in these cases the reflector will be still displayed as entered.

If reflections are entered reflections at boundary surfaces of barriers will be taken into account according to the mirror sound source method. Strict provisions are made by RLS-90 concerning the neglecting of lateral diffraction and of ground attenuation in the calculation of the shielding effect. For all other sources it may be defined on dialog **Calculation|Configuration**, tab „Industry“ to what extent lateral diffraction shall be taken into account, and the barrier coefficients may be modified/specified.

Exclude Edges

When clicking on button "Exclude Edges" on dialog 3D-Reflector a dialog box opens allowing to mark reflector edges not to be taken into account for the calculation of diffraction.

To exclude an edge, click once on the name of the edge in the upper part of the dialog, e.g., E01. Marked identifiers exclude the corresponding edge from a calculation of diffraction. In the graphic representation, in the lower part of the dialog, the currently marked edge is marked by a thick black line. If the black dot of a edge is faded it indicates the deactivation of this edge. If you click again on the name of an edge it will again be included in the calculation. In this case the black dot is visible again.

The function is restricted to max. 32 edges. If a 3D-reflector has more then 32 edges further edges cannot be excluded.

see also Technical-Notes:
TN02012004_Special_Objects.pdf
3D_reflector_e.pdf

Chapter 4 - Topography

The contour of the terrain has two major effects on the calculation of sound propagation.

1. It determines the heights of sources, shielding objects, and receiver points, if the heights of these have been entered as relative values. For short distances, this, in turn, may affect the length of the sound path, thus the propagation loss, the path length difference around the barrier, and, consequently, the insertion loss.

2. The average height of the sound ray, thus the ground attenuation, is determined from the contour of the terrain.

Any program calculating immission must approximately calculate the heights of the terrain from the input information available. Modelling the terrain completely - using, e.g., an overall system of contour lines in fine steps - is often ruled out because data is missing and would lead to a considerable increase in calculation times.

Therefore, the most effective method with regard to data input is to use only as much detail in the height information as is needed, from the acoustic point of view, taking into account the two above-mentioned effects. This is particularly true where data collection and input require time and, consequently, expenses. It does not apply where existing data can be imported. In this case, it may become necessary to reduce the amount of data by the command **Simplify Geometry** (see manual „Introduction to **CadnaA**“).

Being somewhat familiar with the program-internal procedures will help you to determine the degree of detail needed and reasonable. Therefore, we will give you a brief description of how contour-line information is processed by **CadnaA**.

For each contour line and fault of line, the program internally generates a barrier with this line as its top edge and which is perpendicular to the reference plane with an absolute height of 0.

Where the height of an object has been given as a relative value, i.e., as height above the ground, the program calculates, prior to the actual calculation of propagation, the absolute height of the terrain at the object base - or the height of the terrain above the reference plane - for the polygon points determining the object height. This is achieved by evaluating the information on the nearest contour lines.

This evaluation is done for

- the first point (corner entered first) of closed polygon lines defining buildings
- each point entered for open polygon lines defining roads, and for general line sources, barriers, and similar objects
- each point entered for closed polygon lines defining parking lots, general area sources, and similar objects.

In the calculation of propagation, the sound ray from the source point to the receiver point intersects the horizontal projections of all contour lines and fault lines and any path length difference. Thus the shielding effect of the elevated terrain is determined. Furthermore, the height of the sound ray above the contour lines and fault lines at all intersections along with the path lengths between these points serve to determine, by numerical integration, the average height of the sound ray, and from this value, the ground attenuation. The heights of the terrain at source and receiver point, determined, if necessary, from the contour lines near these points, are taken into account.

The procedures and program strategies described above lead to the following conclusions regarding correct data input.

Point-like Objects

Point-like objects such as point sources, receiver points and tennis points of service have three co-ordinates - x to the right, y upwards, and z for the height - which describe their position. These values are listed in the columns of the pertinent object tables.

The z coordinate can be entered as a relative height, an absolute height, or the height above the building roof. If a relative height is given, the absolute height z results from the height of the terrain at the position given by the x and y coordinates of the point plus the relative height entered. If, for a point, a definite height is to be achieved, it is convenient to enter an absolute height.

Line-like Objects

The line-like objects such as line sources, roads, and railways, are defined by an open polygon line or by a series of points.

The first and last points of the polygon line may have the same, or different, heights (relative, absolute, or above the building roof, see chapter 4.1). The heights of the points in between are determined automatically by linear interpolation. Another alternative is to enter each point of the polygon line with a different absolute height.

Two-dimensional Objects

Two-dimensional Objects (Excluding Vertical Ones)

Two-dimensional objects, such as area sources and parking lots, are described by a closed polygon line or by a series of points.

By entering the height of the first point, all points can be assigned the same height (relative, absolute, or above the building roof). Another alternative is to enter each point of the polygon line with a different absolute height.

Two-dimensional Vertical Objects

Two-dimensional vertical objects such as vertical area sources and barriers are defined by an open polygon line or by a series of points describing their top edge plus a z dimension describing their bottom edge. The top and bottom edges are always parallel and have identical horizontal projections. Refer to "Line-like Objects" above for the entering of the height, or z coordinate, of the points of the polygon line defining the top edge.

Three-dimensional Objects

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Buildings

Buildings are defined by a closed polygon line or by a series of points defining their top edge. They always extend from the ground to the top edge thus defined. Refer to "Two-dimensional Objects (Excluding Vertical Ones)" above for the entering of the height, or z coordinate, of the points on the polygon line defining the top edge.

If the height of the building has been given as a relative value, the absolute height of the top edge results from the height of the terrain at the first point (corner entered first) plus the relative height of the building.

Cylinders

Cylinders are defined by the position of their centres in the horizontal projections, and also by their radii and heights (relative, absolute, or above the building roof).

If the height is entered as a relative value, the absolute height of the cylinder's top edge is the sum of the height of the terrain at the centre and the relative height.

4

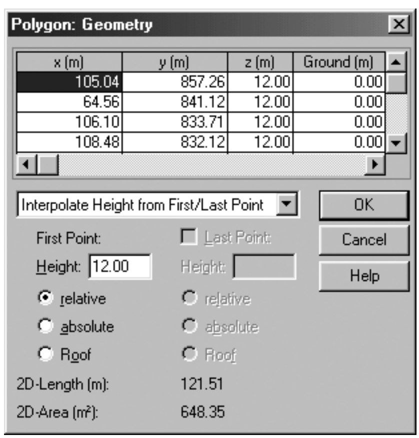
4.1 Object's Geometry

Horizontal Projections With Right Angles

Any line-like, two-dimensional or three-dimensional object, except cylinders, can be forced to be rectangular while entering the defining polygon line by positioning the points using the mouse with the SHIFT key pushed down. If rectangles are to be generated, it is convenient to enter the longer side first. When clicking the third point to define the shorter side, the mouse pointer is positioned on the first point, and when clicking again, the third, longer side is automatically drawn with the correct length. A final click with the right mouse button suffices to close the rectangle. This procedure is particularly advisable when inserting buildings having right angles in their horizontal projection.

Dialog Geometry

The geometry dialog shows the coordinates of an object. It is accessible via the **Geometry** button in the edit dialog. The edit dialog can vary from the displayed dialog of a **building** depending on the selected object..



Example of geometry dialog

Coordinates Polygon point

The table of coordinates in the edit dialog can be edited. For that, double-click on the corresponding row.

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x-y-z-Coordinates Ground height

Depending on the selected options from the list under the table of coordinates you can either edit only the x-y-coordinates and/or the z-height and/ or the ground height.

Cross section/Distance/ Slope of Roads

Also in the road dialog **Geometry** you can enter the **Standard Cross Section (SCS)/Distance** of the central axis from both outer lanes and/or the slope of the road for each polygon point.

If the distance of a lane and/or a slope is entered, **CadnaA** adjusts the value for all further polygon points until a new input ensues.

The corresponding fields of the table remain empty. A new value is entered only if a value changes. Consequently for the calculation the next above entered value will be considered for an empty table field in the columns **Distance** and **Slope**.

More Options

Depending on the selected option from the list, the following parameters in the coordinate table are possible:

Interpolate from First/Last Point

- Only the x- and y-coordinates are editable in the table of coordinates.
- Enter the heights, or z co-ordinates of the first and, if necessary, last point. For that mark the identically named option.

  After a calculation - if an initial and final height, for the **First** and **Last** point, was entered - the interpolated heights on each point are displayed in the table of coordinates.

  If the height is equal for each point of an object then the checkbox of the **Last Point** should be deactivated. The initial height of the **First Point** will be assigned to the whole object (standard setting).
- With the following options determine the kind of height by activating its check box.

relative Height

Height, in metres (m), above ground. The absolute height of the ground can be different for different locations due to contour lines, fault lines, and the default height specified under Calculation Configuration.

absolute Height

The **absolute Height** is the height above a reference plane, usually mean see level (M.S.L.)

Roof

This option allows you to directly enter the height above the roof of a building in order to facilitate the specification of the height for external sound sources on the roof of the building. If the source lies within the horizontal projection of the building, its height will be calculated as the sum of the height of the building and the height above the roof specified here.

If different heights for polygon points are assigned to a building, the height for that object will be calculated with the first height point of the building.

An area source, e.g., placed within the horizontal projection of a building and whose height is assigned to the option "Roof" will have a uniform height even if the heights of the polygon points are different. You may have to input the height on each point directly by using the option "absolute height at every point".

You may model a building on top of a building with a relative height from the building. Therefore check the option **Roof** in the geometry dialog. The order of input of ***two*** buildings with a height relative to each other is irrelevant and also another sorting of the object table afterwards let no problems arise. But another building on top of a building which already has a relative height assigned to its roof should be avoided.

K_0

In CadnaA buildings are modelled like "open boxes" without a roof. Therefore K_0 will be calculated according to the height above the digital terrain model for point-, line- and area sources placed within the horizontal projection of the building.

This option may also be activated for **Floating barriers** (see chapter 3.3.1) on bridges. The height of the top edge of a barrier then results from the bridge height plus the specified height above the building's roof.

Enter Absolute Height at Every Point

If this option is activated, the z co-ordinate can be specified individually for every point. The given value of z is the absolute height of the object in this case.

To this end, double-click on the relevant row in the coordinate table of the edit dialog. The edit dialog **polygon point** appears. When the desired z coordinate has been entered, by clicking the arrow buttons, or pressing ALT+SHIFT+> or ALT+SHIFT+<, you will be taken to the next or previous set of coordinates, respectively, without leaving this window.

The advantage of using the hot keys is that the cell currently selected will remain selected while switching, and that the corresponding entry will be overwritten when you enter a new value. This procedure allows you to easily enter all heights for a polygon line one after the other.

unknown Heights

Usually, to correctly model the course of a polygon, you will also have to enter polygon points whose heights are unknown and which would have to be interpolated. This task can be performed by **CadnaA** as well.

If the absolute height of some points is unknown, the value of the height is **deleted** for these points. The default height is 0 m. Just press the DEL key to delete it (the box is now empty). When the dialog is closed, **CadnaA** updates the value by interpolation. You can check the interpolated values by opening the dialog again.

Absolute Height/Ground at every point

With the option **absolute Height/Ground at every Point** we can enter the ground height for each point additionally.

All other possibilities are the same as described above for **Enter Absolute Height at Every Point**.

Reference Point

CadnaA has an internal list of reference points which is helpful to transmit coordinates automatically, e.g. for transformation of objects or for calibration of bitmaps. Particular if you have big coordinates you could produce mistakes while entering values via the keyboard yourself. With the list of reference points you can easily transmit coordinate into the corresponding fields automatically.

Example:

Calibrate a bitmap using reference points without entering a single coordinate.

Examples\Demo2.cna

- Therefore open the file **Demo2.cna** on your CD in the directory **Examples**. This is a copy of the file **Demo1.cna** in which originally a bitmap is contained. But you will calibrate a bitmap yourself now.

To calibrate the bitmap as accurate as possible you should choose four reference points in your opened file.

- Double-click an object which coordinates shall be the first reference point. Open its **Geometry** dialog and double-click the corresponding data record of the coordinates.

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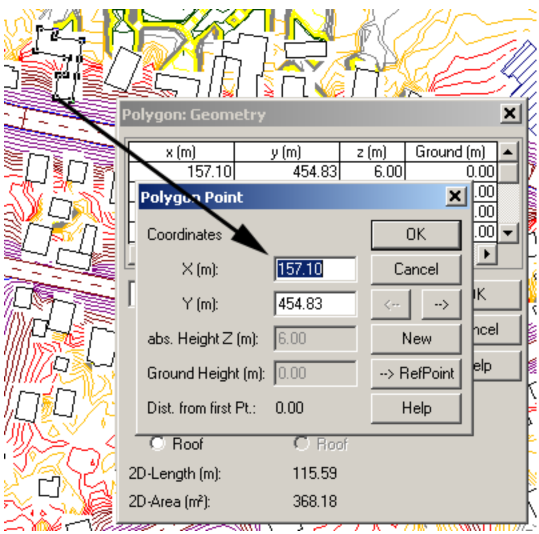
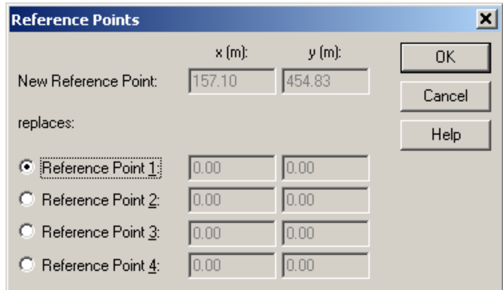
In this example you must remember the building's corner because subsequently you have to click on the corresponding corner in the bitmap for the first reference point if you calibrate the bitmap.



- Click on the button **RefPoint** - the following dialog opens.

4



As you can see the coordinates of your reference point is entered automatically in the corresponding fields **New Reference Point**. If you now want to use it - like in our example - as first reference point you have to activate the pertinent option **Reference Point 1.**

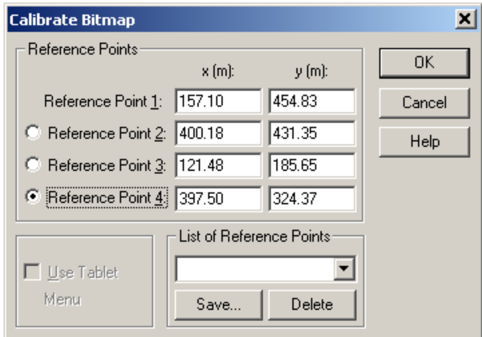
- Proceed with the other three reference points analogously. You only have to activate the pertinent option for the respective coordinates. Therefore for the next reference point the option **Reference Point 2**: etc.

If you have defined all four reference points

- insert an arbitrary frame of a bitmap anywhere in your file and open its edit dialog.

Examples\
Demo1.bmp

- Click on the card-index icon beside the field **File** and choose the bitmap file **Demo1.bmp** on your CD in the directory **Examples**. The path and the file name has to be displayed in the field **File**.
- Afterwards click the button **Calibrate Bitmap** and activate all four reference points by clicking the corresponding options. As you can see all coordinates are entered in the pertinent fields automatically.



- After confirming with OK you will be prompted to locate the reference points by clicking in the bitmap point by point.

After clicking the fourth reference point and confirming with OK the bitmap should now be placed correctly in your file.

For further information:

see Chapter 10 - Bitmaps.

4

4.2 Contour Lines

Contour lines and fault lines serve to create a model of the topographical conditions or of the contour of the terrain. They are entered with absolute heights.

A contour line allocates to the terrain along these lines a defined height above the reference plane. The height at any point of the line is specified as generally described for line-like objects.

The contour of the terrain between the contour lines is interpolated for the calculation, depending on the settings specified on the **Calculation|Configuration|DMT** tab.

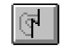
The topographical conditions or uneven terrain may cause shielding effects and affect ground attenuation in the propagation calculation. Furthermore, the absolute height of objects whose height has been given as a relative value is determined by taking into account the height of the terrain at the base of the object as resulting from contour lines and fault lines.

For the calculation of the shielding effects of elevated terrain, contour lines are treated like the top edges of barriers. Elevations generated by interpolation between the contour lines are not taken into account in this calculation.

The table **Contour Lines** (**Tables** menu) only lists the first and last points. The listed heights are absolute values (see above).

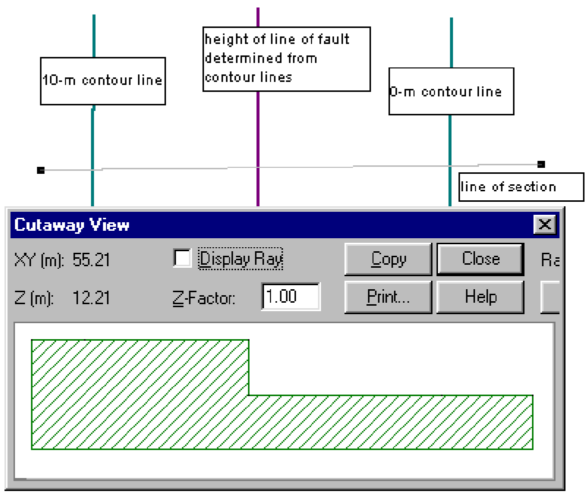
The geometry data of the contour lines can be exported or printed by referring to the key word #(Table, Hline_GEO) .

4.3 Line of Fault



Contour lines and fault lines serve to create a model of topographical conditions or of the contour of a terrain.

A fault line is interpreted as a discontinuity in the terrain surface between the heights of the terrain defined by the adjacent contour lines or the heights applying directly to the terrain on both sides.



A fault line is defined by a line in the x-and-y plane. The **fault lines** table (**Tables** menu) lists these lines with their automatically generated serial numbers.

The geometry data of fault lines can be printed or exported using the key word #(Table, Bruch_GEO).

(see **CadnaA**-manual "Attributes & Abbreviations").

The height of the terrain near fault lines is interpolated arithmetically if the option „Determine Height from Contour Lines“ is active and is not easily predictable in the individual case.

If a specific discontinuity is to be forced, it is always advisable to activate the option „Enter Height at Every Point“ and to directly assign the z values to the left and right of the fault line by editing the coordinates table (see chapter 4.1).

For the calculation of the shielding effects caused by elevated terrain, fault lines fault lines are treated like the top edges of barriers, with their heights as determined by the contour line model.

Elevations generated by interpolation between contour lines and fault lines are not taken into account in the calculation of the shielding effect.

fault lines are entered as line-like objects. Once the line has been inserted and double-clicked, the edit line-of-fault dialog opens. You can then enter the co-ordinates like for any line-like object. (Giving the height is optional).

see chapter 6.2.6 "DTM Digital Terrain Model Tab"

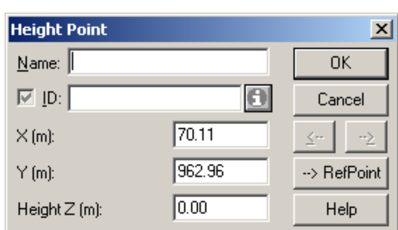
4.4 Height Points

The structure of the ground’s surface can be modelled using object types „Contour Line“, „Height Point“ and „Lines of Fault“. However, only contour lines and lines of fault are considered as screening objects. Although the ground surface constructed from height points is used to determine the object height with relative heights, it does not influence the average height of a ray above ground (ground attenuation!) and does not cause a screening effect. In order to cause screening activate the option „Triangulation“ (see chapter 6.2.6 "DTM Digital Terrain Model Tab"). As long as the option „Explicit Edges Only“ is deactivated the triangulated contour lines cause screening and effect the ground attenuation.

By height points a defined height is assigned to the terrain above the reference plane at the respective location. The shape of the terrain between height points will be interpolated upon the calculation according to the settings on menu **Calculation|Configuration**, tab „DTM“. In case „Triangulation“ is deactivated a terrain model just defined by height points does not cause screening.

The absolute height of objects being defined by entering a relative height is calculated according to the ground height resulting from the height point model at the base point of the object.

Height points are entered using the mouse as usual with point-like objects. After input and double-clicking on the height point, the edit dialog opens with input boxes for the coordinates as usual with point-like objects.



4

Use Contour line as Cluster of Height Points

Many height points will require a large amount of memory and, thus, increase the size of the project file, also due to the fact that for each height points the name and ID have to be stored as well. To save memory convert the height points into contour lines which produces a cluster of height points (via the command **Modify Object**, action „Convert to“, object type „Height Points“). A cluster may consist of up to 10,000 height points joint to a contour line. The contour lines can be converted back again into individual height points.

Examples\ 04_Topography\ HP.cna

Open the file **HP.cna** from CD (directory **Examples| 04_Topography**). The file contains about 4,000 height points.

- From the context menu execute the command **Modify Object**, action „Convert to“ for object type „Height Point“, to be converted to „Contour lines“.
- Subsequently, open the **Tables|Obstacles|Contour Lines**.

In this example, there are just five contour lines remaining. If you click on a row in the table the corresponding contour line will be highlighted.

Import ASCII-File as Height Points

An ASCII-file with xyz-coordinates supposed to be height points can either be imported into **CadnaA** via the ODBC-interface (see chapter 7.3 "Import via ODBC Interface") or by using the command **File|Import**, import format „ASCII-Objects“ (see chapter 7.2.17 "ASCII-Objects").

Generating Contour Lines via Grid Interpolation

To generate different contour lines from height points using grid interpolation see chapter 4.4.1 "Generate Contour Lines from Height Points".

4.4.1 Generate Contour Lines from Height Points

In contrast to contour lines height points usually have the disadvantage that ground attenuation and shielding will not be taken into account in the calculation of sound propagation (except if you have activated the DTM **Triangulation** see chapter 6.2.6).

To avoid this you can generate contour lines from the height points.

- First define a grid in the menu **Grid|Specification** in which the heights are to be calculated.
- Choose „Ground“ form the list box evaluation parameters
- Execute a grid calculation (**Grid|Calc. Grid**).

☝ For definition and representation of the lines of equal height the dialog boxes of the receiver point’s grid are used analogously.

For the representation of the lines of equal height use also the dialog of the receiver point’s grid (**Grid|Appearance**). The lines of equal sound power level are now lines of equal height. You can also use color settings in the menu Options.

In the menu **Level Range** (upper limit, lower limit, class width) you can define - from which height (lower limit) to which height (upper limit) and with which height differences (class width) - these lines shall be represented. If you quit the dialog with OK, you can see which contour lines will be generated in the next step.

Now press ALT+F12 - the represented lines of equal height are now converted into the object type Contour Line.

see also chapter Use Contour line as Cluster of Height Points

4

4.4.2 Generate Cluster of Heights Points from a Bitmap

When terrain height data is provided as a gray-scale bitmap, these data can be converted into clusters of height points. The gray-scale bitmap may have a resolution up to 16 bits.

- Load the bitmap using the specific functions for the import of bitmaps (see chapter 10.1 "Insert Bitmaps").
- Open the dialog **Modify Objects**.
- Select the action „Convert to“ for the object type „Bitmap“ and click OK.
- On the dialog **Convert to** just the terrain contours are available as target object type.
- Confirm the query with OK.

The bitmap is converted into terrain contours being a cluster of heights points (see section „Use Contour line as Cluster of Height Points“ in chapter 4.4 Height Points).

4.5 Display Ground Height

At the individual points of a calculated grid (beside the sound level for the evaluation parameters) the ground height is also calculated and saved as a separate value from the contour lines, height points and fault lines as taken into account from the standard height defined in **Calculation|Configuration** if necessary.

After the grid calculation beside the coordinates (x/y) and the sound level (L), the ground height (G) will also be displayed in the status bar at the position of the mouse cursor.

You do not need a sound source if you only calculate the ground height.

If you choose **Ground** from the evaluation parameter list box in the symbol bar not the sound level is shown longer, but the value of the ground height will be activated and displayed on the screen equivalent to the settings made in **Grid|Appearence**. The **Lower** and **Upper Limit** should now be entered, and it should include all current ground height values.

If you activate **Line of Equal Sound Level,** the contour lines calculated with interpolation will be displayed.

Hints for professionals: If you want to generate proper contour lines in your project just press ALT+F12.

see chapter 4.4.1 "Generate Contour Lines from Height Points" and 4.4 Height Points: „Use Contour line as Cluster of Height Points“

4.6 Fit Objects to DTM or DTM to Objects

CadnaA calculates the heights of objects and of the terrain at the pertinent polygon points of the objects. For the area in-between, a linear interpolation is performed.

Therefore, the user may have to enter additional points where contour lines and objects intersect to allow the change in slope of the terrain at such points to be taken into account.

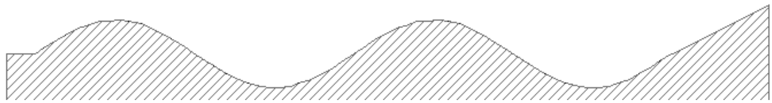
To evaluate the heights between contour lines with only a few polygon points you can also insert additional polygon points for the contour lines automatically in **CadnaA**. For that, you have two possibilities when executing the command: either directly at the object's context menu, this would affect only that object or its surrounding terrain, or with the **Modify Object** command and the corresponding action which would affect the desired objects which you have selected in the dialog (see manual „Introduction to **CadnaA**"):

1. **Fit Objects to DTM**. This command uses contour lines and edges of triangulation to fit the object to the surface of the digital terrain model.

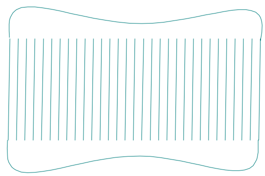
2. **Fit DTM to Object**. This command changes the whole terrain model by cutting existing contour lines and inserting new ones.

4

An example with the object **Road**:
The existing DTM in the cross-section view

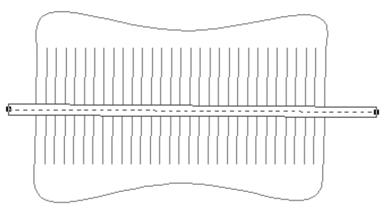


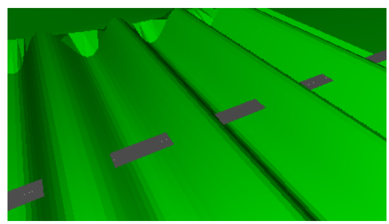
and in the top view:



Example:
Fit Object to DTM

A road on a DTM with only an initial and a final point. Therefore the object is unable to adjust to the ground..

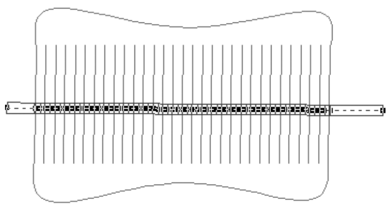




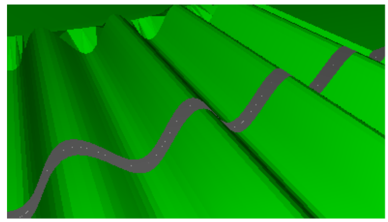
Top View 3D-Special View

4

The road after executing the command in the C**ontext menu|Fit Object to DTM**. Additional polygon points are inserted for the road at the intersection of the contour lines. Therefore, the object adjusts itself to the ground.



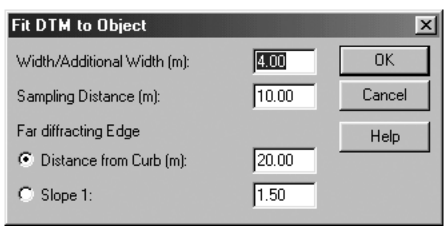
Top View



3D-Special View

Example:
Fit DTM to Object

After executing the command **Fit DTM to Object the** following dialog appears in which you can set the parameters for the adjustment of the objects.

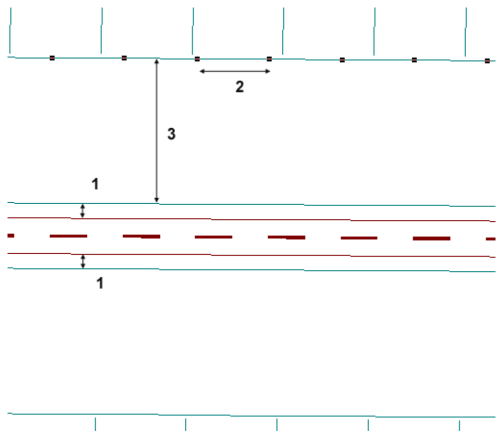


Width/Additional Width

In this box define the additional width for the ground around the object which shall be located at the same height. **CadnaA** than inserted parallel contour lines in the defined distance and deleted them between road and parallel contour lines.

Because the margin of the **Road** symbolizes the middle axis of the outermost lanes you have to insert an additional width for the real width of the road which is taken into account with the half width for each side.

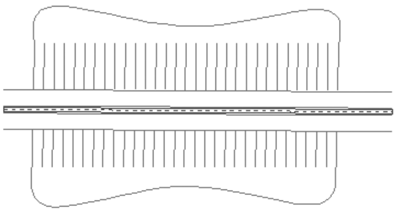
☝ With open objects like **Roads**, **Railways**, **Line sources** etc., the parallel contour lines are placed at the distance of the half value of the defined additional width; with closed objects like **Buildings**, **Area sources** etc., contour lines are placed around the objects with the defined value.



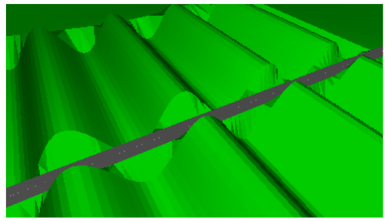
Top View: 1 Width/Additional Width, 2 Sampling Distance, 3 Distance from Curb

Sampling Distance

For the best adaptation on the DTM you can define a distance (box **Sampling Distance**) in the cross-section of the object in which a base-point should be placed for the new contour line.



Top View



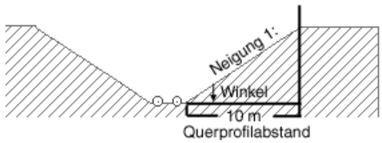
3D-Special View

The Situation after the command **Fit DTM to Object** has been executed with the **Sampling Distance** of 20 m. The parallel contour lines are clearly visible.

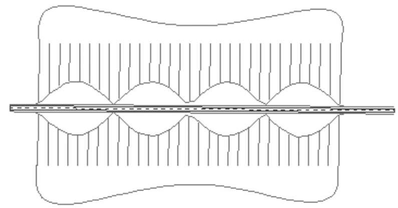
Slope 1:

When inputting a slope the resulting angle adjusts the DTM in this area by inserting new base-points of contour lines.

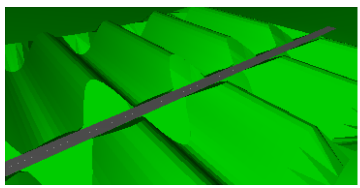
4



Cross-Section



Top View



3D-Special View

Situation after executing the command **Fit DTM to Objects** with a **Slope 1:** 1.50.

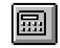
Chapter 5 - Immissions

For the calculation and the evaluation of receiver levels the following objects are available in **CadnaA**:

- receiver point (see chapter 5.1),
- area of designated land use (see chapter 5.2),
- calculation area or horizontal grid (see chapter 5.3),
- vertical grid (see chapter 5.3.6),
- building evaluation (see chapter 5.4).

Furthermore, this chapter explains the evaluation features available within the **CadnaA-**option XL (see chapter 5.5).

5.1 Receiver Point

A calculation of sound immission can be performed for a grid of points (see chapter 5.3) or for points specified individually after clicking the **Pocket Calculator** in the icon bar. The icon shown above serves to insert single receiver points at the desired position in the project.

As opposed to receiver points in a grid you can save all intermediate values for the individually placed receiver points (see chapter 6.4 Calculation Protocol).

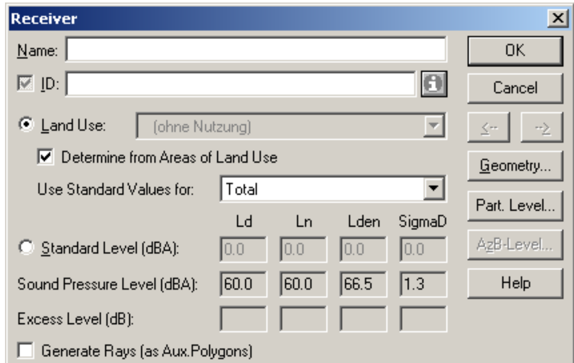
Generate Rays

You also can display the sound rays of the corresponding order of reflection (see chapter 6.1.7). Therefore activate the option **Generate Rays** in the edit dialog of the receiver point. The rays are deleted if you calculate again with deactivated option **Generate Rays**.

Allocating a receiver point to a building

To allocate a receiver point with the same distance to a building, you can activate the **Object Snap** in the menu **Options**. The receiver points will then be placed in front of the building at the defined distance from the facade. The default distance is 0,05 m. Therefore no receiver point disappears accidently inside the building.

To open the edit dialog **Receiver Point** click either with the right mouse click (insertion mode) on the border of the receiver point or make a double-click (in the edit mode).



Receiver Point Edit Dialog

The presentation and number of calculated values depend on the defined evaluation parameters (see chapter 6.2.5).

As default if the results at a receiver point exceeded the defined limiting values its symbol changed red. Alternative you can choose a different color via a formula (see chapter 9.6).

Object Geometry see chapter 4.1

5.1.1 Utilization - Standard Level - Infringement

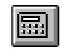
If standard levels are allocated to receiver points after a calculation you can easily notice in the graphic if the standard level has been exceeded or not. In the case of infringement the receiver point has been colored red on default or in a color defined via a formula (see chapter 9.6 "Object Appearance").

The standard level can be entered either directly in the pertinent edit field or can be defined by the kind of utilization (land use) and their allocated standard levels. Choose one kind of land use from the combo box, which has been previously entered in the menu **Options|Land Use** (see chapter 5.2.1).

If the checkbox **Determine from Areas of Land Use** is activated, the standard level will be determined through a calculation from the kind of land use inside of whose area the receiver point lies. The standard level is displayed after the calculation in the corresponding field.

5.1.2 Calculation at Receiver Points & Presentation of Results

In **CadnaA**, up to four evaluation parameters can be calculated simultaneously for single receiver points (see chapter 6.2.5).



Start the calculation of the evaluation parameters for the individual receiver points either in the menu **Calculation|Calc** or via the icon in the icon bar.

5

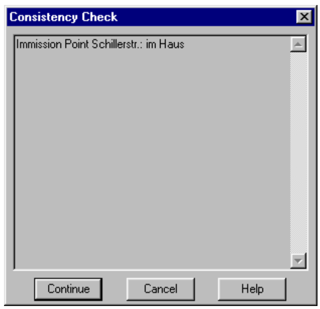
If you have defined different evaluation parameters after a calculation, the colors for receiver points may change when a limiting value has been exceeded (see chapter 9.6 "Object Appearance").

To see the results of the calculated evaluation parameters select its identifier from the symbol bar. Also in **Tables|Partial Level** you will see the result of the evaluation parameter selected.

see also chapter 11.2 paragraph: Allocating a Receiver Point to a building.

5.1.3 Check Consistency

If receiver points or point sources lie within a building, **CadnaA** will draw your attention to this by opening the dialogue **Check for Consistency** as soon as you trigger a calculation.



If required, this allows for modifications before the calculation.

Click a line on this window to select the pertinent object in the graphic. If the object in question lies outside the area visible on the screen, click the line again while holding sown the SHIFT key. This brings the object on the screen.

Double-clicking a line opens the pertinent edit dialog.

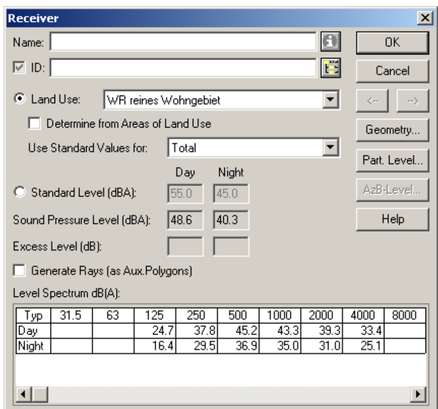
Click the **Cancel** button to stop the calculation, or click **Continue** to proceed.

5.1.4 Sound Pressure Level

Level Spectra

If a frequency-dependent calculation has been performed, levels will be displayed for each frequency band. If, for a noise source, only one band is missing, no spectra will be displayed.

The calculated levels of the evaluation parameters are displayed in the **Level (dBA)** box. As time-averaging has already been performed, this will usually be a rating level (if other corrections needed for the calculation of the rating level have been taken into account when entering the emission data.).



Results in frequency bands for Day (Ld) and Night (Ln)

Weighting for Octave bands

The weighting for octave bands (lin, A,B,C,D) for display and print out can be selected via the command **Miscellaneous** on the **Options** menu. After changing the weighting the resulting octave bands will be displayed immediately.

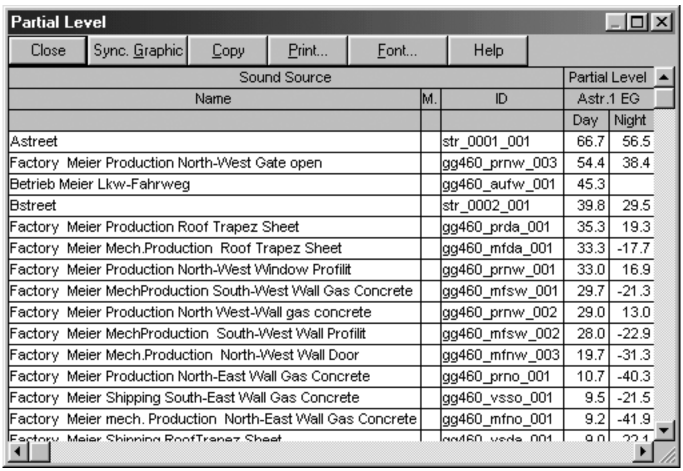
Excess Level

The level difference due to exceedance is displayed in the box **Excess Level** if the standard level has been exceeded for this receiver point.

5.1.5 Partial Levels

The sound level at a receiver point resulting from a specific sound source is called a partial level.

Clicking the button **Partial Level** on the receiver's edit dialog opens the list of partial levels.



Sound Source			Partial Level	
Name	M.	ID	Astr.1 EG	
			Day	Night
Astreet		str_0001_001	66.7	56.5
Factory Meier Production North-West Gate open		gg460_prnw_003	54.4	38.4
Betrieb Meier Lkw-Fahrweg		gg460_aufw_001	45.3	
Bstreet		str_0002_001	39.8	29.5
Factory Meier Production Roof Trapez Sheet		gg460_prda_001	35.3	19.3
Factory Meier Mech.Production Roof Trapez Sheet		gg460_mfda_001	33.3	-17.7
Factory Meier Production North-West Window Profilit		gg460_prnw_001	33.0	16.9
Factory Meier MechProduction South-West Wall Gas Concrete		gg460_mfsw_001	29.7	-21.3
Factory Meier Production North West-Wall gas concrete		gg460_prnw_002	29.0	13.0
Factory Meier MechProduction South-West Wall Profilit		gg460_mfsw_002	28.0	-22.9
Factory Meier Mech.Production North-West Wall Door		gg460_mfnw_003	19.7	-31.3
Factory Meier Production North-East Wall Gas Concrete		gg460_prno_001	10.7	-40.3
Factory Meier Shipping South-East Wall Gas Concrete		gg460_vsso_001	9.5	-21.5
Factory Meier mech. Production North-East Wall Gas Concrete		gg460_mfno_001	9.2	-41.9

List of partial levels at a receiver point with all noise sources and calculated evaluation parameters

Partial Level Receiver

The list of partial levels displays for all existent receivers the partial levels of the defined evaluation parameters - in frequency bands, if necessary - of all sound sources accounted for in the calculation. The list of partial levels determines, e.g. the ranking of priorities for effective noise control measures.

Select the **Sort Column** (see chapter 11.1.4) command from the context menu to have the columns sorted by, e.g., partial levels in ascending order. Double-clicking the cell of the receiver point opens the edit dialog of the source that causes this partial level.

Overall Partial Levels

Selecting the menu **Tables|Partial Levels** opens an overall list of the partial levels at **all** receiver points caused by **all** sources accounted for in the calculation.

Column Limit

However the number of columns showing the partial level is enlarged to about 5.000 columns (formally 277). In case you will reach the limit you can create groups with the receivers and calculate the group one after the other to show the partial levels.

Group

Menu **Tables|Groups** display the partial levels of all noise sources which belong to the group (see chapter 14.1 "Groups").

Variants

In case variants are defined, the list of partial levels will be displayed for the variant most recently calculated.

☝ Did you choose for evaluation parameter **Sigma** or an **equation** (=f(x)) no partial levels for these parameters will be shown.

Suppress Display of empty Table Lines

The display of "empty" lines in the table **Partial Level** can be suppressed by a corresponding entry in the file CADNAA.INI. Add in section [Main] the following line to achieve this:

NoEmptyPartLev=1

With that value being 1 no „empty“ spectra will be displayed.

☝ „Empty“ spectra result from sources outside of the search radius or from sources been excluded from the calculation due to a maximum error specified.

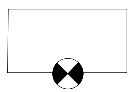
☝ Irrespective of this setting, the partial levels of <u>all</u> sources will be displayed on dialog **ObjectTree|Partial Level** and on table **Partial Level** on the **Tables** menu.

5.1.6 Floors

This context menu command allows you to generate at a receiver point a row of further receiver points for the floors above or below.

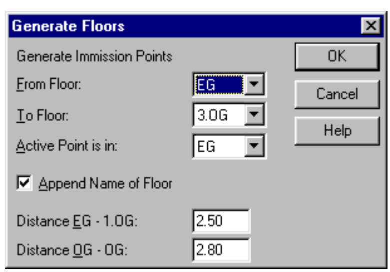
Example

Insert a receiver point in front of a building. (Be sure the object snap is activated.)



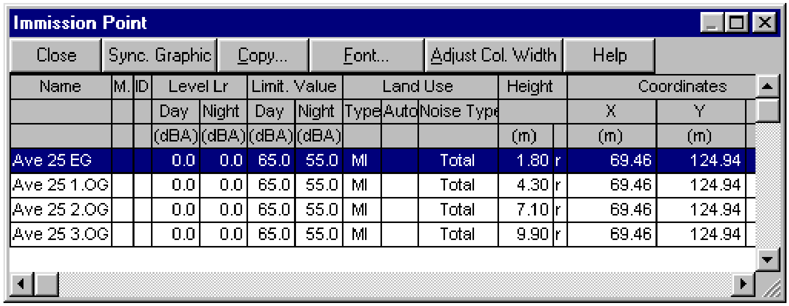
A building in CadnaA with a receiver point at a distance of 5 cm (object snap) from the facade.

- Click the receiver point using the right mouse button. From the context menu (see manual "Introduction to **CadnaA**") select **Generate Floors**.



- Select/enter the values as on the dialog **Floor** above
- Click **OK** to close the dialog. **CadnaA** then creates three more receiver points in a vertical row above the first one. They have the same name as the first one, plus the storey number.
- Afterwards open the **Table|Receiver Points**.

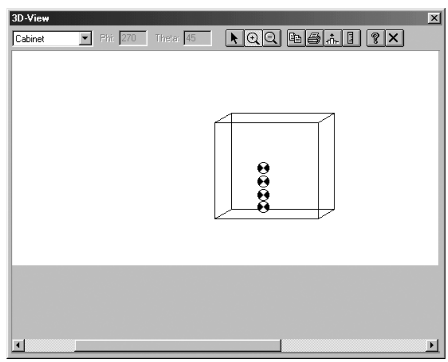
5



Name	M.	ID	Level Lr		Limit. Value		Land Use			Height		Coordinates	
			Day	Night	Day	Night	Type	Auto	Noise Type			X	Y
			(dBA)	(dBA)	(dBA)	(dBA)				(m)		(m)	(m)
Ave 25 EG			0.0	0.0	65.0	55.0	MI		Total	1.80	r	69.46	124.94
Ave 25 1.OG			0.0	0.0	65.0	55.0	MI		Total	4.30	r	69.46	124.94
Ave 25 2.OG			0.0	0.0	65.0	55.0	MI		Total	7.10	r	69.46	124.94
Ave 25 3.OG			0.0	0.0	65.0	55.0	MI		Total	9.90	r	69.46	124.94

When all heights have been entered, and the storey numbers have been appended, the table of receiver points should look similar to the above illustration.

If necessary, use the 3-D view (see chapter 9.13) to check if the storeys were entered correctly.



3D-Wire model View „Cabinet“

5.2 Area of designated Land Use

Areas of different land use allow for the description of the designated land use in accordance with the Land Use Ordinance. Points within such areas can thus be assigned the standard levels for the different types of noise (**Options|Land Use**). This feature allows you to adopt the types of designated land use for the entire **CadnaA** project directly from development plans, and to calculate sensitivity maps. This leads to conflicting maps where the differences between the rating levels calculated for each type of noise and the standard levels, as per the designated land use, are calculated (Prerequisite: **XL** module).

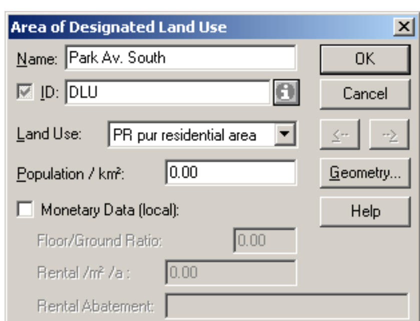
CadnaA can also automatically assign the pertinent standard levels to all receiver points lying within a defined area of **Land Use**. The prerequisites are

1. that the checkbox **Determine from Areas of Land Use** is activated in the edit dialog of the receiver point and

2. an area of designated land use is inserted in which the receiver points are included.

Enter the borderlines of the areas of designated land use after clicking the icon on tool box.

In the edit mode double-click the borderline of the inserted area and select the type of land use from the list box.



Population / km²

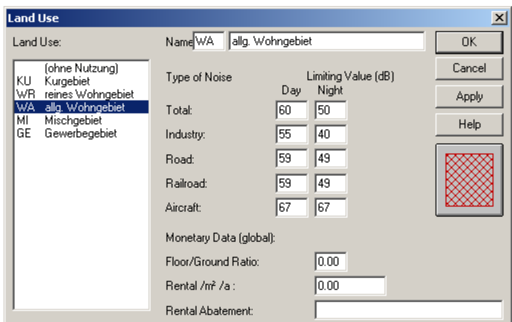
(Prerequisite: XL module) - The menu command **Grid|Population Density** allows **CadnaA** to approximate the population density from the buildings, and to assign it to the areas of designated land use (see chapter 5.5.4).

Monetary Data

(Prerequisite: XL module) - A technique to evaluate the noise is described in the study /75/. This method has been integrated into **CadnaA** (see chapter 5.5.6).

5.2.1 Type of Land Use

Via the menu **Options|Land Use**, the standard levels for the defined evaluation parameters (see chapter 6.2.5) applying to the different types of noise and the appearance - filling pattern and color - are assigned to the different types of land use. These different kinds of land use can be selected in the edit dialog of the object **Area of Designated Land Use** (see chapter 5.2).



Via this dialog new types of land use areas can be defined.

- Select a blank line in the **Land Use** table. Just click the white area.
- Then enter a name and the pertinent standard levels in the boxes.

Colors, line style, and filling pattern for representation of the area can then be selected as customary after clicking the color button.

In practical work it will be useful to switch off the filling pattern of areas with a certain land use for the clarity of the colored noise maps.

User-defined types of land use are saved with the project. They are not available for other projects.

5.3 Grid of Receiver Points

Calc Grid

In the menu **Grid** you can specify a grid of points on which the level is calculated for all defined evaluation parameters (for up to four grids, plus the ground grid) and the result displayed as colored noise map with lines or areas of equal sound levels. The calculation of the sound level for this grid of points is started with the command **Grid|Calc Grid** (see chapter 5.3.2).

5

Select Evaluation Parameter

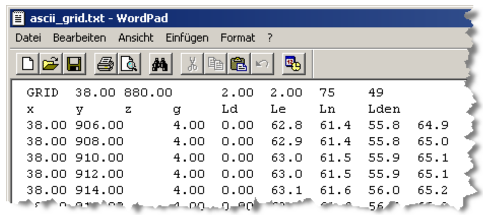
Selects the grid for the corresponding evaluation parameter from the list box on the symbol bar on the **CadnaA** main dialog.

Save Grid as

With the command **Grid|Save as** only the calculated grids will be saved, not the project file with the objects. The following file formats are available:

- **CadnaA**-Grids (*.cnr)
- ASCII-Grids (*.rst)
- LimA Grids (*.ert) and
- NMGF Grids (*.grd).

When saving to an ASCII-grid the evaluation parameters as entered or edited will be used as a designation (see **Configuration**, Evaluation Parameter Tab).



Text file with ASCII-grid data for 4 evaluation parameters

Open Grid

With the command **Grid|Open** you can load calculated grids (noise map) only when it has been saved before either as a grid with the command **Grid|Save** or from a **CadnaA** file which included a calculated grid. For that, select the corresponding file in the dialog. With multiple selections you are able to load several grids simultaneously into the current file. A grid cannot be opened via the menu **File|Import**!

different Eval. Parameters

☝ In case a grid file contains several grids of different evaluation parameters they will only be displayed if the same evaluation parameters also exist in the current file.

Grid Formats

Following grid formats can be opened:

- **CadnaA**-grid (*.cnr) and **CadnaA**-files (*.cna),
- ESRI ASCII-grid (*.asc),
- ASCII-grid (*.rst),
- LimA grid (*.ert),
- SoundPLAN grid (rlk_.*;*.gm),
- Immi grid (*.ird),
- AUSTAL grid (*.dmna) and
- NMGF grid (*.grd, from NMPlot, TNM, INM).

Keep Current Grid

When the option „Keep Current Grid“ is activated you can load grids in the current file without deleting the existing ones. The first existing calculated grid in the current file sets the mash of the grid. By different widths the loaded grids will be adjusted to the first grid by interpolation.

This function enables the calculation of a big file with divided calculation areas on different computers sharing the file by calculating only one of the calculation areas one after the other. Afterwards all the grids will be loaded together into the original file with **Grid|Load** and activated option „Keep Current Grid“ (see chapter 14.8 "PCSP - Program Controlled Segmented Processing").

Delete Grid

By the command **Grid|Delete** the existing grid (for up to four evaluation parameters, plus the ground grid) is deleted from the screen and from the file (upon Save). This command cannot be undone.

When deleting a grid, the settings for the grid spacing and for the grid appearance are maintained. However, when selecting the command **Grid|Delete** while keeping the SHIFT-key depressed restores the default settings for grid spacing and grid appearance.

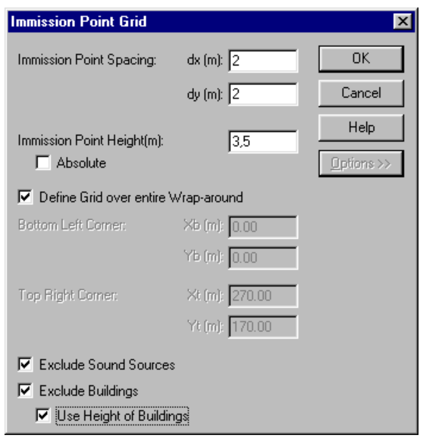
5

5.3.1 Grid Specification

Enter the distance between receiver points for the x and y directions and the receiver point height, in meters. By default, the receiver point height is relative, with regard to the ground.

If you wish to calculate an **absolute** grid height, activate the pertinent option. In this case, the grid does not follow the topography. Receiver points lying in the ground are omitted.

A finer grid results in a higher density of receiver points. This enhances contrast in the graphic representation of the areas or lines of equal sound level, but it will also require more time for calculation.



Determine the limits of the grid under **Options**.

Define Grid over entire Limit

If the option **Define Grid over entire Limit** is activated the grid covers the entire defined limits (**Options|Limits**) of the project file.

If the option is deactivated you can restrict the calculation area by input of the x- and y-coordinates for the upper and lower edges of the receiver point grid. Another alternative is to draw a **Calculation Area** with the icon from the toolbox (see chapter 6.3 "Selecting Data for the Calculation").

Exclude Sound Sources/ Buildings

This default setting means that, as far as possible, no receiver points are placed, and thus calculated, within the horizontal projections of sound sources and buildings.

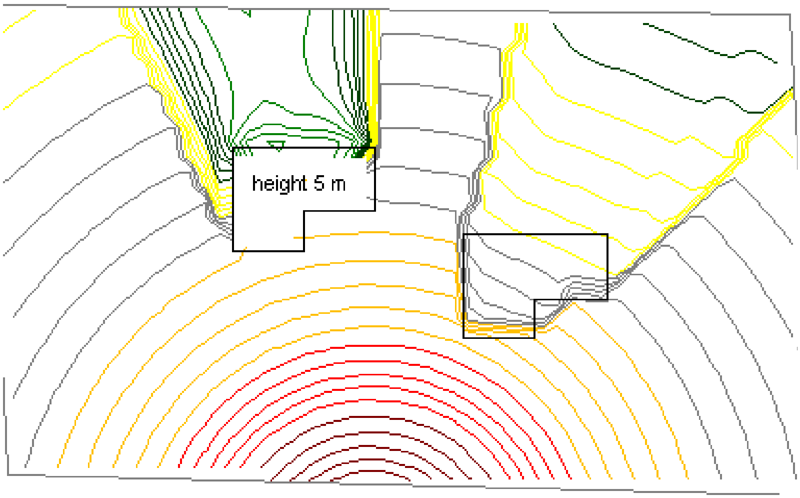
Use Height of Buildings

When **Use Height of Buildings** and **Exclude Buildings** are activated at the same time, the horizontal projection of a building is excluded from the grid where the building height exceeds the height of the immission point grid.

Example:

- Building 1 = 3 metres high
- Building 2 = 5 metres high
- Immission point height 3. 5 metres
- Under Grid specification, **Exclude Buildings** and **Use Height of Building** are activated.
- Under **Options|Appearance|Buildings,** the fill is set to "transparent“.
- On the tab **Calculation|Configuration|General**, the option **Extrapolate Grid under Buildings** is deactivated.

A grid calculation with an appropriate sound source at an appropriate height would, for example, result in the following graphic.

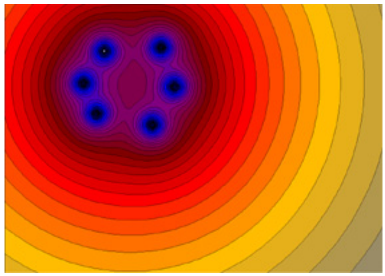


Graphic representation after calculation of a receiver point grid at a height of 3.5 m with the option **Use Height of Building** active

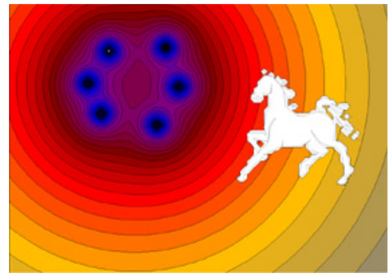
☝ To see this effect make sure that the buildings' color is not opaque! (see **Options|Appearance**)

Delete Grid Points

The command **Delete Grid Points** from the context menu of a calculation area is useful to „cut out" calculated noise maps either to replace that portion after a new calculation or to use only a section of a big noise map. The PC-memory used for the deleted section of the grid will be released.

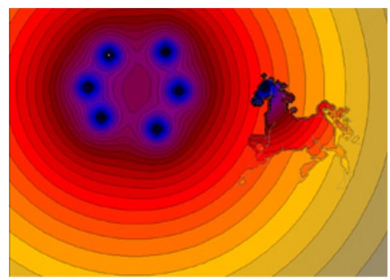


The whole Noise Map



Calculation area (horse) with deleted grid points inside the polygon

New calculated grid for a portion of the noise map



the small noise map imported with **Grid|Open| Keep current Grid**

Insert an arbitrarily shaped calculation area over a calculated noise map, highlight the polygon and select **Delete Grid Points** from the context menu. Choose either **inside** or **outside the polygon**.

The settings of the current grid will be assigned to the imported grid.

5

5.3.2 Grid Calculation

The command **Calculate Grid** in the menu **Grid** starts the calculation for the specified receiver point grid.

If no calculation area has been defined (see chapter 6.3 "Selecting Data for the Calculation") the calculation is performed within the entire limits (see **Options|Limits**). Otherwise, only the active calculation areas will be calculated. The grid calculation takes into account all objects and sound sources, even if they lie outside the specified calculation area.

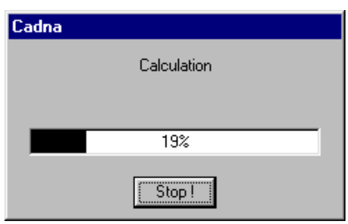
see also Check Consistency chapter 5.1.3.

Update during Grid Calculation

With the activated option „Update during Grid Calculation“ (menu **Options|Miscellaneous**) the calculated grid is built up by colored areas while the calculation is still in progress.

Stop Grid Calculation

A grid calculation may be stopped, or interrupted to be resumed later on, at exactly the point where it was stopped.



To stop the calculation, click the **Stop** button.

Some time may elapse before **CadnaA** reacts to your input and stops the calculation.

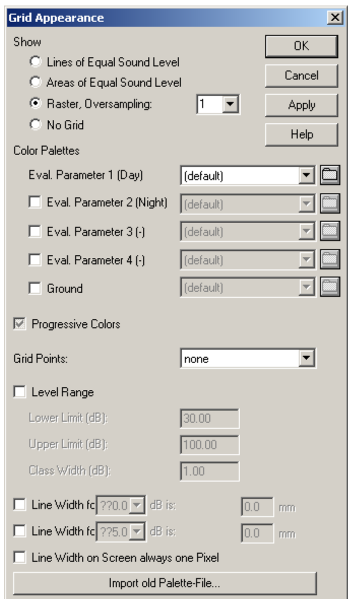
Press Shift key to continue

If you wish to resume the calculation where you stopped it, save the project file. **CadnaA** "memorizes" the progress made in the calculation. To continue the calculation, hold down the SHIFT key while clicking **Grid|Calculate Grid**.

5.3.3 Grid Appearance

Via the dialog **Appearance** on the **Grid** menu the settings for displaying grid results are defined. The dialog comprises of the following sections:

- section „Show“: selection of display mode
- section „Color Palettes“: selection of color palettes, globally for all evaluation parameters or individually for each evaluation parameter.
- Level Range and Line Width: This section corresponds with the options available in former releases of **CadnaA**. The display options resulting from former **CadnaA**-files will be displayed for color palette „(file)“.



Dialog **Grid Appearance**

Button „Apply“

When clicking the button „Apply“ the modifications are applied to the main window immediately while keeping the dialog open.

5

Show ...

Lines of Equal Sound Level

With this option the lines of equal sound level are displayed on the grid. The value range and the class width (and all further settings) result from the select color palette/s. The grid caption results from the specification for „Single Value“ of the selected color palette (see chapter 12.3 "Symbol Library").

Areas of Equal Sound Level

With this option the areas of equal sound level are displayed on the grid. The value range and the class width (and all further settings) result from the selected color palette/s. The grid caption results from the specification for „Interval“ of the selected color palette (see chapter 12.3 "Symbol Library").

In either case, the boundaries are interpolated (by linear interpolation). With the option „Exclude Sound Sources/Buildings“ (see chapter 5.3.1 "Grid Specification") activated, uncolored areas in the vicinity of buildings or area sources may result, depending on the spacing of receiver point. In order to avoid this, the option „Extrapolate Grid under Buildings“ on menu **Calculation|Configuration** is activated by default (see chapter 6.2.2 "General Tab"). In this case, the colored areas of the grid start from the object’s boundaries.

Raster, Oversampling

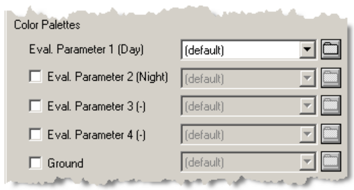
When the oversampling is set to 1 (default value) the representation applies the resolution of the specified receiver spacing (see chapter 5.3.1 "Grid Specification"). With an oversampling of larger than 1 intermediate grid points are generated additionally. The sound level at those intermediate points is determined by linear interpolation.

No Grid

With this option no noise map is displayed on the graphics (2D-view). Nevertheless, on the **3D-Special** view the colored grid is still displayed. To avoid this, switch to the option „Ground“ from the list box on the symbol bar of the main dialog. This will cause the no grid being displayed on the **3D-Special** view.

Color Palettes

On the dialog section „Color Palettes“ the color palettes for up to four evaluation parameters and for the ground grid are selected. With the default setting, the color palette selected for evaluation parameter 1 is applied to all further evaluation parameters and the ground grid. To select a color palette for each evaluation parameter and the ground grid activate the respective check box.



Dialog **Grid Appearance**, section „Color Palettes“

Color Palette „default“

By default, the color palette „(default)“ is preselected for all grids. The default color palette corresponds with the formerly used grid appearance settings, with respect to the type of grid shown (Raster, Oversampling 1) and the level range.

Color Palette „file“

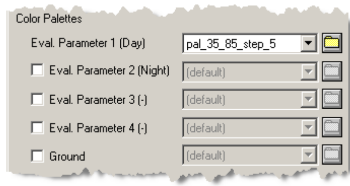
When loading a file which has been generated using a former version of **CadnaA** the settings on dialog **Grid Appearance** will be displayed for the color palette „(file)“. The color palette „(file)“ is stored in the local library of color palettes (see chapter 12.5).

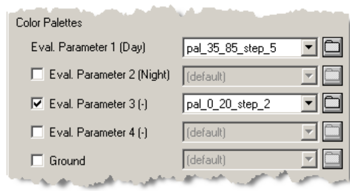
Selecting Color Palettes

After activation of the check box, color palettes from the local library can be selected from the list box for each evaluation parameter. The text displayed on the list box is the ID-code of the respective color palette in the local library.

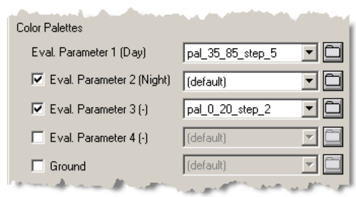
Color palettes from the global library, however, are selected by clicking the file selection symbol.

Examples

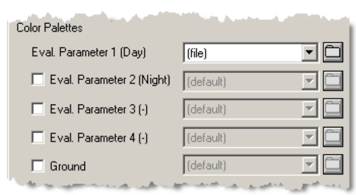
<table>
<tr><td>


</td><td>The palette „pal_35_85_step_5“ is used for all four evaluation parameters (if any) and the ground grid.</td></tr>
<tr><td>


</td><td>The palette „pal_35_85_step_5“ is used for evaluation parameters 1, 2, 4 and for the ground grid.

For evaluation parameter 3 the palette „pal_0_20_step_2“ is used.</td></tr>
<tr><td>


</td><td>Compared to the last setting, now the default color palette is used for the second evaluation parameter.

For evaluation parameter 3 and for the ground grid the palette „pal_35_85_step_5“ is still used.</td></tr>
<tr><td>


</td><td>When loading a file from a former release of CadnaA, the color palette „(file)“ resulting from this file is used for all evaluation parameters and for the ground grid.

REMARK: In this case, the grid appearance corresponds with the appearance in former CadnaA-releases.</td></tr>
</table>

Progressive Colors

This option may have three modes: deactivated (no tick mark), activated (black tick mark), neutral (grey tick mark). In the neutral mode (default setting) the setting for „Progressive Color“ of the respective color palette applies. Thus, if a progressive color has been defined in the color palette it will be used, and vice versa. With this option deactivated, color palettes with progressive colors show use distinct color with transition. With this option activated, color palettes without progressive colors show them, instead.

Grid Points

The option „Grid Points“ enables to mark the locations on the grid where the level has been calculated (selection „Dots“) or of the calculated levels at those locations (selection „Values“).

When displaying the terrain’s height (see chapter 4.5) the height in meters is displayed with the option „Values“ selected. The same holds for attribute values resulting from ObjectScan (see chapter 5.5.5).

Level Range

When loading a file created by a former release of **CadnaA**, the dialog **Grid Appearance** displays the grid settings for the color palette „(file)“. The lines and areas of equal sound level include - as it was the case with former releases of **CadnaA** - the upper limit of every value range (i.e the option „Interval Border to Lower Interval (lo < xxx <= hi)“ is activated, see chapter 12.5 "Color Palettes").

Class Width

The value in this box will just have an effect if either the option „Lines of Equal Sound Level“ or „Areas of Equal Sound Level“ is activated. The class width defines the width between adjacent lines of equal sound level.

Lower/Upper Limit

The lower and upper limits define the level range.

☝ The option „Level Range“ should nowadays not be used when defining the grid appearance as it disables the selected color palettes.

The grid captions as being defined can be inserted into the graphics and be printed via the Plot-Designer by use of the object „Symbol“ (see chapter 9.11.3 "Symbol" and see chapter 13.1.6 "Cell Types"). Furthermore, a grid caption can be added even to the 3D-Special view (see chapter 9.14 "3D-Special View", section "Display Grid Caption").

Line Width

Provided the display mode „Lines of Equal Sound Level“ is selected, noise contours can be highlighted by thicker lines in intervals. For example, in order to draw a thicker line in steps of 10 dB, activate the first option „Line Width“ and select „??0.0" from the list box. Here, the question marks serve as wild cards for any other figure. In order to draw a thicker line in steps of 5 dB in addition, activate the second option „Line Width“ and select „??5.0" from the list box. The line widths are specified in tenths of millimeters (mm/10).

☝ As already with the level range, the option „Line Width“ is only used to display grid appearance settings resulting from former **CadnaA** files. Nowadays, the definition of the line width for each value range is part of the color palette.

Import of old Palette-Files

The button „Import old Palette-File“ enables to load files with color palettes (file extension *.PAL) from former **CadnaA** releases. The imported color palette is shown on the list box for the evaluation parameter 1 and simultaneously copied to the local library.

This feature can be used to import an arbitrary number of existing color palettes to the local library by multiple import.

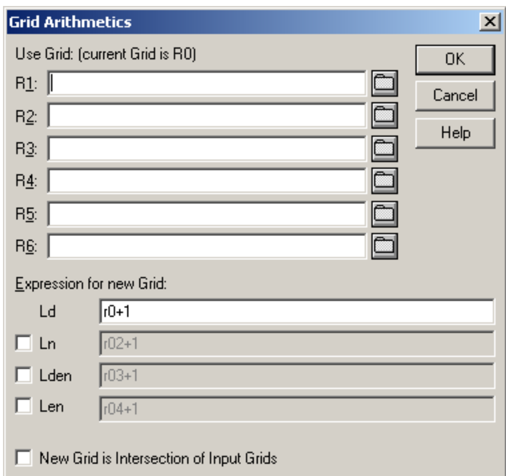
5.3.4 Grid Arithmetic

In the field **Expression for New Grid** you may enter a formula from which a new noise map is generated using the grid currently displayed on the screen, *r0*, and the grid files specified under **R1** through **R6**.

The expression *r0* for the current grid refers to the grids of all defined evaluation parameters (max. four). Therefore a grid arithmetics will be executed for all grids of evaluation parameters.

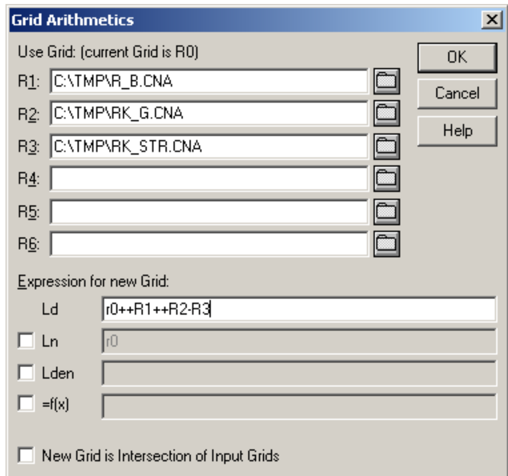
5

For clarification a simple example is shown in the following screen shot:



If you enter in the first field **Expression for New Grid** *r0+1* and if the checkboxes of the other evaluation parameters are deactivated the grids of all evaluation parameters will be taken into account automatically. (the same effect would be if you activate the corresponding checkboxes and enter in each field starting with the first one: r01+1 - second field r02+1 and so on). The checkboxes of the single evaluation parameters have to be activated only for special cases.

In the further example given here, the levels of the grid RK_STR.CNA are numerically subtracted from the energetic sum of the levels of the current grid (r0) and those of the grids saved as R_B.CNA and RK_G.CNA. Also in this example all grids of evaluation parameters are taken into account.



As a test problem calculate the grid for a point source in front of a reflecting barrier and save it and refer to it in field R1. Now deactivate reflection and calculate the energetic difference between r0 and the saved grid using the command sequence r1-- r0. The ISO-dB lines in the graphics illustrate the sound field of the mirror's sound source.

The referencing of the itemization grids of evaluation parameters field „Expression for New Grid“ 1 till 4:

- r0 references all existing grids (i.e. up to four grids),
- r01 references the grid of the first evaluation parameter,
- r02 references the grid of the 2nd evaluation parameter etc. till r04.

Grid Variable of Evaluation Parameter

In one grid file up to four evaluation parameters plus a ground grid can be saved - you may refer to them as follows:

R0	presently displayed grid of all defined evaluation parameters: A grid arithmetic would effect all defined evaluation parameters.
R01 to R04	current displayed grid of one grid of the defined evaluation parameter 1 to 4
R1	refers to a saved grid which is linked in the field R1 in the dialog **Grid Arithmetics** and effects all grids for all evaluation parameters included in that file
R11 to R14	refers to the grid of one of the evaluation parameter 1 till 4 which is linked in the R1-field of the grid dialog
R2	refers to a saved grid which is linked in the field R2 in the dialog **Grid Arithmetics** and effects all grids for all evaluation parameters included in that file
R21 to R24	refers to the grid of one of the evaluation parameter 1 till 4 which is linked in the R2-field of the grid dialog
R3 to R6	analog as described above

further information:

see chapter 6.2.5 "Evaluation Parameter Tab"

see chapter 5.3.5 "Creating a Grid from Noise Contours"

Grid calculations for EU-noise indices with CRTN

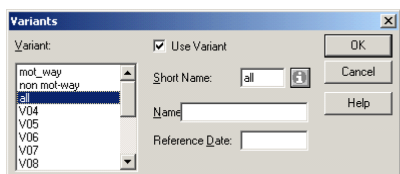
When applying the English guideline CRTN ("Calculation of Road Traffic Noise") in conjunction with calculations according to the EC-Environmental Noise Directive /106/ the calculated grid for L_{10} has to be converted to a L_{eq}-grid according to the TRL-study in order to evaluate L_{den} and L_n.

The entire procedure requires several steps:

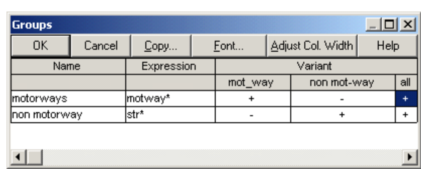
1. setup for calculation of initial levels $L_{A10,18h}$ for Non-Motorways and Motorways: In order to calculate $L_{A10,18h}$ select the performance parameters L_d on the tab Performance Parameters (**Calculation|Configuration** menu) with CRTN selected as road standard.

Later, the conversion of levels $L_{A10,18h}$ into levels L_{den} and L_n according to TRL-study can be performed with both, non-motorways and motorways, in a single **CadnaA**-file provided that non-motorways and motorways are addressed to two variants.

2. Define three variants, for non-motorways, motorways, and for all roads.



Define groups according to IDs being different for non-motorways and motorways, for example:



As the grid is calculated just for the active variant the grids for non-motorways and motorways has to be calculated in two steps.

3. Select variant "non-motorways" and calculate grid. Save this grid via **Grid** menu, **Save as** (e.g. filename "non_motorways.cnr").

4. Switch to variant "motorways" and calculate grid.

Next, the two grids for $L_{A10,18h}$ are converted into grids L_{den} and L_n.

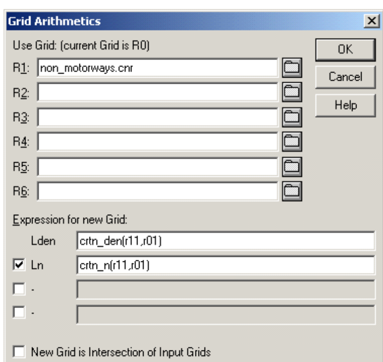
5. Activate the END-performance parameters 1: L_{den} and 2: L_n on the dialog **Configuration** (**Calculation** menu). Make sure that hours are allocated to the three daily periods D, E, N and penalties are entered.

6. Convert grids using the following expressions via the dialog **Grid Arithmetic** (on **Grid** menu) for „Expression or a new Grid“ with the syntax:

crtn_X (LA10,18h_nonmot, LA10,18h_mot)

with the possible evaluation parameters X = (d, e, n, den)

At the first location within the brackets, the L_{10} grid for "non-motorways" is referenced (e.g. LA10, 18 h_nonmot). At the second location, the L_{10} grid for "motorways" is referenced (e.g. LA10, 18 h_mot). With the specifications as in a following illustration the grids for L_{den} and for L_n result in a single step.



In the example above, the present grid is for „non-motorways“ (R0) while the loaded grid R1 is the grid for „non-motorways“. The expressions to be entered are:

for Lden:crtn_den(r11,r01)

for Ln: crtn_n(r11,r01)

☝ Please consider that the first grid has to be <u>always</u> the grid for non-motorways and the second for motorways.

7. In this example, the result are grid for L_{den} (1st parameter) and L_n (2nd parameter). Select variant "all" to activate both types of roads.

Explanatory Remarks:
The TRL-study /71/ lists regression formulas to recalculate L_{eq} for the time periods Day, Evening, and Night based on statistical evaluations. When just having daily traffic counts available „Method 3“ of the TRL-study applies.

For non-motorway roads: $L_{day} = 0.95 \cdot L_{A10,18h} + 1.44\ dB$ (Equation 1)

$L_{evening} = 0.97 \cdot L_{A10,18h} - 2.87\ dB$ (Equation 2)

$L_{night} = 0.90 \cdot L_{A10,18h} - 3.77\ dB$ (Equation 3)

For motorway roads: $L_{day} = 0.98 \cdot L_{A10,18h} + 0.09\ dB$ (Equation 4)

$L_{evening} = 0.89 \cdot L_{A10,18h} + 5.08\ dB$ (Equation 5)

$L_{night} = 0.87 \cdot L_{A10,18h} + 4.24\ dB$ (Equation 6)

The above equations will be used in **CadnaA** when converting the grid for $L_{A10,18h}$ into the resulting grids for L_{den} and L_n.

Additional features for grid conversion with CRTN

CadnaA offers additional commands for converting $L_{A10,18h}$ into L_d and L_e. The general syntax is:

crtn_x (LA10,18h_nonmot, LA10,18h_mot) where x = (d, e, n, den)

LA10,18h_nonmot: grid for non-motorways

LA10,18h_mot: grid for motorways

This conversion respects the allocation of hours and the entered penalties.

Example 1

The expression:

crtn_den (r01, r11)

converts the parameter 1 for non-motorways in the current grid (r01) and the parameter 1 for motorways of loaded grid r1 (r11) into Lden-grid.

For evaluation the Lden-grid based on Leq-levels Ld, Le, and Ln the expression is:

Lden(day, evening, night)

This conversion respects the allocation of hours and the entered penalties as well.

Example 2

Having three grid for Ld, Le, Ln calculated the Lden-grid can be generated as the 4th grid by entering the following expression:

Lden(r01, r02, r03)

converts the parameter 1,2,3 of the current grid (r01, r02, r03) into Lden-grid

see also:

chapter 11.2.1 "Edit Result Table", section "Conversion to EU-indices at individual receivers with CRTN"

5.3.5 Creating a Grid from Noise Contours

You can also generate a grid of receiver points in **CadnaA** from Iso-dB-lines of an external file. In some cases you will only get certain Iso-dB-lines, e.g., aircraft noise areas. If you now wish to add this information to your already existing grid you will also need a grid of receiver points (see chapter 5.3.4 "Grid Arithmetic").

Try out this function by, e.g., first exporting the Iso-dB-lines to DXF (with activated option **Height is Level** and deactivated option **No Grid points**) and then using this file to generate a grid of receiver points from these Iso-dB-lines. For that use a separate new **CadnaA** file to avoid to calculate the maybe existing grids of evaluation parameters again.

Examples\07_Import\IsodB.dxf

1. **File|Import|Format:** DXF

   In the **Options** dialog import the Iso-dB-lines as Contour Lines, layer name *. Deactivate the auxiliary polygons.

   But of course this way only works if the values of sound levels are integrated as height in the file of importation.

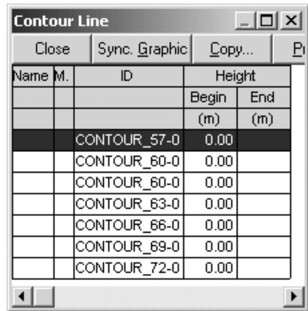
2. Subsequently calculate ground grid (its calculated automatically with **Grid|Calc Grid** - if necessary, enter **class width** as well as **upper** and **lower limit** (When calculating only the ground grid, no source is needed - but first specify the desired spacing of the receiver point grid in **Grid|Specification**).

3. **Raster|Arithmetics** - Expression for new grid: r0g

That's it. This has turned the ground grid to a grid which you can save for further use but make sure that an evaluation parameter from the symbol bar is selected - not **Ground,** then **Grid|Save**. Now this grid file can be used for grid arithmetics. Open it in one of the fields **R1** to **R6** and refer to it in your expression.

If necessary do not forget to delete the contour lines.

But what is happened, if the value of sound level is only integrated as textual information, e.g., like an entry in the **ID** box after the file has been imported as contour line?



Sound level values as textual information in the ID box - the values are not yet assigned as height.

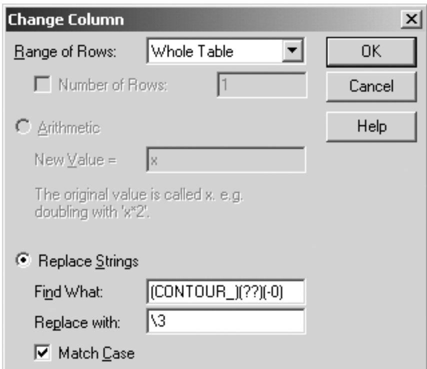
A resolution also exists here - keyword **Modify Attribute**.

Go on as described above with point 1 and 2 but integrate the following steps

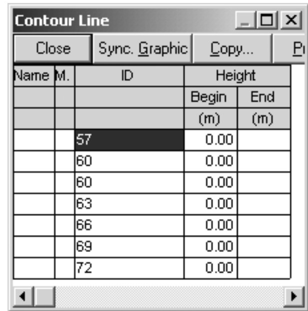
Examples\
05_Immissions\
Raster_IsodB.cna

Step 2 a

- Change the entry in the **ID** box with the function **Change Column** (see chapter 11.1.5) so that only the entry of the sound level value exist. In the example in the above figure leads the following entry to the desired result.



Expression for the command **Replace String**



The results are the sound level values only

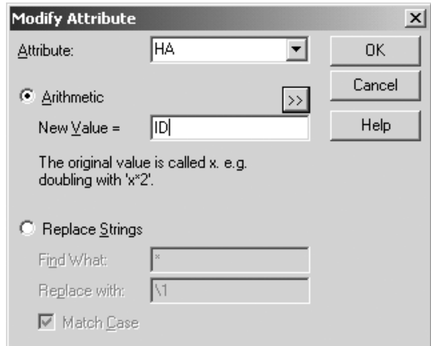
Step 2 b

Now you have to swap the sound level values from the **ID** box into the field **Geometry|Height (First Point)**. Therefore

- Click with the right mouse key on a free space in your project file and select **Modify Object|Action|Modify Attribute|Object type Contour Line** from the context menu and confirm with **OK**.

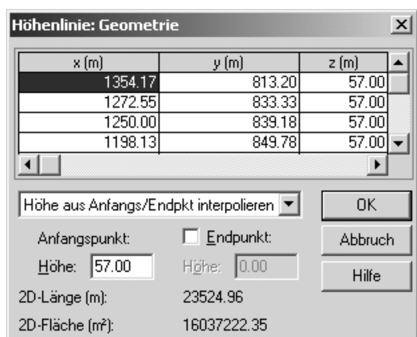
Double-arrow key

- In the dialog **Modify Attribute** select *HA* as **Attribute** (for the height of the first point) and the option Arithmetic|New Value= *ID* (you can choose this attribute from the list if you click on the double-arrow button)

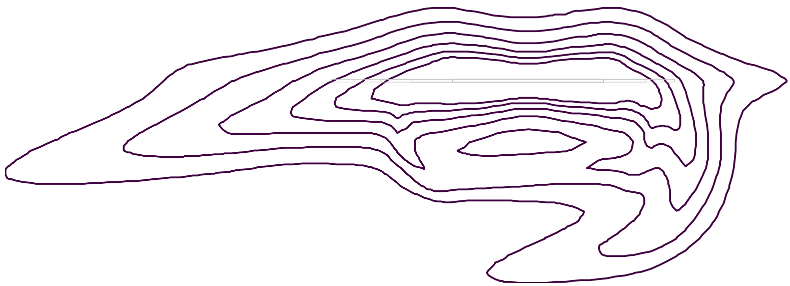


Settings to insert the sound level value from the ID box into the height field

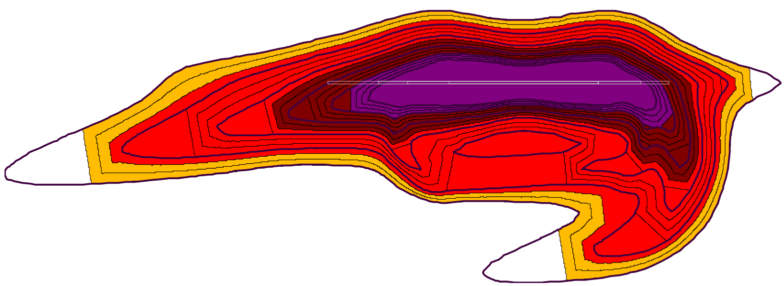
- Close the dialog with **OK** and confirm also the following dialog with button **ALL**. The sound level value from the **ID** box is then inserted into the height field as z-coordinate.



Now go on again as described with point 3. In this example we have specified a grid spacing of 5 x 5 m.



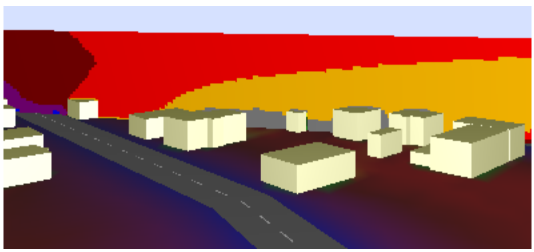
Iso-dB lines imported as Contour lines and



converted into a grid (appearance with ares of equal sound levels)

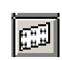
5.3.6 Vertical Receiver Grid

Grid calculations can be performed for arbitrary vertical sections, and the results can be displayed as lines of equal sound level or as colored noise maps. This representation may be printed, copied or saved or displayed in the 3D-special view.



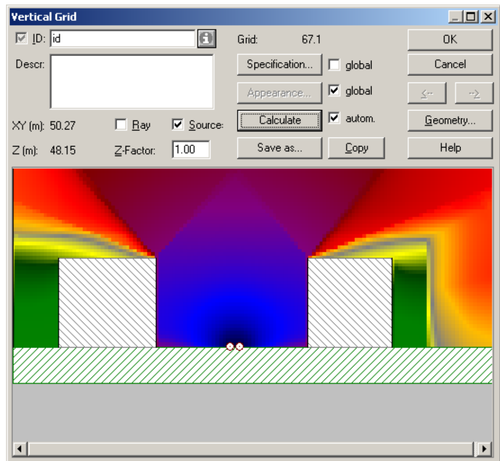
vertical noise map in 3D-special View

The following example illustrates an initial situation that is easily generated. On both sides of a road are two buildings.



Click the pertinent icon **Vertical Grid** and draw a line with only two polygon points to determine the position of the desired vertical grid. You may enter an arbitrarily number of vertical grids. Open the edit dialog and under **Geometry,** assign a height to the vertical grid polygon up to which a grid calculation is to be performed. The default-height for the vertical grid is 20m. In our example we have set 50 m.

Upon the first access of the dialog **Vertical Grid** the same scale as for the horizontal grid is used.



The vertical grids dialog

Calculate automatically

Trigger the calculation of the grid by clicking the button **Calculate**. The edit dialog remains open. If the option **autom**. right to the button **Calculate** is activated the grid would be calculated together with the horizontal grid. In that case the dialog would be closed.

Global

In the edit dialog of the **Vertical Grid** the settings of the grid can be specified directly if the option **global** right to the button **Specification** is deactivated . The settings can be different to the horizontal grid. In the other case the specifications of the horizontal grid will be used.

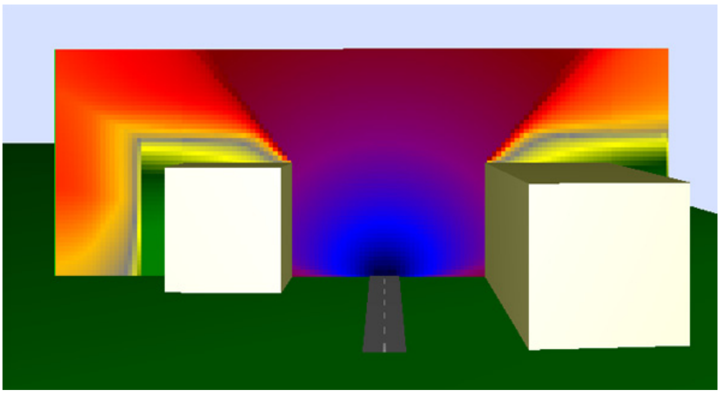
OK Save
Save as

Save the grid as usual either with the *OK-Save* button or as *.CNR file. If you do so the grid will be kept and displayed again if you open the edit dialog after closing otherwise not.

Noise Level displayed

The pertinent noise level is displayed at the particular position of the mouse pointer in the cover bar of the dialog.

Via the button **Copy** you can copy the graphics into the clipboard and you can inserted it again with STRG+v in a third-party program. *Copy*



Scenario in 3D-Special view - the path on the road

If you have inserted several vertical grid sections you can see them all in the 3D-special view if you use e.g. an **Aux. Polygon** as path.

For printing the vertical grids can be referred to in the plot-designer as 3D-special view or as cross-section view from the edit dialog.

In the 3D-special view's Properties menu you can assign a transparency (%) to the vertical grid so that the scenario behind the grid could be still visible. *Grid transparency*

Grid Arithmetics

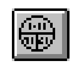
The generation of level difference grids is possible also with vertical grids. To this end, save the two original via the button „Save as" on the **Vertical** Grid dialog. Load the two vertical grids via the dialog **Arithmetics** (menu **Grid**), e.g. into R1 and R2. Generate the difference grid, e.g. using the formula R2-R1. The resulting grid is inserted into the xy-plane starting from the origin at (x,y)=(0,0). If required adjust the limits accordingly to display the origin (menu **Options|Limits**).

5.4 Building Evaluation

According to the requirements of RLS 90 /12/ and using the map symbols defined in this guideline, there is a fairly simple way of demonstrating for a building close to a traffic route whether the predefined and maximum permissible rate levels on the basis of designated land use have been exceeded. It is also possible to ascertain which storeys this is true for and which values are to be expected at the most exposed position of the facade during the day and night.

Procedure

- We activate - for better understanding and not because it is necessary - the option „No calculation of Building Noise Map“ in the menu **Options|Building Noise Map** (see chapter 5.4.1).
- Insert the object **Building Evaluation** with the corresponding icon from the toolbox. For that, click inside the building plan for that building for which an evaluation is supposed to be made.



Examples\05_Immissions\Industry.cna

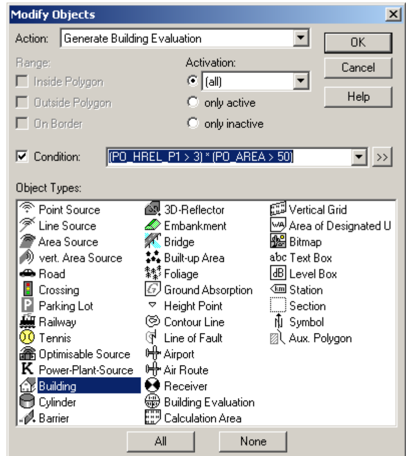
- After placing the first symbol we should adjust the size if necessary (see manual "Introduction to **CadnaA**", *Change Dimensions*). All further inserted symbols then have the same size.

If several or even all buildings or only buildings with a certain condition of a project shall be evaluated we can use the command from the context menu **Modify Object|Action: Generate Building Evaluation** to insert the **Building Evaluation** symbols all at once (see manual "Introduction to **CadnaA**", *Modify Objects*).

In this case **CadnaA** automatically places these symbols in the selected buildings. The name of the building, entered in the identically named edit box in the edit dialog, will be automatically transferred into the corresponding box of the Building Evaluation.

Building Evaluation with Condition

If you want enforce a building evaluation only for buildings e.g. with a certain height and/or base area you can define a corresponding condition for that.



Action „Generate Building Evaluation“ with condition

To insert an expression for a condition activate the pertinent check-box and either enter the abbreviations (see **CadnaA**-manual "Attributes & Abbreviations") via keyboard or select them from the list which opens by clicking the button with the double-arrows.

With the above example would be generated symbols for all buildings which have a relative height higher than 3 m and a base area bigger than 50 m². In this case both conditions must be „true“.

Symbol Size

Adjust the symbol sizes via the table **Building Evaluation** (**Tables|Other Objects**) using the context menu command **Change Column** (see chapter 11.1.5) and define the pertinent **Land Uses**. But also you can first insert one symbol from the toolbox and make all settings you wish. **CadnaA** accept the settings of the last symbol in the table for the following building evaluation symbols generated.

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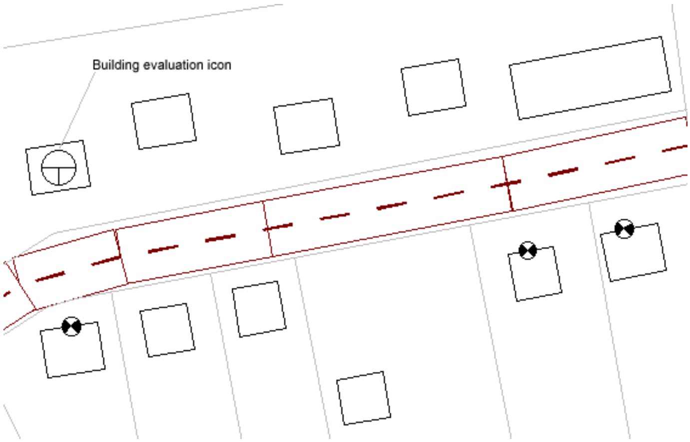


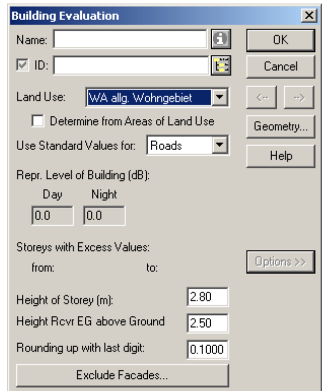
Default situation: The building evaluation symbol is set for the upper left building. The calculation has not been launched yet

When a building is evaluated, levels computed by **CadnaA** for all storeys and in front of all facades are compared to the pertinent limit values or standard values. The latter can be defined in two ways.

- Double-clicking on the building evaluation icon opens the corresponding dialog.
- Activate the appropriate option for the standard values (see chapter 5.1.1).

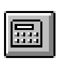
If the option „Determine from Designated Land Use“ is deactivated, you can select the type of area by clicking the card-index icon next to the „Land Use“ box, and the type of noise can be selected in the „Use Standard Values for“ list box.

Although this building evaluation was originally aimed at traffic noise, this flexible concept can also be applied to other types of noise like, e.g., industrial noise.



Building Evaluation of a building in a residential area (WA), with respect to road traffic noise

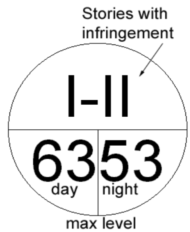
The second way is to click the Designated Land Use icon and assign a type of land use to an area by drawing a closed line around it. Then activate the option „Determine from Designated Land Use“. The standard values to be compared should then be known.



When all buildings have been provided with a building evaluation symbol, and the calculation is triggered by clicking the Pocket-Calculator icon on the symbol bar, the progress bar window will first display the calculation for the specified receiver points and then the progress of the building evaluation.

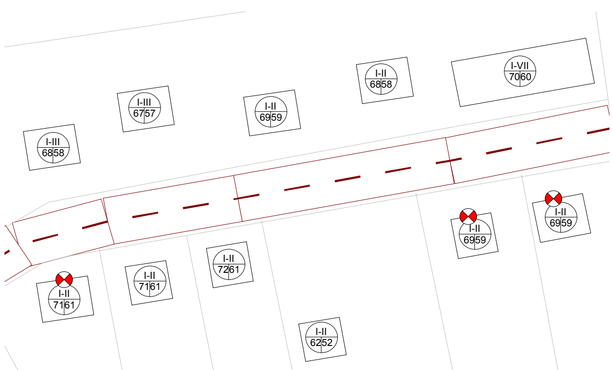
In this building evaluation, calculations are performed and evaluated one after the other

- for all buildings bearing this symbol,
- for all storeys which result from the ratio of building height to storey height (storey heights may be edited under button „Options“ on the edit dialog **Building Evaluation**), and
- for all outer facades.



Building Evaluation Symbol after calculation

Upon completion of the calculation, the top semicircle of the icon indicates the range of storeys where excess levels occur. If it remains blank, no excess levels occur, or no area of designated land use has been assigned. The bottom quarters display the highest levels determined for the day and for night or rather for the first evaluation parameters defined on dialog **Calculation|Configuration|**.



Labelling of the building after calculation

use different Calculation Point

In some cases it could make sense to place the building evaluation symbol outside the layout of the house. For that you can check the option „use different calculation point“ on the dialog **Geometry** and place the symbol somewhere outside of the house without loosing the connection to this building. The original coordinates will be saved.

- Insert the symbol within the building base.
- Open the dialog **Geometry** and check the pertinent option.
- Close all dialogs with OK and push the symbol outside the building.

The calculation point is displayed with a connecting line (auxiliary polygon).

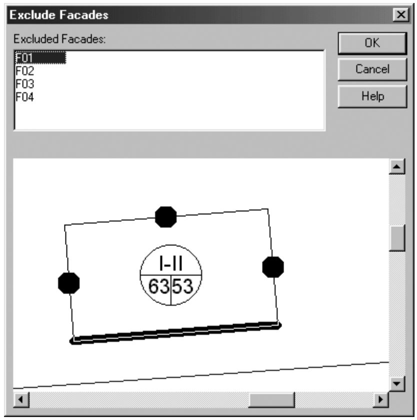
Attribute: USE_PCALC

Activation via **Change Attribute**|string: „x“

When transforming the Building Evaluation Symbol (via dialog **Modify Objects** or via the context menu, action/command **Transformation**) the connecting line will be transformed automatically.

Excluding Facades

In the edit dialog **Building Evaluation** if you click on the button **Option|Exclude Facade** another dialog opens in which you can mark facades not to be taken into account for a calculation.



The exclusion of irrelevant facades for a calculation of a noise map of buildings can save a lot of calculation time.

To exclude a facade, click on the identifier of the facade, in the upper part of the dialog, e.g., F01. Marked identifiers exclude the corresponding facades from a calculation. In the graphic representation, in the lower part of the dialog, the currently marked facade is marked by a thick black line. If the black dot of a facade is faded it indicates the deactivation of this facade. If you click again on the identifier of a facade it will again be included in the calculation. In this case the black dot is visible.

Importing Building Evaluation Symbols

In case the buildings and the accompanying building evaluations are saved in separate files after a calculation run, no proper link between both objects is established when re-importing the building evaluations into the file with the buildings (via menu **File|Import**). This causes all building-related evaluations to fail (e.g. via the **ObjectScan**, **Grid** menu - requires option XL), since the corresponding data for the buildings does not exist (e.g. the building noise levels HB_LP1 to HB_LP4). In those situations, the link between the buildings and the building evaluations has to be reestablished.

Use the command **Link Buildings to Building Evaluations** on the menu **Tables|Miscellaneous** to update the link.

☝ Please consider that when loading the building evaluations via the command **PCSP|Load PCSP-Tiles** (menu Ta**bles|Miscellaneous**) the link is updated automatically (see chapter 14.8 "PCSP - Program Controlled Segmented Processing"). The above statements just hold when importing the calculated building evaluations via the menu **File|Import**.

5.4.1 Building Noise Map

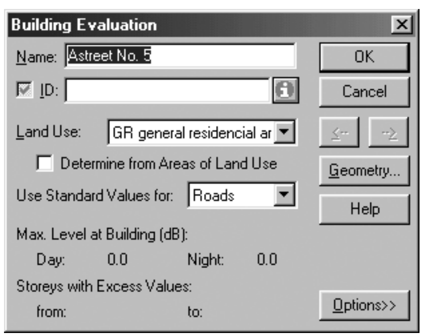
With the object „Building Evaluation“ (see chapter 5.4) indicates the maximum sound level across the storeys of a building with exceedance of a limiting value addressed. Furthermore, a colored building noise map based on the level calculated for each storey can be produced.

☝ In conjunction with the use of variants (see chapter 14.2) to calculate different scenarios, also level-difference-maps at building facades can be generated (see chapter 5.4.3) and displayed.

5

Procedure

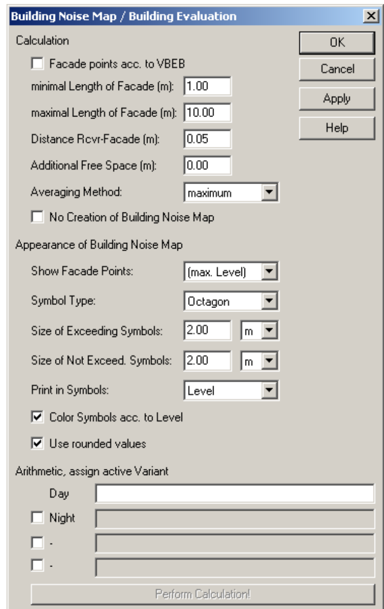
- Insert the object „Building Evaluation“ with a mouse click on the building plan.
- In the edit mode, double-click the building evaluation symbol and define a standard value by selecting the pertinent option.



The options for the data displayed on the building noise map are available on the menu **Options|Building Noise Map**.

- If necessary deactivate the option „No Calculation of Building Noise Map“ and set the further desired parameters by input or selection.
- Start the calculation with the pocket calculator from the symbol bar or with menu command **Calculation|Calc**.

Dialog Building Noise Map/ Building Evaluation



Dialog **Building Noise Map/Building Evaluation** (on **Options** menu)

Dialog Options Calculation

Facade points according to VBEB

Activating this option the facade length will be subdivided into special sections according to the German VBEB /98/. Consequently the input boxes for minimum and maximum length are locked.

☝ This option is not relevant for evaluations besides Germany.

minimum/maximum Length of Facade

CadnaA subdivides the facade based on the entered length and inserts a level symbol into each section.

Distance Receiver-Facade (m)

This value specifies at which distance the facade points are generated off the buildings facade surface. In conjunction with the configuration setting for „Minimum Distance Receiver - Reflector“ (see chapter 6.2.8 "Reflection Tab") this will define whether the facade levels consider the reflection at the building’s facade or not.

The default value is 0.05 m. With respect to the default setting for „Minimum Distance Receiver - Reflector“ of 1 m this means that, by default, the reflection at the building’s facade is not considered in the facade levels.

Additional Free Space

Is the distance from the facade point to the next obstacle smaller or equal to the value entered, no façade point/s will be generated and calculated. This may be useful when buildings have been imported having small gaps between each other, but should calculated as without gaps. The default value is 0 m.

Averaging Method

This selects the method for the calculation of the characteristic noise level of each building from the noise level of the facades (arithmetic, energetic average value, minimum or maximum value). The resulting value is shown inside the building evaluation symbol for the first two evaluation parameters (see chapter 6.2.5 "Evaluation Parameter Tab").

No Creation of Building Noise Map

By activating this option, no noise map is calculated and displayed for the building. The building evaluation, however, is still executed as long as the symbol/s are activated.

Appearance of Building Noise Map

Show Facade Points

Choose the facade points/levels you want to display in the noise map for buildings from the list box.

☝ The storey's designation can be displayed for the generated facade points on the Result Table (see chapter 11.2.3) using the string variable STW.

5

Symbol Type

Either „Octagon“ or „Ribbon“ can be selected.

Size of Exceeding/Not Exceeding Symbol

The size of the facade point symbols exceeding or not exceeding the limiting value may differ. Selecting the unit (m) will adjust the size of the symbol when change the scale, but not when selecting the unit (mm).

Color Symbols according to Level

Activating this option will colorize the facade point symbols according to the color palette specified via the menu **Grid|Appearance**.

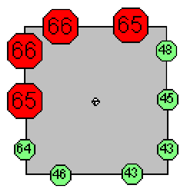
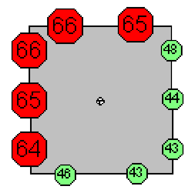
Use rounded values

When this option is activated (default setting) the facade level displayed for each face point will apply the rounding rule as specified in the respective building evaluation symbol. Otherwise, the level not being rounded off will be displayed (integer value). In conjunction with the color palettes (see chapter 5.3.3 "Grid Appearance" and chapter 12.5 "Color Palettes") and the option „Size of Exceeding/Not Exceeding Symbol“ this option can be used to define a rule for the color and the size of the facade point symbols applying the rounding or not.

Examples\05_Immissions

Open the file `BuildNoiseMap-Option Use rounded values ON.cna` in directory **Examples\05_Immissions**. The limiting value in this example is 64 dB(A) and the rounding used is 0.1 dB. Thus, applying this rule to 64.1 dB(A), for example, will cause a rounded value of 65 dB(A). Values form 64.0 to 64.1, however, will be rounded off to 64 dB(A) and respect the limiting value, consequently. Displaying the Result Table it can be checked at which facade points on the ground floor the level ranges ranges between 64.0 and 64.1dB(A).

In the next figure, the nominal level exceedances are indicated by a red color and an enlarged size of the facade point symbol.

	
option „Use rounded values“ activated (file BuildNoiseMap - Option Use rounded values ON.cna): The level at the lower left facade point is larger than 64.0 dB(A), but smaller than 64.1 dB(A). So, the limiting value of 64 dB(A) is respected considering the rounding rule 0.1 dB.	option „Use rounded values“ deactivated (file BuildNoiseMap - Option Use rounded values OFF.cna): The rounding rule is not considered when displaying the facade point levels. So, all levels larger than 64 dB(A) will be exceedances and displayed as such. *)

*) This setting corresponds with former releases of **CadnaA** (prior to release 4.1).

Print in Symbols

Activation of this option will show either the level - in addition to coloring - within the level symbol. Alternatively, the number of the facade point number generated by **CadnaA** is displayed. The facade levels can be displayed in the Result Table (see chapter 11.2) by selecting from the list box „Receivers from Building Noise Map“. The facade point numbers can be displayed in the Result Table by use of the string variable FASSNR.

Apply

By clicking the „Apply“ button, the actual the settings are applied instantaneously, without closing the dialog. When changing now the facade length the effect is just visible after a new calculation. By clicking the „Cancel“ button the altered settings will be ignored.

3D-Special View

The building's facades are also displayed in colors on the 3D-special view according to the specified grid caption after a calculation.

Dialog Options Arithmetic

With the „Arithmetic" field you are able to calculate different formula for or with the noise map of buildings, e.g. level-difference-map for building noise (see chapter 5.4.3)

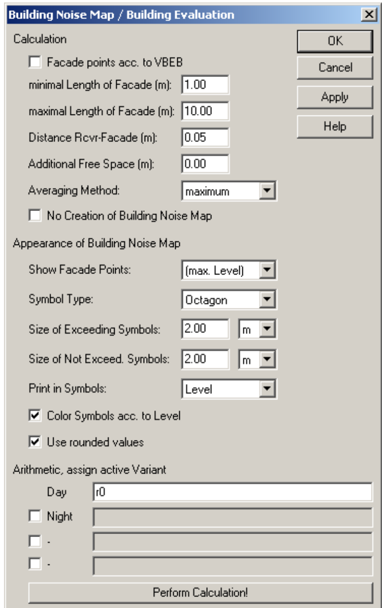
In case a horizontal receiver grid has already been calculated you can allocate interpolated grid values to facade points. A separate calculation of a noise map for buildings is unnecessary which would save calculation time.

Independent from the number of defined evaluation parameters (see chapter 6.2.5) the calculation results of the horizontal receiver grid provides a basis for the building evaluation.

☝ Prior to the allocation is that building evaluation symbols have to be addressed to the relevant buildings and the facade points been generated which can be generated by a „dummy" calculation with a point source.

Example

1. calculate the receiver grid
2. generate face points with calculation of one single noise source (e.g. point source - all other noise sources deactivated with **Modify Objects**, action „Activation", „Deactivate" for all objects except the buildings and the building evaluation symbols
3. calculate the dummy noise map of buildings with the pocket calculator from the symbol bar
4. On dialog **Building Noise Map**, dialog range „Arithmetic" enter the expression r0 and click the button „Perform Calculation".



By the expression r0 the interpolated calculation results of the horizontal grid will be allocated to the corresponding evaluation parameters of the facade points, not depending in what evaluation parameter's input box (in our example Day|Night) the expression was entered.

Subsequently, when selecting one of the evaluation parameters from the list on the symbol bar, the respective results are displayed within the facade points.

To address interpolated results of the horizontal receiver grid, coordinates or the ground height to the facade points, the following additional expressions can be used in a formula:

Input	Result
r0	allocation of the results from the horizontal grid to all the corresponding evaluation parameters
r01 to r04	allocation to the corresponding evaluation parameter LP1 - LP4 (r01 allocates the result to LP1, r02 to LP2 etc. - special application)
x | y | z	evaluates the corresponding x-, y- or z-coordinate of the facade point (z allocate the z-coordinate to the facade point - special application)
g	evaluates the ground height at the facade

Example

iff(STW==1;r0;LP)

(in words: if it is the first floor, then address the interpolated result from the grid - otherwise not, i.e. keep the existing value)

With the **CadnaA** Option XL (see chapter 5.5) also facade points are selectable as object type for evaluation.

Option XL

For the facade points the following attributes are available:

Attribute	Remarks
TOT_EINW	total no. of inhabitants of a building to which the corresponding facade point belongs to
FAC_EINW	assigned number of inhabitants of a facade point, whereas the same number of inhabitants is assumed per façade length
FAC_EIN_V	assigned number of inhabitants of a facade point according to German VBEB-procedure (FAC_EIN_V=TOT_EINW/TOT_FACP_N)
STW	storey No. (ground floor=0, 1st floor=1, 2nd floor=2 etc.)
FAC_NR	number of facade point counted from the first point of the building (FAC_NR=1, FAC_NR=2 etc.) to the last facade point
FAC_LEN	corresponding facade 2D-length (m) of the facade point
TOT_LEN	sum of all facade length referring to the facade points
TOT_LEN_N	sum of all facade length referring to the facade points, facade lengths deactivated by the option „Additional Free Space“ (see above) are not considered
FAC_AREA	corresponding facade area (m²) of the facade point
TOT_AREA	sum of all facade areas referring to the facade points
TOT_AREA_N	sum of all facade areas referring to the facade points, facade areas deactivated by the option „Additional Free Space“ (see above) are not considered
TOT_FAC	number of facade sections
TOT_FACPTS	number of facade points

TOT_FACP_N	number of facade points, facade points deactivated by the option „Additional Free Space“ (see above) are not considered
CENTER_X	x-coordinate of the buildings center point
CENTER_Y	y-coordinate of the buildings center point
CENTER_ANG	angle between the buildings center point and a facade point (North direction = Zero)

5

Example

If, e.g. the assigned number of inhabitants to a façade point should be evaluated select „Facade Point“ as object type and enter the following attributes and expressions in the input boxes:

for „Formula for Summation“: FAC_EINW
for „Formula for Total“: sum/num

for more information see chapter 5.5.5 "Object-Scan"

5.4.2 Result Table for the Building Noise

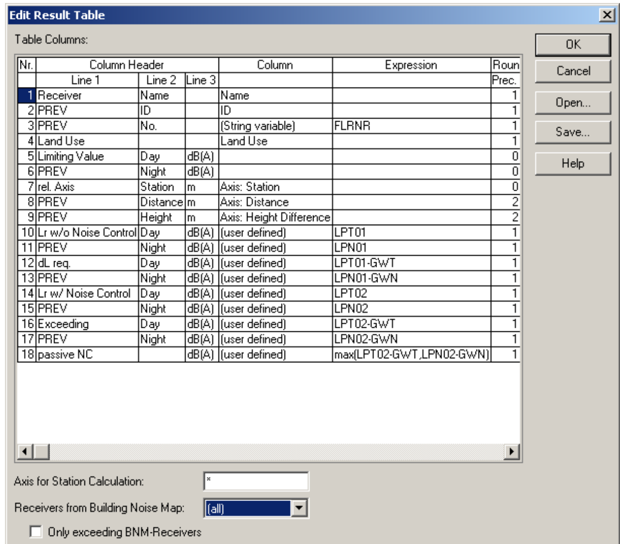
With the generator of the new result table you can define a table showing the results in a desired form.

Immission Point			Land	Limiting Value		rel. Axis			Lr w/ Noise Control		dL req.	
Name	ID	Storey		Day	Night	Station	Distance	Height	Day	Night	Day	Night
				dB(A)	dB(A)	m	m	m	dB(A)	dB(A)	dB(A)	dB(A)
IP 01			MI	64	54	22	21.51	0.50	59.6	49.3	-	-
IP 02			MI	64	54	0	53.58	1.50	53.2	43.0	-	-
IP 03			MI	64	54	51	35.94	1.50	51.2	41.0	-	-
Building 01		EG	MI	64	54	123	9.19	2.50	68.3	58.1	4.3	4.1
Building 01		EG	MI	64	54	126	8.80	2.50	68.7	58.5	4.7	4.5
Building 01		EG	MI	64	54	133	12.08	2.50	65.1	54.9	1.1	0.9
Building 02		EG	MI	64	54	107	9.70	2.50	68.1	57.9	4.1	3.9
Building 03		EG	MI	64	54	91	8.83	2.50	68.6	58.4	4.6	4.4
Building 05		1.OG	MI	64	54	61	12.24	5.30	66.7	56.5	2.7	2.5
Building 06		EG	MI	64	54	43	11.82	2.50	66.9	56.7	2.9	2.7
Building 07		EG	MI	64	54	26	11.71	2.50	66.8	56.6	2.8	2.6
Building 08		EG	MI	64	54	165	9.57	2.50	64.5	54.2	0.5	0.2
Building 08		EG	MI	64	54	162	9.67	2.50	64.5	54.2	0.5	0.2
Building 13		EG	MI	64	54	81	8.59	2.50	65.7	55.4	1.7	1.4
Building 19		1.OG	MI	64	54	141	12.78	5.30	66.4	56.2	2.4	2.2
Building 19		1.OG	MI	64	54	138	12.81	5.30	66.4	56.2	2.4	2.2

Result table with receiver points taken from the noise map for buildings

If you want to look at the results for the receiver points taken from the noise map of the building in addition to the standard receiver points, please activate the option „Receivers from Building Noise Map“ on the dialog **Edit Result Table** and choose the desired levels/storeys from the list box.

5

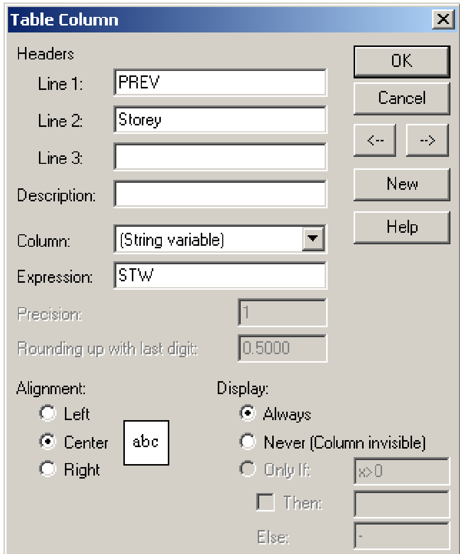


Nr.	Column Header Line 1	Line 2	Line 3	Column	Expression	Roun Prec.
1	Receiver	Name		Name		1
2	PREV	ID		ID		1
3	PREV	No.		(String variable)	FLRNR	1
4	Land Use			Land Use		1
5	Limiting Value	Day	dB(A)			0
6	PREV	Night	dB(A)			0
7	rel. Axis	Station	m	Axis: Station		0
8	PREV	Distance	m	Axis: Distance		2
9	PREV	Height	m	Axis: Height Difference		2
10	Lr w/o Noise Control	Day	dB(A)	(user defined)	LPT01	1
11	PREV	Night	dB(A)	(user defined)	LPN01	1
12	dL req.	Day	dB(A)	(user defined)	LPT01-GWT	1
13	PREV	Night	dB(A)	(user defined)	LPN01-GWN	1
14	Lr w/ Noise Control	Day	dB(A)	(user defined)	LPT02	1
15	PREV	Night	dB(A)	(user defined)	LPN02	1
16	Exceeding	Day	dB(A)	(user defined)	LPT02-GWT	1
17	PREV	Night	dB(A)	(user defined)	LPN02-GWN	1
18	passive NC		dB(A)	(user defined)	max(LPT02-GWT,LPN02-GWN)	1

Dialog **Edit Result Table**

To show also the column *Storey*, insert a new line in the edit box’s result table if necessary.

A double-click on the line will open the edit box’s table column.



Column-Edit dialog of the Result Table

Storeys, string variable STW

Enter the parameters shown above and close the dialog box by clicking OK. The string variable STW represents the corresponding storey.

☝ The string variable STW displays the pertinent storey identifier.

5

String variable for Building Noise Map

Following string variables can be used in the Result Table to view more information about the facade points of a Building Noise Map:

STW	floor identifier: EG = ground floor 1.OG = first floor 2.OG = 2nd floor etc.
FASSNR	facade point number of the building noise map, starting with the first polygon point of the building. Example: On the basis of the facade partitioning (menu **Options|Building Noise Map**) 12 level icons are generated together for all sides of the building. Consequently, they will be covered intern with the facade numbering from 1, 2, 3 etc. till 12. If each level icon has even 5 storeys so each storey will be assigned to the corresponding facade number.
DIR	degree No. 0-360 where 0 is the North direction
HIRI	direction with one letter (N-North, O-East, S-South, W-West)
HIRI2	direction with two letters if necessary (e.g. NW-North-West, SO-South-East)

5.4.3 Level Difference Map for Building Noise

With the Noise-Map for Buildings and activated variants we can quickly calculate the differences in levels at buildings in various project scenarios and can represent them easily.

Therefore, at first we calculate the noise maps for buildings for all variants with **Calculation|Calc|All Variants**. If we switch through the variants by selecting the variant name at the symbol bar the pertinent result is displayed on the screen.

To better recognize the levels, displayed in the symbols, deactivate the option **Color Symbols according to Level,** if necessary, or choose a different color palette with **Open Palette** in the menu **Grid|Appearence|Option** (see chapter 5.3.3).

Calculate Level Differences

We calculate the level differences by subtracting the results of the variants. For that, open the dialog **Options|Building Noise Map** and enter the pertinent formula in the box **Arithmetic/actual Variant**.

Example:

Examples\Tutorial\Building\BuildingNoiseMap.cna

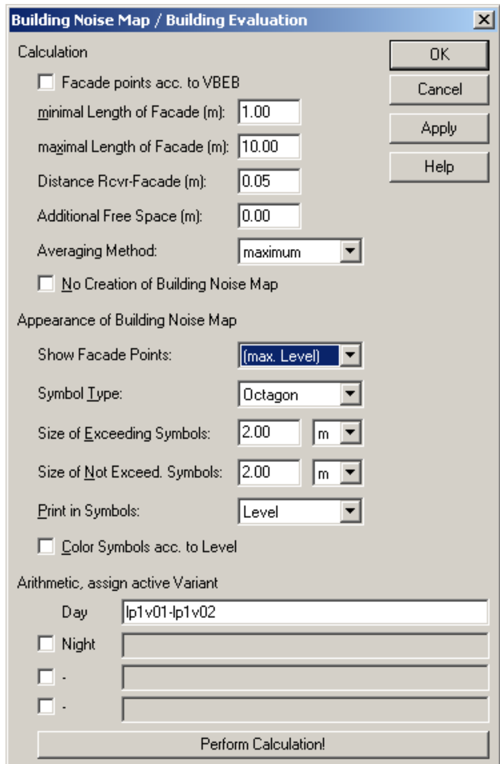
We calculate the first variant V01 with the actual situation and the second variant V02 with the actual situation plus noise protection measures, e.g. a noise protection wall. What level differences does the noise protection wall gain at the facades?

After calculating all variants (**Calculation|Calc|All Variants**), we create another variant, e.g., V03 - differences - and activate this by selecting its name from the list box in the symbol bar.

In the dialog **Options|Building Noise Map|Arithmetic/actual Variant** we enter the following:

```
LPV01 - LPV02
```

Click the button **Perform Calculation**. With this expression all evaluation parameters will be calculated if no other arithmetic field of has been checked.



If you want to calculate only a specific evaluation parameter you have to indicate the number of the desired evaluation parameter.

The expression in the above dialog means evaluation parameter 1 (lp1) of the variant 1 (V01) minus evaluation parameter 1of the variant 2 (V02).

The row names of the arithmetic fields (in our example Day and Night) are changing depending on the name defined in the **Calculation|Configuration|Evaluation** Parameter tab.

The button **Apply** displays the result immediately without closing the dialog. Otherwise close the dialog by clicking the **OK** button.

☝ In this example the variant V03 will be overwritten if we calculate all variants again. The calculation of the level differences must be refreshed. The map of level differences for buildings is always displayed in the activated variant and therefore overwrites the existing result.

The functions, which you can use in the **Arithmetic** box, are identical with those from the Result Table.

For function and operators see **CadnaA**-manual "Attributes & Abbreviations"

5.5 CadnaA - Option XL

☝ The **Option XL** is an additional module for the **CadnaA**-software. The following menu functions are accessible only if the option **XL** has been purchased:

- Calc Map of Conflicts, see chapter 5.5.2,
- Evaluation, see chapter 5.5.3,
- Population Density, see chapter 5.5.4,
- Close Polygons, see chapter 5.5.7,
- ObjectScan, see chapter 5.5.5, and
- Monetary Evaluation of Noise accord. BUWAL, see chapter 5.5.6.

5

The **CadnaA** option XL is an extremely flexible tool for creating noise maps. If all the data exists for a given scenario and a corresponding project file has also be created, the final process is easily done with the XL-option of **CadnaA**.

We will not discuss the accumulation of data any further here, but we would like to point out that the difficulty, for the production of noise maps, considerably depends on whether a part of or all the essential data can be obtained in a digital format and whether the software can import them.

5

5.5.1 Noise Maps and their Evaluation

Initial Situation

The following picture is an excellent example of this situation. A heavily traveled road with a mean daily traffic density of about 15.000 vehicles per 24 hours leads through a built-up area.

A built-up area with 13.000 inhabitants for which a noise map and a noise reduction plan is to be produced.

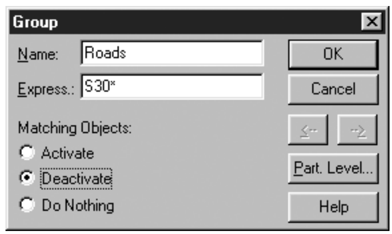
Noise Maps

The complete data of the project - this is valid for our built-up area as well as for a big city - is contained in a single file which can be opened with a double-click on its file name. Anyone who has already suffered under other programs with its numberless run files, command files and the modules which have to be loaded one after the other will very much appreciate this.

On the basis of the mighty group concept of **CadnaA** it is easily possible to calculate noise maps consecutively for road traffic and/or railways, for industry and trade plants, for sport and leisure facilities, for aircraft noise and for any other source of noise. For that, it is only necessary that each source is allocated a noise type with at least one character in its ID code. If, for example, the ID codes of all roads contain the characters `S30` as first digits, then all roads will be deactivated for a calculation with the following entry in the edit dialog **Group**.

5

Examples\
05_Immissions\
Option XL\ XL_01.cna



Edit dialog **Group**

If all noise sources are deactivated - except those which have to be calculated - you can start the calculation (**Grid|Calc Grid**) with the desired settings made in **Calculation|Configuration**.

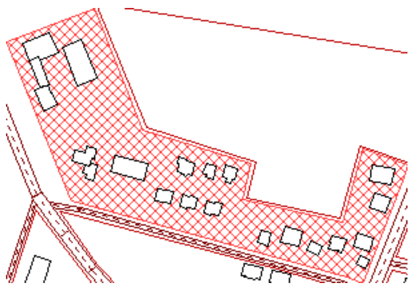
In our example for the built-up area with the through-road it has been calculated in a 10 m grid. Switch on the option **Raster, Oversampling 1** in **Grid|Appearance**.

The noise exposure for each city or built-up area can be easily discovered with such a colored noise map with the corresponding legend .

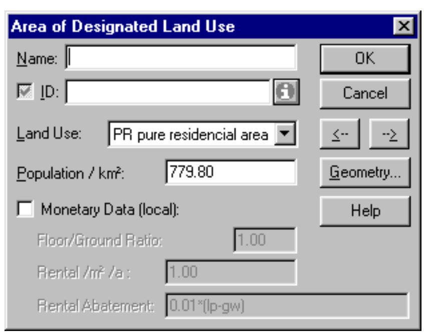
see chapter 5.3 "Grid of Receiver Points"

Noise Maps Maximum Values

In **CadnaA** the areas of diverse land use can be allocated different permitted or standard values for the individual noise types. Therefore you have to draw a closed polygon (with the icon **Area of Designated Land use** from the toolbox) around a region which you can allocate a certain usage. After double-click on this polygon you can enter the pertinent ranking of land use.



The hatched area is in our example a pure residential area (PR) with standard values for the individual noise types



Edit dialog **Land Use** in which the classification of land use can be allocated.

In the edit dialog **Land Use** the density of inhabitants (population/km²) can also be entered. This value is required if, e.g., an evaluation is to be carried out according to a noise impact value. The population density can determined, also automatically, by counting the buildings in this area with **CadnaA**.

5

Digital Zoning Plan/ Land Utilization Plan

The mentioned land uses result from the zoning plan, urban land use planning or the legally binding land use plan or by consideration of the actual present usage. We practically have a digital zoning plan if all areas are allocated such land use.

see chapter 5.2 "Area of designated Land Use" and chapter 5.2.1.

5.5.2 Conflict Maps

A conflict occurs where the relevant maximum receiver value has been exceeded. In the same way as the actual noise impact is illustrated as a level in the noise map, the conflict maps can depict the degree of excess and deviation from the relevant standard receiver value in a colored map.

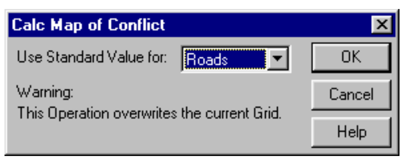
Prior to the calculation of the conflict map the file with the noise map should be saved (**File|Save As**).

5

After the areas of designated land use (see chapter 5.2) have been specified, the conflict maps can be calculated because **CadnaA** then knows the relevant maximum sound levels at the receiver points for each type of noise.

- To this end, select from the list the type of noise which was used to calculate the current noise map on the dialog opening. In our example we only have calculated the traffic noise.

Examples\
05_Immissions\
Option XL\
XL_01.cna



In the calculation, the standard receiver values specified for this type of noise will be considered for any type of land use. (They are specified under **Options|Land Use** - see chapter 5.2.1.)

As a rule, the colored representation of the map disappears upon completion of the calculation, because the palette was not matched to the differences in level occurring in the conflict map. It is therefore convenient to generate a specific palette for maps of conflicts under **Grid|Appearance|Options**, and to save it as conflict.pal. A negative value for the lower limit of the representation range should also be selected here.

Examples\
ColorPalettes\
conflict.pal

With such created conflict maps it becomes immediately clear which residential buildings lie in red areas or by which buildings the standard or permitted level has been exceeded.

5.5.3 Evaluation

Although the conflict maps (see chapter 5.5.2) neatly illustrate problem areas, this information is still far too detailed for an evaluation of different planning alternatives. An unambiguous scaling in terms of a single-number rating is required here.

There are numerous ways for such a single-number rating. Presently, however, there is no generally accepted and standardized algorithm. As the purpose is to quantify the noise impact on a complete area, all these concepts agree in raising the noise impact quantity with an increasing number of persons concerned and with increasing sound level or increasing excess level. The number of persons concerned, *N*, is generally considered as a linear influence. The influence of the sound level, however, is a matter of controversy. An exponential term is certainly appropriate since the effect of an increase in level by x dB is the more detrimental the higher the original level, or the excess level, is.

In order to accommodate different concepts and to remain open to future developments the evaluation formula may be specified arbitrarily by the user. The following example illustrates the simplest possible concept, i.e., adding the excess levels per inhabitant for the entire area.

$$LB = \sum N_i \times \ddot{U}_i$$

with

LB Noise impact value

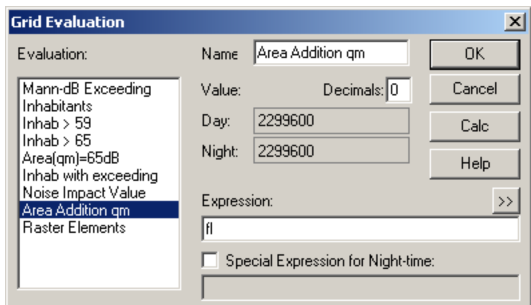
N_i Number of persons subject to excess level $\ddot{U}_i$

$\ddot{U}_i$ Excess level in dB

Such an evaluation can only be carried out for an area, if

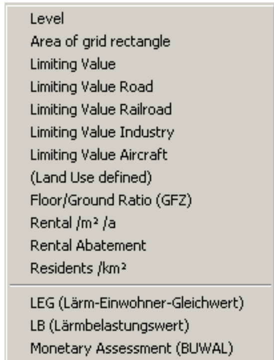
- the calculated noise map is available in **CadnaA** and
- all areas to be considered in the evaluation are assigned a designated land use, and thereby a standard receiver value.

Then, under **Grid|Evaluation,** open the dialog and - as a simple test - enter the characters `fl` in the field **Expression**. This entry `fl` causes the addition of all grid surfaces which results in the total area.



Since `fl` shows the area in m² of each grid point when scanning them all, and consequently, adding up these areas, clicking **Calculate** will yield the total area covered by the grid. For a noise map the entry shown in the following dialog may appear as an example. The total area here is approximately 2.3 km² .

If you click on the double arrow button on the right hand side of the field expression a list with predefined expressions and formulas opens - e.g. you also could mark the identifier „Area of grid rectangle“ of the expression *fl* instead of entering it via keyboard. The expression will be inserted automatically.



The following variables are available for an evaluation formula:

Variable	Meaning
fl	area of a grid element in m^2
r0	current level on this grid element
na	limiting value
naein	population density in inhabitants/km^2
nages	limiting value of noise caused at the receiver point from all noise types together
naind	limiting value of noise caused at the receiver point from industry
nastr	limiting value of noise caused at the receiver point from road traffic
nasch	limiting value of noise caused at the receiver point from railway
naflg	limiting value of noise caused at the receiver point from air traffic

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naog	grid point in area of land us, yes/
nagfz	Floor Space Ratio FSR
namiete	Rent/m²/a
namind	Abatement of rent (in monetary unit, by increase of the noise level by 1 dB), e.g. 1% percent abatement of rent per 1 dB (according to BUWAL)

All the usual operators (see **CadnaA**-manual "Attributes & Abbreviations") like +,-,*,/,<,> can be used. The sequence of operators ++ causes an energetic summation, while the sequence „--“ causes an energetic subtraction.

The command structure:

iif(criterion, expression1, expression2)

results in the criterion being checked and the value resulting from expression1 being returned if the criterion has been fulfilled; the one resulting from expression2 being returned if the criterion has not been fulfilled.

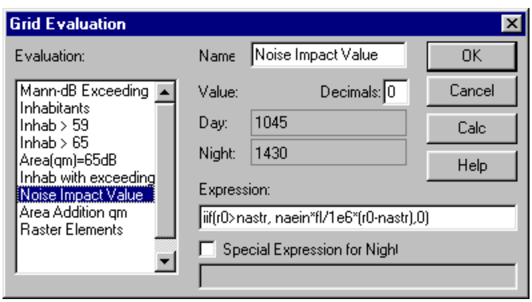
Example with functions

Function	Result after Calculation
1	number of raster elements
fl	total raster area
naein*fl/1e6	number of inhabitants in all areas of designated land use
iif(r0>=65,naein*fl/1e6,0)	number of inhabitants subject to levels of more than 65 dB

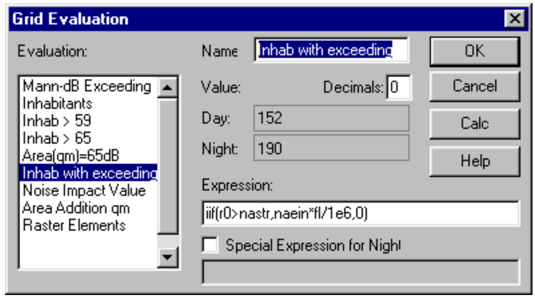
iif(r0>=nastr,naein*fl/1e6,0)	number of inhabitants subject to excess road noise
max(naein*fl/1e6*r0,0)	the above-mentioned value of noise impact, if applied to the conflict maps
iif((r0<Lo)*(r0>Lu),fl,0)	qm-area of a certain level (Lo = upper level, Lu = lower level)

With this, subtly differentiated analyses can be created quickly an simply.

After an expression has been specified, it is convenient to enter an identification in the field **Name** for the quantity to be calculated. This identification appears in the list box **Evaluation** as soon as another line in this box is clicked. Now you may enter a further expression for a single-number evaluation. For a noise map, e.g., with the evaluation dialog below, the noise impact results in a value of 1430 (inh.*dB) for the night-time.



Clicking the line "Inhab with exceeding" results in the following display:



Thus 190 inhabitants are subject to excess night-time levels. The average excess level AL is:

$$AL_{average} = 1430 / 190 = 7{,}5 \text{ dB}$$

You can find a list with pre-defined expressions if you click on the arrow-button. To insert a pre-defined expression just click on its identifier. You can change and save the expression with a new name in the user-defined list **Evaluation**.

5.5.4 Population Density

The density of inhabitants for a certain area or the numbers of residents per building will be required if an evaluation like the noise impact value is to be performed.

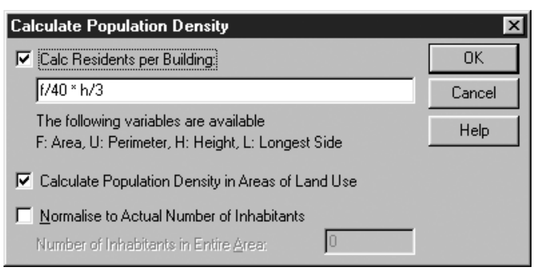
Either we have these numbers and enter them via keyboard and import or we evaluate and enter them. This estimation can, however, be a laborious job. **CadnaA** can settle this automatically in an effective way.

The following is required to calculate the density of inhabitants/km²:

- areas of designated land use (see chapter 5.2) have to be inserted
- in these areas buildings (see chapter 3.1.2) are included and
- a formula (see **CadnaA**-manual "Attributes & Abbreviations") has to be entered for the calculation of inhabitants.

We do not need areas of designated land uses if we calculate only the residents of buildings.

With **Grid|Population Density** we open a dialog for entering a formula with the variables indicated in the dialog for the calculation of the inhabitants.



In the above figure we have presupposed that in each case, on average, 40 m² of floor space can be allocated to one person and that the floor height is on average 3 m.

Calc Residents per Building

After confirming the dialog with **OK** all buildings which are marked as residential buildings will be allocated a population according to the entered formula and the number of inhabitants will be entered in the dialog **Building**. The population is also displayed in the table **Building** (**Tables|Obstacles**).

Calculate Population Density in areas of Land Use

After confirming the dialog **Calculate Population Density** with **OK** all individual areas with designated land uses - and here again all buildings - will be run through to determine the population with the entered formula. The calculated number of inhabitants will be entered in the field **Population/km²** in the dialog **Area of Designated Land Use**. In each case this results in the population per km² in each area of designated land use.

Normalize to actual number of Inhabitants and Number of Inhabitants in Entire Area

The number of inhabitants determined while considering the buildings may deviate from the actual number of inhabitants. If the latter is known, it may be entered in the edit dialog **Number of Inhabitants in Entire Area:** when **Normalize to Actual Number of Inhabitants** has been activated. **CadnaA** then converts the population densities determined for the individual areas of designated land use by an appropriate factor to match the total number of inhabitants in all areas of designated land use to the total number specified.

Afterwards, when the edit dialog for an area of designated land use is opened, the calculated population density is displayed. **In the menu Tables|Other Objects|Areas of Designated Land Use** all values are listed in the table.

5.5.5 Object-Scan

The dialog **Object-Scan** on menu **Grid** is a powerful tool. The dialog enables to sum up

- for a selectable type of object
- an arbitrary attribute value or a calculated attribute value by a user-defined expression

for all objects of the chosen type by the specified action.

Action / Sum into:

The adding and displaying of the final value can occur in the following ways:

Single Values

1. As a target in „Action/Sum into“ select „Single Values“. The evaluation then takes place for the entire project file and the result value is displayed in a message dialog.

Specified Areas/ Polygons

2. As a target in „Action/Sum into“ select „Specified Areas/Polygons“. Then select a „Target Object Type“ to sum to. Furthermore, select an attribute of the selected „Target Object Type“ in which the values being summed up inside the closed polygon are assigned to.

Grid and Window Size

3. As a target in „Action/Sum into“ select „Grid“ and as „Window Size“ define the length of a side of a square inside of which a result should be determined in a grid. This square is arranged so that its pivot is a grid point. The entire grid is run through in that way, by shifting the window step by step to the next grid point.

Table

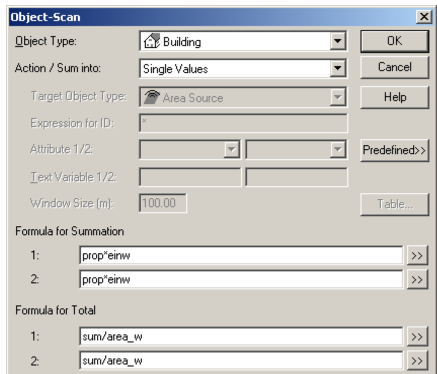
4. As a target in „Action/Sum into“ select „Table“. In this case, the evaluation takes place in a table either with user-defined intervals (min - max) of an arbitrary attribute or by predefined formulas (button „Predefined“).

☝ The procedures applying the available methods are described in this chapter, each by an example.

Remark

As **CadnaA** allows to calculate up to four evaluation parameters simultaneously (see chapter 6.2.5) the input boxes in sections **Formula for Summation** and **Formula for Total** are identified by „1“ and „2“. As summations can be performed for arbitrary evaluation parameters a link to „Day“ and „Night“ does not apply any longer. Based on the attributes of the object type selected you can evaluate up to two formulas at the same time.

Open the dialog **Object-Scan** via menu **Grid|Object-Scan**.



The Dialog **Object-Scan**

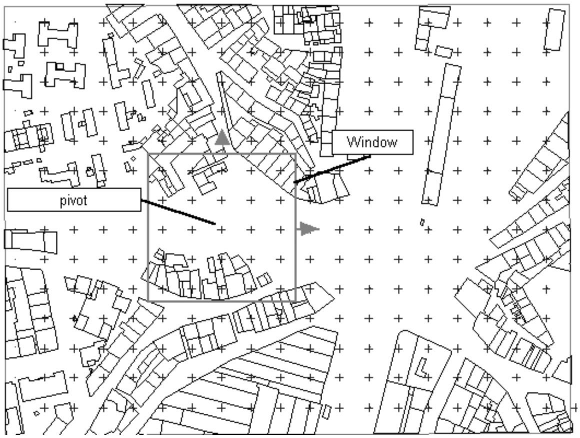
Target Object Type
Expression for ID
Attribute 1/2

You can only select a **Target Object Type** if **Specified Areas /Polygons** are selected in the field **Action /Sum into**. The result is then written in the selected **Attribute** (e.g., **Name** for the corresponding field in the edit dialog of the object)

☝ Do not use the same attribute for boxes 1 and 2 at the same time. The results will be overwritten in this case.

Window Size (m)

In the field **Window Size (m)** you can define the side length of an invisible square within which a result in a grid is calculated. This quadrate is arranged so that a grid point its central point is. The whole grid will be calculated by shifting iteratively the window to the next grid point.



The **window** only has an effect if the option **Grid** (**Action/Sum into**) is selected.

Formula for Summation

For boxes 1 and 2 you can enter an expression or select parameters from the *List of Attributes*. By this, you determine which value will be added up for each object detected during the scanning operation.

List of Attributes

We open the list of attributes by clicking the double-arrow button (>>), to the right of the corresponding input line. Only the pertinent attributes of the selected object type are displayed. To select and insert a desired attribute just click on it. To overwrite an existing expression in an input box, double-click the variable before selecting from the *List of Attributes*.

prop	HA_ATT	LMEE	VPKW	PLAT	SSCR_AW_L
area_p	HE_ATT	LMEN	VPKWD	PLAE	SSCR_AW_R
area_i	PO_LENAREA	RQ	VPKWE	PLAN	SSCR_H_L
area_w	PO_LEN	FBABST	VPKWN	PLLAT	SSCR_H_R
prop_l	PO_AREA	DTV	VLKW	PLLAE	SSCR_ONLYGA
len_p	PO_HREL_P1	STRGATT	VLKWD	PLLAN	TEXDEP
len_i	PO_HGND_P1	STRGATTNR	VLKWE	PSLAT	SIGMA
BEZ	PO_HABS	CRTN_HGV	VLKWN	PSLAE	MOTORWAY
BEZRAW	PO_HABSMIN	MT	DSTRO	PSLAN	YEAR
ID	PO_HABSMAX	ME	STRONR	PMCT	THROTTLE
MARK	PO_HGND	MN	STRO	PMCE	RB_LME
MEMO	PO_HGNDMIN	PT	STEIG	PMCN	
MEMOTXTVAR	PO_HGNDMAX	PE	DREFL	MKT	
DAT_VON	PO_CENTERX	PN	HBEB	MKE	
DAT_BIS	PO_CENTERY		ABST	MKN	
HA	PO_PKTANZ		ABSNR	NO_K1	
HE	KILO		ABS	FLOWNR	
	KILO_DESC		PLT	FLOW	
	LMET		PLE	SSCR_ADDWID	
			PLN		

List of Attributes on dialog **Object-Scan** (here for object „Road“)

Variable

The list of attributes is separated by a horizontal line. The attributes below this line are object specific. You will find an explanation for these abbreviations in the **CadnaA**-manual "Attributes & Abbreviations".

Above this line are all special attributes listed which also can be used for the object-scanning.

prop	part of the object which is inside the window. With extended objects it is the proportion of the area; with line objects the proportion of the length..
area_p	total area of an object (by closed polygons).
area_i	area of an object which lies inside the window.
area_w	area of the window
prop_l	proportion of the length of open or closed lines which are lying inside the window (well in distinction to `prop` with areas determined by the proportion of the perimeter)
len_p	total length of an open or closed line (therefore also the perimeter line of an area)
len_i	length of the part, of an open or closed line, which is lying inside the window

int_lo lower limit of an interval (when summing up into a table)
int_hi upper limit of an interval (when summing up into a table)

Example of formulas

- to determine the total kilometers of roads in a project, choose the following

  object type *Road*
  Action/Sum in *Single Values*
  and enter the following term into the box **Formula for Summation**:

  ```
  len_p
  ```

  in words: sum up the total length of the line objects of type „Road“

- to determine the total residents of buildings in a project, choose the following

  object type *Building*
  Action/Sum in *Single Values*
  and enter the following term into the box **Formula for Summation:**

  ```
  iif(WG_NUM, EINW,0
  ```

  in words: if it is a residential building, add the residents, otherwise add zero

- to determine the total floor area of the buildings, enter the following

  object type *Building*
  Action/Sum in *Single Values*
  and enter the following term into the box **Formula for Summation**:

  ```
  iif(WG_NUM, area_p,0)*PO_HREL_P1/3
  ```

  in words: if it is a residential building, add the ground area of the buildings, otherwise not and multiply the total area with the relative height of the first building point for each building divided by 3 m floor height

Calculation

After completing the inputs for all desired fields and closing the dialog by confirming **OK** the results are automatically written in a local **Textblock**.

Textblock

The name of the local textblocks generated automatically for the results is

box 1: #(Text, OBJSCAN1)
box 2: #(Text, OBJSCAN2)

The textblocks are located in **Tables|Libraries (local)**. You can use them as usual, e.g,. for reports, legend or for export files.

If you want to determine different object attributes you should rename the textblocks because a new result overwrites the previous result.

In case you have determined the road kilometers of a project then rename the textblock, e.g., in `RdKm`. **CadnaA** creates a new textblock OBJSCAN if you repeat the **Object-Scan**.

But we can also display the result in a text box in the graphics by referring the textblock in the text box, e.g., as follows:

```
Roadtraffic = #(Text, OBJSCAN1) km
```

Formula for Total

An entered expression determines which value is calculated with the value saved in the variable *sum* from the above **Formula for Summation**.

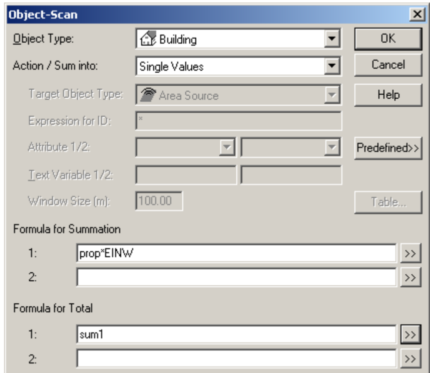
Grid

By choosing **Grid,** in the field **Action/Sum into,** the result is assigned to the grid point in the pivot of the **Window**.

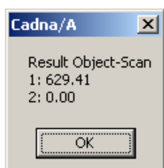
We can use the variable `sum` for both boxes *Formula for Total* 1 and 2 instead `sumt` or `sumn`. The saved result for formulas 1 and 2 will be recognized and used from **CadnaA** by entering `sum` in the corresponding field.

Single values

A total evaluation for the entire calculation area can also be determined. For this choose **Single Values** in field **Action/Sum into**. With the variable **sum** is the term, defined in the field **Formula for Summation**, evaluated for all objects in the whole calculation area and displayed in a message dialog. With the following example results the number of all residents in the area.



Dialog **Object-Scan** and the corresponding terms



Result Dialog

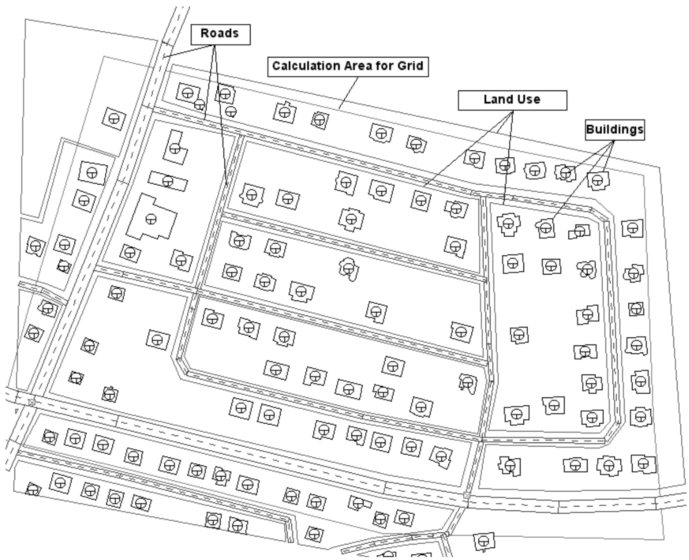
A common way of using the Object-Scan is the calculation and representation of indicators for annoyance by noise.

5

Examples of the four mentioned methods

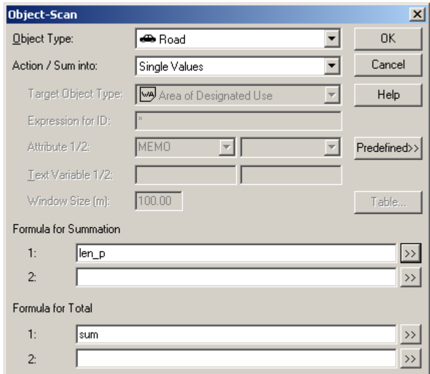
Examples\
05_Immissions\
Option XL\
SmallCity01.cna

The basis is the example file **SmallCity01.cna** (If you want to see the english or German text boxes you can switch to variant V01 or V02 in the symbol bar).



Example Single Values

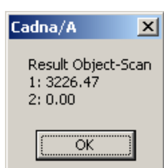
The total length of all roads in the project shall be determined.



Selected is the **Object Type** *Road* and *Single Values* in **Action/Sum into**. In the field **Formula for Summation** the term `len_p` is entered for the Attribute or via the list selected.

`len_p` shows generally the polygon length of the object representation. The alternative is to select the object-specific parameter PO_LEN from the variable list.

After confirming with **OK** the result dialog appears with the following message



The road net has consequently a total length of 3226 m.

In the same manner the number of buildings can be evaluated or the whole sound level of all point sources, or each other computable or deducible value from the attribute parameters of the selected object type.

Example: Areas

- In the **Name** box of each area of **Land Use**, in the above displayed example, the number of buildings shall be displayed.

  Object Type: Building
  Action / Sum into: Areas
  Target Object: Areas of Designated Use

With these settings and with the list box **Attribute D/N** you have access to all attributes of the **Object Type** „Land Use“. The summed final value, for the selected attribute, is assigned to each existing area of **Land Use**. With selection of **Name** as attribute this value is written in the **Name** box of the **Land Uses**.

Just counting the formula „1“ for the summation could be used. But then buildings also placed on the border of the areas are completely counted - the sum of the entered buildings is bigger than the real number of buildings in the whole project.

If this final balance is to be correct, a building on an area border must be counted as only a part < 1, which correspond to the area part of the building inside the area of land use. This is happen with an entry of `prop` as **Formula for Summation** via the variable list.

After confirming **OK** the number of buildings are entered in the **Name** box in the edit dialog of the **Land Uses**.

Summation of Facade Points into Building Evaluation Symbols

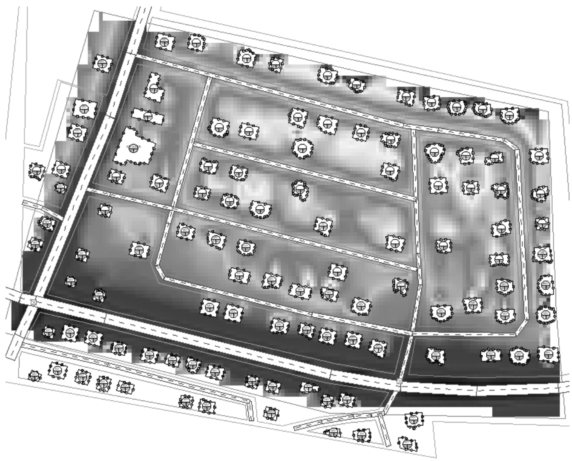
The summation of object attributes into specified areas is usually carried out based on the geometric location. This means that the objects scanned for must lay geometrically within the target object type. When summing up facade points into building evaluations, however, the summation occurs per appropriate building and not per geometry. There is e.g. useful in conjunction with the noise scoring of building evaluation symbols being addressed to the buildings via Object-Scan.

In the following example each building having a Building Evaluation Symbol got assigned a characteristic pressure level (via dialog **Modify Objects**, action „Generate Building Evaluation“).

Example: Grid

In this example the population is assigned to the individual buildings...

Examples\
05_Immissions\
Option XL\
SmallCity02.cna



The amount of the noise impact shall now be evaluated for each building. This is dependent on the number of residents *n* and the sound level *L* of the buildings.

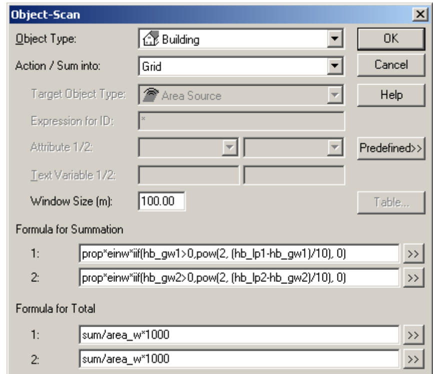
$$LEG_{Haus} = n \cdot 2^{0.1 \cdot (L - L_0)}$$

whereas L_0 is the limiting value.

This impact measure (Noise Impact of Residents, NIR) shall be added for the entire area and a colored map shall be generated, which displays the impact measure corresponding to 1000 m² in each case.

The **Object-Scan** achieves this with the following dialog:

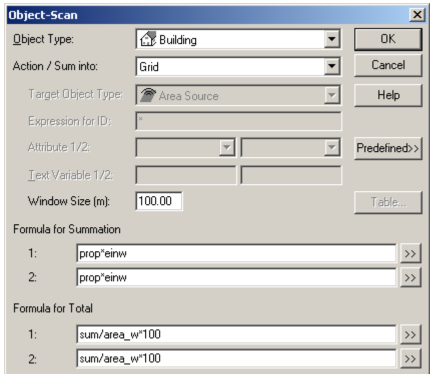
5



The **Formula for Summation** correspond to the above term.

In a further example, the population density shall be averaged over a larger area of 100 m x 100 m and displayed as a colored map with population/ 100 m². To this end, open again the file „smallCity02.cna“.

Select in the first box for **Object Type** *Building* because the evaluation shall refer to the population in buildings



The variable `prop` supplies for each building inside the **Window** the value 1 and for buildings on the border of the **Window** a value from 0 to 1 which specifies the part of the building area located inside the **Window**. With the product `prop*einw` therefore the population which has been allotted to the specified square is added. The result is saved in the variables `sum` for the parameter 1 and `2` (the building attribute „population“ is equal for parameters 1 „day“ and 2 „night“).

In the example the area of the specified **Window** and therefore 100 m x 100 m = 10000 m², is divided by the `area_w` and multiplied by 100. The division leads to the population per m² and the multiplication to the population per 100 m².

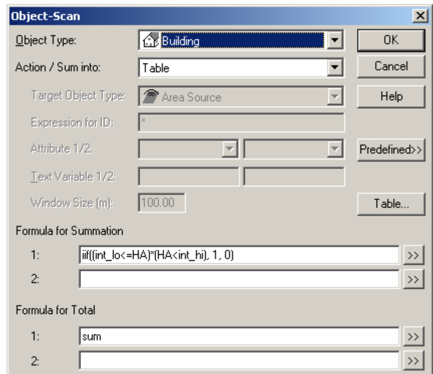
As the grids palette does not match with the values to be displayed, load via **Grid|Appearance|Options** and button „Open Palette“ the file „0_5.PAL“.

Example Table

We want to determine the number of buildings within height intervals by using a table.

Examples\
05_Immissions\
Option XL\
SmallCity03.cna

Open the file SmallCity03.cna and then the dialog **Object-Scan** on the **Grid** menu. Enter the formulas as shown in the following. To this end, specify the settings shown in the following picture.

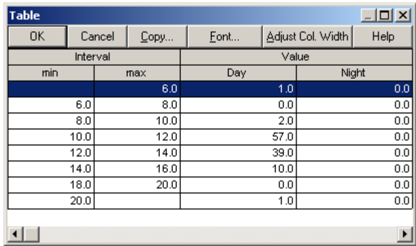


Formula for Summation:

int_lo < = HA: The lower interval limit is smaller than or equal to the building height.

HA < int_hi: The building height is smaller than the upper interval limit

You have to enter the desired height intervals in a table. Therefore, click on the button **Table,** insert as many lines (Ins-key) as necessary and enter the corresponding limits in the columns **min** and **max** .



Interval		Value	
min	max	Day	Night
	6.0	1.0	0.0
6.0	8.0	0.0	0.0
8.0	10.0	2.0	0.0
10.0	12.0	57.0	0.0
12.0	14.0	39.0	0.0
14.0	16.0	10.0	0.0
18.0	20.0	0.0	0.0
20.0		1.0	0.0

If you close the table and the dialog **Object-Scan** with **OK** the evaluation will be executed and the result is shown in the table. The result are the building heights in intervals of 2 m interval width.

Predefined

If you choose a predefined entry via the button **Predefined** both a corresponding formula is entered in the field **Formula for Summation** and an appropriate table is created automatically.

For the time being, the following predefined evaluations are available:

- people in level classes (accord. to EC-directive 2002/49/EC, annex VI /106/)
- people with quite facade in level classes (ibid)
- people without quite facade in level classes (ibid)
- people in level classes (accord. to German VBEB /98/)
- building heights, averaged from height points
- noise impact index LEG (similar: Noise Impact Ranking NIR)

Save as

User defined settings on the dialog **Object-Scan** (including the expressions for „Summation“ and „Total“) can be saved. Select the command **Save to** at the lower end of the default entries and enter a name.

☝ The user defined settings are saved in the **CadnaA** installation directory in the file **objscan.ini** (default path: C:\Program Files\Datakustik\CadnaA).

Delete

User defined settings can be deleted again (via button „Predefined“, command **Delete**). Select the corresponding name. The respective settings are deleted without safety request.

5.5.6 Monetary Evaluation according to BUWAL

☝ The **CadnaA** option XL is required to make use of the subsequently described evaluation.

Method

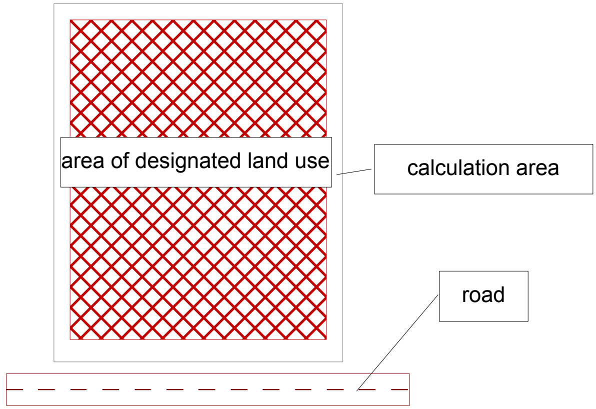
A technique to evaluate the noise is described in the study /60/. This method has been implemented into **CadnaA**.

This method takes into account the reduction in value of rented flats that results from high noise levels. This is done by converting the noise load of residential areas into amounts of money. If the value of a noise reduction measure is to be evaluated, then this is done by calculating the noise distribution with and without this measure. The difference in the two amounts of money is represented by the reduced value according to the noise expressed in value of the measure.

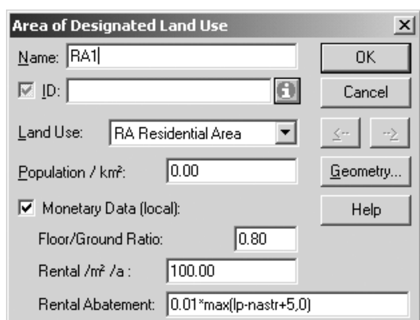
The philosophy behind this procedure tends to underestimate the negative aspects of noise. The effect of noise impact on the rental rates of residential areas does not take into account many other negative consequences of noise. Nevertheless, this procedure is a pragmatic way of assessing cost-benefit relations in conjunction with noise.

Application with areas of designated land use (Example 1)

The evaluation method is applied to areas of designated land use. The following diagram shows a simple and easily understandable example.



Area of designated land use with road



and the edit dialog of this object (example 1)

Monetary Data (local)

The edit dialog of the **RA**-residential area shows (see chapter 5.2) that when "Monetary Data" is activated three further values can be entered

- Floor/Ground Ratio (NAGFZ)
- Rental/m²/a (NAMIETE)
- Rental abatement (NAMIND)

The bracketed abbreviations are the names of variables needed later to perform necessary operations.

In the edit fields for rental abatement in the dialog **Area of designated Land Use** the two variables

- LP sound pressure level
- NA_STR maximum value for noise from road traffic (defined in **Options|Land Use|Limiting Value**)

are used to express the loss in value for all areas with sound levels within 5 dB under the maximum value.

Floor/ground ratio: A factor when multiplied by the ground area, gives the maximal residential area of buildings permitted on this area.

Rental/m²/a: can be entered in any currency unit. The calculated results are then related to this currency.

The factor in the equation of input line „Rental Abatement“ - 0.01 in the first example - is the loss of rent due to a level increase of 1 dB. 0.01, meaning rentals are reduced by 1% if the level raises 1 dB.

Further variables needed in the expressions of evaluation :

- Area of a grid element in m² (FL)
- Logical value (0-false, 1-true) as a definition if a grid element is inside an area of designated land-use or not (NAOK)

5

Calc Grid

In the first step, to come to a monetary evaluation of the noise, the noise level is calculated on a grid for the whole area.

Evaluate Grid

With the second step the evaluation, with the defined formula in **Grid|Evaluation,** is calculated for all grid points and the result is added up.

The following results are obtained when using the expressions on the right side. The accuracy depends on the size of the grid elements because a grid element is taken to be in an area if the grid point is located in it. It is, therefore, recommended you use grid spacings as small as possible.

FL Calculation area in m²

FL*NAOKArea of designated land use in m²

FL*NAOK*NAGFZTotal residential area in an area of designated land use

FL*NAOK*NAGFZ*NAMIETERental for all areas of designated land use

FL*NAOK*NAGFZ*NAMIETE*NAMIND
Reduction in rent caused by noise

For example 1:

- the calculation area (FL) is 10,080 m².
- The size of the area of designated land use is 8,000 m².
- The floor/ground ratio is 0.8.

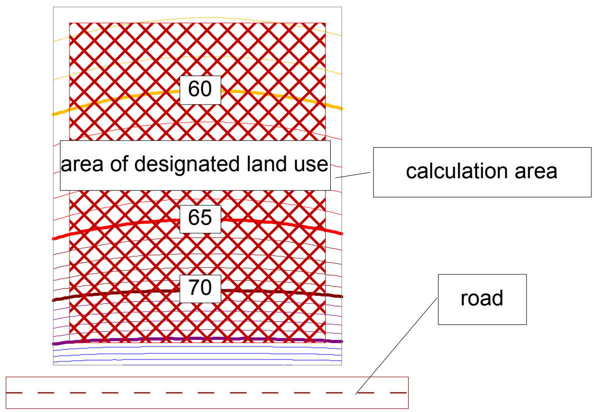
So the maximal residential area on this estate is 0.8 x 8,000 m² = 6,400 m². The rental with 100 € per year and m² is therefore 640,000 €.

Evaluation example 1--loss in value based on residential areas

The three above mentioned values **floor/ground ratio**, **rental/m²/a** and **rental abatement** have been entered in the edit dialog of this area - the values are therefore only valid for this individual area (local). It is also possible to enter these values in **Options|Land use** for each type of general land use (global) - in this case they are valid for all areas of this type. If the values have been entered globally and locally, the local values for an area dominate. Globally defined values are used for all areas of this type where no local ones exists.

Step 1 - Calculation of sound pressure levels

The calculation of levels for example 1 with a grid spacing of 1 m x 1 m and a receiver height of 4 m (see chapter 5.3.1) leads to the result shown in the following diagram.



Result of the grid calculation with a grid spacing of 1m and a receiver height of 4m

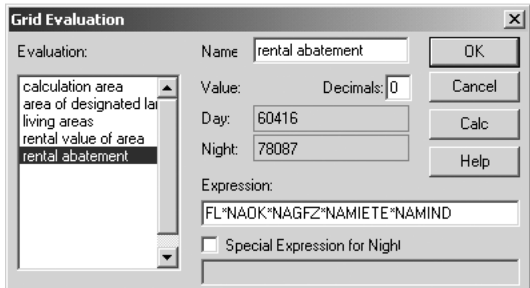
Step 2 - Evaluation

After noise levels have been calculated on the specified grid, the evaluation in the form of a reduction in value is carried out in **Grid|Evaluation**. The example file Monetary1.cna just includes the correct expressions.

Examples\
05_Immissions\
Option XL\´
Monetary1.cna

The expression for calculating the annual reduction in rent resulting from noise is

FL*NAOK*NAGFZ*NAMIETE*NAMIND



After a click on **Calculate** the reduction in rent of 60416 € caused by the noise is shown.

Changing the number of cars (MDTD) to 10000 cars/24h, recalculating and evaluating with the described steps shows a reduction in this noise induced loss to 40789 €. With the same technique all possible measures like screens and barriers or reorganization of traffic flows can easily be evaluated and ranked.

Evaluation example 2a - loss in value based on residential premises as single digit value

With example 1 the residential area was calculated from the whole area and the floor/ground ratio was the basis for the evaluation. This meant that the probability of people living at any certain position in this area was regarded to be the same for all positions.

It is also possible to use the exact position of all buildings and their geometric location. Example 2 uses this technique. With example 2a the noise induced loss of value for all buildings is calculated as a single number value. This is the best procedure if different strategies for noise reduction are to be ranked.

The following diagram shows example 2, a scenario with roads, buildings and areas of designated land-use. The above mentioned values are defined globally (**Options|Land use**).

Examples\
05_Immissions\
Option XL\
Monetary2.cna

Step 1 - Building evaluation and calculation of a building's noise map for all residential premises

In **Options|Building noise map** select energetic for the **Averaging Method** (see chapter 5.4.1).

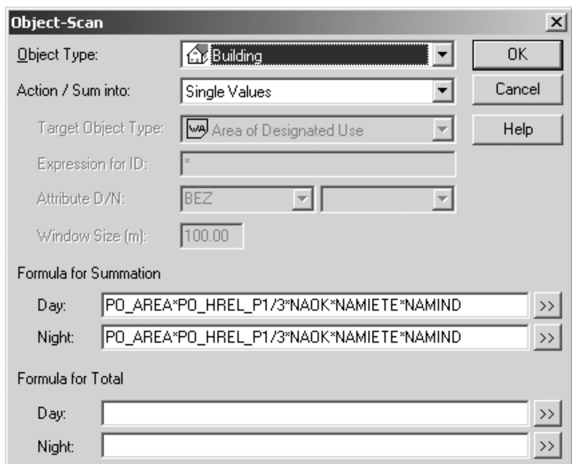
Scenario with buildings, roads and areas of designated land use
(and symbols for building evaluation)

The building evaluation symbols have been attached to all buildings automatically using the **Modify Object** command. Then the calculation for defined receiver points is started (this includes calculation of façade levels and building evaluation.

Step 2 - Evaluation as single digit result using Object-Scan

5

Evaluation is carried out using the command **Grid|Object-Scan** (see chapter 5.5.5). The parameters and expressions that should be used for this type of evaluation are shown in the following window. Leaving this window with OK, the single digit result is calculated taking into account the façade levels of all 97 buildings.



Edit Dialog **Object-Scan**

The following parameters are used:

PO_AREAground surface covered by the building (area of polygon)

PO_HREL_P1relative height of the building at point 1

The other parameters are explained above.

After confirmation with **OK** the noise induced reduction in value for all buildings is shown. In this case: 513038,35 € .

Evaluation example 2b - loss in value based on individual residential premises for all areas of designated land-use

The same scenario shown in example 2a is used again, but now the result is to be evaluated for all areas separately.

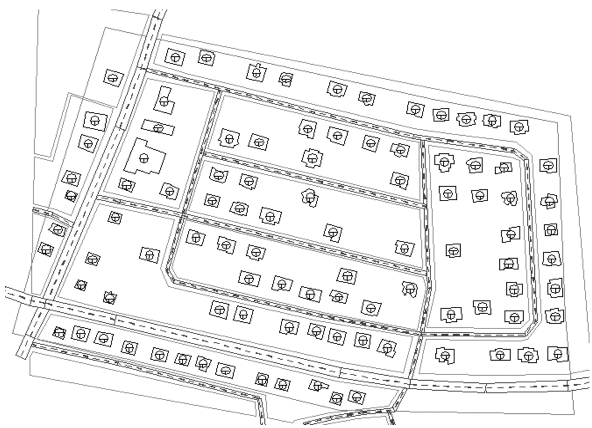
Load example2.cna and open **Tables|Other Objects|Areas of designated Land use**. You see that the column **Name** is empty.

Examples\
05_Immissions\
Option XL\
Monetary2.cna

5

Step 1 - Building evaluation and calculation of a building's noise map for all residential areas

This calculation has just been done - if not look to step 1 in the last chapter.



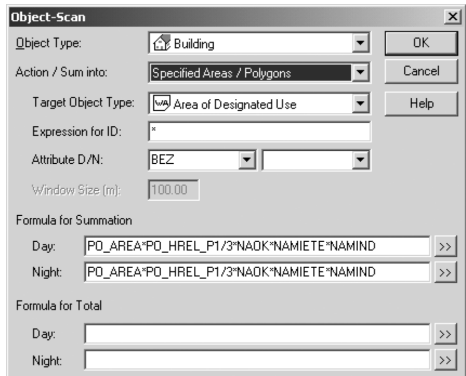
Scenario with several areas of designated land use

Step 2 - Evaluation for each separate area using Object-Scan

The reduction of value due to noise shall be calculated separately with regard to the buildings in each area. This resulting value shall be written into the attribute **Bez** (that means that the result is written in the field **Name** in the edit dialog - any other attribute can be chosen).

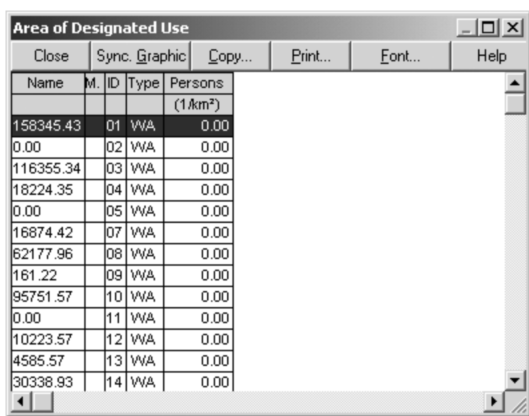
5

Open the dialog **Object-Scan** with **Grid|Object-Scan** and in **Action / Sum into:** select **Specified Areas / Polygons** as shown in the following figure.



The parameters in the dialog **Object-Scan** to write the results in the field **Name** of each area

Target object type is **Area of Designated Use**. With **Bez** as attribute the result is written in the field **Name** of each area. After doing this evaluation you find the result value in column **Name** of **Tables|Other Objects|Area of Designated Use** as shown in the following table.


Area of Designated Use

Close | Sync. Graphic | Copy... | Print... | Font... | Help

Name	M.	ID	Type	Persons (1/km²)
158345.43		01	WA	0.00
0.00		02	WA	0.00
116355.34		03	WA	0.00
18224.35		04	WA	0.00
0.00		05	WA	0.00
16874.42		07	WA	0.00
62177.96		08	WA	0.00
161.22		09	WA	0.00
95751.57		10	WA	0.00
0.00		11	WA	0.00
10223.57		12	WA	0.00
4585.57		13	WA	0.00
30338.93		14	WA	0.00

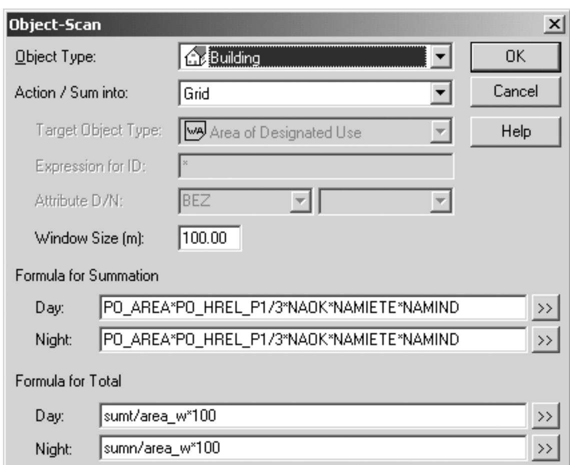
Results in column **Name** after evaluation

The value 0.00 (zero) in the field **Name** indicates that either the assessment level is more then 5 dB below the maximum sound level (and therefore no rent reduction occurs) or that non building is placed in that area.

Evaluation Example 2c - Evaluation of average loss in value in a gliding window and presentation as a colored map

Only to be complete, this further method shall be mentioned. Calculation of facade levels and building evaluation is the same as in the examples before. To present the result as a colored map a grid must be calculated. This is necessary because the grid points must already exist before you can allocate a value to a grid point calculated for a window with Object-Scan.

To save calculation time, this is best done with all roads switched off. Calculate the grid, e.g., with a spacing of 5 m. For evaluation use **Grid|Object-Scan** with the parameters and adjustments as shown:



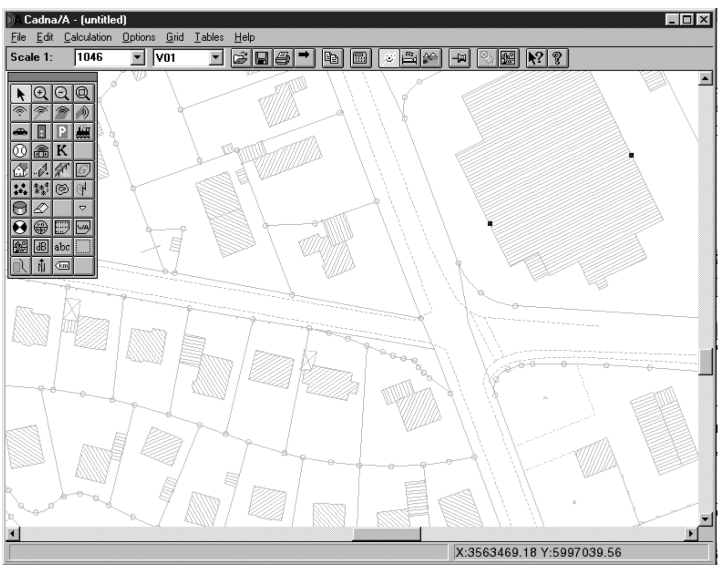
Parameter settings to calculate the reduction in rent

The reduction in value for all buildings is added up in a window of 100m x 100m, normalized to 100 m² and attached with the grid point in the center. Then the window is moved one grid spacing and the same is repeated. At the end all parameters in **Grid|Appearance** must be chosen so that all values can be presented in the map (colors, the lower and upper limit etc).

5.5.7 Close Polygons

The command **Close Polygons** on menu **Tables|Miscellaneous** enables to connect automatically individual polygon lines to a closed polygon. This is useful when importing e.g. buildings into **CadnaA** from some external software program, like a AutoCad DXF file. By default, the closed polygons are converted into buildings. In case of a different target object than a building, convert the building polygons after import using the command Close Polygons (see chapter 11.13 in the manual „Introduction to **CadnaA**“).

The procedure is described in the following using building-polygons.

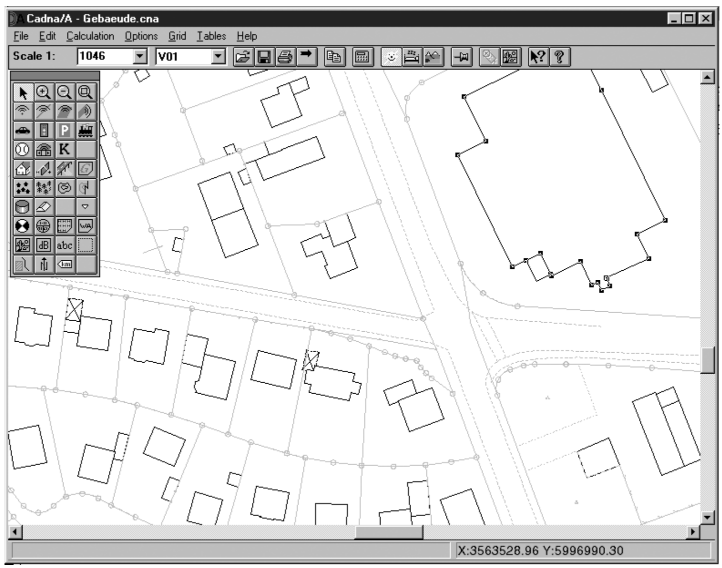


Initial situation: An imported DXF file where buildings are drawn with individual lines. Those have to be imported first as the object Auxiliary Polygon. Then the lines have to be connected to a closed polygon and are automatically converted to buildings afterwards.

5

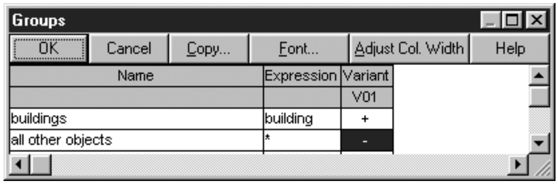
First import (see chapter 7.1) the third-party file with the corresponding file format into **CadnaA**. Make sure that the „open“ buildings are imported as object type **Auxiliary Polygon**.

After import delete elements which you do not need or use the group function (see chapter 14.1) to deactivate elements. When activating the command **Close Polygons**, all existing and activated auxiliary polygons are connected to the corresponding settings and converted to the object Building automatically.



The imported DXF file after transaction of the command **Close Polygons**. The buildings are now closed polygons.

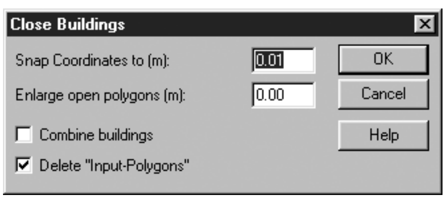
In the provided picture the „open“ buildings have the layer name „building“. This identifier appears in the ID box on the edit dialog of the object after being imported into **CadnaA**. Therefore, groups can be created quite easily.



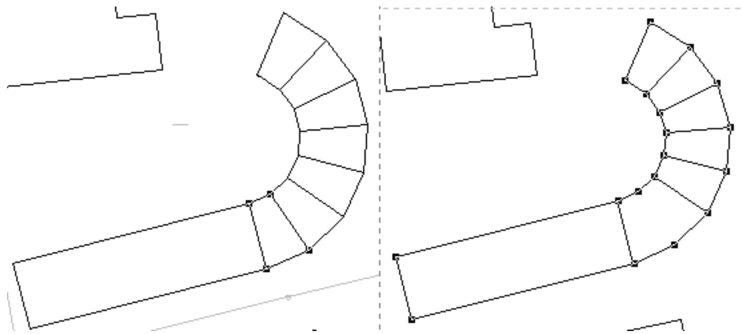
Group definition in **CadnaA**

The first group for the buildings is activated and the second group with the asterisk * in the field „Expression“ is deactivated for all remaining objects. Therefore only the lines are closed and automatically converted in the object Building with the identifier „building“ in their ID-box.

After clicking the command **Table|Miscellanous|Close Polygons** the following dialog appears with self-explanatory settings.

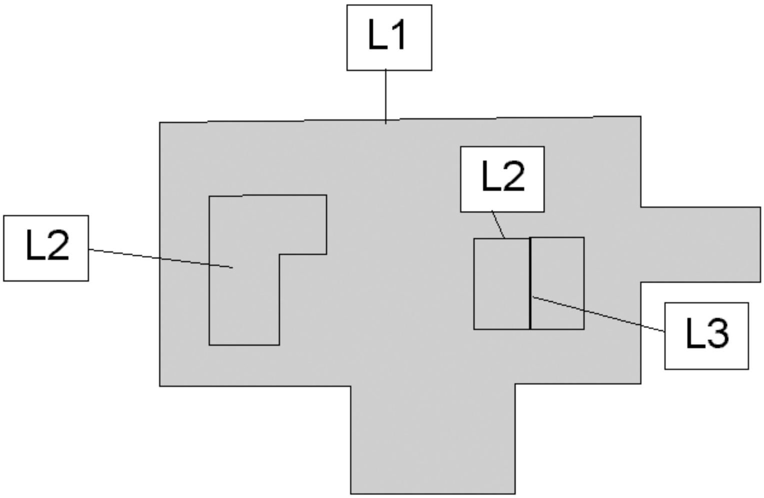


With the activated option „Combine Buildings“ terraces are combined to a single Building with barriers lying inside, replacing the indoor walls.



With the command **Close Polygons** the option „Combine Buildings“ has been activated for the buildings in the right-hand picture. For those buildings all indoor walls are replaced with barriers and the buildings are combined in a single building as a closed polygon. The objects in the upper left-hand picture are eight individual buildings. The option „Combine Buildings“ was not activated.

After combining the lines to generate a closed polygon and converting them into buildings, the original identifier (ID) is overwritten by an identifier containing the character L and a number, e.g., L1, L2, L3 etc. These identifiers indicate what has happened while connecting and combining auxiliary polygons to buildings or barriers.



L1	detached building or barrier
L2	building inside a building *or* barrier inside a building
L3	building inside a building inside a building *or* barrier inside a building inside a building etc.

So, just create groups to check whether the connection and conversion has been successful in all cases.

5.5.8 Delete Height Points

When the amounts of height points for a digital terrain model is too large and too detailed height points can be deleted by the command **Delete Height Points** on **Tables|Miscellaneous** menu. After executing the command and entering a height, the height points are deleted which deviate from each other less than the defined height. By this procedure the number of height points will be reduced accordingly.

The result does not depend on the sequence of points when being entered or imported. In order to decide whether a height point has to be deleted or not, based on the criterion entered, **CadnaA** compares with the resulting (!) terrain model and not with the existing one.

see chapter 4.4.1 Generate Contour Lines from Height points

Delete Height Points, Multifile-Import

Deleting height points can be achieved also when importing height point data. This feature enables to import even terrain models which exceed the default file size limit of 32 bit-systems (of 2 GBytes). To this end, select the command **Delete Height Points - Multifile** on menu **Tables|Miscellaneous**. Enter - as before - a height tolerance. After click on „OK“ an import dialog is opened giving access to several files of type „ASCII-Object“. Via the button „Options“ the import filter can be configured (see chapter 7.2.17 "ASCII-Objects").

Chapter 6 - Calculation

CadnaA enables

- the calculation of sound propagation according to standardized procedures

and

- with settings that are defined by the user.

This chapter deals with the second task and its possibilities with **CadnaA** and is therefore more concerned with the physical aspects of sound propagation. This is very important because **CadnaA** is used for expert work, in scientific work at universities and in lectures. Although the professional usage requires a strict application of the procedures fixed by standards and guidelines, it can be very useful the be able to process special calculation tasks which are not covered by the regulations in detail.

Especially, this concerns the handling of reflections with higher order. According to the standard procedures a reflection of the first order is only dealt with according to the mirror image method, So just a single reflection of a ray at a flat surface. In case more orders of reflections contribute to the total result (e.g. at the building facades on both sides of a road), this will be taken into account - in the majority of road and railway noise standards - by calculating analytically a correction for multiple reflections from the geometrical and acoustic parameters.

This strategy fails if the geometry of the building lateral to the road is completely different and varies from building to building. The same problem exists with the noise level in backyard locations. Those cases can just be treated by calculating higher orders of reflection.

6.1 Sound Rays and Reflection

CadnaA is able to calculate reflections completely up to higher order. It is clear that this increases calculation times, because the number of rays grow exponentially with this reflection order. With the possibility to show all these calculated rays at the screen, **CadnaA** is a very helpful tool when teaching about sound propagation.

The chapter chapter 6.1.1 "Sound Rays at Point Sources", chapter 6.1.2 "Sound Rays at Line and Area Sources" and chapter 6.1.4 "Reflection" treat the contents of a major publication, see reference /88/. It explains the way of segmentation of extended sources, like line and area sources and the projection technique applied with this. Furthermore, the calculation of multiple orders of reflections is explained, again applying the projection technique. It is worth mentioning that there are still some software packages available that do not apply any projection technique when segmenting area sources to assess the direct path. The partial levels of reflections evaluated with extended sources - like roads or parking lots - are arbitrary in this case and not conform to the specification found in the respective standards or guidelines.

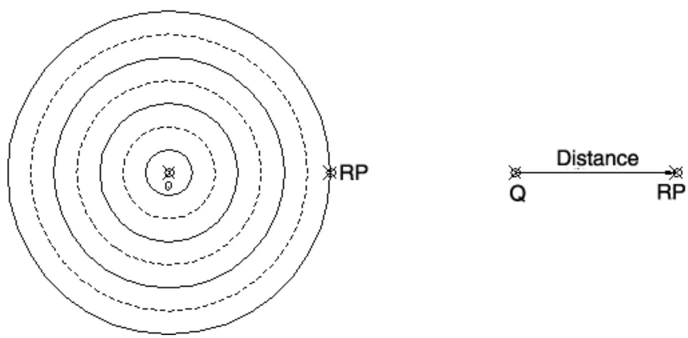
Chapter 6.1.7 explains how paths of rays can be displayed. Because of the selective display possibilities for the different orders (by using groups), the handling might look a bit complicated, but it is an excellent tool for clarifying the executed calculation and therefore can be helpful in a technical report in many cases. We recommend that the detailed examples be understood step by step. Once you have taken this initial hurdle the inclusion of ray representations in drawings and text documents is easily possible.

6

6.1.1 Sound Rays at Point Sources

In a physical sense a wave field goes out from a source Q which transports the sound power in all directions via the movement of the air particles. Because the surface of the spheres' hull expands with increasing distance, and the sound power is distributed over the hull over a certain period of time, the sound intensity decreases and therefore the sound pressure level, too. With increasing distance source - receiver it becomes quieter.

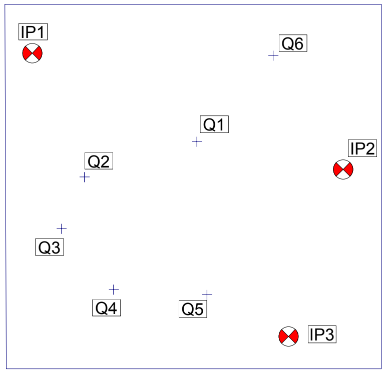
6



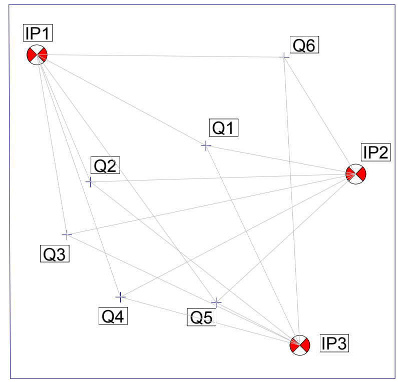
Sound propagation from Source Q to Receiver Point RP physical (left) and numerical (right)

If **CadnaA** calculates, the distance between source Q and receiver RP will be determined and, with the sound power level of the source, the sound pressure level at the receiver point will be calculated with analytical formulas which have been derived from the physical model. The wave field is in a certain way replaced by one ray from source to receiver.

If there are many sources there are also many sound rays which have to be considered in the calculation. For all receivers affecting sound rays the calculated proportion of the level will be added energetically.



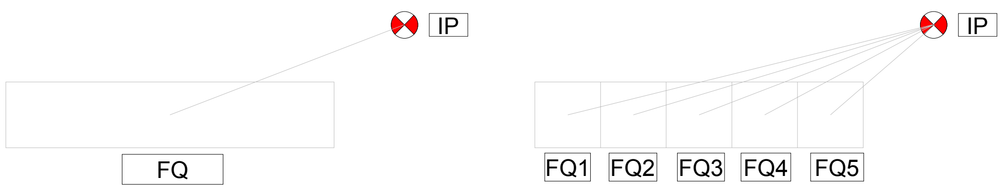
5 Sources and 3 Receiver (IP)



The Sound Rays

6.1.2 Sound Rays at Line and Area Sources

Even in the case of calculating the noise level from an extended source as the area source shown in fig. A, a distance has to be found that can be used in the equation of propagation. This may be wrong if the pivot of the extended source is used as starting point of the ray. Since, actually, each arbitrary portion of the area source emits sound, the same value of a level must result if the total stripe according to figure B is to be subdivided and the sound pressure level at the receiver point is calculated as the sum of the levels of the 5 contributions from the partial sources FQ1 till FQ5.



A: Area source with sound ray

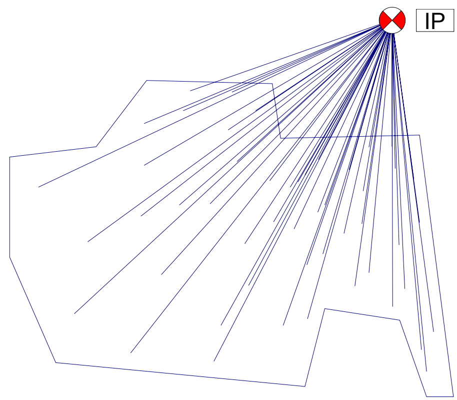
B: Partitioning of the area sources

However, the partial sources, according to figure B, result in different partial levels because of the different distances. On the basis of the energetic addition a higher sound pressure level results from fig. B than from taking into account only one ray emitted from the pivot as shown in fig. A.

This error has been avoided in **CadnaA** by partitioning each extended line or area source in sufficiently small parts for automatic calculation.

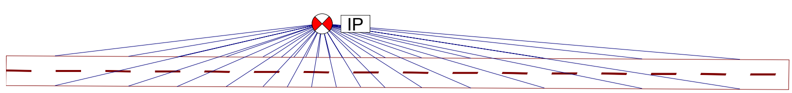
But these partial areas do not have the same size as shown in figure B. They become even smaller the closer the corresponding section of the extended source is to the receiver.

This dynamic division, which must newly be calculated for each receiver, leads to a considerably faster calculation in comparison to the equal division. The following figure shows the sound rays, which **CadnaA** takes into account, with the irregularly shaped area source provided below.



The sound rays of an area source considered by **CadnaA**.

The same applies to line sources. By the road shown in the following figure the borders of the stripe are the axis of the outer lanes which are each considered as line sources and taken into account in the calculation of level .



The sound rays of a roads considered by **CadnaA**.

6.1.3 Projection at extended Sound Sources

The automatic division of an extended sound source into smaller partial areas depending on the distance of the receiver (see chapter 6.1.2 "Sound Rays at Line and Area Sources") is not sufficient to avoid errors in the calculation of sound pressure levels.

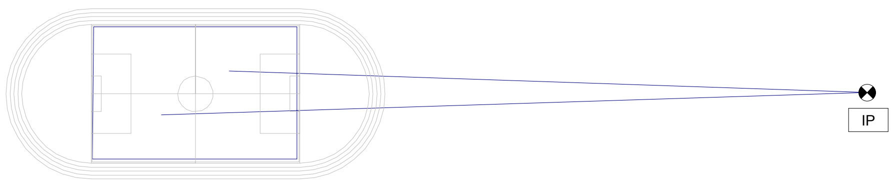


Figure 1: Calculation of the area source „soccer field“ with two sound rays

Let us take the example of a soccer field as in the upper figure. For a noise calculation at the remote receiver point IP **CadnaA** would split the soccer field into two partial areas and would therefore take into account two sound rays. This is correct for the shown situation.

Now a shielding club house with a height of 8 m is located in the position shown in the following figure.

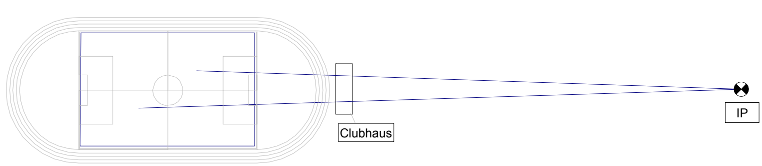


Figure 2: Soccer field with partially shielding club house

In the calculation of both displayed sound rays, screening and therefore a lower sound pressure level occurs in each case. But, in fact, not all partial areas, which are included in the calculation with the paths of the two rays, are shielded by the building. The resulting sound pressure level would be too low in the present example.

CadnaA avoids this error by using a projection method.

With that, in the first step the area sources will be divided into shielded and non-shielded areas and in the second step subdivided according to the relation of area size to receiver distance. In this way, in the present example, 12 partial areas are created: altogether, nevertheless, because of the large distance from the receiver (340 m), 8 areas are not shielded and 4 areas are shielded.

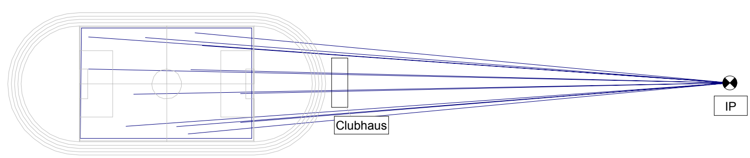


Figure 3a: Two step division according to shielding objects in the path of rays and the distance of the receiver

In the present example the calculation results in 44 dB(A) of free sound propagation according to figure 1, 39 dB(A) in the calculation of the situation with the club house without using the projection method according to figure 2 and 42 dB(A) with correct division resulting from the use of the projection method according to the figure 3a.

Figure 3b shows the projection method with a road

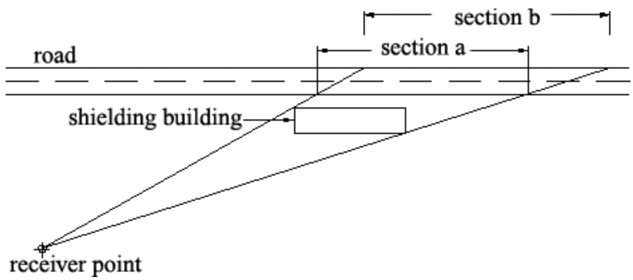


Figure 3b Projection method for a road

Both axis of the outer road lanes - that is the margin of the road stripe in the **CadnaA** presentation - are first divided according to the shielding objects between receiver and road. Then a subdivision occurs according to the distance criteria.

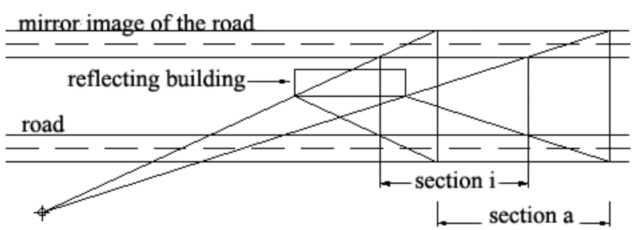


Figure 3 c: Projection method for reflecting sound parts

Much more complicated are the relations in the projection of the reflecting sound parts dealt with in the next chapter. Figure 3 c shows the construction of both sections for the axis of the outer road lanes which are necessary because of the reflecting building. The same method - graphically hardly to explain - will also be applied by **CadnaA** for the multiple reflections dealt with further on.

Although the projection method naturally extends the calculation considerably it should always be switched on for a detailed calculation like „acoustical zoom“. After all, even in the simple situation figure 3a, 12 paths of rays instead of 2 must be calculated.

6.1.4 Reflection

Additional sound rays appear in the sector of the path of sound propagation from reflective objects which affect the receiver and could increase the sound level.

The mirror-source method will be applied regularly by the calculation of reflection and it is therefore assumed that the reflective areas are „acoustically even“. In the experience of engineering the numerical calculation of diffuse reflection has only been achieved over the statistical approach for the density of scattering objects (see e.g. /82/). A numerically correct resolution for point-precise calculation with diffuse reflection is dealt with in /86/. But this is still a lavish resolution for the professional practice.

On the other hand the mirror-source method has been proved excellent for the propagation of sound, also in cases strictly without even areas. The propagation of sound including reflection up to an extremely high order has been described precisely (see to this /87/ and /36/) for industry halls in which the surfaces areas are anything but even (through extensions such as pipelines and so on).

6

6.1.5 Reflection of the 1st Order

The calculation of the first reflection is required by certain standards if this reflection contributes to the sound level at the receiver (e.g. according to the guidelines RLS90 /12/, Schall03 /18/ and ISO 9613-2 /7/).

The calculation occurs in three steps which have to be carried out for each reflective area according to each pair source (Q) - receiver (IP).

step 1: constructing the position of the mirror sources,

step 2: sectioning the connecting line of the reflected source - receiver point with an area and determining the breakhrough-point,

step 3: calculating the part of the sound level according to the longer path of the ray over the reflecting area including the absorption coefficient of this area.

In the example shown below two parts of sound level are taken into account at the receiver (IP) which are calculated from the displayed paths of rays.

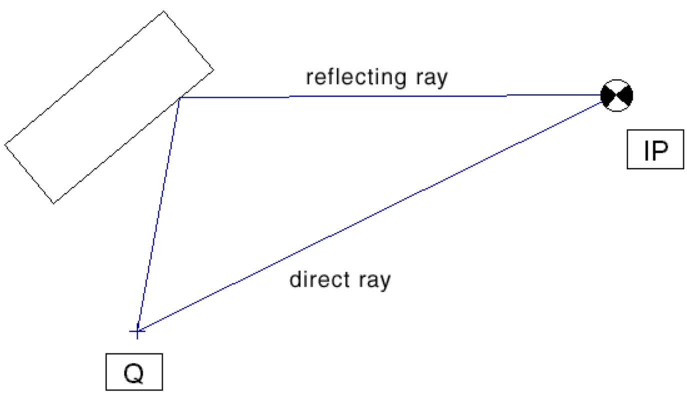


Figure A: The paths of rays with the reflection of the first order

Important for the correct calculation of reflection, according to the mentioned guidelines, is that all reflections of the first order be checked and, if necessary, be included in the calculation. That is not obvious - software programs exist which check, starting at the receiver, a ray only till the first reflector crosses the path of the ray in the plan, even if this reflector is not affecting anything because of the low height and the area lying behind which reflects the ray. The calculation of reflection must, as in the example of picture A, also find a level-raising contribution if, as in picture B, a low obstacle at the base seems to block the ray's path.

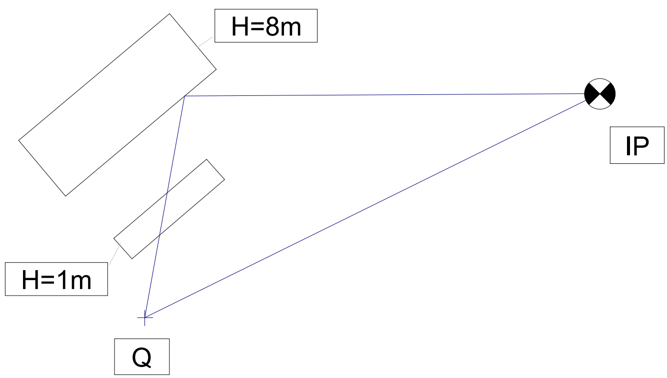


Figure B: The paths of rays for the reflection of the first order with obstacles in the path of the ray.

A typical example of this case is shown in figure C. The program only investigates up to the first reflector which is found, then at the house on the left side of the road the amount of reflection which is caused by the high building is not taken into account only because a 1 m high wall is located between this high building and the four lane road. This calculation is not in accordance with RLS-90 in this case.

Besides this, **CadnaA** takes into account reflections if screening objects obstruct the path of the reflected sound ray. The part of the sound level which was caused by the reflecting sound at the receiver point is then reduced by the value which results from the screening calculation for the path: mirror-source - receiver.

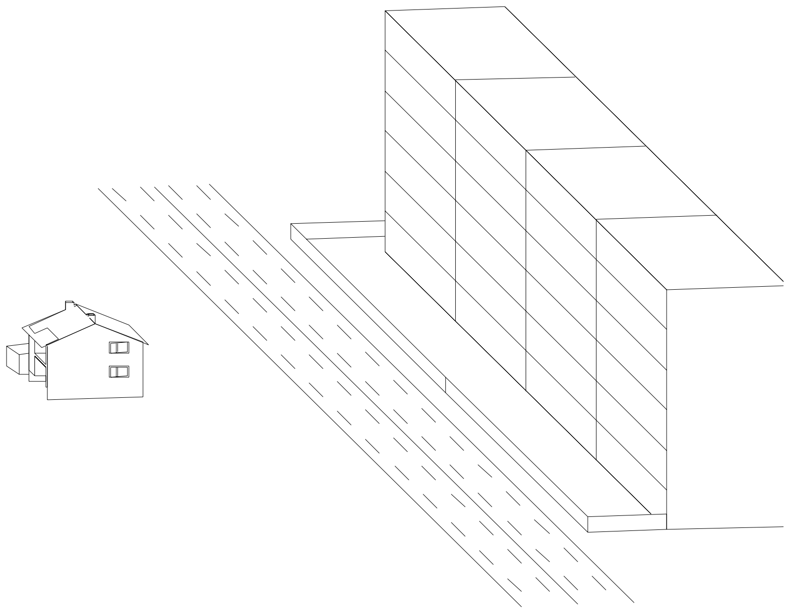


Figure C: For the calculation of the sound level at the left residential building, according to RLS90, the reflection of the traffic noise on the high right building has to be calculated despite the low wall between the road and the building.

CadnaA also calculates the reflection for extended sources such as line or area sources, but these objects will be split into sufficiently small partial sources. Figure D shows the already familiar soccer field with three buildings located in the neighborhood and the paths of rays taken into account.

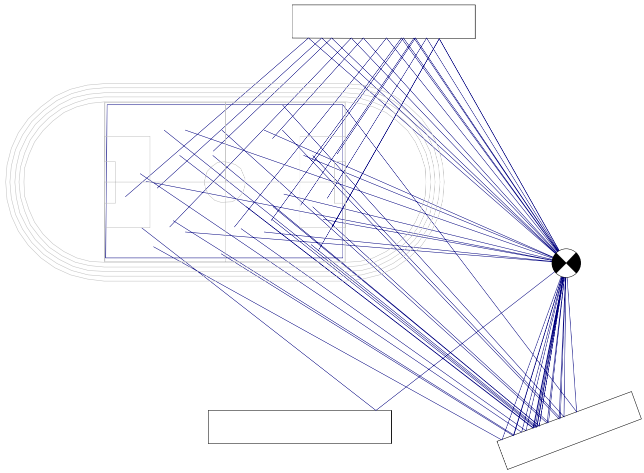


Figure D: The paths of rays taken into account in a calculation of sound levels on a soccer field

6.1.6 Reflections of Higher Order

In calculating reflections of second order all valid mirror-sources have to be reflected again on all reflecting areas to prove the validity of each reflection and to calculate the corresponding path of the ray.

The number of rays with a further order of reflection results from the product of the number of reflections from the last order multiplied by the number of valid reflectors. The specification of this numeric method is found in /86/.

It is obvious that the number of possible reflections explodes with an increasing number of orders. Calculations up to higher orders are only completely possible for very restricted arrangements. On the other hand, a reflection has to be calculated first before its contribution can be evaluated as irrelevant.

CadnaA enables the calculation of reflections of high orders for all type of sources. The paths of ray can be displayed and the sound level contributions of the reflections are separately identified. According to the specifications of the standards for the source type **Road** and **Railway** with activating these standards only reflection of first order are calculated using mirror-image method - reflections of higher order are taken into account with a penalty for multiple reflections.

An example for the complete calculation of reflection up to the 10. order is shown with the backyard in figure A. A point source located in front of the opening beams into the backyard, and the sound level shall be calculated at the represented receiver IP.

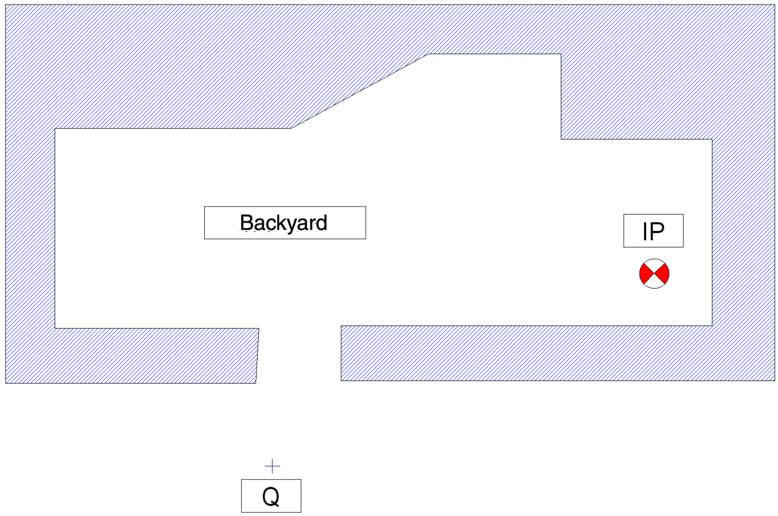
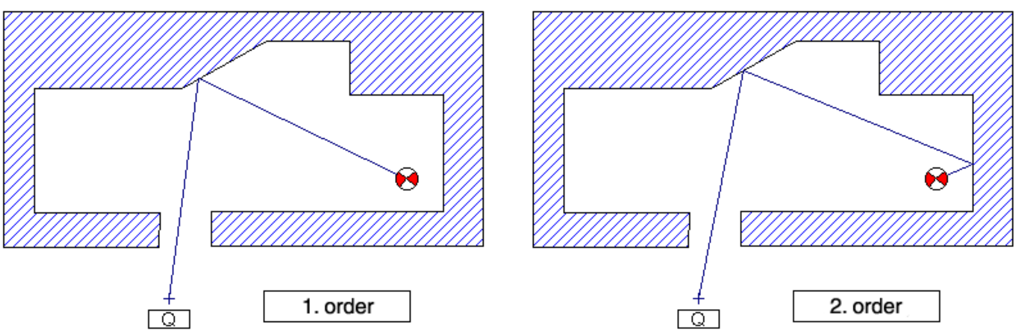
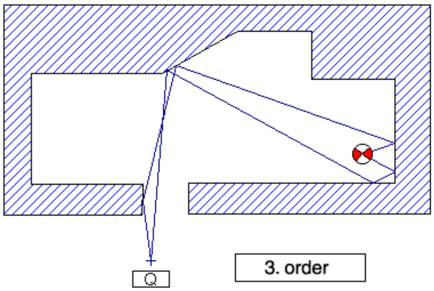
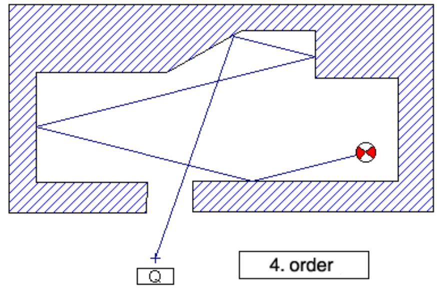
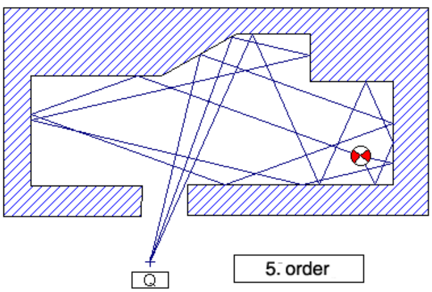


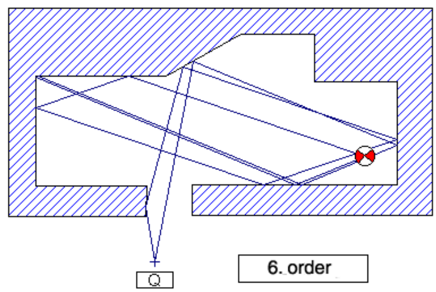
Figure A: Radiation in a backyard

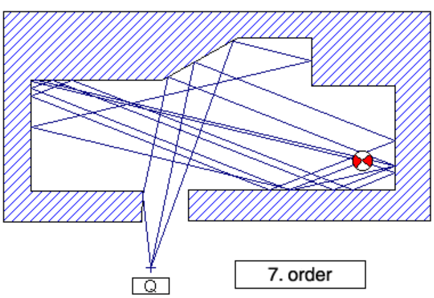


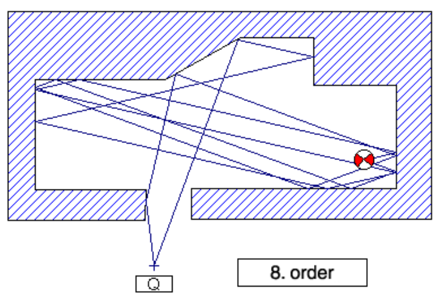

Q
3. order

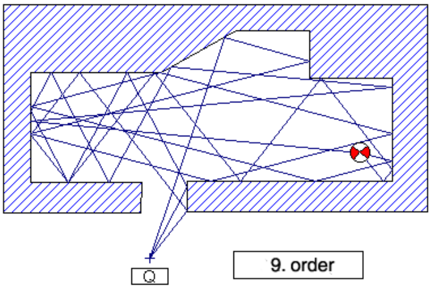

Q
4. order


Q
5. order


Q
6. order


Q
7. order


Q
8. order



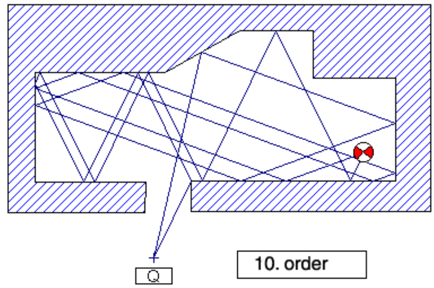


Figure B: All paths of rays for each individual order of reflections in the backyard

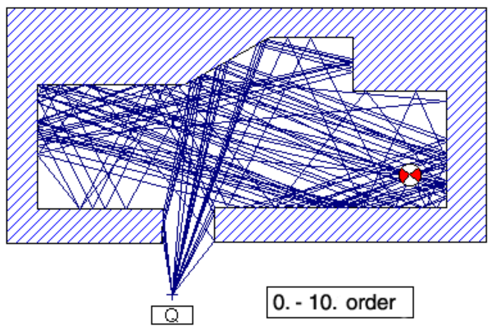


Figure C: All possible paths of rays in a calculation up to the 10. order

Arbitrary arrangements of objects can be taken into account for a calculation of reflections. With this technique it is possible to perform the calculation of the sound level corresponding to the reality in cases not corresponding to the valid guidelines.

6.1.7 Displaying Sound Rays

If **Generate Rays** is activated in the edit dialog of a receiver point all calculated rays with this target point are inserted as auxiliary polygon lines. With double-click on such a ray its contribution to the sound level at the receiver is indicated. This sound contribution is shown in the field **ID** with its proportionate level, e.g., `RAY_419_00` which signifies that the direct sound ray (_00) contributes 41.9 dB.

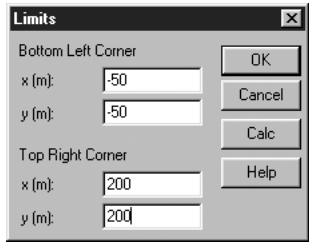
The rays are shown on screen as if they cross screening objects straightly - nevertheless screening is calculated taking into account vertical and lateral diffraction. In this case an ***s*** will be attached in their identifier. A shielded ray of the eighth order for which a calculation of diffraction has been enforced may have an identifier `RAY_419_08`s.

On this base, rays with a certain order of reflection can be displayed or switched off easily in **CadnaA** with the efficient group function (**Tables|Groups** see chapter 14.1 "Groups"). If the rays are displayed, all diffracted sound rays can be switched off in the representation by deactivating the group with the expression `*_??s`.

With corresponding settings for all deactivated objects in **Options|Apperance** (see chapter 9.6 "Object Appearance") you can enforce the diffracted and non-contributed, mostly irrelevant rays to disappear completely.

But the best is learning by doing - trace step by step the following example.

- Start **CadnaA**
- In **Options|Limits** enter the values for the limit as shown in the following dialog.



Insert the following objects

- Point source with **PWL** 100 dB, Name Q1 - coordinates 20/5/5

- 2 buildings with a height of 25 m and **Reflection loss** of 0 dB:

  building 1 (80/60, 85/60, 85/100, 80/100)
  building 2 (0/130, 5/130, 5/160, 0/160)

- Click in the toolbox on the icon and enter the value 80 via the keyboard - hereby an edit dialog opens to enter a polygon point - press the TAB-key and enter the value 60 - confirm with OK and enter the next value for the second pair of coordinates.
- After inserting the coordinates of the first building, quit the insertion mode by clicking with the right mouse button.
- Again with the right mouse button, click once on the line of the building plan - the edit dialog opens.
- Click on the button **Geometry** and enter a building with a relative height of 25 m.
- Repeat this for the second building. The building height is adjusted automatically.

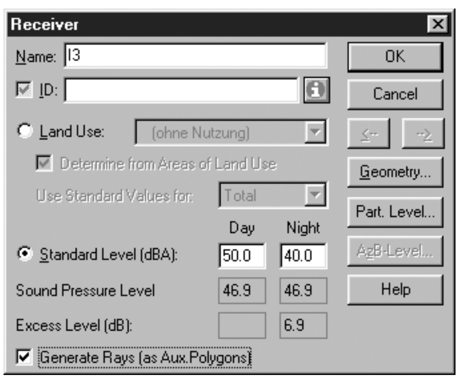
- 2 Receiver points:

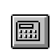
  I2 (35/110/5) and
  I3 (35/170/5)

- Click on the corresponding icon in the toolbox
- Enter the coordinate via keyboard and close the edit dialog **polygon point** by clicking **OK**
- Open the edit dialog by clicking with the Right mouse key on the margin of the receiver point.
- Confirm with **OK**.
- In **Calculation|Configuration|Reflection** adjust a **max. reflection order** of 2 or more

The rays for the receiver I3 shall be displayed.

- In the edit mode, open the edit dialog for receiver I3 by double-clicking on its border and activating the option **Generate Rays**.

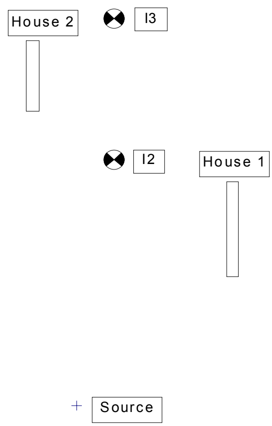




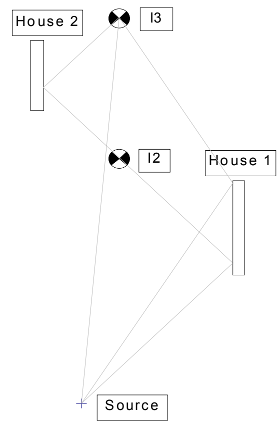
- Now start the calculation with a click on the **Pocket Calculator** in the icon bar.

6

The following representation occurs after the calculation. **CadnaA** has calculated the direct ray, a reflection of the first order and a reflection of the second order. (**CadnaA** calculates reflections completely up to the specified order - shall we bet that there are no more possible paths?)



The scenario



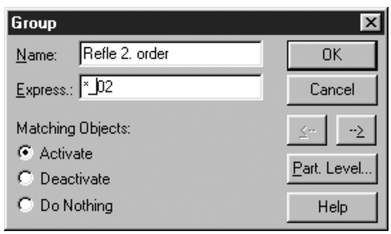
after calculation and display of rays

After double-clicking a ray - or by **Tables|Other Objects|Aux.Polygon** - you can identify the rays on the basis of its **ID,** e.g., `RAY_419_00` which means that the level contribution of this ray is 41.9 dB and the last two digits indicate the order of reflection. Double zero is the direct ray without reflection, 01 is a reflection of the first order, 02 of the second order and so on.

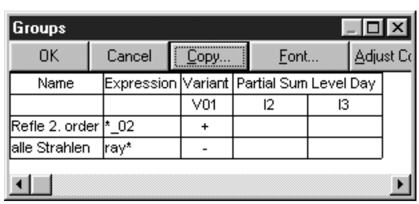
☝ Now pay attention to the possibility of **CadnaA** in the tables - if you click on a data record, e.g., of the table **Other Objects|Aux. Polygon** the corresponding ray in the diagram will be marked and can easily be identified.

Now only rays of the second order shall be displayed . This is in our example simplified by directly switching off the non-desired ray in the corresponding edit dialog on its **ID** field. But the deactivation of rays described in the following way is, however, with complex layouts the only realistic alternative.

- Insert in **Tables|Group** a new table row (press the INS-key), double-click it and enter the expression *_02 in the same-named field and confirm with OK.



- Insert a second line after the first one and enter the expression `R*` .



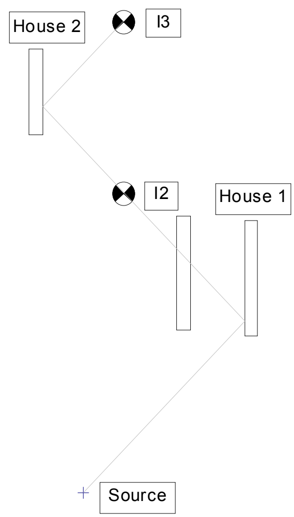
- Deactivate this group (just enter a minus character - in the column Marking „M.“). After confirming with OK you will only see the desired group with rays of the second order.

Examples\
06_Configuration\
DisplayRays.cna

If the deactivated rays are displayed as bright grey dashes, let them disappear completely - this representation would still cover all activated rays in more complex situations. For this, use **Options|Appearance| (deactivate)** see chapter 9.6 "Object Appearance".

To get to know the deleting of rays and the handling with shielded rays we recommend you do the following exercise.

- Activate all groups again in **Tables|Group**
- Click on the House 1 and copy it in a position with a left offset so that only a ray of the second order is intersected (see following figure)



The rays need not to be deleted. Just restart the calculation and the rays are updated.

Now start a new calculation - click on the **Pocket Calculator** in the icon bar. The ID of the ray which intersects the new building now contains the identifier `RAY_220_02S`. To eliminate only the shielded rays from the representation

Examples\
06_Configuration\
DisplayRays2.cna

- insert a new row in **Tables|Group**, enter `*s` in the field expression and deactivate this group. The shielded ray disappears.

Maybe you should save this file as a default file for some tests on your own and open this file if you want to create such situations. You can delete all existing objects before. The correct groups then exist and you only need to change the order of reflection in the middle row to display all orders of reflections, one after the other.

6.2 Configuration

In developing **CadnaA**, it was, and continues to be, our goal to give the professional user the desired freedom of choice and control while relieving those only interested in overall results from having to master all the available options. This complexity and flexibility of **CadnaA** is particularly evident when large stocks of data have been entered which are then to be processed under the **Calculation|Configuration** menu.

To meet the requirements for the calculation according to EC-Directive on Environmental Noise **CadnaA** offers a flexible concept for defining and calculating evaluation parameters (see chapter 6.2.5). This concept enables to select from a number of pre-defined evaluation parameters (levels for single or combined time intervals) and some more specific parameters (such as the uncertainty Sigma). Furthermore, you may define your own evaluation parameters using formulas.

In **CadnaA** up to four evaluation parameters can be calculated simultaneously, either for single receiver points or in a receiver grid (in addition to the ground).

The dialog **Calculation|Configuration** serves to specify all settings required for the calculation, and, quite conveniently, to save these settings with the calculated project file. There are various tabs for groups of options within this dialog. Click the tab for the desired group to specify and select the options.

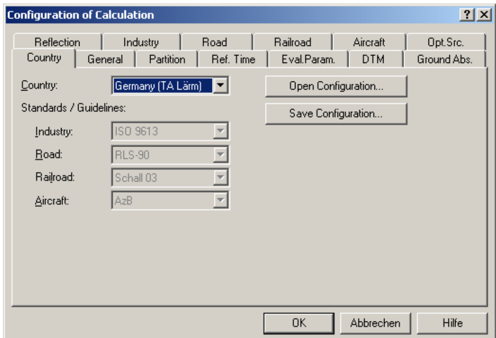
By way of example, the tabs are described here for application of the German guidelines. They apply accordingly to those of other countries.

also see chapters:
5.1.2 Calculation at Receiver Points & Presentation of Results
5.3.2 Grid Calculation
14.7 Batch Operation
14.8 PCSP - Program Controlled Segmented Processing

6

6

6.2.1 Country Tab



Country

From the list box „Country“ a country’s name or a group designation is selected where specific standards or guidelines for all noise types are linked to. In the list boxes for „Industry“, „Road“, „Railway“, and „Aircraft“ the respective guidelines/standards used in a calculation are displayed.

Option „user-defined“

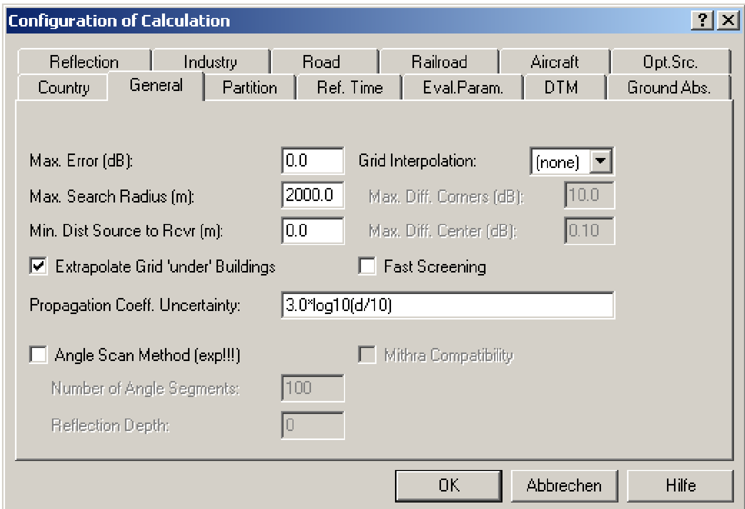
When selecting the option „user-defined“ from the list box „Country“ a calculation procedure - depending on availability - can be selected for each noise type individually. Please consider that all standards/guidelines are linked to a group designation „Country“. Depending on the selection the further configuration tabs and the available options differ.

Open/Save Configuration

Via the buttons „Open Configuration“ and „Save Configuration“ the configuration settings (including all settings on all further tabs) can be opened and saved.

see also chapter 14.10 Prototype File

6.2.2 General Tab



max. Error (dB)

Sound sources, whose contribution to the sound immission at the receiver point is negligible, will be disregarded in the calculation if the overall error induced by this simplification is not larger than the defined value. Therefore, the larger the maximum permissible error in the final result, the shorter the time required for the calculation.

For expertise work and not very large projects the setting 0 should be chosen. If noise maps of cities are calculated a value of 0.5 or 1 should be a good compromise.

max. Search Radius (m)

The search radius defines a circle around the receiver point. Only sound sources within this circle will be considered in the calculation. This is helpful with very large projects - 2000 m maybe a good choice in those cases.

Min. Distance Source to Receiver

The minimum distance source to receiver point serves to avoid calculations near the area around a sound source.

Uncertainty

In **CadnaA** you also have the possibility to evaluate the accuracy of noise prediction. This accuracy depends on the accuracy of the emission values used and the accuracy resulting from the calculation of propagation.

Propagation Coefficient Uncertainty

In addition to the uncertainty of the emission levels you also can take into account the uncertainty of the propagation calculation (meteorology etc.). For that enter the corresponding value in the box **Propagation Coefficient Uncertainty**.

6

By default, a standard deviation depending on distance is used:

σ_D = 3*log10(d)/10) in dB

where the propagation constant is k=3 and d the distance source-receiver (reference distance 10 m).

For example, in a German country it is required that for noise predictions by wind turbines the following expression for the propagation uncertainty shall be used:

σ_D = 2*log10(max(d,10)/10)-3 in dB

The expression „max(d,10)" means that it holds: d>=10 m.

In this input box the Examples abbreviations are used:

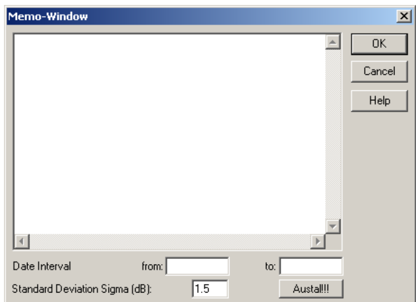
- d: 3D-distance source-receiver
- d2: 2D-distance source-receiver

plus all further operators for expressions available in **CadnaA**.

☝ By default, a specified sigma or a propagation coefficient uncertainty does not alter the calculated sound levels. To achieve this a suitable expression has to be defined on tab „Evaluation Parameter".

Standard Deviation

To take the uncertainty into account you have to enter a **Standard Deviation sigma in dB** in the Memo Window (see manual "Introduction to **CadnaA**") of all noise sources. If the sound power level of the source has been measured, this is the standard deviation according to grade 1, 2 or 3 (see ISO 3740 series).



The Memo-Window in the Edit Dialog of a Source

Sigma

Make sure that you have chosen at least one of the evaluation parameter SIGMA (for day | evening | night) in the tab „Evaluation Parameter“.

After confirming the dialog with OK and executing the calculation with **Grid|Calc Grid** (see chapter 5.3) you get the distribution of uncertainty in a grid.

The calculation of sigma for single receiver points (see chapter 5.3) is executed with the command **Calculation|Calc** or by clicking on the calculator on the symbol bar. You can display the sigma for the receiver points either in the **Result Table** (see chapter 11.2) choosing the expression e.g. Level SigmaD (for sigma day-time) from the column list in the dialog of the Result Table or in a label (see manual "Introduction to **CadnaA**") directly at the receiver point.

Samples\Infos\Uncertainty.pdf

In /83/ is showed how the uncertainty of calculated assessment levels and the uncertainty of calculated noise propagation can be determined. The application of the system realized in **CadnaA** is demonstrated in this publication with an explicit example.

Extrapolate Grid Under Buildings

Selecting this option will generate "seamless" transitions from the horizontal projection of an object to colored areas and lines of equal sound levels regardless of the calculation grid selected (e.g with the objects „Building“, „Area Source“, and „Parking Lot“). This is achieved by interpolation of the levels calculated for the grid points (see chapter 5.3.3 Grid Appearance).

We recommend, however, that you deactivate this option before the calculation if lines of equal sound level are to be displayed with the option „Exclude Grid under Buildings“ active (see Chapter 5.3.1 Absatz "Exclude Sound Sources/ Buildings").

Grid interpolation

If this option with the settings n*n is selected, then a calculation is made at each of these (n+1) points of the specified grid points (menu **Grid|Specification**), in the first step only and at the pivot of every rectangle, limited by 4 points.

If one of the following conditions is not fulfilled for one of the 4 edge points and the center point of a n*n arrangement of grid points then this rectangle is subdivided into 4 equal quadrangles and, for each quadrangle, the same test is again performed. If one of these conditions is still exceeded, then a further subdivision recursively occurs until the conditions are fulfilled or all points, in accordance with the grid specification, are taken into account in the calculation.

Conditions:

The conditions are:

1. The mean level calculated from the levels at the 4 edge points should not differ from the level at the center point more than the specified maximum deviation (default setting 0.1 dB). This must be fulfilled for both diagonal lines.
2. The difference between the largest and the smallest calculated level

at the 4 corner points of the rectangle is, at most, equal to the specified maximum value (default setting 10 dB).

If these conditions are fulfilled, then the interpolated values match the real values inside the rectangle sufficiently and the levels at the remaining points inside the rectangle are interpolated from the levels calculated at the 4 corner points.

fast Screening (exp.)

You can use this approximation method to accelerate advantageously the time consuming calculation of diffraction for road and railway traffic with many buildings.

In the calculation of diffraction you only take into account objects which protrude into a predefined graduation of a parabolic ray - low buildings will not be checked in this way at all.

If this option is activated obstacles which are not cut by the ray are not displayed in the cross-section (see chapter 9.12) either.

☝ This method should not be used for the calculation of point, line and area sources according to VDI 2714 /33/ or ISO 9613-2 /7/.

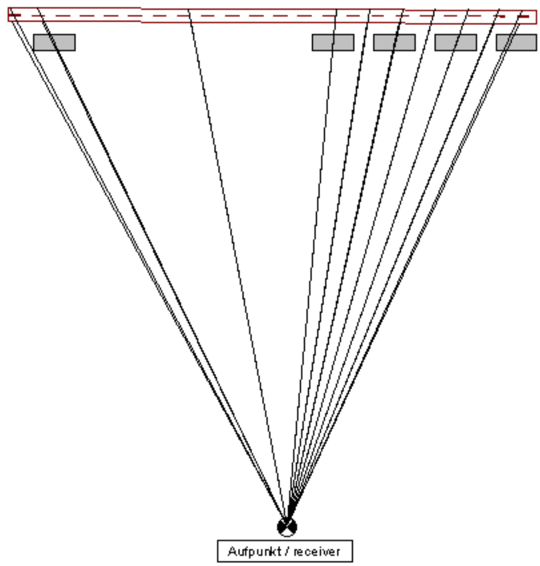
Selection of calculation method: Ray Tracing (RT) and Angle Scanning (AS)

Basically two methods or calculation strategies are used by noise prediction software - the Ray-Tracing or the Angle Scanning model. **CadnaA** is the only software program which both models offers to use. The Ray-Tracing model is used by default.

Ray Tracing (RT)

The ray paths between sources and receivers are constructed deterministically. Extended sources are subdivided dynamically using the projection method. The parts covered by a single calculation ray are smaller in small distances and larger in large distances. Screening objects and all gaps between them produce one ray minimum.

With deactivated option **Angle Scan Method** the Ray-Tracing model is used.



Ray-Tracing-model - with projection - extended sources subdivided dynamically

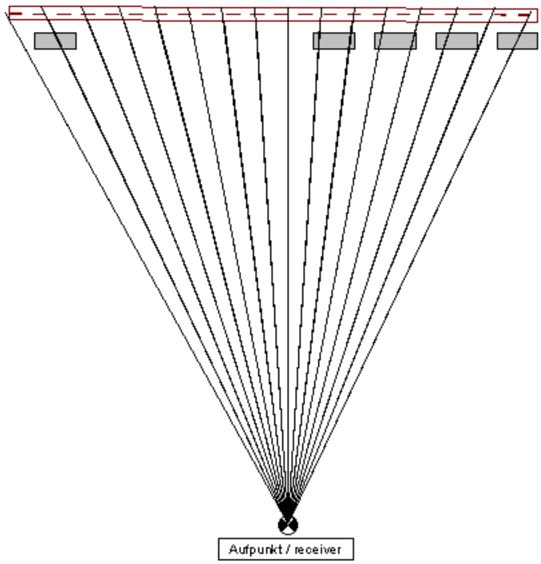
Angle Scanning (AS)

With activated checkbox **Angle Scan Method** the following described method is taken into account.

It was additionally implemented to be compatible with Mithra a french software program (CSTB).

Calculation of the level at a receiver point is done by rays starting from the receiver and spaced in equal angle steps. Only objects crossed by the ray are taken into account in the calculation. Point sources in the angle cone are virtually moved to lay on the calculation ray.

6



Angle Scan Method - Rays starting from the receiver and spaced in equal angle steps

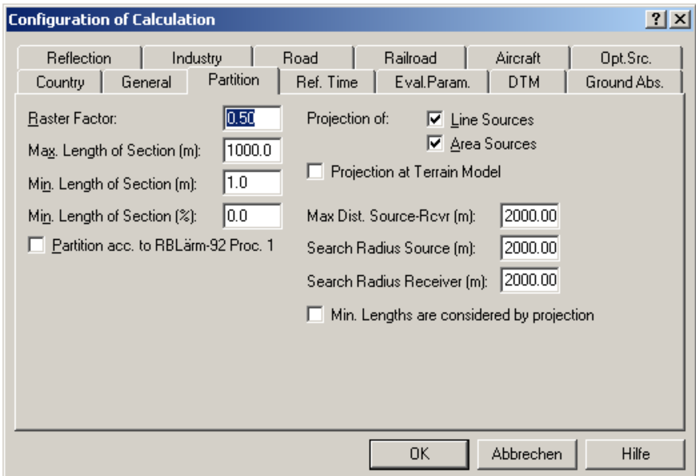
Mithra Compatibility

When **MITHRA Compatibility** is activated, all the approximations used in Mithra are also used in **CadnaA** - this is the mode that should be used if existing MITHRA projects are loaded and the results in **CadnaA** should be the same.

☝ The checkbox is only available if the option **CadnaA**-Mithra is purchased.

By Mithra compatible calculation among others additional screening will be taken into account which has been investigated due to a complex physical method. See also the barriers with special crowning in CadnaA (see chapter 3.3.2).

6.2.3 Partition Tab



Raster Factor

For line sources and area sources the largest dimension of a section, generated by splitting, equals the product of the grid factor and the distance of the centre of the section from the receiver point.

Length of Section

You may specify the ***max***imum and ***min***imum section lengths to be generated by automatic splitting. The **min.** section length may also be given as percentage of the total length.

Partition Acc. to RB-Lärm 92, Method 1

Method 1 is the so-called "precise" method according to /15/, which yields the longest possible sections.

Projection of:

When this option is activated, the calculation will be executed by projecting the obstacles and applying the propagation rules. Otherwise, only propagation rules will be considered in the calculation.

Extended sources such as line or area sources will be - according to the normative requirements - divided into such small elements that their biggest expansion is smaller than the distance of source-receiver points when multiplied by the **Raster Factor**.

If the option projection is activated, also a pre-partitioning of shielded and non-shielded elements takes place before the partition according to criteria of distance (pre-partitioning of all rays of sound from the immission point to both outermost points of each shielding object).

For noise maps of cities it is recommended to deactivate this option to accelerate the calculation.
See also chapter 6.1.3 Projection at extended Sound Sources.

Min. Length considered

Min. Lengths are considered by projection can be checked optionally.

If so the projection method wouldn't create smaller sections as defined in the fields **Min. Length of Section**. The bigger value would be taken into account which would result from the both fields **Min. Length of Section** in **(%)** or **(m)**.
This could accelerate the calculation.

Projection at Terrain Model

With this option also elevated areas defined by **Contour Lines**, are also taken into account in the pre-partitioning of line and area sound sources.

Maximum Distance Source-Receiver:

If the receiver point is further away from the source than the entered distance then no projection is taken into account.

Search Radius Source:

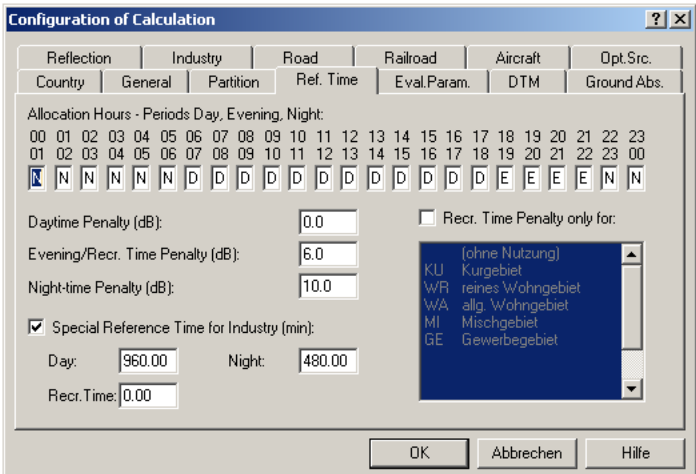
For the partitioning of sources according to the projection requirements the only obstacles which are taken into account are those within the entered distance from the source.

Search Radius Receiver:

For the partitioning of sources according to the projection requirements the only obstacles which are taken into account are those not as far from the receiver point as the entered distance.

6

6.2.4 Reference Time Tab



Reference Time:

The average level of sound pressure over a period of time is to be computed, taking into account the actual duration of the sound impact from a source in accordance with the basic requirements for the evaluation.

To calculate the noise indicators at single receiver points with **CadnaA** according to the requirements of a guideline the configurations of the calculation have to be preset (menu **Calculation|Configuration**). On the tab **Reference Time** the required settings for the reference times and the assignment of each hour of the day with respect to the intervals day/evening/night can be selected.

☝ The calculation of the noise indicators Lde, Ln and Lden is possible with the standard version of **CadnaA**. However, the evaluation and the assessment of the number of people living in dwellings with a certain noise level applies with the method "Object Scan". Prerequisite is the **CadnaA** option XL.

The reference time is applied for all noise types and concerns primarily the combined evaluation parameters like L_{den}, L_{de}, L_{dn} and L_{en} (see chapter 6.2.5). For the single evaluation parameters like L_d, L_e and L_n no time correction is taken into account except by industry sources if the **Operating Time** is activated and an operating time is entered in the industry dialog.

Allocating Hours/Time Periods

In the 24 input boxes in the dialog each hour is assigned to the three time intervals day/ evening/ night. As variables the letters ***D*** (daytime), ***E*** (evening), and ***N*** (nighttime) can be applied. Enter the corresponding letters respecting the requirements of the relevant guideline. From the assigned time intervals it follows for which relative parts of the day the corresponding penalties have to be considered.

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It is not mandatory to fill all fields with letters you can let them empty and you can write either with capital letters or lower cases. Therefore if you like to calculate the loudest hour at night-time according to TA-Lärm it is sufficient if you enter only one ***N*** (and of course in the industry dialog you have to activate the checkbox **Operating Time** and you have to enter the operating time in minutes during this loudest hour in the field Night).

Penalties

Penalties are only taken into account for combined evaluation parameters like e.g. L_{de}, L_{dn} etc. Enter the desired penalty according to your requirements, e.g. according to the definition of L_{den} enter penalties for **Evening/ Recr. Time Penalty** 5 (dB) and for the **Night** 10 (dB).

With all these setting both total levels for single receiver points and for grids will be calculated.

Special Reference Time for Industry

On the lower part of the tab **Reference Time** special reference times for industrial sources can be entered (in minutes).

This option is interesting if standards or guidelines require not the whole hour but e.g. a half hour (30 minutes).

This option has also an historical meaning - it assured the compatibility with projects calculated with older **CadnaA** releases. If an older project is opened this option and the option **Compatibility Mode for Industry** from the **evaluation parameter** tab are activated.

☝ With the option **Special Reference Time for Industry** activated the allocation of hours (see further above) is ignored and the entered time intervals are considered.

The default value is 960 minutes (16 hours) for the daytime (the evening is considered being a part of the daytime), 480 minutes (8 hours) for the night-time - these times have been the default settings in older releases of **CadnaA**.

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Therefore if e.g. the loudest hour of the night is to be calculated as required by TA-Lärm you can either enter the reference time here for night 60 minutes or alternative above in the dialog **Allocation Hours** with only one ***N*** for one hour. The operating time in the source dialog must then, of course, be the operating time of the source during this loudest hour in both cases.

You will find further information about the EU directive and **CadnaA** in the three files **RefTime_Eval_1/2/3.PDF** on your CD in directory **Examples\Tutorial\Configuration**.

Examples\Tutorial\Configuration\RefTime_Eval.PDF

Recreation Time Penalty only for

If this option is activated, you can select the areas for which to calculate recreation time penalties. This is only possible if

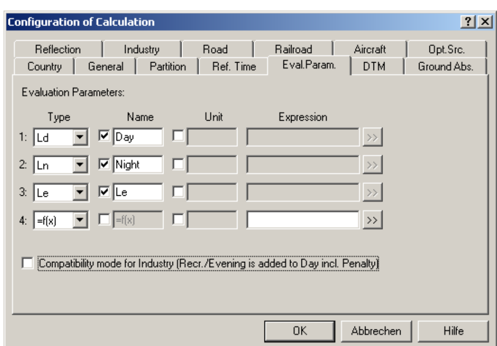
- areas of designated land use have been specified using the object **Area of Designated Use** from the toolbox
- or receiver points have been assigned to a type of land use on the dialog **Receiver**.

In accordance with the requirements of the German TA-Lärm, this option allows you to apply the recreation time penalty only to "general" and "purely" residential areas while excluding mixed and industrial areas.

6.2.5 Evaluation Parameter Tab

To meet the requirements for the calculation according to EC-directive on environmental noise **CadnaA** offers a new concept for defining and calculating evaluation parameters. Besides a multitude of pre-defined noise levels (for single or combined time intervals like L_{den}, L_{de}, L_d etc.) also further evaluation parameters (like uncertainty *sigma*) are selectable. Furthermore, you may define your own evaluation parameters by using formulas. The following evaluation parameters can be selected or entered:

- noise levels for single time intervals: Ld (day), Le (evening), Ln (night)
- noise levels for combined time intervals: Lden, Lde, Len, Ldn
- uncertainty for time intervals: SigmaD (day), SigmaE (evening), SigmaN (night)
- number of flight movements above a threshold level: NATd, NATe, NATn
- uncertainty for the number of flight movements above a threshold level: SigmaNATd, SigmaNATe, SigmaNATn
- formulas (total noise levels or noise type specific, day|evening|night, single number value or spectral values, total level or levels in octave, linear/A-/B-/C- or D-weighted)



Evaluation Parameter tab on menu **Calculation|Configuration**

If no formula is entered (which would exclude noise types for calculation) all defined evaluation parameters will be calculated for all existing noise types.

In **CadnaA** since release 3.5 can be calculated simultaneously up to four evaluation parameters either for single receiver points or in a receiver grid (additionally to the ground).

List box Type

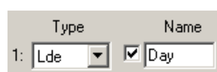
Select from the list box **Type** the evaluation parameter you like to calculate. In the corresponding dialogs, like e.g. receiver point edit-dialog, up to four evaluation parameters are displayed depending on how many you have defined.

The evaluation parameters according to e.g. TA-Lärm are **Lde** (noise level for day- and evening-time) and **Ln** (level night-time) or one parameter according to EC-directive e.g. **Lden** (for the day-evening-night index).

The evaluation parameters are internal serially numbered with alias LP1, LP2, LP3 and LP4 starting with the initial field. With these alias you can refer to in formula or expression.

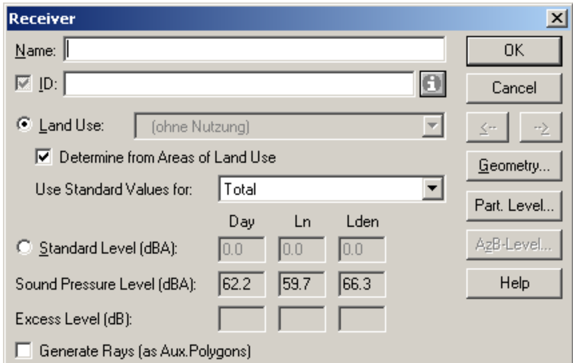
Field Name

In the list box **Name** you may enter an user-defined expression (alias) for the selected evaluation parameter, e.g. *Day*. You have to activate the checkbox on the left hand side of the field before you can enter an alias..



Field Type with selected noise index Lde and activated field Name with an entered user-defined alias „Day“.

With the checkbox **Name** activated the alias of the evaluation parameter will be displayed in the corresponding dialogs instead.



Receiver points dialog with three defined and calculated evaluation parameters - the first parameter with an alias.

Unit Field

Additionally in the field **Unit** you may enter an identifying item (e.g. dB(A) or sigma) which will also be displayed if the checkbox is activated.

Expression Field

If you have chosen the type formula **(=f(x))** from the list box **Type** you can either enter an user-defined formula and/or you can define one with pre-defined expression by clicking on the double arrow on the right-hand side of the expression field..

With the example formula the noise level index Ld will be calculated only for industry sources spectral and linear weighted.

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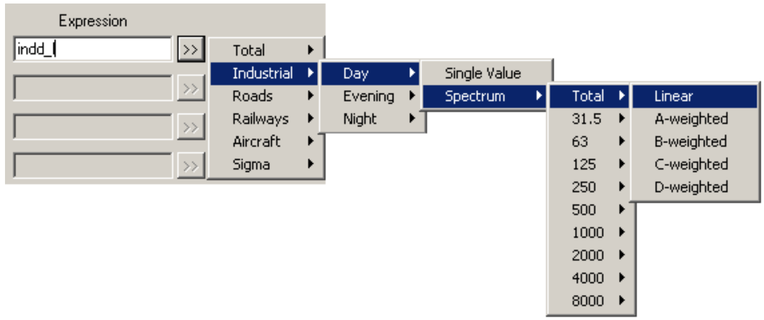

If you click on the double arrows you open sub-lists with pre-defined formulas.

With these pre-defined expressions and corresponding operators you can define your own formulas. In case an error occurs within an expression the value -88 will result for that evaluation parameter.

Examples\Tutorial\Configuration\RefTime_Eval.PDF

You will find advanced information about reference time and evaluation parameters with **CadnaA** in the three files **RefTime_Eval_1/2/3.PDF** on your CD in directory **Examples\Tutorial\Configuration**.

Compatibility mode for Industry

This option is implemented to be compatible with files calculated with older releases of **CadnaA**.

This option is active automatically (together with option **Special Reference Time for Industry** on **Reference Time** tab) if these files are opened because the time interval **day** (Ld) includes the evening and the penalties accordingly. Therefore this option can only be used with single evaluation parameters like Ld but not with combined evaluation values like Lde. In the last case an error message would occur with the possibility to change the evaluation parameter.

☝ Please consider that with option „Compatibility Mode for Industry“ activated the specification of the operating times for industrial sources (point, line, area sources) are mandatory, also and in special when the sources are operating permanently. In this case, the entered operating times equal the entered reference time intervals (dialog **Configuration**, tab “Reference Time“). The penalty for the recruitment is just considered in this case and not when the option „Operating Time“ on the source’s dialog is deactivated.

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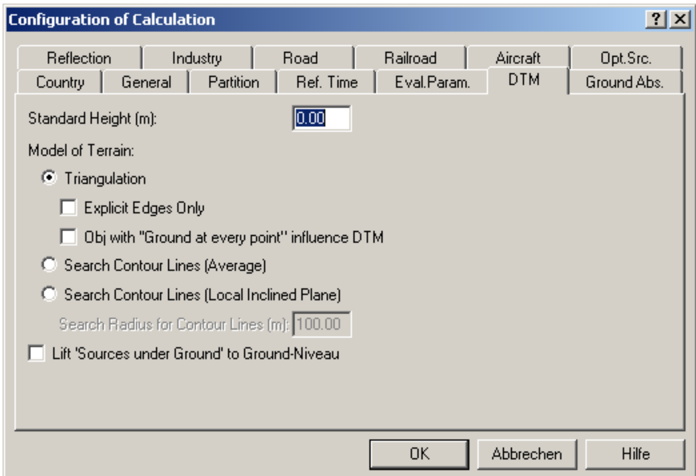
6.2.6 DTM Digital Terrain Model Tab

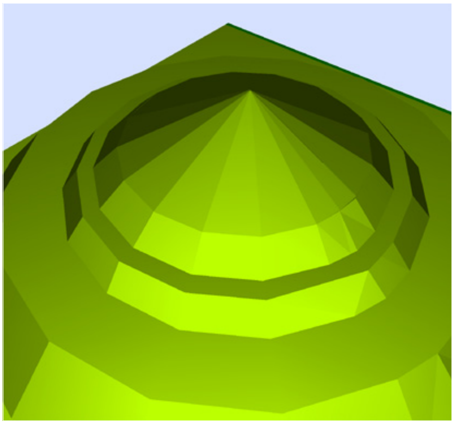


Standard Height

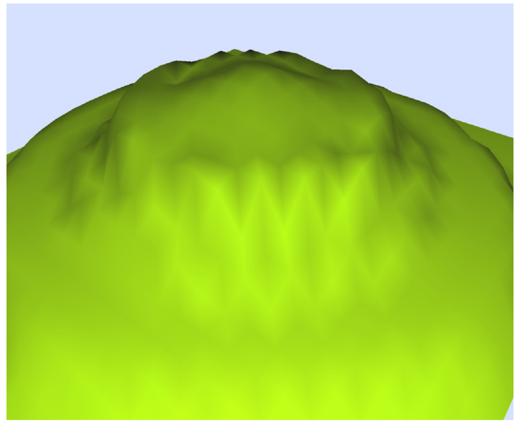
The ground height defined by this option is used in the calculation if no other information, given by contour lines or height points, is available in an area. To each source, receiver point and object, an absolute ground height is assigned which results from its position within the system of contour lines .

Terrain Models

Triangulation meshes existing height points and contour lines to form triangular planes. This speeds up the calculation. In this case you must not calculate a grid to be able to look at the terrain model in 3D (Special) (see chapter 9.14).



DTM: **Triangulation**
The edges of the triangle is taken into account for shielding



DTM: **Search Contour Lines**
This DTM shows the ground height which is taken into account when positioning objects with relative heights.

Explicit Edges Only

In addition, when activating the option **Explicit Edges Only**, only the entered contour lines will cause a screening effect and not the contours resulting from triangulation. The activation of this option does not effect the 3D (Special) view.

Objects with Ground at every Point influence DTM

If this option is activated, the height of the base point of the objects, whose heights have been entered in the **Geometry** dialog with the option **absolute Height/Ground at every Point**, determines the terrain height at their position.

Search Contour Lines (Average)

Search Contour Lines (Average) - (Average of a contour line information according to squared-distance).

Local Inclined Plane

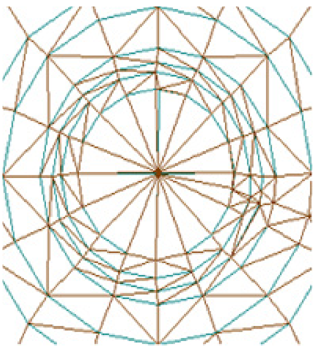
Search Contour Lines (Local Inclined Plane) (approximation of plane surfaces by using the defined contour lines).

Normally the triangulation method should give the best results because it also takes into account - according to the physical reality - the convex surface planes between the contour lines and the height points, which are formed by the newly set edges during screening.

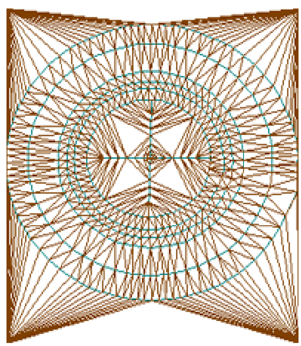
☝ When applying triangulation you should always keep in mind, though, that the contour lines should be formed by a dense succession of points because these represent the corners of the created triangles. A surface modelled by contour lines with only two end points will form a very coarse and extended plane.

Representation of Triangulation Lines:

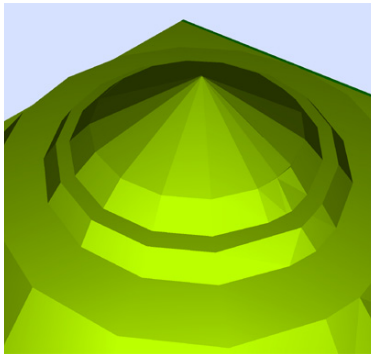
You can show triangulation lines in **CadnaA**. The setting is "invisible" by default. Select a corresponding line type in **Options|Appearance** (see chapter 9.6)..



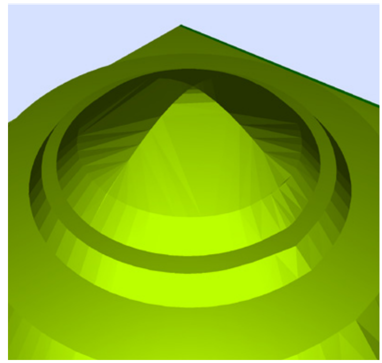
DTM: Triangulation (rough) plan presentation



DTM: Triangulation (fine) plan presentation after using the command Spline



DTM: Triangulation (rough)
3D-Special view



DTM: Triangulation (fine)
3D-Special view

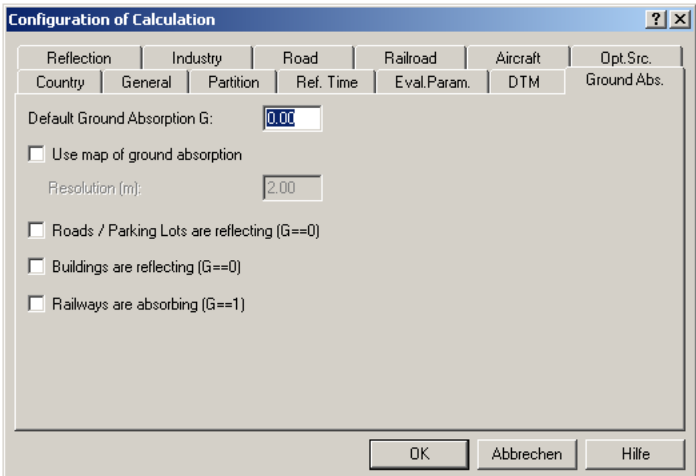
Search Radius for Contour Lines (m)

In order to determine the height of the terrain at a point, all contour lines within the radius specified here are considered. The greater the search radius, the longer the calculation time.

Lift Sources under Ground to Ground Level

If objects are located below the terrain height - e.g., this may happen after importing digital data from different data sources - it will be assumed, that the relative height is zero during the calculation. The terrain model is not changed.

6.2.7 Ground Absorption Tab



Default Ground Absorption G

When calculating the ground absorption the global ground absorption for areas not covered by the object "Ground Absorption" (see chapter 3.6) can be defined here (0 <= G <= 1). By default, a value of G=1 is assumed (porous soil).

Use map of ground absorption

We recommend to activate the option **Use Map of Ground Absorption** if a lot of areas of ground absorption are inserted in your project file. This would accelerate your calculation because a program internal "map of ground absorption" will be pre estimated and be used for the final calculation.

Define also the resolution of the grid. The default value is 2 m.

The grid of ground absorption can be exported with File |**Export|ArcView** Grid (*.asc).

Base Area of Objects

Regarding the ground absorption you can define the base area of roads, parking lots and buildings as reflecting and railways as absorbing by checking the pertinent checkbox.

see chapter 6.2.9.1 "ISO 9613", section "Ground Attenuation"

6.2.8 Reflection Tab

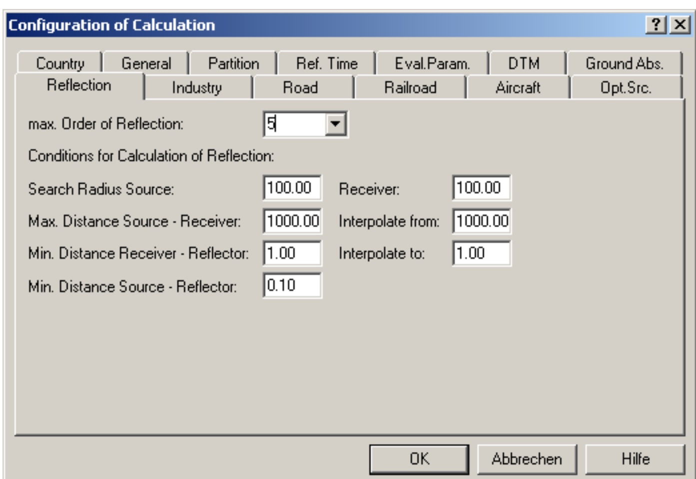
When calculating reflections the following points have to be respected:

1. Specify on tab „Reflection“ (on **Calculation|Configuration** menu) the maximum order of reflection to be taken into account and

2. ensure that the objects (buildings, barriers, cylinders, 3D-reflectors), to be considered have been defined as reflective (see chapter 3.1 "Reflection Properties of Obstacles").

Although **CadnaA** calculates reflection using a time-efficient algorithm, the number of calculation steps increases heavily with the order of reflection and with the number of reflecting surfaces. Any calculation with higher orders of reflection should, therefore, always be restricted to well defined scenarios with a few objects only.

For such investigations a corresponding small part from the total scenario can be cut from the project file (see manual "Introduction to **CadnaA**").



Reflection Tab in **Calculation|Configuration** - input of the max. order of reflection and search radius (m) for reflectors.

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max. Order of Reflection

The maximum order of reflections, which are taken into account as mirror image sources, strongly influences the calculation time. In most cases, taking into account first-order reflections is sufficient. Considering the calculation times, it is recommended you use higher orders of reflection only for limited scenarios containing few objects.

RLS-90 / Schall 03

For calculations of road traffic noise according to RLS 90 /12/ and railway noise according to Schall03 /18/, first-order reflections shall be considered exclusively. Therefore, if values ≥ 1 are entered, the user input is ignored, provided that the options „Strictly according to RLS-90“ (see chapter 6.2.10) or „Strictly according to Schall 03“ (see chapter 6.2.11 have been activated

☝ At present, **CadnaA** calculates reflections up to a maximum order of 20. It is possible to display the sound rays contributing to the level at a receiver point (see chapter 6.1.7 "Displaying Sound Rays").

Criteria for the Calculation of Reflections

Search Radius for Reflecting Objects Around Source/ Receiver Point

If the field is empty or the value 0 is entered, no reflecting areas will be checked in principle.

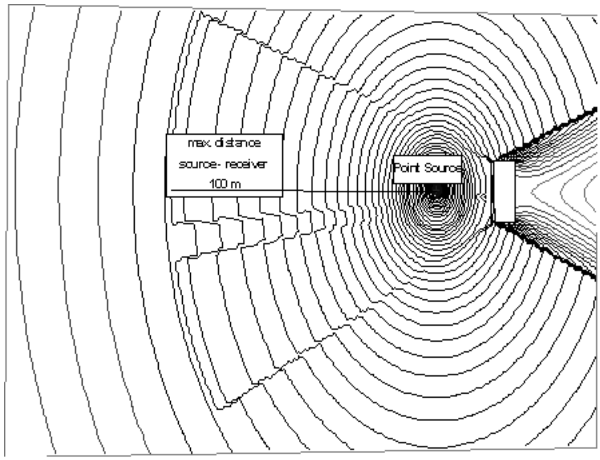
If a value different from zero is entered, this is interpreted as the distance, in metres, from the source point, or receiver point, within which all reflecting objects are taken into account.

Max. Distance Source to Receiver Point

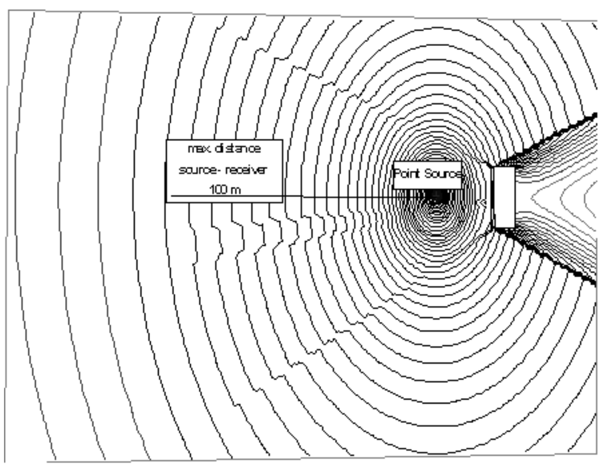
If the receiver point lies outside the distance here specified, no reflections are calculated.

Interpolate from

If the distance entered here is smaller than the one mentioned above, the proportion of reflected sound is continuously reduced between these two distances to avoid discontinuities in the representation of the iso-dB lines.



Settings: max. distance Source-Receiver: 100 m, interpolate from: 100 m
and reflection of 1st order. The Iso-dB-Lines show leaps because of reflections.



For interpolate from: Leaps will be avoided for Iso-dB-Lines with a value
which is smaller (in the example 30 m) than the distance source-receiver

Min. Distance Immission Point to Reflecting Object

If, for the calculation of the sound level in front of a window, a receiver point is placed in front of the building wall, the reflection from the building itself must not be taken into account in the determination of the characteristic immission level.

It is therefore recommended you enter approximately 0.5 m or 1 m. In accordance with the guidelines, no reflections are then calculated for those immission points which have been assigned to the building by means of the Object Snap (see chapter 9.4).

Interpolate to

If the distance entered here is larger than the one mentioned before, there is a continuous transition from "no reflection at all" to "maximum" reflection.

Min. Distance Source to Reflecting Object

Enter approximately 0.5 m if the increase in radiation in the half- or quarter-space due to the sources of reflections from the building is accounted for by assigning a global directivity index K_0. This reduces calculation time without preventing the calculation of reflections for other sources (see chapter 2.1.1 "Common Input Data", section "K0 without Ground").

6.2.9 Industry Tab

☝ Information on the calculation options for the following standards or guidelines for industrial sources can be found in the German version of the **CadnaA**-reference manual:

- VDI 2714/2720
- DIN 18055 (1987)
- OEAL 28 (1987)

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The options on tab „Industry" effect the following types of sources:

- point, line, and area sources, vertical/horizontal (see chapter 2.1.1)
- tennis point of serve (see chapter 2.3)
- parking lot (see chapter 2.7)
- optimizable area source (see chapter 2.9)

Table „Propagation Models Industry"

The subsequent table lists the main characteristics of the propagation models for industrial sources as treated in the next chapters explaining the configuration options. A special focus is put to the type of modelling being used for the various attenuating effects in sound propagation.

Table „Obstacles and Special-Objects"

A further table describes the properties of obstacles and special-objects in **CadnaA** with each propagation model.

Propagation Models Industry

No	Option or Propagation Effect	Standard / Guideline
		ISO 9613 (1996)
1	calculation using A-weighted levels	yes
2	spectral calculation	yes (for octaves 63 Hz to 8000 Hz, extended in **CadnaA** down to 31.5 Hz)
3	geometrical attenuation (divergence)	full sphere ($4\pi\ r^2$)
4	attenuation by air absorption	based on the air absorption coefficient accord. to ISO 9613-1
5	handling of ground reflections	not using image sources, but using an algorithm which includes the correction for ground absorption (see below)
6	handling of reflections at obstacles	by image sources with no restriction to the maximum order of reflection, condition for reflection considers obstacle size compared to wavelength, sound power of the image source may include absorption coefficient/reflection loss of the reflector
7	attenuation due to ground effect (ground attenuation)	2 procedures: 1. general method (spectral): using ground factor G (0<=G<=1), „applicable only to ground which is approximately flat“ 2. alternative method (for A-weighted levels): generalized, not using ground factor G, „for ground surfaces of any shape“
8	attenuation due to screening (at objects)	for single and double diffraction based on the path difference of the direct path across the obstacle, screened ray does by default not include a ground attenuation, screening effect considers wavelength REMARK: transmission through obstacles is not considered by default, in **CadnaA** an approximative approach using „acoustical Transparency“ available
9	handling of lateral diffraction	by considering two, lateral ray paths (via the vertical edges of an obstacle), lateral diffraction includes the ground attenuation by default
10	handling of multiple obstacles in ray path	unclear specification („may also be calculated approximately ... by choosing the two most effective barriers ...“) In **CadnaA** the so-called „ribbon band method“ is used for the calculation of the path difference with multiple screening objects.
11	attenuation due to screening (terrain)	screening by terrain not treated explicitly, In **CadnaA** the algorithm for multiple screening objects is applied, however not considering any lateral diffraction.
12	handling of meteorological effects (wind)	2 options (empirical correction Cmet): 1. based on the factor C0 2. additionally in **CadnaA**: derivation of C0 from a distribution of wind direction (which is not treated ISO 9613-2 completely)
13	attenuation due to foliage	without screening calculation, but based on the length of the curved ray path (arc of a circle) passing through the foliage (with height h) assuming a radius of 5 km
14	attenuation due to built-up areas	without screening calculation, but based on the length of the curved ray path (arc of a circle) passing through the built-up area (with height h) assuming a radius of 5 km

Standard / Guideline					No
Nordic Prediction Method (1996)	**Ljud fran vindkraftverk**	**BS 5228**	**Harmonoise**	**Concawe**	
yes (though not part of NPM originally)	yes	yes	yes	yes	1
yes, see ISO 9613	yes (for A-weighted sum level only)	yes (though not part of original paper)	yes, see ISO 9613	yes, see ISO 9613	2
see ISO 9613	half sphere ($2\pi\ r^2$)	divergence mixed with ground attenuation	full sphere ($4\pi\ r^2$)	full sphere ($4\pi\ r^2$)	3
according to NPM, Annex B	using 0.005 dB/m	not available	complex transfer function (inside DLL)	based on air absorption coefficient (tabulated)	4
see ISO 9613	see ISO 9613	for two categories (soft/ hard)	see above	specific algorithm, not using image sources	5
see ISO 9613, but separate criteria for minimum length and height of reflector	not available	see ISO 9613	see above	see ISO 9613	6
see spectral method of ISO 9613, but with height correction when „significant screening occurs“	two ground categories (over land = soft, over water = hard)	ground attenuation for two categories (soft/ hard) and for mixed ground	see above	spectral model only (63 to 4000 Hz, in **CadnaA** extended to 32 and 8000 Hz)	7
effective height h_e is reduced by Δh for single screen, considers wave length, screened ray with ground attenuation	not available	see ISO 9613	see above	using the Fresnel-number based on the path length difference	8
for single screen only	not available	not available	see above	not available	9
at multiple screens: „... find the two most effective single screens.“ (annex C)	not available	not available	see above	so-called „ribbon band method“ is used to obtain path length difference	10
as with multiple screens (no lateral diffraction)	not available	see ISO 9613	see above	see ISO 9613	11
for „moderate down-wind or slight tempera-ture inversions“, no meteorol. correction	not available	not available	for a specific meteoro-logical situation (based on stability class, wind direction and speed)	for a specific meteoro-logical situation (based on stability class, wind direction and speed)	12
based on transmission path length (with Δh)	not available	not available	not available	not available	13
not in NPM, in **CadnaA** according to ISO 9613	not available	not available	not available	not available	14

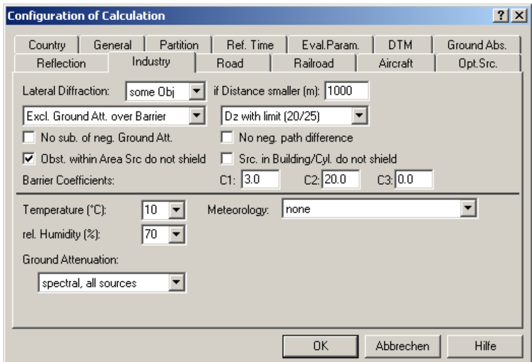
Obstacles and Special Objects

No	Object Type/ Option	Standard / Guideline
		ISO 9613 (1996)
1	building	single and multiple diffraction for edges parallel to the ground based on the shortest path difference, lateral diffraction via the vertical edges, no reflection or by input of absorption coefficient/reflection loss, additionally (not normative): input of transmission coefficient (%), no acoustical transparency by default
2	cylinder	single and multiple diffraction via the cylinder based on the shortest path difference, lateral diffraction via the perimeter, no reflection or by input of absorption coefficient/ reflection loss, reflection up to 1st order (implementation in **CadnaA** differs from ISO 9613-2 as incomplete there)
3	barrier	single and multiple diffraction for edges parallel to the ground based on the shortest path difference, lateral diffraction via the vertical edges, no reflection or by input of absorption coefficient/reflection loss
4	floating barrier	no diffraction via the lower edge (screening edge without diffraction), otherwise see barrier
5	barrier with cantilever	cantilever is totally absorbing (no reflection), calculation of the path length difference valid for receivers/grid points outside and below the cantilever, otherwise see barrier
6	bridge plate	diffraction calculation for horizontal plate only (inclined plate approximated to horizontal plate), screening for sources below/above the bridge plate (diffraction up-/ downwards), no reflection-induced level increase below the bridge plate (as ground is not modelled by mirror sources)
7	embankment	acts as a double barrier, diffraction for direct path (without lateral diffraction), no absorptive/reflective properties REMARK: The embankment is not considered in the triangulation!
8	ground absorption area	just relevant with the frequency dependant ground attenuation: procedure uses three regions (source, receiver, and middle region), empirical attenuation based on source and receiver height and distance (accord. to *Kragh*)
9	built-up area/ foliage	without screening calculation, attenuation based on the length of the curved ray path (arc of a circle) passing through the built-up area/foliage assuming a radius of 5 km
10	3D-reflector	screening calculation based on the shortest path length difference, plus two lateral paths, diffraction can be suppressed for up to 32 edges, no reflection or by input of absorption coefficient/reflection loss, reflection up to 1st order, no summation of diffraction components via multiple edges, no multiple diffraction
11	self screening	not relevant
12	additional width/ parapet L/R	not relevant

Standard / Guideline					No
Nordic PM (1996)	**Ljud fran vindkraftv.**	**BS 5228**	**Harmonoise**	**Concawe**	
diffract. at upper edge, no lateral diffr. (in NPM for single edge only), no acoust. transp.	no effect	diffraction for first edge parallel to the ground only, no lateral diffr., no acoust. transparency	see ISO 9613, but no acoustical transparency, reflection based on air-flow resistivity	see ISO 9613	1
diffract. at upper edge, lateral diffr. as for a single edge	no effect	see ISO 9613	see ISO 9613	see ISO 9613	2
diffract. at upper edge, lateral diffr. only at the first vertical edge	no effect	diffraction for first edge parallel to the ground only, no lateral diffraction	see ISO 9613, reflection based on airflow resistivity	see ISO 9613	3
see ISO 9613	no effect	see ISO 9613	no effect	see ISO 9613	4
cantilever not available (not compatible with „effective height“ concept)	no effect	see ISO 9613	no effect	see ISO 9613	5
see ISO 9613	no effect	see ISO 9613	no effect	see ISO 9613	6
see ISO 9613	no effect	see ISO 9613	no effect	see ISO 9613	7
see ISO 9613	no effect	see ISO 9613, also with weighted source data (based on the frequency specified)	based on airflow resistivity (in **CadnaA**: classes of ground factor G)	see ISO 9613, also with weighted source data (based on the frequency specified)	8
no built-up area in NPM (in **CadnaA** as in ISO 9613), foliage: based on path length using heff	no effect	no effect	no effect	no effect	9
no screening effect (not compatible with „effective height“ concept)	no effect	see ISO 9613	no effect	see ISO 9613	10
not relevant	not relevant	not relevant	not relevant	not relevant	11
not relevant	not relevant	not relevant	not relevant	not relevant	12

6

6.2.9.1 ISO 9613



Lateral Diffraction

Three options for lateral diffraction are available for selection:

- none: no lateral diffraction considered, just the direct path is evaluated.
- only one object: lateral diffraction is not calculated if more than one object intersects the line connecting the source to the immission point.
- some objects: The two shortest possible convex rays around the arrangement are determined and taken as a basis for the calculation.

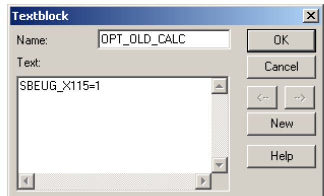
if Distance smaller (m)

This setting defines the distance between source and receiver for which lateral diffraction is taken into account. The default value is 1000 m.

Level Increase due to Lateral Diffraction

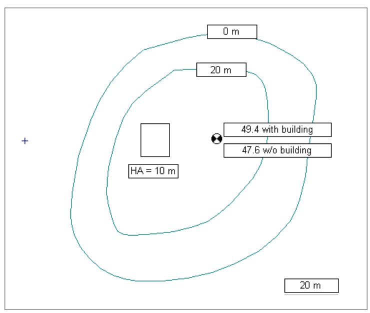
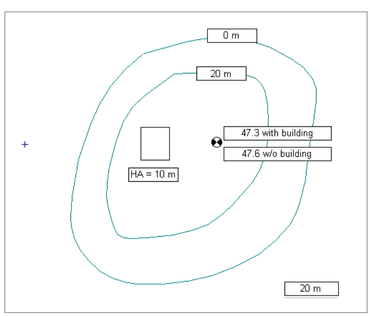
With calculations accord. to ISO 9613-2 the receiver level including an obstacle (e.g a building) and terrain can be higher, than just with terrain (e.g. with the buildings deactivated). When calculating the screening effect by terrain no lateral diffraction is calculated. With an additional obstacle, however, the effect by lateral diffraction by that obstacle is added. This could cause an increase of the local receiver level.

Therefore, in case the screening effect by an obstacle is smaller than without (i.e. with terrain only) the screening effect ignoring the obstacle is considered by **CadnaA**. This strategy can be deactivated using the local text block OPT_OLD_CALC with the text SBEUG_X115=1.



Local Text Block OPT_OLD_CALC

Example

<table>
<tr><td>
</td><td>effect by lateral diffraction: higher receiver level with building, than without (local text block OPT_OLD_CALC with text SBEUG_X115=1)</td></tr>
<tr><td>
</td><td>default setting with lateral diffraction accord. to ISO: level with obstacle (e.g. with building) must be lower than without.
(no local text block or local text block OPT_OLD_CALC with text SBEUG_X115=0)</td></tr>
</table>

Screening & Ground Attenuation

The following options are available to account for the ground attenuation in conjunction with the calculation of the screening effect.

Exclude Ground Attenuation over Barrier

With this setting the ground attenuation is excluded from the total attenuation of screened rays. This is the default setting in **CadnaA**.

> **Explanatory Remarks:**
>
> ISO 9613-2, equation (12) states (for top edge): $A_{bar} = D_z - A_{gr} > 0\ dB$
>
> In conjunction with equation (4): $A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}$
>
> it results that for screened rays no ground attenuation A_{gr} is considered:
>
> $$A = A_{div} + A_{atm} + A_{gr} + (D_z - A_{gr}) + A_{misc} = A_{div} + A_{atm} + D_z + A_{misc}$$
>
> This setting is, therefore, in line with the specifications in ISO 9613-2.

Include Ground Attenuation over Barrier

The ground attenuation is included in the total attenuation of screened rays. The mean height above ground of the diffracted ray passing over the barrier is considered in the calculation.

> **Explanatory Remarks:**
>
> With this option the equation (13) of ISO 9613-2 is applied: $A_{bar} = D_z > 0\ dB$
>
> This equation holds as well for the two lateral paths. For the total attenuation it results according to equation (4):
>
> $$A = A_{div} + A_{atm} + A_{gr} + D_z + A_{misc}$$
>
> In this case, the ground attenuation A_{gr} is considered also for the diffracted rays.

10 m-Criterion

When a source is higher than 10 m above ground and at least one screening edge is higher than 10 m above ground, accord. to ISO 9613-2, note 15, equation (13) is used to calculate the attenuation by a barrier A_{bar} (with $A_{bar} = D_z > 0$ dB).

Barrier Attenuation

For the barrier attenuation the following options are available from the list box:

- Dz without limit
- Dz with limit (20/25)
- De,o with limit
- Dz with limit (20/20)

Dz without limit

With this option activated the barrier attenuation Dz increases with increasing path difference z without any limitation (accord. to equation (14) in ISO 9613-2).

Dz with limit 20/25

According to ISO 9613-2 the barrier attenuation Dz is limited to 20 dB for a single, and to 25 dB for a double screening edge. Therefore, this is the default setting.

De,o with limit

The option „De,o with limit“ was a former option in **CadnaA** applied in conjunction with the guideline VDI 2714 /33/. This setting is for not relevant for ISO-calculations not relevant, but has to be kept to ensure downward compatibility with old projects.

Dz with limit 20/20

According the new Austrian edition of ISO 9613-2 (see ÖNORM ISO 9613-2:2008-01) the barrier attenuation Dz of double screening edges is for Austria limited to 20 dB, thus deviating from the original document.

No Subtraction of negative Ground Attenuation

With this option activated, a negative ground attenuation (e.g. with reflecting ground) will not be subtracted from total attenuation A of the screened ray. This means that, with reflecting ground, equation (12) of ISO 9613-2 is not applied, but equation (13).

By default, this option is deactivated as ISO 9613-2 does not specify this additional condition (A_{gr} > 0 dB).

Explanatory Remarks:

Equation (12) in ISO 9613-2 is: $A_{bar} = D_z - A_{gr} > 0\ dB$

For low frequencies and the absorbing ground or generally with reflecting ground A_{gr} gets negative. In this case, the attenuation due to a barrier A_{bar} would be increased since the ground attenuation A_{gr} would be added to the barrier attenuation D_z. With this option activated, it will be used for the screened ray instead:

$$A_{bar} = D_z > 0\ dB$$

Thus, when calculation the total attenuation A the ground attenuation Agr is considered according to:

$$A = A_{div} + A_{atm} + A_{gr} + D_z + A_{misc}$$

6

No negative path difference

With activated option no barrier attenuation is calculated when the ray from the source to the receiver is above the upper edge of the barrier.

Explanatory Remarks:

The barrier attenuation D_z according to equation (14) in ISO 9613-2 produces a distinct screening effect even when the ray passes slightly above the barrier's top edge. ISO 9613-2, section 7.4, states that the path difference z receives a negative sign in this case.

Ground Attenuation

In ISO 9613-2, two methods are mentioned to calculate the ground attenuation A_{gr}:

1. „general method": method in frequency bands according to section 7.3.1 with the ground factor G as parameter,
2. „alternative method": method for A-weighted levels according to section 7.3.2 not applying the ground factor G.

As in projects the sound emission of sources can either be given in spectral form or as A-weighted levels, several possibilities exist to calculate the ground attenuation. In **CadnaA** four calculation options are available:

Designation	Procedure
none	no ground attenuation at all ☝ However, the ground reflection is still accounted for by using equation (11) of ISO 9613-2.
not spectral	method 7.3.2 is used in all cases For spectral sources the same value of A_{gr} results for all octaves.
spectral, spectral sources only	The method 7.3.1 is used for all spectral sources, in all other cases the method 7.3.2 is used. ☝ This corresponds in **CadnaA**, version 3.3 and former, with the option "Ground Attenuation spectral" being activated.
spectral, all sources	Method 7.3.1 is used in all cases, for non-spectral sources the corresponding octave band is used. For A-level sources the value for A_{gr} at the specified frequency is used.

The default setting in **CadnaA** is the option „spectral, all sources" as this is the „general method of calculation" according to ISO 9613-2.

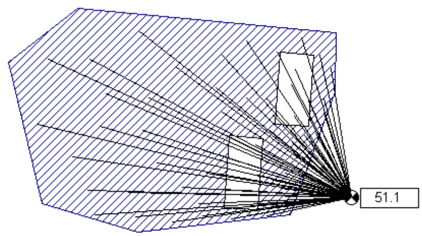
spectral Ground Attenuation

When calculating the ground absorption in frequency bands the global ground absorption for areas not covered by the object "Ground Absorption" (see chapter 3.6) is defined via the „Ground Absorption" tab (see chapter 6.2.7). A default value of G=1 is used (porous ground).

Obstacles within Area Source do not Shield

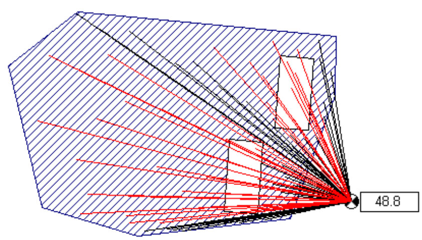
When this option is active, any obstacle (e.g. buildings, foliage, barriers etc.) located within area sources (including parking lots and optimizable sources) provide no screening for any sub-source of that area source.

Example



Area source with 2 buildings inside, option activated: sources with free propagation (with all rays displayed)

With this option activated the result levels are calculated as if the obstacles were not present (i.e. no screening effect).



Area source with 2 buildings inside,
option deactivated: sub-sources behind the buildings are screened,
sub-sources in front of buildings with free propagation (screened rays in RED)

With this option deactivated lower levels result at the receiver points due to the screening effect of the obstacles inside. Nevertheless, for all other sources (i.e. sources outside of the are source's border) the obstacles inside cause always screening.

Sources in Building/Cylinder do not shield

By default, a screening effect results for sources inside buildings and cylinders as the outer walls act as barriers.

☝ In this case, prior to the calculation, a message will be displayed (dialog **Consistency Check**) which enables to proceed with the operation (button „Continue“).

This procedure is due to the fact that buildings and cylinders are treated as open boxes within the calculation of propagation (despite they are displayed as „closed“ objects (i.e. with roof) on the 3D-Special View).

With this option activated, sources located inside of the geometrical borders of buildings or cylinders are not screened as if the obstacle were not present. For sources outside, those obstacles are always screening and - if any - reflecting. This option enables to model e.g. sound radiating chimneys by using point or line sources located inside the cylinder. In this case, the directivity pattern of the chimney - whether entered or selected from the default directivities - will not distorted by the cylinder's screening edge.

Example

see manual „Introduction to **CadnaA**“, chapter 6.3 Directivity

Barrier Coefficient

The barrier coefficients C_1, C_2 and C_3 according to ISO 9613-2 can be edited. This option enables to adapt the barrier equation to special applications (see /7/, section 7.4).

☝ In ISO 9613-2 the coefficient C_1 is not expressed explicitly. The first constant („3“) in equation (14) corresponds with C_1.

The default values are: C_1 = 3 dB; C_2 = 20 dB; C_3 = 0 dB.

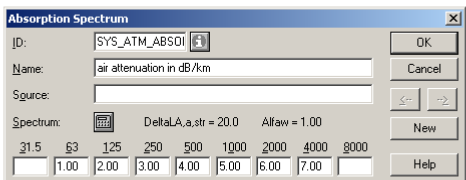
The input C_3 = 0 dB causes this value to be calculated according to ISO 9613-2, equations (15), (16) and (17) for single and double barriers automatically.

Temperature / rel. Humidity

The air attenuation is calculated based on the temperature and relative humidity according to ISO 9613-1. Intermediate frequency values result from linear interpolation. The temperature specified serves also as the ambient temperature when calculating the exhaust stack's directivity.

User-defined Air Attenuation

For calculations according to ISO 9613-2 a user-defined air attenuation spectrum can be referenced. Enter a spectrum in the local library "Absorptions" with the ID "SYS_ATM_ABSORB". The values have to be specified in dB/km. Missing octave band data will be considered as 0 dB/km.



Local Absorption Spectrum SYS_ATM_ABSORB

Meteorology

For calculations according to ISO 9613 the following options are available:

none

No meteorological correction is applied. The resulting equivalent continuous sound pressure level is calculated applying equation (3) for the meteorological situation as described in ISO 9613-2, section 5 (downwind).

Cmet, C0 constant

This option calculates the long-term average A-weighted sound pressure level according to ISO 9613-2, equation (6). This requires to specify the value of C_0 for the periods Day/Evening/Night where the meteorological correction C_{met} is calculated from according to ISO 9613-2, section 8, equations (21) and (22) resp.

☝ The factor C_0 may be estimated from an elementary analysis of the local meteorological statistics or be established by the local authorities.

Cmet, C0 from wind statistics

With this option two methods for calculation of C_0 from wind statistics are available on the subsequent dialog **Wind Statistics**:

- method LfU Bayern:

The approach used by the LfU-Bayern (Bayerisches Landesamt für Umweltschutz) to calculate C_0 is:

$$C_0 = -10\lg\left(\frac{T_m}{100}10^{-\frac{K_m}{10}} + \frac{T_q}{100}10^{-\frac{K_q}{10}} + \frac{T_g}{100}10^{-\frac{K_g}{10}}\right)$$

where
Tmpercentage of annual downwind situations and calmness (inversions) in %
Kmlevel difference to the downwind situation in dB
Tq percentage of annual cross-wind situations in %
Kqlevel difference of cross-wind situations to the downwind situation in dB
Tg percentage of annual upwind situations in %
Kglevel difference of upwind situations to the downwind situation in dB

The percentages T for downwind, crosswind, and upwind result from the wind frequencies in the following sectors:
- down: +/-45° in direction of propagation (=90° sector) and calmness,
- cross: 45° to 135° and 225° to 315° in direction of propagation,
- up: +-45° opposite to the direction of propagation (=90° sector).

Example for method „LfU Bayern“

see chapter 6.6.2 "Correction based on Wind Statistics" in the manual „Introduction to **CadnaA**“.

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- method LUA NRW:

The approach used by the LUA NRW (Landesumweltamtes Nordrhein-Westfalen) to calculate C_0 is:

$$\Delta L_z(\varepsilon) = 5 - 5 * \cos(\varepsilon - 45° \sin(\varepsilon))$$

where ε wind direction referring to downwind

And

$$c = h(\delta) * 10 \lg 10^{0.1 * \Delta L(\varepsilon)}$$

with the frequency h(δ) in wind sector α1 to α2:

$$h(\delta) = h(\alpha 1) + [h(\alpha 2) - h(\alpha 1)] * \frac{\delta - \alpha 1}{\alpha 2 - \alpha 1}$$

where δ angle 0-360 degrees

The value C0 results by summation from:

$$C_0 = 10 \lg\left(\frac{\sum c}{100}\right) \quad \text{in dB}$$

This means that at large distances and on a long-term annual average basis the attenuation with cross winds is 1.5 dB and with upwind 10 dB.
The frequency of calmness is evenly distributed among the 12 wind sectors.

The values of C0 for the locations investigated by LUA NRW range from 1 dB to 3.9 dB.

6

VBUI

relevant for Germany only!

According to the „Vorläufige Berechnungsmethode für den Umgebungslärm durch Industrie und Gewerbe (VBUI)“ /101/ the following values for C_0 are to used when calculating C_{met}:

$C_{0,Day} = 2$ dB

$C_{0,Evening} = 1$ dB

$C_{0,Night} = 0$ dB

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Concawe

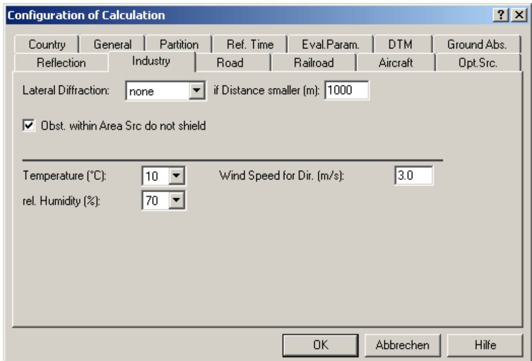
With former releases of **CadnaA** an additional option enabling to apply the meteorological correction K_4 according to CONCAWE /1/ was offered. As the entire CONCAWE-model is now available in **CadnaA** this option has been removed. However, it can be reactivated by adding the following lines to the MAIN-section of the file CADNA.INI in the directory C:\WINDOWS:

[Main]
IsoCmetConcawe=1

When this option is selected from the „Industry“ tab the correction term C_{met} in the ISO 9613-calculation is replaced by K_4 from CONCAWE.

☝ Please consider that the ISO-model be default addresses a moderate downwind situation. In ISO 9613, the C_{met}-term corrects for a long-term average level with a different meteorological situation than the default situation. As the meteorological correction K_4 according to CONCAWE itself represents a distinct meteorological situation, it is questionable what the K_4-term in conjunction with the downwind approach is focussing at. This option was formerly introduced into **CadnaA** based in user requests.

6.2.9.2 Nordic Prediction Method (1996)



Lateral Diffraction

Three options for lateral diffraction are available for selection:

- none: no lateral diffraction considered, just the direct path is evaluated.
- only one object: This option has in conjunction with NPM the same effect as „none" and should, therefore, NOT be used.
- some objects: In conjunction with NPM this option causes the two shortest possible convex rays around the first diffracting edge to be determined and used in the calculation.

☝ Due to restrictions in Nordic Prediction Method, lateral diffraction occurs just at the first diffracting edge. Consequently, a further barrier behind a first barrier in ray direction will not cause a lateral diffraction. Also at buildings (being multipoint objects) no lateral diffraction occurs.

if Distance smaller (m)

This setting defines the distance between source and receiver for which lateral diffraction is taken into account. The default value is 1000 m.

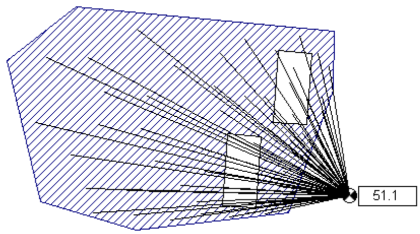
6

6

Obstacles within Area Source do not Shield

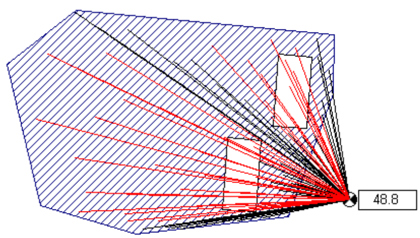
When this option is active, any obstacle (e.g. buildings, foliage, barriers etc.) located within area sources (including parking lots and optimizable sources) provide no screening for any sub-source of that area source.

Example



Area source with 2 buildings inside, option activated: sources with free propagation (with all rays displayed)

With this option activated the result levels are calculated as if the obstacles were not present (i.e. no screening effect).



Area source with 2 buildings inside,
option deactivated: sub-sources behind the buildings are screened,
sub-sources in front of buildings with free propagation (screened rays in RED)

With this option deactivated lower levels result at the receiver points due to the screening effect of the obstacles inside. Nevertheless, for all other sources (i.e. sources outside of the are source's border) the obstacles inside cause always screening.

The air attenuation is calculated based on the temperature and relative humidity as given in annex B of the paper /62/. Intermediate frequency values result from linear interpolation. The temperature specified serves also as the ambient temperature when calculating the exhaust stack's directivity.

Temperature / rel. Humidity

The entered wind speed will be used in the calculation of the directivity of chimneys (see chapter 2.2.1 "Sound Radiation from Chimneys or Stacks").

Wind Speed for Directivity (m/s)

Additional Information

Diffraction Model

The screening model for industrial noise of Nordic Prediction Method /62/ covers the diffraction effect with just a single screening edge. With two or more edges, there is no specification on how to apply the concept using the additional height Δh to multiple screening edges.

In section 4.5.1 of /62/ it is said:

> „The general principle in calculating the screening correction, ΔL_s, is to identify all screening obstacles between source and immission point. ... The calculation procedure depends on the number of screens present. Usually only one screen is taken into account. ΔL_s is then calculated according to section 4.5.4. If more than one screen are present, the procedure in Appendix C should be applied.“

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Section 4.5.4 describes the procedure for a single screening edge. The additional height Δh above the direct path is calculated from the horizontal distance (2D-distance) from source and receiver, respectively. The remaining height to the barrier's top edge is the so-called „effective“ height h_e which is used to evaluate the path difference.

Lateral Diffraction

For the lateral path it is stated on page 37:

> „When a building is represented by a single screen, δ_r and δ_l [path differences] are calculated for the edges yielding the highest values.“

This expresses that the diffraction model cannot handle several edges neither for the direct (vertical), nor for the lateral paths (horizontal). In figure 4.5.7 (sectional view) just the first edge of the building is addressed (as it would be a flat barrier).

Annex C describes for an arrangement of multiple screens with respect to the direct path on how to evaluate „the two most effective single screens“ („effective“ with respect to the ray's elevation angle is meant). However, nothing is said on how to account for lateral diffraction in this case.

In note 1 it says:

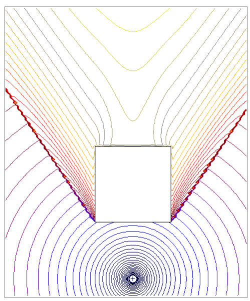
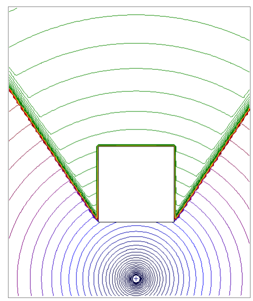
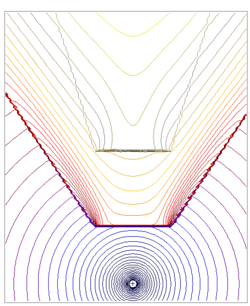
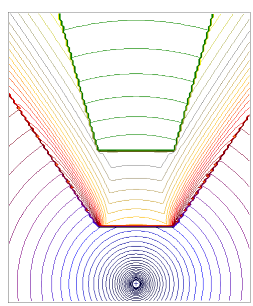
> „It must be emphasized that the recommended procedure is of rather speculative nature ...“

As annex C does not address the application of this scheme to the lateral paths in an arrangement with multiple screening objects, **CadnaA** applies the lateral path calculation to the first screening edge only.

☝ Applying the „ribbon band method“ for multiple objects (as with ISO 9613-2) would cause a difference with a single screening edge only.

Example

Comparing lateral diffraction using ISO 9613-2 and NPM.

Object	ISO 9613-2	Nordic Prediction Model (1996)
building (height 100 m), option „some objects“ for lateral diffraction selected		
	lateral diffraction occurring at 1st and 2nd vertical edge	no lateral diffraction due to the restrictions of the diffraction model
two barriers behind each other (height 100 m each), option „some objects“ for lateral diffraction selected		
	lateral diffraction occurring at 1st and 2nd barrier	lateral diffraction occurring at 1st barrier, but not at 2nd barrier

Attenuation due to Vegetation

The Nordic Prediction Method distinguishes between a single and multiple vegetation areas in the ray path. For single vegetation area, the attenuation depends on the length of the ray passing through the foliage (considering the additional height Δh above direct path). For multiple vegetation areas, the attenuation depends on the number of vegetation areas, with a maximum of four.

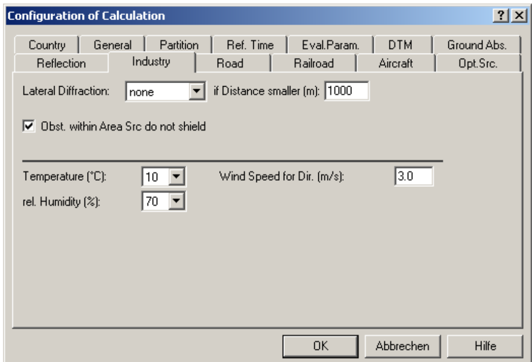
In **CadnaA**, the attenuation ΔL_v for a single and multiple vegetation areas is always calculated based transmission path length d_v (considering the additional height Δh) and not on the number of groups of vegetation:

6

$$\Delta L_v = -n_V \cdot \alpha_v \quad \text{with} \quad n_V = \frac{d_v}{50} \leq 4$$

where
d_V: transmission path length (m)
α_V: attenuation coefficient accord. to table 4.6.1 of /62/

6.2.9.3 Ljud från vindkraftverk



The same configuration settings as for Nordic Prediction Method for industrial noise apply.

Please refer to chapter 6.2.9.2 "Nordic Prediction Method (1996)".

Additional Information

Propagation Model

The guideline states different equations for the geometrical divergence over land and over water, for land depending on the distance r to the receiver.

- propagation over land:

  - for distances r <= 1000 m:

$$L_{p,A} = L_{WA,korr} - 8 - 20\lg r - 0.005\, r$$

where
$L_{WA,korr}$ A-weighted sound power level, corrected for terrain roughness and statistical error (see below)
r distance source-receiver (m)

  - for distances r > 1000 m:

$$L_{p,A} = L_{WA,korr} - 10 - 20\lg r - \Delta L_a$$

where
$L_{WA,korr}$ A-weighted sound power level, corrected for terrain roughness and statistical error (see below)
r distance source-receiver (m)
ΔL_a correction calculated according to:

$$\Delta L_a = 10\lg \sum 10^{(L_i + A_i)/10} - 10\lg \sum 10^{(L_i + A_i - r \cdot a_i)/10}$$

where
L_i A-weighted sound pressure level (background level) at the receiver
A_i A-weighting for octave data, 63 to 4000 Hz (dB)
a_i air absorption (dB/m)

- propagation over water:

$$L_{p,A} = L_{WA,korr} - 8 - 20\lg r - \Delta L_a + 10\lg\left(\frac{r}{200}\right)$$

☝ The correction term ΔL_a is not evaluated by **CadnaA** and, thus, has to be accounted for after calculation.

Terrain Roughness

The correction for terrain roughness Δv_h (based on the roughness length z0) is not considered by **CadnaA** as this is part of the emission data. This correction will have to be calculated externally and to be added to the sound power level PWL.

Statistical Error

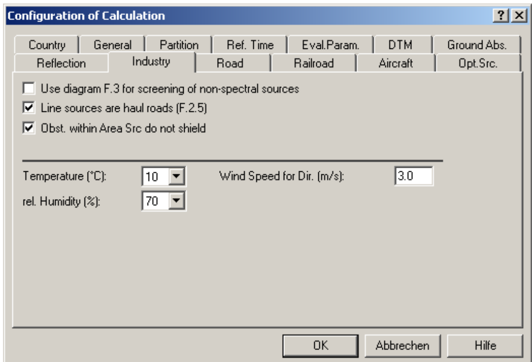
The statistical error k is also considered to be part of the emission (see also example on page 25 of /65/). Again, this correction will have to be calculated externally and to be added to the sound power level PWL.

Ground Absorption

The object „Ground Absorption Area“ (see chapter 3.6) can be applied in conjunction with the tab „Ground Absorption“ (see chapter 6.2.7) with "Ljud från vindkraftverk". There are two cases to be distinguished by the ground factor G:

- propagation over land (soft ground): G > 0.5
- propagation over water (hard ground): G <= 0.5

6.2.9.4 BS 5228



☝ The following specifications refer to the edition 2009 of the standard /72/.

☝ BS 5228 does neither account for lateral diffraction, nor for meteorological effects.

Use diagram F.3 for screening of non-spectral sources

By activating this option the spectral screening model of BS 5228 is applied to non-spectral sources as well (see figure F.3 in BS 5228). In this case, the attenuation due to screening at the specified frequency is used.

When this option is not activated the attenuation at non-spectral sources depends just on the visibility of the top of the source from the receiver (see section F.2.2.2.1 in BS 5228). In **CadnaA**, this attenuation depends on the path difference z as well:

- $z < -0.25$ m: $A_{screen} = 0$ dB
- $-0.25 <= z <= 0.25$ m: $A_{screen} = 5$ dB
- $z > 0.25$ m: $A_{screen} = 10$ dB

Line sources are haul roads (F.2.5)

By activating this option, the propagation by line sources will no longer be influenced by soft ground. In other words, the ground attenuation being used for line sources refers always to reflective ground, independently of what ground factor G is specified.

Furthermore, the **CadnaA**-protocol (see chapter 6.4) specifies in this case on column Kh’ no longer the divergence-ground attenuation term as specified by BS 5228 (see below), but the sum of the divergence and the angle correction according to:

6

$$K'_h = A_{div} + A_{angle} = 10\lg\frac{r_{segment}}{1\,m} + 10\lg\frac{\varphi}{180°}$$

where
r is the distance from the center of the source segment to the receiver (m),
φ is the angle of view of that source segment seen from the receiver, (degrees).

☝ In this respect, the procedure applied is similar to the one used in **CadnaA** for calculations according to CTRN/CRN.

Explanatory Remarks:
For mobile items of a plant, a separate model is used (section F.2.5 of the standard) which is not consistent with the general calculation method (section 2.3 of the standard). While the general calculation method accounts for the ground attenuation (over hard, soft, and mixed ground, see below) the recesses level $L_{A,eq}$ for well-defined routes, e.g. haul roads, uses the following equation:

$$L_{A,eq} = L_{WA} - 33 + 10\lg Q - 10\lg V - 10\lg d$$

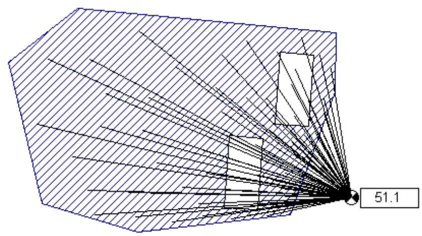
where
L_{WA} the sound power level of the moving source, in dB(A),
Q the number of vehicles/sources per hour,
v the speed (km/h),
d the distance from the receiver to the center of the haul road (m).

The equation in section F.2.5 of the standard mixes up emission and immission. In **CadnaA** however, emission and immission are always treated separately. When using moving point sources (PWL-Pt) in **CadnaA**, the overall PWL of the line source is calculated prior to the propagation according to (see chapter 2.1.1 "Common Input Data").
When using other equations to specify emission it is advisable to calculate the sound power level PWL beforehand and to enter this as a calculated PWL directly. This applies, for example, when using the -33 dB correction instead of -30 dB from the equation in section F.2.5 of BS 5228.

Obstacles within Area Source do not Shield

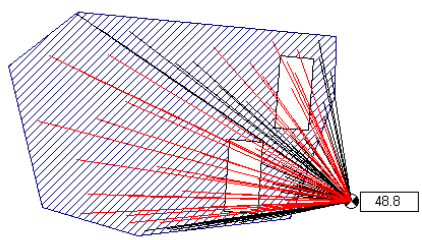
When this option is active, any obstacle (e.g. buildings, foliage, barriers etc.) located within area sources (including parking lots and optimizable sources) provide no screening for any sub-source of that area source.

Example



Area source with 2 buildings inside, option activated: sources with free propagation (with all rays displayed)

With this option activated the result levels are calculated as if the obstacles were not present (i.e. no screening effect).



Area source with 2 buildings inside,
option deactivated: sub-sources behind the buildings are screened,
sub-sources in front of buildings with free propagation (screened rays in RED)

With this option deactivated lower levels result at the receiver points due to the screening effect of the obstacles inside. Nevertheless, for all other sources (i.e. sources outside of the are source’s border) the obstacles inside cause always screening.

Temperature / rel. Humidity

The air attenuation is calculated based on the temperature and relative humidity. Intermediate frequency values result from linear interpolation. The temperature specified serves also as the ambient temperature when calculating the exhaust stack's directivity.

Wind Speed for Directivity (m/s)

The entered wind speed will be used in the calculation of the directivity of chimneys (see chapter 2.2.1 "Sound Radiation from Chimneys or Stacks").

Additional Information

Divergence & Ground Absorption

The propagation model in BS 5228 distinguishes three kinds of situations with respect to ground attenuation. In each of these three situations the calculation in **CadnaA** is based on the ground factor G as being entered on the „Ground Absorption“ tab (see chapter 6.2.7).

- geometrical divergence K'_h for hard ground (G=0):

  $$K'_h = 20\lg r + 8\ dB$$

  where r is the distance source-receiver

- geometrical divergence K'_s for soft ground (G=1):

  $$K'_s = 25\lg r + 1\ dB$$

  where r is the distance source-receiver (with r >= 25 m)

- geometrical divergence for mixed ground (0 < G <1):

  $$soft = G \cdot \left(K'_s - K'_h\right)$$

For all three settings the conditions expressed in section F.2.3.2.1 regarding the distance adjustments are respected.

Screening

BS 5228 states that in case of a barrier being present the screening effect and the ground attenuation can just be combined for hard ground. Consequently, the correction K'_h is always used for the ground attenuation when a barrier is intersecting the path.

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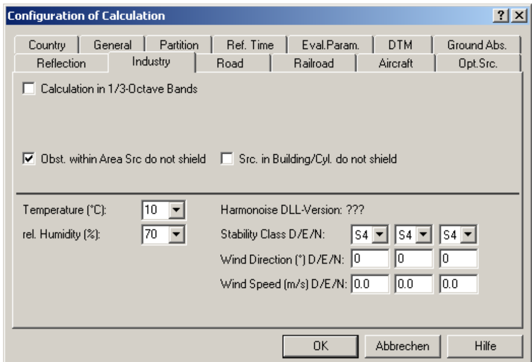
6.2.9.5 Harmonoise



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Calculation in 1/3-Octave Bands

When this option is activated the propagation calculation is performed in third-octave band width (25 to 10000 Hz). In this case with a source spectrum supplied in octave band width (31.5 to 8000 Hz), for all three third-octaves within an octave the <u>same</u> input data (PWL) is used. The result is displayed just in octave band width.

☝ The main effect from this setting is that the impact of air absorption is more severe when calculating in third-octave band width resulting in a lower receiver level, especially at higher frequencies.

Obstacles within Area Source do not shield

When this option is active, any obstacle (e.g. buildings, foliage, barriers etc.) located within area sources (including parking lots and optimizable sources) provide no screening for any sub-source of that area source.

for an example see chapter 6.2.9.4 "BS 5228"

Sources in Building/ Cylinder do not shield

By default, a screening effect results for sources inside buildings and cylinders as the outer walls act as barriers.

☝ In this case, prior to the calculation, a message will be displayed (dialog **Consistency Check**) which enables to proceed with the operation (button „Continue“).

This procedure is due to the fact that buildings and cylinders are treated as open boxes within the calculation of propagation (despite they are displayed as „closed“ objects, i.e. with roof, on the 3D-Special View).

With this option activated, sources located inside of the geometrical borders of buildings or cylinders are not screened as if the obstacle were not present. For sources outside, those obstacles are always screening and - if any - reflecting. This option enables to model e.g. sound radiating chimneys by using point or line sources located inside the cylinder. In this case, the directivity pattern of the chimney - whether entered or selected from the default directivities - will not distorted by the cylinder's screening edge.

Example

see manual „Introduction to **CadnaA**“, chapter 6.3 Directivity

Temperature / rel. Humidity

The air attenuation is calculated based on the temperature and relative humidity. Intermediate frequency values result from linear interpolation. The temperature specified serves also as the ambient temperature when calculating the exhaust stack's directivity.

Harmonoise DLL-Version

After the first calculation using Harmonoise the version of the file `PointToPoint.dll` in the **CadnaA**-installation directory will be displayed.

☝ The Harmonoise DLL presently implemented in **CadnaA** is of version 2.016.

Meteorology

Harmonoise method applies a specific input data set for the meteorological correction, not considering any statistical distribution for long-term averaging. A proposal on how to handle the Harmonoise model to predict long-term average levels see /2/, chapter 3.3.11.

Harmonoise offers five meteorological propagation classes depending on the following parameters:

- wind speed at 10 m above the ground, v (m/s) at z = 10 m,
- wind speed component in the direction of sound propagation at 10 m above the ground, u (z = 10 m),
- cloud cover in octas (i.e. as a multiple of 1/8), and
- time of the day (day/night).

Within the engineering model besides the five stability classes, eight distinct wind directions (i.e. in steps of 45°), and three wind speed classes are applied. In **CadnaA**, intermediate values are linearly interpolated.

Stability Class D/E/N

The stability class addressing the vertical stability of the atmosphere can be specified for the daily periods D/E/N separately. The five stability classes are characterized by day/night and cloud cover /3/:

stability class	day/night, cloud cover
S1	day, 0/8 ... 2/8
S2	day, 3/8 ... 5/8
S3	day, 6/8 ... 8/8
S4	night, 5/8 ... 8/8
S5	night, 0/8 ... 4/8

From this a classification with respect to favorable or unfavorable propagation conditions depending on wind direction (see below) can be derived (simplified from /4/):

	wind direction α (*1)				
stability class	**-90°**	**-45°**	**0°**	**45°**	**90°**
S1: day, no clouds					
S2: days, clouds 50%					
S3: day, clouds 100%					
S4: night, cloudy					
S5: night, clear sky					

(*1): α is the angle between the wind direction and the direction of sound propagation

Note: From the wind speed class and the stability class the inverse of the Monin-Obukhov length 1/L results being used to predict the height difference Δh above the straight ray path.

Legend:

very favorable	
favorable	
neutral	
unfavorable	
very unfavorable	

Consequently, by class S1 a vertically very unstable atmospheric condition is addressed („sunny day“), while class S5 models a stable condition („clear night“). A neutral atmospheric condition would be represented by class S3 („heavily clouded/overcast“).

Wind Direction (°) D/E/N

The wind direction is the direction from which a wind originates (with 0° being North wind, i.e. wind blowing from North, with 180° being South wind etc.).

Wind Speed (m/s) D/E/N

The wind speed refers to a height of 10 m above ground. The following wind speed classification is used /3/:

wind speed class	**wind speed at 10 m above ground v (z=10 m)**
W1	0 ... 1 m/s
W2	1 ... 3 m/s
W3	3 ... 6 m/s
W4	6 ... 10 m/s
W5	> 10 m/s

Additional Information

Default Calculation Settings used by ' Harmonoise-DLL

The calculations when using Harmonoise method are performed by the dynamic link library `PointToPoint.dll` in the **CadnaA** installation directory. This DLL (Dynamic Link Library) represents the so-called „Engineering Model“ for industrial noise sources within the Harmonoise project /2/. The calculation settings of the DLL used per default have been fixed in accordance with CSTB (Centre Scientifique et Technique du Bâtiment, Grénoble/France) which has implemented the engineering propagation model.

The following options are applied:

- EnableAveraging option: enabled
- EnableScattering option: not enabled
- For all three third-octaves within an octave the same input data is used (i.e. spectrum is step function).
- The ground factor G and the absorption coefficient Alpha are transformed by linear interpolation to an air resistivity according to:
  - for the ground factor G (as entered on the **Configuration** dialog, „Ground Absorption“ tab, see chapter 6.2.7, and for the object „Ground Absorption“, see chapter 3.6):

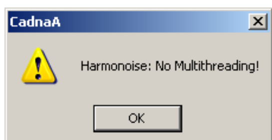
ground factor G	airflow resistivity σ ($kNsm^{-4}$)
0	20000
0.33	1000
0.50	600
0.67	400
1.00	50

- and for the absorption coefficient Alpha of buildings and barriers (see Chapter 3 - Obstacles):

absorption coefficient Alpha	airflow resistivity σ ($kNsm^{-4}$)
0	20000
0.25	1000
0.50	600
0.75	400
1.00	50

Multi-Threading

The Harmonoise DLL is restricted to single processor use only. So, the multi-threading option **CadnaA** cannot be used in conjunction with Harmonoise (see also chapter 14.6). Otherwise a warning message will be displayed.



In this case, select via **Options** menu, command **Multithreading**, the option „only one“ for the number of processors to be used. This will suppress the warning message to come up.

Batch Processing

Different meteorological configurations for a distinct situation can be processed automatically. The procedure to be followed consists of the following:

- the situation file with several receiver points (in the example below: `meteo.cna`),
- the macro-file specifying the configuration of calculation and the results to be exported (in the example below: `meteo.cnm`).
- The macro-file is loaded into **CadnaA** via menu **File|Open**. Select the option „All Files“ from the list box „File Type“ to select the cnm-file.
- Upon opening of the file the batch processing start automatically and saves the results to a text file with file extension `*.log` (in the example below: `meteo.log`).

Examples\ 05_Immissions\ Harmonoise

An example is provided on the **CadnaA**-CD. Follow the procedure as described above.

The macro-file `meteo.cnm` makes use of the keywords *CalcConf* and *ObjAtt* (see **CadnaA**-manual „Attributes, Variables, and Keywords, chapter 4.2.2 and chapter 4.2.25).

File Structure of meteo.cnm

The file `meteo.cna` is loaded by the command: #*(LoadFile, meteo.cna)*. The next line specifies the column headings. The keyword #*(ObjAttAll, 02000000, ID)* establishes a dynamic link the name of each receiver (see **CadnaA**-manual „Attributes, Variables, and Keywords, chapter 4.2.26). The four subsequent lines define the configuration settings for meteorological classes S1 to S4 (of Harmonoise), start the calculation for receivers (using the keyword #*(CalcImm)*), and retrieve the results for level LP1 (using the keyword #*(ObjAttAll)*). The command #*(QuitAtOnce)* closes the file saving the result file `meteo.log`.

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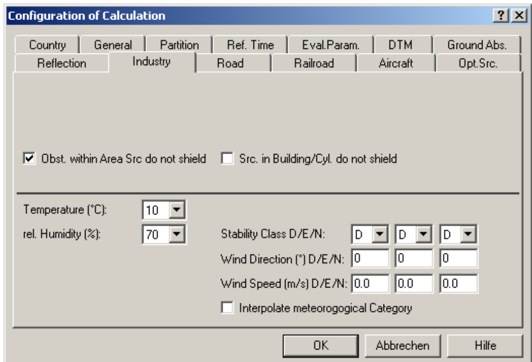
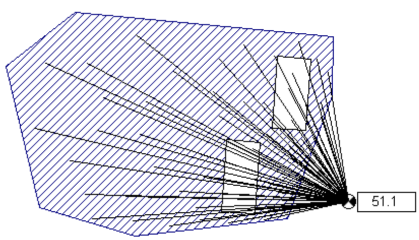
6.2.9.6 Concawe



Obstacles within Area Sources do not shield

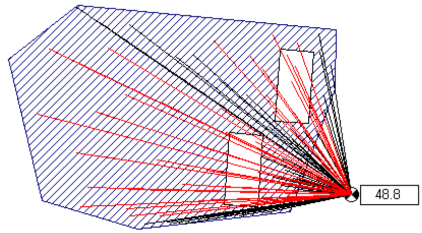
When this option is active, any obstacle (e.g. buildings, foliage, barriers etc.) located within area sources (including parking lots and optimizable sources) provide no screening for any sub-source of that area source.

Example



Area source with 2 buildings inside, option activated: sources with free propagation (with all rays displayed)

With this option activated the result levels are calculated as if the obstacles were not present (i.e. no screening effect).



Area source with 2 buildings inside,
option deactivated: sub-sources behind the buildings are screened,
sub-sources in front of buildings with free propagation (screened rays in RED)

With this option deactivated lower levels result at the receiver points due to the screening effect of the obstacles inside. Nevertheless, for all other sources (i.e. sources outside of the are source's border) the obstacles inside cause always screening.

Sources in Building/ Cylinder do not shield

By default, a screening effect results for sources inside buildings and cylinders as the outer walls act as barriers.

☝ In this case, prior to the calculation, a message will be displayed (dialog **Consistency Check**) which enables to proceed with the operation (button „Continue“).

This procedure is due to the fact that buildings and cylinders are treated as open boxes within the calculation of propagation (despite they are displayed as „closed“ objects, i.e. with roof, on the 3D-Special View).

With this option activated, sources located inside of the geometrical borders of buildings or cylinders are not screened as if the obstacle were not present. For sources outside, those obstacles are always screening and reflecting. This option enables to model e.g. sound radiating chimneys by using point or line sources located inside the cylinder.

In this case, the directivity pattern of the chimney - whether entered or selected from the default directivities - will not distorted by the cylinder's screening edge.

Example

see manual „Introduction to **CadnaA**", chapter 6.3 Directivity

Temperature / rel. Humidity

The air attenuation is calculated based on the temperature and relative humidity. Intermediate frequency values result from linear interpolation. The temperature specified serves also as the ambient temperature when calculating the exhaust stack's directivity.

Meteorology

In the CONCAWE propagation model the meteorological correction is named „attenuation factor for meteorological effects K4" /1/. The attenuation is a function of frequency, distance, and meteorological category.

Stability Class D/E/N

The assessment of atmospheric temperature gradient is replaced by use of Pasquill Stability Categories A to G (for periods D/E/N separately). The definition of the categories depends on wind speed, time, and cloud cover:

Wind Speed * m/s	Day Time, Incoming Solar Radiation (mW/cm²)				1 hour before Sunset or after Sunrise	Night-Time, Cloud Cover (octas)		
	> 60	30-60	< 30	Overcast		0-3	4-7	8
<=1.5	A	A-B	B	C	D	F or G**	F	D
2.0 - 2.5	A-B	B	C	C	D	F	E	D
3.0 - 4.5	B	B-C	C	C	D	E	D	D
5.0 - 6.0	C	C-D	D	D	D	D	D	D
> 6.0	D	D	D	D	D	D	D	D

Notes:
*: wind speed is measured to the nearest 0.5 m/s
**: category G is restricted to night-time with less than 1 octa of cloud and a wind speed of less than 0.5 m/s

☝ Based on literature, class A represents a strong lapse condition (large temperature decrease vs. height), category G a temperature inversion observed early on a clear morning. Classes E and F apply to slight inversions. However, inversion conditions - particularly those over water - are highly variable and not easy to predict. The acoustical effect depends on additional factors (e.g. geometry).

From this classification six new meteorological categories have been defined, based an a combination of Pasquill Stability Categories (representing the temperature gradient) and vector wind speeds (v (z=10 m) in m/s). The effect on the attenuation is indicated by the arrow.

	Meteorological Category	Pasquill Stability Category		
		A, B	C, D, E	F, G
decreasing attenuation ↓	1	v <-3.0	-	-
	2	-3.0 < v <-0.5	v < -3.0	-
	3	-0,5 < v < + 0.5	-3.0 < v < -0.5	v < -3.0
	4*	+0.5 < v <+3.0	-0.5 < v < +0.5	-3.0 < v < -0.5
	5	v > +3.0	+0.5 < v < +3.0	-0.5 < v < +0.5
	6	-	v > +3.0	+0.5 < v < +3.0

Note:
*: category with assumed zero meteorological influence

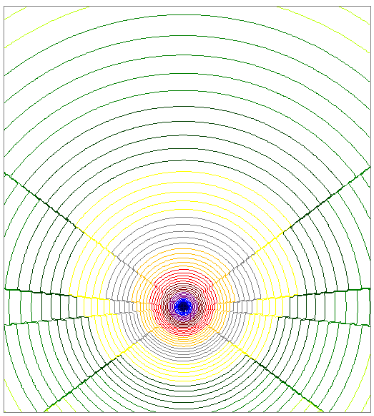
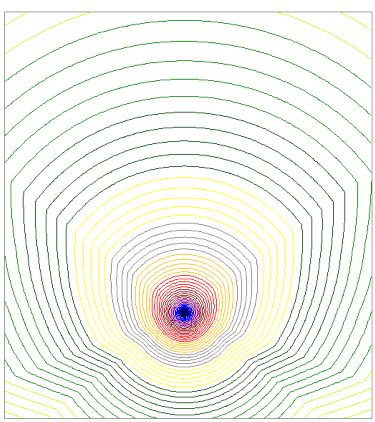
Wind Direction (°) D/E/N The wind direction is the direction from which a wind originates (with 0° being North wind, i.e. wind blowing from North, with 180° being South wind etc.).

Wind Speed (m/s) D/E/N The wind speed refers to a height of 10 m above ground.

Interpolate meteorological Category

As the velocity vector of the wind in source-receiver direction is relevant for the calculation of the meteorological correction steps may result between categories. This option causes to smoothen the noise contours at the limits of areas with different meteorological categories by interpolation.

Example

	horizontal grid from a point source with meteo settings: - stability class: A - wind direction: 180° - wind speed: 5.0 m/s option „Interpolate meteorological Category“ deactivated
	as above option „Interpolate meteorological Category“ activated

Batch Processing

Different meteorological configurations for a distinct situation can be processed automatically. The procedure to be followed consists of the following:

- the situation file with several receiver points (`*.cna`),
- the macro-file specifying the configuration of calculation and the results to be exported (`*.cnm`).
- The macro-file is loaded into **CadnaA** via menu **File|Open**. Select the option „All Files" from the list box „File Type" to select the cnm-file.
- Upon opening of the file the batch processing start automatically and saves the results to a text file with file extension `*.log`.

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Examples\ 05_Immissions\ Harmonoise_Concawe

An example is provided on the **CadnaA**-CD. The settings in the example refer to the method „Harmonoise". Please see chapter 6.2.9.5 for more details.

Additional Information

Barrier Attenuation

In the CONCAWE-report, section 2.7, it says:

„The presence of a discrete barrier may reduce ground effects and it is proposed that this be covered by recalculating K5 based an the barrier height and barrier-receiver distance."

Furthermore, it says in section 5.1.6:

„This is not, however, necessary if the barrier is a topographical feature."

This proposal is not respected in **CadnaA** as it causes level jumps due to different path length differences.

6.2.10 Road Tab

☝ Information on the calculation options for the following standards or guidelines for industry can be found in the German version of the **CadnaA**-reference manual:

- RVS 4.02 (Austria)
- StL-86 (Switzerland)
- DIN 18005 (1987, Germany)

Table „Propagation Models Road"

The subsequent table lists the main characteristics of the propagation models for road noise as treated in the chapters explaining the configuration options. A special focus is put to the type of modelling being used for the various attenuating effects in sound propagation.

Table „Obstacles and Special-Objects"

A further table describes the properties of obstacles and special-objects in **CadnaA** with each propagation model.

Propagation Models Road

No	Option or Propagation Effect	Standard / Guideline RLS-90 (1990)
1	calculation using A-weighted levels	yes
2	spectral calculation	no
3	geometrical attenuation (divergence)	line source propagation (includes air absorption)
4	attenuation by air absorption	considered within the geometrical attenuation
5	handling of ground reflections	not by image sources, but by an algorithm considering ground attenuation and meteorological effects in common (see below)
6	handling of reflections at obstacles	just up to 1st order of reflection, higher orders of reflection applying a „Correction for multiple Reflections“, in **CadnaA** optionally: calculation to up the 20th order, condition for reflection considers obstacle’s size and absorption coefficient/reflection loss of the reflector
7	attenuation due to ground effect (ground attenuation)	for A-weighted levels (not applying ground factor G)
8	attenuation due to screening (at objects)	single and double diffraction based on the path length difference of the direct path via the obstacle, screening effect does not depend on wavelength (as just for A-weighted levels), negative path difference cause no screening REMARK: „acoustical Transparency“ of buildings not available
9	handling of lateral diffraction	not considered, in **CadnaA** optionally available
10	handling of multiple obstacles in ray path	based on the path length difference of the direct path across all obstacles („ribbon band method“)
11	attenuation due to screening (terrain)	screening by terrain not treated explicitly, In **CadnaA** the algorithm for multiple screening objects is applied.
12	handling of meteorological effects (wind)	not treated explicitly as being part of the ground attenuation (meteorological correction is part of the screening calculation), in **CadnaA** optional application of Cmet accord. to ISO 9613-2
13	attenuation due to foliage	not considered, in **CadnaA** optionally accord. to ISO 9613
14	attenuation due to built-up areas	not considered, in **CadnaA** optionally accord. to ISO 9613

Standard / Guideline							No
Nordic (1996)	**NMPB (1996)**	**CRTN**	**TNM**	**Czech Method**	**SonRoad**	**NMPB (2008)**	
yes	yes	yes	yes	yes	yes	yes	1
no	yes (125 to 4000 Hz)	no	yes (in third-octaves)	no	yes (in third-octaves)	yes (125 to 4000 Hz)	2
LAeq/LAFmax: line/point source propagation	point source propagation ($4\pi r^2$)	in **CadnaA**: segmented line source	point source propagation ($4\pi r^2$)	point source propagation ($4\pi r^2$)	point source propagation ($4\pi r^2$)	point source propagation ($4\pi r^2$)	3
not considered	yes (for 15°C and 70% r.h.)	not considered	acc. ISO 9613-1 (e.g. 20°C, 50%)	combined with ground att.	acc. ISO 9613-1 (for 15°C, 70%)	acc. ISO 9613-1 (for 15°C, 70%)	4
concept of reflection planes	algorithmic, not by image sources	algorithmic, not by image sources	complex ground impedance (air-flow resistivity)	algorithmic, not by image sources	complex ground impedance (air-flow resistivity)	algorithmic, not by image sources	5
see RLS-90	no mult. reflect. correction by default, optional in **CadnaA**	not using image sources (optional in **CadnaA**)	in **CadnaA**: via absorption coeff./reflect. loss of reflector	see RLS-90	using complex reflection factor & phase relation	no mult. reflect. correction by default, optional in **CadnaA**	6
soft or hard ground only (combined with screening)	spectral model (for favorable: ISO 9613-2, for homogeneous specific)	empirical correction	via transfer table from airflow resistivity σ to ground factor G	combined ground and meteorological correction	via transfer table from airflow resistivity σ to ground factor G	see NMPB (1996)	7
concept of effective height	based on path length difference	based on path length difference	diffraction model using Fresnel-zones & complex ground impedance	see RLS-90	using path length difference (ISO 9613-2), ground reflection based on Fresnel-zones	based on path length difference	8
not considered	not considered	not considered	not considered	see RLS-90	not considered	not considered	9
using the two most efficient screens	see RLS-90	inverse energetic sum of individual barrier corrections	via path length difference	see RLS-90	via path length difference	via path length difference	10
as with multiple screens	see RLS-90	as with multiple screens (no lateral diffraction)	as with multiple screens	see RLS-90	as with multiple screens	as with multiple screens	11
not available	for homogeneous or favorable conditions	not available	not available	not available, optional in **CadnaA**: using Cmet	for homogeneous meteorological conditions (see NMPB)	for homogeneous or favorable conditions	12
not available	not available	not available	in **CadnaA** not available	not available	available	not available	13
not available	not available	not available	in **CadnaA** not available	not available	not available	not available	14

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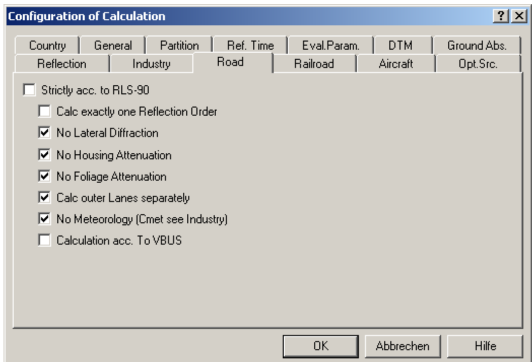
Obstacles and Special-Objects

No	Object Type/ Option	Standard / Guideline
		RLS-90
1	building	single and multiple diffraction for edges parallel to the ground based on the shortest path difference, no lateral diffraction via the vertical edges by default, no reflection or by input of absorption coefficient/reflection loss, no acoustical transparency
2	cylinder	single and multiple diffraction for edges parallel to the ground based on the shortest path difference, no lateral diffraction by default, no reflection or by input of absorption coefficient/reflection loss, reflection up to 1st order
3	barrier	single and multiple diffraction for edges parallel to the ground based on the shortest path difference, no lateral diffraction by default, no reflection or by input of absorption coefficient/reflection loss
4	floating barrier	no diffraction via the lower edge (screening edge without diffraction), otherwise see barrier
5	barrier with cantilever	cantilever is totally absorbing (no reflection), calculation of the path length difference valid for receivers/grid points outside and below the cantilever, otherwise see barrier
6	bridge plate	diffraction calculation for horizontal plate only (inclined plate approximated to horizontal plate), screening calculation valid for sources above the bridge plate (diffraction downwards), no reflection-induced level increase below the bridge plate (as ground is not modelled by mirror sources)
7	embankment	acts as a double barrier, diffraction for direct path (without lateral diffraction), no absorptive/reflective properties REMARK: The embankment is not considered in the triangulation!
8	ground absorption area	not relevant (generalized ground attenuation)
9	built-up area/ foliage	not relevant by default, optionally accord. to VDI 2714
10	3D-reflector	screening calculation based on the shortest path length difference, plus two lateral paths, diffraction can be suppressed for up to 32 edges, no reflection or by input of absorption coefficient/reflection loss, reflection up to 1st order, no summation of diffraction effects via multiple edges, no multiple diffraction
11	self screening	additional feature in **CadnaA**: causes screening effect downwards, additional with left/ right available (fixed to the road, screening just for the own road source)
12	additional width/ parapet L/R	parapet left/right available, parapet length can be restricted using station marks, additional width just for ground absorption with no effect with RSL-90

Standard / Guideline							No
Nordic (1996)	NMPB (1996)	CRTN	TNM	Czech Method	SonRoad	NMPB (2008)	
see RLS-90	see RLS-90	see RLS-90	numerical diffraction model	see RLS-90	numerical diffraction model	see RLS-90	1
see RLS-90	see RLS-90	see RLS-90	see above	see RLS-90	see above	see RLS-90	2
see RLS-90	see RLS-90	see RLS-90	see above	see RLS-90	see above	see RLS-90	3
see RLS-90	see RLS-90	see RLS-90	not available	see RLS-90	not available	see RLS-90	4
not available (due to „effective height“ concept)	not available	not available	not available	not available	not available	not available	5
see RLS-90	see RLS-90	see RLS-90	available	see RLS-90	available	see RLS-90	6
see RLS-90	see RLS-90	see RLS-90	available	see RLS-90	available	see RLS-90	7
in **CadnaA**: using ground factor G (soft/ hard only)	using ground factor G (for favorable and homogeneous)	empirical ground correction (chart)	from ground factor G transferred to airflow resistivity σ	not relevant	from ground factor G transferred to airflow resistivity σ	using ground factor G (for favorable and homogeneous)	8
not available	not available	not available	not available in **CadnaA** (for the time being)	not available	not available in **CadnaA** (for the time being)	not available	9
not available (due to „effective height“ concept)	see RLS-90	see RLS-90	not available	see RLS-90	not available	see RLS-90	10
see RLS-90	see RLS-90	see RLS-90	available	see RLS-90	available	see RLS-90	11
see RLS-90	see RLS-90	see RLS-90	available	see RLS-90	available	see RLS-90	12

6.2.10.1 RLS-90



Dialog **Configuration**, tab „Road“ for RLS-90
(with option „strictly accord. to RLS-90“ deactivated)

6

Strictly according to RLS-90

With the check box „Strictly according to RLS-90“ activated, **CadnaA** calculates using the following settings:

- only the first-order reflections, irrespective of the order of reflection specified on the „Reflection“ tab,
- no lateral diffraction at obstacles,
- no attenuation due to foliage and built-up areas,
- no meteorological correction, and
- the two outermost lanes of a road are calculated as separate line sources with a height of 0.5 m above road.

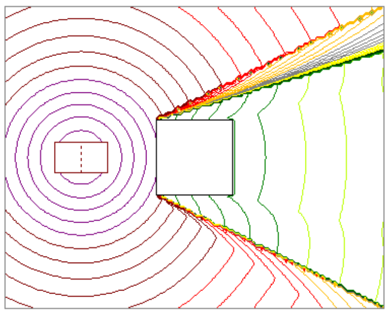
☝ All other settings made on the „Reflection“ tab, "Conditions for Calculation of Reflection", such as the search radius for reflecting objects, will apply even when the option „Strictly according to RLS-90“ is activated (see chapter 6.2.8 "Reflection Tab").

Calc exactly one reflection order

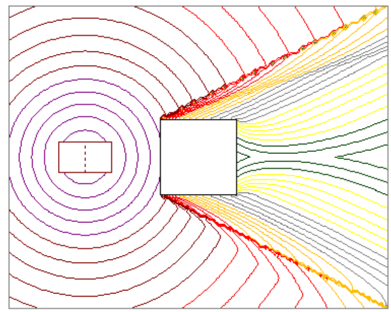
With this option deactivated the maximum order of reflection is specified via the „Reflection“ tab (see chapter 6.2.8 "Reflection Tab").

No Lateral Diffraction

When this option is deactivated the lateral diffraction will be considered which is normally not the relevant to the receiver level due to the extension of the road sources (line sources) in normal situations.



no lateral diffraction by default, option „Strictly according to RLS-90“ activated (short road section)



with lateral diffraction, option „Strictly according to RLS-90“ and „No Lateral Diffraction“ deactivated

No Housing Attenuation

By default, the attenuation by built-up areas is not considered by RLS-90. When this option is deactivated the **CadnaA**-object „Built-Up Area“ causes a screening effect.

☝ The housing attenuation D_G is calculated accord. to VDI 2714 (see chapter 3.7 "Built-Up Areas and Foliage"). This value is <u>not</u> displayed on the calculation protocol in a separate column (see **CadnaA**-manual „Attributes, Variables, and Keywords“, chapter 7.2 "Protocol - Abbreviations").

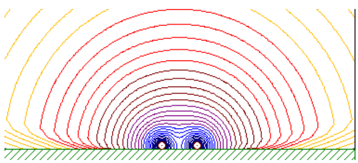
No Foliage Attenuation

By default, the attenuation by foliage is not considered by RLS-90. When this option is deactivated the **CadnaA**-object „Foliage“ causes a screening effect.

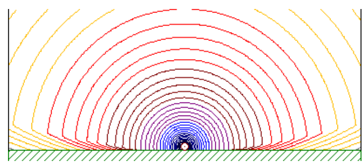
☝ The attenuation due to foliage D_G is calculated accord. to VDI 2714 (see chapter 3.7 "Built-Up Areas and Foliage"). This value is <u>not</u> displayed on the calculation protocol in a separate column.

Calc outer Lanes separately

By default, the center lines of the outermost lanes of a road are the emission lines in RLS-90 (at a height of 0.5 m). When this option is inactive just the road’s center line represents the emission line.



vertical grid,
perpendicular to the road’s axis:
option „Strictly according
to RLS-90“ activated



vertical grid:
option „Strictly according
to RLS-90“ and „Calc outer Lanes
separately“ deactivated

No Meteorology (Cmet see Industry)

No meteorological correction is established by RLS-90. In **CadnaA**, nevertheless, the meteorological effect can be considered by deactivation of this option. In this case, the settings on the list box „Meteorology“ on the „Industry“ tab are relevant.

☝ Die value of C_{met} will be calculated according to ISO 9613-2. This value is <u>not</u> displayed on the calculation protocol in a separate column.

see also: chapter 6.2.9.1 "ISO 9613", section "Meteorology"

6

Calculation accord. to VBUS

☝ relevant for Germany only!

The German guideline VBUS is selectable on the „Road“ tab with RLS-90 selected. The main modifications compared to the original procedure from RLS-90 are:

- The setting for lateral diffraction is not possible any longer.
- The calculation includes the meteorological correction C_{met} (C_0 for Day/Evening/Night is 2/1/0 dB).
- From MDTD values the number of vehicles per hour M (Day/Evening/Night) are calculated according to VBUS (different from RLS-90).

Displaying the value of C_{met}

The value of C_{met} when calculating road noise accord. to RLS-90 can be displayed for raids with a road width of 0 m. Different values result for the two emission lines of roads with a finite road width (the values of which, however, cannot be displayed using the procedure described in the following).

Proceed as follows:

- First, deactivate the option „No Meteorology (Cmet see Industry)“ and enter - for example - the following values for C0 on the „Industry“ tab: D/E/N = 3/2/1 dB (for ISO 9613).
- Activate the option „Write Protocol“ on the **Calculation|Protocol** menu.
- Start the calculation by clicking on the pocket calculator symbol on the symbol bar.
- Open the protocol via **Calculation(|Protocol** menu, button „Print“|Preview“.
- When subtracting the individual attenuation terms from the emission value you will appreciate that not the receiving level as shown results, but that for every segment a difference remains.
- In order to display this difference on the protocol the road source is converted into a line source (via the dialog **Modify Objects|Convert to**, „Road“ into „line Source“).

With this, the emission parameter will be converted according to:

$$L_{wA}" = L_{m,E} + 19.2\ dB$$

As the source height of the road is 0.5 m above ground, the line source needs to get lifted up to 0.5 m first.

- Open again the dialog **Modify Objects|Modify Attribute** for the object „Line Source“ and click OK.
- On the dialog **Modify Attribute**, select the attribute HA form the list box and enter for „Arithmetic|New Value“ 0.5 m.

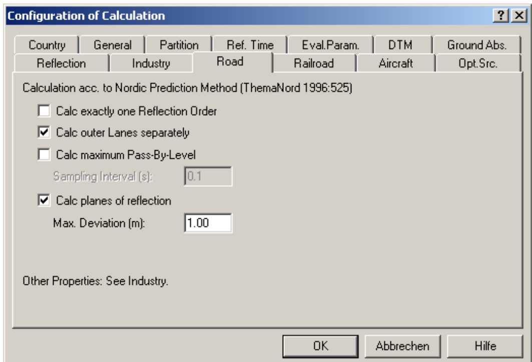
After click on OK the relative height of the line sources is set to 0.5 m.

- Start the calculation by clicking on the pocket calculator symbol once more.
- Open the protocol (**Calculation|Protocol** menu, button „Print“|Preview“).

The values for C_{met} displayed on the protocol are those relevant for the road noise calculation. The receiver level and the further attenuation terms displayed on the protocol are, however, not relevant as the result from ISO 9613-2 and not from RLS-90.

6

6.2.10.2 Nordic Prediction Method (1996)



Dialog **Configuration**, tab „Road“ for Nordic Prediction Method (1996)

6

Calc exactly one Reflection Order

With this option deactivated the maximum order of reflection is specified via the „Reflection“ tab (see chapter 6.2.8 "Reflection Tab").

see also 2.4.3 Nordic Prediction Method 1996

Calc outer Lanes separately

By default, the center lines of the outermost lanes of a road are the emission lines (at a height of 0.5 m). When this option is active just the road’s center represents the emission line.

☝ According to NPM, when screening occurs, the source location for receivers behind the barrier is shifted to the barrier’s top edge.

Calc maximum Pass-By-Level

The A-weighted maximum sound pressure level L_{AFmax} is an additional descriptor of noise from road traffic in Nordic Prediction Method /64/. The different corrections are calculated in complete analogy with those of the A-weighted equivalent continuous sound pressure level $L_{A,eq}$ with the one exception that the shortest distance source-receiver is used instead of the distance of calculation.

To calculate maximum levels, **CadnaA** moves a point source along each road according to its speed and specified sampling interval. The source is starting from either ends of the road due to the two emission lines representing the road where different corrections may apply (e.g. gradient correction).

The maximum level for this point source for each position with the specified sound power level and length is calculated.

Sampling Interval (s)

6

In order to determine the highest level, **CadnaA** shifts the source along the road in steps based on the sampling interval (in seconds). The default value for the sampling interval is 0.1 seconds. Consequently, the resulting distance difference between two source positions is:

$$s = v \cdot t_{sampling} \cdot \frac{1000}{3600}$$

where
s: distance steps (m)
v: speed (km/h), as entered on dialog **Road** for „Autos“
t: sampling interval (s)

Example

The maximum level for the road is calculated using the default sampling interval of 0.1 seconds. The maximum speed for autos is 100 km/h resulting in a sampling distance of:

$$s = 100 \cdot 0.1 \cdot \frac{1000}{3600} = 2.78\ m$$

The stated maximum level is the maximum level from all sub-sources.

Calc planes of reflection

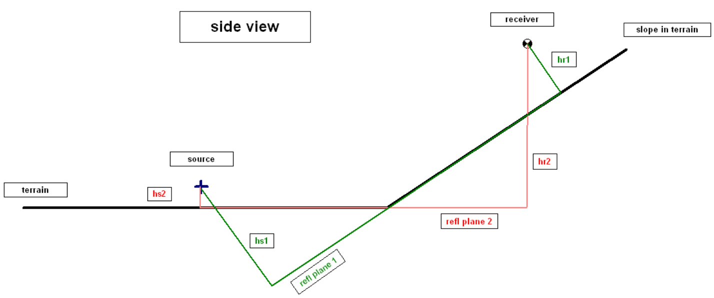
When this option is activated, the shape of terrain is approximated by at least a single or several planes of reflection when calculating the ground effect.

☝ The use of reflection planes is required with strict application of Nordic Prediction Method (NPM).

The intention with this approach is to model the direct path and the reflected path (as reflected by the ground) separately. Furthermore, NPM states that:

„If more than one valid plane of reflection can be found, the one giving the highest noise level shall be selected.“

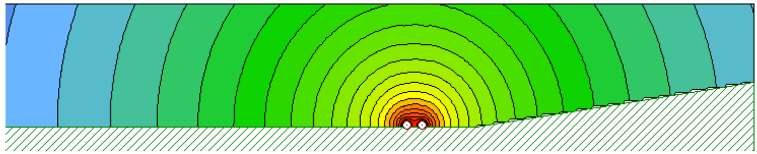
The principle of the procedure to construct the plane/s of reflection as simple terrain slope is studied (see figure below).



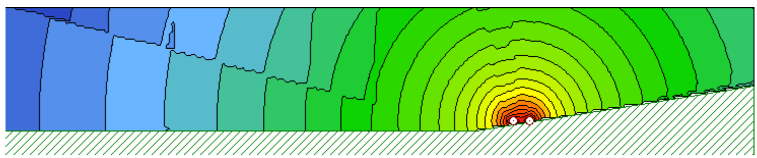
Constructing the reflection plane in Nordic Prediction Method (NPM)

The black line represents the terrain slope between source and receiver. In this simple scenario, two reflection planes can be constructed (each with different source and receiver heights referring to the respective reflection plane). According to the above rule the reflection plane giving the highest level for each receiver point is relevant.

In conjunction with grid calculations the effect of this rule becomes obvious: At some grid point the relevant reflection plane switches from one to another causing a level jump on the grid (see figures below).



Vertical grid: road on plane ground, reflecting ground (G=0),
highest level occurs from reflection plane 2 (see before) for the entire grid,
no ground effect to the right of the road as highest
level occurs from plane 2 assuming even ground



Vertical grid: road on slope, reflecting ground (G=0),
considering reflection plane 1 (see above) causing
ground effect to the right and level jumps to the left of the road

Maximum Deviation (m)

According to Nordic Prediction Model, section 2.4.1.4, the vertical deviation from the real terrain shall not exceed +/- 1 m. In addition, it is stated: „+/- 0.5 m desirable for „hard“ ground“.

In **CadnaA**, the default value is 1 meter. The smaller this value the more reflection planes are to be generated, increasing also the calculation time.

Other Properties: See Industry

This hint refers to the following settings on the „Industry“ tab:

- option „lateral diffraction“
- option „if distance smaller“
- temperature/relative humidity

Further Information

Ground Absorption

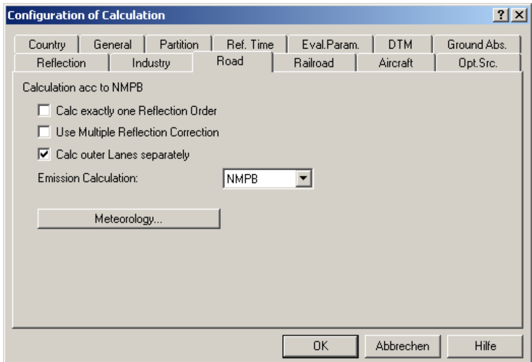
In NPM, the ground can either be acoustically soft or hard. There are no specifications for intermediate ground properties.

In **CadnaA**, the ground factor G is used to distinguish both cases (see chapter 6.2.7 "Ground Absorption Tab"):

- soft ground: G > 0.5 (enter G=1)
- hard ground: G <= 0.5 (enter G=0)

According to NPM, the valid ground type for the situation is the ground type (absorption factor G) in the area of the reflection point +/- 10 m. In **CadnaA**, it depends on the ground absorption factor between the source line and the reflection point (resp. line) whether soft or hard ground is considered.

6.2.10.3 NMPB 1996



Dialog **Configuration**, tab „Road“ for NMPB (1996)

Calc exactly one Reflection Order

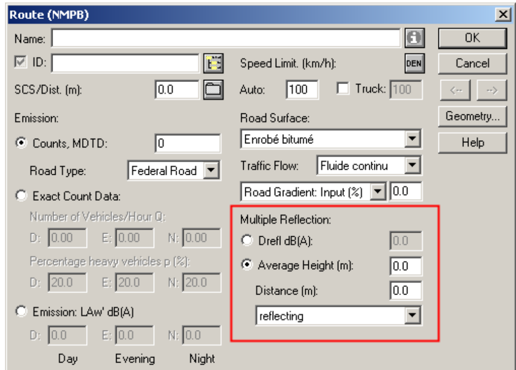
By default, this option is deactivated. In this case, the maximum order of reflection is specified via the „Reflection“ tab (see chapter 6.2.8 "Reflection Tab").

With this option being activated just 1st order of reflection will be considered. In this case, higher reflections should be accounted for by the multiple reflection correction according to RLS-90 /12/ (see below).

Use Multiple Reflection Correction

When this option is activated the multiple reflection correction is calculated according to RLS-90 (see chapter 2.4.2 "RLS-90"), based on additional input data in the edit dialog of each road object. By default, this option is deactivated.

☝ The application of both options, „Calc exactly one Reflection Order“ and „Use Multiple Reflection Correction“, may heavily reduce the calculation time as NMPB-method usually requires a higher order of reflection to be selected to obtain realistic levels.



Extended dialog **Road** to consider the Correction
for Multiple Reflections acc. to RLS-90 (inside red frame)

In this case the dialog is extended at the bottom right by an input scheme to enter the required data (for details see chapter 2.4.2 "RLS-90", section "Correction for Multiple Reflections").

Calculate outer Lanes separately

By default, the center lines of the outermost lanes of a road are the emission lines (at a height of 0.5 m). When this option is activated just the road's center line represents the emission line.

Emission Calculation

Three different types of emission spectrum can be selected:

- NMPB - Guide de Bruit:
  This setting applies the emission spectrum as specified by the original guideline /66/ (see chapter 2.4.4).
- Mithra:
  This setting applies the modified emission spectrum as used in the former French software MITHRA which differs from the guideline.
- EC-guideline 2003/613/EC:
  This setting applies the modified emission spectrum (see below) to be used in conjunction with the EC-interim calculation methods /99/.

Reference Spectrum accord. to 2003/613/EC

The values R(j) of the weighting spectrum to be used in accordance with 2003/613/EC is:

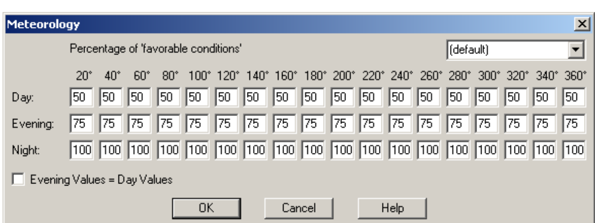
i	Frequency (Hz)	R(j) in dB(A)
1	125	-14,5
2	250	-10,2
3	500	-7,2
4	1000	-3,9
5	2000	-6,4
6	4000	-11,4

Meteorology

Via the button „Meteorology“ the percentage of „favorable conditions“ in wind sectors stepped by 20° can be specified for the time periods D/E/N separately. The percentage refers to the assessment interval, usually an entire year.

Note 1 - „Favorable conditions“ are such which faciliates the propagation of sound (i.e. which are likely to cause a higher sound pressure level at the receiver point). This situation makes use of the (spectral) ground attenuation for downwind propagation conditions as specified in ISO 9613-2 /7/.

Note 2 - The „homogeneous condition“ does not refer to any specific meteorological situation. In fact, the rays are straight lines, not accounting for any atmospheric influence. This kind of meteorological situation has been applied by all former prediction models used in France.



Evening Values = Day Values

With this option active the daytime values will be applied for the Evening period as well.

List Box Locations

The list box offers a variety of predefined locations (within France) combined with respective data for the percentage of favorable conditions.

☝ No hint is possible here what percentage may apply to an unknown location when just having a general description of the local orography.

6

Additional Information

Diffraction Model

NMPB applies a different correction with one screen and with two screens. The correction of ground attenuation for rays above barriers depends on the distance from the source to the first barrier, and from the distance from the last barrier to the receiver. Thus, the obtained results are specific to the NMPB-approach and not due to **CadnaA**-implementation (see equation (16) in chapter 7.4.4 of NMPB /66/).

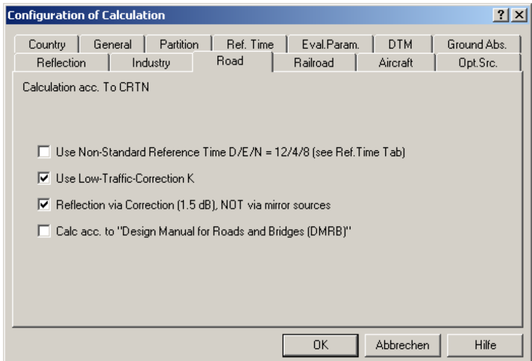
Additional Road Surfaces

The additional road surfaces selectable according to EC-guideline 2003/613/EC are selectable from the **Road** dialog, list box “Road Surface“.

see chapter 2.4.4 "NMPB 1996"

6

6.2.10.4 CRTN



Dialog **Configuration**, tab „Road“ for CRTN

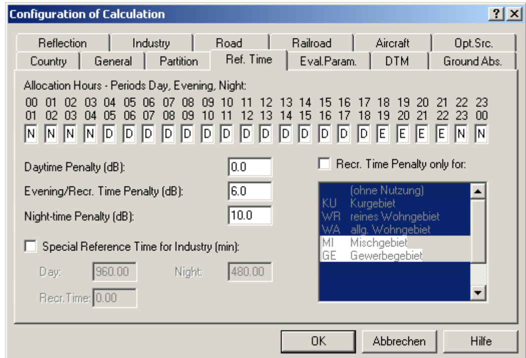
Use Non Standard Reference Time D/E/N = 12/4/8

When using diurnal patterns the hourly traffic flow considered to calculate the emission is by default restricted to the time interval from 6:00 to 24:00 hours. To apply the daily hours as allocated to the intervals D/E/N on the „Reference Time“ tab this option has to be activated.

☝ The application of diurnal patterns with this option deactivated (i.e. strictly applying CRTN) is explained in chapter 2.4.5 "CRTN".

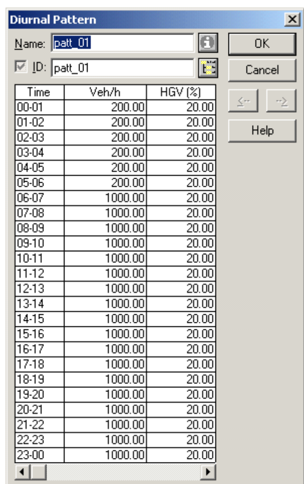
Example

In this example, the daily intervals D/E/N are set to D from 4 to 18 hours (14 hours), to E from 18 to 22 hours (=4 hours), and to N from 22 to 4 hours (= 6 hours).



Calculation|Configuration dialog, „Reference Time“ tab

The following diurnal pattern „patt_01“ is used in this example. Traffic figures are 200 vehicles/h from 0:00 to 6:00 hours, and 1000 vehicles/h from 6:00 to 24:00 hours (with HGV=20% for each hour).



Diurnal Pattern „patt_01“

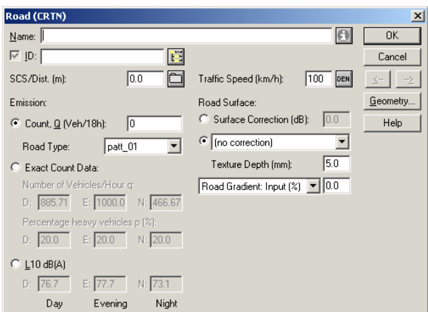
The hourly traffic data for periods D/E/N result from (see dialogs below):

for D: 12400 veh/14 h = 885.71 veh/h

for E: 4000 veh/4 h = 1000 veh/h

for N: 2800 veh/6 h = 466.67 veh/h

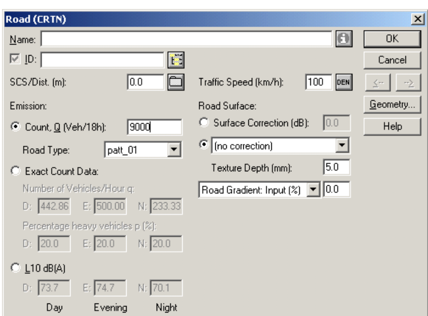
The figure to be entered to normalize to a different total traffic count Q still refers to the traffic counts within the time interval from 6:00 to 24:00 hours (i.e. 18 hours) of the pattern selected.



Example 1:

diurnal pattern PATT_01 with Q=0 veh/18 h (6-24h)

applies full traffic counts as from selected diurnal pattern



Example 2:

diurnal pattern PATT_01 with Q=9000 veh/18 h (6-24h)

applies - in this example - 50% of the traffic counts from the selected diurnal pattern

(so, not entering 50% of 19200 veh/24h = 9600 veh/24h

Use Low Traffic-Correction K

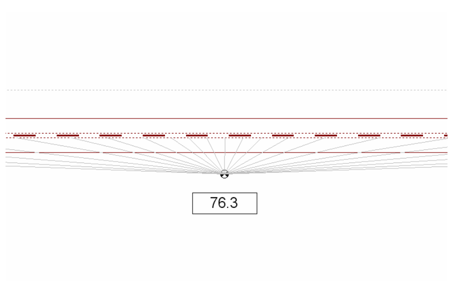
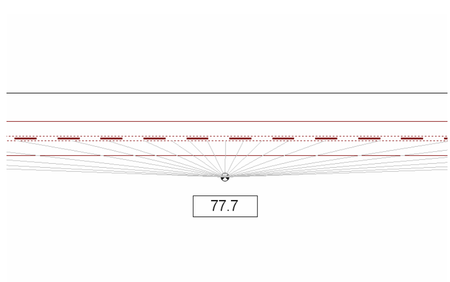
Clause 30 of CRTN specifies that for a road segment where the traffic flow is in the range 50<=q<2000 veh/h or 1000<=Q<4000 veh/18h and the shortest slant distance d' source-receiver is less than 30 metres a low traffic-correction shall be applied.

In **CadnaA**, the condition for q and Q are respected independently, depending on what is selected. The emission value L10 displayed on the road dialog, however, is not corrected as the receiver's distance is not known to the road object. The low traffic-correction is applied to all receivers respecting the conditions.

Reflection via Correction (1.5 dB), NOT via mirror sources

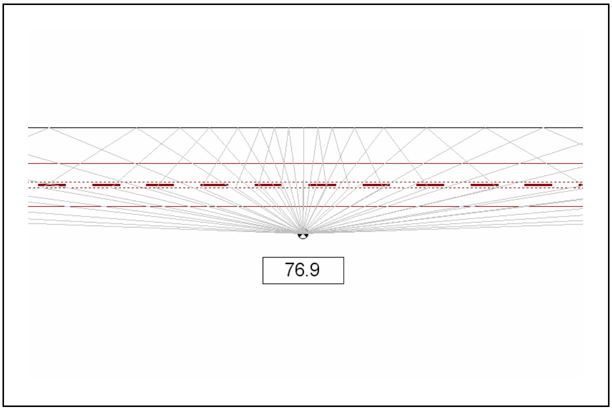
CRTN clause 26.2 specifies that the reflection from buildings or other reflecting objects (e.g. barriers) on the opposite side of the road have to be considered by a correction of 1.5 dB depending on the angle of the reflecting object/s seen from the receiver. The value of 1.5 dB occurs in case the entire length of the road has reflecting buildings (i.e. is the maximum reflection correction).

When activating this option this CRTN-specific reflection correction of +1.5 dB is applied. **CadnaA** considers the sum of angles of reflection in relation to the total segment angle as specified in figure 5 of CRTN.

	long road with opposite reflecting barrier, reflecting barrier <u>deactivated</u>
	reflecting barrier <u>activated</u>, calculation of reflections according to CRTN clause 26.2 Note - Level increase is just 1.4 dB due to finite road & barrier length.

With this option being deactivated, the increase due to reflections is calculated by mirror sources (as usually with **CadnaA**). In this case, the settings on „Reflection“ tab apply (e.g. order of reflection etc.).

☝ Buildings/barriers should be set to reflective for reflections to be included.



Reflected rays by a barrier (1st order of reflection)

However, the results with this option deactivated are not in line with the specifications of CRTN.

☝ Buildings and barriers with an absorption coefficient of less than 0.8 will be accounted for as being reflecting in CRTN-calculations where the max. 1.5 dB-correction applies. Buildings and barriers with an absorption coefficient larger or equal to 0.8 will be excluded from the 1.5 dB-correction.

Calc accord. to "Design Manual for Roads and Bridges (DMRB)"

The "Design Manual for Roads and Bridges" (release August 2008 /73/) states the following modifications to CRTN-calculation:

- road surface correction editable (attribute DSTRO),
- no further increase of ground absorption beyond 600 m distance from the road (A_{gr}=A_{gr}(600 m) for d>600 m),
- additional rules whether reflections from opposite facades or barriers occur.

With this option activated the DMRB-calculation rules are applied.

☝ The option "Reflection via Correction (1.5 dB), NOT via mirror sources" needs to be activated in this case.

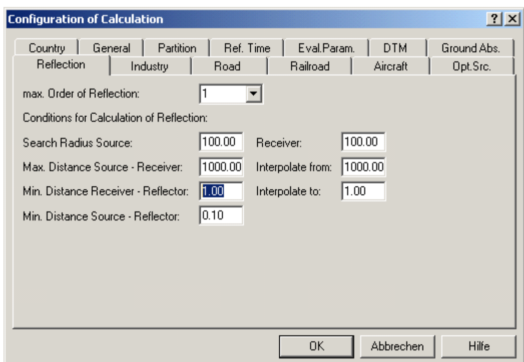
6

Additional Information

Facade Effect

CRTN specifies in clause 26.1 that for calculations of the noise level at a distance of 1 metre in front of a façade a correction of +2.5 dB has to be made. **CadnaA** does not apply this correction automatically for the time being as this CRTN-specification does not match the normal approach when calculating façade reflections.

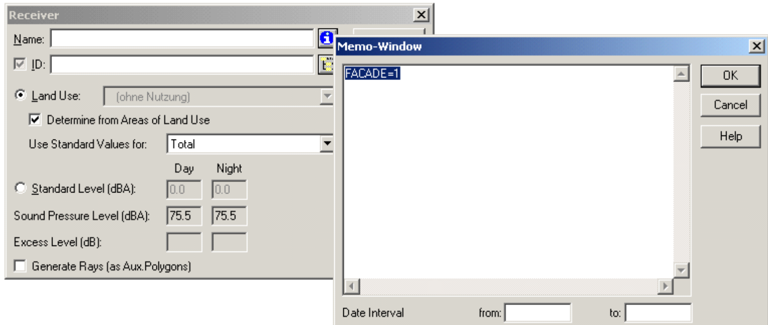
By default, the façade level at receiver points in front of the façade (e.g. at 0.05 m off the facades plane) does not include reflections at the own buildings surface. This is achieved in **CadnaA** by setting the "Minimum Distance Receiver-Reflector" to e.g. 1 m (so, larger than the distance of the receiver from the façade).



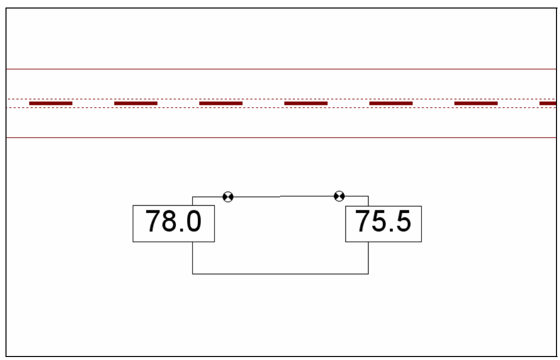
Reflections are calculated when this distance is set to 0 m, when the building is reflective, and when at least the first reflection order has been selected (**Configuration** dialog, „Reflection“ tab). To apply the correction of 2.5 dB for CRTN-calculation the following conditions have to be fulfilled:

- The option "Reflection via Correction …" on the „Road“ tab of the dialog **Configuration** is activated.
- Each receiver intended to consider the CRTN-correction of +2.5 dB has the text-variable FACADE=1 specified on the receivers memo window.

6



The building below has got two receivers attached to its facade.



Two receivers at building’s facade, left rcvr with correction, right rcvr w/o

The receiver on the left has a text-variable FACADE=1 defined. The increase of 2.5 dB according to CRTN is considered. The receiver on the right has no text variable defined (or with the text variable being zero, FACADE=0). Thus, the level increase is not added.

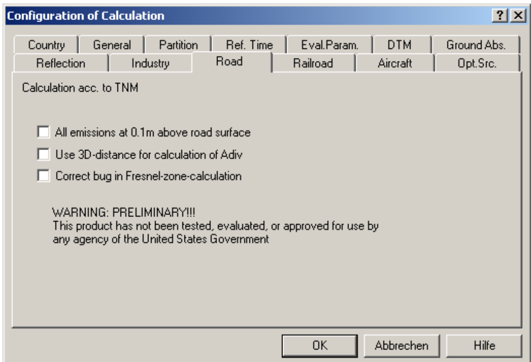
Grid calculations for EU-noise indices

see chapter 5.3.4 "Grid Arithmetic", section "Grid calculations for EU-noise indices with CRTN"

Conversion to EU-indices at individual receivers

see chapter 11.2.1 "Edit Result Table", section "Conversion to EU-indices at individual receivers with CRTN"

6.2.10.5 TNM

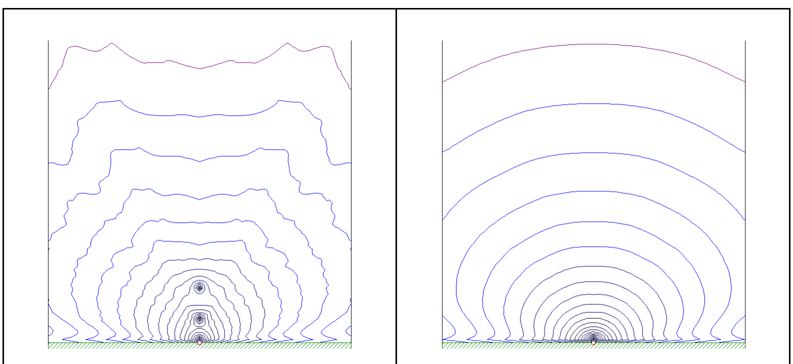


Dialog **Configuration**, tab „Road“ for TNM

By default, all available settings listed below are deactivated.

All Emissions at 0.1 m above road surface

The emission model of TNM considers - depending on the type of source - several emission heights. Activating this option will level down all types of sub-sources to a common height of 0.1 m above road surface.

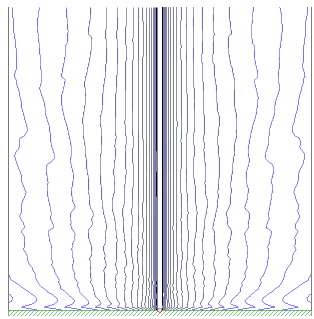
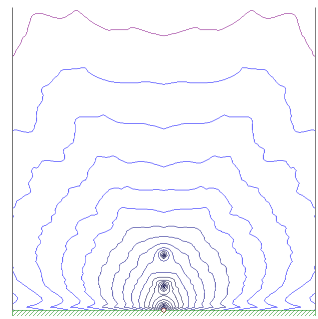


option deactivated: up to 3 sub-sources visible on the vertical grid (at 0.1/1.5/3.66 m)	option activated: just a single source height at 0.1 m (<u>for both</u>: Adiv based on 3D-distance)

6

Use 3D-distance for calculation of Adiv

In TNM, the geometrical divergence is calculated based on the 2D-path length in xy-plane only. This causes the receiver level not depending on height (i.e. level is not decreasing with receiver height). By activating this option calculated levels will depend on receiver height or height of grid points.

	
option „3D-distance for calculation of Adiv“ deactivated (i.e „strictly accord. to TNM“	option „3D-distance for calculation of Adiv“ activated

Correct bug in Fresnel-zone-calculation

In TNM 2.5-code a sign error in the calculation of Fresnel zones was discovered altering calculation results reasonably. With this option activated the Fresnel zone-bug will be corrected for in **CadnaA**-TNM.

☝ In case results shall be compared with results obtained by TNM 2.5-software this option should, however, be deactivated.

Additional Information

In order to obtain correct results in comparison with the release 2.5 of the TNM-software further configuration settings are to be respected. Those will be described here.

Ground Absorption

Regarding the ground attenuation, the settings (on **Calculation| Configuration** menu, tab "Ground Absorption") are based on the ground absorption factor G of ISO 9613-2 /7/. For the time being, the following airflow resistivities refer to the ground absorption factor G:

Airflow Resistivity (in rayls)	**Ground Absorption Factor G (ISO 9613-2)**	**TNM-specific ground type**
20000	0 (i.e. reflecting)	pavement
1000	0.33	*)
600	0.5	*)
400	0.67	*)
300	1 (i.e. absorbing)	lawn

*) These ground types are not available in **CadnaA** for the time being.

In addition activate the option „Roads/Parking Lots are reflecting (G==0)“.

☝ The latter setting will - in conjunction with the additional width from self-screening (see below) - ensure that the entire road width as considered by TNM is reflecting (and not just the region between the emission lines).

DTM: Explicit Edges only

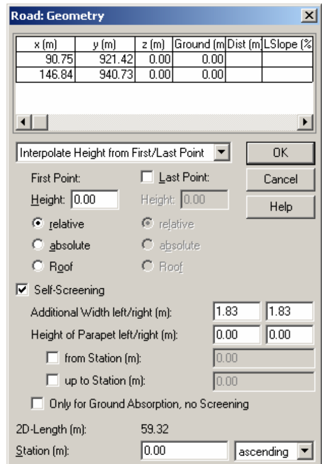
Activate on the **Calculation|Configuration** option „Explicit Edges only“, „DTM“ tab (see chapter 6.2.6 "DTM Digital Terrain Model Tab").

☝ TNM 2.5-software just triangulates between „real“ terrain contours, not using the heights of objects (e.g. roads and barriers with absolute heights). For this reason it is required that the geometry of all objects are imported additionally as terrain contours or heights points, as otherwise they will not influence the resulting terrain shape.

6

Self-Screening of Roads

Activate for all types of roads the option "Self-Screening" (dialog **Road|Geometry**) and enter an additional width of 1.83 m (6 feet).



Dialog **Road:Geometry**: self-screening
with additional width left/right of 1.83 m

☝ Changing the attribute’s values for all roads in a project is achieved more conveniently via the dialog **Modify Objects|Modfy Attribute**, for attributes SCCR_AW_L and SCCR_AW_R, respectively.

Temperature and relative Humidity

The general settings for the temperature and the relative humidity in **CadnaA** match with the default settings in TNM 2.5-software (see menu **Calculation|Configuration**, tab "Industry"):

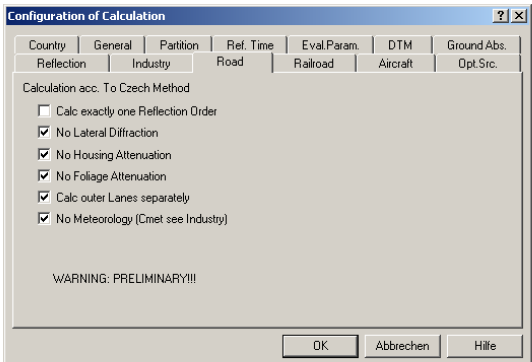
- 50% relative humidity
- temperature 20°C

Restrictions

The following features of the TNM-software are not implemented in **CadnaA** for the time being:

- no TNM-specific parallel barrier analysis,
- no accelerating ramps and flow control devices, and
- no import of TNM-files.

6.2.10.6 Czech Method

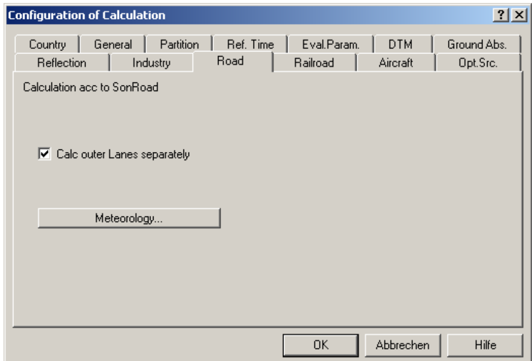


Dialog **Configuration**, tab „Road“ for Czech Method (accord. to Liberko)

6

The available configuration settings comply with those for RLS-90 (see chapter 6.2.10.1 "RLS-90").

6.2.10.7 SonRoad



Dialog **Configuration**, tab „Road" for SonRoad

Calculate outer Lanes separately

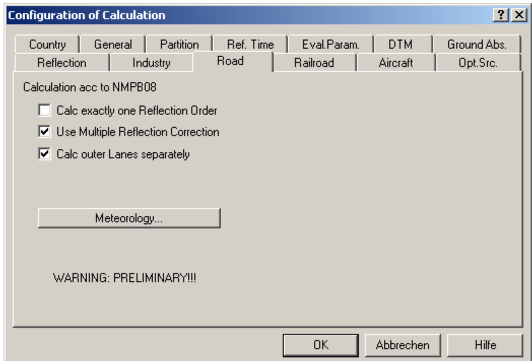
By default, the center lines of the outermost lanes of a road are the emission lines (at a height of 0.5 m). When this option is activated just the road's center line represents the emission line.

Meteorology

see chapter 6.2.10.3 "NMPB 1996", section "Meteorology"

6.2.10.8 NMPB 2008

*The implementation of the NMPB-2008 calculation procedure in **CadnaA** has a preliminary status for the time being!*



Dialog **Configuration**, tab „Road" for NMPB 2008

Calc exactly one Reflection Order

By default, this option is deactivated. In this case, the maximum order of reflection is specified via the „Reflection" tab (see chapter 6.2.8 "Reflection Tab").

With this option being activated just 1st order of reflection will be considered. In this case, higher reflections should be accounted for by the multiple reflection correction according to RLS-90 /12/ (see below).

Use Multiple Reflection Correction

When this option is activated the multiple reflection correction is calculated according to RLS-90 (see chapter 2.4.2 "RLS-90"), based on additional input data in the edit dialog of each road object. By default, this option is deactivated.

☝ The application of both options, „Calc exactly one Reflection Order" and „Use Multiple Reflection Correction", may heavily reduce the calculation time as NMPB-method usually requires a higher order of reflection to be selected to obtain realistic levels.

In this case the dialog is extended at the bottom right by an input scheme to enter the required data (for details see chapter 2.4.2 "RLS-90", section "Correction for Multiple Reflections").

Calculate outer Lanes separately

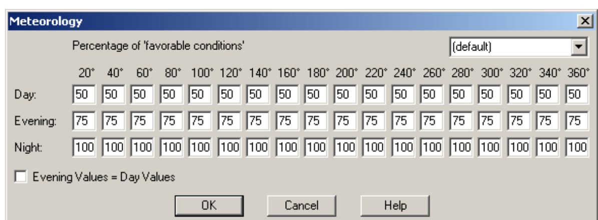
By default, the center lines of the outermost lanes of a road are the emission lines (at a height of 0.05 m). When this option is activated just the road's center line represents the emission line.

Meteorology

Via the button „Meteorology“ the percentage of „favorable conditions“ in wind sectors stepped by 20° can be specified for the time periods D/E/N separately. The percentage refers to the assessment interval, usually an entire year.

Note 1 - „Favorable conditions“ are such which faciliates the propagation of sound (i.e. which are likely to cause a higher sound pressure level at the receiver point). This situation makes use of the (spectral) ground attenuation for downwind propagation conditions as specified in ISO 9613-2 /7/.

Note 2 - The „homogeneous condition“ does not refer to any specific meteorological situation. In fact, the rays are straight lines, not accounting for any atmospheric influence. This kind of meteorological situation has been applied by all former prediction models used in France.



Evening Values = Day Values

With this option active the daytime values will be applied for the Evening period as well.

List Box Locations

The list box offers a variety of predefined locations (within France) combined with respective data for the percentage of favorable conditions.

☝ No hint is possible here what percentage may apply to an unknown location when just having a general description of the local orography.

6.2.11 Railroad Tab

☝ Information on the calculation options for the following standards or guidelines for industry can be found in the German version of the **CadnaA**-reference manual:

- ONR 305011 (Austria)
- DIN 18005 (1987, Germany)
- Semibel (Switzerland)
- Schall 03 (200X, Germany)

Table „Propagation Models Railroad“

The subsequent table lists the main characteristics of the propagation models for railroad noise as treated in the chapters explaining the configuration options. A special focus is put to the type of modelling being used for the various attenuating effects in sound propagation.

Table „Obstacles and Special-Objects“

A further table describes the properties of obstacles and special-objects in **CadnaA** with each propagation model.

Propagation Models Railroad

No	Option or Propagation Effect	Standard / Guideline Schall 03
1	calculation using A-weighted levels	yes
2	spectral calculation	no
3	geometrical attenuation (divergence)	full sphere (4π r^2)
4	attenuation by air absorption	yes (according to VDI 2714)
5	handling of ground reflections	not by image sources, but by an algorithm considering ground attenuation and meteorological effects in common (see below)
6	handling of reflections at obstacles	just up to 1st order of reflection, higher orders of reflection applying a „Correction for multiple Reflections“, in **CadnaA** optionally: calculation to up the 20th order, condition for reflection considers obstacle’s size and absorption coefficient/reflection loss of the reflector
7	attenuation due to ground effect (ground attenuation)	for A-weighted levels (not applying ground factor G)
8	attenuation due to screening (at objects)	single and double diffraction based on the path length difference of the direct path via the obstacle, screening effect does not depend on wavelength (as just for A-weighted levels), negative path difference cause no screening REMARK: „acoustical Transparency“ of buildings not available
9	handling of lateral diffraction	not considered, in **CadnaA** optionally available
10	handling of multiple obstacles in ray path	based on the path length difference of the direct path across all obstacles („ribbon band method“)
11	attenuation due to screening (terrain)	screening by terrain not treated explicitly, In **CadnaA** the algorithm for multiple screening objects is applied.
12	handling of meteorological effects (wind)	not treated explicitly as being part of the ground attenuation (meteorological correction is part of the screening calculation), in **CadnaA** optional application of Cmet accord. to ISO 9613-2
13	attenuation due to foliage	without screening calculation, but based on the length of the curved ray path (arc of a circle) passing through the foliage (with height h) assuming a radius of 5 km
14	attenuation due to built-up areas	not considered, in **CadnaA** optionally accord. to VDI 2714

Standard / Guideline					No
Nordic (1996)	**CRN**	**SRM II**	**NMPB-Fer (1996)**	**FTA/FRA**	
yes	yes	yes	see NMPB-routes (1996), chapter 6.2.10	yes	1
yes	no	yes (63 to 8000 Hz)	as above	no	2
full sphere ($4\pi\ r^2$)	in **CadnaA**: segmented line source	segmented line source (distance & viewing angle)	as above	in **CadnaA**: segmented line source	3
yes (for 15°C, 70% RH)	not considered	yes (for 10°C, 80% RH), optional acc. ISO 9613-2	as above	not considered	4
algorithmic, not by image sources	algorithmic, not by image sources	algorithmic, not by image sources	as above	algorithmic, not by image sources	5
see Schall 03	using a global correction, optional in **CadnaA**: using image sources	using image sources, using absorption coeff./ reflection loss of reflector	as above	using image sources, using absorption coeff./ reflection loss of reflector	6
complies with spectral ground attenuation model of ISO 9613-2	empirical correction	spectral ground attenua-tion model applying ground factor G (similar to ISO 9613-2)	as above	using ground factor G, based on „effective height", in **CadnaA**: average height (acc. ISO 9613-2)	7
concept of effective height	based on path length difference	concept of effective height	as above	based on path length difference and source height	8
not considered	not considered	not considered	as above	not considered	9
using the two most efficient screens	based on path length difference	concept of equivalent screens (instead of multi-ple diffraction)	as above	see Schall-03	10
as with multiple screens	as with multiple screens	as with multiple screens (no lateral diffraction)	as above	see Schall-03	11
not available	not available	available using Cm (upper limit 3.5 dB), optional in **CadnaA**: Cmet acc. to ISO 9613-2	as above	not considered	12
available	not available	not available	as above	in **CadnaA** not available (for the time being)	13
available	not available	not available	as above	in **CadnaA** not available (for the time being)	14

Obstacles and Special-Objects

No	Object Type/ Option	Standard / Guideline
		Schall 03
1	building	single and multiple diffraction for edges parallel to the ground based on the shortest path difference, no lateral diffraction via the vertical edges by default, no reflection or by input of absorption coefficient/reflection loss, no acoustical transparency
2	cylinder	single and multiple diffraction for edges parallel to the ground based on the shortest path difference, no lateral diffraction by default, no reflection or by input of absorption coefficient/reflection loss, reflection up to 1st order
3	barrier	single and multiple diffraction for edges parallel to the ground based on the shortest path difference, no lateral diffraction by default, no reflection or by input of absorption coefficient/reflection loss
4	floating barrier	no diffraction via the lower edge (screening edge without diffraction), otherwise see barrier
5	barrier with cantilever	cantilever is totally absorbing (no reflection), calculation of the path length difference valid for receivers/grid points outside and below the cantilever, otherwise see barrier
6	bridge plate	diffraction calculation for horizontal plate only (inclined plate approximated to horizontal plate), screening calculation valid for sources above the bridge plate (diffraction downwards), no reflection-induced level increase below the bridge plate (as ground is not modelled by mirror sources)
7	embankment	acts as a double barrier, diffraction for direct path (without lateral diffraction), no absorptive/reflective properties REMARK: The embankment is not considered in the triangulation!
8	ground absorption area	not relevant (generalized ground attenuation)
9	built-up area/ foliage	not relevant by default, optionally accord. to VDI 2714
10	3D-reflector	screening calculation based on the shortest path length difference, plus two lateral paths, diffraction can be suppressed for up to 32 edges, no reflection or by input of absorption coefficient/reflection loss, reflection up to 1st order, no summation of diffraction effects via multiple edges, no multiple diffraction
11	self screening	additional feature in **CadnaA**: causes screening effect downwards, additional with left/right available (fixed to the road, screening just for the own road source)
12	additional width/ parapet L/R	parapet left/right available, parapet length can be restricted using station marks, additional width just for ground absorption with no effect with RSL-90

Standard / Guideline					No
Nordic (1996)	CRN	SRM II	NMPB-Fer (1996)	FTA/FRA	
see Schall 03	see Schall 03	see Schall 03	see NMPB-routes (1996), chapter 6.2.10	see Schall 03	1
see Schall 03	see Schall 03	see Schall 03	as above	see Schall 03	2
see Schall 03	see Schall 03	see Schall 03	as above	see Schall 03	3
see Schall 03	see Schall 03	see Schall 03	as above	see Schall 03	4
not available (due to „effective height“ concept)	available, using path length difference	not available (due to „effective height“ concept)	as above	not available (procedure just for vertical barriers)	5
see Schall 03	see Schall 03	see Schall 03	as above	see Schall 03	6
see Schall 03	see Schall 03	see Schall 03	as above	see Schall 03	7
yes, frequency dependent using ground factor G (as in ISO 9613-2, section 7.3.1)	empirical ground correction (chart)	frequency dependent using ground factor G (see ISO 9613-2, section 7.3.1)	as above	using ground factor G, averaging with multiple ground absorption areas	8
built-up area by sound dispersion accord. to NPM, foliage: based on path length using heff	not available	not available	as above	not available in **CadnaA** (for the time being)	9
not available (due to „effective height“ concept)	see Schall 03	not available (due to „effective height“ concept)	as above	not available (procedure just for vertical barriers)	10
see Schall 03	see Schall 03	see Schall 03	as above	see Schall 03	11
see Schall 03	see Schall 03	see Schall 03	as above	see Schall 03	12

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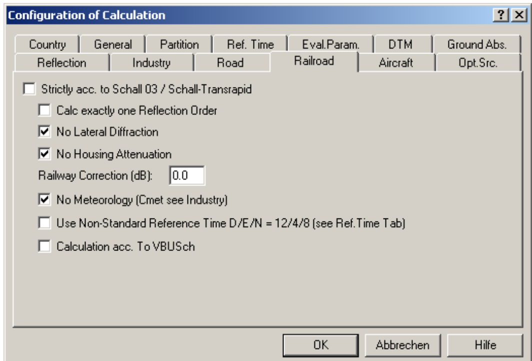
6.2.11.1 Schall 03



Dialog **Configuration**, tab „Railroad“ for Schall 03
(option „strictly according to Schall 03“ deactivated)

6

Strictly according to Schall 03

With this option activated, **CadnaA** will calculate for railways

- only the first-order reflections, irrespective of the order of reflection specified on the „Reflection“ tab,
- no lateral diffraction at obstacles,
- no attenuation by built-up areas, and
- no meteorological correction.

☝ All other settings made on the „Reflection“ tab, "Conditions for Calculation of Reflection", such as the search radius for reflecting objects, will apply even when the option „Strictly according to RLS-90“ is activated (see chapter 6.2.8 "Reflection Tab").

Calc exactly one reflection order

With this option deactivated the maximum order of reflection is specified via the „Reflection“ tab (see chapter 6.2.8 "Reflection Tab").

No Lateral Diffraction

When this option is deactivated the lateral diffraction will be considered which is normally not relevant to the receiver level due to the extension of the railway sources (line sources) in normal situations

No Housing Attenuation

By default, the attenuation by built-up areas is not considered by Schall 03. When this option is deactivated the **CadnaA**-object „Built-Up Area“ causes a screening effect.

☝ The housing attenuation D_G is calculated accord. to VDI 2714 (see chapter 3.7 "Built-Up Areas and Foliage"). This value is <u>not</u> displayed on the calculation protocol in a separate column (see **CadnaA**-manual „Attributes, Variables, and Keywords“, chapter 7.2 "Protocol - Abbreviations").

Railway Correction (dB)

Any entered railway correction will be considered upon calculation. Thus, to consider no railway correction a value of 0 dB has to be entered.

see also section "Strictly according to Schall 03"

No Meteorology (Cmet see Industry)

No meteorological correction is established by Schall 03. In **CadnaA**, nevertheless, the meteorological effect can be considered by deactivation of this option. In this case, the settings on the list box „Meteorology“ on the „Industry“ tab are relevant.

☝ Die value of C_{met} will be calculated according to ISO 9613-2. This value s <u>not</u> displayed on the calculation protocol in a separate column.

see also: chapter 6.2.9.1 "ISO 9613", section "Meteorology"

Use Non-Standard Reference Time D/E/N

When the option „Use Non-Standard Reference Time“ is activated the time intervals and penalties on the „Reference Time“ tab are taken into account in the calculation.

Railway noise - according to the majority of standards/guidelines - is calculated just for two daily periods: day and night. When doing calculations with respect to END (Environmental Noise Directive /106/), however, this option has to be activated to consider the number of trains (or the emission parameter) during the Evening period as well.

see also:

chapter 6.2.4 "Reference Time Tab"

chapter 6.2.5 "Evaluation Parameter Tab"

☝ The values displayed on the „Reference Time“ tab (D/E/N=12/4/8 h) will be updated based on the defined time intervals (hours Day/ Evening/Night).

Calculation acc. to VBUSch

relevant for Germany only!

The German method VBUSch is just relevant in conjunction with evaluations for END /106/. First, deactivate the option „Strictly according to Schall 03“ and activate the option „Calculation acc. To VBUSch“.

The main modifications are:

- The setting for lateral diffraction is not possible any longer.
- No railway bonus specifiable.
- C_{met} is calculated automatically (C_0 (D/E/N)=2/1/0 dB).
- fixed reference Time Day/Evening/Night = 12h/4h/8h
- The penalty for railway lines with wooden sleepers is 2 dB (instead 0 dB according to Schall 03).
- For maximum speeds v_{max}>200 km/h an additional aerodynamic noise source is included at a source height of 4,5 m.

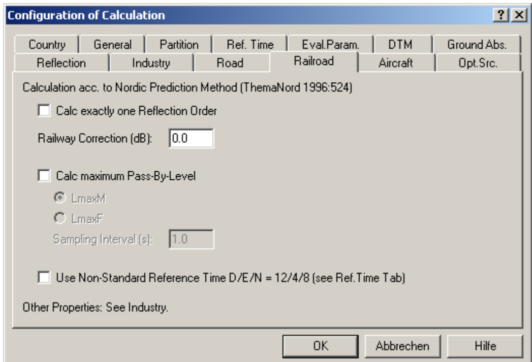
Self-Screening at Buildings

For calculations according to the German railway guideline Schall 03 the self-screening of buildings with backside receivers can alternatively be considered or not. This option refers to a requirement stated by Schall 03 (section 7.5) that „at buildings with gaps in between ... just the screening by the first row of building, being next to the railway line, shall be considered ...“ (translated from German).

To do so, a string variable SCREEN_TEST_ID=1 (on the dialog **Memo-Window**) is defined for the respective building. With the variable being set it will be checked whether the ID of a receiver corresponds with the building-ID. With corresponding IDs the respective building is screening, otherwise not.

This option enables to respect the detailed specification of Schall 03, just to consider the screening by the first row of buildings, while for backside facades the self-screening effect shall be included.

6.2.11.2 Nordic Prediction Method (1996)



Dialog **Configuration**, tab „Railway“ for Nordic Prediction Method (1996)

6

Calc exactly one reflection order

With this option deactivate the maximum order of reflection is specified via the „Reflection“ tab (see chapter 6.2.8 "Reflection Tab").

Railway Correction (dB)

Any entered railway correction will be considered upon calculation. Thus, to consider no railway correction a value of 0 dB has to be entered.

Calc maximum Pass-By-Level

The A-weighted maximum levels L_{AFmax} and L_{maxF} are additional descriptors for railway noise in Nordic Prediction Method /63/. The different corrections are calculated in complete analogy with those of the A-weighted equivalent continuous sound pressure level $L_{A,eq}$, but a different emission parameter is used (see chapter 2.6.3 "Nordic Prediction Method 1996").

Besides the emission level, the propagation models for L_{eq} and L_{max} calculations differ as well.

6

Option LmaxM/LmaxF

In **CadnaA**, the two A-weighted maximum sound pressure levels, L_{maxM} (energy average over train length) or L_{maxF} (highest level with weighting „Fast“) can be calculated alternatively.

The receiver level obtained from the emission and propagation model for maximum levels is the level L_{maxM}. The level L_{maxF} calculates from:

$$L_{\max F} = L_{\max M} + 3 - \left(\frac{3d_c}{100}\right) \quad \text{for electric trains}$$

$$L_{\max F} = L_{\max M} + 6 - \left(\frac{3d_c}{100}\right) \quad \text{for diesel trains}$$

where d_c: distance from the receiver to the trains centre, in m

☝ The option „Diesel“ has to be set accordingly for each railway group/ train class on the dialog **Library: Train Class** (see chapter 2.6.9 "Train Class Libraries", section "Application Nordic Prediction Method").

According to NPM, for d_c>100 m (electric trains) and for d_c>200 m L_{maxF} is assumed to be equal to LmaxM. These equations are used for all frequency bands.

To calculate maximum levels, **CadnaA** moves a line source for each train class in the train classes list of the railway object. This line source has the sound power level and length as specified in the list. This source is moved according to its speed and specified sampling interval (see below). The maximum level for this line source for each position with the specified sound power level and length is calculated. To cope with segmented railways (e.g. due to different maximum speeds), the train length is extended half of its length beyond the start and the end of the drawn railway object.

Sampling Interval (s)

In order to determine the highest level, **CadnaA** shifts the source along the road in steps based on the sampling interval (in seconds). The default value for the sampling interval is 0.1 seconds.

Consequently, the resulting distance difference between two source positions is:

$$s = v \cdot t_{sampling} \cdot \frac{1000}{3600}$$

where
s: distance steps (m)
v: speed (km/h), as entered on dialog **Road** for „Autos“
t: sampling interval (s)

☝ Displaying rays with maximum levels does not make sense as the radiating points are defined by the sampling time along the source' axis. The rays coming from points outside result from the procedure when calculating maximum levels: The center point of the first, respectively last section is shifted to the very beginning and end of the drawn road segment. So, a section is apparently extended, but these parts are not relevant for the maximum level.

6

Other Properties: See Industry

This hint refers to the following settings on the „Industry“ tab:

- lateral diffraction
- if distance smaller
- temperature/relative humidity

Use Non-Standard Reference Time D/E/N

When the option „Use Non-Standard Reference Time“ is activated the time intervals and penalties on the „Reference Time“ tab are taken into account in the calculation.

Railway noise - according to the majority of standards/guidelines - is calculated just for two daily periods: day and night. When doing calculations with respect to END (Environmental Noise Directive /106/), however, this option has to be activated to consider the number of trains (or the emission parameter) during the Evening period as well.

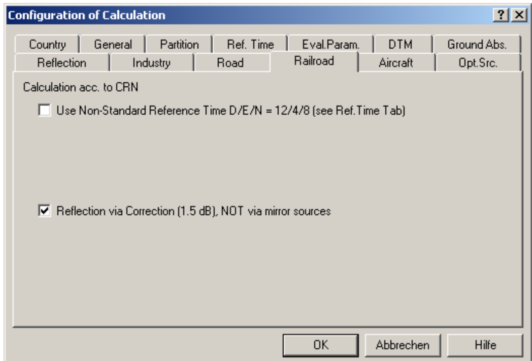
☝ The values displayed on the „Reference Time“ tab (D/E/N=12/4/8 h) will be updated based on the defined time periods DEN.

see also:

chapter 6.2.4 "Reference Time Tab"

chapter 6.2.5 "Evaluation Parameter Tab"

6.2.11.3 CRN



Dialog **Configuration**, tab „Railway“ for CRN

Use Non-Standard Reference Time

When the option „Use Non-Standard Reference Time“ is activated the time intervals and penalties on the „Reference Time“ tab are taken into account in the calculation.

Railway noise - according to the majority of standards/guidelines - is calculated just for two daily periods: day and night. When doing calculations with respect to END (Environmental Noise Directive /106/), however, this option has to be activated to consider the number of trains (or the emission parameter) during the Evening period as well.

see also:

chapter 6.2.4 "Reference Time Tab"

chapter 6.2.5 "Evaluation Parameter Tab"

☝ The values displayed on the „Reference Time“ tab (D/E/N=12/4/8 h) will be updated based on the defined time intervals (hours Day/Evening/Night).

Reflection via Correction (1.5 dB), NOT via mirror sources

CRN clause 31.2 specifies that the reflection from buildings or other reflecting objects (e.g. barriers) on the opposite side of the road have to be considered by a correction of 1.5 dB depending on the angle of the reflecting object/s seen from the receiver. The value of 1.5 dB occurs in case the entire length of the road has reflecting buildings (i.e. is the maximum reflection correction).

for more details and examples see chapter 6.2.10.4 "CRTN", section "Reflection via Correction (1.5 dB), NOT via mirror sources"

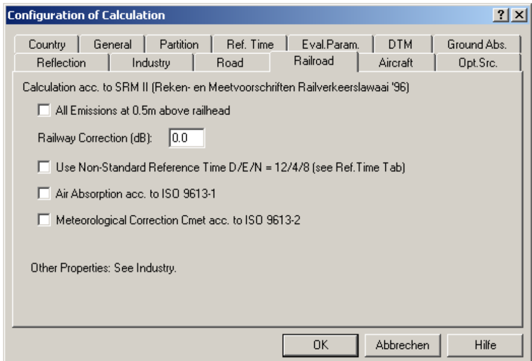
Additional Information

Facade Effect

CRN specifies in clause 31.1 that for calculations of the noise level at a distance of 1 metre in front of a façade a correction of +2.5 dB has to be made. **CadnaA** does not apply this correction automatically for the time being as this CRN-specification do not match the normal approach when calculating façade reflections.

for more details and examples see chapter 6.2.10.4 "CRTN", section "Facade Effect"

6.2.11.4 SRM II

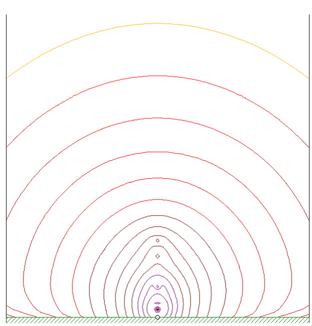
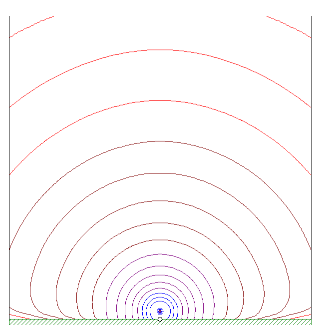


Dialog **Configuration**, tab „Railway“ for SRM II

☝ When SRM II is selected for railway noise the calculation in **CadnaA** follows the procedures as defined by the „Reken- en Meetvoorschriften Railverkeerslawaai '96“ /74/ (not from the recent revision).

All Emissions at 0.5 m above railhead

All emission sources are placed at 0.5 m above the railhead instead of applying the sub-source heights as defined in the train class.

	
option deactivated (for train classes C9 and C9r only)	option activated

6

Railway Correction (dB)

Any entered railway correction will be considered upon calculation. Thus, to consider no railway correction a value of 0 dB has to be entered.

Use Non-Standard Reference Time D/E/N = 12/4/8

When the option „Use Non-Standard Reference Time“ is activated the time intervals and penalties on the „Reference Time“ tab are taken into account in the calculation.

Railway noise - according to the majority of standards/guidelines - is calculated just for two daily periods: day and night. When doing calculations with respect to END (Environmental Noise Directive /106/), however, this option has to be activated to consider the number of trains (or the emission parameter) during the Evening period as well.

see also:

chapter 6.2.4 "Reference Time Tab"

chapter 6.2.5 "Evaluation Parameter Tab"

☝ The values displayed on the „Reference Time“ tab (D/E/N=12/4/8 h) will be updated based on the defined time intervals (hours Day/ Evening/Night).

Air Absorption accord. to ISO 9613-1

In SRM II the air attenuation is based on spectral data at a temperature of 10°C and a relative humidity of 80%.

In **CadnaA**, with activating this option the air absorption can, alternatively, be calculated according to ISO 9613-1 /7/.

Meteorological Correction Cmet acc. to ISO 9613-2

SRM II defines a meteorological correction term C_M. The equations used to determine C_M are identical to the equations used in ISO 9613-2 to determine C_{met}. However, instead of the variable C_0 an upper limit of 3.5 dB is used.

In order to calculate long-term levels this option enables to replace the 3.5 dB by C_0 and using the calculation procedure for C_{met} as established by ISO 9613-2 /7/.

6

Other Properties: See Industry

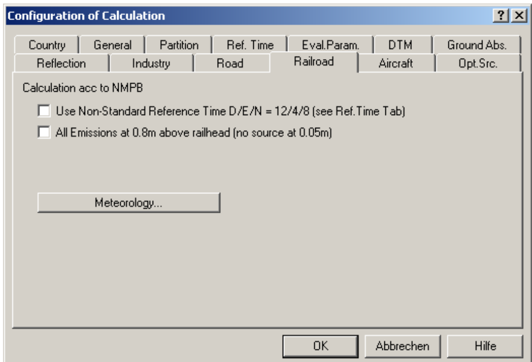
This hint refers to the settings on the „Industry“ tab:

- lateral diffraction
- if distance smaller
- temperature/relative humidity

6

6

6.2.11.5 NMPB-Fer 1996



Dialog **Configuration**, tab „Railway“ for NMPB-Fer (1996)

Use Non-Standard Reference Time D/E/N

When the option „Use Non-Standard Reference Time“ is activated the time intervals and penalties on the „Reference Time“ tab are taken into account in the calculation (e.g with calculations for END (Environmental Noise Directive /106/)

see also:

chapter 6.2.4 "Reference Time Tab"

chapter 6.2.5 "Evaluation Parameter Tab"

☝ The values displayed on the „Reference Time“ tab (D/E/N=12/4/8 h) will be updated based on the defined time intervals (hours Day/ Evening/Night).

All Emissions at 0.8m above railhead (no source at 0.05m)

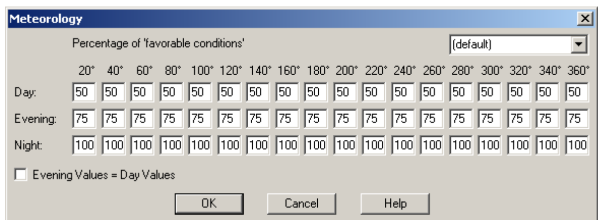
The emission model of NMPB-Fer considers two emission heights. Activating this option will put all emission to a common height of 0.8 m above railhead.

Meteorology

Via the button „Meteorology“ the percentage of „favorable conditions“ in wind sectors stepped by 20° can be specified for the time periods D/E/N separately. The percentage refers to the assessment interval, usually an entire year.

Note 1 - „Favorable conditions“ are such which faciliates the propagation of sound (i.e. which are likely to cause a higher sound pressure level at the receiver point than with a moderate situation). This situation makes use of the (spectral) ground attenuation for moderate downwind as specified by ISO 9613-2 /7/.

Note 2 - By the condition „homogène“ the contrary is assumed, the propagation situation is now neither downwind, nor moderate. The rays are straight lines, not accounting for any atmospheric influence. This kind of meteorological situation has been applied by all former prediction models used in France.



Evening Values = Day Values

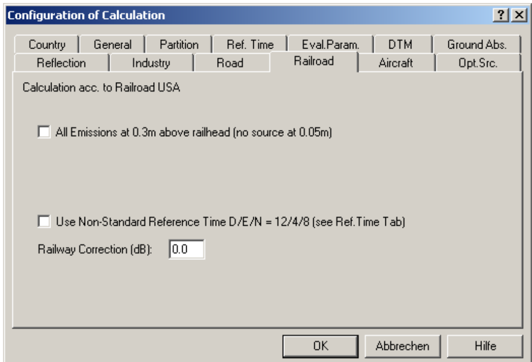
With this option active the daytime values will be applied for the Evening period as well.

List Box Locations

The list box offers a variety of predefined locations (within France) combined with respective data for the percentage of favorable conditions.

☝ No hint is possible here what percentage may apply to an unknown location when just having a general description of the local orography.

6.2.11.6 FTA/FRA



Dialog **Configuration**, tab „Railway“ for FTA/FRA

All Emissions at 0.0 m above railhead

All emission sources are placed at 0.3 m above the railhead instead of applying the sub-source heights as defined in the train class. Consequently, also the sub-source height at 0.05 m is not used.

☝ Consider that the default height of the object Railway is 0.6 m which requires to be changed to 0.0 m to correspond with FTA/FRA specifications.

Use non-Standard Reference Time D/E/N

In case this option is deactivated time intervals Day (D)=15 hours, Evening (E)=0 hours, and Night (N)=9 hours will be considered.

With this option activated the allocation of hours as specified on the „Reference Time“ tab will be used instead.

☝ The designation "D/E/N=..." will be update based on settings on „Reference Time“ tab.

Railway Correction

This option enables to address a general correction or penalty for the receiver level:

$SPL_{with\ corr} = SPL_{w/o\ corr}$ - (Railway Correction)

In order to apply no railway correction a value of 0 dB has to be entered.

Additional Information

Barrier Attenuation

According to the FRA/FTA-reports, the ground factor G for barrier attenuation is calculated from the effective height H_{eff} (see figure 5-3 of the FRA-report /79/ or figure 6-5 of the FTA-report /78/). As this simplified concept does not work properly in complex situations **CadnaA** does not apply this computation scheme.

In contrary, the ground factor G for barrier attenuation is calculated using the mean height concept of ISO 9613-2 /7/ resulting in a smooth value of A_{ground} even with complex terrain structures in conjunction with multiple obstacles in the ray's path (see ISO 9613-2, section 7.3, for details).

The barrier insertion loss $A_{shielding}$ is based on the equations in table 5-1, page 5-14 of the FRA-report /79/. For source types LOCO and CAR the barrier insertion loss is calculated using the equations for "propulsion subsources" (type PROP).

Ground Attenuation

The ground attenuation A_{ground} for wheel-rail and for propulsion subsources is calculated using the equations on page 5-16 of the FRA-report /79/. For source types LOCO and CAR the equations for "propulsion subsources" (type PROP) are applied. Aerodynamic subsources receive no ground attenuation at all.

Excess Shielding

The excess shielding (as of table 5-5, page 5-18, FRA-report /79/) by rows of buildings (in **CadnaA** called "built-up areas") and by dense tree zones (in **CadnaA** called "foliage") are not considered - for the time being.

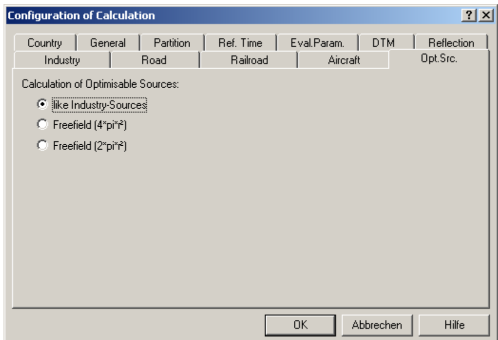
6.2.12 Aircraft Tab

This tab is only relevant in conjunction with the **CadnaA** option FLG . See the specific manual on „Aircraft Noise Calculation".

6.2.13 Optimizable Source Tab

This command is only available if you have purchased the **CadnaA** BPL option (Commercial Areas).

Option BPL



With the optional feature **BPL** of **CadnaA** the object **optimal source** can be used. This is an area source with an adjustable sound power level per m². With one or more of these radiating areas and immission points with defined maximum values for the noise levels in the vicinity, the emission of these sources can be adjusted automatically by an iterative process. This option is used to find the maximum noise emission of planned industrial areas that is possible without an inadmissible noise load for residential areas nearby.

This calculation of the maximum permissible emissions can be carried out with different strategies (according to the governmental requirements in different countries). The relevant options can be selected in menu **Calculation|Configuration|Tab Opt.Src**. These options for the Calculation of Optimizable Sources are

like Industry-Sources

like Industry-Sources: all calculations with optimizable sources use the settings as they are defined in the menu **Calculation|Configuration|Tab Industry**

*free field (4*pi*r²)*

Free field (4*pi*r²): The sound propagation is calculated with only geometrical divergence in a free-field being taken into account. No other damping effects like air absorption and diffraction are considered in the calculation (SPL = PWL - 11 dB - 20 lg r).

*free field (2*pi*r²)*

Free field (2*pi*r²): The sound propagation is calculated with only geometrical divergence in a semi-free-field being taken into account. No other damping effects like air absorption and diffraction are considered in the calculation (SPL = PWL - 8 dB - 20 lg r).

r is horizontal (2D) distance: With this option activated the 2D-distance as projected to the x,y-plane is used to calculate the geometrical divergence. This setting complies with the requirement of DIN 45691 /29/.

Mixed parameters in conjunction with option BPL

Please note that the optimization of sound power levels per m² using the option BPL can be carried out only for the daytime level Ld and the nighttime level Ln (list box „Day/Night“ on the dialog **Optimizable Source**). I)n particular, the optimization of mixed evaluation parameters (like Lde or Lden) is excluded - for the time being.

6.3 Selecting Data for the Calculation

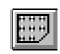
For a partial calculation, deactivate existing objects. Various tools, which may be combined, are available for this purpose. These tools are described below.

Exclude Objects for the calculation

We either include or exclude objects for the calculation

- individual objects via the **ID** in the edit dialog of the object (see manual "Introduction to **CadnaA**") or
- with groups (see chapter 14.1) or
- with variants (see chapter 14.2)

Deactivated objects are displayed by default with dashed lines. You can change this in **Options|Appearance** (see chapter 9.6).



Calculation Area calculating defined Areas

After clicking this toolbox icon, you insert a closed polygon around the area for which you want to calculate the level distribution over a grid of receiver points (see chapter 5.3). You can insert several calculation areas.

With the option **Exclude Area** in the edit dialog **Calculation Area** it is possible to exclude for a calculation another area inside the existing calculation area. Inside this area the receiver point grid is not calculated.

The inserted calculation areas are also registered simultaneously in **Tables|Other Objects|Calculation Areas**. The order of the records also determine the order of calculation.

For these calculation areas, **CadnaA** will take into account all objects, even outside the calculation area, unless they are deactivated.

You may specify several calculation areas. The total area of all defined calculation areas essentially determines the time required for the calculation. It is therefore advisable, for the first test, to specify a large spacing between the receiver points under **Grid|Properties**, in order to watch the progress of the calculation once it has been started and, if required, to abort the calculation and restart it with a different spacing between the receiver points.

The level distribution was calculated for this calculation area with all objects within the limits.

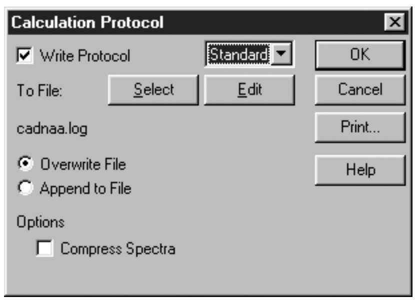
The calculation for a **calculation area** is started via the menu **Grid|Calculate Grid** (see chapter 5.3.2). If several **calculation areas** exist, these are calculated one after the other.

see also Check Consistency Chapter 5.1.3.

6.4 Calculation Protocol

The command **Calculation|Protocol** allows you to save all intermediate results from the calculation for individual receiver points (not for a grid of receiver points). You may then generate a formatted printout of this protocol file, or import it, as ASCII format, to another application, such as a spreadsheet program, for further processing.

Already with normal projects these tables will become quite large. So, deactivate all sources not relevant and activate only those that shall be analysed. (For that: after a calculation in **Tables|Partial Level** sort your partial levels ascending to see which noise sources are the loudest.)



Write Protocol

To this end, activate the check box **Write Protocol** in the **Calculation Protocol** dialog. The default log file is cadnaa.log. If a different file name shall be used, click the **Select** button to enter a file name or select an existing file. Activate one of the options **Overwrite File** or **Append to File**. Close the dialog by clicking **OK**.

Don't forget to deactivate the option **Write Protocol** afterwards.

Compress Spectra

If this option is activated, not the entire calculation will be entered for all frequency bands. An A-level calculation with the accordingly weighted levels will then be issued for the attenuation values dependent on frequency (e.g. De).

see also 6.4.1 Compact Protocol)

Protocol

When the calculation for defined immission points - no grid point calculation - has been performed via the calculator icon on the icon bar, the specified file will list all intermediate results for each ray from sound source to immission point. To view the protocol file, either click the button „Edit" on the dialog **Protocol** (unformated protocol) or click the button „Print" (formatted protocol).

unformated protocol

In the first case, the text editor opens the log file as ASCII text. If an error message appears, the text editor cannot open the file because it is too big. In this case, run a different word processor, such as MS-Word, and open the file in the usual way. The ASCII-protocol can be edited by the user.

☝ The unformated ASCII-protocol is not updated any longer with regard to more recent calculation standards or guidelines. This unformated protocol is, therefore, no longer exhaustive. Please use the formatted protocol instead (see below).

The legend of the protocol can also be printed. The file PROT_END.TXT is copied to the program directory during the installation of **CadnaA**. This file generates the key at the end of the protocol. If you prefer having the legend at the beginning, rename the file to PROT_BEG.TXT.

You can modify this file to your needs. To this end, open it using a text editor (see chapter 13.1.1 "Template Files").

formated protocol

When clicking the **Print** button the **Print Protocol** dialog opens where the printer, the paper size, and the printing range options are specified. Then click **Preview** button. The formatted protocol appears on the dialog **Print Preview**.

The **Print Preview** dialog displays the formatted tables. Depending on the size of the project, completing the print preview on the screen may take several minutes, because also for each partial level, all intermediate results are shown. Therefore, if necessary, restrict the protocol to just a single receiver point as the **Printing Range** on dialog **Print**. The processing of the print preview cannot be aborted.

see also chapter 6.4.1 Compact Protocol

6.4.1 Compact Protocol

☝ The compact protocol is available just for industry sources calculated according to ISO 9613.

Use the Compact Protocol to produce a single value for the effective screening coefficient and the proportion of reflected sound, referred to the overall source, line by line for each source, even extended sources such as area or line sources.

When calculating, e.g., an area source with screening, the values with and without a screen are calculated automatically, and the effective screening coefficient is indicated as the difference $A_{bar,eff}$.

Procedure:

- For the compact protocol, generate a protocol using the function **Calculation|Protocol** (see chapter 6.4).
- Restart the calculation for receivers. The protocol file is written.
- Then compress it using **File|Export**, Export format „Compact protocol“ and specify a filename.
- After entering a file name **CadnaA** automatically adds the extension TXT to it.
- Click OK to confirm.

Now, **CadnaA** creates an ASCII file containing TAB-separated data with the following column headings:

Name	ID	Freq	LxT	LxN	LrT	LrN	Refl	Abar,eff

6.5 Special Calculations

☝ Monetary Evaluation of Noise according to BUWAL see chapter 5.5.6

6.5.1 HAP-Calculation accord. to *Miedema*

The noise evaluation method by *Miedema* /75/ has been implemented in **CadnaA**. This method generates three evaluation indicators which specify in statistical respect:

- the number of Highly Annoyed Persons (HAP) by noise,
- the number of highly sleep disturbed persons due to noise, and
- the statistical value of expectation of myocardial infarction due to noise.

The method enables the evaluation of different strategy scenarios due to the noise pollution and makes actually only sense for big projects. Prerequisite for the appliance of this method are

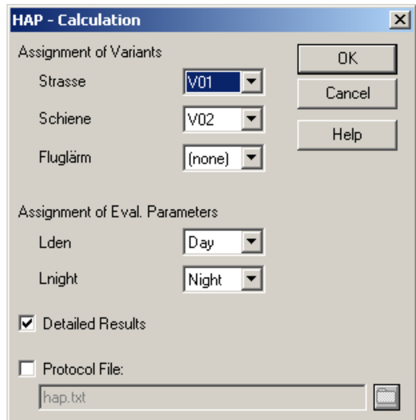
- the max. noise levels of the building evaluation (for Lden and Lnight) (see chapter 5.4) and
- the inhabitants of the building (see chapter 3.1.2).

As result will be generated three values which are entered in the **Info**-field of the edit dialog of a building.

HAPtot	Part of highly annoyed persons, e.g. HAPtot=0.85.
HSDtot	Part of highly disturbed sleeping persons (Highly Sleep Disturbed, e.g. HSDtot=0.58)
NMItot	extra noise induced cases of myocard infarction (e.g. NMItot=0.000510)

The command **HAP-calculation** is available on the menu **Tables|Miscellaneous**.

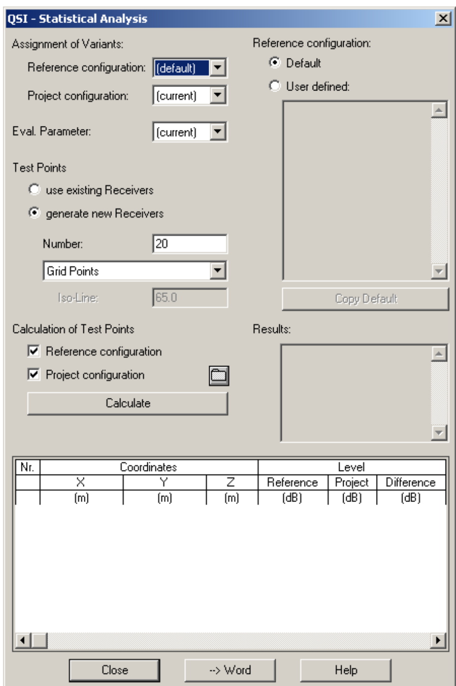
After clicking the command a dialog opens in which the parameters have to be chosen from the list boxes like the variant for the desired noise type and the evaluation parameters. Start the evaluation with **OK**.



6.5.2 QSI - Statistical Analysis

The "Requirements and Testing Conditions for statistical qualification of level differences" stated in DIN 45687 /28/, annex F (available in German only) are implemented in **CadnaA**. To statistically evaluate the level differences from two calculation runs with different configuration settings the 0.1-quantile and the 0.9-quantile are calculated and displayed (10%- resp. 90 %-value of the distribution of the level differences).

The command **QSI-Statistical Analysis** is available via the menu **Tables |Miscellaneous**. The evaluation may be applied to grid points, to facade points or to points on lines of equal sound level (Iso-Lines).



Dialog **QSI - Statistical Analysis**

The statistical evaluation in **CadnaA** considers all active receiver points (minimum number of receivers = 20). The additional requirement according to annex F of DIN 45687 regarding a minimum horizontal distance of user-defined receivers of 2 m from sources and obstacles has to be ensured by the user himself. When receivers are generated by **CadnaA** the minimum horizontal distance will be respected automatically.

Assignment of Variants

6

Specify which of the variants in the project file should be considered as reference configuration and as project configuration. Normally, the setting „(default“)“ applies for the reference configuration which is defined globally (see below, Reference Configuration). With the default reference configuration selected, the additional variant „REF“ (corresponding with variant V16) will be listed on the list boxes „Reference Configuration“ and „Project Configuration“ after calculation.

Reference Configuration

As far as the reference configuration is concerned the default values (setting „Default“) can be applied or be altered by the user (setting „User defined“). In the latter case the default reference configuration values will be listed in the box upon click onto the button „Copy Default“. The parameters listed in the table below are available for the time being..

parameter (unit / value range)	variable/default value
maximum error (dB):	MAXERROR=0.0
search radius (m):	SEARCHRAD=3000
grid interpolation on/off (1/0):	RASTER_INT=0
raster factor (-):	RASTERFACT=0.5
projection of line sources on/off (1/0):	PROJ_LQ=1
projection of area sources /off (1/0):	PROJ_FQ=1
order of reflection (1-20):	REFLORDER=1
max. distance source-receiver (m):	REFL_DMAX=3000
ibid, interpolate from (m):	REFL_DMAXI=3000
reflector-search radius source (m):	REFL_RAD_S=3000
reflector-search radius receiver (m):	REFL_RAD_R=3000

The reference configuration settings can be changed by entering different values for the parameters as required.

Evaluation Parameter

Select the evaluation parameter used for the statistical evaluation. With setting „(current)“ the active performance parameter is used.

Test Points

DIN 45687, annex F, requires a minimum number of 20 receivers for the evaluation.

use existing Receivers

In order to use the existing receivers shall, their ID must be changed to the text string „QSI“ in order to be considered upon calculation.

generate new Receivers

By activating the option „generate new Receivers“ three options are available:

- Grid Points: By clicking the „Calculate“ button the specified number of receivers will be generated at arbitrary locations. With a calculation area defined the receiver points will be distributed inside that area, otherwise within the entire limits.
- Facade Points: By clicking „Calculate“ the specified number of facade points (as QSI-receivers) will be generated at arbitrary locations (at a distance off the facades specified on dialog **Building Noise Map**). The generation of facade receivers requires to generate building evaluation symbols for a reasonable number of buildings in the project (or for all buildings). Facade receivers will just be generated for buildings having a building evaluation symbol addressed.
- Points on Iso-Lines: With this option the approach is different. First, select on dialog **Configuration of Calculation** the project configuration as required and recalculate the grid (via **Grid** menu). Now, select on dialog **QSI-Statistical Analysis** the option „Points on Iso-Lines“ and change - if required - the reference configuration. By clicking „Calculate“ the specified number of receiver will be generated at arbitrary locations on the iso-line with the specified level. This option requires that a valid grid exists. The appearance of the grid is not relevant.

Calculation of Test Points

This option enables to control whether the reference and/or the project configuration should be considered upon recalculation. In case of evaluation options „Grid Points“ and „Facade Points“ the settings of the project configuration can be altered directly via the file-selector symbol.

Results

This box displays the results of the statistical evaluation, as there are:

resulting parameters	abbreviation
0,1-quantile	q0.1
0,9-quantile	q0.9
standard deviation of level differences	sigma
mean value of level differences	mean
minimum level difference	min
maximum level difference	max

Individual Results

The lower table displays the coordinates of the receiver points, the levels for the reference and then project configuration, and the level differences.

Word-Export

Upon click on the button „--> Word“ both configuration settings, the results for the statistical parameters, and the individual results will be exported to MS-Word. The template file QSI_TMPL.RTF supplied with **CadnaA** (see installation directory) can be edited by the user.

In section „Configuration“ only those parameters are displayed where the reference and the project configuration differ from each other. At the end of a QSI-analysis, this enables to check whether the intended settings for both configurations have been set correctly.

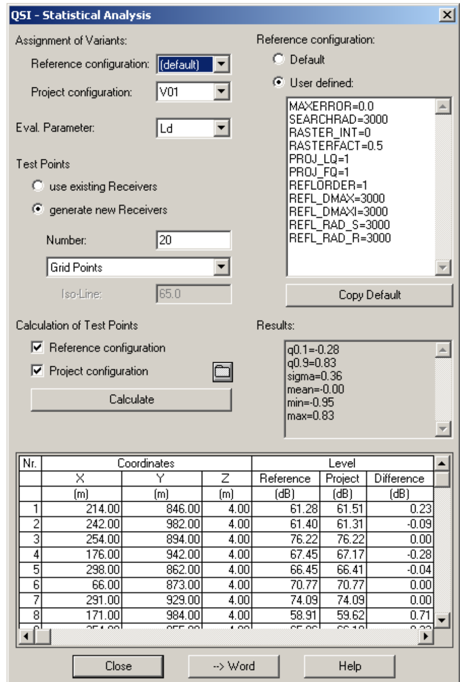
Example

The influence of the projection of line sources on the receiver level shall be statistically be evaluated for a project with roads and buildings. The receiver points for QSI-analysis will be generated by **CadnaA**. In the reference configuration, the projection of line and area sources shall be turned off and the maximum error shall be set to 1 dB.

Open the QSI-dialog an assign the variant „(default)“ for the reference and V01 for the project configuration. To check for the default-reference settings switch to „User defined“ and click the button „Copy default“ to display all relevant parameters. The project configuration shall comply with this reference configuration, besides the projection for line sources deactivated.

To check and alter the project configuration, click on the file-selector symbol in the dialog section „Calculation of Test Points“. Ensure that the projection of line and area sources on tab „Partition“ is deactivated and enter on tab „General“ a maximum error of 1 dB.

Run the calculation with options „Test Points, generate new Receivers, 20 Grid Points“. The result is displayed below.



QSI-result after calculation

The exported MS-Word-file indicates that the project configuration differs from the reference configuration just by the setting of projection of line sources (template file QSI_TMPL.RTF edited).

DataKustik

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Ergebnisse schalltechnischer Berechnungen nach DIN 45687
Projekt:

Berechnungseinstellungen	Referenz	Projekt
Max. Fehler (dB)	0.0	1.0
Max. Suchradius (m)	3000	2000
Proj. Linienquellen	1	0
Proj. Flächenquellen	1	0
max. Reflexionsordnung	1	0
Max. Abstand Quelle - Immpkt	3000	1000
Reflektor-Suchradius um Qu	3000	100
Reflektor-Suchradius um Imm	3000	100

Statistische Auswertung:

Quantil q0.1:	-0.3
Quantil q0.9:	0.8
Mittelwert:	-0.0
Standardabweichung:	0.4
Minimum:	-1.0
Maximim:	0.8

Einzelwerte

Nr.	Koordinaten			Pegel		
	X	Y	Z	Referenz	Projekt	Differenz
	(m)	(m)	(m)	(dB)	(dB)	(dB)
1	214.00	846.00	4.00	61.28	61.51	0.23
2	242.00	982.00	4.00	61.40	61.31	-0.09
3	254.00	894.00	4.00	76.22	76.22	0.00
4	176.00	942.00	4.00	67.45	67.17	-0.28
5	298.00	862.00	4.00	66.45	66.41	-0.04
6	66.00	873.00	4.00	70.77	70.77	0.00
7	291.00	929.00	4.00	74.09	74.09	0.00
8	171.00	984.00	4.00	58.91	59.62	0.71
9	254.00	955.00	4.00	65.96	66.18	0.22
10	236.00	897.00	4.00	77.71	77.71	0.00
11	291.00	972.00	4.00	63.75	63.49	-0.26
12	64.00	950.00	4.00	65.28	65.40	0.13
13	172.00	955.00	4.00	61.89	60.94	-0.95
14	159.00	897.00	4.00	79.03	79.03	0.00
15	200.00	984.00	4.00	59.60	60.43	0.83
16	263.00	855.00	4.00	65.47	65.09	-0.38
17	302.00	981.00	4.00	62.31	62.10	-0.21
18	104.00	875.00	4.00	71.75	71.75	0.00
19	112.00	913.00	4.00	77.83	77.83	0.00
20	98.00	893.00	4.00	78.10	78.10	0.00

CadnaA Version 4.0.136 (32 Bit) - Datei: qsi3 - statistik für IPs.cna - Datum: 04.10.10

6

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6.6 Miscellaneous

The dialog **Miscellaneous** (**Options** menu) offers several options relevant to the graphics and the options in the following:

Decimal Separator

You may choose a point or a comma as decimal separator. Use the corresponding separator by input in edit boxes or table columns. CADNAA is able to correct wrong separators in the most cases. But this is not always possible especially by fields which are also used for equations. In this cases you have to use the point as separator because the comma is a special character (e.g. max(1,2) = 2) in these fields.

Weighting for Octave Bands

For calculated octave bands you can choose the weighting (lin, A,B,C,D) for display and print out. After changing the weighting the resulting octave bands will be displayed straight.

The further options relevant for the graphics, are described in chapter 9.17.

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Chapter 7 - Import

Data from third-party programs can be imported by **CadnaA** using various file formats or via the ODBC interface (see chapter 7.3). Any objects contained in the current **CadnaA**-file will not be deleted, but the external file will be inserted or existing data will be updated. This enables you to continuously complete a file by importing external and/or internal data.

Import Options

Depending on the file format, **CadnaA** allows you to specify certain importing options:

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Layer

- selection of layers to be assigned to specified object types (see chapter 7.1.1 "Allocate Object type to Layer").

Importing in a target area

- specification of a target area in your project file by using the **Section** tool, to where the data are to be imported in order to reduce the amount of data (see chapter 7.1.2 "Importing in Section only").

Coordinate Transformation

- coordinate transformation serving to match the data to those of your project file (see chapter 7.1.4).

Selection of Object Types

- selection of object types - by this you may import only the needed object types from a file, e.g., only roads.

Simplify Geometry

- Already during the import the object geometry can be simplified by entering a reasonable value for the option **Simplify Geo** (see manual "Introduction to **CadnaA**")

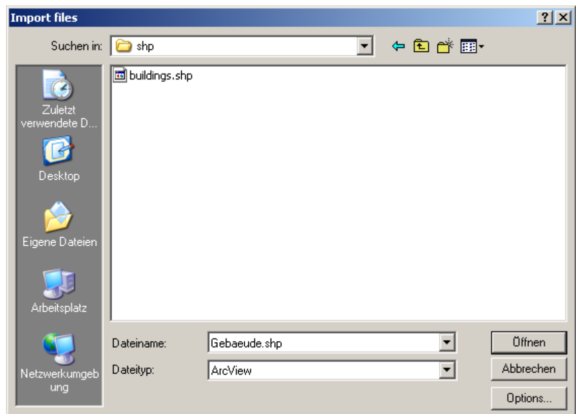
unknown Attributes

- In case attributes respectively parameters cannot be assigned to **CadnaA** attributes, because they have be named differently as used to be in CadnaA, these unknown attributes can be saved automatically as memo variable in the Info-field of the corresponding objects. They can be still assigned to afterwards.

File Formats

Select the **Import** command from the **File** menu and specify the file format to import objects from into your project file (file formats like, e.g. ArcView, MapInfo, AutoCad-DXF, AutoCad-DWG and others). Importing data from database files like dBase, MS-Excel, MS-Access etc. via ODBC interface use the command **File|Database**.

In the file selection dialog **Import Files**, select the file format first from the list box „File Type“, then select the file to be imported.



The button „Options“ offers to specify the further import options depending on the file format selected (see further below in this chapter).

The files are imported by clicking the „Open“ button.

7.1 Import Options

After clicking the **Options** button on the **Open File** dialog, you can specify different import options depending on the selected format, e.g. a desired coordinate transformation and, for some file formats like AtlasGis, DXF, and SICAD, enter information concerning layer IDs and/or the limits.

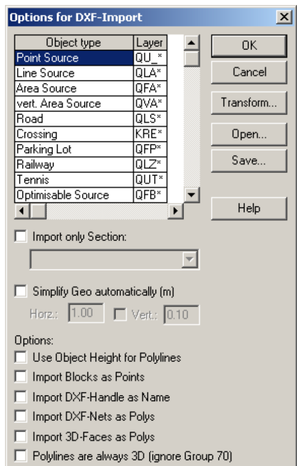
CadnaA makes use of the geometrical object types: point, open and closed lines (see Chapter 4 - Topography). If any object to be imported does not comply with the geometrical object types under **CadnaA** – like, e.g. an open polygon being imported as an area source – it will always be interpreted as an auxiliary polygon, which means it will be irrelevant for the acoustical calculations. In such a case, you would have to select the **Convert to** command from the context menu (see manual "Introduction to **CadnaA**") to convert the auxiliary polygon to an object of the desired type.

☝ If you intend to import data from third-party programs, we recommend you ensure that the object types conform to the geometrical object types under **CadnaA**.

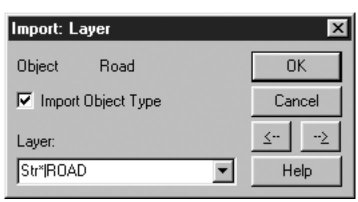
CadnaA may interpret imported points as, e.g., point sources, height points, crossing lights or tennis balls or imported lines as line sources, roads, railways or barriers etc.

7.1.1 Allocate Object type to Layer

The **Import|Options|Layer** dialog serves to identify layers of the imported data with the pertinent object types. You can **Save** the allocation list to a file for re-use (**Open**). **CadnaA** will interpret all lines belonging to one layer as objects of the type allocated to that layer in the list.



In order to allocate object types to layers, double-click the pertinent row. In the **Import: Layer** dialog, enter the names of the layers containing the geometry data of the object type in question or select them from a layer list. A layer list could exist, e.g., in a DXF file if this attribute has been saved as well. In any case you have to know the layer names.



If several layers are to be identified by common character strings, you can also use wild cards, such as *, to substitute arbitrary strings (see **CadnaA**-manual "Attributes & Abbreviations").

Example:

Roads A through F are on layer STR1, roads G through M on layer STR2. You can import all of the roads *A* through *M* at once by entering `STR*` in the **Import: Layer** dialog for the object type **Road**.

If roads *A* through *F* were to lie on layer `STR1`, and roads *G* through *M* on layer `ROAD`, roads *A* through *M* could also be imported all at once by entering `STR1|ROAD` (i.e. `STR1` "or" `ROAD`) in the **Import: Layer** dialog for the object type **Road**.

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This "allocation list" can be saved to a file for subsequent re-use by clicking the **Save AS** button, and can be opened again (**Open** button) as required.

The data will be imported after confirming with **OK.**

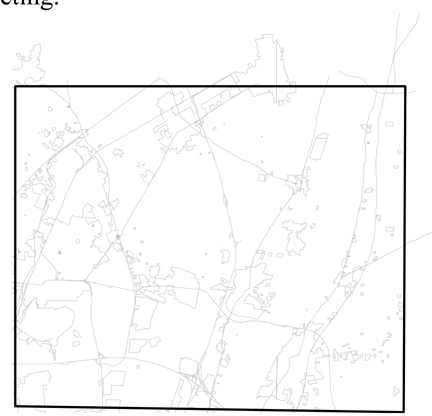
7.1.2 Importing in Section only

Import only Section

If you activate **Import only Section** in the **Import|Options** dialog, you must have defined at least one Section with a unique identifier (see chapter 9.10), which can be selected from the list. In this case you can only import from the file the data which lie within an area which coordinates are identical with the coordinates of the selected **Section**.

This option is very convenient in that it can save you a lot of memory by importing only the area you actually need from a file of many megabytes.

Objects lying within the **Section**, and extending beyond it, will also be imported. If necessary, delete them using the context menu (see manual "Introduction to **CadnaA**") **Modify Objects|Action: Delete**. You may need to use the **Break Lines** and/or **Break Areas** command from the context menu before deleting.



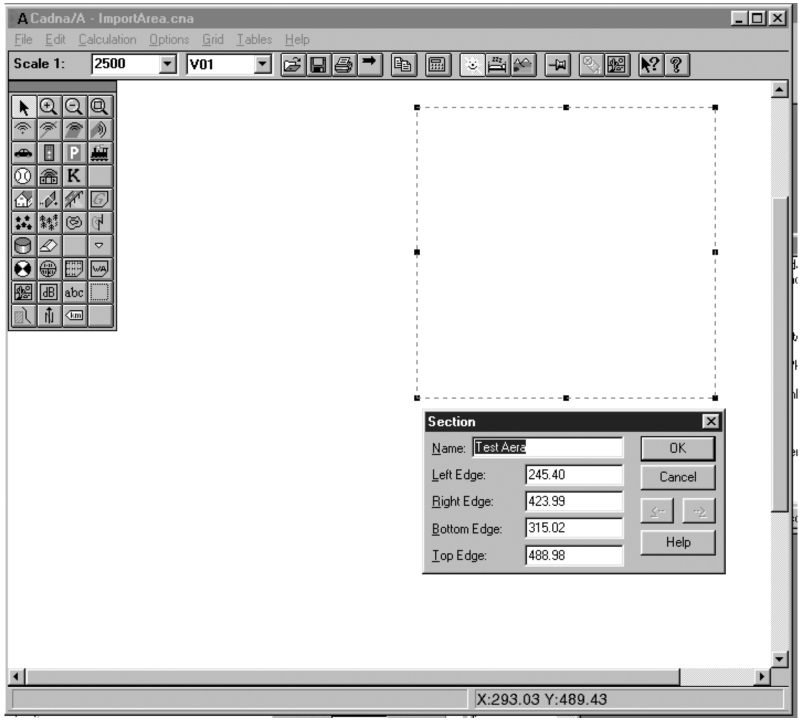
An area imported using the above option.

Example

You have a large project file in which you have to make an expert report about a small area in detail. You only want to import that area in question.

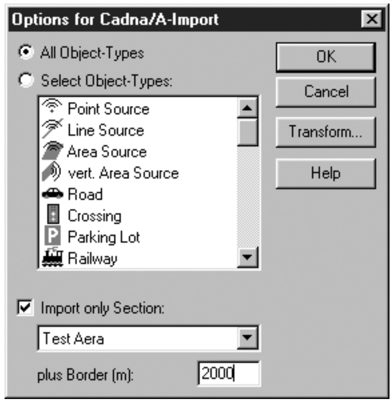
Examples\07_Import\Import Section.cna

- Open the example file. This contains a **Section** frame named `Test Area` (a name is mandatory!). Now, only in this area, shall objects be imported from another file **Demo1.cna**.



The file **Import Section.cna** contains only a section frame - in the edit dialog you can see the name and the coordinates of the frame.

- Select **File|Import**, file format „CadnaA“ and afterwards the file to be imported from - in our example **Demo1.cna** in your program folder.
- Then click on the **Option** button and set the parameter as in the following figure.

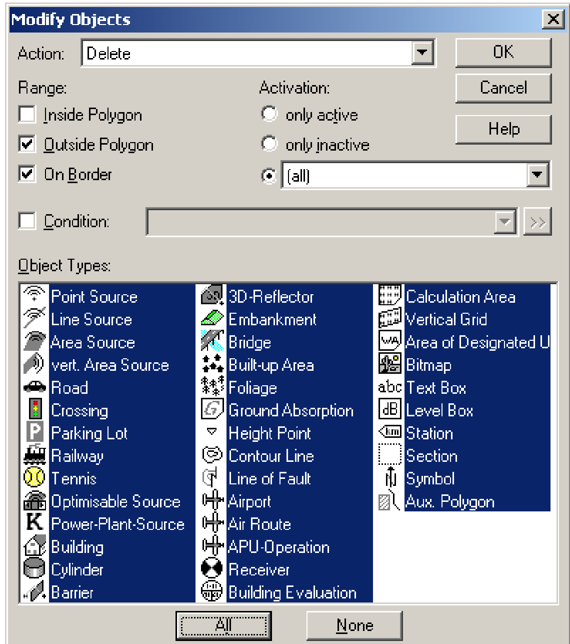


Import options available with the file format CadnaA

In the list box you can see all the identified **Section**s. Select one by clicking on its name.

After confirming all dialogs the objects placed in the target area will be imported in the **Section** frame. As you may see, all objects which affect respectively protrude the area will be imported, too. If necessary, these objects have to be broken on the border of the **Section** frame and deleted outside this area as follows:

- Mark the section frame with the right mouse click again and select from the context menu one after the other **Break Lines** and **Break Areas**.
- If you now click on the objects outside the section area they will be marked independently of the original complete object. Also buildings are divided, but not Bitmaps. Bitmaps have to be trimmed separately in a graphic program.
- Once more mark with a right mouse click the section frame and select from the context menu **Modify Objects|Action: Delete**.
- Activate the corresponding options as shown in the following figure. After confirming with **OK** the concerned objects will be deleted.



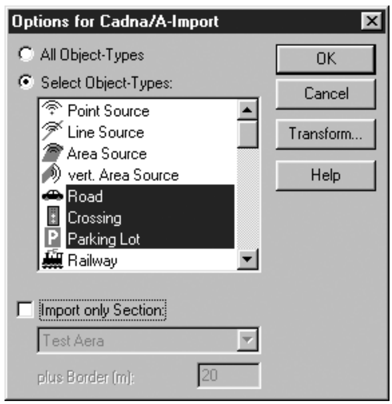
At the end you may update the limits (**Options|Limits|Calc**).

Border Area

If you define an additional border area to be imported, objects within this area will also be imported. This may be necessary if you want to calculate a noise map for the section and if you must consider the noise impact from sources and other objects outside the section.

7.1.3 Importing selected Object Types

If the function **Select Object Type** in menu **File|Import|Options** is available you may choose which object type you want to import from the file. Multiple choice (mouse-click + CTRL) is possible.



Example:

- Repeat the import as explained in the previous chapter, but this time activate the additionally the option **Select Object Type** and highlight the object type **Area source**, **Road** and **Building**.
- Confirming **OK** only these object types are imported in the section.

7.1.4 Coordinate Transformation

The transformation of objects and/or even entire projects is a strong feature of **CadnaA**.

Import files from third-party programs

When files are imported, differences in the coordinate systems may have to be taken into account. The possibility of coordinate transformations exists, therefore, with all import formats available in **CadnaA**.

Duplicate, displace, rotate, distort objects

In order to duplicate and/or displace a group of objects in a project or just to simply rotate a building - this can be achieved more easily by the coordinate transformation. Apply the command from the context menu or via the dialog **Modify Objects**, Action „Transformation“ (see also manual „Introduction to **CadnaA**“).

For the coordinate transformation several possibilities are available:

- rotation + translation,
- transformation via match points,
- affine transformation,
- geodetic transformation,
- general transformation, and
- interactive transformation.

☝ Bitmap-files can just be transformed using the option „Rotation + Translation“).

☝ Calculated grids cannot be transferred applying these features.

Transformation of the directivity vector

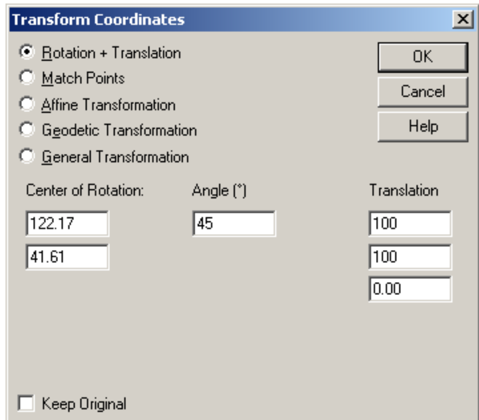
When addressing a coordinate transformation to point, line, or area sources the directivity vector is also subjected to the transformation (see chapter 2.2 "Directional Sound Radiation").

Rotation + Translation

Enter the coordinates of the pivot, the angle of rotation and the translation in the x, y and z directions. The rotation about the specified pivot is performed first, the displacements follow in the three directions. The pivot is a pair of coordinates to be imported from the project.

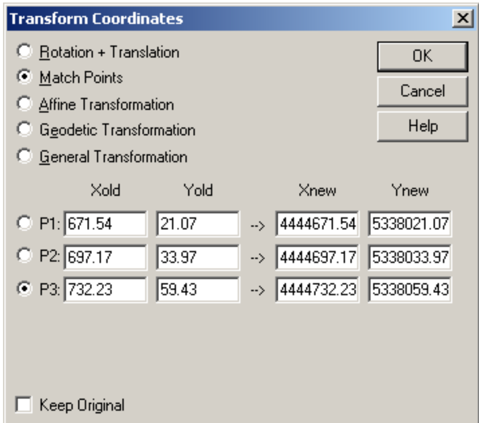
Example Rotation + Translation

122,17/41,61 are the coordinates of one corner of a building belonging to the project being imported. This is the pivot. With the data in the dialog below, the imported project is rotated about that point by 45°, and displaced by 100 m to the right and by 100 m upwards.



Match Points

The coordinate transformation option „Match Points“ allows to combine different project files into a new coordinate systems in easy way. If you enter the existing coordinates for all three points and the new coordinates for the transformation you also can get a correction of the project file.



In the edit boxes x-old/y-old insert the current coordinates of the corresponding points and in the edit boxes x-new/y-new the prospective coordinates of these points valid after the transformation.

Inserting the coordinates x-old, y-old and x-new, y-new

- for one point - a simple offset occurs
- for two points - in general, an offset, a rotation and a scaling occurs (angle remained)
- for three points - in general, an offset, a rotation, scaling and a bending (not angle remained) occurs

☝ After transformation the data of the displacement vector in the transformation matrix are shown when opening the transformation dialog again and activating the option **Affine Transformation**.

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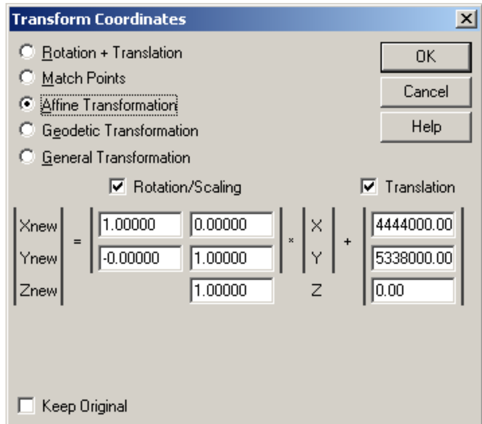


The displacement vector in the transformation matrix after transformation

Example Match Points

Try this effect with the help of the file Demo1.cna. From three different objects pick out one coordinate pair in each case. For there open the **Geometry** dialog of the corresponding polygon point and write down the coordinates x and y. For these coordinates you now have to determine the new coordinates. Point with the mouse cursor on the place in your project where the polygon point should be after the translation and look up the values in the status bar.

- Click with the Right mouse button on an empty area in your file and select **Modify Object** from the context menu.
- In the dialog which has been opened activate „All“ objects and confirm with OK.
- In the transformation dialog activate „Match Points“ and enter the old and new coordinates.
- Activate the option „Keep Original“ to see the difference. In this case a copy of the entire project will be generated.

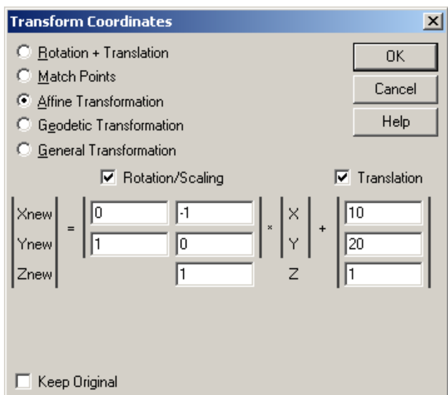
Affine Transformation

A rotation and/or a scaling is specified by the coefficients of the transformation matrix.

If all objects of the imported file are to be rotated by an angle of φ about the coordinate zero of the file, the values of the matrix result from:

$$\begin{matrix} x_{neu} \\ y_{neu} \end{matrix} = \begin{pmatrix} \cos\varphi & -\sin\varphi \\ \sin\varphi & \cos\varphi \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

To specify a displacement along an axis, enter the offsets of x and y.

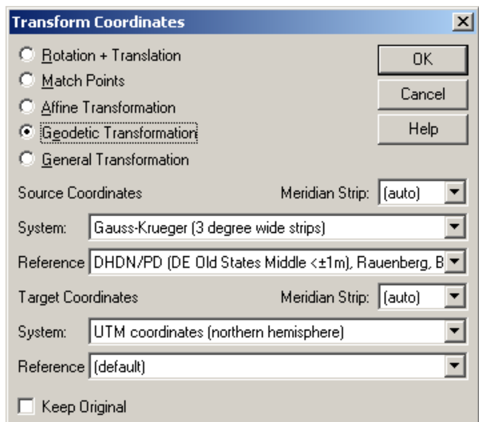


The example above results in a 90° counterclockwise rotation about the coordinate zero, which, after importing, corresponds to point (10,20).

Geodetic Transformation

This option enables to transform objects between different geodetic coordinate systems. For the designation of the geodetic location of objects numerous national and international coordinate systems exist which may have different reference points in addition (datum). The majority of national coordinate systems describe an object's location in orthogonal coordinates with a local reference point, while global coordinate systems assign the object’s location on the 3-dimensional surface of the Earth by globally defined values for Easting and Northing. So, any point on the Earth’s surface can be stated by specific coordinates.

By this kind of transformation the object’s location given in national geodetic coordinates (e.g. GK, Gauss-Krueger-coordinates) can be transformed to other national or to global geodetic coordinates (e.g. UTM, Universal Transversal Mercator projection).



Source Coordinates

Select in section „Source Coordinates“ the coordinate system and the reference point referring to the present object coordinates. By default, the system „UTM (Northern Hemisphere)“ with the reference point „(default)“ is selected. The setting for the median strip is on „(auto)“ by default. With the option „show user-defined coordinate systems only“ activated on dialog „Coordinate System“ (Options menu) just those are listed besides the global and the UTM-coordinate system.

Target Coordinates

Select in section „Target Coordinates“ the coordinate system and reference point the existing object coordinates shall be transformed to. Source and target coordinate system are related to specific reference points. However, useful combinations system-reference will not be filtered when having selecting either items. The selection of appropriate combinations system-reference has to ensured by the user.

Median Strip

On the list box „Median Strip“ the relevant strip can be selected. There are a maximum of 120 strips with 3 degrees of longitude available. The coordinate systems make use of a different number of strips each (e.g. UTM-system: 60 strips of 6°each, GK-system: 120 strips of 3° or 60 strips of 6° each). When „(auto)“ is selected the information on the strip number is taken from the first two digits of the coordinate value.

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General Transformation

When this option is selected, every new value of the three dimensions, $x_{new,}$ y_{new}, and z_{new} can be assigned an arbitrary nexus of the values of the three coordinates of the old system. This allows to apply arbitrary distortions, reflections, and other modifications.

The following transformation generates a rectangle that is parallel to its axes and transforms it into a parallelogram which is shifted to smaller values of the y-coordinate by 500 m.

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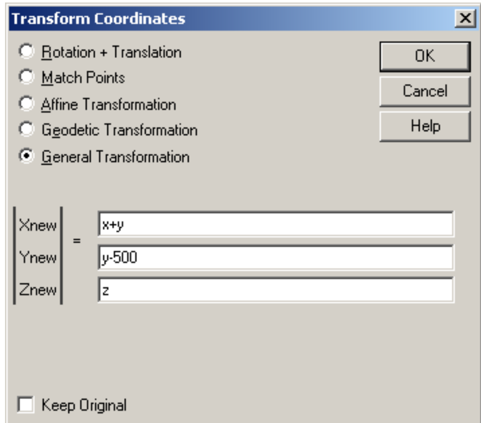


- Check this out yourself: Draw a rectangle

Then either

- Save the file and afterwards File New, **Import|Options**, button „Transformation“ or - not touching an object - select
- **Modify Objects**, action „Transformation“ and the option „Keep Original“ activated or not.

If you don’t see the new object then change your scale!

Delete polygon points depending on height z

With the **General Transformation** dialog you may also delete polygon points from lines and areas depending on a user-defined height of the polygon points.

This feature may be useful for objects which have some points with a height of zero while the other ones have heights greater than zero and, moreover, the distances to each other are very small. This may happen with a file imported from a third party program.

With contour lines for e.g. you would have a very jagged digital terrain model. In this case you may purge these objects by defining a formula in the z-coordinate field as follows:

```
iif(z==0,del,z)
```

(if the height is 0, then delete that point, otherwise do not alter the height).

Of course you may enter a different value for zero. After confirming with OK the affected points are deleted.

Interpolate height z of polygon points

Instead of deleting the points if their z-heights are not desired, you may interpolate the z-height, depending on the next corresponding z-height and the distance of these points, with the formula as follows:


```
iif(z==0,int,z)
```

Of course you may enter a different value instead of zero as well. After confirming with OK the affected points are interpolated.

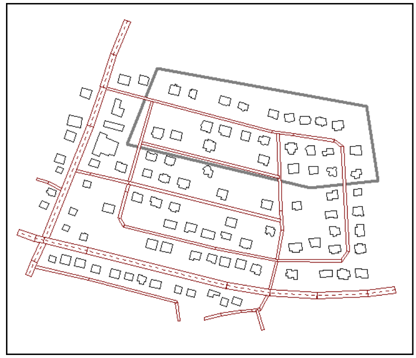
Interactive Transformation

By the interactive transformation objects can be duplicated or relocated using the mouse, i.e. without entering numerical values via the keyboard. In order to select objects all options on the dialog **Modify Objects** are available. By clicking in the white area on the screen all types of objects - as before - are addressed.

☝ The interactive transformation is not available via the context menu of individual objects.

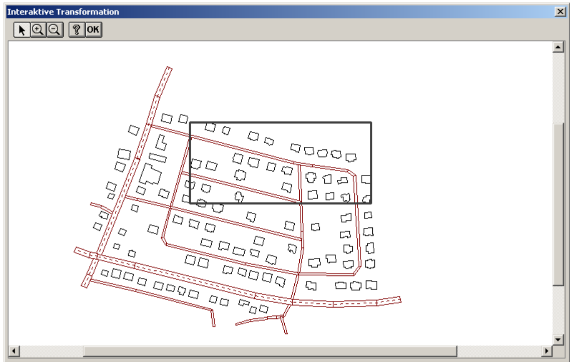
Example

All buildings inside the polygon area shall be duplicated and relocated.



To achieve this proceed as follows:

- Select from the context menu of the polygon the command **Modify Objects**.
- Select the action „Transformation", as range „Inside Polygon" and the object type „Building" and click OK.
- In the subsequent dialog **Coordinate Transformation** select the type „Interactive Transformation", check the option „Keep Original" and click OK.
- The dialog **Interactive Transformation** is shown.



Dialog **Interactive Transformation** (objects under consideration with frame)

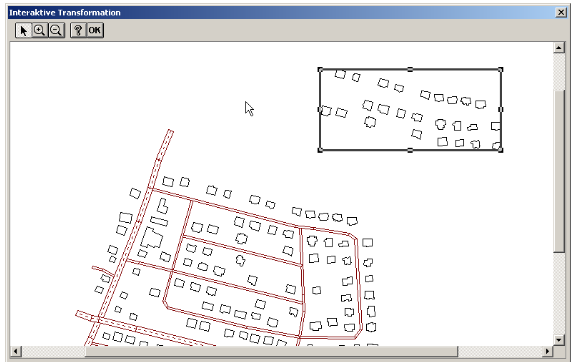
The frame displayed delimits all objects addressed by the selection and subjected to the selected action. The following dialog options are available:

Symbol	Action
	relocate/stretch/turn selected objects
	zoom in
	zoom out
	display help
	confirm transformation (close dialog)

- To relocate the framed objects click with option  selected onto the frame and keep the left mouse button depressed.
- Now move the frame to the desired location and release the left mouse button.

By using zoom in/zoom out a smaller or larger project section will be displayed.

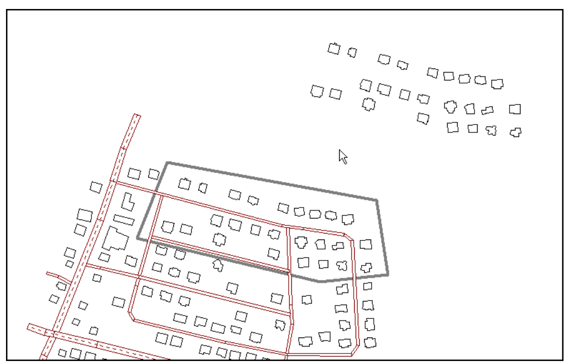
With just translatoric transformation the result will look like this:



Dialog **Interactive Transformation** (objects under consideration relocated)

- Close the dialog **Interactive Transformation** by OK.

After having confirmed the action by „All“ the selected objects will be transformed to the new location.

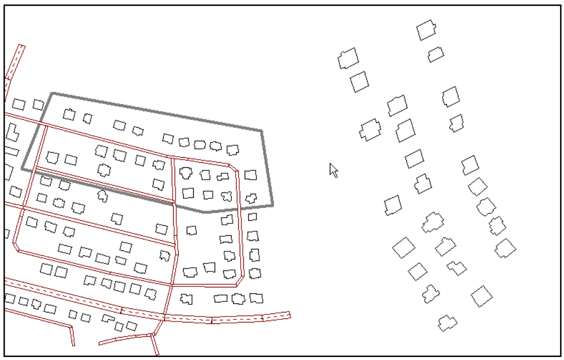


Translatoric transformed building

Stretching/Turning of Objects

Furthermore, the following options are available:

- By dragging the frame by one of its polygon points the objects selected can be stretched.
- While keeping the ALT-button depressed the frame including the objects can be turned to a desired angle.



Stretched and turned buildings

Cancelling the Transformation Action

To cancel an interactive transformation without any change close the dialog **Interactive Transformation** via the symbol „Close Dialog" on the top right corner (☒).

Reapply the Transformation Action

When having finalized an interactive transformation the same transformation rule can be reapplied to a further selection of objects. Proceed as follows:

- After finalized of an interactive transformation select the new group of objects to be transformed as required.
- Select on the dialog **Modify Objects** the action „Transformation", the range, and the objects type/s and click OK.
- When selecting the type „Affine Transformation" on the dialog **Coordinate Transformation** the transformation matrix will be shown.
- Click OK in order to reapply this matrix to the new selection of objects.

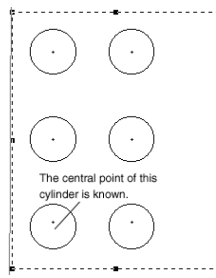
Duplication by Transformation

If you want to transform and simultaneously duplicate several and/or different objects you may also accomplish this by Transformation. The subsequent actions can - in contrary to the interactive transformation type - be applied to transform objects based on distinct numerically known distances or to distinct numerically known locations.

To this end, select **Modify Object**, action „Transformation“ from the context menu (see manual „Introduction to **CadnaA**“, keyword „Modify Objects“).

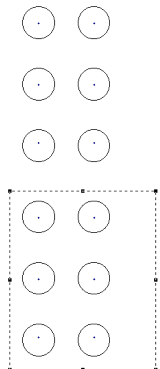
Example

The following figure is the starting situation. Six cylinders with point sources shall be duplicated above the existing cylinders.



The central coordinates of a cylinder will be looked up in the **Geometry** dialog and transcribed - in our example the lower left cylinder with x=179.03 and y=51.09.

The entire construction shall be transferred 60 m going out from the lower left cylinder up toward the top on the y-axis. The following figure shows the layout which should emerge after the transformation.



Transformation with activated option „Keep Original“

In this case the transformation is executed via the context menu of the section selecting the command **Modify Object**, action „Transformation“, the range to „Inside Polygon“, and for object types „Cylinder“ and „Point Source“. Upon OK the dialog **Coordinate Transformation** is displayed. Besides the interactive transformation type the following types are available:

Rotation and Displacement

When choosing this option enter in the column „Translation“ only for the y-coordinate (middle box) 60. In this way the object will be transferred 60 m upward. With a negative value (- 60) the object will be transferred downward.

Match Points

When choosing this option, you will need in every case the old and the new coordinates. For our example enter, for a simple shift upward, only for P1 old x 179.03 / y 51.09 and for new x 179.03 / y 111.09.

Affine Transformation

When choosing this option activate the checkbox „Rotation/Translation“ and enter also 60 in this column for the y-coordinate.

General Transformation

When choosing this option for our example enter the following:

Xnew = x

Ynew = y + 60

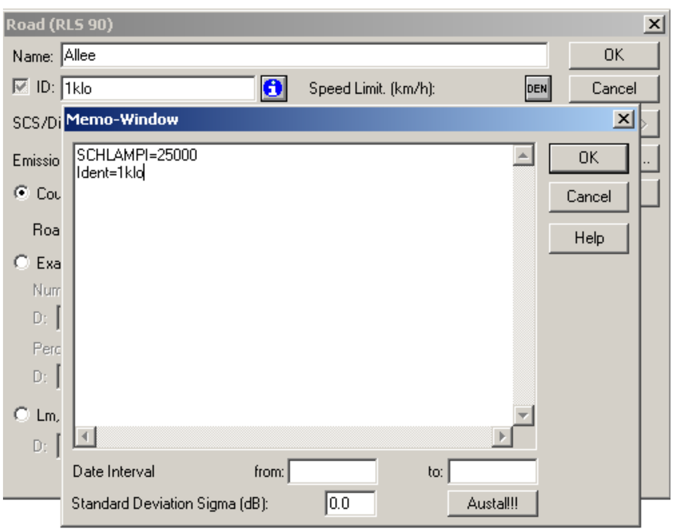
Znew = z

7.1.5 Unknown Attributes to Memo-Variable

By some import formats the attributes like height of an object, road surface or the MDTD etc. will be assigned to a **CadnaA** attribute. That means the fields in an edit dialog are filled with data.

If the attributes have different names as in **CadnaA** used the attributes have to be assigned to each other. This takes place in the field **Transform Attributes**. This table can be saved then in a file (*.shi) for later use (buttons Open and Save).

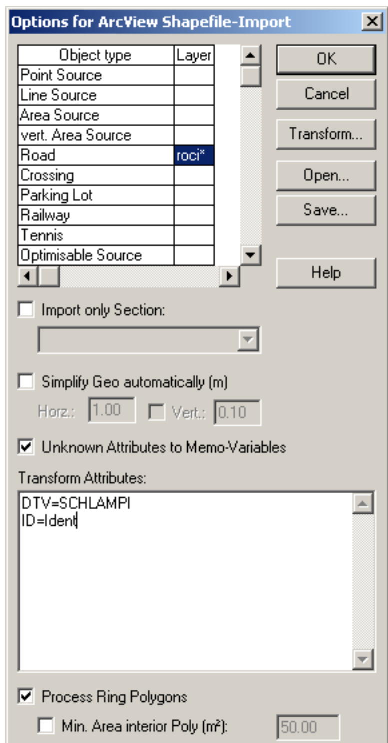
If the import option **Unknown Attributes to Memo-Variables** is checked all unknown attributes will be saved as memo variable into the **Memo-field** of the corresponding object, e.g. in the Memo-field of the road dialog will be saved SCHLAMPI=25.000 and Ident=1klo.



Of course the user has to know what SCHLAMPI and Ident means so that it can be assigned to the right CadnaA attribute.

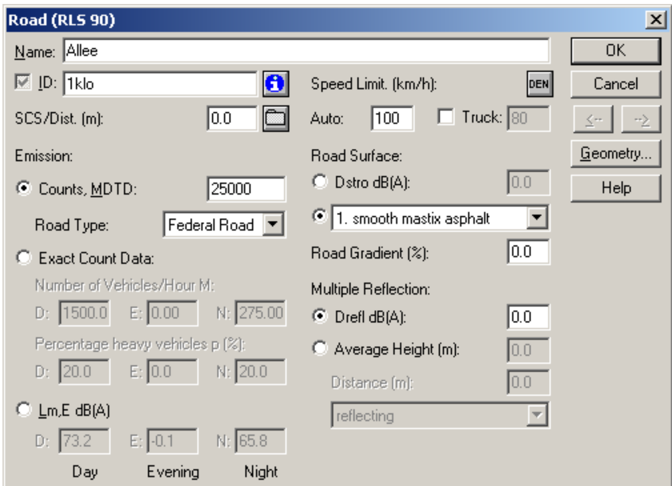
If we assume that SCHLAMPI is the alias for MDTD (attribute *DTV*) and *Ident* for the **CadnaA** attribute *ID* we are able to correlate them in the field **Transform Attributes** in the following way: First write the **CadnaA** attribute followed by an equal sign and the attribute name of the import file. Please be aware of the syntax.

DTV=SCHLAMPI
ID=Ident



If you like save this table.

CadnaA is now enabled to assign the pertinent attributes to each other and would import the corresponding values in the correct columns for the road in our example for MDTD 25,000 and for the ID the string 1klo.



All object attributes are listed in the **CadnaA**-manual „Attributes, Variables, and Keywords“ and on the online help, button „Keywords“.

7.1.6 Process Ring Polygons

During the import **CadnaA** also can process ring polygons. A lower limit for the area (m^2) which should be taken into account for the interior polygon can also be assigned. For that check the corresponding options in Import|Options.

Ring polygons are areas which have "holes" inside an area. This happen when in GIS so-called "Island" or "Doughnut" polygons have been drawn on a bigger area and following gashed.

7.2 Import Formats

With the extremely efficient interface for many third-party file formats it is guaranteed that **CadnaA** users can take advantage of all available data sources. Because of continuous development it cannot be excluded that a file format has changed and therefore the corresponding data cannot be correctly imported. It is recommended you check a file format by importing a little test file before importing big data volume.

If a file format, which is supported by **CadnaA**, cannot be perfectly imported or you require a file format which has not yet been implemented in **CadnaA**, please let us know.

The following chapters describe the currently available import formats.

7.2.1 CadnaA

CadnaA's internal file format with the extension CNA. Any **CadnaA** file can be imported into any other **CadnaA** file.

Import options:

- Select object type (see chapter 7.1.3)
- Import only in a Section (see chapter 7.1.2)
- Transformation (see chapter 7.1.4)

With the import option „Just Update Immission Values" you can force that only the values of „Receiver" or/and „Building Evaluation" points are imported not the objects itself. For that check this option, even when object type "Receiver" and/or „Building Evaluation" is highlighted. Doing so you have to choose the pertinent variant from the local list from which the values result.

Via the option „Import only Section" a section in the **CadnaA**-target file can be specified. Only those objects will be imported which are inside of the section specified, plus a border area when specified.

7.2.2 AutoCad-DXF

Using the DXF format to import geometry data is an option often made use of. Many CAD programs are capable of exporting DXF files, which means that practically all maps generated using a CAD system can be imported by **CadnaA**. This feature, however, is limited to geometry data – other features and parameters are not imported. If necessary, this has to be done in a second step using the database interface (see chapter 7.3 "Import via ODBC Interface").

CAD systems can be used in a very flexible manner. Designers are free in their definition of objects. Buildings need not necessarily be drawn as closed polygon. The simplest representation consists of four individual walls (lines). Often, heights are not given, as for many maps two-dimensional representations are sufficient.

To ensure proper interpretation of the DXF data by **CadnaA**, observe the following hints:

- Allocate all drawing elements belonging to one acoustical object type in **CadnaA** to one layer.
- Prior to saving the DXF file, all those elements should be removed from the drawing (such as lettering, structural elements etc.), which are not required for the representation of the object in **CadnaA**. (A lettering, e.g. is imported as a set of vectors in many small sections. This results in more memory being used than actually necessary, which, in turn, slows down work with your file.).
- Points, such as point sources and receiver points, are exported with x, y, and z coordinates. When **CadnaA** imports them, the z co-ordinate is interpreted as absolute height.
- All lines must be saved as polygon lines.
- Any object represented as a closed polygon in **CadnaA** (buildings, area sources, built-up areas, foliage etc.) is to be represented by a closed polygon line. For three-dimensional objects, such as buildings, the z coordinate of each point means the absolute height of the roof. The

polygon, therefore, defines the outline of the roof area.

- Save open lines such as roads, railways, line sources etc. as open polygon lines.
- In the case of roads, only the axis (centre line) can be used as a DXF element. If the axis of several tracks are saved as lines, **CadnaA** will accordingly display several parallel roads. In this case, you would have to assign to each road the width of one of the tracks, and the traffic density applicable to that track. It is therefore much simpler just to import the main axis of the road and then specify the road cross section as a parameter.

Our DXF format will intercept some of the individual inputs made by CAD users. To be able to interpret a polygon as, e.g. a building, **CadnaA** requires that the polygon is closed. **CadnaA** will therefore assume a building to be a closed polygon, although its walls, in the CAD system, are represented by individual lines with, however, identical first and last points (which is not supposed to be a closed polygon). If the pertinent layer name is given, the polygon is then imported as a building.

Block saving is also supported by the **CadnaA** DXF format, and the objects are processed accordingly.

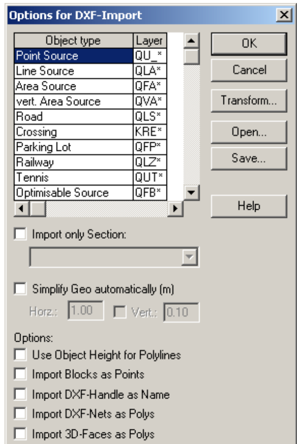
see also chapter see chapter 5.5.7 "Close Polygons"

Import Options

The „Options" button offers the Examples options for DXF-import:

- Object layer (see chapter 7.1.1)
- Import only in a section (see chapter 7.1.2)
- Simply Geometry (see chapter 11.9 "Simplify Geometry" in the manual „Introduction to **CadnaA**")
- Transformation (see chapter 7.1.4)
- Use Object Height for Polylines
- Import Blocks as Points
- Import DXF-Handle as Name
- Import DXF-Nets as Polys

- Import 3D-Faces as Polys



Dialog **Options for DXF-Import**

Layer Description with more than 23 Characters

With layer descriptions of more than 23 characters (restriction for the ID's length, see chapter 4.4.2 "Dialog Options Name, ID, INFO, ObjectTree" in the manual „Introduction to **CadnaA**") the original description is written to the text variable ORG_LAYER (as long as the respective variable does not exist).

Use Object Heights for Polylines

With the activated option **CadnaA** adds the z-height and the object height from the DXF file, and defines this height as object height in **CadnaA**.

Example

In a CAD program the layer of an object is, e.g., defined by 15 m, the object height by 20 m. This is in **CadnaA** an object height of 35 m, absolute.

Import Blocks as Points

With the activated option for the DXF-Import only, the "Insertion points" of the blocks will be imported.

Example

In a CAD program if height points are drawn as crossing lines and defined as block, **CadnaA** will import crosses instead of intersection points if the option is deactivated.

Import DXF-Handle as Name

Sometimes DXF files contain identifiers (ID) so-called „Handle“. Importing these in **CadnaA** is only useful if you also want to import interconnected parameters located in a separate database. The **ID** is the connecting element between the graphic objects from the DXF file and the parameters from the database (see chapter 7.3 "Import via ODBC Interface").

Activate this option if the mentioned condition is to be fulfilled. After importing the DXF file the Handle is entered automatically in the **Name** box in the object dialog. Before you merge the data from a database via the ODBC interface you have to „hand over“ the Handle from the **Name** into the **ID** box of **CadnaA**.

To achieve this you may apply the command from the context menu **Modify Object|Swap Name/ID** (see manual „Introduction into **CadnaA**“). Subsequently, the object data can be imported via the ODBC-database connection (see chapter 7.3 "Import via ODBC Interface").

Import DXF-Nets as Polys

So-called „nets“ (inter-meshing) can also be imported. Enable this option in case nets are to be imported.

Example DXF Import

Following a DXF import example in which two height references are contained in a file.

Import 3D-Faces as Polys

So-called „3D-faces“ are several 3D polylines connected to each other. After activation of this option these are imported as polylines.

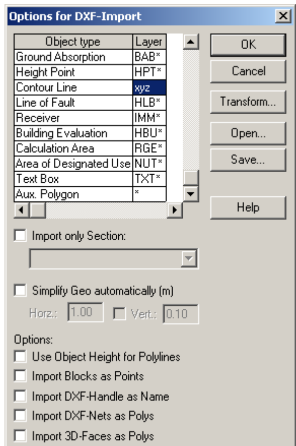
DXF Import with two heights

Following situation: you get a DXF file in which are saved buildings with two heights - the base point height and the object height. The base point height shall be imported for the digital terrain model (DTM) as contour lines. The following procedure is started with **File|Import,** format “AutoCad DXF“. The DXF file has to be imported twice with the below mentioned option settings.

1st Import

Contour line - Layer: e.g. „xyz“ (or more layer names which include buildings, too - e.g. xyz|zyx|micky. . . .)

Aux. Polygon - Layer: *
Option „Use Object height for Polylines“ not activated.



1st Import: settings for import of terrain contours

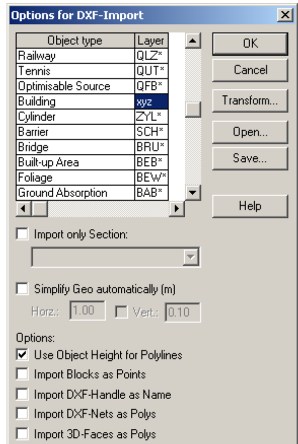
Close the dialog with OK. The file will be imported.

2nd Import

Building - Layer: „xyz“

Contour lines - not imported!
Aux. Polygon - not imported!
Option „Use Object height for Polylines“ now activated

Close the dialog with OK. The file will be imported.



2nd Import: settings for import of buildings

But there are probably too many contour lines imported with a slight height difference which is surely not useful. If necessary, thin the contour line model by deleting them or eliminate polygon points from the contour lines with the function **Modify Objects|Action: Simplify Geometry** from the context menu (see manual "Introduction to **CadnaA**") or generate new contour lines by calculating a ground model (see chapter 4.5).

7.2.3 AutoCad-DWG

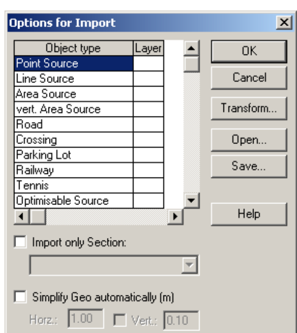
The import of DWG-files requires option BMP.

The DWG-file format is specific to the design software „AutoCAD“ by Autodesk Corp. The file format uses the file extension *.dwg (for „**draw**-ing“). The **CadnaA** import filter supports DWG2000 and DWG2004 at present.

In principle, there is a restricted compatibility of the DWG file format to older AutoCAD versions. In these cases we recommend alternatively using the DXF import filter or external converter software.

Via the button „Options“ the following DWG-specific settings are available:

- Object Layer (see chapter 7.1.1)
- Import only Section (see chapter 7.1.2)
- Simplify Geo automatically (see chapter 11.9 "Simplify Geometry" in the manual „Introduction to **CadnaA**“)
- Transformation (see chapter 7.1.4)



Dialog **Options for DWG-Import**

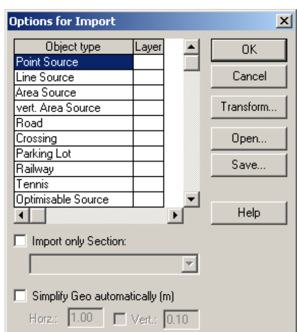
7.2.4 MicroStation-DGN

☝ The import of DGN-files requires option BMP.

The DGN-file format is specific to the design software „MicroStation“ by Bentley Systems Inc. (USA). The file format uses the file extension *.dgn (for „**d**esi**g**n file“). The **CadnaA** import filter supports DGN versions 1, 2 and 3 at present.

Via the button „Options“ the following DGN-specific settings are available:

- Object Layer (see chapter 7.1.1)
- Import only Section (see chapter 7.1.2)
- Simplify Geo automatically (see chapter 11.9 "Simplify Geometry" in the manual „Introduction to **CadnaA**“)
- Transformation (see chapter 7.1.4)



Dialog **Options for DGN-Import**

7.2.5 ArcView

ArcView files are shape files which were generated as exported files from the ESRI company's Geographic Information System (GIS) using ArcView or ArcInfo software.

Possible import options:

- Object Layer (see chapter 7.1.1)
- Transformation (see chapter 7.1.4)
- Unknown Attributes to Memo-Variable (see chapter 7.1.5)
- Process Ring Polygons (see chapter 7.1.6)

The GIS system is based on layers and themes. These themes are labelled and contain objects to be specified by the user. The themes "Buildings.shp", e.g. might comprise all buildings in a city, or "Traffic Systems.shp" might include all roads.

Via the ArcView format, **CadnaA** is capable of exporting shape files and importing these files, while at the same time allocating the GIS objects to the appropriate **CadnaA** objects by entering the themes in the allocation list (**Options** button).

Lines (ISO-dB) and areas with equal sound sources (noise map) and the calculated receiver grid can also be exported to ArcView or ArcInfo. Data exchange with the ArcView GIS system is thus guaranteed.

In total you will get three files with the same name but different extensions:

- the shape file with the extension „shp“ which comprises the geometrical object data;
- the database file with the extension „dbf“ with object attributes like, e.g., object height, MDTD of a road (Mean Daily Traffic Density), SCS/Distance of a road (Standard Cross Section) or the sound emission level etc.;
- and a so-called index file with the extension „shx“.

To import from ArcView all three files have to be in the same directory.

In the dialog **Import Options** enter the theme/file name without the extension „shp“ as the layer name for the appropriate object type without extension but with an asterisk *. The data being imported is then allocated to that object type under **CadnaA**.

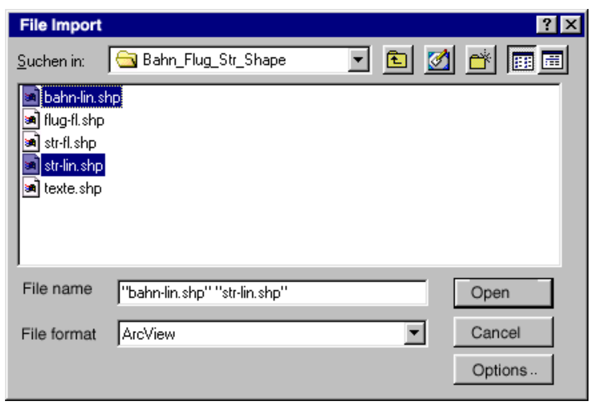
Clicking **OK** closes the dialog and imports the data.

Example Import of Objects

ArcView files of the shape-format consist of three file types *.shp, *.shx, and *.dbf, all in the same directory. Within **CadnaA** import the shp-file with **File|Import**, file format „Arc View“. This file type comprises the geometrical object references.

After clicking the **Option** button you may allocate the ArcView files to the appropriate object types by entering the file names (themes) in the corresponding layer boxes. You may import several files simultaneously.

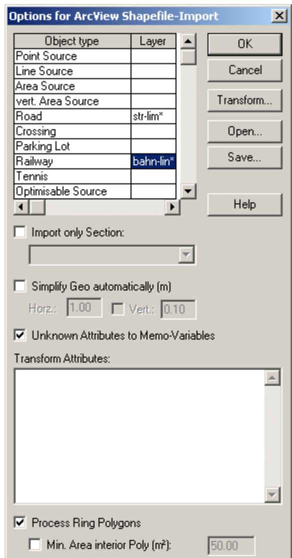
- Mark, if necessary, by multiple choice (see manual "Introduction to **CadnaA**"), the files you would like to import.



- Afterwards click on the **Option** button.
- Enter the ArcView file name without the extension „shp“ and - very important - with an asterisk (*) behind the file’s name in the corre-

sponding object type of the layer boxes.

- The data will be imported after confirming and closing all dialogs with OK.



In this example data is being imported which is found in the files named `bahn-lin`.shp and `str-lin`.shp.

unknown Attributes

If not all attributes are imported use the option „Unknown Attributes to Memo-Variable“.

ArcView ASCII Grid

An ASCII-grid can be opened via the menu **Grid|Open**.

Bitmap files

If Bitmap files also being delivered by ArcView, and if they are geo referenced, you may import these files with the file format **Bitmap** without having to calibrate them again.

7.2.6 Atlas GIS

The extension of the file format AtlasGis is BNA.

Import options:

- Object Layer (see chapter 7.1.1)
- Import only in Section (see chapter 7.1.2)
- Transformation (see chapter 7.1.4)
- Simplify Geometry (see manual "Introduction to **CadnaA**")

7.2.7 Sicad

The allocation of the imported data to the object types is managed by the layer names in **CadnaA** (see chapter 7.1.1). The layers in Sicad format are called levels.

When doing so, please note:

You may enter four different parameters for one layer name. These four parameters are written in capital letters so as to be separated from each other for better alignment as follows:

Parameter	Explanation	Example
E	Level no.	E3
M	Line Style	M1
S	Line width	S5
T	Element type	KR = Circle, LI = Line

A possible entry in the layer column in **CadnaA** would be:

`E15M1S7TKR`

If necessary, references concerning a coordinate transformation may be entered.

Import options:

- Object Layer (see chapter 7.1.1)
- Import only in Section (see chapter 7.1.2)
- Transformation (see chapter 7.1.4)
- Simplify Geometry (see manual "Introduction to **CadnaA**")

7.2.8 EDBS

The EDBS format is a standardized file format used by the German institutions for ordnance survey.

Importation options:

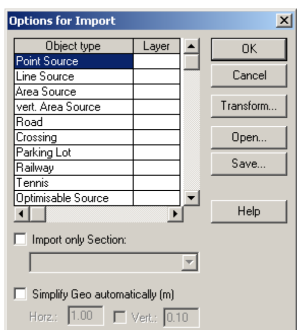
- Object Layer (see chapter 7.1.1)
- Import only in Section (see chapter 7.1.2)
- Transformation (see chapter 7.1.4)

7.2.9 GML and CityGML

The GML-format is used by the Ordnance Survey of the United Kingdom (see http://www.ordnancesurvey.co.uk). GML is a XML-dialect extended by spatial data. Thus, GML can be understood as a world-wide applicable standard language for the generation and the communication of geographical data.

In case layers are used those can be addressed to the corresponding **CadnaA**-object types in the usual way. Via the button „Options“ the following GML-specific settings are available:

- Object Layer (see chapter 7.1.1)
- Import only Section (see chapter 7.1.2)
- Simplify Geo automatically (see chapter 11.9 "Simplify Geometry" in the manual „Introduction to **CadnaA**“)
- Transformation (see chapter 7.1.4)



Dialog **Options for GML-Import**

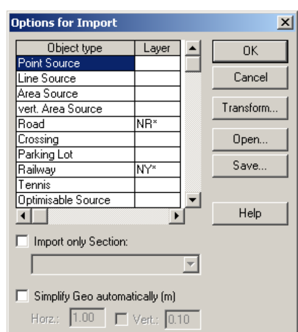
CityGML-Format

The CityGML format (City Geography Markup Language) is a data interchange format for 3D-data for geometries of cities and areas. The format is based on GML3, the Geographic Markup Language (see http://www.citygml.org). Unlike the GML format, the CityGML format makes use of fixed descriptions for object layers. These layer descriptions are predefined on the import-dialog of **CadnaA**. This concerns the following **CadnaA**-objects:

Object Type	Layer Description
road	NR*
railway	NY*
building	HA*|UU*
barrier	CN*|NC*
contour line	UL*
auxiliary polygon	* (remaining objects)

Via the button „Options“ the following CityGML-specific settings are available:

- Object Layer (see chapter 7.1.1)
- Import only Section (see chapter 7.1.2)
- Simplify Geo automatically (see chapter 11.9 "Simplify Geometry" in the manual „Introduction to **CadnaA**“)
- Transformation (see chapter 7.1.4)



Dialog **Options for CityGML-Import**

7.2.10 WINPUT-DGM

Height Points

The WINPUT-DGM file is a special ASCII-file format which either contains coordinates of height points (one x-y-coordinate pair per row) or contour lines (more then one x-y-coordinate pair per row). The data can be directly imported as a digital terrain model in **CadnaA**.

When calculating the sound propagation, ground attenuation and screening will also be taken into account for height points if the option „Triangulation“ is activated on dialog **Calculation|Configuration**, tab „DTM“ (see chapter 6.2.6).

7.2.11 Stratis

Stratis is a program system for road construction and civil engineering by the company RIB Software AG, Germany).

For export of data from STRATIS and subsequently import into **CadnaA** the specific exchange format CST is available for the following objects:

in STRATIS		in **CadnaA**
Object	Export format	Import format
Roads	CST	Stratis
Contour lines	CST	Stratis
Dam-/Embankment lines	CST	Stratis
Build up Area	CST	Stratis

7

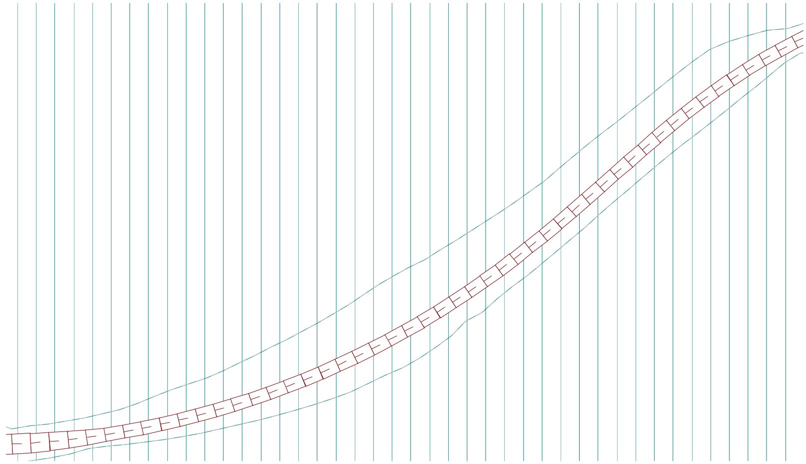
The following features have been added to the Stratis-import filter:

- import of the roads axis as auxiliary poly (if existent),
- automatic import of defined areas,
- considers an entered additional width right/left,
- considers asymmetrical cross-sections and lateral slopes,
- import object designation as defined in Stratis.

☝ For better understanding open the example file **Sca_hl.cna** in **CadnaA** and import the file S1.sca via menu **File|Import**, file format „STRATIS“.

Examples\07_Import\Sca_hl.cna & S1.sca

After a STRATIS file with road axis and embankment has been imported within a **CadnaA** project with an existing terrain model. It had been necessary to delete the existing contour lines between road and embankment base line „by hand“. This procedure is now automated to some extent.

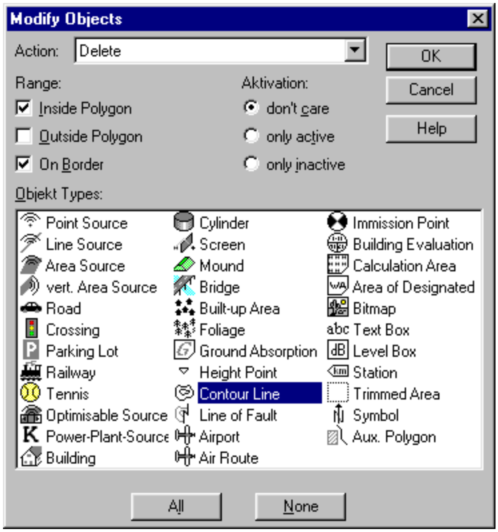


Example: terrain model with imported road and embankment base line from Stratis

When importing in **CadnaA** a closed auxiliary polygon is automatically laid over the imported embankment base line of the road. If you open its edit dialog with a double-click you can look up the identifier „STRASSENRAUM" in the **ID** box.

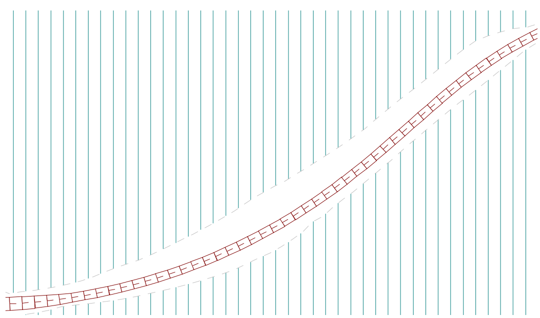
Close the edit dialog again and open with the right mouse key the context menu of this auxiliary polygon.

- click on the command **Break Lines** and
- again in the context menu **Modify Object**.
- Choose the following in the opening dialog **Action: Delete** the options **inside** and **on the border** of the polygon and from the object list **Contour Lines**.



Modify Object from the context menu of the auxiliary polygon

- After confirming with **OK** click on the button **All** in the next dialog.



After deleting the contour lines between road and embankment base line.

Now all contour lines are deleted including the embankment base line.

- Afterwards also delete the auxiliary polygon and the road.
- Then, import the road again.

7.2.12 MapInfo

The import format MapInfo® (MapInfo Corporation, USA) enables the importing of so-called MIF files (ASCII) which contain the geometrical references for objects like, e.g., building coordinates. If necessary you can also assign object layers (button Option).

The generally supplied ASCII data file with the extension MID contains further parameters like, e.g., object height, MDTD, or road distances etc. Both files should be stored in the same directory.

If not all attributes are imported you have to assign the pertinent CadnaA attributes once (see chapter 7.1.5)

Further import options:

- Object Layer (see chapter 7.1.1)
- Import only Section (see chapter 7.1.2)
- Simplify Geometry (see manual "Introduction to **CadnaA**")
- Transformation (see chapter 7.1.4)
- Unknown Attributes to Memo-Variable (see chapter 7.1.5)

7.2.13 Import / Export of Numbers of Trains

The list with number of trains (on menu **Tables|Library (local)**) can be updated from ASCII-files (*.txt) with via menu **File|Import**, format „Number of Trains“.

During import it has to be specified whether the data imported shall be copied to locally defined railway tracks (option Railway) or to library on number-of-trains (option Number of Trains) and if the data should be „updated“ or if they should be „appended“.

Attention should be paid to that the data are only assigned to the railway tracks if the name (e.g. xyz) of the list with number of trains is identical with the ID (ID: xyz) of the pertinent railway track.

Table format:

The parameters have to be separated by TABs. The name of the track or of the train list are in the first row (NOT="Number of Trains"):

1. row:
name of track or train list

2. row:
Train_Type|NOT_Day|NOT_Evening|NOT_Night|Speed|...
Train_Length|Percentage_Disc_Brakes|Correction_Dfz|Selection_Train

3. row:
(empty line)

☝ Remark: The last two parameters are just required for the German calculation model (Schall 03). For all other methods these parameters shall be zero.

7.2.14 Special Formats

The import of **Bitmaps** only works correctly if the option BITMAP is purchased (see chapter 10.1.2). **Bitmap**

With this import format (Deutsche Telekom MobilNet GmbH) you can import buildings and ArcView-Terrain-Grid. The file extension can vary, so that they cannot be used as a file filter in the import dialog (import options on dialog **Transformation** see chapter 7.1.4). **T-Mobil**

Special format from the program SLIP by Grolimund & Partner AG, Bern (Switzerland). **Slip**

special Scandinavian file format **SOSI**

United Kingdom National Transfer Format **NTF**

File format according to DIN 45687 /28/, intended for data exchange between software programs for the calculation of sound propagation. On import of the QSI-project file (*.qsi) all corresponding SHP-, DBF- and SHX-files are loaded automatically. **QSI**

Import of complete project data of the program MITHRA - only possible if the option **CadnaA**-MITHRA is purchased. **Mithra**

When importing railroads from MITHRA the option "Railways are absorbing (G==1)" is deactivated (dialog **Configuration/Ground Absorption**).

Import of train emission data (for method „NMPB-Fer)“ of the software MITHRA - only available if the option **CadnaA**-MITHRA is purchased. **Mithra Trains**

7.2.15 Third-Party Software

LimA-files

With this format, files from the program LimA by the company „Ingenieurgesellschaft Stapelfeldt“, Germany, are imported.

The files can have different file extensions like, e.g., „ert“, „hge“, „ind“, „spo“, „nut“ etc. and therefore cannot be used as a file filter for choosing the files in the import dialog.

You can import all kinds of files simultaneously with multiple choice.

SoundPlan-files

With this format, files from the program SoundPlan by the company „Braunstein & Berndt“ are imported.

These files have no consistent extension and therefore cannot be used as a file filter in the import dialog.

You can import all kind of files simultaneously by multiple selection.

The ground heights are also imported from SoundPlan files (**Geometry** dialog, option „absolute Height/Ground at every point“).

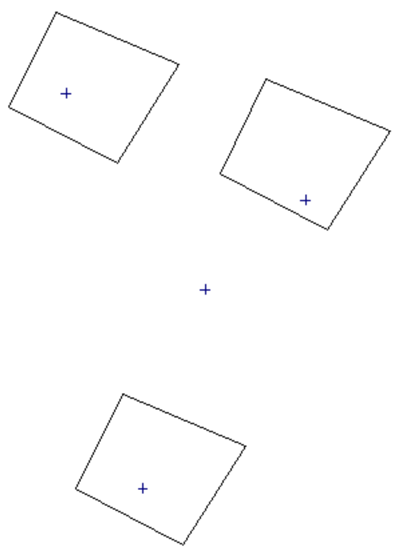
CadnaA imports SoundPlan receiver points as follows:

If SoundPlan receiver points are assigned to „Reflex files“, the option „Use next building“ will be activated in **CadnaA** automatically. This affects the searching for buildings within 1,5 meters of the receiver point and assigns it the ground height of the next building facade. If no building is found, the terrain model is evaluated.

If the receiver points aren’t assigned to any „Reflex files“, the control line IHM will be appraised: The base at the receiver point will then be IHM under the Z-height (therefore the option „Input of Value“ will be activated automatically). In case the IHM is not specified the standard of 2,8 m will be applied.

7.2.16 Building Height Points

Use this ASCII-format to import building heights previously exported from **CadnaA** using the export function of the same name, or obtained as a separate file from the surveyor's office or the like. It may happen, however, that the file received shows the ground plans of the buildings and, within these ground plans, points which merely provide information on the height of these buildings. In the latter case, you will wish to allocate the heights of these points to the respective buildings as easily as possible. This can be managed by means of the command **File|Import** resp. **Export |Building Height Points**.



The ASCII file contains points with x-y-z coordinates which would lie within a building ground plan. When importing, only the z-coordinates are considered, and the height is allocated to that building in whose ground plan the respective point lies.

On import, the following text variables - based on the height points within the buildings border - are written into the **Memo-Window** of each building:

- HH_NUM: number of height points
- HH_HSUM: sum of all heights
- HH_MEAN: mean height

It may happen that you adopt building ground plans from an automated real-estate map where no height information is supplied. The heights would then have to be determined in some way or another (e.g. by means of local inspection or aerial survey, etc.).

Having determined the heights, possibly at great expense, and allocated them manually to the buildings in your **CadnaA**-file, you will of course wish to keep the height information even if the building ground plans are updated.

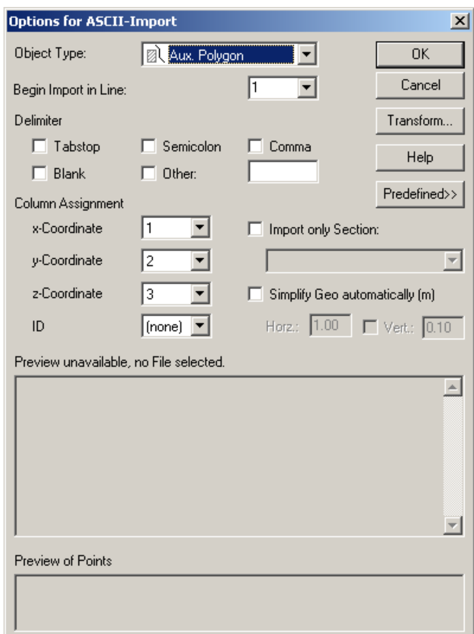
So, before transcribing your building ground plans, first export the building heights using the export format **File|Export|Building Height Points**, and save them to an ASCII-file by specifying a name.

Having updated your building ground plans, just re-import the heights previously exported using the function of the same name.

7.2.17 ASCII-Objects

The format „ASCII-Objects“ enables to import object geometry data from ASCII-files. Open (line-like) and as well as closed (area-like) polygons based on an arbitrary number of coordinate points (x,y,z) can be imported. Objects which are defined in **CadnaA** as closed polygons are closed correctly on import.

The object geometry is addressed to the specified **CadnaA**-object on import, i.e. not requiring any later conversion of object types. Besides the line the import to start with, the delimiter of columns and the column assignment to coordinates (x,y,z) can be freely defined.



Dialog **Options for ASCII-Import**

Object Type

Select here the target object type. By default, the object type "Aux Polygon" is selected.

Begin Import in Line

When the ASCII-file header contains lines with irrelevant data you can specify here the line number to start the import with (line no.s 1 to 20). So, the text file does not need to be reedited externally in any case.

Delimiter

By default, TAB or SPACE are supposed to be the delimiters for data columns. When no delimiter is activated also several tab stops or several blanks in a sequence will not be interpreted as new columns.

In case a single or more delimiters are activated each of those will be interpreted as column delimiter. On "other", an arbitrary text sign can be entered as column separator.

Column Assignment

Address the data columns to the coordinates (x,y,z) by using the three list boxes. An empty line marks separate objects. As delimiter for decimals the point has to be used.

Up to 20 columns can be addressed. Via the list box "ID" - if any - a column can be linked to the attribute ID (default setting "none").

Import only Section

When this option is activated a section in the **CadnaA**-target file can be specified. Only those objects will be imported which are inside of the section specified.

Simplify Geo automatically

In order to reduce the amount of data - in special with terrain data - you can simplify the geometry on import. After activation, enter a horizontal and - if any - a vertical distance. When the perpendicular from a point onto the connecting line between neighboring points is smaller than the entered length, this point will be deleted.

Preview of File

This part of the dialog shows the first lines of the selected ASCII-file facilitating the configuration of the import options.

Preview of Points

This part of the dialog shows a preview of the points applying the import options as specified. In conjunction with the file preview, you can assess in a comfortable way whether the present settings result in a correct import of the data. And this, before starting the actual import procedure.

Button „Transformation“

Via the button „Transformation“ object’s coordinate data can be transformed on import.

see Chapter 7.1.4 Coordinate Transformation

Button „Predefined“

Via the button „Predefined“ the present settings on dialog **Options for ASCII-Import** can be saved. Select the command **Save As** from the context menu and enter a designation on dialog **Save Settings**.

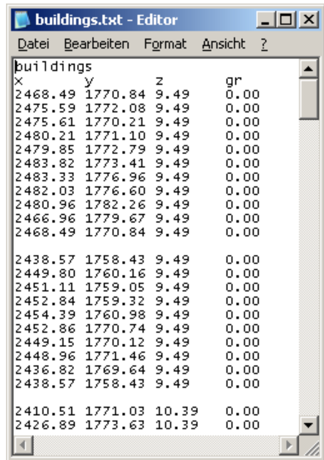
The designations entered will be displayed when clicking on button „Predefined“. To select a setting click to it using the mouse.

Via the sub-menu of the command **Delete** the setting selected is deleted without confirmation prompt.

Example: Import of closed polygons

We begin with an ASCII-file (filename „buildings.txt") with four columns delimited by TABs. Building polygons are separated by an empty line. Consider that a point is used as a decimal sign. The column headings are not evaluated. The first and the last point of each building correspond.

Examples\07_Import\ASCII_Objects\buildings.txt



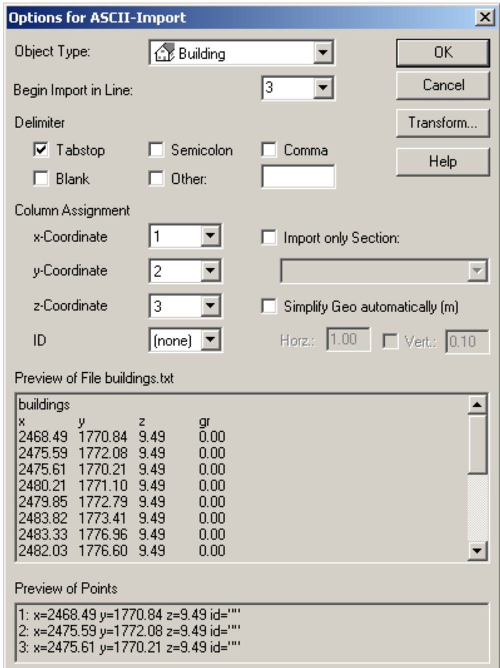

```
buildings
x       y       z       gr
2468.49 1770.84 9.49    0.00
2475.59 1772.08 9.49    0.00
2475.61 1770.21 9.49    0.00
2480.21 1771.10 9.49    0.00
2479.85 1772.79 9.49    0.00
2483.82 1773.41 9.49    0.00
2483.33 1776.96 9.49    0.00
2482.03 1776.60 9.49    0.00
2480.96 1782.26 9.49    0.00
2466.96 1779.67 9.49    0.00
2468.49 1770.84 9.49    0.00

2438.57 1758.43 9.49    0.00
2449.80 1760.16 9.49    0.00
2451.11 1759.05 9.49    0.00
2452.84 1759.32 9.49    0.00
2454.39 1760.98 9.49    0.00
2452.86 1770.74 9.49    0.00
2449.15 1770.12 9.49    0.00
2448.96 1771.46 9.49    0.00
2436.82 1769.64 9.49    0.00
2438.57 1758.43 9.49    0.00

2410.51 1771.03 10.39   0.00
2426.89 1773.63 10.39   0.00
```

Select from the menu **File|Import** the file type „ASCII-Objects", select the file `buildings.txt`, and click the „Options" button. Via the subsequent dialog the import filter is configured.

The import of the buildings starts in the third row. Columns are delimited by the TAB-key. The coordinates (x,y,z) result from columns No.s 1, 2, and 3. Comparing the previews „Preview of File" and „Preview of Points" indicates that with these settings the import will start with the first polygon point.



7

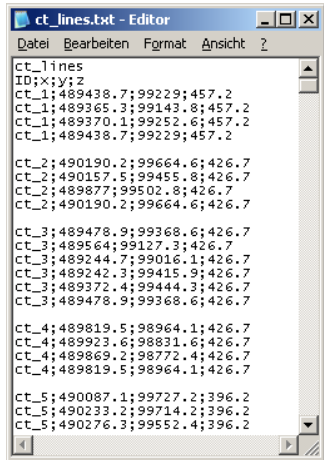
As the object coordinates may be laying outside of the limits click on dialog **Options|Limits** the button „Calc“. Afterwards, click on the symbol **Zoom to limits** on the **CadnaA**-toolbox to display all objects imported.

☝ Remark: Imagine the last point of each building polygon not being present. This would result in open building-polygons after import. In this case, convert the buildings into e.g aux-polygons first, and then back to buildings. (via **Modify Objects|Convert to**). This procedure will automatically close the building polygons.

Example: Import of open polygons

Examples\07_Import\ASCII_Objects\ct_lines.txt

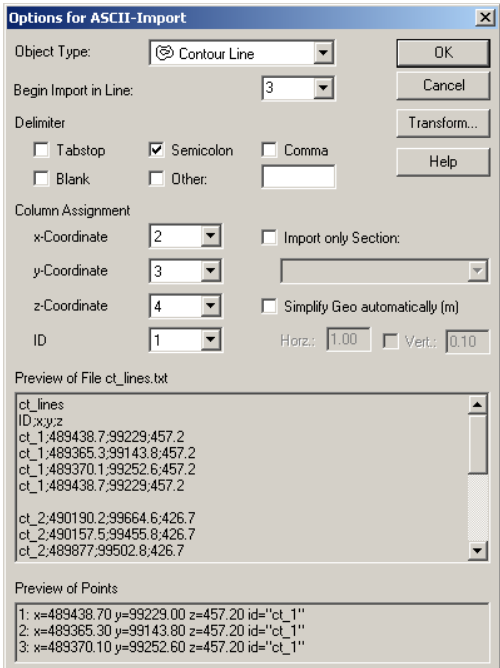
The ASCII-file to be imported has got four data columns, separated by semicolons from each other. Polygons are supposed to be contour lines and are separated from each other by a blank line.



Select from the menu **File|Import** the file type „ASCII-Objects", select the file „ct_lines.cna", and click the „Options"-button. Via the subsequent dialog the import filter is configured.

The import of the contour lines starts in the 3rd row. The delimiter is the semicolon (;). The identifier ID is standing in the 1st column while the (x,y,z)-coordinates result from columns No.s 2, 3 and 4. Comparing the previews „Preview of File" and „Preview of Points" indicates that with these settings the import will start with the 1st polygon point.

7



7

If you cannot see any objects click the symbol **Zoom to Limits** on the toolbox.

see chapter 4.4 "Height Points", section "Import ASCII-File as Height Points".

7

7.3 Import via ODBC Interface

The menu **File|Database** enables to import data from various data sources using ODBC (Open Database Connectivity).

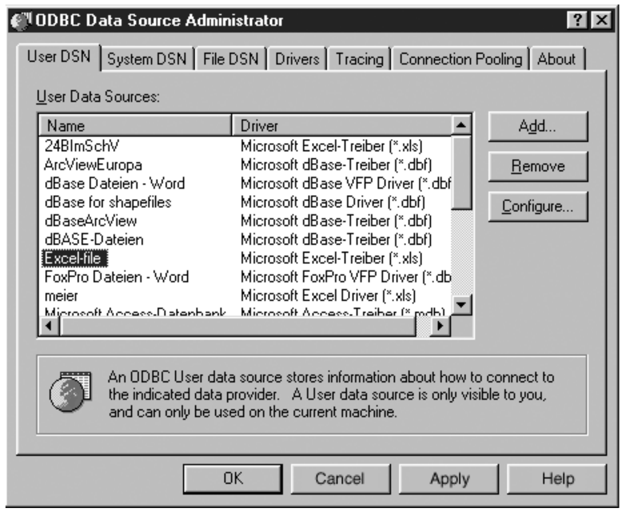
The ODBC-interface offers to import the geometry (i.e. xyz-coordinates) of point-like objects (e.g. point sources, receiver points or crossing lights). For line- and area-like objects, the geometry has to be imported from further data formats, for example, from ArcView (Shape), AutoCAD (dxf) or from ASCII-data (see chapter 7.2 "Import Formats"). Which objects or which object data can be imported via the ODBC-interface can be seen from the menu **File|Database|Definition**, table „Object Type“, as explained below.

In order to use the database interface, make sure that the required ODBC drivers are installed on your PC. They are not necessarily installed with the WINDOWS system software. Please refer to the software documentation whether your database software offers an ODBC-interface (e.g. available for MS-Access, dBase, MS-Excel, Paradox, FoxPro, Oracle).

The ODBC-drivers installed on your PC are displayed via the WINDOWS-start button, **Settings|Control Panel|Administrative Tools|Data Sources (ODBC)**.

If necessary, double-click the pertinent icon and install the desired drivers, or configure database connections.

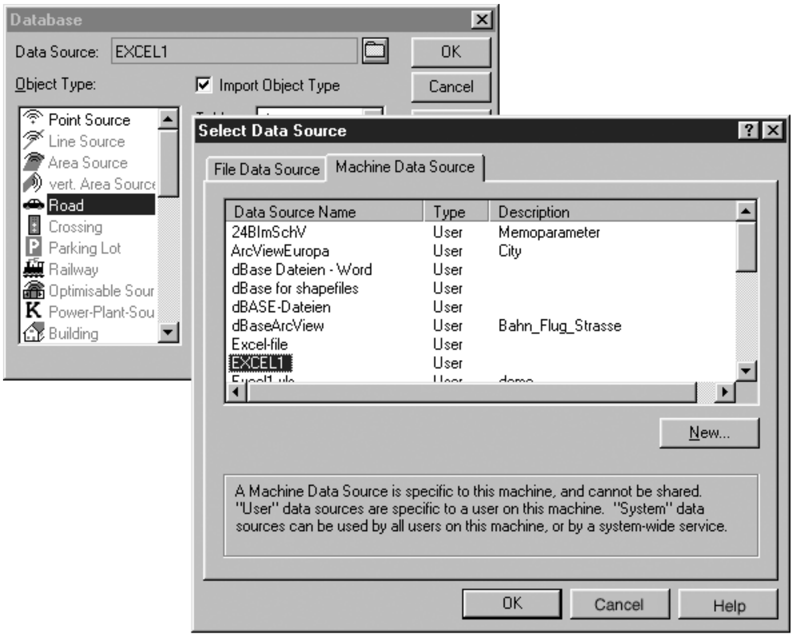
It is not sufficient just to have the drivers on your system. The database with the table from which you wish to adopt the parameters must also be configured (assign the ODBC driver to the desired database). Only then will the selected data source appear on the list.



ODBC data source administrator

☝ The displayed dialogs may deviate from yours. They depend on the installed ODBC version. In that case proceed analogously or look it up your Windows manual.

You can then access this list under **CadnaA** by selecting **File|Database|Definition**. But you also may connect your database in **CadnaA** directly with that menu function.

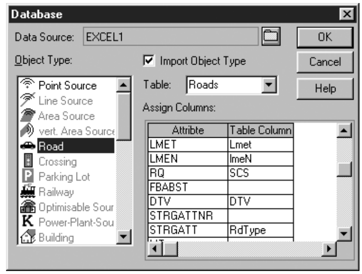


ODBC data source dialog started in **CadnaA** File|Database|Definition

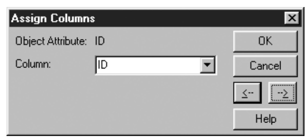
First, select the data source in the Database dialog by clicking the card index icon. Then click the data source corresponding to your database. In our example, this is an Excel file named EXCEL1 (data *source*). Then close the dialog by clicking OK.

In this Excel file, a section named "Road" (database *table*) was defined, containing the road parameters to be imported. This table – the pertinent section of the Excel file – is now accessible.

Next, before selecting a table from the specified database, select the object type ("Road" in our example) for which the parameters are to be imported. Then click the „Import Object Type“ check box and select the table from the „Table“ list box.

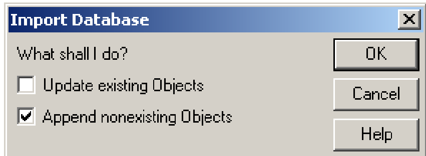


Then double-click in the „Attribute“ column in the „Assign Column“ section that row for which data exists, and click the pertinent column name of the selected database table to allocate it to the object attribute in **CadnaA**.



You always have to import the object geometry first before you can link the pertinent object parameter. The connective element between the geometry and the data is therefore the matching ID. The ID can be seen in the object edit dialog (see manual "Introduction to **CadnaA**") or in the corresponding tables. If necessary, allocate the ID with the function **Change Column** from the context menu in **CadnaA** or in the database directly.

Upon completion of the column allocation, and after closing the dialog by clicking OK, the data can be imported using the command **File|Database|Import**.



For importing, specify whether you want to *update existing objects* and/or to *insert new objects*. Both check boxes may be activated at the same time. The import process, however, may be faster when only one of the options is activated.

The **CadnaA**-manual "Attributes & Abbreviations" lists all attributes used on the „Column Assign“ table of the **Database** dialog.

Requirements for Text Formats for ODBC-Import

Please consider that the data import via ODBC is, in principal, a text import and demands that the following requirements on the document formats are met:

- Column headings must start with text (i.e. with letters). Numbers as leading character in column headings cause import errors.
- In column heading no special characters or blanks are permitted (except for the underscore "_").
- If a column lacks data in the first data lines, the ODBC driver assumes that no data are existing also in the subsequent lines. The import then does not provide the desired data. Fill the void cells in these cases in the import file with permissible values (e.g. zero) and repeat the import procedure.
- When importing mixed levels or level spectra (e.g. sound power levels <u>and</u> interior sound pressure levels, LWTYP=LW or LI) from a single table the radiating area is relevant for the interior level, however, not for the sound power level. In this case, fill the empty cells by entering "zero".

- When importing of interior levels a value of „-1“ i the respective line of the import table causes the area based object’s geometry to be considered. On import of positive numerical values, however, those are interpreted as the radiating area even if the value based on the object’s geometry is different (option „Area (m²)“ with option „Trans:loss“ activated with point, line, and area sources).

Examples:

ID	L	LWTYP	R	S
v1	100	LW	25	
v2	100	LI	25	
v3	100	LI	25	5

The value „5“ in column S (area) for ID „v3“ will not be imported because the ODBC-driver assumes due the preceding empty cells in this column that no subsequent data follows.

ID	L	LWTYP	R	S
v1	100	LW	25	0
v2	100	LI	25	-1
v3	100	LI	25	5

For ID „v1“ the area S is not relevant (value „0“ in column S).
For ID „v2“ the areas based on the object’s geometry is used (value „-1“)
while for ID „v3“ the area 5 m² is imported and used.

Resetting the ODBC-Connection

In case error messages by the Windows-system appear during ODBC-import, this can result from a ODBC-connection not having been reset during a previous import procedure. To reset a failing ODBC-connection hold the CTRL-key depressed while selected the command **Database|Definition** (**File** menu). In case attributes have been addressed already, those will be kept when resetting.

Chapter 8 - Digitizer

When the digitizer has been connected to the PC and configured properly, the coordinates of objects can be digitized directly from a print-out. At any time, it can be switched between digitizer magnifier, mouse, and keyboard.

8

8.1 Digitizer

Upon clicking the **Digitizer** command on the **File** menu, you can select the digitizer to be used, and configure it. The digitizer menu on the icon bar is only available when the digitizer has been connected and configured.

Type

Select the appropriate digitizer from the **Type** list box. The default setting after installation of **CadnaA** is "Auto": Most digitizers are *auto*matically recognized. Try this setting first. Only if the system does not recognize your digitizer, select its type from the list box.

WINTAB driver

When having installed a WINTAB-driver on your system, **CadnaA** will recognize this. In this case, the WINTAB driver will configure the digitizer, and you must specify the settings there. You can check the success of the configuration before first using the digitizer (see further below in this chapter).

☝ **Note**: Check your digitizer manual and configure the interface or the options, and check the modified settings. Please remember that most digitizers also allow settings to be made at the device itself. The recommended settings are displayed when you click the **INFO** button on the **Digitizer** dialog. If all else fails, we will be pleased to help you.

Interface

Once a digitizer has been selected from the list of types, all settings except the port that remains to be selected should be correct. You can still modify the settings. To this end, select the appropriate value on the pertinent list box. You can check the functioning of the digitizer before first using it by clicking the **Test** button.

Test

1. Test correct co-ordinate transfer:

   Steadily increasing x and y values should be displayed on the screen while you move the magnifier in a preferably straight line from the left to the right, across the tablet, and from the bottom to the top of the tablet, respectively, without pressing a button.

   If this is not so, the settings are not yet correct.

2. Test the magnifier buttons:

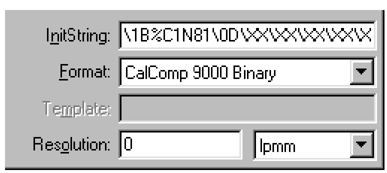
   The check boxes corresponding to *Buttons 1* through *4* should be checked when you press the respective buttons on the magnifier. **CadnaA** uses *buttons 1* and *4* only. Button 1 is used to select a toolbar icon, and to position polygon points. Button 4 serves to terminate the insertion.

When you press a magnifier button, the corresponding *Button* check box in the dialog is activated to show you which button is button 1 and button 4 to **CadnaA**. The button designation need not be the same as on the magnifier.

If, e. g., button 0 on the magnifier is pressed, and *Button 1* is checked in the dialog, button 0 on the magnifier is button 1 to **CadnaA** .

Options

Clicking the *Options* button on the **Digitizer** dialog opens the bottom part of the dialog.



In case an installed digitizer fails to function properly, enter further device parameters in the option boxes. These depend on the device used. Guidance is given in the instruction manual of your digitizer.

Initial strings:

\HexHex	represents arbitrary, and also not printable, ASCII characters like

\1b	for Esc character
\xx	pause of 0.1 sec (for some devices necessary)

Resolution

If the resolution of the digitizer is given in lines per inch (lpi) or lines per millimeter (lpmm), the dialog will display the scale of the map for checking, once the reference points have been digitized. If more than two reference points are digitized, two values are given for checking.

Info

Depending on the type of digitizer selected from the list of types, you can click the **Info** button on the **Digitizer** dialog to find out the recommended hardware settings on the digitizer itself. Many digitizers allow for saving different configurations for different applications. These configurations can then be reactivated by pushing a button. (Please refer to the instruction manual of your digitizer.)

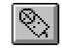
Upon clicking this button, a terminal program is opened showing you the commands the digitizer sends when it is switched on. This information may be important if a digitizer that seems to be properly configured does not work.

Terminal

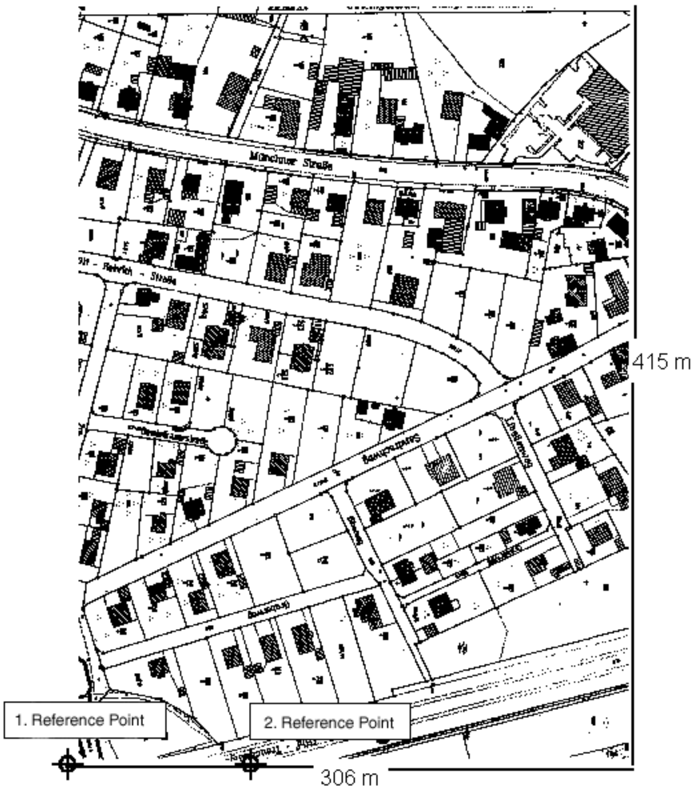
Once the digitizer test has been completed successfully, and all settings have been made, you can start digitizing.

8

8.2 Digitizing



Use a map - one with a scale of, e.g. 1:1,000 to digitize the objects.



To digitize objects from a scanned bitmap, you must know either the scale or the co-ordinates of at least two reference points on the map (assuming just translation, i.e. no rotation). This allows to enter or to calculate the width and height (limits) of the map in terms of coordinates.

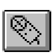
At least these limits must be defined on the **CadnaA Options** menu. (see chapter 9.1).

In the case of the map above, the limits would be defined by the lower-left corner, 0/0, and the upper-right corner, 308/415. This comprises the entire map.

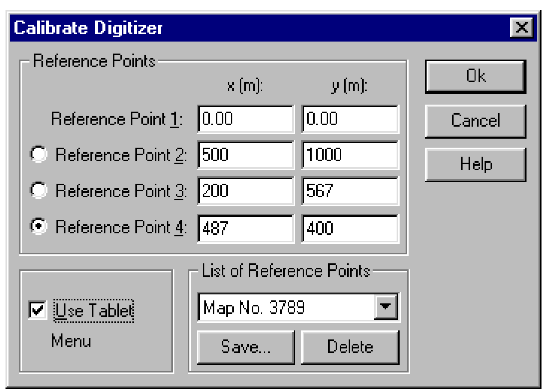
If you know only the scale - 1:1,000 for example - you can draw a reference line of 10 cm on the map, and enter the coordinates of its first and last points.

With the scale as given above, the reference line is 100 m. If you were to position this reference line at the lower-left corner of the map, you could enter this point as having x and y coordinates 0/0. The last point of the reference line would then have the coordinates 100/0. These points would then be the reference points for this map.

The more reference points are given - the maximum being four - the smaller the deviations in the position coordinates of the objects to be digitized.



In order to start digitizing, select the icon on the icon bar. In the dialog which then opens, calibrate the map on the digitizer. To achieve this, you need the reference points.



First, enter the co-ordinates of the reference points. Up to four reference points can be entered. These can be saved in the reference point list to be re-used when the map is needed again later.

In order to save, click the **Save** button, enter a name, and close the "Save Reference Points" dialog by clicking **OK**.

In order to re-use saved co-ordinates, click the list box arrow and select the pertinent name. This results in the co-ordinates being written to the edit boxes.

The option "Enter Tablet Menu" (see further below) allows direct activation of the toolbox objects in the **CadnaA** main window by means of the digitizer. To this end, activate this option.

Having entered all required data - the tablet menu and the map to be digitized are lying on the digitizer - close the "Calibrate Digitizer" dialog by clicking **OK**.

CadnaA now expects you to enter the corresponding reference points by clicking them on the map using the digitizer magnifier. The reference point co-ordinates entered are also displayed during this process.

You can use the zoom magnifiers at your convenience. If necessary, first zoom out in order to facilitate finding the reference point, then zoom in again on the area, so as to allow precise clicking of the point.

If the option "Enter Tablet Menu" is active, you will be prompted to enter further reference points defining the position of this menu on the digitizer.

If under **File|Digitizer|Options**, the resolution of the digitizer has been specified, **CadnaA** will display the scale of the map for checking as soon as all reference points have been digitized.

Now you can start digitizing the individual objects.

Please note: When inserting objects by digitizing, you can choose

- to start by entering all co-ordinate points belonging to one polygon line, and assign heights to these points afterwards, or

- to enter the height of each polygon point immediately upon clicking it.

In this context, take a look at the following example

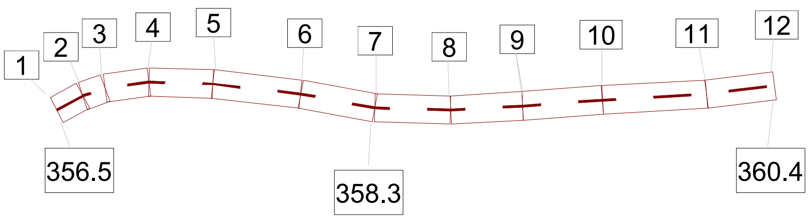
8.3 Example: Digitizing a Road

First Option

Having entered an object, switch to the **Edit** mode, and open the edit dialog by double-clicking. Clicking the **Geometry** button opens the Geometry dialog containing a coordinate table in which the heights of the points are entered.

Second Option

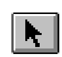
We want to digitize a road. The common form for documentation of a road indicates absolute heights at specific cross sections (see the figure below).



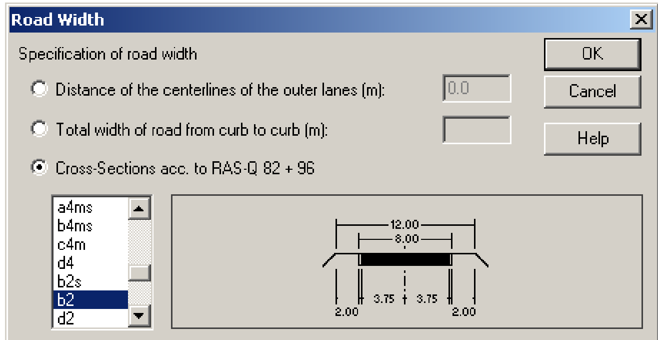
In order to properly model the curvature of a polygon, we need to enter points between these cross sections for which the heights are indicated. This series of points is numbered on the figure. In the example, absolute heights are known at points 1, 7, and 12. For all other points, which are only required to properly model the curvature, heights are interpolated. This calculation can be performed automatically by **CadnaA**.

1. After clicking the road icon or pressing CTRL+s, we digitize the first two points.

2. We switch to the edit mode by pressing CTRL+e.



3. Having double-clicked the polygon line generated on the screen, we can enter the parameters for this section.
   Although you can also do this later, it is recommended we enter all parameters immediately because **CadnaA** adopts these values for the following polygon points until you enter new values. In this example, the cross section b2 is chosen from the list.



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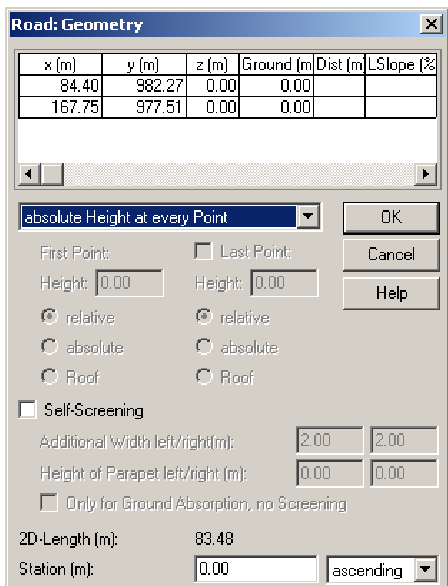
4. We enter all parameters. Then we click the **Geometry** button and activate **Enter Absolute Height At Each Point**.

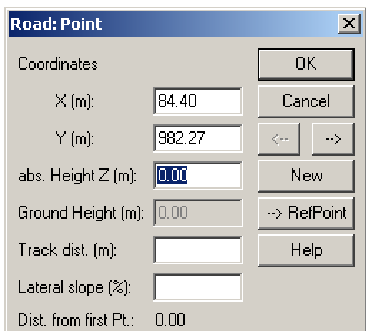


5. Double-clicking on the first row of the coordinate table opens the dialog in which we can enter additional coordinates, the center-line/ axis distance of the outermost tracks, if necessary, and the transverse slope, if any exists.

6. By either

   - skipping from one box to the next using the TAB key, or
   - dragging the mouse pointer over the z value with the left mouse button held down, or
   - double-clicking,

the current value is selected (highlighted).



7. Enter the desired z value and, after using the TAB key, the transverse slope, if any exists.

8. Switch to the next point by pressing the arrow button.

   It may be faster using the keyboard. The hot key ALT+SHIFT+ > (move forward through list) bring us to the next point where we can immediately enter the next value in the box already selected. When using the hooky, we will always automatically hop to the last edited box on the preceding record.

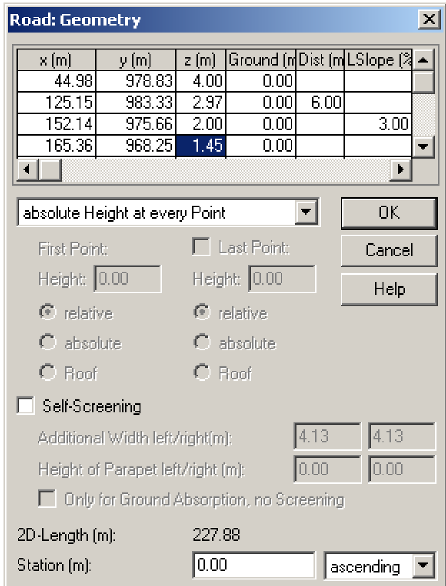
☝ In case the height is unknown **CadnaA** will calculate the unknown height. To this end, delete the value in the z-coordinate box using the DEL or SPACE key. The box must be blank.

CadnaA then provides interpolated values. We can check this by re-opening the geometry dialog when all points have been entered.

9. We press ALT+n with the coordinate dialog still open (or we click the **New** button) to create a new point.
10. Click this third point on the digitizer tablet using the digitizer magnifier. The coordinates in the active dialog are updated (when a new point is created, its x and y coordinates are set to 0/0).
11. Enter the height of the third point from the keyboard, or delete it (the value on the Height box is already selected).
12. Proceed as from 10. ....ALT+n .... etc. until all points have been digitized.

☝ If a track distance and/or a transverse slope is given in the **Geometry** table, the program will adopt these values for all following polygon points until we insert a new value. All subsequent points are then assigned the new value. For those points, for which the preceding value applies, no value is listed on the table.

Consequently, when calculating, the preceding value is taken into account for an empty box in the table in the column **Distance (m) a**nd **Slope (%)**.


Road: Geometry
x (m)
y (m)
z (m)
Ground (m
Dist (m
LSlope (%
44.98
978.83
4.00
0.00
125.15
983.33
2.97
0.00
6.00
152.14
975.66
2.00
0.00
3.00
165.36
968.25
1.45
0.00
absolute Height at every Point
OK
Cancel
Help
First Point:
Last Point:
Height:
0.00
relative
absolute
Roof
Self-Screening
Additional Width left/right(m):
4.13
Height of Parapet left/right (m):
0.00
Only for Ground Absorption, no Screening
2D-Length (m):
227.88
Station (m):
0.00
ascending

8.4 Tablet Menu

The tablet menu consists of the toolbox icons which are suitable for digitizing.

CadnaA Tablet menu

The file TABMENU.BMP on the CD contains these icons. You can open and print this file using an appropriate application (such as PAINT or PAINTBRUSH from the Windows accessories group). Put this hard copy on your tablet. This allows you to switch to the desired mode and to select the appropriate object by means of the digitizer magnifier on the tablet instead of using the mouse pointer on the screen. The reference points P1, P2, and P3 of the tablet menu must be clicked when the digitizer is calibrated (see above in this chapter).

8

Chapter 9 - Graphics

The diagram in the **CadnaA** main window displays all objects that have been entered, irrespective of whether they have been entered using the mouse or the keyboard, or by digitizing or importing. The graphic representation can be displayed in different scales by zooming (see chapter 9.2), copying (see manual "Introduction to **CadnaA**") and printing out (see chapter 13.1.3).

The graphic objects are synchronized with the corresponding data record in the object tables. The current data recorded in the table automatically marks the corresponding graphic object so that you can always see which object or which polygon point you are working on (see chapter 12.1).

This chapter covers the **CadnaA**-specific objects and operations being used within the graphic representation and output. This includes:

- the definition of the project area („Limits“), of the scale and - if any - a coordinate grid,
- the settings for the ObjectSnap,
- the definition of the coordinate system,
- the graphical design of the objects,
- the drawing sequence of objects („Layer“),
- the features provided by the objects „Auxiliary Polygon“ and „Section“,
- the features provided by the objects „Text Frame“, „Level Box“, „Symbol“ and „Stationing“, and
- the handling of the viewing options „Section“, „3D-View“ (wired frame model) and the 3D-Special View.

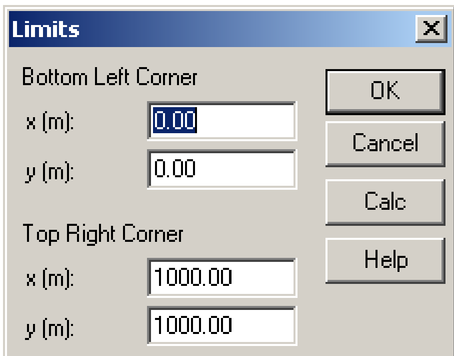
9

9.1 Limits

The limit is a rectangular area to which the graphic representation on the screen and thus the accessibility of objects is restricted.

It is specified in **Options|Limits**. You can enter the coordinates of the bottom left and top right corners in the dialog which then opens.

The limits may be edited at any time.



The Edit Dialog **Limits**

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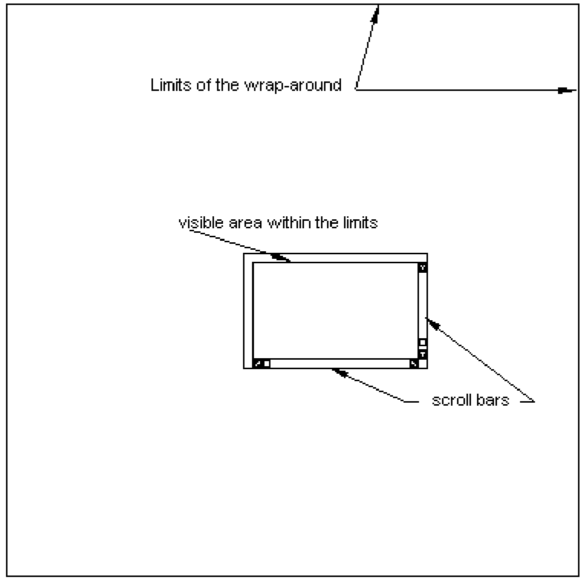
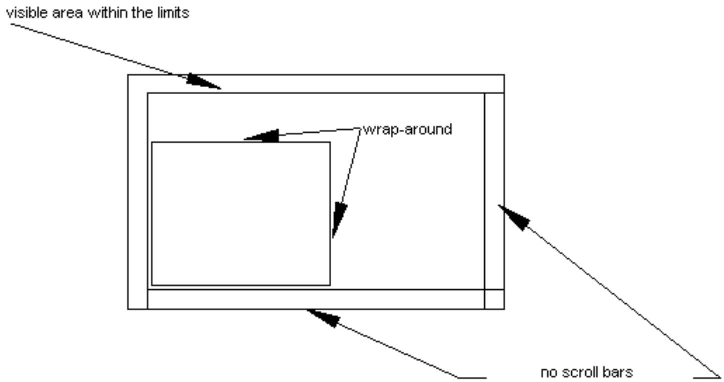


Background of the Limits

The background of the limits is the area outside the specified limits. The default color is grey. You can change the background color in **Options|Miscellaneous** in the usual way by clicking on the color button.

Scroll bars

Calculations can be restricted to shielding objects only (buildings and barriers) within the limits. If, for the currently selected scale, the limits extend beyond the area represented on the screen, scroll bars will be shown at the bottom and/or right sides of the window. These serve to position the visible area within the limits. If the limits do not extend beyond the area visible on the screen, the scroll bars will be hidden.



Drag Graphic

Instead of adjusting the sector of the graphic with the scroll bars you can also drag the graphic representation, with the mouse key depressed, like a sheet of paper, freely to all sides. With the mouse key depressed on a free area in the graphic the mouse cursor changes to a mouse pointer looking like a hand. In this mode you can move the representation accordingly.

Update during Drag

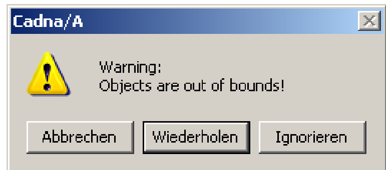
With the activated option **Options|Miscellaneous**, option „Update during Drag“ the graphic is either built up continuously while moving the representation or after letting go the mouse key.

Information in the Status Bar

The coordinates of a point can be seen in the status bar at the bottom right of the **CadnaA** main window when the mouse pointer is positioned on that point. After a grid calculation, the status bar will also display the levels (L) and the ground height (G) at the point where the mouse pointer is positioned.

Objects outside the limits

Sources lying outside the limits are also considered in the calculation. Obstacles that lie outside the limits, however, are not automatically considered. In this case, a warning message will appear.

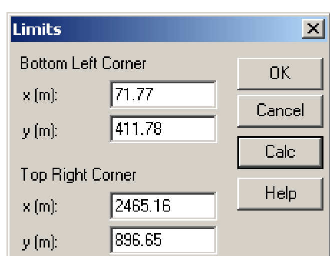


Ignore	causes the objects outside the limits to be disregarded in the calculation.
Repeat	results in the limits being modified so as to comprise all objects.
Cancel	aborts the calculation.

Calc Limits

As a further tool for correcting the limits when objects lie outside, you can select the menu command **Options|Limits** and click the „Calc“ button in the dialog. The limits will then be modified so as to comprise all objects.

The dialog will then display the x and y co-ordinates of the updated limits.

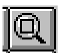


9.2 Scale

Use the zoom tools to modify the scale of the diagram, either via the editable list box **Scale 1:** on the icon bar, or via the three global tools in the toolbox

 „Zoom +“

 „Zoom -“

 „Zoom to Limits“

Combo Box "Scale 1:“

By clicking the arrow to the right of the box **Scale 1:** on the icon bar, a list of predefined scales drops down. You may click the desired scale on that list. The graphic on the **CadnaA** main window will be modified accordingly

Combo box

You may also enter an arbitrary scale. Click the edit box and enter the desired value. Then press RETURN.

 **Zoom +**

The "Zoom +" icon on the toolbox allows you to enlarge the graphic representation of a specific area. After clicking this icon, the mouse pointer drags along a little magnifier icon with a "+" sign.

There are two comfortable ways of enlarging a selected area:

1. Clicking an object with the left mouse button enlarges the graphic by a factor of two with each click. The position of the mouse pointer becomes the new centre of the displayed area.

2. If you hold the left mouse button down, you can draw a rectangle around the objects you wish to enlarge. Upon releasing the mouse button, the area within the rectangle will be enlarged so as to fill the screen.

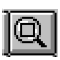
The enlarging is undone in reverse order by clicking with the right mouse button.

Zoom -

The "Zoom -" icon on the toolbox allows you to reduce the graphic representation of a specific area. After clicking this icon, the mouse pointer drags along a little magnifier icon with a "-" sign.

Clicking an object with the left mouse button reduces its size by a factor of two. You may repeat this several times.

The reducing is undone in reverse order by clicking with the right mouse button.



Zoom to Limits

All objects lying outside the visible area will immediately be shown on the **CadnaA** window when you click this icon. The scale of the representation is automatically selected according to the dimensions of the limits and the size of the **CadnaA** window.

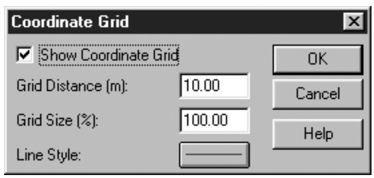
If you hold the SHIFT key depressed while clicking the "Zoom to Limits" icon, **CadnaA** will recalculate the limits and will also show all objects in the window. However, the new limits are only **temporary** (analogous to the command **Options|Limits|Calc**), which means the limits specified by the user are not overwritten.

This feature is convenient where the specified limits cover a wide area containing relatively few objects, or if the objects all lie within a small proportion of the limits.

9.3 Coordinate Grid

By selecting the command **Coordinate Grid** in **Options**, you can have a user-defined grid displayed on the screen, serving, e.g. as an aid for positioning and/or reading of coordinates. If this grid is shown on the screen, it will also be copied and printed.

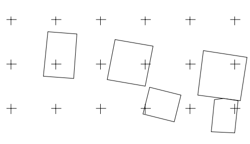
The grid spacing and the appearance are defined in the dialog **Coordinate Grid**.



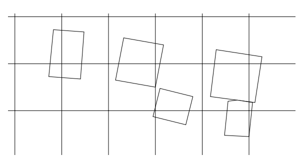
Activate the option **Show Coordinate Grid** by clicking the check box.

The grid spacing is given in metres, and the grid size is given as a percentage. With a grid size of 100 % the grid lines are solid.

Example



Grid spacing 10 m, Grid size 20 %



Grid spacing 10 m, Grid size 100 %

You can select line style and color via the **Line Style** button to match your preferences. Click this button and select appropriate values.

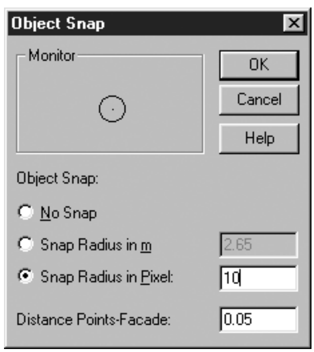
9.4 Object Snap

Open the **Object Snap** dialog via the menu command **Options|Object Snap**.

If a line is supposed to connect to an existing line, the new first point will be positioned precisely on the last point of the existing line, if the distance of the two points is less than the specified object snap.

Likewise, points sources and receiver points located within that distance in front of a building side are assigned to that building side. They will then be positioned at a user defined distance in front of it. The default distance is 5 cm. The object snap also allows the seamless joining of partial areas to give one combined area, for example, for the purpose of determining noise quota for area sources in the process of noise allotment.

ó



If the object snap is given in pixels, the snap radius on the screen will be independent of the selected scale. If it is given in metres, the scale must be considered. In both cases, checking is facilitated by the effective snap radius being displayed on the monitor box.

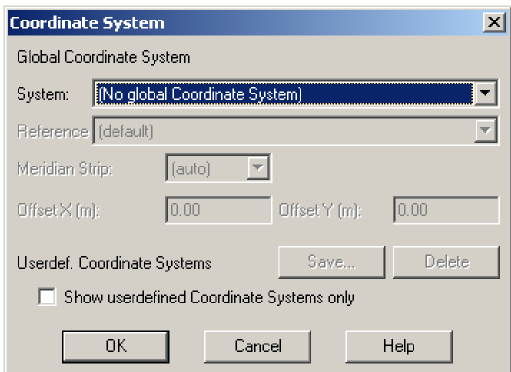
9

9

9.5 Coordinate System

The dialog **Coordinate System** is available from the **Options|Coordinate System** menu.

By default, no global coordinate system is selected. This corresponds to the presently used coordinate system in **CadnaA** as specified via **Options|Limits**-dialog (see chapter 9.1).



Click on the arrow to the right of list boxes „System“ and „Reference“ to display all available national and international coordinate systems and reference points. Select appropriate items from the lists sorted in alphabetical order.

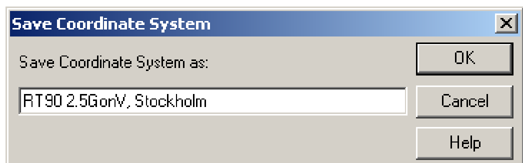
On list box „Median Strip“ the relevant strip can be selected. The maximum is 120 strips with 3 degrees longitudinal length each. Different coordinate systems make use of different strip number (e.g. TUTM-system: 60 strips with 6° each, GK-system: 120 strips with 3° or 60 strips with 6° each). In case „(auto)“ is selected the strip number will be extracted from the first 2 digits of the coordinate entered.

By entering offsets (X,Y) coordinates translatoric shifts can be considered. The offset-values entered will be added to the coordinates for the specified coordinate system.

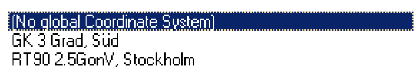
User-defined coordinate system

When working with **CadnaA** distinct combinations coordinate system-reference will be used repeatedly. To facilitate the selection user-defined coordinate systems can be saved in **CadnaA**. To this end, select - for example - the system „Swedish Transv. Mercator RT90 2.5gonV 0:-15“ with the reference point „RT90 (SE), Stockholm, Bessel“.

Click the button „Save“ and enter a name for the chosen combination.



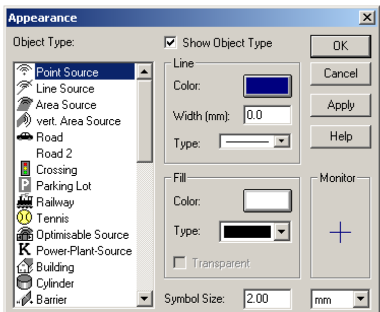
Activate the option „Show user defined Coordinate Systems only“ on dialog „Coordinate System“. Subsequently, only those combination are listed on the list box „System“..



To delete user-defined coordinate systems select the respective system and click the button „Delete“. The specified system will be deleted without warning.

9.6 Object Appearance

The menu **Options|Appearance** is used to edit the graphic representation of the **CadnaA**-specific object types regarding the line width, the color and - depending on the type of object - the type of hatching and the symbol size. The settings apply globally to all objects of the respective object type in a project. Just the object „Auxiliary Polygon“ can be defined individually via its edit dialog regarding its appearance (see chapter 9.9 "Auxiliary Polygon").



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The subsequent settings refer to the selected object type.

Show Object Type

This option enables to suppress globally an object type from being displayed on screen at all.

☝ This setting is saved when quitting **CadnaA**. Thus, upon a restart not all kinds of objects may be displayed.

Buttons

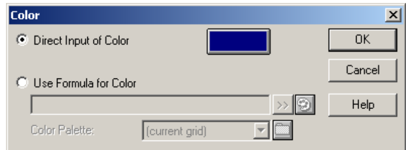
When clicking the button „Apply“ the modifications are applied to the main window immediately. Clicking the button „Cancel“ results in the dialog being closed and the modifications being ignored. Clicking OK closes the dialog, but applying the modifications.

Edit Ranges „Line“ & „Fill“

Depending on the object type either just the range „Line“ (e.g. with point and line objects) or both ranges are available (e.g. with area objects).

Color

Via the button „Color“ a color can be selected directly (option „Direct Input of Color“). Alternatively, the color can be defined using a formula (option „Use Formula for Color“).



Direct Input of Color

After clicking the colored button select the desired color from the WINDOWS palette by clicking on it and confirm with OK. In this case the coloring of this object does not depend on a condition.

Define Color

With the button „Define Color“ on dialog **Color** a new color can be defined and be added to the color palette.

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Use Formula for Color

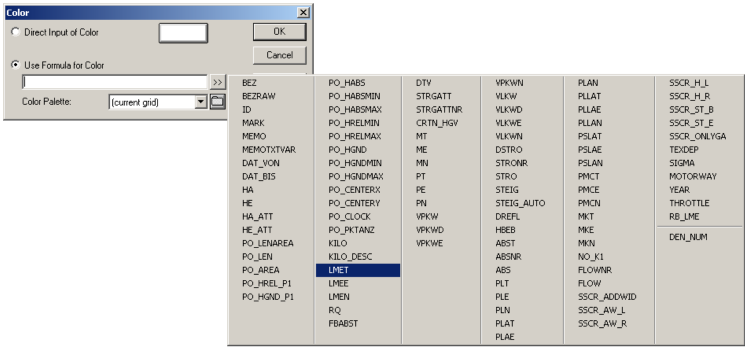
By the option „Use Formula for Color“ an object can be colored depending on an object attribute (a numerical value). The attributes (see **CadnaA**-manual „Attributes, Variables, and Keywords“) can either be entered directly or be selected from the popup menu when clicking the double arrow symbol (>>).

Example

In the following example the fill color of roads is defined based on their emission level for daytime.

Examples/ 09_Graphic

- Load the example file `Roads - Fill Color.cna`.
- Open the dialog **Appearance** and select the object type „Road“.
- Click in the edit range „Fill“ the button „Color“.
- Select the option „Use Formula for Color“.
- Now, select via the double arrow (>>) from the popup menu the attribute LMET (for $L_{m,E}$ daytime).



- Close the dialog **Color** by OK and click on button „Apply“.

Subsequently, the filling of the roads are colored according to presently selected color palette.

Dialog **Appearance**: fill color or roads
defined via option „Use Formula for Color“

Color Palette

Option „current grid“

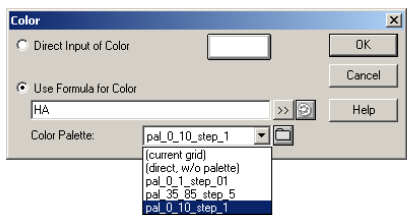
Upon selection of the option „current grid“ from the list box „Color Palette“ the presently selected color palette is used (dialog **Grid| Appearance**).

Example

Examples/ 09_Graphics

- Open the example file `Buildings - Fill Color.cna`.
- Click on the dialog **Appearance** and select the object type „Building“.
- Click the button „Color“ in the edit range „Fill“.
- Select the option „Use Formula for Color“ and enter the attribute HA into the formula box (alternatively, select via the double arrow (>>).
- Select from the list box „Color Palette“ the palette „pal_0_10_step_1“.

☝ The color palettes must reside in the local library of color palettes. If necessary copy the palette from the global to the local library using the button „--> Local Lib.“.



- Close the dialog **Color** by OK and click the button „Apply“ or OK.

Subsequently, the buildings receive, depending on their height, the color from the selected color palette. A grid caption can be displayed using the object „Symbol“ and by selecting there the corresponding color palette (see chapter 9.11.3).

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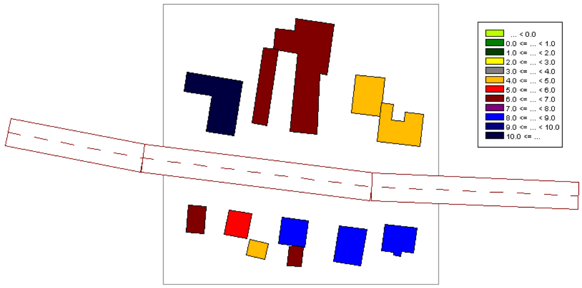

Color fill of buildings applying the color palette „pal_0_10_step_1“

Option „direct, w/o palette“

In this case the color to be used is specified directly, without a color palette. This feature is useful when a distinct object within an object type shall be highlighted.

Example

In the subsequent example the line color of residential buildings shall be different from the rest of the buildings.

Examples/ 09_Graphic

- Load the example file `Buildings - Line Color.cna`.
- Open the dialog **Appearance** and select the object type „Building“ from the list.
- Click on the edit range „Line“ the button „Color“.
- Select the option „Use Formula for Color“ and enter the following formula:

  ```
  iif(WG_NUM==1, rgb(255,0,0), rgb(0,0,0))
  ```

  This formula means: In case the attribute WG_NUM has the value=1 use the RGB-color 255,0,0 (red), else use the RGB-color 0,0,0 (black). The attribute WG_NUM represent the numerical setting of the option „Residential Buildings“ on the **Building** dialog.

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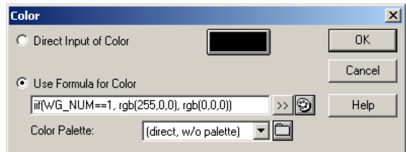


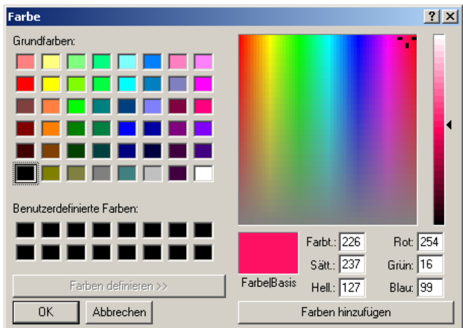
- Close the dialog **Color** by OK and click the button „Apply“ or OK.

Line color of the buildings defined using the option „Use Formula for Color“

Further Color Palettes

Furthermore, all other available color palettes from the dialog **Grid|Appearance** are listed on dialog **Color**.

To facilitate the selection click the color palette button displaying the available WINDOWS system colors. When having selected a color by OK the respective RGB-value is written into the input box of the formula.



9

transparent/solid color

Objects can be displayed in transparent mode (value=-1) or with a solid color (RGB). This holds, however, just for objects which do not have an empty filling. This option may be applied to display the noise contours in a noise map running across buildings depending whether their height is lower than the calculated grid height or not.

Example

A horizontal grid has been calculated at 5 m height. Now, those buildings having a height below 5 m shall be transparent, while those above shall be solid filled.

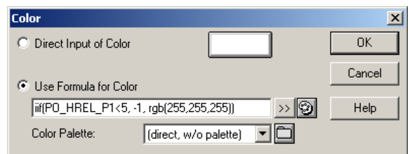
Examples/
09_Graphics

- Load the example file `transparent buildings.cna`.
- Open the dialog **Appearance** and select the object type „Building“ form the list of objects.
- Click on the edit range „Fill“ the button „Color“.

- Select the option „Use Formula for Color“ and enter the following formula:

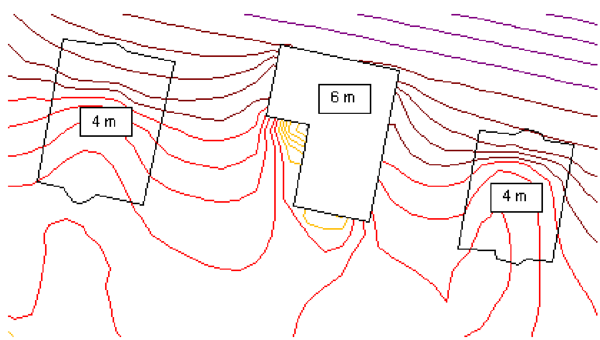
  ```
  iif(PO_HREL_P1<5, -1, rgb(255,255,255)
  ```

  in words: If the attribute PO_HREL_P1 (relative height of the first polygon point) has a value <5 display this object in transparent fill mode, otherwise use the RGB-color 255,255,255 (white).



- Close the dialog **Color** with OK and click on button „Apply“ or OK.

In the following figure, two buildings have a height of 4 m, the other 6 m. The receiver grid is calculated with a height of 5 m. With the above formula and by activating the option „Use Height of Buildings“ on dialog **Grid|Properties|Option** the following representation results.



Grid representation depending on building height,
buildings with PO_HREL_P1>5 m with fill, otherwise transparent

Fill

Transparent

Via the option „Transparent" it can be specified whether an object type should be displayed transparent (activated option) or solid (deactivated option) against the background. This is useful, for example, when a background bitmap is used in a project. With the option „Transparent" activated the bitmap will still be visible with **CadnaA** objects drawn on top of it.

☝ When objects do not appear transparent - despite the option „Transparent" is activated - this is in the majority of cases not an error by **CadnaA**, but the graphics driver. In this case, check for a new driver from the hardware manufacturer. Whether the actual driver provides a transparent mode can be checked by the „Monitor" which providing a preview.

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Symbol Size

This value specifies the size of the object's symbol and applies to point-like objects only. Selecting the unit sets for absolute or relative size:

- meter (m): With this setting the symbol's size changes when scaling of the graphics is changed.
- millimeter (mm): With this setting the symbol's size is independent form the selected scale.

Color Attributes for Auxiliary Polygons

With the command **Modify Objects** (or when importing via ODBC interface colors can be allocated to auxiliary polygons.

The meaning of the color attribute ?_COLOR of auxiliary polygons is:

L_COLOR defines the color of the line and
F_COLOR defines the color of the filling.

?_COLORR is r, the red component (0..255)
?_COLORG is g, the green component (0..255)
?_COLORB is b, the blue component (0..255)

?_COLOR and ?_COLORX is the sum r+256*g+256*256*b,

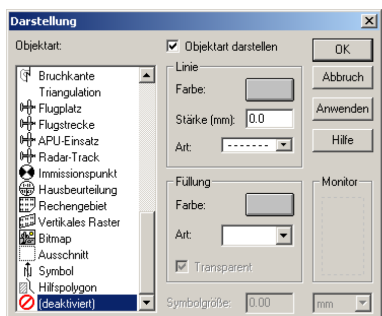
where

?_COLOR is a decimal value and

?_COLORX a hexadecimal.

Deactivated Objects

On the **Appearance** dialog also the options for deactivated objects are defined (see object type „(deactivated)" at the lower bottom of the object type list).

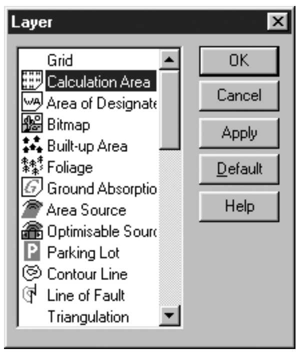


Deactivated objects which are invisible in the graphics cannot be selected or edited anymore. In contrary, in case deactivated objects are still visible (e.g. using a hatched line) those can still be selected and edited.

9.7 Layer

In **Options|Layer** you can determine the order in which objects are drawn. With that you can manipulate the object type which will be covered by another one. Therefore, click onto the corresponding object type and drag this, with the mouse key held down, to the desired order. The object on the top of the layer list is drawn first and the object on the bottom of the layer list last.

,



Apply

If you click the button „Apply“, then all alterations will be applied without closing the dialog.

3D-Special

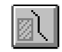
Please consider that due to internal reasons objects located in front of the object „Bitmap“ in the layer list will not be displayed on the **3D-View** (**Options** menu).

9.8 Fix Objects


Fix Objects

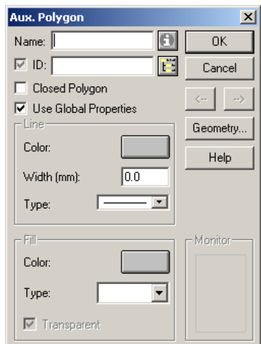
You can protect all objects from inadvertently shifting with the icon **Fix Object** in the icon bar. If you click on it, all objects are then „frozen". Editing is still possible. Another click on the icon removes the fixing.

9.9 Auxiliary Polygon



Auxiliary Polygon

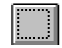
The auxiliary polygon is an object having acoustically no relevance. It can be used to generate open or closed polygon lines to enhance the graphical representation. Auxiliary polygons can either be open or closed. Check or uncheck the option „Closed Polygon“ on the edit dialog as required.



The appearance of the auxiliary polygons can either be changed globally (via **Options|Appearance** menu) or individually via its edit dialog. Each polygon can have a different color, line width or line type. To enable this, first deactivate the option „Use Global Properties“.

☝ Auxiliary polygons are not be adjusted to the digital terrain model. When this required convert them into e.g. line sources. Switch to the 3D-View on **Options|3D-View** menu. **CadnaA** determines the heights of polygon points. Afterwards convert them back again to auxiliary polygons.

9.10 Section



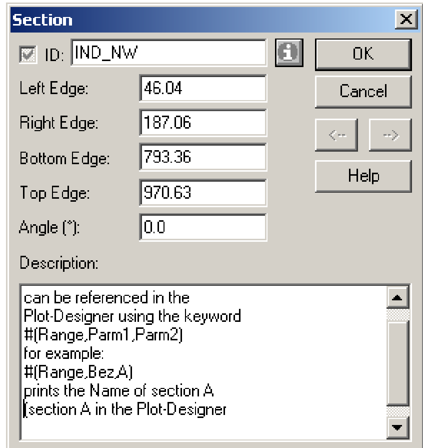
This object has no acoustical relevance. A section can be used

- to copy objects inside a section to the clipboard (see **CadnaA**-manual "Attributes, Variables, and Keywords"). For that, the section has to be marked.
- to print objects inside a section. For that you have to give it a name (see chapter 13.1.3 "Print Graphics").
- to modify objects (see **CadnaA**-manual "Attributes, Variables, and Keywords").
- to import objects only inside an existing section (see chapter 7.1.2 "Importing in Section only").
- to calculate in the **PCSP** mode (see chapter 14.8 "PCSP - Program Controlled Segmented Processing").

Turn Section

The section can be turned by entering a pertinent angle. For the print out or copy of the turned section the output of the section area will be transformed against the angle entry.

The margin of the section is neither printed nor copied. You can insert a text in the field description which can be printed via the Plot-Designer. For that use the keyword #(Range, Parm1, Parm2) either in a text box directly in the file or in a text cell in the Plot-Designer (keywords see **CadnaA**-manual "Attributes & Abbreviations").



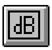
The number of sections in a project is not limited. These are listed with their names and coordinates on menu **Tables|Other Objects|Section**.

Insert Section see manual "Introduction to **CadnaA**".

9.11 Settings for Objects with Frames

With respect to their appearance in the graphics, objects with a frame around them are edited individually via their edit dialog. This does not hold for the object „Symbol“. The following objects appear with frame:

Text Box



Level Box


Symbol

Station Mark

They are used for information purposes or to refine the graphic representation and are acoustically irrelevant.

We will use the text box as an example to explain all settings which apply analogously to all such objects. Special settings are explained in the pertinent sections.

The chapter **Inserting Objects** (see manual "Introduction to **CadnaA**") describes how to insert the individual objects.

☝ Adjust the size and all other settings immediately after having entered the first object. All further objects of the same type adopt the settings. In this case insert the following objects only by clicking once on the desired position.

Any inserted box is listed on the pertinent object table under **Tables|Other Objects**. You may use this table to change settings for all existing boxes at once without clicking each individual box. Select the **Change Column** command and define the desired settings.

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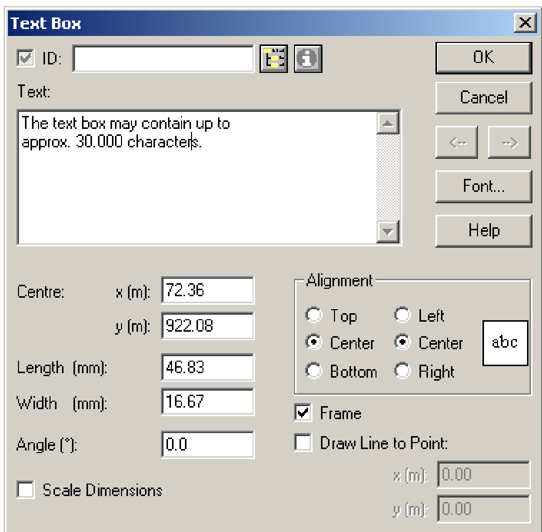
9.11.1 Text Box

This tool allows you to insert up to 30,000 characters of text in your graphics.

Open the dialog of the text box to enter text in the corresponding box.

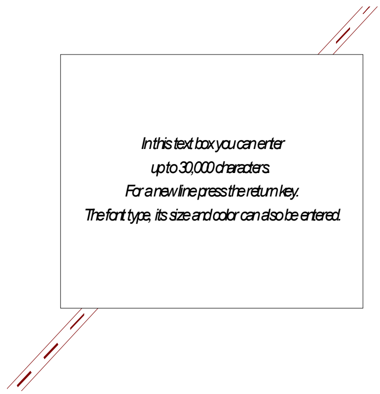


The dialog of the text box.

Font

As soon as the box is closed, the text you entered appears. The font's type, size and style are specified via the „Font“ button. The style can be changed using the attributes UNDERLINED, STRIKEOUT, BOLD, and ITALICS (see chapter 2.2 "Object Attributes" in the **CadnaA**-manual „Attributes, Variables, and Keywords“).

In the example below, this is Arial, 10 pt, italic at a scale of 1 : 1,000.



A text box with frame

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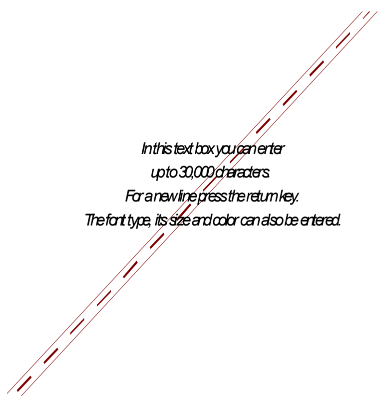
Frame

If the „Frame“ option is active, the box will hide objects lying under it, as is the case in the figure above. If this option is inactive, no frame is drawn around the text, and objects that were hidden before will become visible.



Text box with option frame inactive

Scale Dimension

If you select the **Scale Dimensions** option on the edit dialog, the box and the text are scaled in accordance with the current scale.

☝ If this option is active, it is convenient to switch to the intended print-out scale before you enter the text for the first text box. Then specify the font size you consider appropriate for the scale you chose. You may then return to the scale which is appropriate for the work on the screen. The selected setting is adopted, although re-scaled, for all further text boxes, until you edit it again. This makes sure that all text boxes have the same font size.

Otherwise:

$$\frac{Pkt_1 \cdot M_1}{M_2} = Pkt_2$$

where is:

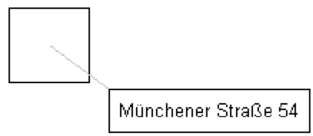
- Pkt_1 size of the font in the box at scale M_1
- M_1 scale under which the font size was selected
- Pkt_2 font size under different scale M_2 of the graphic representation
- M_2 new scale chosen after inserting the text box.

☝ If you wish to globally edit the frame sizes, font sizes or fonts of all boxes after having inserted them, you can do so via the tables by selecting the **Change Column** command (see chapter 11.1.5 "Change Column Content"). It is then not necessary to edit each individual box.

Draw Line to Point xy

A line may connect the respective text box with the object (as an auxiliary polygon). This option of automatic generation of labels is useful (via the dialog **Modify Objects** or the context menu, action/command **Generate Label**), to prevent that objects are covered by the accompanying text boxes.

When dragging the text box to a different location via the mouse the connecting line is updated automatically. When transforming the Text Box (via dialog **Modify Objects** or via the context menu, action/command **Transformation**) the connecting line will be transformed automatically.



Building with a text box and a connecting line automatically generated

Frame coordinates

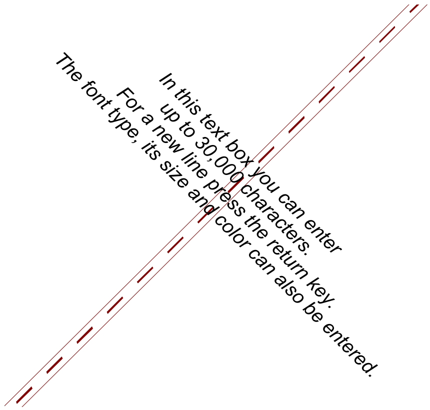
Enter the centre coordinates to precisely position each box.

Frame size

The size of the boxes/frames can be given to millimeter precision by entering width and height.

Angle

Enter an angle to continuously rotate the box.

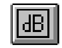


Rotated text box with angle -45°

Alignment Text

The options on the **Alignment** dialog serve to align the text in the box.

9.11.2 Level Box



After performing a grid calculation, this tool allows you to display the calculated value at any point within the calculated grid (see chapter 5.3) - also the height of the ground at that point.

Update automatically/ Hold Value

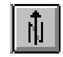
By default, the calculated value displayed in the box is updated automatically. This corresponds to the **Update Automatically** option. It means that each time a calculation is performed or a other evaluation parameter is chosen from the list box on the symbol bar, the actual result calculated for that point is displayed in the level box in the graphics.

If **Hold Value** is activated, the level box will not display the new value after a calculation, but the "old" value is retained. Iso-dB lines and areas of equal sound level, however, will always be updated.

This is an interesting option when, e.g. calculation variants with and without noise-control measures are to be represented. In that case, however, the **Update Level** option would have to be activated for the second level box inserted at that point.

The other options are explained in chapter 9.11.1 Text Box.

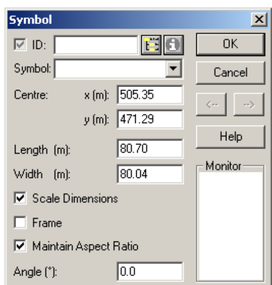
9.11.3 Symbol


Symbol

This tool offers to insert various symbols into the graphic representation. Furthermore, an angle can be specified to position them accordingly. There are two ways define a new symbol object:

1. When inserting a graphical object from the MS-WINDOWS clipboard into the **CadnaA** graphics - e.g. a table or an image - **CadnaA** will automatically create a „Symbol" object containing this graphic object. The settings for this symbol can be edited.

2. After clicking the „Symbol" tool and with a further click in the **CadnaA** main window, a dotted frame appears (default setting is "no frame"). Double-clicking on this frame opens the dialog **Symbol** opens.



Symbol dialog

The list box on the dialog offers to select a symbol from. A preview of the selected symbol is shown on the monitor.

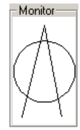
Symbols inserted into the graphics will be listed on the table **Symbol** (on **Tables|Other Objects**).

Default Symbols

By default, the following symbols are available:

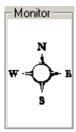
North Arrow 1

North Arrow 2

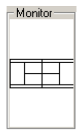


North Arrow 3

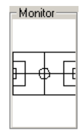
North Arrow 4



North Arrow 5

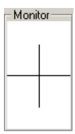


Tennis

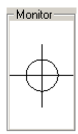


Football / Soccer

Circle

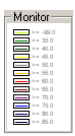


Cross



Mark

Stop

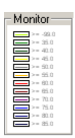


Caption: Grid *)

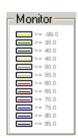
Caption: Grid EvalP1 *)

Caption: Grid EvalP2 *)

Caption: Grid EvalP3 *)



Caption: Grid EvalP4 *)



Caption: Grid Ground *)

Caption: Land Use

Caption: Objects

*) The graphics displayed on the monitor depends on the color palette and its settings for the evaluation parameter selected.

Furthermore, at the bottom of the list box „Symbol“, all local color palettes are listed.

Dialog Options

Centre/Length/Width

geometry data of the symbol

Scale Dimensions

With this option being active, the size of the symbol in the graphical representation depends on the scale selected/entered.

Frame

toggles on/off the display of a frame

Main Aspect Ratio

When the option „Maintain Aspect Ratio“ is activated, the symbol will always be displayed with the original aspect ratio. Consequently, it will not be distorted when the size of the box is edited.

Suffix for Caption

For the symbols of the type „Caption: Grid ...“ the default suffix „dB“ can be replaced by any other suffix (e.g. „inhabitants“). To achive this, open the dialog **Memo-Window** of the respective symbol and define the string variable „Suffix“ and its value (e.g. `suffix=inhabitants`).

Global Appearance

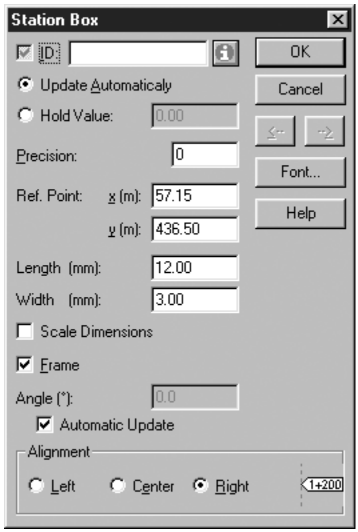
The global appearance of symbols (as for „Line“ and „Fill“) are defined via the dialog **Options|Appearance** (see chapter 9.6). The option „Fill“, however, is not available for all types of symbols.

User defined Symbols

In addition, user-defined symbols may be used. User-defined symbols are kept in the library of symbols (see chapter 12.3) which will be listed subsequently on the list box on the dialog **Symbol**.

9.11.4 Station Mark

Generate Station see manual "Introduction to **CadnaA**".



Reference point

The reference point indicates the coordinates of the station.

Angle automatic update

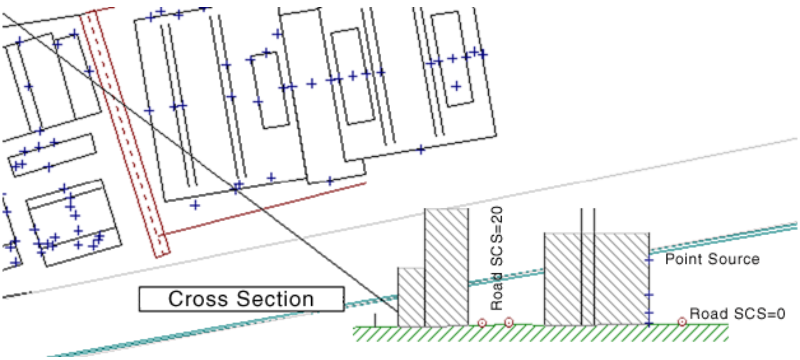
With the activated option (default) the station marks are automatically and perpendicularly directed towards the line or the polygon point.

Deactivate this option in the dialog of a station mark to enter a different angle for the alignment. This angle is kept if the stations would be updated (**Tables|Miscelleaneous|Update Station**).

The other options are explained in chapter 9.11.1 Text Box.

9.12 Cross Section

If you define a line on the map on the screen by entering its first and last points, you can view a section along this line in an additional window. This section shows the height of the terrain as well as the cross sections through any three-dimensional objects encountered, e.g. buildings and barriers.



The sources can also be displayed in the cross Section

To insert a line on the map, activate any toolbox icon for a line-like object, such as an auxiliary polygon, and enter the first and last points. Then switch to the **Edit Mode** and click the line with the right mouse button. This opens the context menu (see manual "Introduction to **CadnaA**") where you select the **Cross Section** command.

Source

In the cross section all sources cut by the section line are also displayed if the checkbox **Source** is activated.

Ray

The path of a ray from the initial to the end point - how it is considered in the calculation by the program - can be displayed by activating the corresponding option.

Z-Factor

The z-coordinates in the sectional view are multiplied by the value of the Z-factor to enlarge arbitrarily and, therefore, to clarify the difference in the height.

Copy/Print

With the **Copy** button you can copy the sectional view in the clipboard and with the **Print** button you can print it out.

In the cross section you can also calculate a vertical grid (see chapter 5.3.6 "Vertical Receiver Grid").

☝ Hint to insert a image of a cross section from the clipboard into **CadnaA** with the right scale:

The sectional drawing includes in its width a margin of 3 mm for each side. In case this picture shall again be inserted, according to scale, in **CadnaA** via the clipboard, the total 6 mm margin has to be taken into account in the length of the object **Symbol**.

Remember: The contents of the clipboard are again inserted in **CadnaA** as Symbol (see chapter 9.11.3 "Symbol").

In the edit dialog of the **Symbol** take into account the 6 mm margin as follows:

- Activate the option **Maintain Aspect Ratio**
- Enter the corresponding length plus the margin in meters

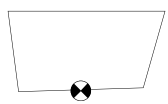
$$\frac{6mm}{1000} \bullet Scale = Meter$$

9.13 3D-Wire Model

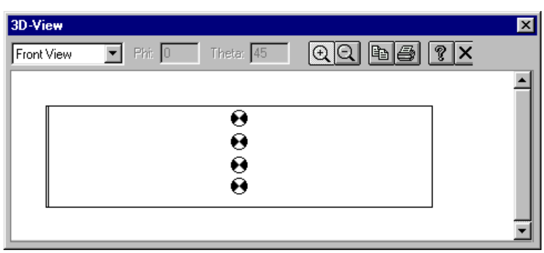
The diagram on the screen is a projection of the entire model on the horizontal reference plane, x/y. Points and lines are thus the shadows of all object outlines, assuming that the model is illuminated by a very distant light source located vertically above it.

Like any individual view, this top view has the disadvantage that objects which lie one behind the other, as viewed along the direction of projection, cannot be distinguished. The height of an object, its dimension in the z direction, cannot be seen from the horizontal projection.

In the following representation in **CadnaA**, the diagram will not enable you to judge whether the immission point on a building is a single point or a group of several points.



There are further viewing options under **OPTIONS|3-D View** which are helpful here. For the example shown here, the **Front View** is as follows:



This representation immediately clarifies that there are two points, one above the other. Position the mouse pointer on one of the points to read its

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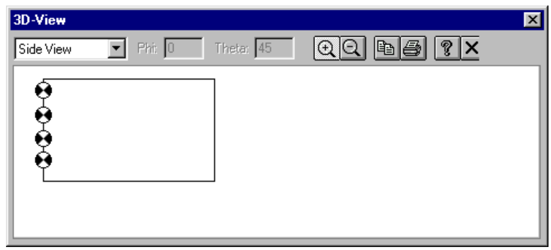
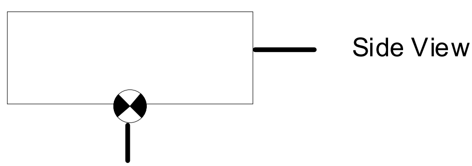
z co-ordinate on the status bar. (Of course, it would also be possible to find that value on the pertinent table, but this would be too inconvenient if you were to check the co-ordinates of many receiver points.)

A side view of the same situation would look like this:



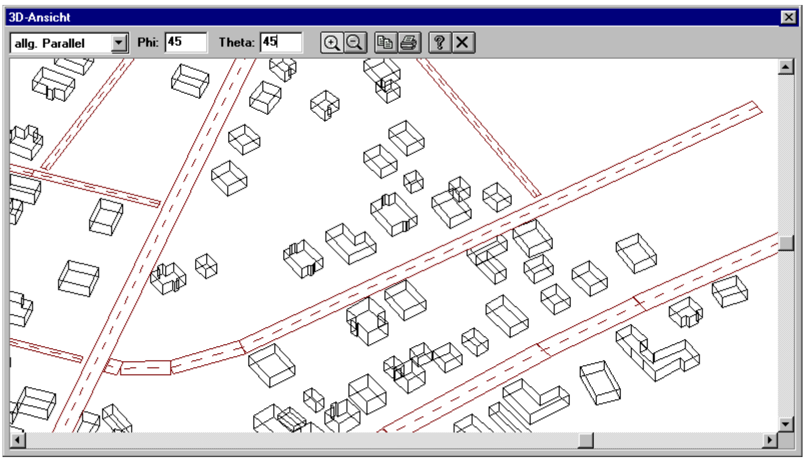
Checking the height is most conveniently done using the front view (looking along the y direction towards higher values of the co-ordinates, which means upwards with respect to the screen) and the side view (looking along the x direction towards smaller values of the co-ordinate, which means to the left with respect to the screen).



The views *Isometric, Cavalier* and *Cabinet* are projections at pre-set angles - just check them out.

Under the general „Parallel Projection“, you may specify arbitrary angles under which to look at the model. „Phi“ is therefore the angle relative to the positive x-axis whereas positive means counterclockwise. „Theta“ is, in line of sight, the elevation angle towards the horizontal plain.

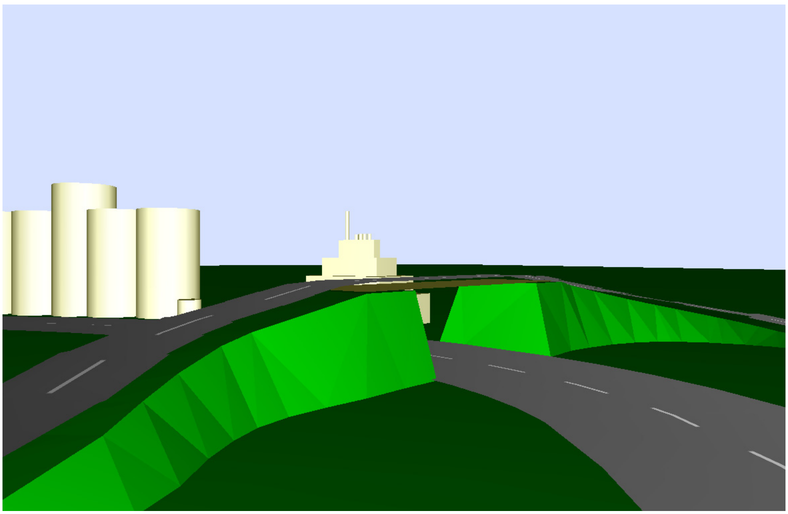
You can change the angles by entering a value via the keyboard or with the arrow keys via the numerical key block: the angle Phi with the keys 4 and 6 and Theta with 3 and 9. Just test it.



see also chapter 3.5.1 Automatically Optimize Noise Barriers.

9.14 3D-Special View

The **3-D special** view is a graphic representation with hidden lines, taking into account the visibility of the individual surfaces. You can move through this 3D-scenario - either along a specified path (e.g. along an auxiliary polygon or a road, or free in 3D-space, see chapter 9.15).



Model with a road on a bridge and an embankment created with contour lines.
The DTM is calculated with triangulation.

Navigate independently through your virtual model like a pilot in an airplane using your arrow buttons and mouse as joystick. You can go in any directions and/or change simultaneously the visual angle.

Monitor your project: Everything fit in correctly? Does the DTM looks ok? Where is the noisiest area? And where is it calm? Have a look - fly there. In case you have to change something in your model just double-click the object and the edit dialog opens. Change what you like to change and fly along.

Because of a special speeding-up technic you can now navigate extreme agile through your 3D-special model even if it is a very big project. You don't need to create a clipping first - you will succeed quickly with a simple change of the near or far plane (see further below). In this case the model seems to appear foreshortened regarding to the settings but you can still navigate along continuously.

All acoustically relevant objects are displayed, if they are not deactivated. Auxiliary polygons are never displayed in the 3-D-special view.

3D-special view command

You can move into the **3D-special view** by pressing the right mouse key on an object which opens the context menu. Click here on the command 3D-special-View. To do so you have to be in the edit mode before (CTRL+e). How you move through the **3D-special-View** is described in detail in the chapter 9.15 Paths of 3D Special View.

Ground Model

Also the digital model of terrain (DTM) is displayed automatically without enforcing a grid calculation by the user if the option **Triangulation** (see chapter 6.2.6 "DTM Digital Terrain Model Tab") is activated. Otherwise you have to calculate a grid. You do not need a sound source if you only want to calculate the terrain model.

Ground Texture

Activated Bitmaps are displayed in the 3D-special view as well. If a DTM exist the bitmaps will be displayed as ground texture and will be adjusted regarding the aspect ratio.

Change sky color

The sky’s color shown on dialog **3D-Special** can be controlled via the INI-file of **CadnaA**. Define a new section called [Open GL] and enter the expression:

[OpenGL]
ColorSky=0 0 128

The triple numbers represent the color settings for RGB-colors red (0-255), green (0-255) and blue (0-255). Each value is separated from the next by a space.

Properties of 3D (Special)

In the dialog **Properties** in **3D (Special)** the following possible settings are given:

Camera offset

Camera offset: with

- **vertical:** changes the height of the view point
- **horizontal**: lateral change of the view point,
  positive value = to the right, negative value = to the left

Speed (km/h)

The entered value will adapt the speed accordingly. However, the real speed depends on the project size and on the hardware.

Rotation Speed

Rotation Speed (°/s) - a value effects the arrow keys left and right of your keyboard.

Field of view (°)

With this value you can determine the angle of the visible area to the left and to the right. There are limitations, however. A default angle of 45° should be appropriate.

Distance Range

This setting has been integrated for a possible adjustment to your graphic card. It defines the visible area of your model from the front (near plane) to the back (far plane - horizon). Some graphic cards cannot handle the default settings or are to slow. If this should be the case, adjust the values accordingly. In both text boxes a value > 0 must be entered.

Minimize the far plane (Properties menu in 3D Special View dialog) e.g. from 10,000 m to 1,000 m the objects will abscond in the "fog" and surface again if you fly to.

Copy to clipboard

Select **Resolution** factor in the dialog **Properties**. This factor determines the resolution of the representation of your 3D-model as metafile for the transfer to another program or for the printout.

☝ Attention: The actual resolution of your bitmap depends on the resolution settings of your monitor. If you already have a high resolution on your monitor and then select the factor 10, copying will take long time. So start your approach very cautiously.

Copying is executed by clicking on the menu **Copy** or by pressing the shortcut ALT+K.

Video Frame Rate:

You can record your 3D animation. This maybe useful if the animation is very slow because you are working on a big project or your computer does not have a good performance or you just want to give the Wave-file to your customer to give him an impression of his project. In that case enter a value for the number of pictures which should be recorded in a second. The default setting is 15 frames.

Record Video

Then click to the menu **Video** after confirming the dialog **Properties** with **OK** . You will be asked for a file name in which the video is saved as AVI-file. After clicking the **Save** button an option dialog appears for compressing the video. Make your corresponding settings dependent on which video drive (codec: compressor and decompressor) you use. After confirming, the video is recorded.

Vertical Grid

Vertical Grids (see chapter 5.3.6). With the transparency you can define if behind the vertical grid is anything to see or not. With 0 you cannot see anything behind it is 100 % opaque.

Display Grid Caption

When this option is checked, the grid caption as defined for the actual evaluation parameter on the dialog **Grid|Appearance** is displayed on the 3D-Special view.

Lights

You can adjust the brightness and/or the color of the 3D-special view (just test it):

- Camera Point - is light from the position of your head
- Camera Parallel - parallel light (as if the sun was shining from behind you)
- Sun Parallel - sun shines perpendicular (high noon)
- Ambient - diffuse light

9.15 Paths of 3D Special View

How do we move through our virtual 3D-model?

Initial Situation:

Features for checking of your model

You have a complete **CadnaA** project with DTM, buildings, roads, streets and miscellaneous sources. You would like to check your model in the **Special-3D-View**. You want to have a closer look at different parts of your model. These may be:

- a certain section of a road,
- several sections of a road,
- a certain area without roads and, of course,
- also the entire project model in the survey, seen from all directions.

Examples\Demo1.cna

For this example we are going to use the file demo1.cna, which you already know and which is on your CD.

Example

- Open the file Demo1.cna (menu **File|Open**).
- If there is a colored grid activated in the file, deactivate it in the menu **Grid|Appearance**, option „No grid".

A calculated receiver point grid is also represented in the Special-3D-View regardless whether this view is activated in the normal view.

In **Calculation|Configuration** (see chapter 6.2.6) we have activated **DTM|Search Contour Lines (Average)**. You can also activate the option Triangulation. There is no terrain model in this example, therefore this aspect is insignificant.

Nevertheless we would like to describe some features related to the alternative terrain models in **3D (Special)**:

- You do not have to calculate a grid to see the terrain model in **3D (Special)** when Triangulation is activated.

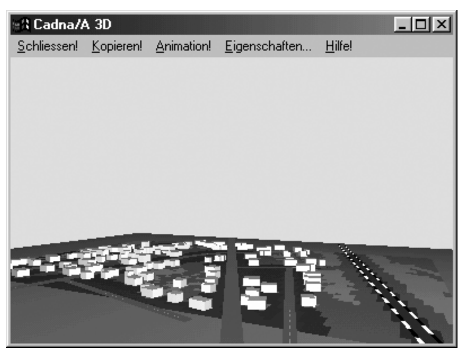
- The terrain model will build up faster with **Triangulation** than with the option **Search Contour Lines**.
- The colored representation of the receiver point's grid is more coarse in **3D (Special)**. You can modify this a little if you select a value >1 in **Grid|Appearance**, option „Raster, Oversampling".

  Just try it: Enter the value 5. After that you can activate the option **No grid** again. This has no effect on the 3D (Special) view, as you already know.
- In our example we click on the *Sandrachweg* - the street running straight from the lower left-hand corner to the upper right-hand corner - with the right mouse key at an optional point on the middle axis and select in the context menu **3D (Special)**. The **3D (Special)** dialog opens.

9

Maximize

- The dialog is usually located in the upper left-hand corner by default. Extend the dialog by dragging or clicking on the symbol **Maximize** in the upper right-hand corner (the symbol in the middle!) of the **3D (Special)** dialog.



3D-special view, the view from the object road called Sandrachweg

- Press ENTER/RETURN - you are now moving at a speed of 100 km/h and with a camera position at a height of 1 m from the beginning of the road until you reach the end or until you press Esc and therefore stop your move.

Automatic drive by pressing the Return-key

- Click on the menu **Properties** in the **3D (Special)** dialog.
- Enter the value 5 in the text box **Vertical** in **Camera Offset**. Confirm with **OK** and press Enter. You are now moving at a height of 5 m above the street. (Try out different heights.)
- Stop the movement with Esc and click on a railway in your project - without closing the 3D (Special) dialog - with the right mouse key - and select **3D (Special)** again.

Different sights

- Minimize the **3D(Special)** window so that you are able simultaneously to look at your project in the normal view.
- As soon as you click with the right mouse key on another object and select **3D (Special)** while the **3D (Special)** dialog is still open, the dialog will show the view from the current object.

Also try out different speeds in the dialog **Properties**.

Enter Speed

If you press Enter or click on the menu **Animation**, the move will start at the first point of the relevant object and will end at the last point.

Also have a look at your model from the top of a building. To do this press RETURN. You will then move "around the roof" at the given speed.

Stop your movement with Esc. If you have stopped the movement, you can easily continue it with the numeric keys on your keyboard. With

Numeric key block or arrow keys

- Keys 8 and 2 move forward or backward
- Keys 4 and 6 turn left or right
- Ctrl + key 4 or 6 sideways left or right
- Keys 9 and 3 move upward or downward (maintaining the view on the object)
- Key 5 return to initial position
- Key 7 move vertically upward
- Key 1 move vertically downward
- Key 0 reset rotation (back to the initial angle)

Mouse

Pressing the left mouse key and moving the mouse changes the perspective. By doing so you can use the keys simultaneously, too. Just try it!

3D-dialog must be active

During this process the **3D (Special)** dialog must be activated - just click on it, if necessary. The entered speed in the dialog **Properties** has no effect on the key movements. These depend on the performance of your hardware!

Summary

With the numeric keys on your keyboard you can move freely in your virtual model, starting from the initial point. Any object can be your starting point. You can also move around this object by pressing ENTER. The settings in the dialog **Properties** are valid then.

If the movement is stopped with Esc - you can make a digression with the other keys or with the mouse - by pressing the Return key again the movement goes ahead from the previous breakpoint. So you cannot go lost.

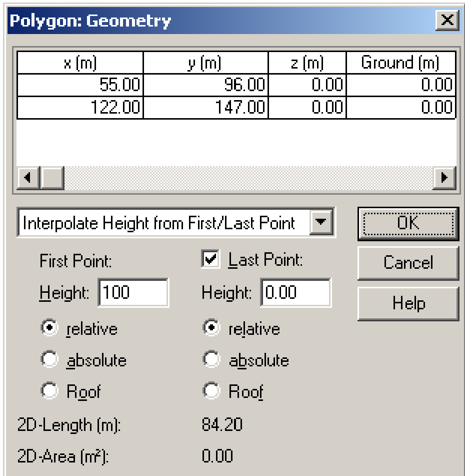
Auxiliary polygon as camera line

Another little exercise:

- enter an auxiliary polygon with the following coordinates into your file **Demo1.cna**:

  Point x 55, y 96, z 100 relative
  Point x 122 y 147 z 50 relative

Remember to activate the icon in the toolbox and just enter the value - the polygon point dialog opens!



Coordinates of the auxiliary polygon

After you have entered the auxiliary polygon

- click on it with the right mouse button and select **3D (Special)**.
- You now look on the demo example from 100 m (first point) down to 50 m (second point). You are looking again from the first to the last point. If you press **Return**, you will move along this line.

Play a little with the length of the polygon - shorten or extend it and have a look at the effect. Select initial and final height or shift the polygon. Leave the 3D (Special) window open.

Closed aux polygon as camera line

When the option „Closed Polygon“ is activated **CadnaA** cycles along the polygon path. This „endless“ 3D-animation can be stopped by pressing the ESC-key on your keyboard.

Road Sections

In practice it will happen that a road consists of several sections, due to changing data (not as smooth as in our demo example). So what can you do to move along this partitioned road (by pressing RETURN) in your virtual model without interruption?

You can insert a continuous auxiliary polygon along the road you want to move on. If you did this with your mouse, you would probably be stopped by the virtual police for an alcohol check.

You better duplicate the road, join the duplicates to form a continuous road (Connect Lines) and convert it into an auxiliary polygon afterwards. Just try it.

☝ Auxiliary polygons are not visible in the Special 3D-View.

If this leads to sharp bends, straighten them out by selecting Spline in the context menu (right mouse key) and, if necessary, correct the design of the lines. You would move along this center line anyway - even if you had not executed Spline - in case the automatic movement around the bend was impossible at the given speed.

3D-Camera

You have now learned that you either can use an arbitrary **CadnaA** object from your project to start and to move along in the 3D-special view or you additionally insert a polygon with a initial and/or final height. Undoubtedly the second possibility has the advantage that you have a defined 3D-path, which you can re-open again without recovering the view you had before. After all, you have still a further possibility.

Generate camera line

If you move through your project within the 3D-special view and you find a position which suit you, then you can press the **C** key on your keyboard to fix this camera position. **CadnaA** inserts then a auxiliary polygon automatically and writes in its **ID** box the expression *3D-CAMERA*. This view can also be displayed in your printout with the Plot-Designer (see chapter 13.1.4) in a 3D-cell.

3D-Camera with a fixed Viewpoint

By a „3D-drive“ above a road or by a virtual „flight“ along a air route with the command **3D-special** from the context menu the point of view is always equal to the moving direction.

In a lot of cases you may wish to keep an object as your center on which you are looking during bypassing. You can manage it - insert a short auxiliary polygon with the center as starting point. The auxiliary polygon’s first point is decisive. This point is always the point of view from each arbitrary object or polygon if you write in its **ID** box the expression

3D-CENTER

(pay attention to the capital letters!). During each movement of the automatic animation - caused by hitting the RETURN key - is now the initial point of the auxiliary polygon the focus.

Examples\09_Graphic\Racingcourse.cna

For an example open the file Racingcourse.cna. The red circle symbolized the air route. Click on it with the right mouse key and select **3D-special**. The 3D window opens and if you press the return key you will fly along this circle but always with the focus on the first polygon point of the small auxiliary polygon 3D-CENTER. This must not be so long as in our example because only the first inserted point is relevant.

see also in the manual "Introduction to **CadnaA**":

Duplicate
Connect Lines
Spline
3D-Special

9.16 Video Recording

The simulation of a **Pass-By Level** (see chapter 2.8) and the movement in the **3D-Special view** (see chapter 9.14) can be recorded in a video. Such a file, like an AVI-format, can be replayed with a corresponding Windows Media Player independent of **CadnaA**. This provides a powerful tool for presentations.

In order to use the video function, you need on your system the corresponding video driver which is able to decode and encode pictures.

Annotation: For the time being we are using the DivXCodec5. You can download this decoder for free (http://www.divx.com). Please understand that we are not responsible for this software and that we cannot support it either.

Recording a Pass-By as Video

For the video recording of a pass-by a lot of receiver point grids are calculated. The number of calculated grids depends on the number of pictures which are recorded per second (**Framerate (fps)**).

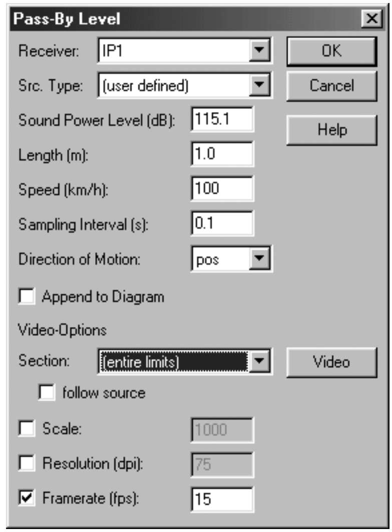
If you enter, e.g., the value 15 in the field **Framerate**, for the replay, 15 grids per second are calculated and recorded while the entered speed is taken into account for the object which is passing by.

So, before you select the command **Pass-By Level** from the context menu make all your desired settings for a grid calculation in menu **Grid** and maybe also in the menu **Calculation|Configuration**.

Afterwards choose the command **Pass-By Level** from the context menu of the corresponding line object and enter the desired setting

Examples\
02_Sources\Road\
Pass-ByVideo.cna

Open the example file, which already has been calculated and recorded, and look at the settings. Also pay attention to the menu **Calculation|Configuration**.



The Dialog **Pass-By Level**

Examples\
02_Sources\Road\
Pass-ByVideo.avi

Open the corresponding video AVI file with a double-click. Should this file not open, then the appropriate Windows Media Player is missing. If this is so then you have to install it from the CD of your Windows operating system.

Section

If you choose a section, then this one is the „calculation area“ for the receiver point grid.

follow source

By activating the option **follow source** the section of the graphics is moved with the source.

Scale

By activating this option the entered scale is used, in other cases, the current scale in the project.

9

Resolution (dpi)

By activating this option and entering a value this resolution is used, in the other case, the settings of your computer screen are used. The bigger the value, the finer the resolution and the bigger the file.

Video

After clicking the button **Video,** the dialog **Save as** opens. Enter the name of the file in which the video is saved.

After confirming with **Save** a further dialog opens in which you can select the desired video driver.

In the example of the **Pass-By** the grid calculation and the recording of the video starts. This created AVI-file can be run with the corresponding Windows Media Player.

Video recording in the 3D-Special View

In the **3D-Special View** the recording of the video starts after clicking on the menu **Video** and entering a file name as described in the preceding paragraph on the pre-defined path.

Individual movements made by the user with the arrow keys are not recorded.

See also see chapter 9.14

9.17 Miscellaneous

The dialog **Miscellaneous** (**Options** menu) offers the following options relevant to the graphics.

The further options on the dialog are described in chapter 6.6.

Marker size

You may choose the size of the marker displayed by a marked object by selecting the pertinent value.

Segment Length

While drawing an open or closed polygon you can enter fixed predefined segments holding the CTRL-key pressed. Enter the desired length (m) for the segment. The default value is 10 m. With this you could enter e.g. equal elements for an noise barrier.

Update during Drag

Click to a white screening area and hold the left mouse button pressed - a hand sign appears on the screen. In this mode you may move the graphic in any direction within your limits. With activated option Update during Drag the graphic will be updated continually during moving otherwise after releasing the mouse button.

Update during Calculation of Grid

By activated option the calculated grid is build up by colored areas during the calculation is still in progress.

Background beyond the Limits

You can assign a different color to the area which doesn't belong to the Limits. For that click on the color button and choose the desired color.

9

Chapter 10 - Bitmaps

☝ In this chapter the features of the **CadnaA**-option BMP are described. Those feature are only available when having purchased option BMP.

There are two kinds of computer graphics: bitmap graphics and vector graphics. In **CadnaA** we can open or import different formats of bitmaps (see chapter 10.1.2) .

Bitmaps

Bitmaps use a color grid (pixel) for the display of images. Each pixel is assigned a certain position and a color value. With bit-mapped images pixels are worked on, not objects or figures.

Bitmaps are the current electronic medium for half tone images as (e.g. photos or digital drawings) because the shades and colors can be reproduced in fine gradations. Bitmaps are resolution dependent, that means they have a solid number of pixels. Scaling on the screen or during print out with a resolution which is too low can therefore result in the losing of details or in irregularities in appearance.

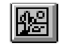
Vector graphics

Vector graphics contain lines and curves which are defined by mathematical objects - so-called vectors. Vectors describe images on the basis of their geometric properties. This type of graphics is not used in **CadnaA**.

The option BMP is mostly used to insert scanned maps such as paper plans received from land register, from technical drawings, and from other sources. They serve as a background image pattern for define the locations of noise sources, receivers and other objects such as screening obstacles (e.g. building and barriers). However, also digital pictures can be used, for instance based on the JPEG format. The number of pictures which can be inserted depends, of course, on your PC-hardware, especially on the memory capacity and on the resolution (DPI) of your image files.

10

10.1 Insert Bitmaps



CadnaA does not save the bitmaps in the cna-file but refers to the bitmap files with their file name and paths. If you now shift your project cna-file and the bitmap into a different folder on your hard drive, **CadnaA** will find the bitmap if the cna-file and the bitmaps file are in the same folder.

There are several different possibilities for inserting bitmaps into a project file:

- via the table (**Tables|Other Objects|Bitmap**)
- with the toolbox icon and
- by importation via **File|Import** (see chapter 10.1.2 "Import Bitmap") or ODBC interface.

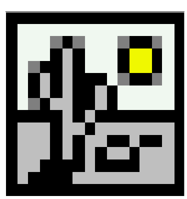
This procedure is advantageous if a lot of bitmaps shall be included in one **CadnaA**-file and if a list exist (e.g. MS-Excel file) which contains all file name of the bitmaps and their corner coordinates. In that case all bitmaps will be imported and placed in the **CadnaA** graphics automatically (see chapter 7.3).

10

Proceed as follows to enter a new bitmap:

- Select the symbol „bitmap“ from the toolbox and draw an arbitrary sized frame.

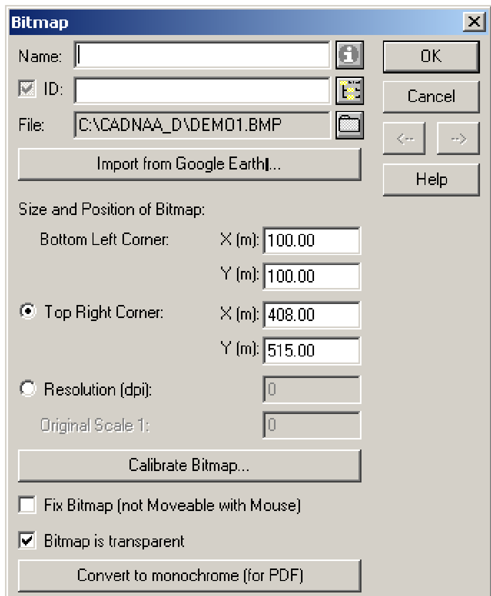
If no bitmap has been inserted yet, a frame with the following bitmap symbol appears.



An empty bitmap frame - a bitmap file has not been selected yet.

If you have already defined a bitmap and if you insert another frame, the new frame will also contain the last selected bitmap file.

- Click with the right mouse key on the border of the frame to open the edit dialog.



- After clicking the folder icon on the right side of the **File** box, select the bitmap file in the usual manner.

As an alternative you can also insert a bitmap file via **Table|Other Objects|Bitmap**. In this table, all inserted bitmaps are clearly registered. Furthermore, bitmaps can be imported from the GoogleEarth-server (see chapter 10.1.2 "Import Bitmap").

- Enter into the box **Name** a designation for the bitmap.

This name is displayed on the first column of the table **Other Objects|Bitmap**.

10

10.1.1 Bitmap Size and Position

To avoid a distorted representation of the background image on the **CadnaA** main window, you must specify its dimensions and its intended position within the main window or the limits.

Coordinates

You may do so by entering

- the co-ordinates of the bottom left and top right corners, or
- the resolution of the map in dots per inch (DPI) and the scale, or
- reference points, the coordinates of which are known (calibration).

Resolution

If the **Resolution** option is activated, you must know the resolution in DPI (e.g. 150, 200, 400 etc.) used when the map was scanned and the scale of the map. This method is particularly convenient if only the relative positions of objects matter, and their absolute coordinates are irrelevant.

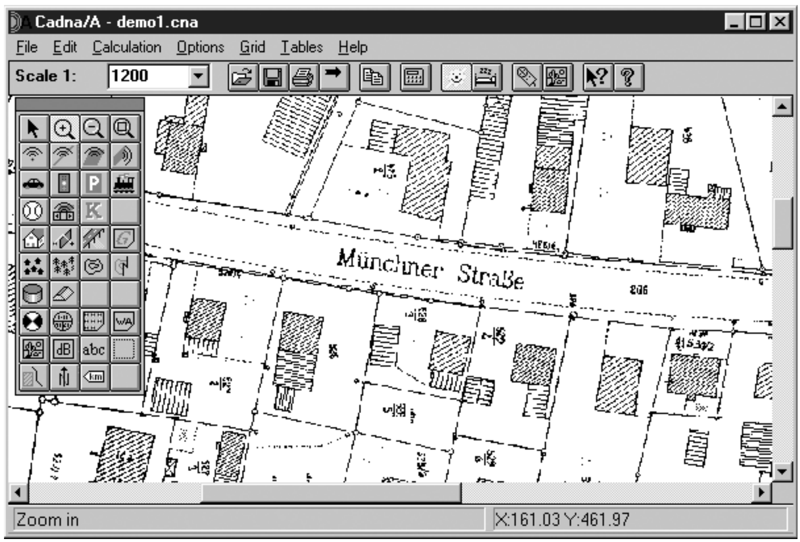
Calibrate Bitmap

The **Calibrate Bitmap** button opens a dialog which allows you to enter up to four points with known coordinates on the map. As soon as you have entered these points and confirmed by clicking **OK, CadnaA** will load the bitmap and prompt you to click the reference points on the bitmap which is displayed on the screen. **CadnaA** will then determine the correct coordinates for the representation. Under this mode, you may use the zoom magnifiers to enlarge the reference point to be clicked.

You should always select this method when more than one bitmap file is to be inserted because in this case the absolute position of the bitmaps is decisive for a correct representation. In practice bitmaps will overlap, particularly near the edges because the scanning causes discontinuities not present in the original map.

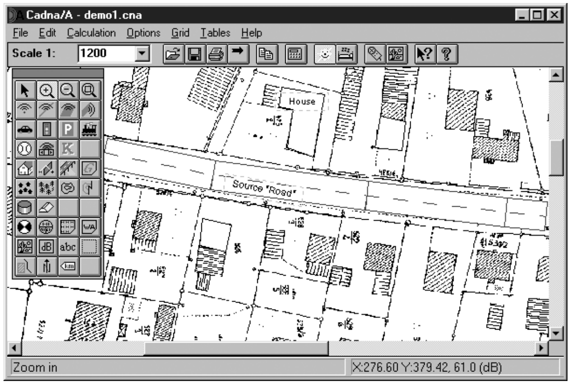
When all reference points have been identified, you can save this calibrated bitmap under a different name. You need not do so, however. It is convenient, when the calibrated bitmap is large, up to several megabytes, and, moreover, has been rotated because of the calibration. **CadnaA** calculates the position of the bitmap, which may take several minutes. Saving the bitmap in the right position means not having to recalculate it when the file is opened again.

Save the entered coordinates under a name so you can reload them by just selecting that name.



Bitmap file as background information for input of acoustically relevant objects.

Insert the objects on the map which is now displayed on the main window.



The background information of the scanned maps allows you to quickly insert and calculate the acoustically relevant objects in **CadnaA**. A representative diagram of the calculation results can be printed.

Fix Bitmap

As long as the option in the dialog **Bitmap|Fix Bitmap** is activated, size and position of the bitmap cannot be modified.

Bitmap is transparent

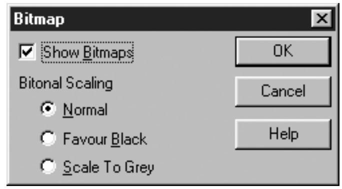
When this option is activated the white area of black & white bitmaps (with 1-bit color depth) will be displayed as transparent areas. By default, this option is activated. Please consider that colored bitmaps (with higher color depths, such as 8-bit or 24-bit) will be displayed in **CadnaA** as transparent as well. They may, however, not be printed with transparency due to restrictions of the printer driver or the printer driver model used.

Convert to monochrome (for PDF)

This option offers to convert a colored bitmap into a monochrome bitmap of 1-bit color depth. After conversion **CadnaA** will prompt you to enter a file name.

Show Bitmap

The bitmap icon on the **icon bar** allows you to show or hide bitmaps by activating or deactivating the **Show Bitmap** check box.



see also chapter 4.1 Object's Geometry, Reference Points

Transforming Bitmaps

Bitmaps can be transformed after import as well. Selects the action/command „Transformation" on the dialog **Modify Objects** or from the context menu of the respective bitmap. Please consider that bitmaps can afterwards be transformed with translation only. Thus, settings leading to rotations or shear deformations will be disregarded.

The entered transformation data will be applied to the corner coordinates of the bitmap. This means that the correction of general or unknown distortions are not possible with this feature. Please use the calibrating procedure described in this chapter for the calibration of bitmaps during import.

10.1.2 Import Bitmap

☝ **The features for importing bitmaps require the option BMP.**

Importing Bitmaps via File|Import

The bitmap format used for **File|Import** enables you to automatically place bitmap files (e.g. TIFF-files) in bitmap frames, provided that the corner coordinates of the bitmap are saved in the equally named additional file with the extension TFW and both files are in the same directory (e.g., bitmap file named 34139ca2.tif and coordinate information file named 34139ca2.tfw).

You can select the files to be imported by multiple choice. It is of no significance whether you mark the TFW file or not - **CadnaA** will find the corresponding information and will automatically load all files one after another.

Importing Bitmaps via ODBC

Furthermore, bitmaps can be imported via the ODBC-connection (see chapter 7.3). You can also import other bitmap files using this method. In this case you do not have to create a bitmap frame from the toolbox. **CadnaA** will automatically create this frame in the lower left corner of your **limits**, giving it a size of 10 x 10 m. You can adjust this frame accordingly in the edit dialog as usual.

Bitmap-formats

The following bitmap-formats can be imported for the time being (modifications subject to change at any time):

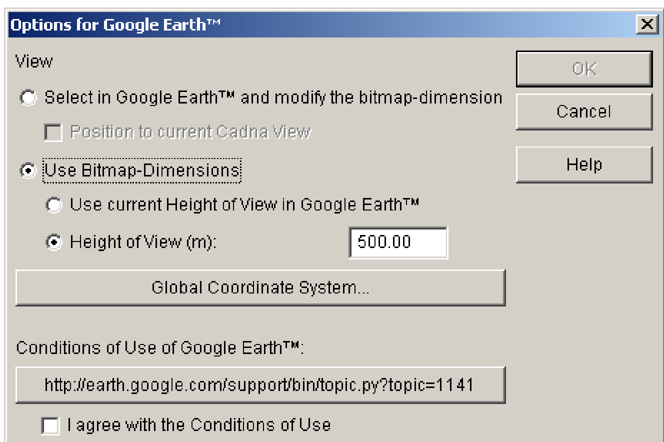
CALS Raster, DCX, DWF, ECW, GEM Image (IMG), GIF, IOCA (ICA), JFIF, JPEG, JTIF, LEAD CMP, Macintosh Pict (PCT Macintosh QuickDraw), MacPaint (MAC), Microsoft Paint (MSP), MPT (Multipage TIFF), OS/2 Bitmap, PCD (Kodak PhotoCD Files), PCX, Photoshop 3.0 (PSD), PNG (Portable Network Graphics), PostScript Raster (Encapsulated PostScript), SUN Raster (RAS), TIFF, TIFF CCITT (also Group 3 and 4), TIFF (LZW), Truevision TGA (TARGA), Windows Bitmap (BMP), Windows Metafile (WMF), WinFax Group 3, WinFax Group 4, WordPerfect (WPG WordPerfect raster files) and some others. Just check formats of your own.

Importing Bitmaps from GoogleEarth

As a further, very comfortable feature, **CadnaA** offers to import bitmaps from GoogleEarth. However, GoogleEarth has first to be installed in your PC in its present release (download: http://earth.google.com/download-earth.html) and the object coordinates in **CadnaA** have to be in a known national or international coordinate system (see chapter 9.5).

GoogleEarth is a software by Google Inc. to display a virtual globe (see http://earth.google.com). This software displays satellite and aerial images of different resolution onto a digital terrain model of the Earth with geo-referenced coordinates (using geographical length/width or UTM-coordinates).

To import bitmaps from GoogleEarth click on the button „Import from GoogleEarth“ opening the following dialog with all import options.



The View type when importing bitmaps can either by specified in GoogleEarth or, alternatively, can be based on the coordinates of a bitmap-object in **CadnaA**.

Selecting the view for GoogleEarth

Agree with the Conditions of Use from GoogleEarth by activating the check-box. Upon click on OK GoogleEarth is launched focussing on the centre point of the bitmap-object in **CadnaA** selected for import. Subsequently, you will have to specify the section in GoogleEarth.

Here the term „view“ means the size of the frame in GoogleEarth showing the bitmap. Change the frame’s size or use the zoom in/out in GoogleEarth to adjust the area to be imported. Press the **OK** button.

By activating the option „Position to current CadnaA view“ the imported bitmap-section will correspond with the present frame size of the **CadnaA**-main window.

Next, you are prompted by **CadnaA** to save the bitmap file. Enter a file name and select a file format. Bitmaps can be saved with formats BMP, CMP, PCX or TIFF. Subsequently, the imported bitmap will be displayed in **CadnaA**.

Use Bitmap-Dimensions

With this option being active the area covered by the actual bitmap-object in **CadnaA** defines the bitmap-area to be imported.

It can be specified whether the height of view as preset in GoogleEarth or the entered height will be used. This setting causes a different resolution of the bitmap file (number of pixels) and, thus, a different file size. By default, a height of view of 500 m is applied. It is recommended to increase the height of view with increasing area covered by the bitmap. Otherwise, the size of the bitmap file may become huge.

In case a global coordinate system has been specified (see chapter 9.5) the import procedure start upon clicking the **OK**-button after having accepted the Conditions of Use by GoogleEarth (activate the check-box). Ensure that no other application is started or is covering the GoogleEarth-dialog during the import procedure.

Alert message

With bitmaps exceeding more than 8000 pixels in either direction (x, y) a message box will be displayed by **CadnaA**. This enables to cancel the import procedure.

Global Coordinate System

A correct import from GoogleEarth requires object coordinates in a known coordinate system. Click on the button „Global Coordinate System". For project files a national or international coordinate system of which has been specified will be displayed on the subsequent dialog **Coordinate System** (description of dialog see chapter 9.5). Otherwise, select the present coordinate system as been sued in the **CadnaA**-file. With the option „User-defined Coordinate Systems" activated just those are listed.

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10.2 Delete Bitmap

Like any other object, you can delete a bitmap using the DEL key. This will only remove the bitmap from the display of your project on the screen, and the reference to the file from the objects table, but it will not delete the file from your disk. The **Edit|Undo** command allows you to restore the display.

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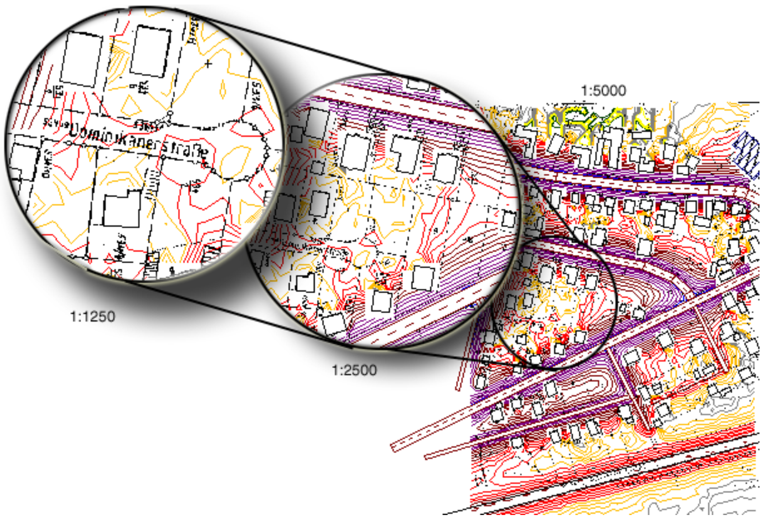
10.3 Web-Bitmaps

By the export format „Web-Bitmaps“, available on dialog **File|Export**, a **CadnaA** project file can be exported to a number of bitmaps serving to be used on an Internet homepage. The bitmaps can be saved with different scales and with a definable resolution.



Bitmaps saved with different scales.

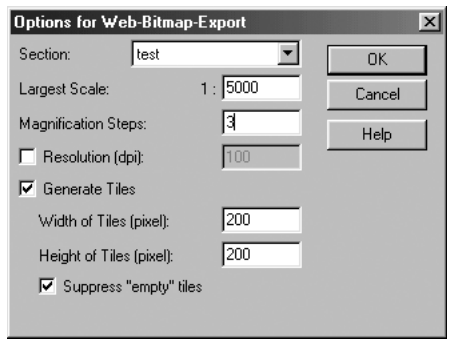
Before you execute the export command draw a section (see chapter 9.10) over the area in your project file which you want to save as Web-Bitmap and enter a name for this section.

File Name

After executing the export command, enter a file name as base name to be saved under and the corresponding options by clicking the „Options“ button. **CadnaA** then saves the necessary number of bitmaps, dependent on the chosen options, automatically with the equivalent extensions in alphabetical order.

For the following example three files with different scales have been saved.

- Webtest_demo1_a.bmp is the file with the largest scale (whereas `Webtest_demo1` was the original file name and a is the extension),
- Webtest_demo1_b.bmp is the file name for the scale with the magnification step 2 and
- Webtest_demo1_c.bmp is the file name for the magnification step 3 etc.



Export Options for Web-Bitmaps

Section

Select the desired section by clicking on the section name in the list.

Largest Scale

Enter the largest scale you want to display (if you are not sure, check in **CadnaA** which scale could be useful).

Magnification Steps

Enter the number of desired magnification steps. If you enter the value 3 then two further diagrams are created magnified by the factor 2 with the start value entered in the box „Largest Scale“ (in the above example diagrams with 1:5000, 1:2500 and 1:1250).

Resolution

Enter the desired resolution in dpi. But remember - the higher the resolution the longer the loading time of the bitmaps. 100 dpi are normally sufficient. The bitmaps are created with the resolution of the computer screen if you don't enter a resolution on your own. This resolution is normally sufficient, also.

Generate Tiles

You can divide your project file if it is too big. In that case activate the option „Generate Tiles". **CadnaA** then divides the file automatically in the defined size („Width" and „Height of Tiles)" and generates for each section or tiles the corresponding number of bitmaps with the settings entered under „Option". Sections without any objects are not created if the check box "Suppress empty Tiles" is activated.

CadnaA does not supply the handling of the bitmaps for an internet presentation, but every web-desginer may process the bitmaps.

An example can be studied on http://www.noiseRus.com

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Chapter 11 - Tables

This chapters explains the handling of the object tables (see chapter 11.1) and of the free editable Result Table in **CadnaA** (see chapter 11.2).

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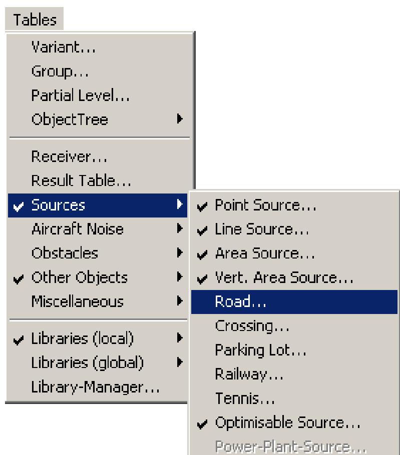
11.1 Tables

All objects inserted via the graphics will automatically be adopted as data records in the pertinent table of objects and vice versa. An object entered by giving its data in the table of objects will appear as a graphic object in the **CadnaA** main window. The tables of objects are all compiled under the pertinent category term on the **Tables** menu.

A check mark in front of an item on the Tables menu indicates that data records of that type are available.



Open Tables with Shortcuts

As you know, some of the toolbox icons (see manual "Introduction to **CadnaA**") can be activated via shortcuts. The edit mode, e.g., with CTRL+e, the street icon with CTRL+s (see also online help keyword „Shortcut“).

You can also open the corresponding table of objects with the same character keys, but without the CTRL key and you can close it again with the ESC key. You press, e.g., the key *s* that opens the road table, key *b* for the railway table and so on. By doing so the first data record is activated automatically.

Synchronization

The tables and the graphics are synchronized. When a record in a table is selected, the corresponding graphic object on the main window is highlighted. Even an individual polygon point, edited on a **Geometry** dialog, will be flashing so you always know what you are working on.

Editing Data records

Data records may be inserted, edited, copied in and deleted from the tables. When a data record is deleted from a table, the corresponding graphical object on the main window is deleted as well.

Delete Data record

For deleting a data record from the table you can use either the DEL key or the command **Delete** from the context menu.

You can bring back a deleted data record with the command **Edit|Undo**.

11.1.1 Table's Button Bar

The button bar shown in the figure below appears on all object tables accessed via the **Table** menu.

Close

Click this button to close the dialog and to adopt any selected value or data record or to apply changes.

Synchronize Graphics

A selected data record, at the same time, selects the corresponding graphic object. If the graphic object is outside the area visible on the screen, clicking this button will make it visible.

Copy

Pressing the button **Copy** copies the entire table to the clipboard (alternatively, press CTRL+c). The table can then be pasted in other Windows' applications or you can paste **one** individual data record in a table of the same object type in **CadnaA** (see chapter 11.1.7).

Print

As usual the tables can be printed directly by clicking the button **Print**. The keywords for user-defined printout or export of the object tables can be found in the online help with the „keyword" or in chapter 11.1 Tables of this manual.

Font

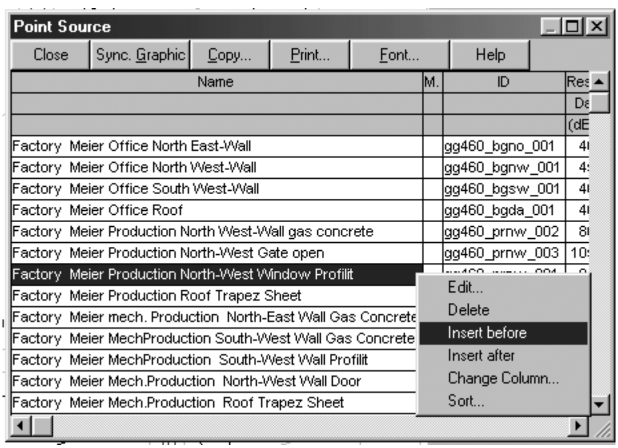
This button allows you to select the font and the character size for screen presentation and printout as usual. The changes will be saved only for the Result Table if the layout is saved.

11.1.2 Inserting a Row

If no object has been inserted then you can only see the table head without any rows. To create a new data record you have to insert a new line either

- via the context menu or (see manual "Introduction to **CadnaA**")
- by pressing the INS key

To insert a row via the table context menu, just press the right mouse key on the row where you want to insert a line before or after the current one. If the table is empty, just click on the right mouse key below the table head and the context menu opens.



Then select the appropriate command **Insert before/after** by clicking it with the left mouse button. A new, blank row is now available for the input of data.

Another alternative is to just press the INS key and the new row will then be inserted before the current one.

11.1.3 Editing Table Cells

The table cell can be edited. If its value depends on that of another cell, it will immediately be updated when a parameter in the other cell is edited.

Example

You can also modify the MDTD in the roads table. This results in an immediate updating of the L_{me} for day-time, and, if necessary, for night-time.

If you enter the L_{me} directly, the data used before to calculate it will not be shown in the table any more.

☝ **Hints regarding Editing:**

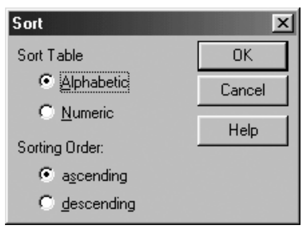
- Clicking a table row will not result in the entire row, but only an individual cell being selected (highlighted). This becomes the active cell which you can edit. The corresponding graphical object will also be selected.
- The up and down arrow keys (↓ ↑) serve to navigate from one **row** to the next, and the left and right arrow keys (→ ←) do the same for the **cells** of a row.
- You can edit the selected cell by entering the desired value or text. A vertical-bar cursor (|) will appear in that cell. Any existing value will be overwritten (overwriting mode). Please also note how to enter decimals (see manual "Introduction to **CadnaA**").
- There are two editing modes: **Overwrite** (default) and **Insert**. Under the overwriting mode, any existing text is overwritten (deleted completely). Under the insertion mode you can modify the text, add to it, or delete it using the BACKSPACE and DEL keys.
- If you wish to add to the existing text, or correct it, press the **F2** key (insertion mode). Any text in the cell will be retained. You can move the vertical-bar cursor backwards and forwards across the text using the left and right arrow keys (→ ←).

- To terminate editing, in the **overwriting** mode, either
  - press the left or right arrow key (→ ←): The cursor moves on to the next **cell** belonging to the same data record –, or
  - press the up or down arrow key (↓ ↑), or RETURN: The cursor moves on to the next **row** but stays in the same column.
- Under the **insertion** mode, just press RETURN to stop editing. This will also result in the cursor moving on to the next **row** following the one just edited it will remain in the same table column.
- ESC exits the edit mode and restores the previous value.
- Pressing RETURN when not in the edit mode results in the Tables dialog being closed (just like clicking **OK**).
- Double-clicking a table cell opens the pertinent edit dialog of the object, as customary.

11.1.4 Sorting Columns

By default, **CadnaA** lists all inserted objects in the sequence in which they were entered. When the **Sort** command on the context menu is clicked, the selected table column is sorted in numerical or alphabetical order, either ascending or descending, depending on which option buttons were activated in the dialog:

Click the column to be sorted with the right mouse button, select the **Sort** command from the context menu, and activate the appropriate options in the dialog.



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The tables will then be sorted as specified and will also be printed in that order. Also the graphic objects will be „drawn“ according to their order in the table.

Shift Rows

You also can shift individual rows within the table. For that, hold down the mouse pointer on that row you want to shift and move the mouse pointer to the desired position and release the mouse key.

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11.1.5 Change Column Content

CadnaA offers a comfortable tool for the editing of specified ranges of tables on the basis of the current value.

This can be either a conversion of numerical values (arithmetics) or a modification (substitution) of character strings.

For the examples below, you should open a table – for example the table of point sources – of a **CadnaA** project, or just enter a few points and open the pertinent table of object.

Click the column to be edited using the right mouse button. On the context menu, select **Change Column**.

Range of Rows

In the dialog which then opens, you may restrict the modification to a Range of rows up to or starting from a row which you specify by clicking it. In the default setting, all elements of the selected column will be modified.

If the column contains numerical values, both **arithmetic** and **string** conversion are possible. In all other cases, only string conversion is possible.

Arithmetic

The current numerical value may be replaced by a different constant value, or by one that is computed from the current value.

+, -, /, * are operators used as customary. x stands for the current value.

++ and -- stand for level addition and subtraction.

(see **CadnaA**-manual "Attributes & Abbreviations")

Replace String

This operation may be required if a data record, e.g. the **CadnaA** project for an enterprise, is to be embedded in larger limits, requiring modification of the ID code.

Search for

Specify a search string in the box **Search For:** only strings matching this string will be converted.

The characters * (asterisk: arbitrary number of arbitrary characters) and ? (questions mark: one arbitrary character) act as wild cards used as customary. If sections of a string are to be re-used in the conversion, these are enclosed in brackets.

Replace with

In the box **Replace with:** you may combine arbitrary character strings with the string sections marked by brackets in the search string. \1 . . . \n is used as a symbol for these marked string sections (see **CadnaA**-manual "Attributes & Abbreviations").

This flexible logic allows you to perform practically any operation required to convert strings.

Automatic Numbering in Tables

With the rhombus # you can number automatically the column in your tables. One rhombus # results in a one digit value from 1 to 9, two rhombuses ## result in a two digit value from 01 to 99, three rhombuses result in a three digit value from 001 to 999 and so on. After the value 9 **CadnaA** starts with 0 again.

Enter the rhombus in the field **replace with**.

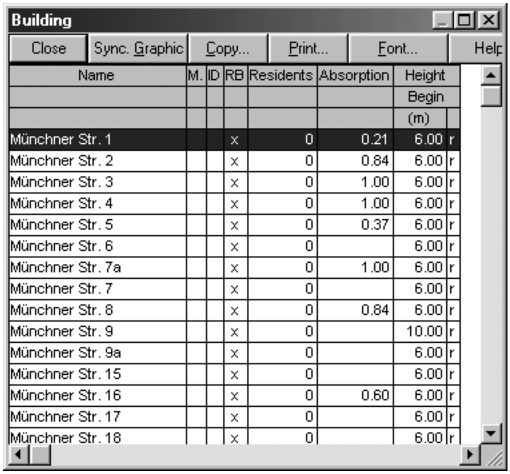
Example

How can you find out how many buildings, barriers, point sources, etc. are in the project without having to count them individually?

Here is the answer:

Examples\Demo1.cna

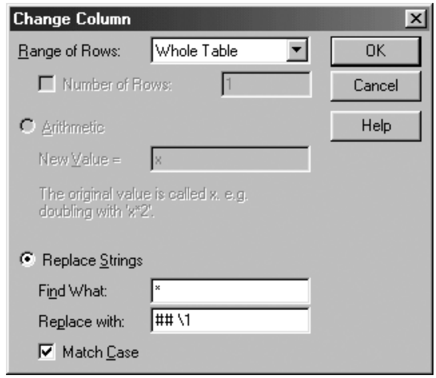
- Open a file, and take a look at the pertinent table of object (e.g., have a look at the building table in the file **DEMO1.CNA**).



Name	M.	ID	RB	Residents	Absorption	Height Begin (m)	
Münchner Str. 1			x	0	0.21	6.00	r
Münchner Str. 2			x	0	0.84	6.00	r
Münchner Str. 3			x	0	1.00	6.00	r
Münchner Str. 4			x	0	1.00	6.00	r
Münchner Str. 5			x	0	0.37	6.00	r
Münchner Str. 6			x	0		6.00	r
Münchner Str. 7a			x	0	1.00	6.00	r
Münchner Str. 7			x	0		6.00	r
Münchner Str. 8			x	0	0.84	6.00	r
Münchner Str. 9			x	0		10.00	r
Münchner Str. 9a			x	0		6.00	r
Münchner Str. 15			x	0		6.00	r
Münchner Str. 16			x	0	0.60	6.00	r
Münchner Str. 17			x	0		6.00	r
Münchner Str. 18			x	0		6.00	r

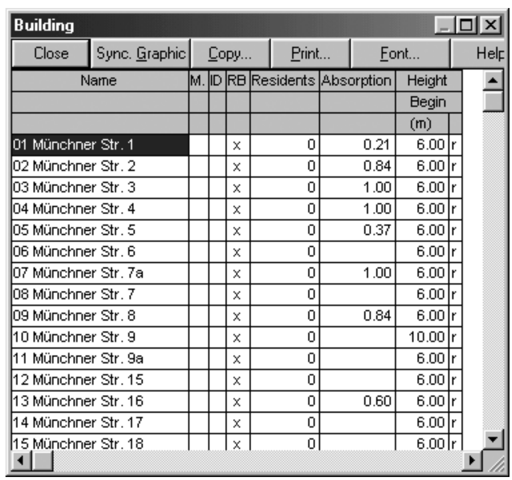
Existing table with building - initial situation

- Position the mouse pointer on the column **Name**.
- Click it using the right mouse button and select **Change Column** on the context menu.
- Specify the settings as shown in the figure below.



Automatic numbering with the function Change Column

The figure shows automatic numbering using two digits and the character string **\1** means that the current value is to be retained.

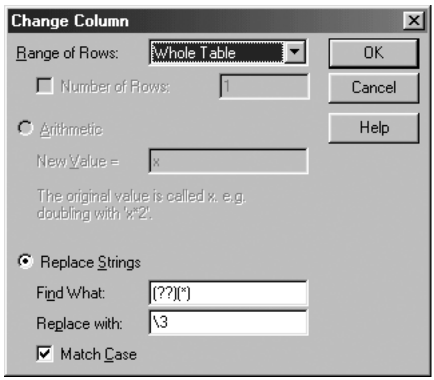


Name	M.	ID	RB	Residents	Absorption	Height Begin (m)	
01 Münchner Str. 1			x	0	0.21	6.00	r
02 Münchner Str. 2			x	0	0.84	6.00	r
03 Münchner Str. 3			x	0	1.00	6.00	r
04 Münchner Str. 4			x	0	1.00	6.00	r
05 Münchner Str. 5			x	0	0.37	6.00	r
06 Münchner Str. 6			x	0		6.00	r
07 Münchner Str. 7a			x	0	1.00	6.00	r
08 Münchner Str. 7			x	0		6.00	r
09 Münchner Str. 8			x	0	0.84	6.00	r
10 Münchner Str. 9			x	0		10.00	r
11 Münchner Str. 9a			x	0		6.00	r
12 Münchner Str. 15			x	0		6.00	r
13 Münchner Str. 16			x	0	0.60	6.00	r
14 Münchner Str. 17			x	0		6.00	r
15 Münchner Str. 18			x	0		6.00	r

Result of the automatic numbering

This command thus allows us to quickly determine the number of objects. (How many buildings are there in Demo1.cna? - Find out.)

If you wish to remove the numbering, use **Change Column** again, and enter what is shown below.



How to remove the automatic numbering from the above example

With this command only the numbering at the beginning of the line is deleted (see **CadnaA**-manual "Attributes & Abbreviations“, *Strings and Operators*).

11.1.6 Adjusting the Column Width

The column widths of all tables can be adjusted

1. To this end, position the mouse pointer on the table header of the line separating the columns which you want to adjust. The mouse pointer turns into a two-headed arrow. Hold the left mouse button down and move the mouse in the desired direction. Then release the mouse button. *individually*

2. Just double-click on the separating line of the table header. The columns will be adjusted so, that all characters of each column are visible. *automatically to the longest columns*

3. For that, hold the SHIFT key down while double-clicking on the dividing line of the table header. **CadnaA** tries to fit all columns into the tables window. You can undo this with another double-click without pressing the Shift key. *automatically to fit table into window*

When closing the table, the table columns will have their default width again.

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11.1.7 Copying and Pasting Data Records

A data record may be copied to the clipboard so as to be pasted in an objects table of the same type.

To do so

- first, click any cell of the record to be copied,
- then click the **Copy** button on the **Tables** dialog (or press CTRL+c),
- insert a new row in the table (context menu **Insert before/after**), and
- finally, press CTRL+v to paste the data record that was saved to the clipboard.

The copied data record can only be pasted in a table of the same object type. Therefore, the data record of, e.g. an area source, cannot be pasted in a point sources' table.

11.2 Result Table

CadnaA contains an efficient generator of tables which can represent all results for defined receiver points in any desired way. If you want to represent the evaluation of projects in the customary form of a table, you have to generate a template for this table. Afterwards this template will only have to be referred to in order to represent calculation results in a standardized way.

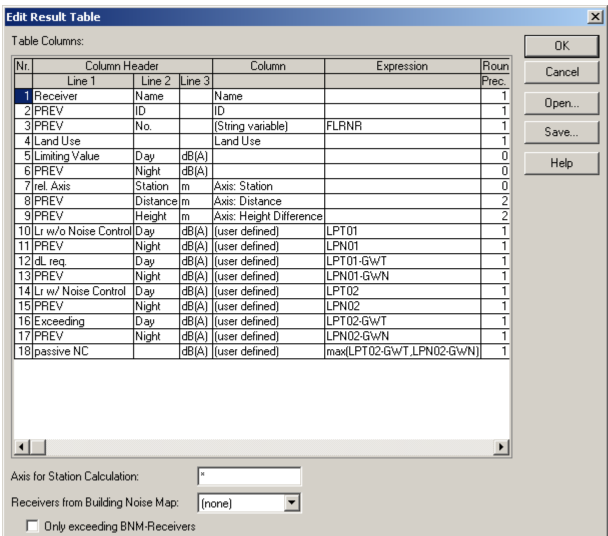
Therefore, save the default table with a different name and adjust it as desired. In each project in which you open this template table the results will be displayed in the created shape. The template table has the extension CNT.

The Result tables can be printed out directly with the button **Print** or the layout can be seen in the print preview.

Editing Result table: see chapter 11.2.1
Results Table's symbol bar: see chapter 11.1.1

11.2.1 Edit Result Table

Via the menu **Tables|Result Table**, button „Edit“ the column headings, the numbers of columns and their contents of the Result Table can be edited. Instead of defining several result tables, just a single one may be defined containing all columns which may be switched on or off with de-pending on the present needs. Intermediate results in invisible table columns are still stored. Those intermediate result, however, can be used (addressed) in subsequent columns.



Edit Dialog **Result Table**

The options on the dialog **Edit Result Table** provide filter options determining which receiver points or parameters are displayed.

Axis for Station

Enter a string corresponding to the ID (see manual "Introduction to **CadnaA**") of a line-type source (e.g. a road or a railway track) in order to display the station, the distance or the height of a receiver point from this source in the Result Table. This requires that corresponding columns for these values have been defined in the Result Table using the corresponding predefined designations as column content (e.g. „Axis: Station“) .

Receiver from Building Noise Maps

Select by clicking in the corresponding list box the range of receiver points of the calculated building noise map to be displayed in the Result Table. Either the highest level (max.), the lowest level (min.), or a level at a distinct storey can be displayed.

Noise map of buildings see chapter 5.4.1.

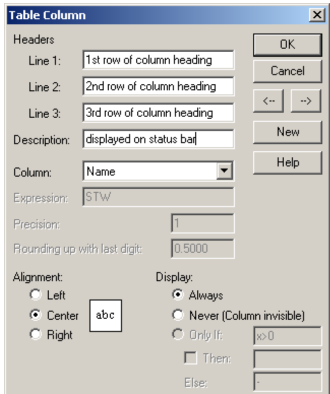
Only exceeding BNM-Receivers

With this option activated, only those receiver points (facade points) exceeding the specified limiting value/s are displayed (BNM = Building Noise Map).

Inserting a Column

In order to create a new column select either the commands **Insert before/ after** from the table’s context menu or press the INS-key.

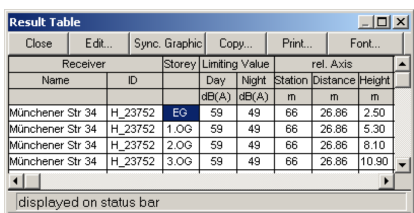
For editing, double-click into the corresponding row or select the **Edit** command from the context menu. This opens the dialog **Table Column** dialog enabling to enter the column headings and to define the column contents.



Description

The text entered in cell „Description“ will be displayed on the status bar of the Result Table when the cursor is placed into the respective table column.

Example:



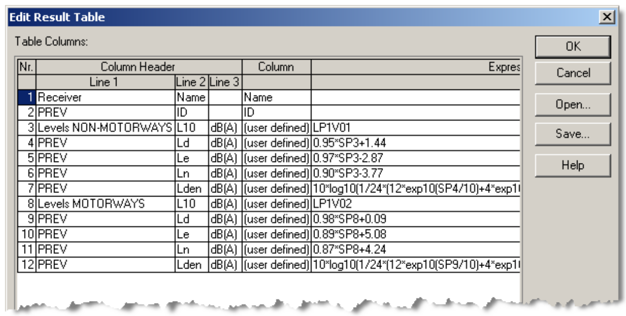
Receiver		Storey	Limiting Value		rel. Axis		
Name	ID		Day	Night	Station	Distance	Height
			dB(A)	dB(A)	m	m	m
Münchener Str 34	H_23752	EG	59	49	66	26.86	2.50
Münchener Str 34	H_23752	1.OG	59	49	66	26.86	5.30
Münchener Str 34	H_23752	2.OG	59	49	66	26.86	8.10
Münchener Str 34	H_23752	3.OG	59	49	66	26.86	10.90

displayed on status bar

For column „Storey“ the text „displayed on status bar“ has been entered in input box „Description“

Conversion to EU-indices at individual receivers with CRTN

In order to convert results at individual receiver points to the EU-indices L_{den} and L_{night} the **Result Table** of **CadnaA** can be used. As with grid calculations (see chapter 5.3.4 "Grid Arithmetic", section "Grid calculations for EU-noise indices with CRTN"), motorways have to be distinguished from non-motorways. Using two variants with variant for the motorways, and variant 2 for the non-motorways the layout of the **Result Table** is as displayed below.



The **Result Table** calculates parameters Ld, Le, Ln, and Lden for either road types depending on the variant selected. In this example:

Variant 1 (motorways):

Receiver		Levels MOTORWAYS					Levels NON-MOTORWAYS				
Name	ID	L10	Ld	Le	Ln	Lden	L10	Ld	Le	Ln	Lden
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
RCVR 1	mot_rcvr1	80.2	78.7	76.5	74.0	81.6	-	-	-	-	-

Variant 2 (non-motorways):

Receiver		Levels MOTORWAYS					Levels NON-MOTORWAYS				
Name	ID	L10	Ld	Le	Ln	Lden	L10	Ld	Le	Ln	Lden
		dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
RCVR 1	nmot_rcvr1	-	-	-	-	-	74.7	72.4	69.6	63.5	73.2

\Examples\11_Tables

The definition file of the **Result Table** layout is provided on CD (filename `Lden table var1_mot var2_nonmot.cnt`).

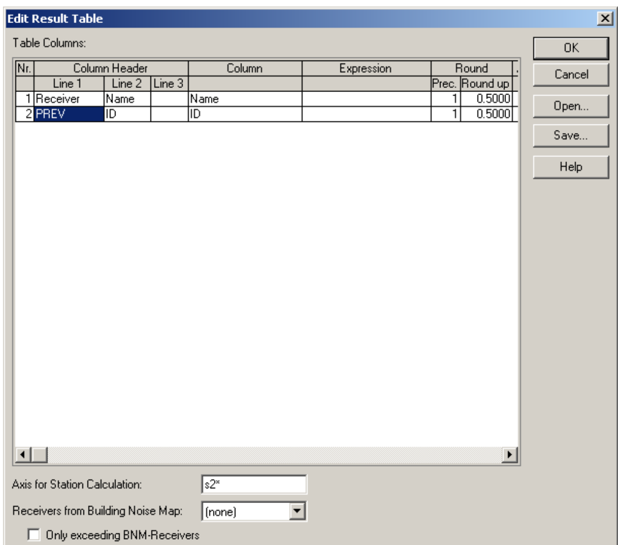
11.2.2 Column Headings

Tables|Result Table|Edit

Up to three column headings at each column of the Result Table can be defined. In case a column heading shall be combined across neighboring columns this can be achieved by the expression PREV.

Example

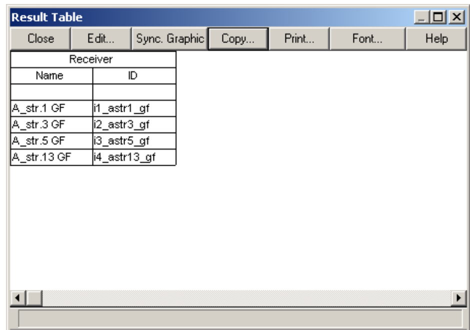
To identify receiver points two columns in the Result Table are defined (via the context menu). The first column shall display the receiver's designation with the heading "Name". The second column shall display the ID with the heading "ID". For both columns, however, the superior heading "Receiver" shall be displayed.



On the dialog **Table Column** insert in „Line 1" of for the first row "Receiver", and in „Line 2" the text "Name". Select from the list box „Column" the item „Name". This first row of the definition table will become the first column of the Result Table.

Click in „Line 1" of the second row and enter PREV and in „Line 2" the text "ID". Select from the list box „Column" the item „ID". This second row of the definition table will become the second column of the Result Table.

Result:



Proceed in the same way for all further columns of the Result Table.

Description

Description is for internal information and only shown on the screen in the dialog **Result Table** in the status bar on the lower left-hand side if the cursor is positioned in the corresponding column.

Field Column

see chapter 11.2.3 "Column Contents"

Precision

Enter the number of digits after the decimal sign. By value 1 levels are shown, e.g. 49,5 dB and by 2, e.g. 49,51 dB.

Rounding up by the last digit

Enter the value by which the last digit shall be rounded up.

If you enter, e.g., 0.1, the value 49.1 will be rounded up to 50.0, the value 49.11 will be rounded up to 49.20.

Alignment

The alignment of the text within the frame or the table column can be selected by clicking the respective option. The preview thumbnail will show the selected alignment.

Display (the content of the columns)

see chapter 11.2.4 "Display Column Content"

11.2.3 Column Contents

You define the column content in the list box **Column**. You may do so by choosing the desired value from the list box with pre-defined variables or by editing an expression. In the last case you have to choose (**user defined**) from the list box. With that, the box expression will be activated and you may enter your own expression consisting of strings and operators.

Selecting **(user defined)** the following strings can be used::

(user defined)

Expression	Information
LP1 to LP4	at the receiver point calculated evaluation parameter 1 to 4 LP1 to LP4 refer to the current variant
LP1V<n> to LP4V<n>	at the receiver point calculated evaluation parameter 1 to 4 for variant no <n> refers to the variant corresponding to the number (LP1V03 means the level of the variant 03 for the evaluation parameter 1)
LP1_<n> to LP4_<n>	Just as above with regard to a corresponding band of a spectrum with the number after the underscore **example:**

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LP1V03_02	The calculated frequency level at 125 Hz of the evaluation parameter 1 for the variant 03 at the receiver point. The numbering of the frequency starts at 00 for 31.5 Hz and is continuously counted for each duplication of Hz-frequency: 00 = 31.3 / 01 = 63 / 02 = 125 / 03 = 250 / 04 = 500 etc. (see result table template Imm_Spek.cnt on your CD as example)
GW1 to GW4	Maximum Value: defined for evaluation parameter 1 to 4 (could be the maximum value of land use or the standard level at the receiver point depending on which parameter is used)
SP<n>	Column of the result table <n> consecutive number of the column, e.g., SP4 (is the 4. column). To count the column number use either the dialog **Edit Result Column** or the dialog **Table column** and not the **Result table** itself because the invisible columns are counted as well.
SIGMAD, SIGMAE, SIGMAN	The resulting uncertainty sigma dB (see chapter 6.2.2) of calculated sound pressure levels can be displayed for the receiver points for Day/Evening/Night.

Examples for Expressions and Formulas

LP1V01-GW1

This expression subtracts from the calculated evaluation parameter 1 of the variant01 the maximum value. The result is displayed in the column.

You can also enter complex Boolean Formulas, like, e.g.,

(SP15>GW1)*(SP19>0.05)*((SP19>2.05)+(SP15>69.05))

With this formula you can define conditions, which - if they are fulfilled - indicate, e.g., a right to noise protection measures in the result table. If the result is 0, the condition is not fulfilled, if the result is >0, the condition is fulfilled (Yes=1; No=0)

For the condition to be true in the given example, the first two brackets must fulfill the condition, but only one of the last two brackets must fulfill the condition.

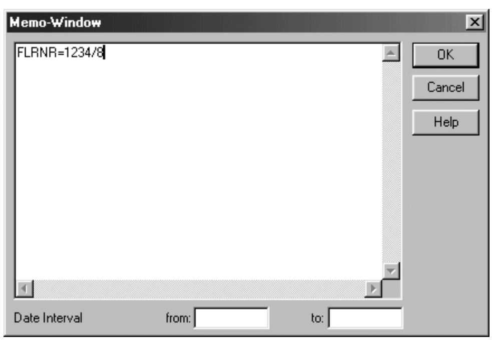
String Variable

You may display information from the info-box in the edit dialog of the receiver point. Enter the same string in the expression-box as you did in the info-box. But first you must choose **String variable** from the column list-box.

In the Memo-box of the receiver point you may write an arbitrary string followed by an equals sign. All information written after the equals sign is reported in the result table.

Example:

The Info-box of the receiver point contains the string: FLRNR=1234/8



In the dialog of the **Result Table** choose (**String variable**) from the list box and enter FLRNR in the expression/variable box.

1234/8 will be displayed as the result.

Default-String variable

Default String variable only for the Result Table - capital letters are mandatory:

STW	Displays the floors of the **Building Noise Map**
FASSNR	Facade numbering - in the Building Noise Map the level icons are internally numbered continuously, starting with the first polygon point of the building's side according to the direction in which the building was inserted. These so-called facade numbers can also be displayed in the Result Table. **Example**: Because of the facade partitioning (menu **Options|Building Noise Map**) 12 level icons for all building facades come out side by side. Therefore, the icons are numbered internally with the facade numbers 1, 2, 3 etc. up to 12. If each level icon has 5 floors, then it will be these floors which are assigned to the corresponding facade number.
DIR	Degree No. 0-360 with 0 symbolized North direction
HIRI	Direction with one letter (N-North, O-East, S-South, W-West)
HIRI2	Direction with two letters if necessary (e.g. NW-North-West, SO-South-East)

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Remark

The tables in this chapter are also listed in the **CadnaA**-manual „Attributes, Variables, and Keywords“, chapter 3.2 Result Table).

11.2.4 Display Column Content

Options

After you have defined the column content you may also affect the display of the results by using one of the options **Display**.

always

always without precondition - the column content is displayed as defined in any case.

never (Column is invisible)

never - column is invisible - neither the column nor the column content is visible but the value is available. You may calculate with it further on by referring to the column number in order to display the final result in another column.

You can refer to a column with `SP<n>`. If you want to refer, e.g., to the fourth column of the table then you have to write `SP4` (see chapter 11.2.3 "Column Contents").

only if

only if: The display is tied on a precondition (only if - then - else)

Example:

only if:	x>0
then:	-

The result is only visible if the value is bigger than zero, if not, a dash is shown. Instead you may also enter:

only if:	x>0
then (activate):	yes
else:	no

In this case if the value is bigger then zero the column content would be "yes" otherwise "no".

Chapter 12 - Libraries

Global and local libraries

Global libraries are available for all project files, whereas local libraries only in the actual project file. Both are accessible via the **Tables** menu.

User-defined spectra can be inserted into both libraries via the keyboard or by an import operation. The import may occur via the library manager (see chapter 12.2) provided that the data is **CadnaA** file format. Spectra with external file format can be imported to the local library via the ODBC database interface (see chapter 7.3).

Global Library

The global library contains data sets for

- spectra (see chapter 12.1)
  - sound levels (see chapter 12.1.3)
  - sound reduction indices (see chapter 12.1.4)
  - absorption coefficients (see chapter 12.1.5)
- SET-S (see chapter 13.4 "Option SET" in the manual „Introduction to **CadnaA**“)
- parking lot movements (see chapter 2.7)
- railway classes (see chapter 2.12.2)
- text blocks (see chapter 12.4)

Local Library

The local library may contain data for:

- spectra
  - sound levels
  - sound reduction indices
  - absorption coefficients
- SET-S
- SET-T
- directivities (see chapter 2.2.3)
- number of trains (see chapter 2.6.9)
- symbols (see chapter 12.3)
- text blocks

User-defined Entry for global Library in CADNA.DAT

The user-defined spectra in the global libraries are saved in the file CADNA.DAT in the **CadnaA** installation directory. This file will not be overwritten by an update. You should copy/save this file regularly to prevent data loss.

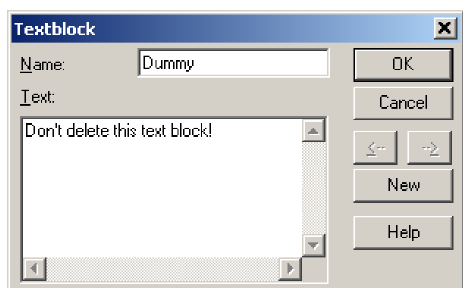
Global Library on a Server

In order to define a destination directory for the CADNA.DAT different from the program directory enter the following in the CADNAA.INI in the paragraph [MAIN]:

```
LibFile=DRV:\Path\Cadna.dat
```

For DRV enter your drive and path of the folder where the CADNA.DAT is saved. This offers the possibility to store your data in the global library onto a server where all your colleagues have access to.

☝ **CadnaA** reads only the INI-file if at least one global Text Block exists (**Tables|Library (global)**, see chapter 12.4). If you actual don't use Text Blocks create a „Dummy“ text block on your computer and afterwards copy this Cadna.dat file to your server.



12.1 Spectra

The **Sound Level Spectra** table already lists a number of spectra. These are the typical indoor level spectra for commercial enterprises as listed in the Guideline VDI 2571 /32/.

This chapter deals with the spectra. We assume that you are already familiar with the edit dialog of the objects for point, line and area sources (horizontal and vertical). Otherwise, please see chapter 2.1 and subsequent chapters.

The **Sound Level Spectra** library stores sound pressure levels and sound power levels independent of their weighting. You can supplement this library according to your needs.

☝ Spectra are made with reference to their **ID**.

If you require a spectrum from the global library for a project file, it will be copied to the local library by either:

- copying all required spectra in advance by pressing the **Local Library** button,

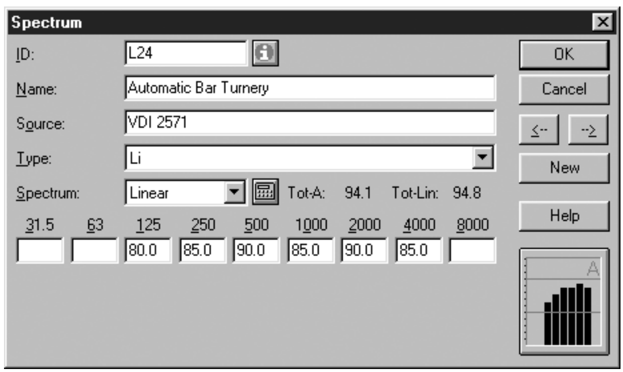
or

- copying the required spectra while working on the project. By making reference to a spectrum via the edit dialog of an object, it will be automatically copied to the local library.

☝ From the edit dialog, you access the global library by clicking the card index icon of the **PWL** box with the SHIFT key held down.

12.1.1 Editing Frequency Spectra

The procedure laid out below applies to both global and local libraries. We assume that you are familiar with the editing of tables and the inserting of new rows (see chapter 11.1.3 Editing Table Cells). Spectra, too, may be entered either directly in the table, or via the spectrum edit dialog (opened by double-clicking the table row).



Name

Under **Name**, enter some explanatory information on the spectrum. The entry may be as long as you wish, but it is convenient to limit it to the column width.

Spectrum ID

The **ID** serves to make reference to a spectrum in the edit dialog of an object..

- It may be up to 15 characters long,
- **must** start with a letter,
- **must not** contain blanks,
- **must not** contain operators (+;-;/;* etc.) - (see **CadnaA**-manual "Attributes & Abbreviations", *Operators and Functions*), and
- **no** special characters (see **CadnaA**-manual "Attributes & Abbrevia-

tions", *Strings and Operators*).

We suggest the following:

Use the first letter to denote the type of sound level, for example

- L = sound pressure
- P = sound power
- R = sound reduction
- A = absorption

Append a serial number, for example L001, L002, P001, P002. In this context please read chapter 11.1.5 Change Column Content.

Source

Enter information on the origin of the spectrum here.

Spectrum and Weighting

A spectrum may A-, B-, C-, D-, or Lin-weighted. The spectrum list box serves to assign a weighting to a spectrum by entering the appropriate letter, or by selection from the list.

☝ Select the weighting **before** you enter the spectrum.

The **Weighting** column of the table lists the corresponding letter codes. A blank entry means the spectrum is Lin-weighted.

Follow the explanations and examples below to get a better understanding.

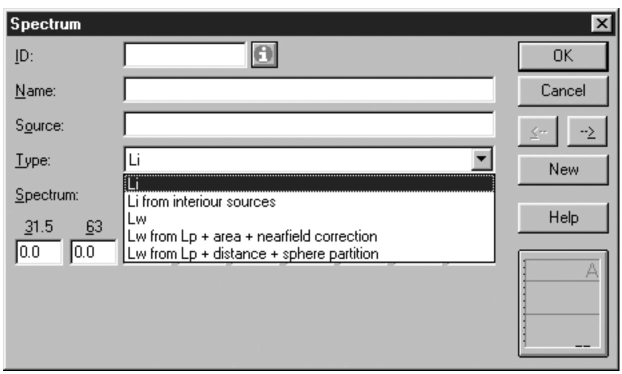
12.1.2 Frequency spectra for sound power & indoor levels

In order to understand the following, we presuppose that your are familiar with dealing with frequency spectra, their generation, storage and transfer, as well as the use of the global and local libraries.

It is also possible to calculate the frequency spectra of the sound power level, e.g., from measured sound level spectra.

These features are reached when generating a new spectrum in the local or in the global library.

Example: Insert a new line in the local library and open the dialog by double-clicking this line.



Spectrum Type

With the expressions available in the list box **Type** you have five possible choices to determine a frequency of a spectrum.

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Li

Li indicates that the entered, or in some other way generated, spectrum is an indoor sound pressure level - e.g. for the calculation of the radiation from a building . This can be useful for documentation.

Li from interior sources

With this option the level of an indoor sound spectrum can be calculated from the level of a spectrum of sound power from sound sources like machines etc.

In principle this calculation requires a statistical theory. For each frequency band the following formula applies:

$$L_i = L_W - 10 \times \lg(A) + 6 \tag{1}$$

For

L_i Indoor level in a room with the frequency band in dB

L_W Sound power level of all sources with the frequency band i in dB

A equivalent absorption area with the frequency band in m²

The equivalent absorption area is calculated with the following formula:

$$A = \alpha \times S \tag{2}$$

with

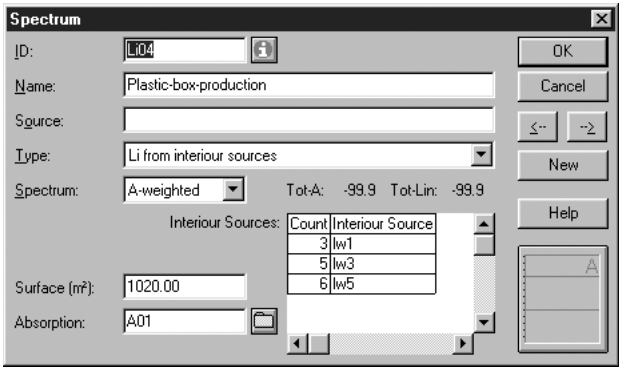
α the average absorption coefficient of the room's surface areas

S the area in m² of the room's surface

Practical procedure

The spectra of the sound power level of the single sources in a room have to be saved so that they can be referenced with their identifier (ID).

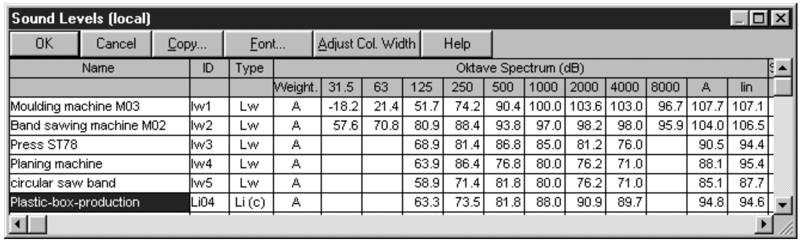
After selection of the option **Li from interior sources** from the list **Type** new lines can be inserted in the list of **Interior Sources** in the usual way.



After double-clicking on the inserted new line, single spectra can be referenced by typing their ID or you can choose the desired spectrum directly from the library by clicking the index card symbol.

In the box **Absorption** displayed in the dialog **Spectrum** you can either enter a single value of the average characteristic coefficient of absorption or the ID-Code of a coefficient-spectrum of absorption from the local library. By clicking the index card symbol the spectrum can be chosen directly from the local or - with SHIFT key - global library.

When the surface of the room in m² is specified, the resulting indoor level of a spectrum is displayed as well in the monitor as in the corresponding line in the table after closing the dialog with **OK** (plastic-box-production in the following figure).



Name	ID	Type	Oktave Spectrum (dB)											
			Weight.	31.5	63	125	250	500	1000	2000	4000	8000	A	lin
Moulding machine M03	lw1	Lw	A	-18.2	21.4	51.7	74.2	90.4	100.0	103.6	103.0	96.7	107.7	107.1
Band sawing machine M02	lw2	Lw	A	57.6	70.8	80.9	88.4	93.8	97.0	98.2	98.0	95.9	104.0	106.5
Press ST78	lw3	Lw	A			68.9	81.4	86.8	85.0	81.2	76.0		90.5	94.4
Planing machine	lw4	Lw	A			63.9	86.4	76.8	80.0	76.2	71.0		88.1	95.4
circular saw band	lw5	Lw	A			58.9	71.4	81.8	80.0	76.2	71.0		85.1	87.7
Plastic-box-production	Li04	Li (c)	A			63.3	73.5	81.8	88.0	90.9	89.7		94.8	94.6

The spectrum of an interior level `Li04` for the „Plastic-box-production“ is therefore the result if 3 moulding machines, 5 presses and 6 circular saw bands are running in a room with a surface area of 1020 m² and an average spectrum of absorption, spectrum `Am` from the local library.

The additional parameter (c) with the type-name Li(c) shows that this spectrum has been calculated from other spectra. Its values cannot be changed by editing.

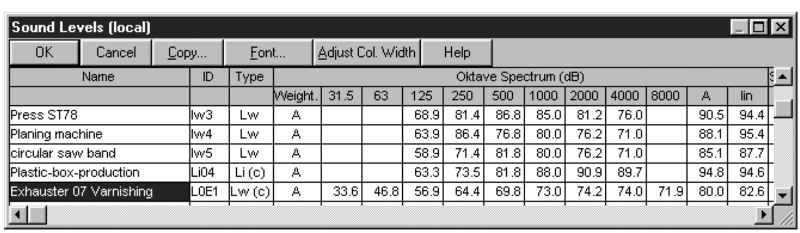
Lw

Lw indicates that the entered, or in some other way generated, spectrum is a sound-power-level - e.g., to define the radiation of an outdoor source. This can be useful for documentation.

Lw calculated from Lp + area + near-field-correction

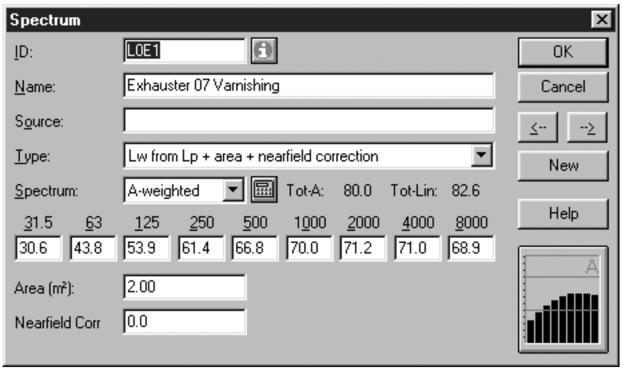
With this option the determination of the sound power level from the radiation from openings is supported. The averaged sound pressure level spectrum is determined by measurement in the opening cross-section.

An example is the spectrum `LOE1` in the following figure:



Name	ID	Type	Oktave Spectrum (dB)											
			Weight.	31.5	63	125	250	500	1000	2000	4000	8000	A	lin
Press ST78	lw3	Lw	A			68.9	81.4	86.8	85.0	81.2	76.0		90.5	94.4
Planing machine	lw4	Lw	A			63.9	86.4	76.8	80.0	76.2	71.0		88.1	95.4
circular saw band	lw5	Lw	A			58.9	71.4	81.8	80.0	76.2	71.0		85.1	87.7
Plastic-box-production	Li04	Li (c)	A			63.3	73.5	81.8	88.0	90.9	89.7		94.8	94.6
Exhauster 07 Varnishing	LOE1	Lw (c)	A	33.6	46.8	56.9	64.4	69.8	73.0	74.2	74.0	71.9	80.0	82.6

This spectrum shall be determined in a 2 m² large cross-section of an outlet of an exhauster. After double-clicking this line the corresponding edit dialog opens. In the list box „Type“ the option „Lw calculated from Lp + area + nearfield-correction“ is selected.



In addition to the size of the exit area a short distance-correction can be entered which will then be added arithmetically to the frequency-band level. With this correction it can be taken into account that the rays don't cross the exit area vertically - only in this case, apply the following conversion formula

$$L_W = L_p + 10 \times \lg(S) \qquad (3)$$

with

S exit area in m^2

(Hint: If sound penetrates the area S from all directions, a correction of -3 dB may be useful. This is the case, e.g., if sound radiated from machines in a room penetrates the environment through an open door. In the exit-cross-section of an absorbent duct there are no cross-modes and the near-field correction is 0. In a duct without any absorption a value between 0 and -3 may be correct depending on the propagation conditions between source and exit along with the diameter of the opening).

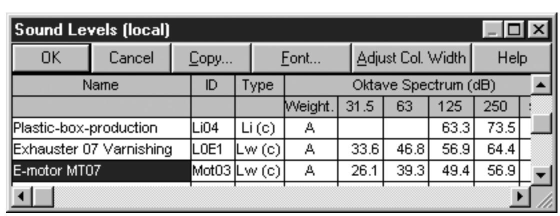
After closing the dialog the calculated spectrum is inserted in the library and its **Type** expression is supplemented with a (c) indicating that this spectrum has been calculated. Its values cannot be edited.

Lw calculated from Lp + distance + sphere partition

The sound power level of a source can be measured with the enveloping surface method in accordance with one of the standards ISO 3744 /6/ or 3746 /10/. In many cases it is appropriate to measure the sound emission of a source at a distance that is large in comparison to source dimensions and to use only one or a few measuring points if the source radiation is unidirectional. If the radiation has a direction, the measurements are undertaken at more points oriented in different directions and a mean spectrum is calculated in the first step by energetic averaging. If the source doesn't radiate in all directions, but only into a portion n% of the sphere, then the sound power level Lw is calculated from the measured level Lp with

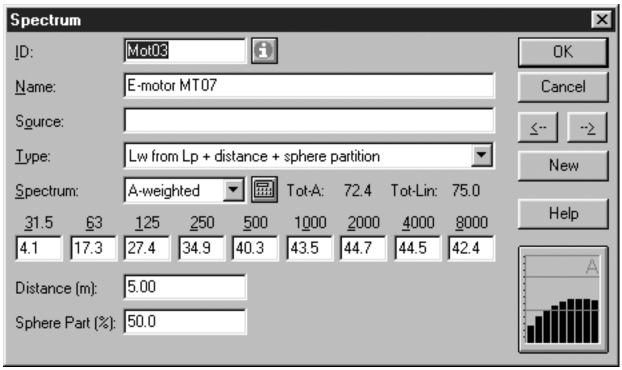
$$L_W = L_p + 10 \times \lg\left(4\pi r^2\right) + 10 \times \lg\left(\frac{n\%}{100\%}\right) \tag{4}$$

It is presupposed that the data record `Mot03` in the local database corresponds with, e.g., the spectrum of sound levels of an operating electric motor standing on a reflecting floor at a distance of 5 m.



Name	ID	Type	Oktave Spectrum (dB)				
			Weight.	31.5	63	125	250
Plastic-box-production	Li04	Li (c)	A			63.3	73.5
Exhauster 07 Varnishing	L0E1	Lw (c)	A	33.6	46.8	56.9	64.4
E-motor MT07	Mot03	Lw (c)	A	26.1	39.3	49.4	56.9

After double-clicking this line you will see the settings made in the edit dialog. You have to enter the **Distance** as 5 m and because of the hemispherical sound propagation a **Sphere Part** with 50 %.



After closing this dialog with **OK** the calculated spectrum is inserted in the library and its expression in the box **Type** is supplemented with (c) indicating that this spectrum is being calculated. Its values cannot be edited.

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12.1.3 Sound Level Spectra

Level Frequency Spectra

A level-over-frequency spectrum is a sequence of values, with each value signifying a level in a specific octave band. Entering zero as a value, not entering anything, or a blank, are interpreted in different ways. 0 means that the level is 0 dB. A blank, or no entry, mean that this frequency band has no valid entry.

If spectra are available, the calculation, evaluation, and representation of the rating level at the immission point will be based on the spectral information. If, however, there is no value in a frequency band of the spectrum for a source being taken into account in the calculation, no rating level will be displayed for this band.

Weighting

A frequency spectrum of levels requires to state the applied weighting – Linear, A-, B-, C-, or D-weighting. The relevant standards always require linear spectra. In practical noise control, however, using the A-weighted levels has proven convenient because it allows to determine the relative contribution of each frequency band to the overall A-weighted sound level. This facilitates a quick selection of those frequency ranges which need to be considered when designing noise-control measures. There is, however, a risk that spectra having different weightings are mixed in a wrong way.

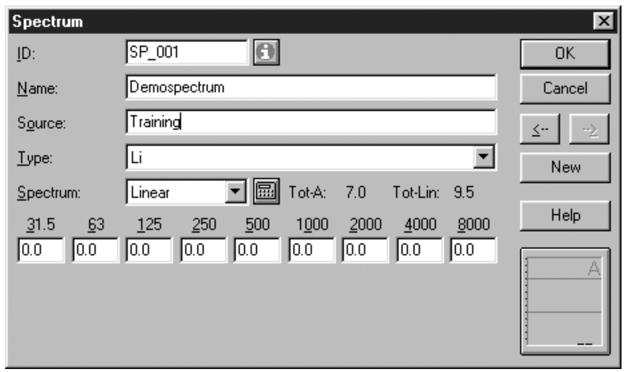
CadnaA makes use of a concept which avoids this risk while still allowing a quick visual evaluation by means of weighted frequency spectra.

- Spectra may be entered with any of the Lin-, A-, B-, C-, or D-weightings, the user being responsible for supplying correct information on the weighting. (Only this information allows for the correct calculation of the unweighted spectrum.)
- If you mistakenly entered the wrong weighting, you may modify this at any time by assigning a different weighting.
- Any of the weightings mentioned above can be selected for output on the screen, or on the printer, either globally for all spectra of one table,

or individually for each one of them.

An example of how to enter a spectrum is given below.

- Open the appropriate, currently blank, table of the local library via **Tables|Libraries [local]|Sound Level**.
- Insert a row, and open the edit dialog (by double-clicking the inserted row).



This standard spectrum with a level of 0 dB in each frequency band is valid for the entire frequency range from 31.5 Hz to 8,000 Hz. Nine valid frequency bands with a level of 0 dB each result in a total Lin-weighted level, indicated as **Total Lin:** of

(0 + 10 x lg(9)) dB = 9.5 dB

The A-weighted level is 7.0 dB(A).

- Change the weighting from Linear to, e.g. A by either
  - entering *A* in the **Spectrum** box, or
  - by selecting a weighting from the list which drops down when you click the arrow to the right of the **Spectrum** box.

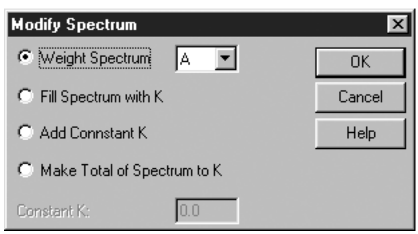
You will then see the weighted spectral levels.

- Repeat this with different weightings, and watch the total weighted level displayed on the dialog in each case.

Switching to another weighting in the edit dialog **Spectrum** does not change the underlying frequency spectrum.
Therefore, at first, switch to the appropriate weighting before you enter a frequency spectrum.

But even if you selected the wrong weighting and confirmed the values you entered, you do not need to delete them in order to just enter them again. The second important dialog, **Modify Spectrum**, is one tool to help you here.

- First, switch back to **Linear** on the edit dialog **Spectrum** which results in 0 being again displayed for each frequency band.
- Click the calculator icon to the right of the **Spectrum** box.

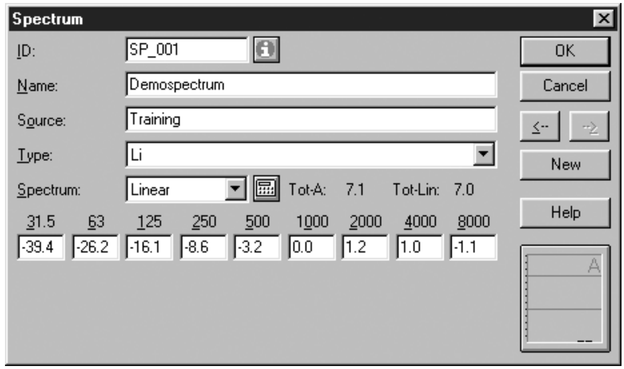


In the default setting, **Apply Weighting** is activated, with the **A**-weighting being selected.

If you click **OK** now, the A-weighting will be applied to the values, but the **Linear** weighting will still be assigned to the spectrum in the edit dialog.

Selecting a specific weighting in the **Modify Spectrum** dialog means converting and thus manipulating the values. This implies an actual modification of the spectrum saved in the library.

The edit dialog should now look similar to the following illustration:

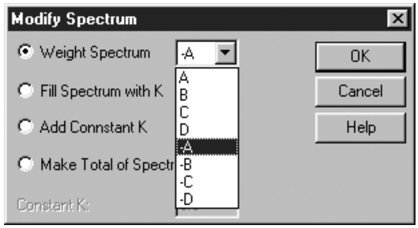


Now the A-weighting corrections are displayed as levels. Your procedure tells the program to interpret and process this spectrum as Lin-weighted. Again, switching to other weightings on the edit dialog will not affect the spectrum saved in the library.

This is very convenient if you have entered the correct values but the wrong weighting. Suppose you enter the above sequence of values directly as a Lin-weighted spectrum. Afterwards, you find out that during the measurement of these values, the instrument had been set to measure A-weighted levels.

Since you have selected **Lin**-weighting, you wish to generate linear levels from the measured A-weighted levels, thus applying a kind of an inverse A-weighting. Therefore,

- click the calculator icon, then the arrow, and select **-A** from the list which opens.



By clicking **OK**, the original spectrum is restored to the edit dialog.

Switch weighting without changing the values

Instead of selecting a different weighting via the dialog **Modify Spectrum** and in order to leave the values unchanged, you may also switch to a different weighting directly on the **Spectrum** dialog. When doing so, hold the SHIFT key down.

Use an exclamation mark going in front of the weighting descriptor to switch the weighting within the table **Sound Levels** without changing the shown values. Enter, for example, in the column „Weight.“ of a spectrum the expression „!A“ to switch to the A-weighting without changing the values. A linear weighting is achieved by entering just an exclamation mark. This syntax is available also on the dialog **Change Column|Replace Strings**.

Modify Spectrum

The three other options on the **Modify Spectrum** dialog similarly lead to a manipulation of the values.

- **Fill Spectrum with Constant K**
  - enters an arbitrary value K for each band.
- **Add Constant K to Bands**
  - arithmetically adds the value of K to the current value.

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- **Normalize Spectrum to Total Level K**
  - adds the same correction to each frequency band value so that the resulting total level, weighted as specified on the edit dialog, equals the value of K.

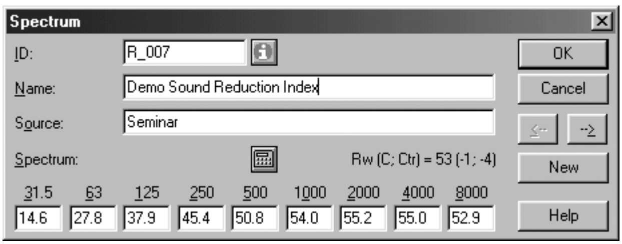
This gives you extreme flexibility in handling spectra while maintaining consistency in the data. We recommend you try out the combinations described above as well as the many other possible ones.

12.1.4 Spectra of Sound Reduction Index

The input dialog for sound reduction indices in octave bands is accessed via **Libraries [local]|Sound Reduction Indices.**

- Insert a new row and open the edit dialog.

Unlike the edit dialog for the level spectrum, this one does not assign any weighting to the values. This would not make any sense with sound reduction indices.



Instead it will be indicated the weighted sound reduction index R_w - determined from these values in accordance with ISO 717-1 /8/ - and the spectrum adaptation terms C and C_{tr} which also depend on the spectrum. All tools for the manipulation of spectra, as described above, are accessible via the calculator icon and effective here.

Applying a weighting here, however, is to be understood as a purely arithmetic operation without any relation to noise effects which are implied in sound level spectra. By activating, e.g. „Fill Spectrum with Constant K“, where K=50, and with the subsequent selection of A on the „Apply Weighting“ box, you generate an approximately realistic sound reduction index spectrum with a weighted sound reduction index of 49 dB. If you then select „Normalize Spectrum to Total Level K“, you generate a sound reduction index for the spectrum with an arbitrary weighted sound reduction index K (for example 53 dB as in the figure above).

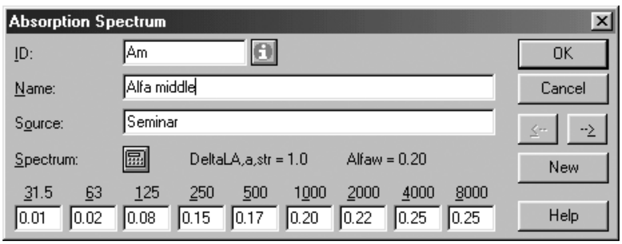
(Such manipulations are only useful for practice and for studying the effects of modifications on parameters. For other projects, you should enter values in the edit dialog which have been measured.)

12.1.5 Absorption Coefficient Spectra

The input dialog for absorption coefficients in octave bands is accessed via **Libraries [local]|Absorption Coefficients.**

- Insert a new row and open the edit dialog.

Unlike the edit dialog for the spectrum of sound level, this one does not assign any weighting to the values. This would not make any sense with absorption coefficients.



Instead, the reflection loss $\Delta L_{A,a,Str}$ - determined from these values by the method given in ZTV-Lsw 88 /105/, and the weighted absorption a_w which also depends on the spectrum - are given. All tools for the manipulation of spectra, as described above and accessible via the calculator icon, are effective here, too.

However, it does not make sense to apply a weighting here, because reasonable sound absorption coefficients lie between 0 and 1.

(Such manipulations are only useful for practise, and to study the effects of modifications to parameters. For other projects, you should enter values in the edit dialog which have been measured).

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12.1.6 Output of Spectra

Just like any other table, spectra tables can be copied to the clipboard using the **Copy** button, or CTRL+c, and they may be printed out (see **CadnaA**-manual "Attributes & Abbreviations", *Keywords*) or exported (see chapter 13.2.2) by using their keywords. Only local libraries can be printed and exported.

Keywords for Spectra Tables

#(Table,LibL)	Table of sound levels
#(Table,LibR)	Table of sound reduction indices
#(Table,LibA)	Table of absorption coefficients

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12.2 Library Manager

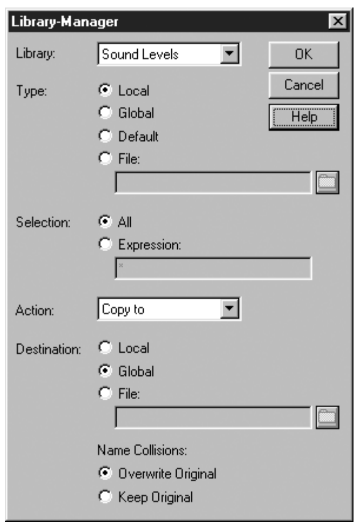
With the Library-Manager in menu **Tables|Library-Manager** all spectra in **CadnaA**-files can be copied or deleted comfortably.

You can

- copy data inside of **CadnaA** from the local to the global library and vice-versa
- save spectra in separate library files (*.dat) and
- delete all, or selected, spectra

With these features your are able to maintain your libraries.

In the list box **Library** choose the desired library and mark the corresponding option for the type of library.



The Dialog Library Manager

Library-Type

With the option **Type** you can determine which spectra or libraries you want to use. **Default** refers to the library which is installed with the program and with **File** you have access to a **CadnaA** library file (*.dat) in which the desired spectra are contained.

Select Spectra

With the option **Selection** you can either select **ALL** spectra from the corresponding library or you can select spectra which only match the expression you have entered with the expression in the ID box (see manual "Introduction to **CadnaA**") of the spectra. For that, mark the corresponding option.

Action

With the option **Action** you determine what you want to do with the selected spectra - to **Copy/Save** or **Delete** them.

Destination

With the action **Copy to** you can define which library - either **global** or **local** - you want to copy the selected spectra to. For that, mark the corresponding option. Having marked the option **File,** you can choose the path and the name of the file. The extension DAT is attached automatically.

The **Destination** is deactivated if you choose **Delete**. In this case all selected spectra are deleted.

Name Collisions

You must also define how you want to handle the original spectrum if a collision of identical names occurs. Do this by clicking the desired options.

Importing Spectra from external Databases

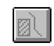
You can import spectra from external databases into the local library via the ODBC interface (**File|Database** see chapter 7.3). This is convenient, e.g., if you have measured spectra on an Excel sheet.

12.3 Symbol Library

Object Symbol

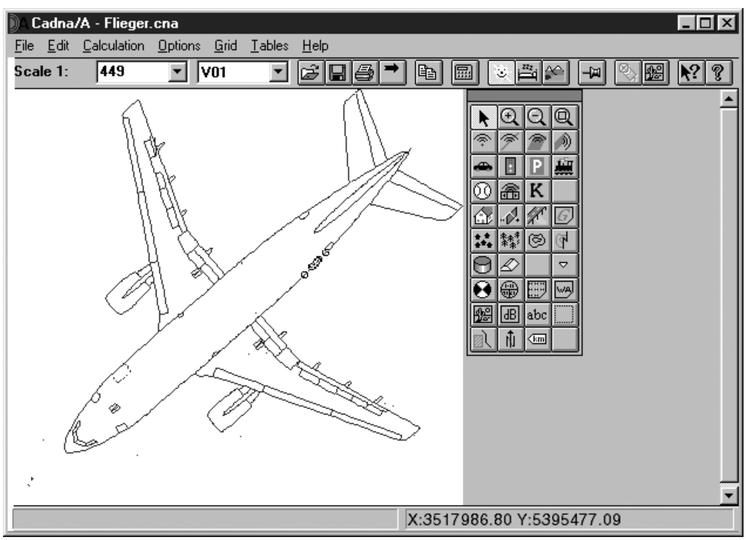
With **Tables|Libraries (local)|Symbol Library** you may import your own created symbols and use them with the tool from the toolbox. This is an advantageous procedure to get the full resolution of an image with each scale. You may also determine the color, the angle of alignment and adjustment by changing the scale factor.

Creating user-defined Symbols



Aux.Polygon

Open a new **CadnaA** file and create the desired picture by using the **auxiliary polygon** from the toolbox. Another option is to import a drawing in DXF format by using the layer of object type **Aux. Polygon** in the option dialog. For that **CadnaA** file, adjust the limits so that the picture occupies it completely (**Options|Limits|Calc**). Save this file with a pertinent name and close it.



DXF CAD graphics imported as **Aux.Polygon** in **CadnaA**. The smallest **Limits** has been calculated with **Options|Limits|Calc**. This file has been saved then as **CadnaA** file (e.g. Flieger.cna).

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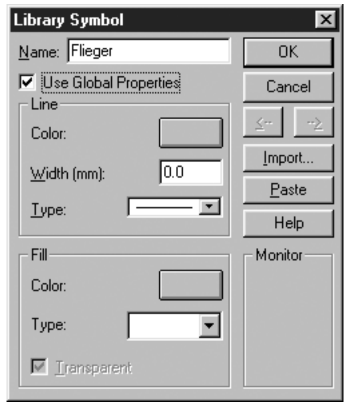
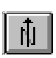
Open a new file and insert (INS key) a new line in **Tables|Libraries (local)|Symbol Library**. A double-click on the new line opens the dialog **Library Symbol**. Enter a name for the new **Symbol** in the corresponding field. This name can be again found in the list box in the dialog of the **Symbol**.



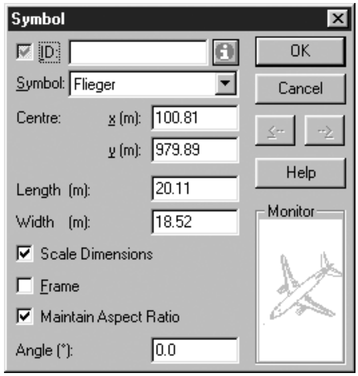
Importation

By clicking the button Import you can select the **CadnaA** file in which your image is saved. Close the dialog by confirming **OK**. Now you can place your „Flieger-Symbol“ in your file and if necessary you can enlarge, reduce or turn it.

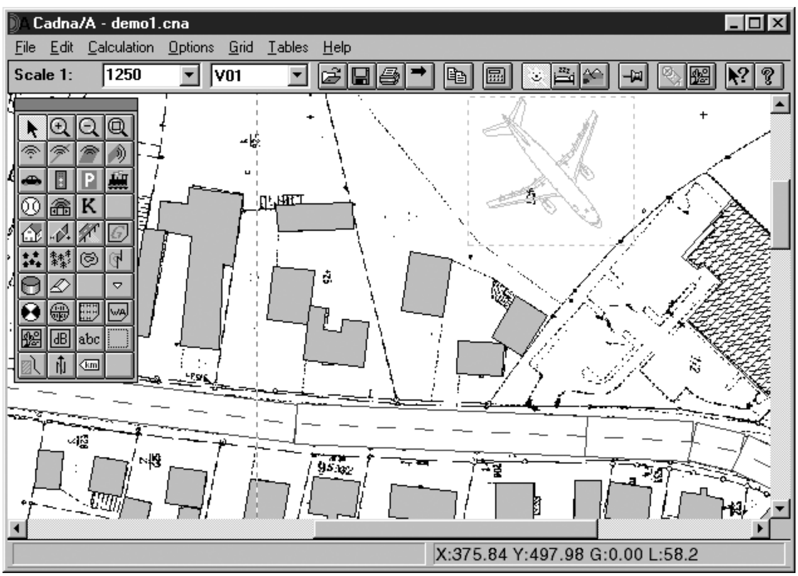


With the tool Symbol from the toolbox draw a pertinent frame in your project file where you want to place this new symbol.

In the dialog of this Symbol frame you can now choose your symbol by clicking the corresponding name - in our example „Flieger“. The image is displayed in the preview monitor.



After the input of all desired settings close the dialog by clicking **OK**. With that, the **Symbol** is placed in your project file.



The inserted Symbol rotated 90°.

Color and line width of the symbols

You have three possibilities to assign the color and line width to these user created symbols.

The first possibility is to define the appearance in the original **CadnaA** file which contains the image. Either in **File|Appearance|Aux. Polygon** as a global setting or directly in the dialog of the **Aux. Polygon**. If the option **Use Global Properties** is deactivated in the dialog of the **Aux. Polygon** with which the image is drawn then you can only change its appearance in this object dialog.

These settings are then allocated to this image and cannot be changed anymore in another project file in which this image is inserted as **Symbol** object.

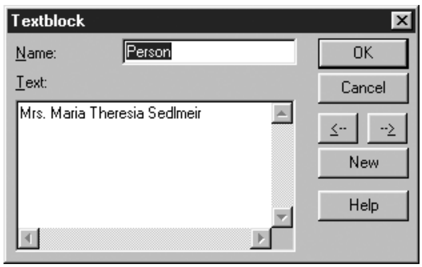
If, in the original file, the option **Use Global Properties** is activated then the image is adopted to the color and line width of the project file in which it is inserted, provided that this option has been activated in the dialog **Library Symbol**, too. Otherwise you can still adjust the settings individually in this dialog.

The Symbol library is a local library and is therefore only available in the project file you are working on. If you want to have the library always available then install a Prototype file with the corresponding settings (see chapter 14.10).

See also manual "Introduction to **CadnaA**"

12.4 Text Blocks

Use text blocks (**Table|Libraries local and global**) to save global or individual (local) text blocks which can be printed along with a report or exported from **CadnaA** by simply naming them in the template file. The key word for the template file for this purpose is #(Text,Identifier) where the identifier is the name of the text block.



Edit Dialog Textblock

This allows you to include, e.g. your company’s address, the identification of the project or your customer's address in the report without having to edit the template file over and over again.

There are local and global text blocks, and also automatically generated text blocks (see chapter 14.12.1 "Project Information"). The global text blocks are available for every **CadnaA** file, whereas the local ones are saved together with the specific project, thus being available for this project only. Local and global text blocks may share the same identifier. **CadnaA** will search through all text blocks. If two text blocks having the same identifier are found, the local one will be used.

Frequently used phrases like "If you have any questions concerning the calculation please contact #(Text, Person)" may be quoted once in a template file. The local text block with the identifier "Person" then supple-

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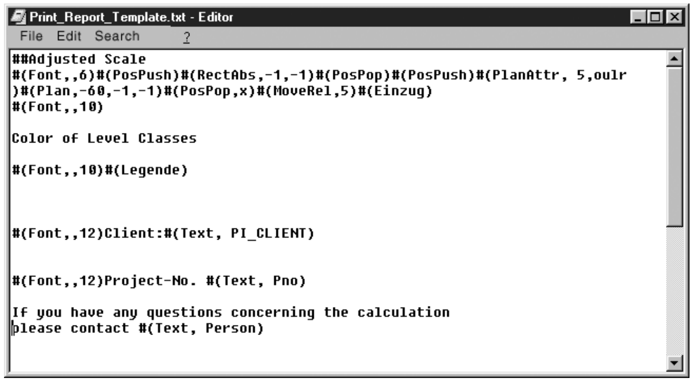
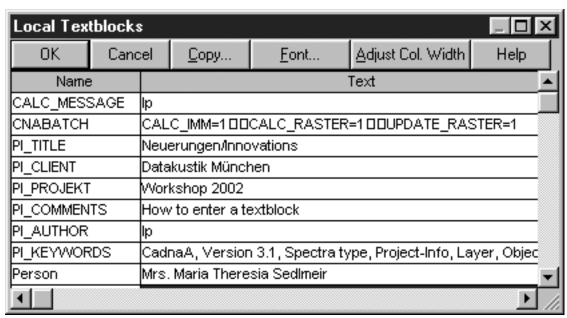
ments the above phrase by appending the text saved in the corresponding local text block.

The template file will remain valid even with a different person in charge when the specific person's name is saved in a local text block



How to enter a Text block

Select the command **Tables|Libraries local** or **global|Textblocks**. This opens the table of Text Blocks. The table will be empty when you first open this menu.



Name	Text
CALC_MESSAGE	lp
CNABATCH	CALC_IMM=1 □□CALC_RASTER=1 □□UPDATE_RASTER=1
PI_TITLE	Neuerungen/Innovations
PI_CLIENT	Datakustik München
PI_PROJEKT	Workshop 2002
PI_COMMENTS	How to enter a textblock
PI_AUTHOR	lp
PI_KEYWORDS	CadnaA, Version 3.1, Spectra type, Project-Info, Layer, Objec
Person	Mrs. Maria Theresia Sedlmeir

Table of existing text blocks. With a double-click on a data record the text block dialog opens.

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To insert a row in the table just press the INS key or hold down the right mouse button and click either **Insert Before** or **Insert After**. This results in a blank row being inserted. Double-clicking this row with the left mouse button will open its edit dialog. Enter a characteristic name for the intended text block in the text box **Name**. Then proceed to the next box using the TAB key, and enter the desired text. Clicking the New button lets you enter another text block. The arrow keys serve to switch from one text block to the next, and OK closes the edit dialog. Click OK again to close the text block's table.

If you click the button **New,** a new line is inserted for another text block. With the arrow keys you can scroll through the existing text blocks, while clicking OK closes this dialog.

You can also use a prefix with text blocks. The prefix is only written if a text is contained in the text block otherwise not. The expression

#(Text, PI_AUTHOR,,"Processor: ")
results in e.g.
Processor: Bernd Huber

The prefix *Processor:* is only written if the text block contains text, e.g. the name of the processor. If the text block is empty the prefix is not written.

Linebreak \n

If you want a carriage return between the prefix and the text you have to enter *\n* in quotation mark („\n") as last parameter with the key word.

#(Text, PI_AUTHOR,, „BearbeiterIn:" „\n")
results in a line break
Processor:
Bernd Huber

With that you can also force a text cell in the Plot-Designer (see chapter 13.1.4) not to be displayed if the textblock is empty and if the size of the text cell is set on **automatically**.

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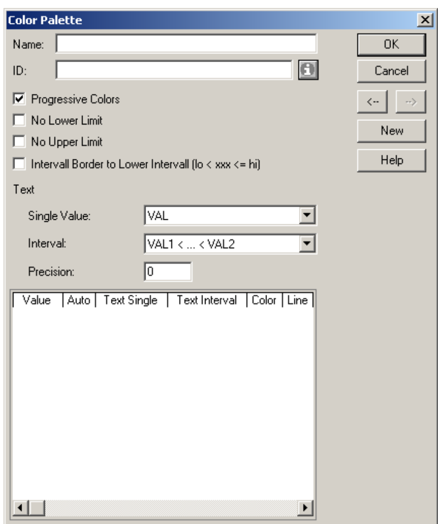
12.5 Color Palettes

Color palettes are library objects which are referred to when defining the appearance of the grid and of objects. In a color palette, single values and intervals of values are addressed to a certain color.

An independent color palette management enables to use different color palettes for the grid appearance and for the coloring of objects. Moreover, it is possible to assign individual color palettes to the four evaluation parameters and to the ground via the dialog **Grid|Appearance**.

Defining a new Color Palette

New color palettes are defined via the menu **Tables|Libraries (local/ global)|Color Palettes**. The handling of the table **Color Palette** occurs - as usually in **CadnaA** - via it's context menu. A new color palette is defined by inserting a new line. Double-clicking into the new line opens the edit dialog **Color palette**.



Dialog **Color Palette**

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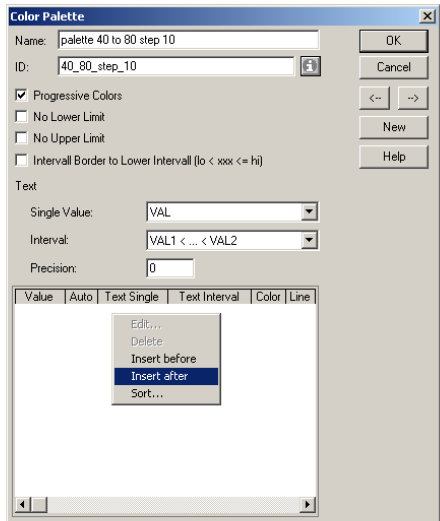
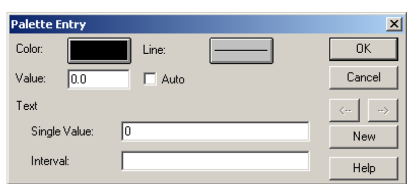
Example

In this example a color palette shall be defined using progressive colors from 40 to 80 dB with a class width of 10 dB. The predefined settings for „Single Value“, „Interval“ and „Precision“ are kept.

- Enter a suitable Name and ID-code.



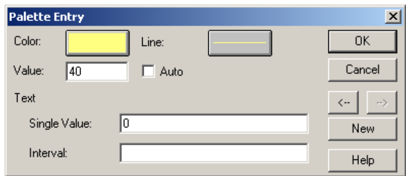
- Insert five new lines (for the level range from 40 to 80 dB, class width 10 dB) into the lower table, either via its context menu or by pressing INSERT key.
- Double click into the first row of this table.



Dialog **Palette Entry**

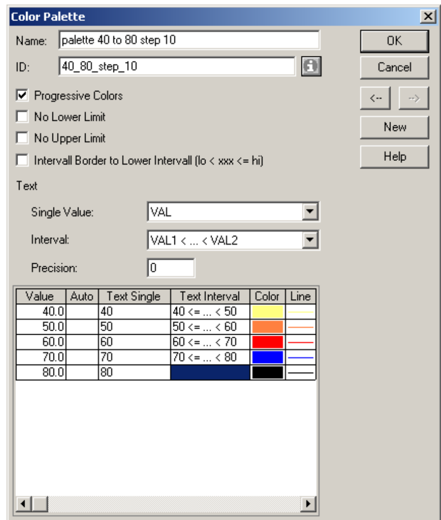
Via the dialog **Palette Entry** the color, the line type and the limiting value for each value range is defined.

- Select for the first value range a yellow color via the button „Color“. The line type (full line) is kept.
- Enter for „Value“ the lower limit of 40 for the range to be displayed.



- Move to the next column row by clicking the right-arrow button  to enter the next value range.
- Select for the second value range a orange color via the button „Color“. The line type (full line) is kept.
- Enter for „Value“ the lower limit of 50 for the range to be displayed.
- Complete the definitions of the further ranges accordingly. Use different colors or the remaining level ranges (e.g. red, blue, black).
- When having defined the value range for 80 dB close the dialog **Palette Entry**.

Subsequently, **CadnaA** displays the resulting legend texts for single values and for intervals in the dialog **Color Palette** automatically. These legend definitions will be made use of when displaying grid captions. The single values refer to lines of equal sound level and the intervals to areas of equal sound level (see section "Defining Grid Captions").



Color palette with five value ranges

- Close the dialog **Color Palette** and the table **Color Palette (local)**.

A color palette defined in this way can be selected as grid caption for an evaluation parameter (via menu **Grid|Appearance**, see chapter 5.3.3 "Grid Appearance") or a color palette when coloring objects (via menu **Options|Appearance**, see chapter 9.6 "Object Appearance").

Dialog Options

Name/ID

Name and ID-code (short name) of a palette

gives access to the dialog **Memo-Window**

Option „Progressive Colors“

When this option is active, progressive colors are used for intermediate grid values based on the defined color classes resulting in a smooth color transition. Otherwise, only the defined colors are used. Thus, the setting for „Progressive Colors" is characteristic of the color palette itself.

Options „No Lower Limit“ & „No Upper Limit“

With this option is activated level below the lower limit or above the upper limit will be displayed as well.

Example

- Activate for the color palette in the preceding example the option „No Lower Limit“.

Subsequently, the lower limit of the first range in the table is changed from „40<= ... <50“ to „<50“.

- Activate the option „No Upper Limit“ in addition.

The upper limit of the last range in the table is changed from the empty status to „80<= ...“. An empty cell means that with the option „No Upper Limit“ deactivated this color will not be used at all, but is just required to define the upper limit of the pre-last range. When the option „No Upper Limit“ is activated, however, the color of the last range is used.

Value	Auto	Text Single	Text Interval	Color	Line
40.0		40	... < 50		
50.0		50	50 <= ... < 60		
60.0		60	60 <= ... < 70		
70.0		70	70 <= ... < 80		
80.0		80	80 <= ...		

Value range (column „text interval)“ with activated options „No Lower Limit“ and „No Upper Limit“

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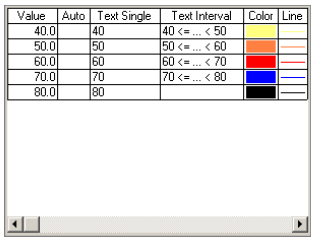
Option „Interval Border to Lower Interval“

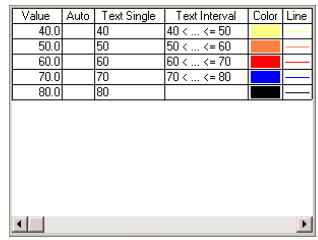
By the option „Interval Border to Lower Interval (lo < xxx <= hi)“ it is specified whether the lower or the upper range limit „val“ is included when selecting the option „VAL1 < … < VAL2“.



Value	Auto	Text Single	Text Interval	Color	Line
40.0		40	40 <= ... < 50		
50.0		50	50 <= ... < 60		
60.0		60	60 <= ... < 70		
70.0		70	70 <= ... < 80		
80.0		80			

option "Interval Border to Lower Interval“ deactivated,

interval definition includes the lower limit (lo <= xxx < hi)



Value	Auto	Text Single	Text Interval	Color	Line
40.0		40	40 < ... <= 50		
50.0		50	50 < ... <= 60		
60.0		60	60 < ... <= 70		
70.0		70	70 < ... <= 80		
80.0		80			

option "Interval Border to Lower Interval“ activated,

interval definition includes the upper limit (lo < xxx <= hi)

☝ When the option „Interval Border to Lower Interval“ is activated, the resulting representation corresponds to the level range definition used in **CadnaA** until now. This former definition always included the upper limit of a level range.

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Defining Grid Captions

In the range „Text“ of the dialog **Color Palette** the text captions for single values and intervals the value ranges are defined based on the values entered.

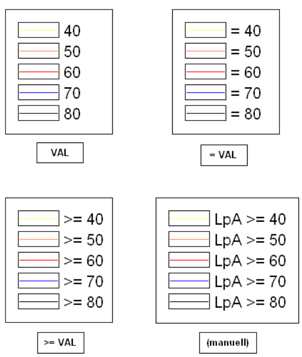
List Box „Single Value“

Select from list box which text caption shall be displayed for single values. The following options are available:

Option	**Remarks**
(manual)	The value of the variable „text value“ in the definition table can be edited manually. The text captions for each row of the table can now be edited individually.
VAL	The entered value is displayed.
= VAL	The entered value with a preceding equal sign is displayed.
> VAL	The entered value with a preceding larger-than-sign is displayed.

Example

Based on the preceding example four color palette definitions for lines of equal sound level are generated using the options as above. The result for the four resulting grid captions is displayed below.



Grid captions for single values

List Box „Intervals“

Select from list box which text caption shall be displayed for intervals. The following options are available:

Option	Remarks
(manual)	The value of the variable „text interval“ in the definition table can be edited manually. The text captions for each row of the table can now be edited individually.
VAL1 < ... < VAL2	The lower and the upper limit of each interval in conjunction with the smaller-than-sign is displayed. The settings for the options „No Lower Limit“ and „No Upper Limit“ determine whether the lower and the upper limits of the value range are included.
VAL1 ... VAL2	The lower and the upper limit of each interval in conjunction with the periods is displayed. The settings for the options „No Lower Limit“ and „No Upper Limit“ determine whether the lower and the upper limits of the value range are included.
> VAL1	The lower and the upper limit of each interval in conjunction with the larger-than-sign is displayed. The settings for the options „No Lower Limit“ and „No Upper Limit“ determine whether the lower and the upper limits of the value range are included.

Example

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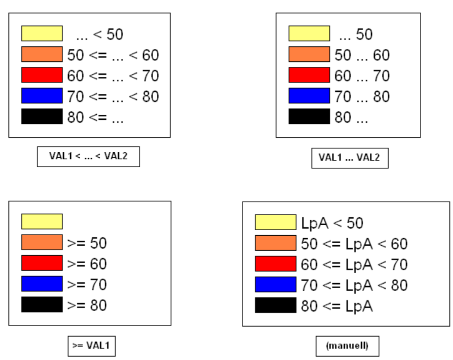
Based on the preceding example four color palette definitions for areas of equal sound level are generated using the options as above. The result for the four resulting grid captions is displayed below.



Grid captions for intervals

Sub-Table

As conventional, table columns data can be modified using the context menu command **Change Column**.

Column „val“

The lower limit of a value range is entered in table column „val“. Alternatively, after a double-click into a column cell, the value can be entered on dialog **Palette Entry**.

Column „Auto“

The auto-scaling ensures that even in cases where the resulting grid values are hard to predict (e.g. with results from ObjectScan, or concentrations for air pollutants, or results from grid arithmetics) a suitable grid caption is displayed.

With the option „Auto“ set on the definition table (or via dialog **Palette Entry**, option „Auto“) the limiting values for the grid caption are generated automatically based on the value range on the grid. The margin between the value ranges (val) depends on the number of ranges and on the maximum and minimum value of the grid. Those values will be updated when selecting this palette from the dialog **Grid Appearance**.

In the definition table the auto-scaling is activated be entering the letter „x“, and deactivated by entering a space. Via the context menu (command **Modify Column**) the setting can be changed for multiple rows at once.

Example

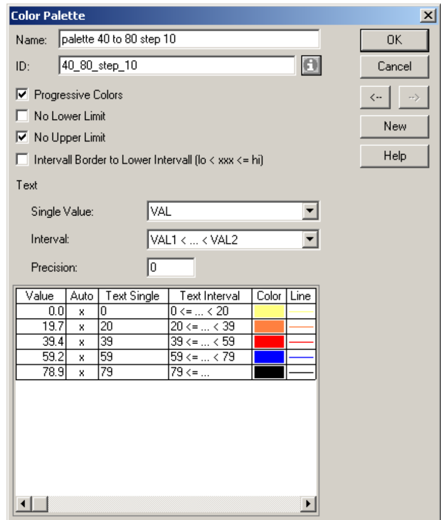
On a grid, the minimum and maximum values are:

minimum value: 39.4 dB(A)

maximum value: 129.0 dB(A)

For example, with five value ranges the margin between the range classes is:

margin = (max_value - min_value)/(number_of_ranges - 1) = 22.4 dB



Color palette using auto-scaling for all value ranges

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Columns "text single" & "text interval"

On the two columns "text single" and "text interval" the text is shown which will later be displayed when using the object „Symbol“ with the grid caption of the actual grid selected. The grid caption can either be entered manually or be generated automatically via the list boxes „single values“ and „intervals“ (as discussed in the preceding sections). Updating of the definition table occurs upon selection of a predefined option.

Precision

The number of decimals can be specified for captions generated automatically.

Importing Color Palettes

The Library-Manager offers to import color palettes from **CadnaA**-files or from DAT-files.

see chapter 12.2 "Library Manager"

12.5.1 Default Color Palettes

Various default color palettes are delivered within the global library of **CadnaA** (see menu **Tables|Libraries (global)| Color Palettes**). Those default palettes are listed and described in the subsequent tables.

Palettes without Auto-Scaling

The following palettes have activated the options „Progressive Colors“, „No Lower Limit“ and „No Upper Limit“ while to option „Auto“ is deactivated.

Name/ID	**Description**
pal_0_1_step_01	value range 0 to 1, class width 0.1
pal_0_2_step_02	value range 0 to 2, class width 0.3
pal_0_5_step_05	value range 0 to 5, class width 0.5
pal_0_10_step_1	value range 0 to 10, class width 1
pal_0_20_step_2	value range 0 to 20, class width 2
pal_0_50_step_5	value range 0 to 50, class width 5
pal_35_85_step_5	value range 35 to 85, class width 5
pal_20_220_step_20	value range 20 to 220, class width 20
pal_100_5000_step_500	value range 100 to 5000, class width 500
pal_0_1000_step_100	value range 0 to 1000, class width 100
pal_0_10000_step_1000	value range 0 to 10000, class width 1000
pal_0_40000_step_4000	value range 0 to 40000, class width 4000

standardized Palette Definitions

The following palettes are from standards, guidelines or legal documents.

Name/ID	**Description**
DIN_18005_2	see /26/
END_Austria_45_75	see Annex 3 of /107/

Palettes with Auto-Scaling

For the following palettes the option „Auto“ (Auto Scaling) is activated.

Name/ID	**Description**
pal_5_ranges_AUTO	auto-palette with 5 value ranges
pal_10_ranges_AUTO	auto-palette with 10 value ranges

Chapter 13 - Export

In this chapter the **CadnaA**-features to export reports and graphics are described (see chapter 13.1), and the export formats available to export object data and object geometry (see chapter 13.2).

13.1 Creating Reports and Graphics

CadnaA offers to export all calculation results and intermediate results, as well as object descriptions in ASCII or RTF format, and to export graphics in the DXF format, or to print using standardized printing commands.

Examples are:

- Calculation results and object descriptions in formatted tables via **File|Print Report,** either standard or user-defined (see chapter 13.1.2)
- intermediate results of receiver point calculations via **Calculation|Protocol|Print** (see chapter 6.4)
- graphic representations via **File|Print Graphics**, either standard or user-defined (see chapter 13.1.3) and
- the export of tables and diagrams via the Windows clipboard (see manual "Introduction to **CadnaA**")

User-defined output can be realized in **CadnaA** by using template files (see chapter 13.1.1) for exporting and printing.

With the corresponding print drivers - like, e.g., PDF-Writer by ADOBE - you can also save your files for archive purposes or transfer these PDF files to your customers via E-mail.

13.1.1 Template Files

Template files contain commands controlling the printing or exporting of calculation results or diagrams.

Key words (see **CadnaA**-manual „Attributes, Variables & Keywords“, chapter 4.2 Keywords) are essential components of the commands. Write these commands and any individual text into a file using either a text editor or a word processor, and save this file in TXT (ASCII) format or RTF (Rich Text Format). Then select these as template files for user-defined output.

If you want, e.g., to print out the current receiver point table in a user-defined report then you would enter the command `#(Table,Imm)`. The result is the current table of receiver points in your **CadnaA** file.

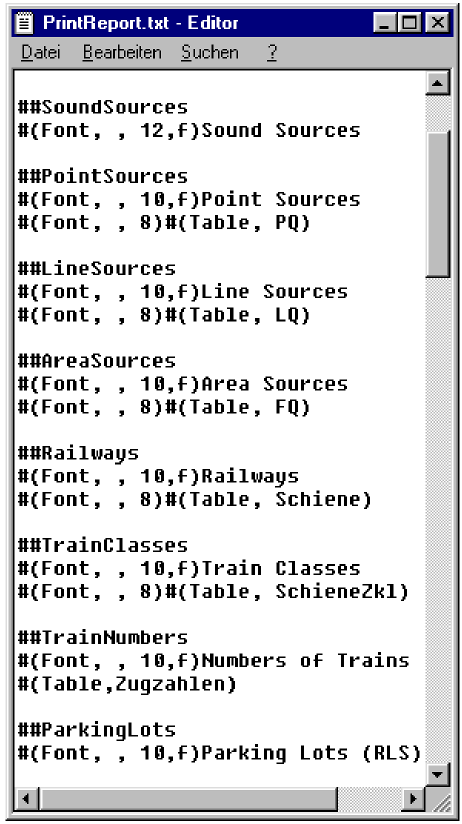
Name	M.	ID	Pegel Lr		Limit. Value		Land Use			Height		Coordinates		
			Day	Night	Day	Night	Type	Auto	Noise Type			X	Y	Z
			(dBA)	(dBA)	(dBA)	(dBA)				(m)		(m)	(m)	(m)
Astr.1 EG		i1_astr1_eg	67.0	56.5	55.0	40.0				1.80	r	66.21	21.28	1.80
Astr.3 EG		i2_astr3_eg	67.0	56.6	55.0	40.0				1.80	r	59.80	36.98	1.80
Astr.5 EG		i3_astr5_eg	66.9	56.4	55.0	40.0				1.80	r	53.06	53.70	1.80
Astr.13 EG		i4_astr13_eg	68.5	58.3	55.0	40.0				1.80	r	33.61	112.13	1.80

Key words must appear in brackets, preceded by a # before the left bracket. The parameters of a key word come next to the key word itself, enclosed in the same brackets and separated by commas.

Another example of a command in a printing template file:

```
#(Font, Times Roman, 14, f)Cadna/A
```

has the effect that the word **CadnaA** will be printed using the Times Roman font, 14 pt size, and bold faced.


PrintReport.txt - Editor

Datei Bearbeiten Suchen ?

```
##SoundSources
#(Font, , 12,f)Sound Sources

##PointSources
#(Font, , 10,f)Point Sources
#(Font, , 8)#(Table, PQ)

##LineSources
#(Font, , 10,f)Line Sources
#(Font, , 8)#(Table, LQ)

##AreaSources
#(Font, , 10,f)Area Sources
#(Font, , 8)#(Table, FQ)

##Railways
#(Font, , 10,f)Railways
#(Font, , 8)#(Table, Schiene)

##TrainClasses
#(Font, , 10,f)Train Classes
#(Font, , 8)#(Table, SchieneZkl)

##TrainNumbers
#(Font, , 10,f)Numbers of Trains
#(Table,Zugzahlen)

##ParkingLots
#(Font, , 10,f)Parking Lots (RLS)
```

Example of a printing template file for printing a report directly from CadnaA

If no parameters are entered, the default value is used. If, in the above example, Times Roman had not been entered, thus

```
#(Font,,14,f)Cadna/A
```

the (default) Arial font would have been used for printing the text.

You may also enter an ordinary text without using a key word. This text will be printed or exported, too. This allows you to prepare standard reports or logs containing the current calculation results.

Template Files

The following types of template files are presently distributed and can be either used as they are or modified (edited):

- Print.TXT = Template file for direct printout from **CadnaA** *Print.TXT*
- Export.TXT = Template file for exporting. The output file to which the results are exported is also an ASCII file which can be imported by any program capable of processing ASCII files (including, e.g. MS-Excel). *Export.TXT*
- Export.RTF = Template file for exporting. The output file to which the results are exported is also a Rich Text Format file which can be recognized and imported by almost any word processor. Tables, e.g. will remain tables with frames when imported to the word processor (e.g. MS-Word). Characters, paragraphs, and tab stops can be formatted directly in the word processor. *Export.RTF*
- Print_Gr.TXT = Template file for printing out diagrams. This template file contains commands regarding, among other items, size and caption of the diagram, whether a frame shall be drawn, or whether co-ordinates or scale shall be printed etc. *Print_Gr.TXT*

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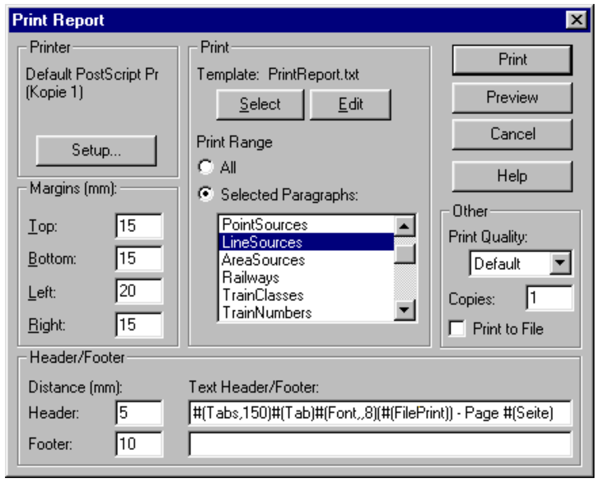
Labelling of Printing Ranges

The template files, such as Print.TXT, which controls the standard printout of reports from **CadnaA** can be structured by labelling ##printing ranges. These will appear for selection in the **Print** dialog. Printing ranges may be selected individually, which allows you to print out just one printing range.

Where a printing range starts in the template file, enter a text - preferably one word, no blanks - identifying this range. Before this text, without blanks in between, insert two ##.

General syntax	##PrintingRangeLabel
Example:	##LineSources

"LineSources" now appears as a selectable printing range in the print dialog. Anything appearing in the template file after "LineSources", but before the next printing range label, is printed. The label itself is not printed.



The label for the printing range from the template file appears in the print dialog. This gives you the chance to restrict the print out only to a certain range by marking the label. Multiple choice is possible.

13.1.2 Printing Reports

The command **Print Report** from the menu **File** opens the **Print** dialog offering options for printing out calculation results and object descriptions as formatted tables.

Selecting a Template File

The name of the template file, which **CadnaA** will use for printing the report, appears in the dialog **Template** (see chapter 13.1.1 "Template Files"). A Print.TXT file is supplied with **CadnaA**. You may edit this template file and save it with a different name.

☝ This version of PRINT.TXT will be overwritten when **CadnaA** is reinstalled or updated. It is therefore strongly recommended that you save the template file PRINT.TXT with a different name if any changes are made!

The **Choose** button allows you to select a template file for printing. Template file names have the extension TXT. Since, among others, the names of the template files for exporting have the same extension, it may be advisable to save template files for exporting and for printing in different directories on your disk because some key words (see **CadnaA**-manual „Attributes, Variables, and Keywords“, see chapter 4.2 "Keywords") are permissible for exporting only, but not for printing.

Editing a Template File

When you click the **Edit** button, the editor is started up and opens the selected template file.

Printing Range
All

If **All** is activated (black dot) as the printing range, all paragraphs – which are determined by the selected printing template file – are printed, regardless of any selection made under **Selected Paragraphs**.

Selected Paragraphs

If **Selected Paragraphs** is activated (black dot) you must mark one or more items in the paragraph’s list. Only those paragraphs which are marked are printed (see also Multiple Selections).

The total length of all labels (see above: labeling of printing range) on this list (sum of the lengths of the individual labels) must not exceed 255 characters. Otherwise, you will have to break up the printing template file in two or more files.

Print to File

If **Print to File** is activated, the printout is redirected to a file. You will be prompted to enter the name of the output file.

Copies

Enter the number of copies you desire.

Page Margins

Distance in millimeters from the edges of the sheet of paper.

Header/ Footer

These lines let you enter additional text for headers and footers. The first line specifies the header, the second the footer.

You can also insert bitmap files (such as company logos) using the key word #(Bitmap), see chapter 17.4.1.

Example of header and footer

In this example, the text entered on the menu **Table|Library|Text Blocks** (see chapter 12.4) under the text block name "Project" would be printed at the top of each page. At the bottom, at the TAB position 15 cm from the left page margin, the word "page" would appear, followed by the respective page number.

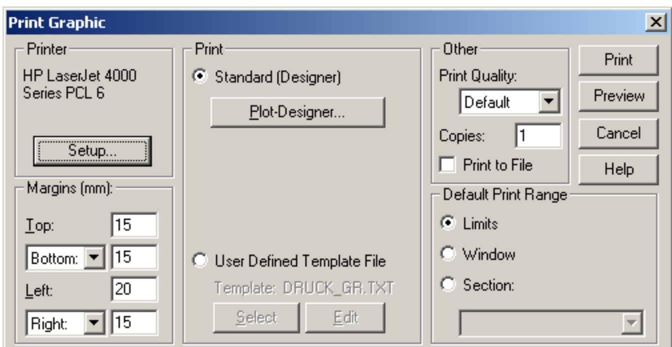
13.1.3 Print Graphics

When all desired objects have been entered, you may print the graphic with or without the background image (see chapter 10.1).

If your diagram contains a bitmap that is not to be printed out, use the bitmap icon on the *icon bar* to deactivate the bitmap prior to printing.

For the printout, either click the printer icon on the icon bar or select the menu command **File|Print Graphics**. The dialog **Print Graphics** opens.

.



Dialog Print Graphic

Printer

On the left hand side of the dialog at first you select all settings for the printer, like printer type, print-out paper size and format.

Margins

The sheet size can be defined optionally either with the page margins or/and with the height and/or width.

The page margin (Top/Bottom and Left/Right) is the distance from the possible printing area of the printer plus the spacing specified in the printing menu.

The height is measured from the margin defined for top and the width from the margin defined for left.

Example: Top margin = 20 mm, height = 200 mm, sheet size 220 mm.

Other

On the right hand size of the dialog you can choose the print quality and number of copies. Furthermore you can decide if the plot shall be printed directly to the printer or written into a file.

Default Print Range

Select the standard printing range by clicking one of the three options:

- **Limits** – prints the limits of the project file, as defined under **Options|Limits** (see chapter 9.1 "Limits").
- **Window** – prints the area visible on the screen. You may modify this area by changing the window size.
- **Section** – prints an identifiable section that has been defined using the **Section** tool (see chapter 9.10). Select its name from the list box.

Print

With one of the options in the middle of the print dialog you can design the layout of your plots with a legend either with the **Plot-Designer** or with a **Template File**.

A **CadnaA** legend is an area that surrounds a plot when it is printed. The legend displays information about the plot, such as descriptive text, a graphical scale, and a north arrow. The legend may also include a border around the plot.

Standard (Designer)

CadnaA captions are based upon a concept of *cells*. Cells are rectangular areas of the paper that can contain text, graphical features such as scales and north arrows, and other cells. In addition, there is a cell that contains the plot itself. Each cell has a variety of properties, such as a background color, a margin, and a border. With the option **Standard (Designer)** activated a predefined caption is used for the printout.

How to design a user-defined caption with the Pot-Designer is described in the following chapter 13.1.4.

User-defined Template File

You need a template file (see chapter 13.1.1) when this option is activated. To select and edit one, click the pertinent buttons.

Specify the printing range in the template file by using the key word #(Plan), see chapter 17.4.24, or use the standard printing range in the dialog **Print Graphic**. When the template file contains a definition of a printing range, **CadnaA** will use it.

An example for a graphics print with a template file is described in chapter 13.1.8.

Saving Print Options

The settings in the print dialog including the page margins and the selected printer are saved with the **CadnaA** file. They are available again with the next opening of the file. If the chosen printer is not available then the default printer is selected automatically.

13.1.4 Plot-Designer

When designing a **CadnaA** plot to print the graphics several captions can be added to display information about the plot.

Via the Plot-Designer the appearance and content of the captions can be edited. The captions may have multiple fonts, colors, and borders. Text can be displayed in separate columns and/or rows. A graphical scale and north arrow or other symbols are supported.

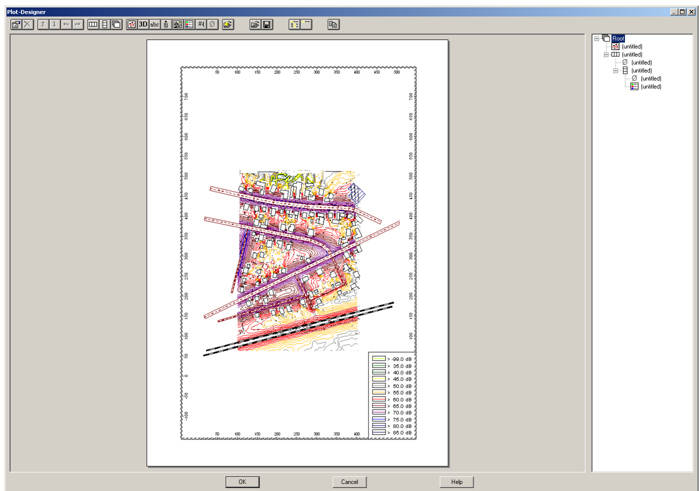
CadnaA users having the option **BMP** (see Chapter 10 - Bitmaps) may also insert images using the available bitmap formats.

CadnaA captions are based on the concept of cells. Cells are rectangular areas of the paper that can contain text, graphical features such as scales and north arrows, and other types of cells. In addition, there is a cell type for the graphics itself. Each cell has a variety of properties, such as a background color, a margin, and a border.

The printable area of the paper (i.e., the paper minus any margins) is the *outermost cell*. You build a caption by adding cells to this outermost cell, and setting their properties. Recall that cells can contains other cells. The caption consists of a hierarchy of cells, with the outermost cell as the root cell which cannot be deleted.

13.1.5 Dialog Cell Properties

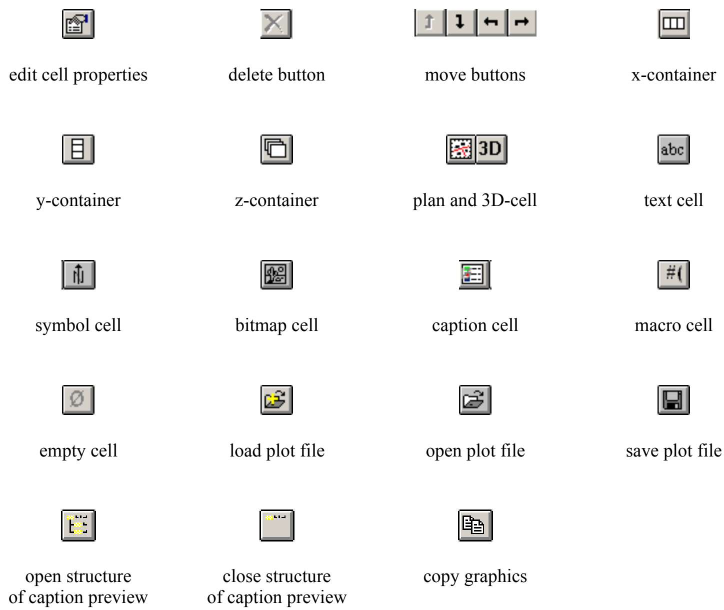
Use the **Cell Properties** dialog to edit a **CadnaA** caption. The printers dialog opens first if you either click the printer icon in the icon bar or the menu command **File|Print Graphic** (see chapter 13.1.3). Open the dialog **Plot-Designer** by clicking the button in the print dialog.



Dialog **Plot-Designer**

The left side of the **Plot-Designer** dialog displays a preview of what the current caption will look like when printed. This is known as the „Caption Preview“. The right side of the **Plot-Designer** dialog displays the hierarchical list of the cells in the caption. This is called the cell list. The selected cell is highlighted in both the caption's preview and the cell list.

On top of the dialog **Plot-Designers** is the symbol bar with the following icons.



Working with the Caption Preview

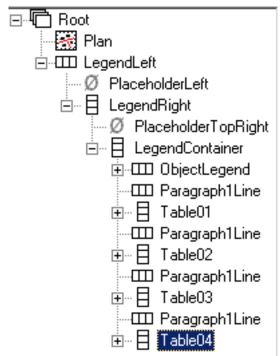
Click once with the right mouse button on the desired point to magnify the caption preview for close study. Click once again to reduce the magnification level.

Properties

Click on a cell in the caption preview to select it. By double-clicking on a cell the dialog **Cell Properties** is displayed. Alternatively, a cell’s edit dialog can be accessed by double-clicking its name in the cell list.

Working with the Cell List

The cell list displays a hierarchical list of the cells (Father, Child) in the captions being edited. The selected cell is always highlighted. To change the selected cell, either use the arrow keys on your keyboard, or click on the cell to be selected.



The Cell List - the Container „Table04“ is highlighted

In front of the container icon is either placed a plus (+) or a minus (-) character. The (+) indicates that the container contains further elements either further container and / or other cells. Click on the (+) to open the container, the (+) exchanges to a (-). Analogously click on the (-) to close the container. A container without any sign in front of is empty.

A container placed left above other cells is the „father“ of the subordinated elements placed right underneath known as „child“. Only a container can be a „father“. „Children“ can adopt the cell properties of their „father“.

Cell Properties

To inspect and edit the properties of a highlighted cell click either on the icon „Properties“ or double-click the cell name in the cell list. In both cases the **Edit Cell** dialog is displayed (see chapter 13.1.7).

Adding Cells

For adding a cell highlight the cell after which you like to add a new cell and click on the desired cell type in the icon bar.

Is the highlighted cell not a container so is the cell added underneath the highlighted cell on the same level. Is a container highlighted so is the cell added into the container as „Child“ one level lower independent if the element is a normal cell or a container.

Move buttons

You can shift the active cell to an other hierarchy level with the **Move** buttons in the icon bar.

- move selected cell up in the cell list
- move selected cell down in the cell list
- move selected cell in one level up in the hierarchy of the cell list
- move selected cell in one level down in the hierarchy of the cell list

Deleting cells

Delete the selected cell by either pressing the Delete button, or by pressing the DEL key.

☝ When deleting a container containing other elements (thus, „children“ are existent), those will be deleted as well.

13

Editing Importing and Saving Captions

Creating a caption from scratch involves a significant amount of work. Therefore, **CadnaA** Plot-Designer offers to save and to load captions to and from files. To simplify your work some predefined captions (file suffix *.cnp) are supplied.

Examples\Tutorial\Output\Plot-Designer

Those can be directly be used for printing or be modified according to your needs (check the CD).

Press the **Load** button to read a previously saved caption.

Press the **Import** button to add a caption to the current caption. The existing and the imported caption will be merged in this case.

Press the **Save** button to write the current caption to a file.

open Structure of Caption Preview

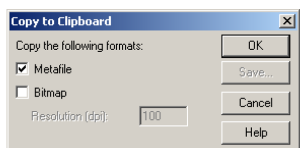
By clicking this symbol the structure of the caption preview with all containers will be opened. So, with this setting, all objects in all containers are visible.

☝ The recent status of the structure of the caption preview is saved to the **CadnaA** file and will be re-displayed when reopening the file.

Close Structure of Caption Preview

By clicking this symbol the structure of the caption preview with all containers will be closed. Just the „Root“ directory will remain. By clicking the „Root“ symbol the first hierarchy level will be re-displayed.

When clicking this symbol the graphics is copied to the clipboard. On a further dialog the file format and - if any - the resolution is to be specified.



With just the file type „Bitmap“ being selected, the file can be saved directly. The following export formats are available:

- Bitmap Files (*.bmp)
- JPEG Files (*.jpg)
- CMP Files (*.cmp)
- PNG Files (*.png)
- TIFF Files (*.tif)

13.1.6 Cell Types

At the time being eight different cell types exist additionally to the three container types which organize the alignment of cells.

Container Cells

The alignment of cells - side by side (in x-direction: these cells contain a horizontal row of other cells), among each other (in y-direction: these cells contain a vertical column of other cells) or overlapped (in z-direction) - are specified by the container cells, which accommodate the other cell types like the „Plan“ or „3D“ cell. Thus you have to insert a container cell first before you can include other cell types. The standard is that at least one container cell must exist, known as root container. If this container is the only one in your caption you cannot delete this container only its properties can be changed. .

x-Container

y-Container

z-Container

To insert a cell highlight either a container cell or an other cell type included in a container cell.

Plan Cell

The „Plan“ cell accommodates your **CadnaA** graphics - your plot itself - like your noise map which is displayed immediately after inserting this cell type. The part of the plan which is displayed depends on the settings in the **Edit Cell** dialog (see the next chapter).

3D Cell

The „3D Cell“ displays a **3D-Special-View** which has been created by an auxiliary polygon either as shaded or as wireframe view. The auxiliary polygons must be named to identify them in the **Edit Cell** dialog where they can be selected.

Text Cell

The „Text Cell“ contains text or even keywords) to automate standard print outs, like #(Scale) which displays the graphical scale or #(Text, Name) which displays the contents of text blocks (see chapter 12.4).

In a new text cell the text „abc“ is displayed by default. There is no restriction regarding the text’s length. As there is no automatic word wrapping use the RETURN key instead.

Symbol Cell

The „Symbol Cell“ may contain **CadnaA**-specific symbols like a North arrow, a grid caption, or the symbols from the symbol’s library (see chapter 12.3).

Bitmap Cell

The „Bitmap Cell“ displays images (pictures, logos, photographs) in bitmap format (TIF, BMP, JPEG, PCX, PNG etc.). This feature requires the **CadnaA** option BMP (see Chapter 10 - Bitmaps).

With the option BMP bitmaps can be inserted either by using the corresponding keyword „#(Bitmap)“ which has to be entered into a „Macro Cell“ (see below) or via a „Symbol Cell“ as a symbol.

Caption Cell

The „Caption Cell“ displays the grid- (color-noise level-scale), object- or land use caption.

Macro Cell

The „Macro Cell“ is actually not necessary, but it offers the possibility to use your already predefined old template files to design a plot.

In that case, copy/paste the contents of the template file into the „Macro Cell“ and delete all other Plot-Designer cells not needed, except of the root container containing the „Macro Cell“.

Empty Cell

An „Empty Cell“ is a cell which cannot have any entries. It just fills out the spaces not needed and forces all other cells on its position. If you insert a cell, it does not matter which cell type, and if this cell is the only one, it occupies normally the whole space in a container. Now if you insert more cells then they all have to share this space. How the sharing looks like depends on the properties of all cells and the selected container type. So if a cell type does not need the whole space you must insert an „Empty Cell“ in any case to force the cell on its position.

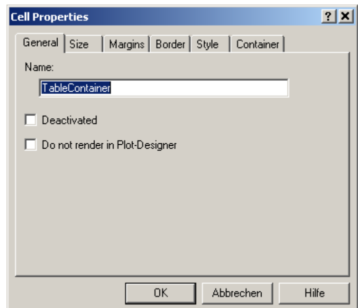
Cell Properties dialog see chapter 13.1.5.

Examples for training see the **CadnaA** CD

Examples\Tutorial\Output\Plot-Designer\CreatingLegend.pdf

13.1.7 Cell's Properties

The dialog **Cell Properties** offers multiple tabs to control and to change the properties of the selected cell type. Click on the desired tab. The properties apply to the active cell only.



„General“ tab

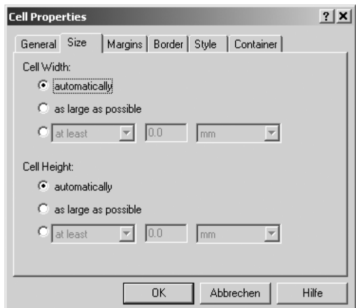
General On the „General“ tab enter a name for the selected cell which is displayed in the cell list.

Deactivated Deactivated cells and their contents are invisible - as if it were deleted. It does not affect your caption anymore.

Do not render in Plot-Designer The option „Do not render in Plot-Designer“ serves to accelerate the screen update. The contents of the cell is not displayed.

Size

The **Size** page allows you to specify both the height (vertical size) and the width (horizontal size) size of the cell. Since the width and height are specified in an analogous manner, only the width is described in detail.



„Size“ tab

Cell's Width

The following options are available:

- automatically: **CadnaA** Plot-Designer will automatically calculate an appropriate width of the cell. For text cells, the width is computed from the text being displayed. For container cells, the width is computed from the widths of the cell's child cells.
- As large as possible: The cell will be as wide as possible; it will fill the horizontal space available for it.
- At least, exactly, at most: Type the width of the cell and choose the corresponding unit from the drop-down list.

  - At least: Choose „At least“ to allow the cell to be wider. **CadnaA** will assign the cell a larger width if there is room for it.
  - Exactly: Choose „exactly“ from the drop-down list to force the cell to be exactly the width you supplied.
  - At most: Choose „at most“ to allow the cell to be smaller in case there is not enough room for it.

The size's property (at least, exactly, at most) and the setting „as large as possible“ determine the priority how the space will be shared.

at least
exactly
at most

When there are only cells with the properties „at least/exactly/at most" the space for the cell with the property „at least" will be accomplished first, then the space for the cell with the property „exactly" and at the end the space for the cell with the property „at most". Thus if there is not enough space for all cells the cell with the size property „at least" will have the best measurement.

As large as possible

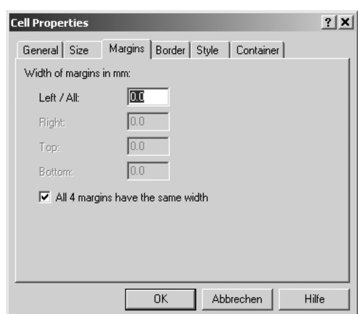
The cell's property „As large as possible" forces the cell to occupy the utmost space. So, two cells with this property receive 50% each of the space available. If only one of two cells has the size property „As large as possible" and the other one the property „automatically" then the cell with the setting „automatically" occupies the lowest possible space but again dependent on the cell type and the style properties of the „father" cell.

Margins

The „Margins" tab of the **Cell Properties** dialog enables to specify the cell's margins. The margins are white space around the edge of the cell, similar to the margins on a piece of paper. This offers to indent a text in a text cell or to reduce a bitmap in a bitmap cell.

Folding Markers

If the checkbox „Folding Markers" according to DIN 824 is checked upright dashes are printed out on the pertinent positions. It could happen, that the dashes are drawn on the axis labeling (Plan cell) if no margins are defined.

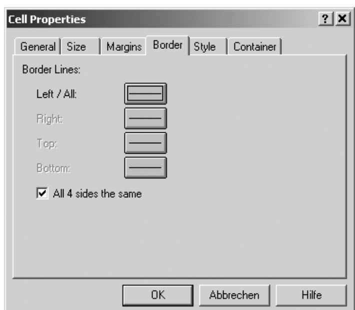


„Margins" tab

Choose the method used to specify the margins. There are three choices: specifying a single margin for all four sides of the cell, specifying different margins for the left-right and top-bottom sides of the cell, and specifying the margins for all four sides individually.

Border

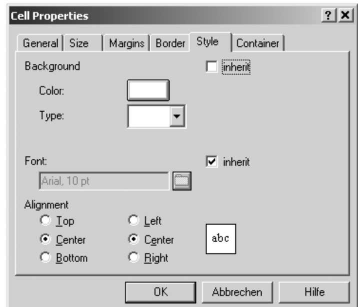
The „Borders“ tab of the **Cell Properties** dialog enables to specify a cell's borders. The borders are optional lines that can be drawn around some or all of the four edges of the cell, just outside of the margins. Choose the method used to specify the borders. Select the desired color(s) of the line(s) used to draw the borders. Type the desired width(s) of the line(s) used to draw the borders, in millimeters. If a width of zero is specified, then the border is not drawn.



„Border“ tab

Style

Via the „Style" tab of the **Cell Properties** dialog the visual appearance of a cell is specified: its color, font, and allignment.



„Style" tab

Background

Select the background color and type of the cell. Note that for some container cells, the background color will not be visible, as the entire cell will be filled with other cells that have their own background colors.

Font

Text Font - Select the font used to display the cell's text. This is relevant only for text cells.

Inherit from „Father"

Also the devisee of properties can be defined. If the option „inherit" is activated the „children" cells inherit the properties of the „father" cell. It is an advantage to make the style's settings in the „father" cell and to activate the option „inherit" in the „children" cells. In case of style changes, it just requires to change the style of the „father" cell. All „children" cells will subsequently adopt the changes as well.

Alignment

Select how the cell's contents are justified.

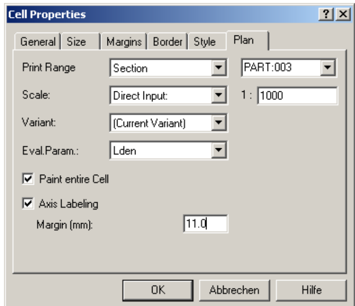
vertical: Top, Center or Bottom

horizontal: left aligned, centered or right aligned

Cell Type

The contents of the last page of the **Cell Properties** dialog depends on the cell type you have chosen.

Plan



„Plan“ tab

The „Plan“ tab allows you to choose the print range - Limits, Window, Section - the scale, the variant and the evaluation parameter. With „Standard“ for the „Print Range“ to the settings made in the print dialog are used.

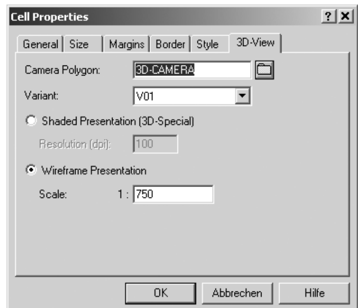
These possibilities offer to print several graphics or noise maps for different evaluation parameters and/or variants in one plot.

The option „Paint entire cell“ has only an effect if for the „Print Range“ either „Window“ or „Section“ is selected. With activated option **CadnaA** displays more of the graphics if there is enough room as if the print range “Window“ or „Section“ actually would show. (For more information concerning Print Range see chapter 13.1.3).

The option „Axis Labeling“ allows you to print the coordinates on all four sides of your plan. A value entered in the option „Margin (mm)“ produced a white space between the plan and the coordinates.

3D

The 3D tab offers to choose 3D-Special-Views either as shaded or as wireframe presentation. To achive this an auxiliary polygon is used serving as a camera line. Select the name of the desired polygon in the „Camera Polygon“ box.



„3D“ tab

The option „Shaded Presentation“ offers to choose the resolution in dpi. With the option „Wireframe Presentation“ an individual graphical scale can be entered. Additionally, a variant from the drop-down list can be selected, in case several variants are defined in the project file. This enables to present different variants on a single plot.

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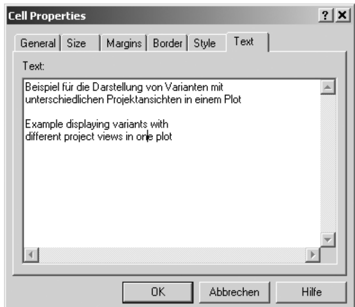
Examples\Tutorial\Output\Plot-Designer\3DPlot.cna

Check for these options using the file 3DPlot.cna from the **CadnaA** CD.

Text

The „Text“ tab of the **Cell Properties** dialog enables to enter and to change a text for the caption. Type the desired text into the input box. The text can have as many lines as desired: press the ENTER key to insert a new line.



„Text“ tab

Keywords

The text can include key words (see chapter 4.2), placeholder for text automatically displayed when the text box is closed by pressing the OK button. For example, the keyword for text blocks:

#(Text, PI_TITEL), see chapter 12.4

is automatically replaced with the contents of the field „Project Name“ in the menu **File|Project-Info**. The following key words make sense, too:

#(Scale) to display the graphical scale or

#(Datum) to display the current date or the contents of the description of a Section.

Symbol

The „Symbol" tab allows you to select and print a **CadnaA** symbol (see chapter 9.11.3).

Maintain Aspect Ratio

That the element does not adjust to the cell measurements and gets bulky activate the option „Maintain Aspect Ratio". This keeps the proportion of the element.

Rotation Angle

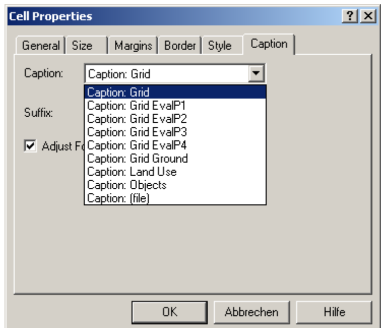
Symbol cells can be rotated by entering an angle of rotation. Alternatively, a reference can be established to a rotated section. This enables to display e.g. the North arrow with rotated sections correctly.

Bitmap

Using the „Bitmap" tab a picture in bitmap format can be inserted into your plot. For that click on the „Tab" icon and choose the desired bitmap. If you do not want the bitmap to adjust to the size's bitmap cell activate the option „Maintain Aspect Ratio".

Caption

The „Caption“ tab offers to select from the drop-down list predefined captions the noise map (level ranges as defined from color palettes via dialog **Grid|Appearance**), the object types being used in the project or the land uses (areas of designated land use).



„Caption“ tab

Grid Captions

The color palettes as assigned via the dialog **Grid|Appearance** (see chapter 5.3.3 "Grid Appearance") can be selected each from the list box „Caption“. The option „Caption: Grid“ displays the caption for the actually selected evaluation parameter. The items on the list box below „Caption: Objects“ refer to the color palettes in the local libraries and are, therefore, user-specific.

Since the grid captions can easily assigned to the evaluation parameters, a special reference to the respective plan is not required. This simplifies working with several plans in a single printout considerably.

Suffix

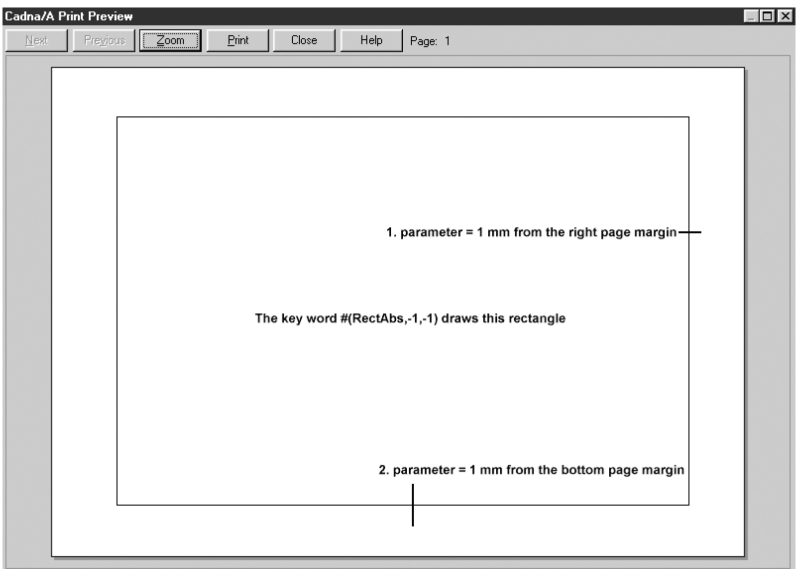
Via the field „Suffix“ a unit for the grid caption can be entered. For example, enter `dB(A)` then is „dB(A)“ displayed on the grid caption as a unit.

13.1.8 Template File for User-defined Graphics Print

(see also button „Keywords“ on the online help of **CadnaA**)

Key words

```
#(Font,,6)
#(PosPush)
#(RectAbs,-1,-1)
```



Command (see chapter 17.4.27, **CadnaA**-manual „Attributes, Variables, and Keywords):

```
#(PosPush)
```

Saves the current position for subsequent retrieval. In our example, the current position is the top left corner (x/y = 0/0 - Standard).

Command (see chapter 17.4.30, **CadnaA**-manual „Attributes, Variables, and Keywords):

```
#(RectAbs,-1,-1)
```

draws a rectangle from the current position (top left corner) to the positions specified by the parameters 1 and 2. In this case, parameter 1 is the distance in millimeters from the right page margin (because the value is negative), and parameter 2 is the distance in millimeters from the bottom margin (because the value is negative).

The margin is the distance from the permissible printing range of the printer in question plus the page margins entered on the print menu.

Now the current position is the bottom right corner, 1 mm from the bottom margin, and 1 mm from the right margin.

```
#(Font,,6)
#(PosPush)
#(RectAbs,-1,-1)
#(PosPop,,,z)
```

The command #(PosPop,,,z) retrieves from the stack (memory) the position previously saved using PosPush (the top left corner in our example), making it the current position, without removing the saved position from the stack. The current position is the top left corner again.

```
#(Font,,6)
#(PosPush)
#(RectAbs,-1,-1)
#(PosPop,,,z)
#(PlanAttr)
#(Plan,-60,-1,-1)
```

The command #(Plan,-60,-1) (see chapter 17.4.24, **CadnaA**-manual „Attributes, Variables, and Keywords) identifies the area where the diagrams are to be placed.

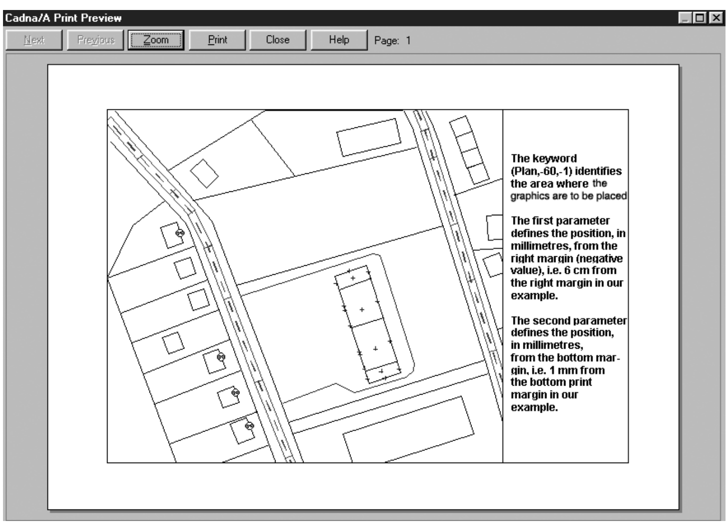
The first parameter defines the position, in millimeters, from the right margin (negative value), i.e. 6 cm from the right margin in our example.

The second parameter defines the position, in millimeters, from the bottom margin, i.e. 1 mm from the bottom print margin in our example.

The third parameter (>0) is the scale factor. 1,000 for example means that the diagram is printed at a scale of 1:1,000. If the third parameter is negative (as in the example), the scale will be chosen to fit the specified paper size. If the third parameter is not given, as in #(Plan,-60,-1), the scale specified for the representation on the screen will be used.

The fourth parameter determines whether to print the limits, the area visible on the screen (enter Window instead of Limits), or a section. In the latter case, the name of the section must be given. If the name of the section is, e.g. *Development_Area*, this must be entered. In our example, the set scale will be used for printing.

If no fourth parameter is given, the option selected on the print dialog is applied.



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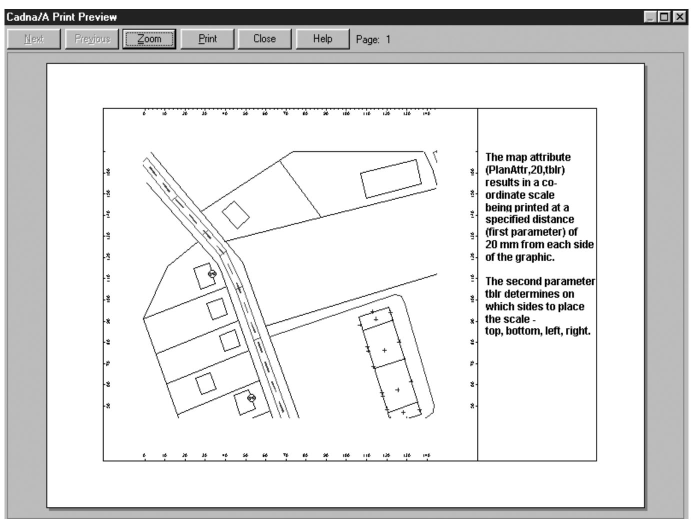
#(PlanAttr) (see chapter 17.4.25, **CadnaA**-manual „Attributes, Variables, and Keywords) without parameters is drawn in the area where the graphics are placed without a coordinate scale. This key word must appear before the command #(Plan). The map attribute #(PlanAttr,20,tblr), on the other hand, draws a coordinate scale at a specified distance (first parameter) of 20 mm from each side of the diagram. The second parameter tblr determines which sides to place the scale on – **t**op, **b**ottom, **l**eft, **r**ight. In this case, all four sides are scaled.

So far the complete command is, including the coordinate scale,

```
#(Font,,6)
#(PosPush)
#(RectAbs,-1,-1)
#(PosPop,,,z)
#(PlanAttr,20,oulr)
#(Plan,-60,-1,)
```



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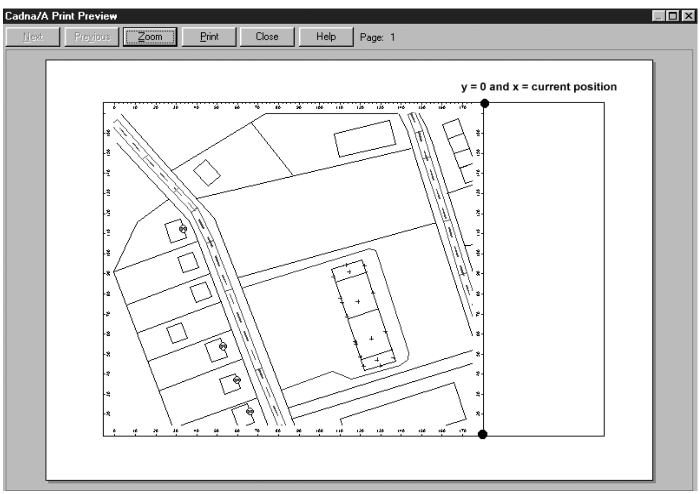
If you find the distance too large between the scale and the diagram, change the command to #(PlanAttr,5,tblr). It will only be 5 mm thencommand.

```
#(Font,,6)
#(PosPush)
#(RectAbs,-1,-1)
#(PosPop)
#(PosPush)
#(PlanAttr,5,oulr)
#(Plan,-60,-1,-1,Limits)
#(PosPop,x)
```

The command #(PosPop,x) leaves the current x coordinate unchanged and, in this example, retrieves from the stack the y coordinate (=0) saved using #(PosPush). This y-coordinate becomes the current position.



```
#(Font,,6)
#(PosPush)
#(RectAbs,-1,-1)
#(PosPop)
#(PosPush)
#(PlanAttr,5,oulr)
#(Plan,-60,-1,-1, Litmits)
#(PosPop,x)
#(MoveRel,5)
#(Einzug)
#(Font,,10)
```

As a result of the command #(MoveRel,5) (see chapter 17.4.20, **CadnaA**-manual „Attributes, Variables, and Keywords), the current position is moved to the right by 5 mm, making this the new current position. The command #(Einzug) (see chapter 17.4.4, **CadnaA**-manual „Attributes, Variables, and Keywords) indents to this position everything that follows. The command #(Font,,10) results in all subsequent texts being printed using the Arial font, 10 pt size.

The very first font command in our template file remains valid until the next font command is given. This means that the coordinate scale of the map is printed out using Arial font, 6 pt size.

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☝ No RETURN or SPACE should be entered in the commands above, even if the line grows too long to fit the screen. If a RETURN or SPACE were entered, this would also be interpreted as a command, and would be executed accordingly.

Individual Text

The commands for placing the graphics have now been completed. If you enter this sentence in the template file, it will also be printed. This means that an individual text for a key can be printed out with the diagrams.

Make sure that the text is placed outside the specified map area - #(Plan,-60,-1,-1). This has been taken into account in the commands above.

```
#(Font,,6)
#(PosPush)
#(RectAbs,-1,-1)
#(PosPop)
#(PosPush)
#(PlanAttr,5,oulr)
#(Plan,-60,-1,)
#(PosPop,x)
#(MoveRel,5)
#(Einzug)
#(Font,,10)
```

The commands for placing the graphics have now been completed.

☝ Whereas no blanks or returns should be entered in the commands controlling the printout of the diagrams/graphics, you may and have to do so for an individual text. No automatic line breaking is executed!

As a result of our „key word commands“, an area of 60 mm - 5 mm, (#(Plan,-60) minus (MoveRel,5)), thus 55-mm-wide, is available for the text in our example, if this text is to be placed outside the diagrams.

```
#(Font,,6)
#(PosPush)
#(RectAbs,-1,-1)
#(PosPop)
#(PosPush)
#(PlanAttr,5,oulr)
#(Plan,-60,-1,)
#(PosPop,x)
#(MoveRel,5)
#(Einzug)
#(Font,,10)
```

The commands for placing the graphics have now been completed.

```
#(Legende)
```

A command containing the key word #(Legende), and appearing below the text entered, results in the level-color palette being printed out. Insert three or four Returns in the template file before the #(Legende) command in order to view the effect of this.

Then remove the RETURNs again to gain space for more important information, such as project identification, the name of the person who ordered the report, or even an image (logo).

The following commands result in a printout as illustrated below.

```
#(Font,,6)
#(PosPush)
#(RectAbs,-1,-1)
#(PosPop)
#(PosPush)
#(PlanAttr,5,oulr)
#(Plan,-60,-1,)
#(PosPop,x)
#(MoveRel,5)
#(Einzug)
#(Font,,10)
```


The commands for placing the graphics have now been completed.

```
#(Legende)

#(Text,Project)

Scale 1:#(Scale)

Munich, #(Datum)

#(Text,Adress)
```

The command #(Text,Project) and #(Text,Address) insert the texts entered on the menu **Tables|Libraries|Text Blocks**. "Project" and "Address" are text blocks.

If you wish to print an image, or a logo, in either bitmap or metafile format, one of the commands #(Bitmap) (see chapter 17.4.1, **CadnaA**-manual „Attributes, Variables, and Keywords) or #(Metafile) (see chapter 17.4.18, **CadnaA**-manual „Attributes, Variables, and Keywords) - with the pertinent parameters - must appear in the template file.

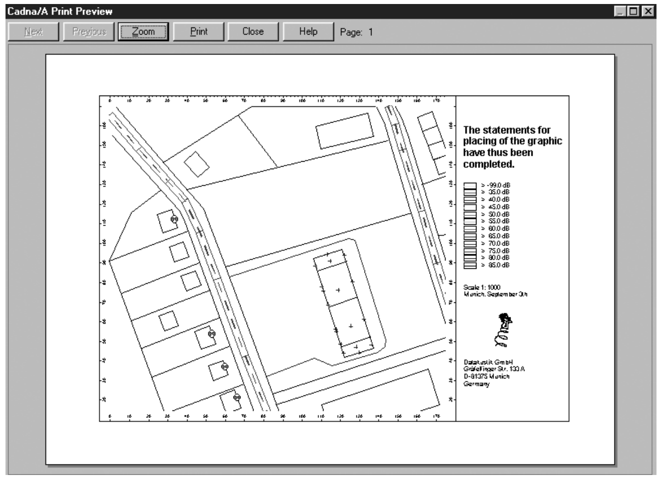
To avoid having to save and retrieve the current position over and over again using PosPush and PosPop, it is useful to put this command at the end of the template file, and enter absolute dimensions like in the following example.

```
#(MoveAbs,-40,110)
#(Bitmap,c:\dtp\bilder\schelm01.bmp,10,20)
```

#(MoveAbs,-40,110) sets the current position to 4 cm from the right margin and 11 cm from the top margin. The structure of the keyword #(Bitmap) is:

#(Bitmap, path + file name, horizontal size, vertical size)

The commands **MoveAbs** and **Bitmap** should appear on one line. (Otherwise, an additional RETURN would be made from the absolute position).



13.1.9 Print Preview

The Preview button opens the print preview window with a full-screen display of the diagram/graphics or the report, depending on whether **Print Report** (see chapter 13.1.2) or **Print Graphics** (see chapter 13.1.3) was selected.

In order to obtain a realistic print preview, you must, of course, specify all printing parameters – printer, paper size, page layout, page margins etc. – as customary.

Button Copy

You can **Copy** the print preview in the Windows clipboard as **Metafile** or **Bitmap** for further use in a third-party software program, e.g., like a word-processing or graphics program. If you choose **Bitmap** you can enter a resolution.

Button Zoom

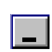
The **Zoom** button serves to switch from full-screen to an actual-size preview and back. To zoom in on a particular area of the print preview, click the desired location once. The next mouse click restores the initial situation.

Button Print

The print command may also be started from the print preview window by clicking the **Print** button.

If you have selected user-defined printing, and opened and edited a template file via the **Edit** button, you need not close this file. **CadnaA** will update the print preview window each time you save changes to the file. This is very convenient and comfortable. We recommend you proceed as follows:

1. Specify all parameters – printer, paper size etc. – in the dialog **Print**.
2. Open the template file for **Edit**ing, and
3. Minimize the window by clicking the minimise button at the top right


Minimize

corner of the window.

4. Click the Preview button on the **Print** dialog. If you are not satisfied with the layout you see on the print preview window, **do not close** the print preview window, but

5. Maximise the template file again by clicking the pertinent icon, (this will now overlap the dialog **Print Preview**)

6. edit it as desired,

7. save it, and

8. minimise it again.

During this saving procedure, **CadnaA** has already updated the display on the print preview window. Continue like this until you are satisfied with the result. In doing so, make sure that the print preview window and the edit window of the template file are the same size, and that the active edit window lies exactly at the same position as the print preview window (maximize, if necessary).


Maximize

13.2 Export

Instead of applying the **Copy** button to individual tables to make them available via the Windows clipboard for further processing in other applications (e.g. MS-Word, MS-Excel, or GoogleEarth) you can use the **Export** command on the **File** menu or the Export icon on the icon bar to export all object parameters at once using any of the formats **CadnaA** offers you.

After clicking the command **File|Export,** the dialog **Save File As** opens. In this dialog, select the appropriate file format from the list in the editable list box. The respective file extension will be added automatically upon saving the file.

Enter a name for the output file, or select an existing file in the file selection dialog. In the latter case, that file will be overwritten. **OK** starts the export procedure.

The **Options** button in the dialog **Save File As** leads you to the import options for the selected file format.

Once all the desired options have been specified, further exports can be started by simply clicking the export symbol on the symbol bar.

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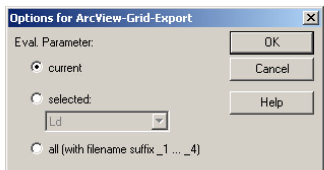
13.2.1 Export Formats

The following formats are available:

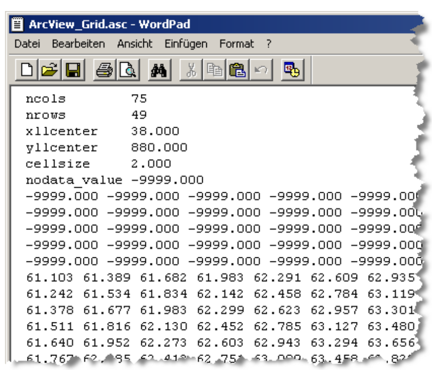
ArcView-grid (*.asc)

The noise map can be saved in ArcView Grid format. It can be specified which for evaluation parameter/s the grid data shall be exported (current, selected, or all).



Dialog **Options for ArcView-Grid-Export**

Up to four export files are generated (having the file extension *.asc) for at most four evaluation parameters. The number attached refers to the respective evaluation parameter (e.g.: „..._1“ for the first evaluation parameter). The export file contains the coordinates of the left lower and right upper corner of the limits, the xyz coordinates of the grid points, the ground height, and the level at each grid point for the respective evaluation parameter.



Export text file using format „ArcView Grid (*.asc)“

Bitmap Files BMP

The calculated distribution level is saved into a bitmap file as a grid of areas with equal sound sources independent of the chosen settings for appearance. If the option **Area of equal sound source** (**Grid|Appearance**) is chosen, you can also use the option **Oversampling** to increase the resolution of the grid.

In addition to the export file a second file is created with the extension WLD in which the coordinates of the grid are saved. With it, it is possible to again import the grid with reference to its coordinates in a GIS program like ArcView, MapInfo etc.

LimA-files BNA,BNX

Such files are processed by Lima software from the Stapelfeldt company.

Immis-Luft files dbf

Interface with the software for airborne emissions from the IVU company, Berlin and Freiburg, Germany.

Height Points of Buildings

see chapter 7.2.16 "Building Height Points"

Compact protocol

see chapter 6.4.1 "Compact Protocol"

Web-Bitmaps

see chapter 10.3 "Web-Bitmaps"

X-File (*.x)

File format used by MS-DirectX and by rendering applications to import DirectX-files (file extension: .x). X-files contain 3-dimensional object data in so-called meshes.

13.2.2 Text Files TXT / RTF

With both formats you can export calculation results or object tables. With that, you are able to automate the output of reports by entering the corresponding commands in a template file.

The exported file may be an ASCII (File.TXT) or Rich Text (File.RTF) format. It is advisable to choose the RTF format, if you wish to edit the file using a word processor capable of handling this format (such as Word for Windows or WordPerfect). The attributes of the exported data, and any frames - as, e.g. for tables - will then remain intact (at least most of them), and can be further processed using the word processor. For any other software, use ASCII format. (This also applies to Excel, for example.)

The name of the template file (see chapter 13.1.1) to be applied when exporting the result log (when RTF or TXT format was selected) appears in the field **Template File**. This template file is selected via the **Select** button.

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13.2.3 AutoCad DXF

DXF files are vector files which are usually generated and imported by CAD programs like, e.g., AUTOCAD. After clicking the button **Options** you can make the following settings:

DXF-file for AutoSketch

If this box is not checked, DXF files will be created to match the specifications of CAD software like, e.g. AutoCad.

If this box is checked, AutoSketch compatible DXF files will be created, i.e.

- no 3-D information
- layer identification for AutoSketch ("1" - "10")
- no "complex" objects like 3-D FACE etc.

generate Header

A header will be written which enables the import of the **CadnaA** diagrams in CAD programs with this request.

Use 3D-Surfaces

If this option is activated, horizontal projections of buildings can be represented as 3-D views after having been exported to the CAD program. Their surfaces may then be edited (e.g. using shading) depending on the CAD program.

Iso-dB-Lines:

Output as Polyline
If this box is checked, dB contour lines will be exported to the DXF file as continuous polylines. Otherwise, isolated sections of lines are exported.

Height is Level
When this box is checked, the sound level becomes the height (z coordinate) of the Iso-dB-Lines in the DXF file. Otherwise the sound level is only visible in the DXF layers and the height of the Iso-dB-Lines is zero.

Iso-DB-Raster:

Output as 3D-Grid
When this box is checked, the sound levels are represented as "mountains" in the CAD program. A sound level will correspond to a "hill", the higher the sound level at a corresponding grid point, the higher the „hill“. Howev-

er, this will only work if in the menu **Grid|Appearance** in **CadnaA** the option **Raster** is selected (see chapter 5.3.3).

No Raster Points
If this option is activated the receiver points of the grid are not exported.

Aircraft Tracks

see special manual of Airport Noise (only available if you have purchased the **CadnaA** extension Airport Noise).

see also chapter Import 7.2.2 AutoCad-DXF

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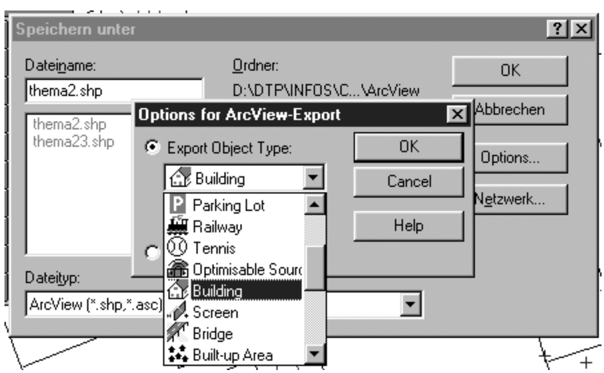
13.2.4 ArcView

If you wish to view **CadnaA** files in ArcView or ArcInfo, you must export them as Shape files. As mentioned under Import (see chapter 7.2.5 "ArcView"), Shape files have a topic-related structure so that you have to export the object types separately.

To export, proceed as follows:

- Choose **File|Export|File Format: ArcView**
- Enter a name for the file to be created.
- Select the type of object to be exported under **Options**.
- If heights are to be exported, select the 3-D option, and confirm by clicking **OK**.
- The actual exporting procedure will be started when you click **OK** in the dialog **Save As** for the second time.



Specify the object type when exporting to ArcView.

☝ In fact with the activated 3D option (button Options) you can export the heights of the objects but the user of the export file requires for the import in ArcInfo or ArcView the Spatial Explorer, a program extension by ESRI.

Grid export for ArcView

You have two possibilities to export the grid of receiver points, either the areas or Iso-dB-lines or as **ArcView Grid** with the same-named format. In this case you would get an file including the x-y-z-coordinates and the dB results on each point.

Export Line and Areas of equal Sound Levels for ArcView

You have to make the corresponding settings in **Grid|Appearance** for exporting lines or areas of equal sound levels before you make your export to ArcView. If you want to export, e.g., areas of equal sound sources you must activate this option in **Grid|Appearance** otherwise lines of equal sound sources. Define also the class width. **CadnaA** exports for each colored area a closed polygon which can be colored correspondingly in ArcView or ArcInfo.

Export of facade points

Facade points can be exported via the ArcView-export filter as well. To this end, select after click on button „Options“ the object type „Facade Point“.

With the option „3D“ activated 3D-objects are generated on export which can be imported into **CadnaA**, ArcView or any other GIS-software. With the option „3D“ deactivated the facade points are exported as 2D-points (i.e. with no height information).

The following attributes are written to the **Memo-Window** of each polygon or point exported:

- NAME: designation/name of facade point
- L1..L4: facade level in dB(A) for performance parameters 1..4
- EINW_L: number of inhabitants at the facade point (assuming a constant number of inhabitants per facade length)
- EINW_N: number of inhabitants at the facade point [assuming a num-

ber of inhabitants at the facade point = (inhabitants building)/(number of facade points of the building)]

Example

- Choose **File|Export|File Format: Arc View**
- enter a name for the export file, e.g., LevelAreas.shp. (You must enter the extension shp is necessary)
- Click the button **Options** and activate **Export Iso-dB-Lines**
- Confirm both dialogs and the export will be executed.

13.2.5 QSI

The QSI-file format according to DIN 45687, annex D /28/, is intended for data exchange between software programs for the calculation of sound propagation. The data is written to a QSI-project file (file extension QSI) and to several QSI-files containing object data the format of which corresponds with ArcView-shape-files (file extensions SHP, DBF, SHX).

The abbreviation QSI stands for „**Q**uality Assurance for **S**oftware-Products for the Calculation of **I**mmission“.

When exporting data the QSI-project file (<filename>.qsi) all corresponding SHP-, DBF- and SHX-files (###) are saved automatically.

QSI-specific sound sources

The QSI-format includes the following sound sources:

- point source (<filename>_SRCP.###)
- line source (<filename>_SRCL.###)
- area source (<filename>_SRCA.###)
- road (<filename>_ROAD.###)
- railway (<filename>_RAIL.###)
- parking lot (<filename>_PARK.###)

Other QSI-specific elements

Further elements included in the QSI-format are:

- receiver point (<filename>_RECV.###)
- crossing/red light (<filename>_CROS.###)
- building (<filename>_BLDG.###)
- barrier (<filename>_BARR.###)
- contour line (<filename>_HLIN.###)
- height point (<filename>_HGPT.###)
- ground absorption (<filename>_GABS.###)
- attenuation area (<filename>_AREA.###)
- train classes (<filename>_TRCL.DBF)
- spectra (<filename>_SPEC.DBF)

- diurnal pattern (<filename>_DIPA.DBF)

☝ On export of point, line, and area sources the PWL-correction will be considered via the operation time

☝ Attenuation areas comprise of the **CadnaA**-objects „built-up area“ and „foliage“.

CadnaA-specific elements for QSI

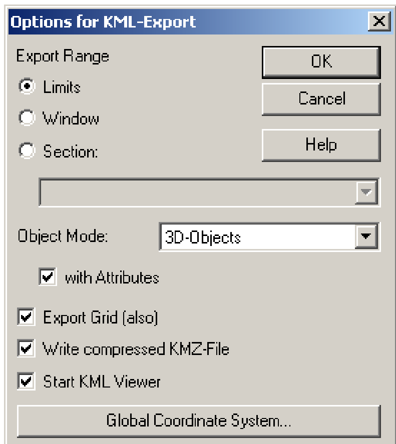
Furthermore, the following **CadnaA**-specific elements are considered when exporting to QSI-format:

- Directivity (<filename>DRCT.DBF)

13.2.6 GoogleEarth

The export format „GoogleEarth (*,.kml)“ on dialog **File|Export** enables to export the objects geometry (e.g. buildings and roads) into the GoogleEarth (by Google Inc., Mountain View CA, USA).

Via the button „Options“ several additional features are available.



Options for GoogleEarth-Export

Upon the first KML-export procedure the export-symbol on the Symbol Bar will change using the GoogleEarth-icon. Further export procedures can easily be started with the present settings by clicking onto this symbol.

Export Range

Specify whether the export range shall cover the entire limits, the present window or an existing section. In the latter case, the respective section can be selected from the list box.

Object Mode

Select whether just a screenshot or the 2D- or 3D-objects shall be exported.

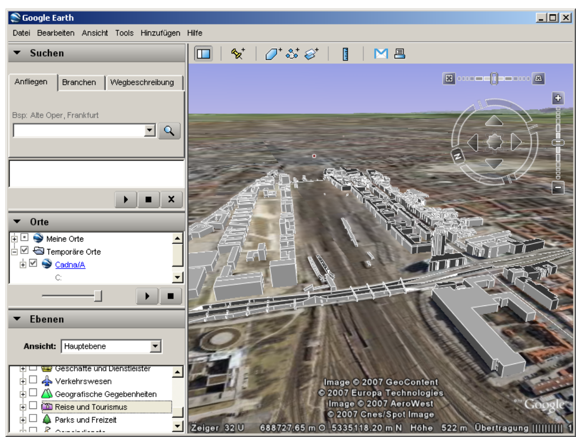
In object mode „Screenshot only“ the specified range is exported as a transparent bitmap. In GoogleEarth, the satellite images are still visible on the background enabling to assess the correct location of **CadnaA**-objects.

In 2D-mode the objects are displayed as non-transparent areas in GoogleEarth.

In 3D-mode the object’s heights are exported as well. The result is a realistic 3D-representation allowing to navigate freely using all navigation tools GoogleEarth provides.

Option „with Attributes“

With this option activated the object’s attributes are exported into a table which is attached to each object displayed in GoogleEarth (see „Places“ list, expand item „CadnaA“). Upon a double-click on the baseline of an object (e.g. a road) the attribute table is displayed in GoogleEarth.



CadnaA-project in GoogleEarth

Export Grid

With this option activated an existing horizontal grid will be exported as a real raster (with or w/o progressive colors, see chapter 5.3.3) with transparency.

Write compressed KMZ-file

The file format KMZ („KML-Zipped“) is a compressed version of the KML-file. Besides coordinate data it contains also images. The file size of KMZ-files without images will be much smaller than the equivalent KML file.

Start KML-Viewer

Activate this option to automatically start the KML-viewer registered on your system after export (normally: GoogleEarth).

Global Coordinate System

A correct export to GoogleEarth requires object coordinates in a known coordinate system. Click on the button „Global Coordinate System“. For project files a national or international coordinate system of which has been specified will be displayed on the subsequent dialog **Coordinate System** (description of dialog see chapter 9.5). Otherwise, select the present coordinate system as been used in the **CadnaA**-file. With the option „User-defined Coordinate Systems“ activated just those are listed.

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13.3 CadnaA - BASTIAN - link

BASTIAN is a program for building acoustics by DataKustik, Munich, Germany. **BASTIAN** calculates the airborne and impact sound insulation according to EN 12354 /11/ part 1, 2 and 3 in frequency spectra or with single number ratings. All performance parameters according to ISO 717-1 and -2 /8/ are available. Furthermore **BASTIAN** enables the calculation of the structural reverberation time according to EN 12354-1, annex C.

How do **CadnaA** and **BASTIAN** work together?

The sound levels are calculated with **CadnaA** at defined receiver points - e.g., in front of building facades. In the program **BASTIAN,** when simultaneously opened, these receiver points are visible in the list of the outdoor sources during calculation of sound transmission.

This enables you to calculate the indoor level with a building construction defined in **BASTIAN**. With this connection the indoor level is immediately displayed correctly if the outdoor level has been changed - e.g., because a noise barrier has been inserted in **CadnaA**. The corresponding construction of the building then follows with **BASTIAN**.

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Chapter 14 - Project Organization

This chapter covers the features available in **CadnaA** to organize the project data. This includes:

- the definition of groups of objects (see chapter 14.1)
- the generation of variants based on the groups defined (see chapter 14.2) and
- the **CadnaA**-specific feature „ObjectTree“ enabling the software-supported generation of groups (see chapter 14.3).

Furthermore, the features in conjunction with the Multi-Threading calculation mode (see chapter 14.6) and the PCSP-calculation with batch-processing (see chapters 14.6, 14.8, and 14.7) are described.

By using the dynamic noise map („Dynmap“) the calculated noise map may be updated automatically using measured data (see chapter 14.9).

Further items covered are:

- the management of projects by using folders (see chapter 14.5),
- the handling of prototype files (see chapter 14.10),
- the automatic saving of files (see chapter 14.11),
- the automatic generated text blocks, also for the checking of calculation runs (see chapter 14.12) and
- the purging of multiple data resulting from multiple import operations (see chapter 14.13).

14.1 Groups

By means of the ID (see manual "Introduction to **CadnaA**") for all objects and by the group definition relying on it, **CadnaA** offers a versatile and powerful tool for data management. If appropriate rules are observed in the definition of the ID, a project and the data stock it is based on can be supplemented at any time by entering or importing further data without creating problems with either the clear identification of the individual sources or with the definition of groups. If the syntax is strictly observed, data stocks may be combined with other stocks at any time. This means that establishing and observing strict ID syntax rules will, in the end, determine the value of a data stock. Such issues are dealt with in detail in the "Advanced **CadnaA**" training course.

Open the list of groups on the **Tables|Group** menu - the edit dialog **Group** opens. The list is empty if no groups have been defined.

A group is a labelled selection of objects. All objects belonging to one group are identified by the character string entered in the „Expression“ box which refers to the object ID (see manual "Introduction to **CadnaA**").

The following features are available for groups:

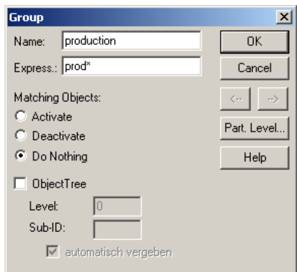
- activation and deactivation for the calculation (to calculate variants),
- presentation of partial **sum-over-the-group** levels at receiver points,
- presentation of partial levels of the individual sources within one group (which allows you to establish priorities for noise-control measures),
- editing objects belonging to one group by various actions (see manual "Introduction to **CadnaA**") such as deleting, conversion to other types of objects, transforming (rotating, shifting) etc.

☝ Groups have a hierarchic structure. This is achieved in the order in which the groups are arranged in the list of groups because this list is checked from top to bottom when verifying the activation state of an object. If you activate or deactivate a group of objects in one line, any specification in groups further down the list will be ineffective for these objects.

see also manual "Introduction to **CadnaA**" about basics on grouping of objects

14.1.1 Defining Groups

Whether or not an object belongs to a group is determined by the „Expression“ string entered in the **Group** dialog. If the specified expression string matches the ID string of an object, this object belongs to the group.



Wild cards may be used in the definition of the expression (see **CadnaA**-manual "Attributes & Abbreviations").

Example Defining a Group

Source 1: ID = Prod_102

Source 2: ID = Prod_105

Express:	Prod*	Source 1 and Source 2 are assigned to the group
Match:	Prod_??5	Source 2 is assigned to the group
Match:	Prod_102|Prod_105	Source 1 and Source 2 are assigned to the group
Match:	*2	Only Source 1 is assigned to the group

With extensive projects you should define the IDs while considering the intended group concept.

Example Hierarchy of Groups and their Partial Sum Level

Name	M.	Expression	Partial Sum Level Day			
			Neighbor EG	Neighbor 1.OG	Neighbor 2.OG	Neighbor 3.OG
Produktion		Prod*	63.1	63.9	63.9	63.6
Produktion Hall 10		Prod_102	54.6	56.0	57.3	57.2
Produktion Hall 10		Prod_105	43.5	44.5	45.5	46.5
Produktion Hall 10 total		Prod_10*	55.0	56.3	57.6	57.5
Produktion Hall 12		Prod_123	62.4	63.0	62.6	62.2
Produktion Hall 13		Prod_135	43.9	45.2	46.6	47.0

The sequence of the groups in the list and their composition has an effect on the calculation of the partial sum-over-the-group levels shown on the list.

☝ Note that you can only manipulate by grouping those objects whose ID has been switched to neutral (grey, i.e. neither activated nor deactivated) in the edit dialog of this object. Therefore, objects activated in the edit dialog cannot be deactivated by grouping, and vice versa.

Six groups have been defined in the above example.

- The first group contains all sources in the "Production" group.
- The second contains Source 1, ID Prod_102, of "Production“ Hall 10.
- The third contains Source 2, ID Prod_105, of "Production“ Hall 10.
- The fourth contains the entire Hall 10 of "Production“.
- The fifth contains Hall 12 with the source ID Prod_123.
- The sixth contains Hall 13 with the source ID Prod_135.

None of the sources or groups were activated or deactivated during the calculation, but the „Do nothing“ option was selected. This means that all groups and sources are considered in the calculation. Therefore, you can see the pertinent partial sum-over-the-group levels at the existing immission points.

If you were to deactivate the first group, "Production“ - which contains all the sources of all halls - for a calculation, none of the groups following below would be considered in this calculation. Even if they were activated, this would not have any effect. The sequence of the groups is therefore decisive.

Now edit the string on the „Expression“ box of the third group to read Prod_??5, and deactivate this group. This would automatically deactivate the sixth group as well because the string on the „Expression“ box would apply for this group, too. You would be unable to re-activate this group unless you either moved the sixth group before the third one and activated it explicitly, or you activated the sources in the edit source dialog.

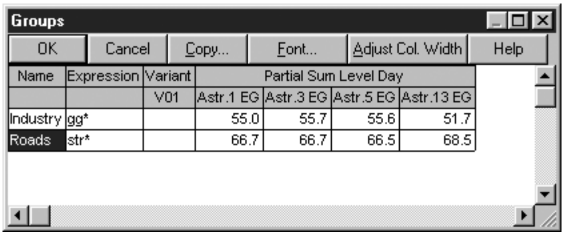
Name	M.	Expression	Partial Sum Level Day			
			Neighbor EG	Neighbor 1.OG	Neighbor 2.OG	Neighbor 3.OG
Produktion		Prod*	63.0	63.8	63.8	63.4
Produktion Hall 10		Prod_102	54.6	56.0	57.3	57.2
Produktion Hall 10	-	Prod_??5				
Produktion Hall 10 total		Prod_10*	54.6	56.0	57.3	57.2
Produktion Hall 12		Prod_123	62.4	63.0	62.6	62.2
Produktion Hall 13		Prod_135				

If the „activate“ option was selected, all sources with matching IDs would be calculated.

Name	M.	Expression	Partial Sum Level Day			
			Neighbor EG	Neighbor 1.OG	Neighbor 2.OG	Neighbor 3.OG
Produktion		Prod*	63.1	63.9	63.8	63.5
Produktion Hall 10		Prod_102	54.6	56.0	57.3	57.2
Produktion Hall 13		Prod_135	43.9	45.2	46.6	47.0
Produktion Hall 10	-	Prod_??5	43.9	45.2	46.6	47.0
Produktion Hall 10 total		Prod_10*	54.6	56.0	57.3	57.2
Produktion Hall 12		Prod_123	62.4	63.0	62.6	62.2
Produktion Hall 13		Prod_135	43.9	45.2	46.6	47.0

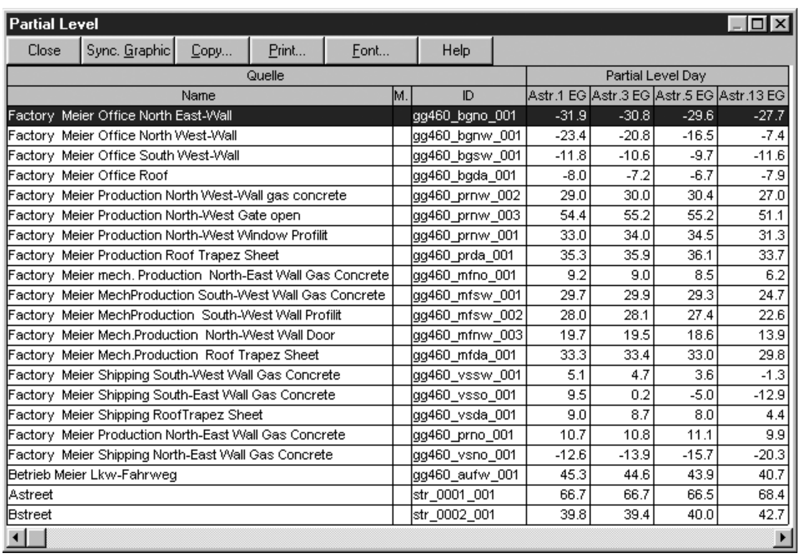
14.1.2 Partial Sound Levels of Groups

If you click the **Partial Levels** button on the edit dialog **Group** you can see the total amount of noise at receiver points resulting from a user-defined group of noise sources.



Name	Expression	Variant	Partial Sum Level Day			
		V01	Astr.1 EG	Astr.3 EG	Astr.5 EG	Astr.13 EG
Industry	gg*		55.0	55.7	55.6	51.7
Roads	str*		66.7	66.7	66.5	68.5

In **Tables|Partial Level,** you can view the sound levels resulting from each sound source included in the calculation for all existing receiver points.



Quelle			Partial Level Day			
Name	M.	ID	Astr.1 EG	Astr.3 EG	Astr.5 EG	Astr.13 EG
Factory Meier Office North East-Wall		gg460_bgno_001	-31.9	-30.8	-29.6	-27.7
Factory Meier Office North West-Wall		gg460_bgnw_001	-23.4	-20.8	-16.5	-7.4
Factory Meier Office South West-Wall		gg460_bgsw_001	-11.8	-10.6	-9.7	-11.6
Factory Meier Office Roof		gg460_bgda_001	-8.0	-7.2	-6.7	-7.9
Factory Meier Production North West-Wall gas concrete		gg460_prnw_002	29.0	30.0	30.4	27.0
Factory Meier Production North-West Gate open		gg460_prnw_003	54.4	55.2	55.2	51.1
Factory Meier Production North-West Window Profilit		gg460_prnw_001	33.0	34.0	34.5	31.3
Factory Meier Production Roof Trapez Sheet		gg460_prda_001	35.3	35.9	36.1	33.7
Factory Meier mech. Production North-East Wall Gas Concrete		gg460_mfno_001	9.2	9.0	8.5	6.2
Factory Meier MechProduction South-West Wall Gas Concrete		gg460_mfsw_001	29.7	29.9	29.3	24.7
Factory Meier MechProduction South-West Wall Profilit		gg460_mfsw_002	28.0	28.1	27.4	22.6
Factory Meier Mech.Production North-West Wall Door		gg460_mfnw_003	19.7	19.5	18.6	13.9
Factory Meier Mech.Production Roof Trapez Sheet		gg460_mfda_001	33.3	33.4	33.0	29.8
Factory Meier Shipping South-West Wall Gas Concrete		gg460_vssw_001	5.1	4.7	3.6	-1.3
Factory Meier Shipping South-East Wall Gas Concrete		gg460_vsso_001	9.5	0.2	-5.0	-12.9
Factory Meier Shipping RoofTrapez Sheet		gg460_vsda_001	9.0	8.7	8.0	4.4
Factory Meier Production North-East Wall Gas Concrete		gg460_prno_001	10.7	10.8	11.1	9.9
Factory Meier Shipping North-East Wall Gas Concrete		gg460_vsno_001	-12.6	-13.9	-15.7	-20.3
Betrieb Meier Lkw-Fahrweg		gg460_aufw_001	45.3	44.6	43.9	40.7
Astreet		str_0001_001	66.7	66.7	66.5	68.4
Bstreet		str_0002_001	39.8	39.4	40.0	42.7

Partial Level in the dialog of the receiver point see chapter 5.1.5.

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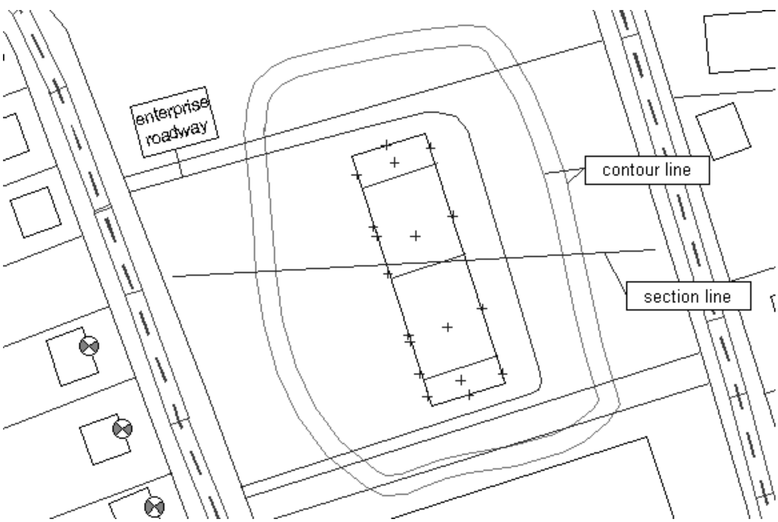
14.2 Variants

The formation of groups offers a very flexible logic for switching between different states of a project. The integration of these group structures into the newly set-up management of variants **(Tables|Variant)** offers you an even more efficient tool for working on your projects.

Examples\
14_ProjectOrg\
Variant.cna

Name	M.	ID	Height	
			Begin	End
			(m)	(m)
		mount	10.00	
		valley	-10.00	
		topo	0.00	

Contour lines with ID (Tables|Obstacles|Contour Line)



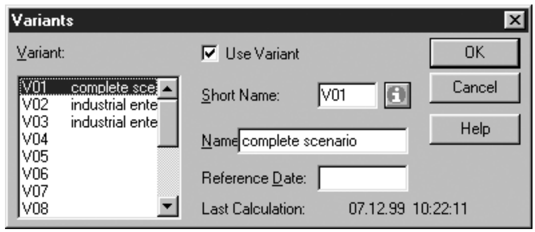
Example: Industrial project with contour lines

In the menu **Tables|Variant** the following dialog can be opened where you can define up to 16 different variants.

Keywords

Output Memo-Field #(VarianteM, Parameter) and output name of variant #(Variante) or #(VarianteL)

see **CadnaA**-manual "Attributes, Variables, and Keywords““



Management of variants in the menu **Tables|Variant**

To do this just click on the relevant line in the list box, activate „use variant“ and enter the desired name in the text box „name“. After clicking the **i**-button you can enter more detailed information. In our example the variants have been defined as follows:

- V01 (all objects),
- V02 (roads deactivated and the industrial enterprise sunk in a valley) and
- V03 (industrial sources deactivated, industrial enterprise located on top of a mount)

If you now open the dialog in the menu **Tables|Groups**, these short names appear as column headings. After the desired groups have been formed in the way you already know, you can set-up a defined on- or off-state for each variant by entering „+“ or „-“.

☝ Activate or deactivate the different groups for the variants by entering „+“ or „-“ directly into the **group table** of the relevant variant column. Do **not** use the group dialog because the options activated there will only be valid for the variant currently selected.

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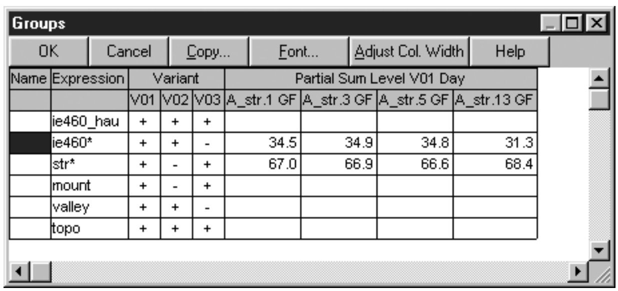
In

- V01 all groups are activated
- V02 the roads and the mountain contour lines are deactivated (the industrial enterprise is located within the -10m contour line and therefore in a hollow)
- V03 all objects of the industrial enterprise except the residential building as well as the 10m contour line are deactivated (the building is therefore located within a 10m contour line on top of an elevation)



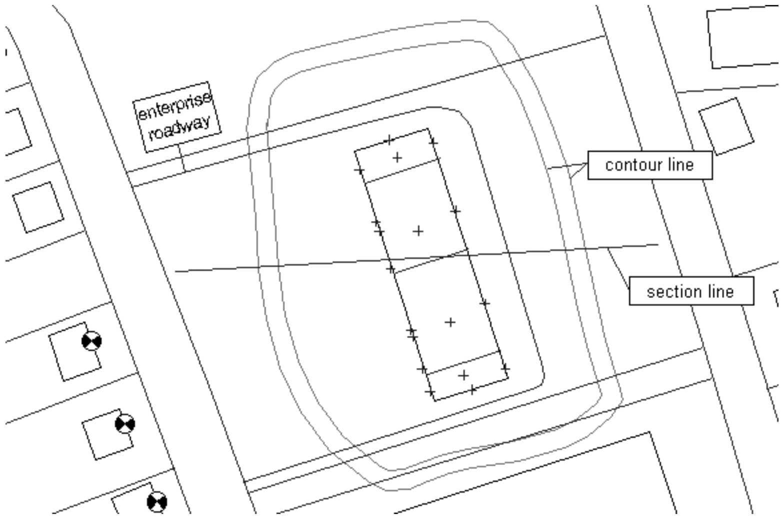
Name	Expression	Variant			Partial Sum Level V01 Day			
		V01	V02	V03	A_str.1 GF	A_str.3 GF	A_str.5 GF	A_str.13 GF
	ie460_hau	+	+	+				
	ie460*	+	+	-	34.5	34.9	34.8	31.3
	str*	+	-	+	67.0	66.9	66.6	68.4
	mount	+	-	+				
	valley	+	+	-				
	topo	+	+	+				

Group table with variants and results of the calculated variant V01.

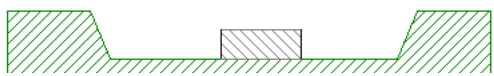
If this assignment is executed, you can easily switch between the different project variants in the corresponding list box of the icon bar.

The variants in use can be selected with a mouse click in the list box

In the given example variant V02 has been selected. The representation of the project and especially the cross section show the consequences expected for this case:

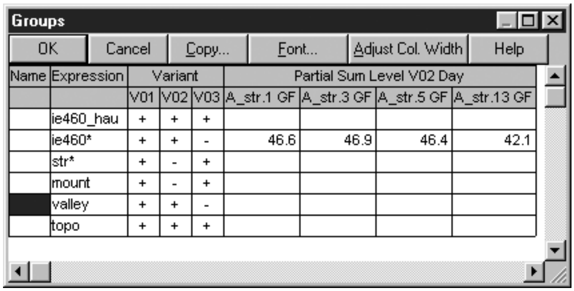


Variant V02 is activated - roads and mountain contour lines are deactivated (the industrial enterprise is located within the -10m contour line and therefore in a valley)



Cross section of the above image - industrial enterprise located in a valley

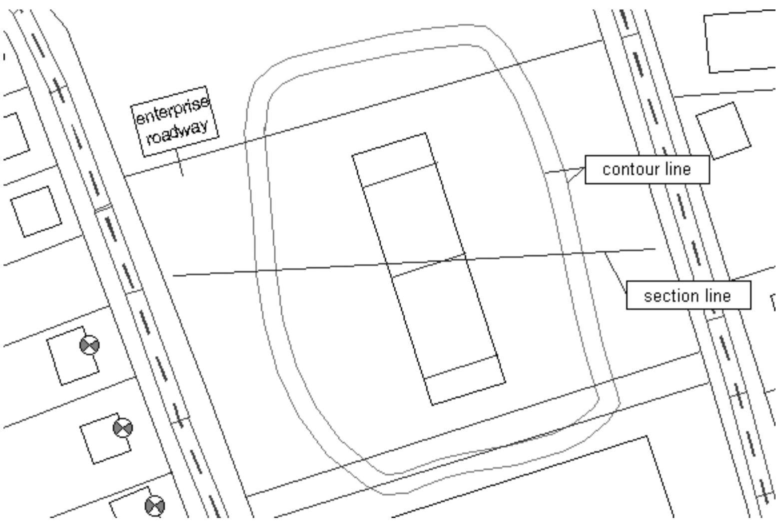
When the calculation is executed, the results relate to the variant defined this way. In the group dialog the rating for the proportionate sound level for each activated group of sources is shown in each table column (receiver points).



Name	Expression	Variant			Partial Sum Level V02 Day			
		V01	V02	V03	A_str.1 GF	A_str.3 GF	A_str.5 GF	A_str.13 GF
	ie460_hau	+	+	+				
	ie460*	+	+	-	46.6	46.9	46.4	42.1
	str*	+	-	+				
	mount	+	-	+				
	valley	+	+	-				
	topo	+	+	+				

List of groups with variants - contour lines with the ID „mount“ are activated in variant V03

According to this, by selecting and calculating variant V03 the project is depicted without industrial sources, but with roads.



Representation of variant V03 without industrial sources, but with roads

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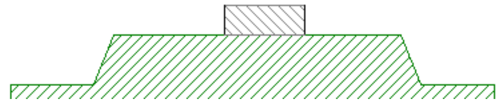


Cross section of above Fig. with elevated building

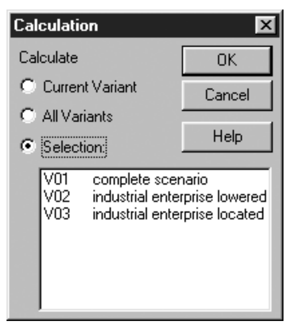
With this description of a simple example only the proceedings in principal shall be explained. There are numerous ways of applying this technique in practice, be it switching between different states of operation with a facility, different architectural variants of buildings or different groups of measures within a reorganization project.

Indications for the calculation of variants

Calculate Variants

☝ By clicking the icon Pocket Calculator on the icon bar only the currently active variant will be calculated.

☝ Via the menu **Calculation|Calc** you may either calculate „all“ or only the „selected“ other „current“ variant/s. Enter the corresponding options on the dialog as required.



Dialog opens after clicking **Calculate** in the menu **Calculation**

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☝ In the dialog **Group Tables|Groups** only the results are shown for the currently selected variant independent, of whether all variants are calculated simultaneously. The same applies for the list of partial levels at the receiver point and in the menu **Tables|Partial Level**.

To display all results of the calculated variants use the **Result Table** from the menu **Tables**. Then use the corresponding layout of the table (see chapter 11.2). You can also save the layout of the result table contained in the file Variantes.cna under a different name and adapt it as desired.

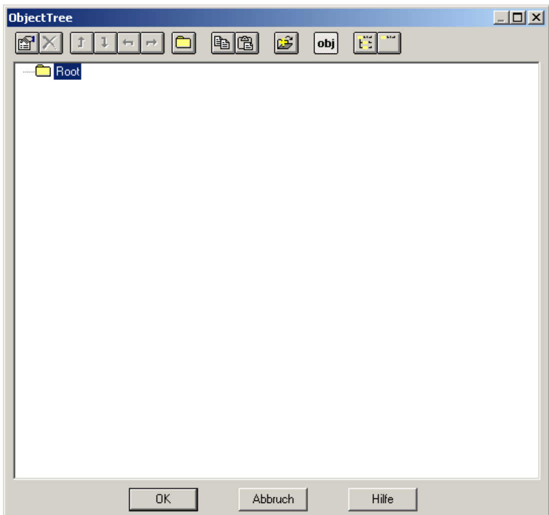
Examples\
14_ProjectOrg\
Variant03.cnt

☝ A file with activated variants contains only one receiver-point grid because of memory space. In case you want to make grid calculations use the commands for **Save** and **Open** in the menu **Grid**.

14.3 ObjectTree

Definition

ObjectTree (menu **Tables|ObjectTree**) allows to arrange the objects of a project in a hierarchic tree structure.

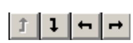


Dialog **ObjectTree|Definition**

The ObjectTree-symbol bar contains the following symbols:

edit
object-properties

delete object



move buttons

insert
object group

copy cell

paste cell

import objects

display objects
On/Off

open structure
of ObjectTree

close structure
of ObjectTree

Symbols on ObjectTree's Symbol Bar

Edit Object Properties

When clicking this symbol the edit dialog of the active object in the ObjectTree will be displayed. In case of group elements (folders) the respective group dialog is displayed. This feature is also accessible by double-clicking on the respective item in the ObjectTree.

Delete Object

By clicking this symbol the active object will be deleted from the ObjectTree, after confirming a prompt. Alternatively, the DEL key can be used to delete items.

☝ When a folder is deleted all folder items inside will be deleted as well from the ObjectTree.

Move Buttons

By the move buttons on the symbol bar the active object can be moved to a different level in the ObjectTree's hierarchy.

- move cell upwards in the hierarchy
- move cell downwards in the hierarchy
- move cell one level up in the hierarchy
- move cell one level down in the hierarchy

Insert Object Group

When clicking this symbol a new folder will be inserted into the ObjectTree, on the hierarchy level of the active object.

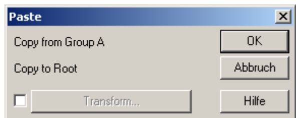
Copy Cell

When clicking this symbol the active object is copied from the ObjectTree and later be pasted at a new location. When a folder is copied, the copy will contain all objects inside.

Paste Cell

When objects have been copied using the command **Copy Cell**, those objects can be inserted at any other location within the ObjectTree.

For example, in order to paste a copy of group A into the root, copy group A, activate the „Root“ by a mouse-click, and select the symbol „Paste Cell“. Subsequently, a dialog will be displayed offering to transform the copied objects to a new location (see chapter 7.1.4 "Coordinate Transformation").



Import Objects

Via this symbol the objects from **CadnaA**-files can be imported into the ObjectTree of the actual file. Besides the **CadnaA**-specific file format (file extension *.cna) all other import formats are available. A new folder will be generated below the presently active hierarchy level. The folder receives the name of the imported file containing all imported objects.

Display Objects On/Off

This toggle enables to suppress the display of all objects inside the defined groups. This holds also for displaying objects on table **Sound Power** and **Partial Level**. So, just the sound power or pressure levels of groups and of the entire arrangement of sources is displayed.

Expand Structure of ObjectTree

By clicking this symbol the structure of the ObjectTree with all subdirectories will be opened. So, with this setting, all objects in all groups are visible.

☝ The recent status of the structure of the ObjectTree is saved to the **CadnaA** file and will be re-displayed when reopening the file.

Collapse Structure of ObjectTree

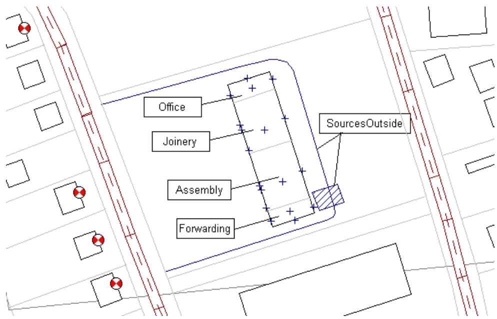
By clicking this symbol the structure of the ObjectTree with all subdirectories will be closed. Just the „Root“ directory will remain. By clicking the „Root“ symbol the first hierarchy level will be re-displayed.

Example

For the shown example shown - an industrial facility - it may be advantageous to define the two main groups "factory_a" and "traffic", where the factory is further subdivided in "sources outside" and the different production areas. The sources are then linked to these subgroups.

Examples\
14_ProjectOrg\
ObjectTree_E.cna

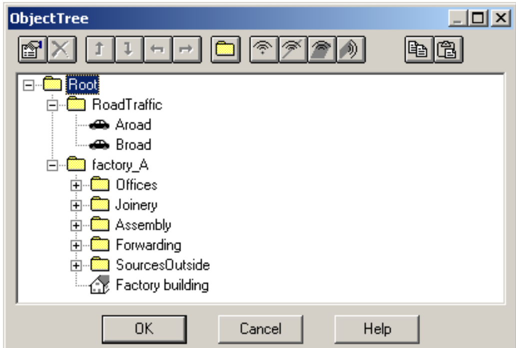
You will find the example file with the industrial site on your CD.



Industrial facility with source structure

Definition and Editing

This structure is created in **Tables|ObjectTree|Definition**. With Marker on "Root" each click on the symbol directory creates a group-symbol. Using the arrow icons this group symbol can be moved to any position inside the structure.



Group structure on dialog **ObjectTree|Definition**

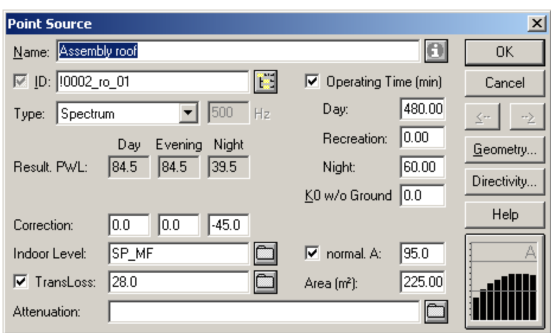
☝ The group structure on dialog ObjectTree will be displayed as well on menu **Tables|Group** (using indents).

Assigning Objects

After having created this structure the objects are linked with the relevant groups. There are two methods available: individual and automatic assignment.

Individual Assignment of Objects

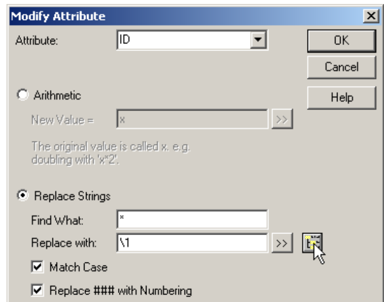
With a click to the ObjectTree-Icon to the right of the ID in the edit window of an object the dialog **ObjectTree** is shown. Click onto a group symbol and close the window by OK will assign this object to the selected group.



Dialog **Point Source** showing the ObjectTree-icon

Automatic Assignment of Objects

There is also the possibility of the automatic assignment of objects in order to speed up the procedure of addressing objects to groups. Open the dialog **Modify Objects**, action „Modify Attribute“, and select the attribute ID and the option „Replace Strings“ enabling access to the ObjectTree.

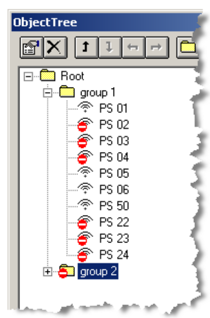


Dialog **Modify Attribute**, accessing the ObjectTree

By click with the mouse on the ObjectTree-symbol access to the ObjectTree is provided. Select a group in the ObjectTree as required and confirm the action.

Deactivated Objects

Deactivated objects or object groups will be marked on dialog **Object-Tree|Definition** by a red deactivation symbol.



Deactivated objects or object groups

Sound Power Level

On menu **Tables|ObjectTree|Sound Power Level** a table of sound power levels is produced. The sound power levels of all sources linked to a group are added energetically and presented as the sound power level of the group.

Sound Power Level

Close | Sync. Graphic | Copy... | Print... | Font... | Help

Name	Expression	Sound Power Level PWL Day (dB(A))										
		31.5	63	125	250	500	1000	2000	4000	8000	A	lin
Root	!*	54.2	67.4	77.5	85.0	90.4	93.6	94.8	94.6	92.5	107.3	103.1
factory_A	!00*	54.2	67.4	77.5	85.0	90.4	93.6	94.8	94.6	92.5	100.6	103.1
Offices	!0000*	3.1	16.3	26.4	33.9	39.3	42.5	43.7	43.5	41.4	49.5	52.1
Office NE facade aerated concrete	!0000_ne_01	-10.6	2.6	12.7	20.2	25.6	28.8	30.0	29.8	27.7	35.8	38.3
Office NW facade aerated concrete	!0000_nw_01	-5.9	7.3	17.4	24.9	30.3	33.5	34.7	34.5	32.4	40.5	43.1
Office SW facade aerated concrete	!0000_sw_01	1.4	14.6	24.7	32.2	37.6	40.8	42.0	41.8	39.7	47.7	50.3
Office roof	!0000_ro_01	-4.6	8.6	18.7	26.2	31.6	34.8	36.0	35.8	33.7	41.7	44.3
Joinery	!0001*	53.8	67.0	77.1	84.6	90.0	93.2	94.4	94.2	92.1	100.2	102.7
Joinery NW facade aerated concrete	!0001_sw_02	29.1	42.3	52.4	59.9	65.3	68.5	69.7	69.5	67.4	75.5	78.0
Joinery SW facade door open	!0001_sw_03	53.6	66.8	76.9	84.4	89.8	93.0	94.2	94.0	91.9	100.0	102.5
Joinery SW facade windows	!0001_sw_01	32.9	46.1	56.2	63.7	69.1	72.3	73.5	73.3	71.2	79.3	81.9
Joinery roof	!0001_ro_01	37.8	51.0	61.1	68.6	74.0	77.2	78.4	78.2	76.1	84.2	86.8
Joinery NE facade aerated concrete	!0001_ne_01	31.9	45.1	55.2	62.7	68.1	71.3	72.5	72.3	70.2	78.2	80.8
Assembly	!0002*	37.2	50.4	60.5	68.0	73.4	76.6	77.8	77.6	75.5	83.6	86.1

ObjectTree: table **Sound Power**

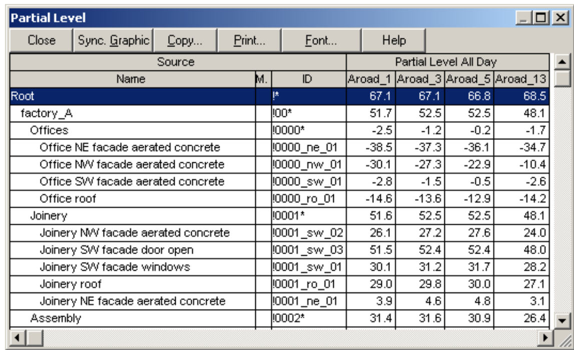
This table provides an excellent overview on the contribution of all parts to the total emission. When this table is sorted with respect to the data in a single column, this sorting is first applied with the groups of the highest level in the hierarchy, then to the groups of the following level and at the end with the sources in each group.

Synchronization ObjectTree - Graphics

Sources selected either on the dialog **ObjectTree|Definition** or in the table Sound Power will be highlighted in the graphics. This faciliates to check for the location of sources being part of an ObjectTree-group.

Partial Level

After calculation for all receivers a table of the partial levels of all sources at all receivers can be produced via **Tables|ObjectTree|Partial levels**. This table shows not only the partial levels produced by each source, but also these produced by all sources of a group together. The table is related to the selected variant and evaluation parameter.



Source			Partial Level All Day			
Name	M.	ID	Aroad_1	Aroad_3	Aroad_5	Aroad_13
Root		!*	67.1	67.1	66.8	68.5
factory_A		!00*	51.7	52.5	52.5	48.1
Offices		!0000*	-2.5	-1.2	-0.2	-1.7
Office NE facade aerated concrete		!0000_ne_01	-38.5	-37.3	-36.1	-34.7
Office NW facade aerated concrete		!0000_nw_01	-30.1	-27.3	-22.9	-10.4
Office SW facade aerated concrete		!0000_sw_01	-2.8	-1.5	-0.5	-2.6
Office roof		!0000_ro_01	-14.6	-13.6	-12.9	-14.2
Joinery		!0001*	51.6	52.5	52.5	48.1
Joinery NW facade aerated concrete		!0001_sw_02	26.1	27.2	27.6	24.0
Joinery SW facade door open		!0001_sw_03	51.5	52.4	52.4	48.0
Joinery SW facade windows		!0001_sw_01	30.1	31.2	31.7	28.2
Joinery roof		!0001_ro_01	29.0	29.8	30.0	27.1
Joinery NE facade aerated concrete		!0001_ne_01	3.9	4.6	4.8	3.1
Assembly		!0002*	31.4	31.6	30.9	26.4

This table can also be sorted according to the partial levels at a receiver point. In the example shown the data have been sorted according to the column "Aroad_1". From this sorted table it can easily be concluded that road traffic contributes more than the factory and that the different parts of the factory contribute according to the sequence:

Joinery - Assembly - SourcesOutside - Forwarding - Offices

at receiver Aroad_1.

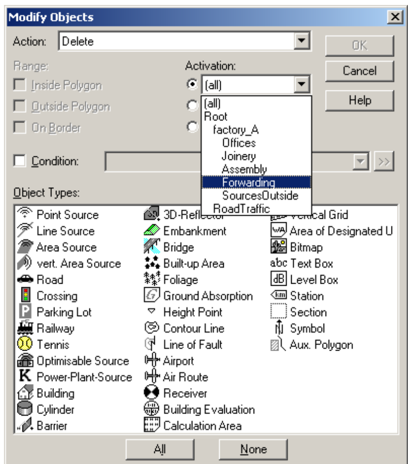
Copying Objects

In **Tables|ObjectTree|Definition** complete groups with all sub-structures and objects can be duplicated with a single copy-action. The selected group is marked and then copied to the clipboard by clicking to the copy-icon. With a further click to the insert-icon a window opens that allows to define a transformation. After accepting by clicking to OK all objects of this group are copied to the position defined by the transformation. Nothing further must be done - the correct ID's defining the hierarchic structure are written into the ID edit lines of the objects automatically.

This is an extremely efficient method to produce an array of units in a power plant if one single unit has been modelled and tested carefully.

Selection of objects via "Modify Objects"

The groups defined in ObjectTree are also shown in the group list **Tables|Groups**. Together with all other defined groups. These groups can also be used to restrict an action selected in the "Modify objects" command to the objects linked to such a group.



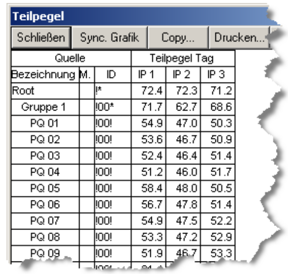
Dialog **Modify Objects**: restricting an action to the objects within a group

Suppress Display of Octave Levels

Displaying columns with octave levels can be suppressed y a corresponding entry in the file CADNAA.INI. The file CADNAA.INI is per default located in the WINDOWS-directory on your C-drive. If required open this file and add to the section [Main] the following line:

ObjTreePartLevSpekImmAnz=X

This variable X specifies the maximum number of receiver points whose octave levels are displayed in the table **Partial Level** of the ObjectTree. No octave levels will be displayed with X=0 (zero).


Teilpegel

Schließen | Sync. Grafik | Copy... | Drucken...

Quelle			Teilpegel Tag		
Bezeichnung	M.	ID	IP 1	IP 2	IP 3
Root		!*	72.4	72.3	71.2
Gruppe 1		!00*	71.7	62.7	68.6
PQ 01		!00!	54.9	47.0	50.3
PQ 02		!00!	53.6	46.7	50.9
PQ 03		!00!	52.4	46.4	51.4
PQ 04		!00!	51.2	46.0	51.7
PQ 05		!00!	58.4	48.0	50.5
PQ 06		!00!	56.7	47.8	51.4
PQ 07		!00!	54.9	47.5	52.2
PQ 08		!00!	53.3	47.2	52.9
PQ 09		!00!	51.9	46.7	53.3

Table **ObjectTree|Partial Level** without octave levels

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14.4 Date of Objects in Info box

The **Date Interval** in the field **Info** of an object dialog enables you to enter a date or date interval for each type of object. By entering a **reference date** you can also define whose objects are valid for the execution of a calculation. This application is appropriate for, e.g., the execution of long-term noise abatement measures for which the effects of partial measures shall also be recorded at the receiver point.

You enter the **reference date** in the menu **Tables|Variant** for the corresponding variant. All objects that do not correspond to the given date will then be deactivated.

If there is **no** date entered in the field **info**, all objects will be valid, even if a reference date for the calculation has been entered.

If you define a date, only the objects corresponding to the date interval of the reference date in addition to those objects that have no date will be taken into consideration in the calculation.

Example

Date interval from: 01.10.1999 - reference date 30.09.1999 - the object is not considered in the calculation.

Date interval to: 1.10.1999 - reference date 30.9.1999 - the object is taken into account for the calculation.

Date interval from: 1.1.1999 **to:** 31.12.1999 - reference date 30.9.1999 - the object is also taken into account for the calculation.

14.5 Managing Project Variants using Folders

If you have extensive files and maybe long-term projects it could be useful to separate objects - like, e.g., buildings, road traffic or industry - by saving them in different files and linking them on demand via import for a calculation.

This has the advantage that only the „mother-files" have to be updated in case of alterations and not all possible copies of this file.

You will often import separately managed files in one common file to perform a calculation.

In order to avoid having to do this manually, and to gain control of the lots of little "Sticky Notes" listing all the files belonging to one project, **CadnaA** offers you the "Folder" tool called Mappe-file.

☝ The **CadnaA** folder is an ASCII file listing the names of all **CadnaA** files to be combined in one project file. As soon as you open this Mappe-file, **CadnaA** automatically loads all files listed in it.

You may specify an arbitrary name for the Mappe file. (In the example below, we choose PROJECT.CNA.). As it is an ASCII file, you may edit it using any editor (also a word processor, such as MS WORD – but then make sure you save the file as *.TXT.). An example of such a file might look like this:

Text in Project.cna	Explanation
Cadna/A Mappe 1.0	This text is compulsory and must appear on the first line! Switch to next line by pressing RETURN.
;now follow the files	This is a comment line.
Ground.cna	In this example a file containing only contour lines. Press RETURN.
Road.cna	In this example a file containing only roads. Press RETURN.
Building.cna	In this example a file containing only buildings. Press RETURN.
e:\tmp\folder5\folder2000\Area s.cna	A file lying in certain directory. The path must be specified whenever a file is to be included which does not lie in the same directory as the folder file.

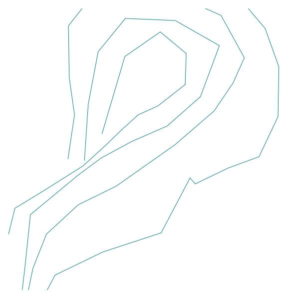
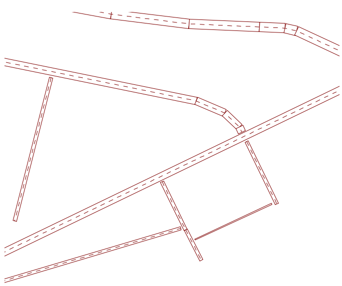
☝ Each file, which is to be imported, must appear on a separate line (RETURN). You can also insert other folders in a folder file.

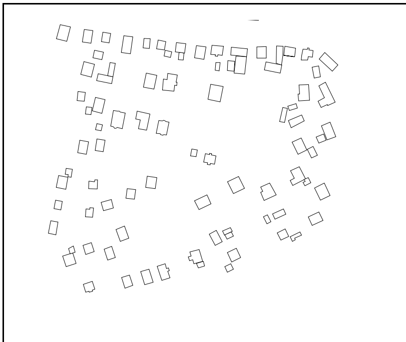
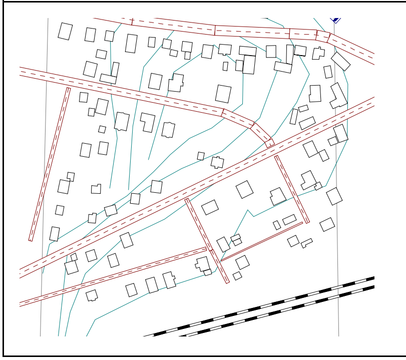
This is what the above file should look like:

```
Cadna/A Mappe 1.0
;now follow the files
Ground.cna
Road.cna
Bulding.cna
e:\tmp\mappe5\mappe2000\Areas.cna
```

☝ You should write-protect this file!

When you open the Project.cna file in **CadnaA**, using the **File|Open File** command, **CadnaA** opens the first file listed in Project.cna – Ground.cna in our example –, and imports the files listed after it. By default, the name of the resulting combined file will be the name of the Mappe file. If you wish to keep this file, use **Save File As** to give it a different name.

	Ground.cna
	Road.cna

	Building.cna
	Project.cna (folder file) loads all the desired files simultaneously and into the same file.

Example

Try for yourself:

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- Check this procedure using the file Demo1.cna which you already know. Create a few files, each of which contains only one type of objects, i.e. one file each for roads, buildings etc. To achieve this, use the context menu command **Modify Objects** (see manual "Introduction to **CadnaA**").

Examples\Demo1.cna

- Open file **Demo1.cna**.
- Select any building by clicking it with the right mouse button. Select **Modify Objects|Action: Delete** from the context menu.
- In the dialog **Modify Objects**, click the **All** button, then click **Road** while holding the CTRL key down. This excludes the roads from the action.

- Activate all three options **Inside, Outside, On Polygon Borderline.**
- Click **OK**. Then confirm **All** in the next dialog. All objects except the roads will have been deleted. (Sorry, not all: The selected building is still there and must be deleted using the DEL key.)
- Save file as – enter a name – e.g. Road.cna.

Create further files with the separate object types. (Such as railways – *Train.cna*, area sources – *Industry.cna*, buildings – *Building.cna*). Finally, the calculated grid with the calculation configuration is to be saved. To this end, delete all objects, except the BMP file, as described above. Then save the grid as Result.cna.

Now open an editor (such as Wordpad) or a word processor. In our example we used MS Word. Create a new file and enter the object files you created.

```
Cadna/A Mappe 1.0
Result.cna
Road.cna
Industry.cna
Train.cna
Building.cna
```

- Save this file as a text file named Project2.cna (You can also save it as Project2.TXT) – **CadnaA** will recognize this as a folder file). Close the file.
- Run **CadnaA**. **File|Open File**, and select Project2.cna (or Project2.txt). The complete file that used to be Demo1.cna will be restored.

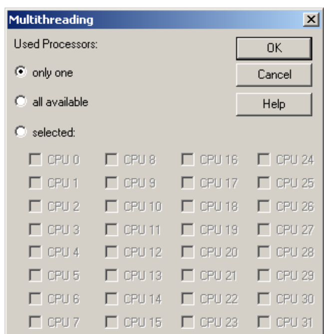
☝ A calculated grid, like, e.g, a noise map, cannot be imported. This is why you should list the result file first. The first file in the folder is opened, whereas all others are imported into the opened file. This is also why the first file should contain all the settings, such as the calculation configuration, because the file that is open determines the calculation configuration and all other settings.

14.6 Multithreading

CadnaA makes use of multithreading and, thus, uses the full capacity of multiprocessors. Practically all new desktop- and laptop-PCs use dual processors and, therefore, cutting down the calculation time to half at once. **CadnaA** is prepared to use up to 32 parallel processors and thus ready for future hardware developments.

Used Processors

By default, the option „Use only one processor" is selected on dialog **Options|Multithreading**. Alternatively, the CPU-usage can be extended to all processors or be addressed to a individual processors. A prerequisite is, of course, that your PC has more then one processor.



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Make your settings and confirm with OK. **CadnaA** keeps the settings when closing the program. After a new start of **CadnaA** they will be used.

Multi-Threaded Processes in CadnaA

CadnaA makes use of multi-threading for the following calculation tasks:

- receiver points, as long as the calculation protocol is not activated (menu **Calculation|Protocol**),
- building evaluations or facade points, respectively, and
- horizontal and vertical grids.

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14.7 Batch Operation

It is possible with **CadnaA** to automatically calculate in succession a grid or individual receiver points. This is especially interesting for long-term calculations if you, e.g., want to calculate different variants during the weekend or over-night.

The required steps to set-up the batch processing are explained in the following.

Change Command starting CadnaA

- Activate the **CadnaA** link on the WINDOWS desktop by clicking it with the right mouse button.
- Select the context menu command **Properties**.
- Insert into the box „Target“, after the string „cna32.exe“ a single blank and the following string: `/batch=1`

Subsequently, the dialog looks like shown on the following page.

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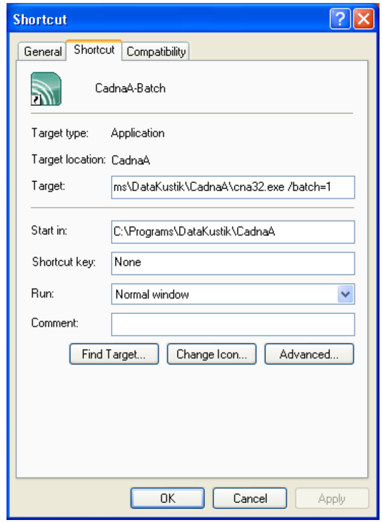


Input box „Target“ extended by „ /batch=1“

CNABATCH IN and OUT

- Create a directory **CNABATCH** on your C-drive. In **CNABATCH**, create two sub-directories called **IN** and **OUT**.

☝ Naming the sub-directories IN and OUT is mandatory!

CNABATCH is the default directory for the batch feature. If you use this name, no modification of the Cadnaa.ini file is required. (If you wish to use a different name, see below.)

The paths then are:

C:\CNABATCH\IN
C.\CNABATCH\OUT

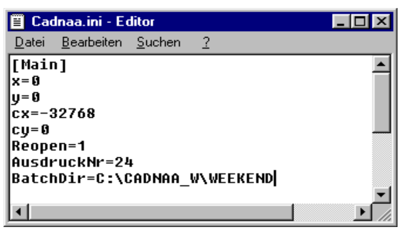
- Copy all those *.CNA files to be processed into the **IN** directory. It goes without saying that in each project file the calculation configuration and the immission point grid must be defined accordingly.

Entry in CADNAA.INI if necessary

If you do not stick to the default directory name **CNABATCH** on drive C, an entry must be made in the file CADNAA.INI residing in the Windows directory (e.g., ...\WINDOWS (for Windows 3.11/95) or ...\WINNT (for Windows NT) etc.).

- Open this file using an editor and insert the path where your two directories **IN** and **OUT** are, in the series of commands following the header [Main]. If, for example, the directory is WEEKEND instead of CNABATCH, and WEEKEND itself contains in a directory CADNAA_W, you will have to insert the following line:

  BatchDir=C:\CADNAA_W\WEEKEND



- Then save the file and close it.

Launching the automatic calculation

When **CadnaA** is launched with the parameter /batch=1 on the expanded command line, it will check the **IN** directory for files every 30 seconds. If any files are found, these will be opened and calculated one by one. The results will be saved under the same name in the **OUT** directory, and the files already calculated are deleted from the **IN** directory.

Once **CadnaA** has processed all files, close the program as usual.

☝ **CadnaA** should not be run using the batch mode for normal project work, but just for batch calculations because in the batch mode the software attempts to open any files in the IN-directory.

In order to save the trouble of having to delete and re-enter the batch parameters on the command line over and over again, you may wish to create an additional **CadnaA** shortcut on the WINDOWS desktop (e.g. by copying) where the batch parameter is set permanently. For clarity, the new shortcut might be named, e.g. `CadnaA-Batch`. Use this shortcut to launch the program for a batch calculation.

This enables a highly time-efficient and professional work with **CadnaA**, particularly if several PCs are available in a network.

In this context also pay attention to the comprehensive facility of PCSP (**P**rogram **C**ontrolled **S**egmented **P**rocessing) - (see chapter 14.8).

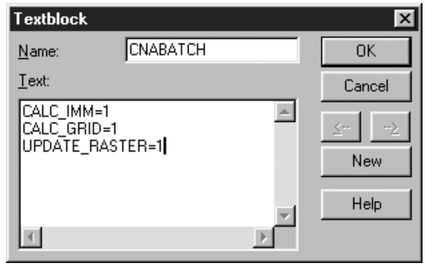
Options BATCH Command

By the BATCH command it is possible to execute calculations automatically for grids (noise map) or individual receiver points for several files or to continue a stopped calculation at the point where it has been stopped. The selection of the desired mode is controlled by parameters in text blocks (see chapter 12.4). If you do not create a text block a grid is calculated automatically.

To define parameters for calculations in the Batch mode create a local text block named CNABATCH (pay attention to the capital letters). Enter one or more of the following commands to execute the corresponding calculation:

Parameter	=	calculation of
CALC_IMM	1	receiver points (currently displayed variant)
CALC_IMM	2	receiver points (all variants)
CALC_IMM	0	no receiver points (default)
CALC_ RASTER	1	grid (default)
CALC_ RASTER	0	no grid
UPDATE_RASTER	1	continue calculation at the interrupted position (as Shift+calc grid)
CALC_MESSAGE	Computer1	
CALC_POLL	1	calculation of air pollution with option APL

☝ Note: CALC_IMM corresponds as well to the individual inserted receivers as to the building evaluation.



Textblock in **CadnaA**

Several Computers and the Batch Command

Access to the same folder/directory through several computers is unambiguously regulated in the Batch mode. If a file is opened, the extension of this file is renamed from CNA in CNC - another opening of this file is therefore impossible. After finishing the calculation the extension is again renamed in CNA and saved in the corresponding OUT directory.

Message after finishing the calculation

You can get an electronic message if a calculation is completed by **CadnaA**. For that it is required that you have installed a message program (e.g. WinPopUp) on your computer and that you have created a local text block named CALC_MESSAGE in your file. In this textblock the computer path or the computer which should get the message must be contained.

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14.8 PCSP - Program Controlled Segmented Processing

CadnaA is able to process more than 16 million objects per object type without any problems, even models of cities. Therefore, the limiting file size is normally given by the PCs RAM. With **PCSP** even this limit is irrelevant.

Program controlled segmentation with user-defined partitioning allows you to load automatically the segments one after another for calculation. Thus the RAM is able to work without hard disk access.

If several **CadnaA** computers are at your disposal for calculation, e.g., within a network, they can simultaneously work on the same project file. PCSP with its PCSP-Part-Viewer by **CadnaA** automatically organizes and manages the required processes.

Choose Batch-Directory

In order to specify a directory for the batch-calculation select form the menu **Calculation|PCSP** the command **Choose Batch-Directory**. On the subsequent dialog you may either select an existing directory or generate a new one. Upon confirmation by OK **CadnaA** creates the sub-directories IN and OUT within the selected directory.

How to activate PCSP

Quick instruction

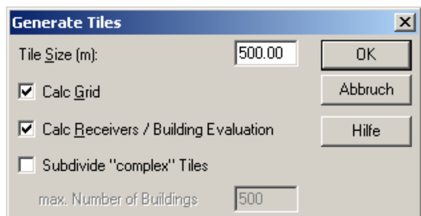
1. Generate in your file to be calculated sections used the subdivide the area into equal sized tiles. This procedure is called "tiling" (see chapter 9.10).
2. Give the sections a special designation:
   `PART: xyz` (where „xyz“ represent an arbitrary string)
3. Start **CadnaA** in the batch mode (see chapter 14.7).

Generate PSCP-Tiles

Step 1 and 2 does **CadnaA** automatically with the command **Generate PCSP-Tiles** via menu **Calculation|PCSP**.

This produced quadrate PCSP tiles with the entered length and the essential identifier in the field ID e.g. PART:030. Do not delete this entry as it is mandatory for the PCSP calculation.

☝ Before generating PSCP tiles a calculation area has to be defined first!



Calculate Grid

The option **Calculate Grid** generates quadratic tiles with the defined edge length across the entire calculation area.

Calculate Receiver / Building Evaluation

The option **Calculate Receiver|Buildings Evaluation** generates quadratic tiles with the defined edge length which includes all receiver points and buildings evaluation symbols.

Subdivide „complex“ Tiles

This option subdivides tiles depending on the specified maximum number of buildings in each tile. When the specified number of buildings is exceeded **CadnaA** subdivides the original tile - in the first step - into four tiles and rechecks for the criterion. When necessary these tiles are subdivided subsequently until the criterion is met. The minimum tile size (edge length) for the subdividing process of complex tiles is 100 m.

User-defined Tiling

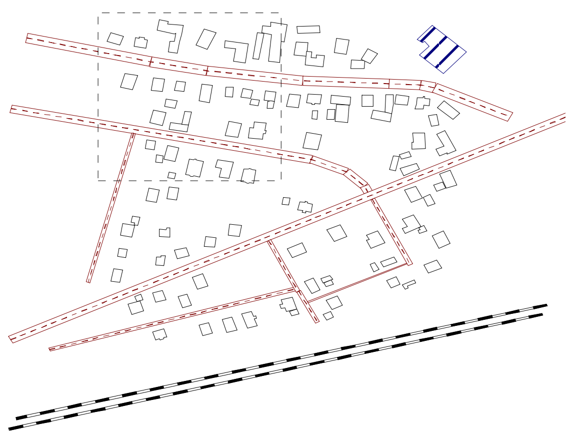
Naturally you can partition your project on your own with arbitrarily amounts of tiles and user-defined dimensions by inserting them manually or with the command **Duplicate** which is described step by step in the following. Skip this instruction if not necessary and go on with *step 3* „Start **CadnaA** in the batch mode (see chapter 14.7) for calculation“.

Step by Step
Step 1:

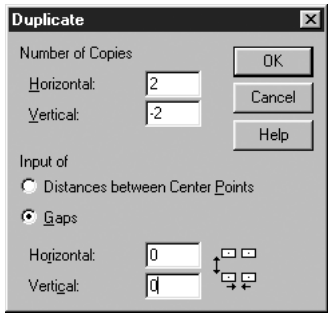
"Tiling" a file using sections

Examples\Demo1.cna

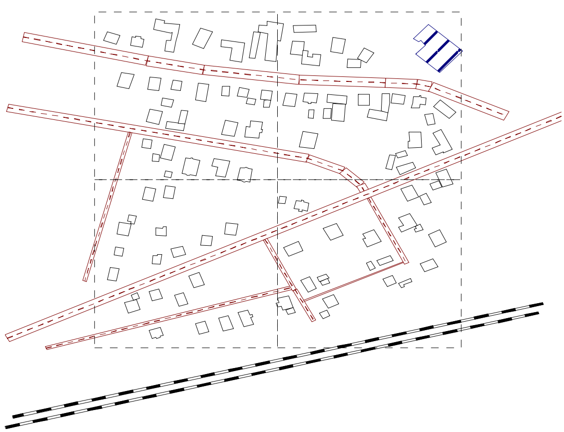
- To follow this example, open the file Demo1.cna - it is on your **CadnaA** CD by default.
- Delete the grid (menu **Grid|Delete**)
- Save the file under a different name, e.g. DemoPCSP.cna
- Paste a correspondingly large section - in the given example in the upper left-hand corner - in the file you would like to calculate. The section may have any desired size.
- Subsequently, duplicate this section in a way that will cover your project file entirely and seamless. In the given example there are two horizontal sections and two vertical sections, altogether 4 sections. To this end, mark the section with the right mouse button and select the command **Duplicate** from the context menu. The receiver-point grid will only be calculated within the sections created this way.



First Section in this example



Settings for duplicating the section

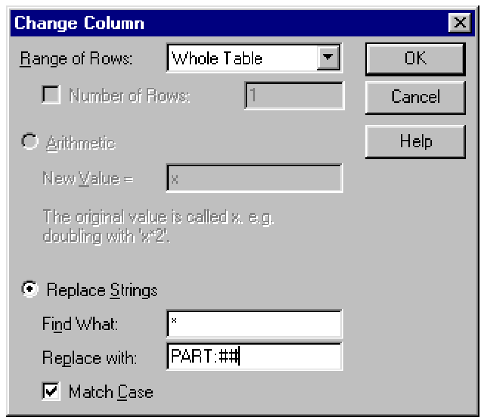


Here is an example of a "tiled" file with 4 sections from which a receiver-point grid is to be calculated. You could further modify this by pasting a calculation area covering all sections. In this case only the calculation area within the tiles would be calculated.

Step 2:

Name Sections

- Open the table **Section** (**Table|Other Objects|Section**)
- Open the table context menu by clicking on the column „Name“ with the right mouse key and select Change Column.
- To give all sections the name „PART:“ and a consecutive numbering, enter the necessary information into the dialog box as is shown in the following picture.



Note that the word „PART:“ must be written in capitals. The two # will automatically number the section with two-digit numbers. Behind the colon, however, you can enter any desired name, but you must not leave it without a name. In the given example these tiles/segments are named PART:01 to PART:04.

- Enter the desired spacing for the grid of receiver points on menu **Grid|Properties**. This setting will apply to all tiles.
- Enter the corresponding settings in **Calculation|Configuration**. Above all, note the **Max. Search Radius** in the **General** tab (see step 3.).

For the calculation start CadnaA in the batch mode (see chapter 14.7)

Step 3:

After you have created and named all the sections, save the file in the corresponding IN-directory!!! When you have tiled a file in the described way, **CadnaA** will automatically create a second file with the extension "Part" (e.g. DemoPCSP.cna.part). This file must also be located in the IN-directory. Therefore it is easiest to save the tiled file directly in this directory because **CadnaA** automatically saves it in the same directory. Now start **CadnaA** in the batch mode. (If necessary, refer to the manual or online help - keyword: batch).

CadnaA now recognizes that this file is segmented. The program calculates each tile separately, taking into account not only those objects located within the tile, but also those objects located within the selected search radius. Then **CadnaA** saves the calculated grid in the corresponding OUT-directory . These grid files have the same names as the original files and are combined with the extension of the section name but without "PART":. In our example it would be DemoPCSP.cna.01.cna, DemoPCSP.cna.02.cna (and so on).

So, if you have several computers in a network or multi-processor computers at your disposal, they can calculate the individual tiles at the same time. **CadnaA** automatically organizes the distribution of the tiles to the computers/processors involved. In this case all the computers involved have to be started in the batch mode, and all of them have to "observe" the same IN-directory. When working with a multi-processor computer **CadnaA** must be started as many times as there are processors in the computer.

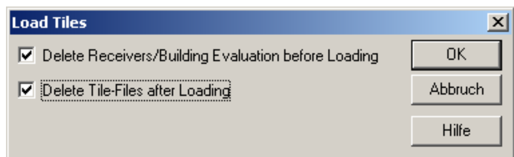
Refresh PCSP-Tiles see paragraph PCSP-Part-Viewer below.

Refresh PCSP Tiles

Load Tiles

After calculation import the results for the grid and/or the calculated building evaluations and receiver points using the command **Load PCSP-Tiles** on menu **Calculation|PCSP**. This will establish the link between the buildings on the one hand and the building evaluation symbols on the other hand automatically.

When the buildings are saved separately from the building evaluation symbols after finalization of a PCSP-calculation, however, the link between both has to be reestablished when not having applied the command **Load PCSP-Tiles** on menu **Calculation|PCSP** (see also section „Importing Building Evaluation Symbols“ in chapter 5.4 Building Evaluation).



Dialog **Load Tiles**

Delete Receivers/ Building Evaluation before Loading

In order that the receivers or building evaluation are not doubled included in the project file they will be deleted before loading the results if this option is activated.

In case only the grid has been calculated without receivers /building evaluation deactivate this option.

Delete Tile-Files after loading

The calculated tile-files, which are located in the **OUT**-directory, are deleted automatically if this option is activated.

PCSP-part-viewer Refresh PCSP Tiles

The PCSP-part-viewer shows the progress of calculation by colored tiles. By this feature you receive an up-to-date information about the calculation progress, in special with large projects.

Displaying the calculation progress

Select from the menu **Tables|Miscellaneous** the command **Refresh PCSP-tiles**. Upon selection the predefined tiles are colored:

red = unprocessed tiles
blue = tiles presently being processed
green = finalized tiles
grey = calculation interrupted

The display of the calculation process is not updated automatically, but has to be engaged manually by re-selection of the command **Refresh PCSP-tiles**. This procedure ensures that the calculation is not slowed down by continuous queries.

Displaying the processing status of the tiles after a calculation

Normally, all tiles should be calculated and are, therefore, displayed in green. If not, check the processing status in the dialog **Info-field** of the respective tile. The following variables are displayed:

Example:

STATUS=2
COMPUTER=LIPRO
TIMEBEG=28.05.2004 15:44:52
TIMEEND=28.05.2004 15:44:58
TIMESECS=5

Legend:

Parameter	Description
STATUS	0 not calculated (red) 1 calculation in process (blue) 2 calculation finalized (green) 3 calculation interrupted (gray)
COMPUTER	computer's name
TIMEBEG	start of the PCSP-calculation
TIMEEND	end of the PCSP-calculation
TIMESECS	required calculation time of the respective tile (in seconds)

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Local Textblock PCSP

During the batch-calculation **CadnaA** automatically creates a local textblock with the name PCSP containing the information of the file processing status, e.g.:

PARTS=25
RADMAX=2000.00
TIMEBEG=28.05.2004 15:44:13
TIMEEND=28.05.2004 15:45:38
TIMESECS=76

where:
:

Parameter	Description
PARTS	number of tiles calculated
RADMAX	search radius (m) around a tile

The time displayed addresses the begin and the end of calculation and the total calculation time (sec) of all tiles together.

Monitor

To watch the calculation process of a **CadnaA**-file with PCSP which is saved on a server and which has been started in Batch-mode, just open this file from your client without batch-mode. In this case serves the **CadnaA** window as monitor.

14.9 Dynmap: The dynamic Noise Map

A noise map generated with **CadnaA** can now be updated dynamically using measured data.

The most important application of this feature is the direct coupling to automatic monitoring systems installed along main roads or in the vicinity of industrial plants or airports. The measured data is automatically transferred to the **CadnaA**-PC to update the noise map and to display the result in a bitmap file.

This operation is extremely fast as no further recalculation of the sound propagation is required to adapt the noise map to the measured data. Each monitoring station is installed in such kind that the dominating sound pressure level is measured from the allocated sound source only.

For each of the monitored noise source and for the remaining noise sources together noise maps with the whole urban area have to be calculated and saved separately. By 30 monitoring systems have to be calculated 31 noise maps in the run up.

CadnaA samples the measured data, adds the resulting difference with respect to the original grid data to the total noise map and calculates by energetic summation of all updated noise maps the new total noise map.

The updating process can either be based on measured sound level data or e.g. on automatically registered traffic count data or other source parameters.

With sound level data provided by the monitoring system **CadnaA** - e.g. hourly mean level Leq - enables to display up-to-date information by a noise map referenced to e.g. the preceding hour. Further CadnaA-features allow to present noise maps as public information via the Internet.

Depending on the configuration, noise maps can be generated even for past time periods. Whether the L_{den} of the preceding year or the mean sound level on all Sundays of the last month shall be displayed, by applying the dynamic noise map DYNMAP of **CadnaA** this is performed automatically, with the well-known **CadnaA**-precision and – if required – fully integrated into a GIS-system.

DYNMAP is not an extra option of **CadnaA** but integrated in the program itself.

Procedure:

Create or import your project file with all desired noise sources, buildings etc.

Determine the position of the monitoring systems for all dominating noise sources. Mark the positions in the CadnaA file with e.g. a receiver point or text frame.

For all monitoring systems determine the dominating noise sources which emission data have to be reassigned to the altered value. To do so just create groups in CadnaA. All noise sources which are assigned to a monitoring system get the same **ID**, e.g. for the monitoring system one the **ID** V01, for the monitoring system two V02 etc.

Calculate a separate noise map for each of these noise groups and save this map with **Grid|Save as** CNR file with a distinct name, e.g. V01.cnr, V02.cnr etc. Create variants and activate or deactivate the corresponding noise groups for which you like to calculate a noise map. All other noise sources which are not monitored but are included in the project file remain untouched activated for each calculation of a variant.

Calculate a noise map with all **not** monitored remaining noise sources. For that deactivate all other monitored groups of noise sources in this variant. Save this noise map, too, e.g. with the filename RST.CNR.

Calculate a overall noise map with all noise sources activated or sum all separate calculated noise maps via the **Grid|Arithmetic** (r0++r1++r2...) and create thus the overall noise map. Now save your project file with the current overall noise map as CadnaA file. In the further below mentioned example we have called this file MEAS.CNA.

Furthermore you will also need the following files to achieve the dynamic noise mapping which you will find on your **CadnaA** CD.

URSVAL.INI

URSVAL.INI (a Windows-INI-file) in which the deviation is written from the primary value to the corresponding measured value of the monitoring system. It makes sense to write a user-defined macro or a little program which analyzed the measured data of the monitoring system and which writes the deviation into this INI-file.

```
Example
[ursval]
val01=0
val02=8
val03=0
val04=0
```

The string val*n*= is mandatory and is the alias name of one of the monitoring system in the project file together with the deviation from the primary measured value (val02=8 means that the measured value is increased by 8 dB from this monitoring system). *n* is a serial numbering starting with 01. The corresponding noise map, e.g. V02.CNR, will be updated with this new value via grid arithmetic. Insert as many rows as monitoring systems exist which you like to evaluate. If you have ten monitoring systems you should have ten rows with val*n* between val01 and val10.

MEAS.CNM

MEAS.CNM is a CadnaA macro which can be adjusted by the user itself corresponding to his project. It opens the CadnaA file with the existing noise map, makes the grid arithmetic taken into account the deviation of the measured values form the URSVAL.INI and creates a Bitmap-file (WEB-Bitmap) automatically form the updated noise map. The CadnaA file MEAS.CNA and in the run-up separately saved noise maps (*.cnr) will not be changed.These files remain untouched as "Mother-files" and are only accounted for the calculation of the noise maps to be updated.

Example

```
Meas.cnm:
Cadna/A·Makro·1.0
#(LoadFile,meas.cna)
#(GridCalc,·"r1",·rst.cnr)·
#(GridCalc,·"r0·++·r1+usrval(1)",·v01.cnr)·
#(GridCalc,·"r0·++·r1+usrval(2)",·v02.cnr)·
```

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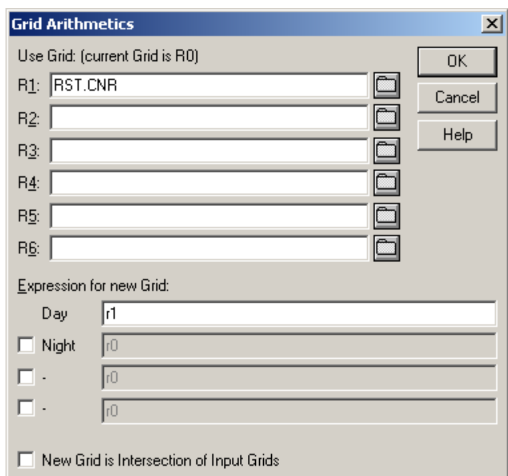
#(GridCalc,·"r0·++·r1+usrval(3)",·v03.cnr)·
#(GridCalc,·"r0·++·r1+usrval(4)",·v04.cnr)·
#(ExportFile,·meas.bmp,·WebBmp,·web,·10000,·1)
#(QuitAtOnce)

General:·#(GridCalc,·Ausdruck,·r1)

The expression #(ExportFile,·meas.bmp,·WebBmp,·web,·10000,·1)·exports a bitmap file saved with the file name *meas.bmp* in *WebBmp* format with the updated noise map including only the section of the noise map named *web*, scaled 1:*10000* of the resolution step *1*. This file would be now applicable for subsequent processing for the Internet. Fore more information about Web-Bitmaps see chapter 10.3 in the **CadnaA** manual.

The strings ·r0,·r1,·r2·...r6·corresponds with the dialog in **Grid|Arithmetic**:·#(GridCalc,·„r1“,·rst.cnr).



Dialog Menu **Grid|Arithmetics**

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In our example after the first line is executed the noise map RST.CNR (without noise sources which are monitored by a monitoring system) will be the current grid and can therefore be referenced with the string r0.

In the second row of the macro to the current grid r0 is added the noise map v01.cnr energetically and the correction value from the URSVAL.INI (val01=) arithmetically. After this operation this updated grid is the current grid r0 etc.

This macro must be adjusted with the corresponding user-defined grid names *.cnr.

MEAS.BAT

The·MEAS.BAT·starts·CadnaA·and·executes·the·**CadnaA**·macro MEAS.CNM.

Example

```
if·""·==·"%CNA_PATH%"·goto·default
%CNA_PATH%\cna32.exe·meas.cnm
goto·ende
:default
c:\cadnaa_w\cna32.exe·meas.cnm
:ende
```

In case the program file `cna32.exe` is not installed in the default directory (c:\Program Files\Datakustik\CadnaA) you have to set an environment variable CNA_PATH without final back slash (\) (e.g. D:\Programs\CadnaA\cna32.exe). For more information how to set an environment variable please see your WINDOWS manual or search in Internet.

Example DYNMAP

The following mentioned example files are saved on your program CD in the directory **Examples|18_ProjectOrg|DYNMAP**. Copy all the files onto your computer in the same directory (its mandatory).

Open the CadnaA file MEAS.CNA - you will see a noise map for the whole road traffic of a small city with four monitoring systems P1 - P4.

In menu **Tables|Groups** you can see the existing variants. The variants are created in such a way that the variant V01 activates the roads which are monitored by the monitoring systems P1, V02 activates the roads which are monitored by the monitoring systems P2 etc. The variant RST switched off all roads which are monitored by a monitoring system. For all these variants the noise maps have been calculated separately with the whole calculation area and their grid have been saved with a corresponding name like V01.cnr, V02.cnr etc. Thus for four monitoring systems five noise maps have been created.

Because we don't have a monitoring system in our example we change the correction values for the measured data manually in the file USRVAL.INI.

- Open this file URSVAL.INI with an editor, change the values behind the equals sign and save the file again with the same name.
- Now execute the MEAS.BAT with a double-click on its file name. This starts CadnaA, opens the file MEAS.CNA, makes the grid arithmetic and saved the result as bitmap file MEAS.BMP. This file can be opened with a arbitrary imaging-editing software.

Example DYNMAP with Excel

Another example shows the EXCEL file MEAS.XLS which is also saved on your CD. The EXCEL file already contains a macro which can be executed with a click on the button CALCULATE. This would write the correction values in the above table in the file USRVAL.INI automatically, makes the grid arithmetic automatically we described above and would save the result in a bitmap file which is displayed at once in the EXCEL file.

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- Just test it - e.g. increase the value in the column *Meas.Value* (yellow colored) for the monitoring system 2 (Point 2) to *77* and execute the macro. Pay attention to the noise map around the road at the monitoring system 2. As you can see everything is executed automatically up to displaying the updated noise map on the screen.

Note: Please understand that we cannot provide any hotline support for MS-Excel at all. We assume that MS-Excel has been installed correctly on your system.

14.10 Prototype File

The menu command **Options|Prototype** allows you to save to a **CadnaA** file pre-defined program settings, thus making them the preferences for future projects. Once a prototype file has been selected, **CadnaA** will always load all the parameters specified in this prototype file when it is launched again or when opening a new file.

- Open a new file.
- Specify the desired parameters for, e.g. calculation configuration, assignment of levels to colors, etc.
- Save this file as usual. Since it will also be a CNA file, it may be useful to create a new folder for prototype files for better distinction.
- Open the menu **Options|Prototype**, and select the file just saved. Close the dialog again by pressing the Open button.
- Now select **File|New**: **CadnaA** opens a new file featuring the settings that you have previously defined on the prototype file. There is no risk of overwriting since the new file was opened "with no name".

CadnaA will open any new file with the settings of the selected prototype file until you select a different prototype file, delete the active prototype file, or move it to a different folder. If **CadnaA** cannot find the selected prototype file, it automatically uses the default settings.

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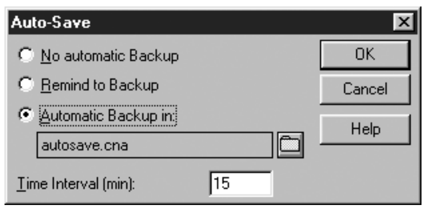
14.11 Automatic Saving of Files

In **CadnaA** you can either save your work automatically at specified intervals, or have yourself reminded to save the file at specified intervals

For that, specify the desired option on the **Options|Auto Save** dialog. If no file name is specified under **Auto Save As:**, **CadnaA** will save the file as autosave.cna in the program directory.



Dialog Auto Save

☝ If you run **CadnaA** with the batch command (see chapter 14.7), any selected auto save option will be deactivated.

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14.12 Automatically generated Text Blocks

CadnaA generates some text blocks automatically during calculation. These are stored in the **Libraries (local)|Text Blocks**.

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14.12.1 Project Information

You can enter project information in the menu **File|Project-Info**; information such as the name of the client, the title of the project, the date etc. If information has been entered you can find it again in

1. the file option in Windows explorer (right mouse click on the file name) and

2. as local text blocks automatically generated from **CadnaA** in **Tables|Libraries (local)**

CadnaA-Version

The name or the number of the program version is always visible in the Windows explorer independent of any entry in the **Project-Info**.

File Information

If you have entered information, then you can see it without opening the **CadnaA** file if you click with the right mouse button on the file name in the Windows explorer and on the corresponding command. Furthermore, if you want to find a **CadnaA** file on your computer, you can also enter a string of project-info as a search criterion on the Windows desktop.

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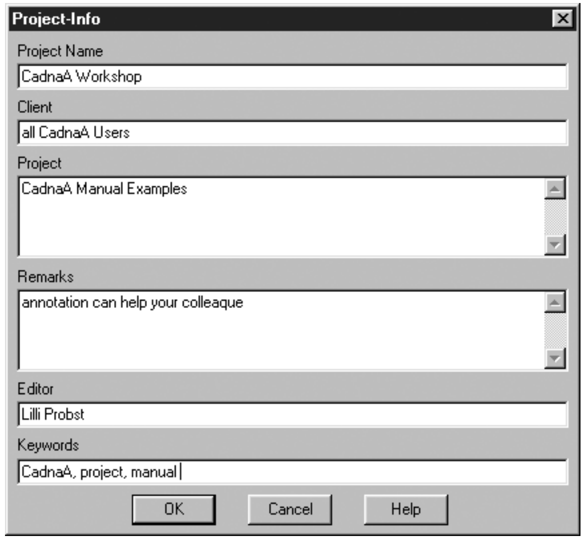

Locale Text blocks

If you enter project information, **CadnaA** automatically generates a text block for the corresponding field. The names of all these so generated local text blocks start with **PI_**. The name is written in capital letters.

Example

If you make an entry in the field **Project Name**, a local text block is generated and named PI_TITLE. This can now be depicted with the keyword #(Text, PI_TITLE).

With that you are able to simplify your print templates

In case you fill out the corresponding fields, the following text blocks are generated:

Name of the Textblocks	Field of the Project-Info
PI_TITLE	Project Name
PI_CLIENT	Client
PI_PROJEKT	Project
PI_COMMENTS	Remarks
PI_AUTHOR	Editor
PI_KEYWORDS	Keyword

See also chapter 12.4 Text Blocks

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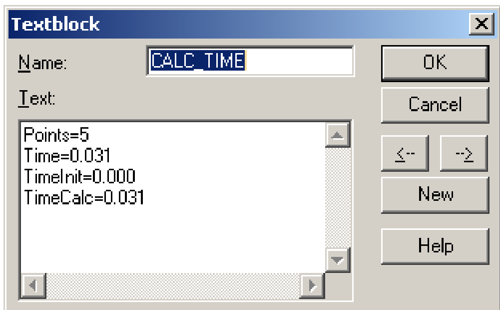
14.12.2 Calculation Data

Upon termination of a calculation of grid or facade points, as well as for individual receivers points **CadnaA** generates a local text block CALC_TIME with information on the last calculation run.



The text block lists the following information::

Points	number of calculation points (grid/facade/receiver points)
Time	end time of calculation
TimeInit	start time of calculation
TimeCalc	duration of calculation

14.13 Purge Tables

The **Tables|Miscellaneous|Purge** command acts as follows:

- Deleting duplicate groups and groups which are not used. This may be the case when a file containing groups was imported.
- Deleting lists of numbers of trains (see chapter 2.12.2) which are allocated to none of the railway sections.
- Deleting duplicates of Areas of Designated Use (menu **Table|Other Objects**).
- Deleting duplicates of text blocks from the local library (menu **Tables**).
- Deleting duplicates of spectra from the local library or spectra which are not used from any noise source.
- Deleting duplicates of directivities from the local library or deleting directivities which are not used by any noise source.