

PRODUCT DATA

ENPro — Type 7811 Version 3.0
Environmental Noise Prediction and Design Software



ENPro™ is a PC-based software package for the easy modelling, precise prediction, and cost-effective simulation and design of indoor and outdoor environmental noise. It is ISO 9613 compliant and its advanced 3D graphic user-interface tools allow you to quickly model complex noise environments such as directional noise sources, multi-sloped barriers and cylindrical towers. It can provide cross-sectional and 3D visualisation of a noise map in a geographical area to show noise population exposure and to identify noise problems. ENPro can also quickly calculate future scenarios by identifying their differences from the results of the current scenario. "Scenario comparison" and "source rank" maps intuitively inform you how to effectively reduce noise in both existing multi-source areas and future land development.

7811

- USES*
- Outdoor and indoor noise prediction and design
 - Creation of noise, source rank and scenario comparison maps in 3D and in cross-sections
 - Cost-effective location and design of noise barriers with multiple-slopes and non-uniform reflection properties
 - Noise-effective layout of sources, buildings, towers, barriers and terrain in industrial and urban areas for land development
 - Management of acoustic data for building materials, noise sources including directivity, and special sites

- FEATURES*
- Outdoor noise calculation according to ISO 9613, NMPB-1996 for ground attenuation of undulating terrain, ASJ-1998 for wind effect, etc.
 - Indoor noise calculation by diffuse-field theory including sound propagation from adjacent rooms and outdoors
 - Sound power estimation of road traffic according to ASJ-1998 (Japanese method), of seven kinds of industrial machines by empirical formulas using their main characteristics, and of sources by measurement of L_W or SPL
 - Calculation of geometrical divergence for industrial machinery, polyline and road sources with real dimensions
 - Databases to enter and manage source directivity, absorption coefficient and transmission loss of building materials, attenuations on special sites and measurements
 - Fast calculation options using previous calculation results, limited propagation distance and with/without reflections
 - CAD functions for easy creation and decoration of 3D model

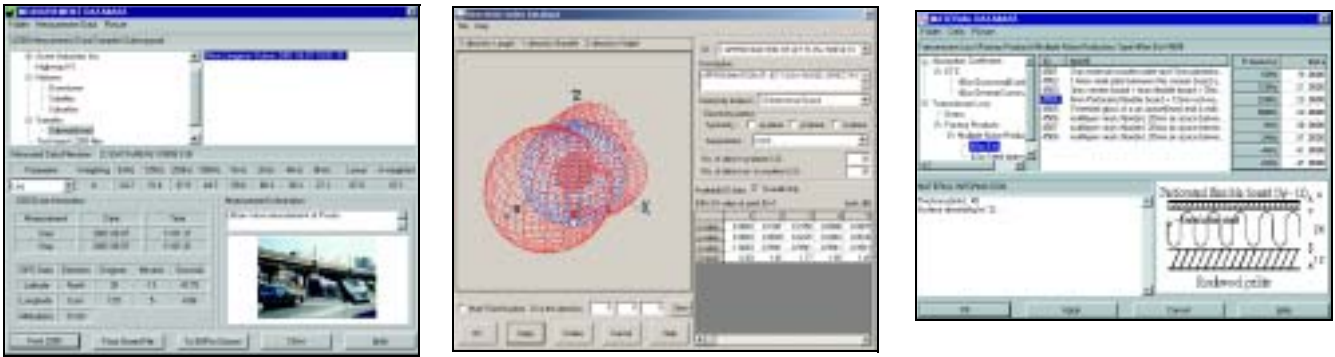
Noise Modelling

ENPro is a Windows[®]-based, software package for indoor and outdoor noise modelling and prediction for easy and economical design of noise environments. ENPro is based on the ISO 9613 standard for the calculation of attenuation during noise propagation outdoors and on the diffuse field model for indoor noise calculation.

Databases

ENPro provides user-defined databases to manage the acoustic data effectively; for example, for noise sources including 2D and 3D directivity (see Fig. 1), absorption and transmission properties of construction materials, and the attenuation of sound during propagation on special sites. ENPro can estimate sound power of road traffic and various types of machinery. It also contains functions for the evaluation of time-variant and time-rated noise, the simulation and evaluation of various “what if” scenarios, and for fast recalculation. ENPro includes a Measurement Database containing L_{eq} , L_{10} , L_{90} , and L_W data from a 2260 Investigator[™] including GPS positional information.

Fig. 1
Some of the database windows available with ENPro

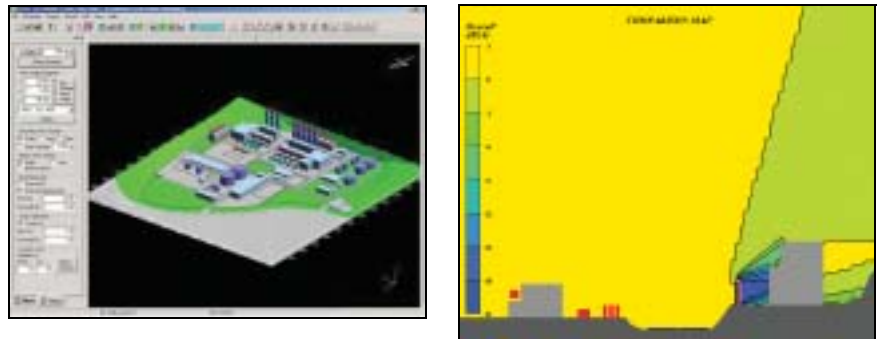


ENPro's database programs effectively manage and utilise all acoustic data (see Fig. 1), including notes and/or BMP format files of building materials, and measurement files in octave-band frequencies from 63 Hz to 8 kHz. Once the acoustic data has been registered, you can use it in all your models by entering its numeric ID, and replacing ENPro's default data.

Data Entry

ENPro provides OpenGL-based, easy-to-use and powerful 3D graphic user interfaces as pre- and post-processing, and design tools. Seeing the ENPro noise prediction model on screen, you can design a physical acoustic environment including topography, building layout, noise barriers, noise sources and so on. ENPro can conveniently access all the data presented on screen through the mouse (see Fig. 2). All model items are visualised in 3D at any view-angle. You can view a cross-section of your model, enabling you to build up your 3D electronic model very quickly and accurately.

Fig. 2
Model views



ENPro provides an automatic triangulation function of ground regions using ground heights specified at arbitrary locations (see screen picture on front cover). This enables you to create undulating terrain and any shape of acoustically hard and soft ground regions affecting screening and ground attenuation. You can also model special sites of any shape and import topographical maps in BMP/DXF file formats as a background to help modelling.

Noise sources can be defined in several ways:

- Measured L_w
- Measured average L_p with surface area to determine L_w
- Estimated L_w for seven kinds of industrial machines by an empirical formula
- Road noise emission according to traffic flow
- Two- or three-dimensional directivity
- Time-variant radiation

Buildings can be modelled with one or more rooms. These rooms can be interconnected and have their own acoustic data. Sound absorption and transmission factors are

registered for both outdoor and indoor noise calculation. In addition to propagation according to ISO 9613, geometrical divergence attenuation in the near field of the source, depending on its dimensions, is accurately modelled.

The ENPro Material Database can be used to give sound absorption properties for both sides of room walls and for barriers with non-uniform slopes and materials. These are used to calculate reflection. The reflection of cylindrical towers is automatically estimated according to ISO 9613.

Noise receiver grid points at absolute or relative heights with respect to ground level can be positioned in a defined horizontal or vertical plane. You can also freely position an unlimited number of noise receiver points.

Calculation and Model Refinement

Outdoor, indoor, or both outdoor and indoor noise can be calculated according to your needs. You can reduce calculation time by limiting the sound propagation distance from each source and/or neglecting reflections.

Once you have calculated your noise model, ENPro stores all your modifications for fast recalculations. If there are no modifications affecting the sound propagation of the entire system, ENPro produces new noise results by recalculating noise levels and using the existing results for the remaining part. ENPro's fast recalculation function also applies to new models created by copying an existing model. This helps you to quickly show the effect of noise reduction plans, and determine noise-effective locations of individual sources in land development. This feature of ENPro not only reduces calculation time to simulate various noise scenarios without any loss of accuracy, but also ensures consistency between input and results.

Fig. 3
Some of the output results in table, graph and noise map form

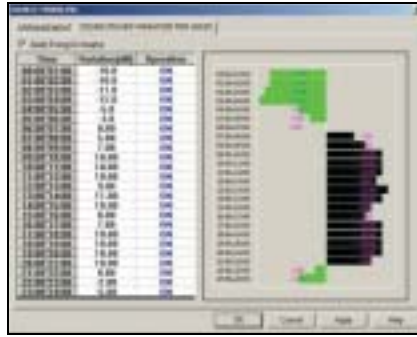


Results and Evaluation

The A-weighted or Linear-weighted total or octave-band results of calculations can be displayed graphically on your model or as a suite of tables. You can also graphically see the noise spectrum of source or receiver. Results can be displayed in various ways using a combination of drawing options for colour-coded noise contour lines, colour-shaded areas with specified colour transparency, marked calculations points and 3D visualisation of noise contours. You can also see the numerical results at each receiver point by simply using the mouse.

ENPro evaluates time-variant noise sources during the post-processing stage to display their results. In addition, you can assign any time-penalty value per hour per day (see Fig. 4). This enables you to quickly evaluate L_T , L_p , L_{eq} and L_n for any time period within a day.

Fig. 4
*Window to enter
time penalty*



You can see the noise results in a wide variety of formats (see below). ENPro's features for viewing and evaluating results help you to quickly verify your model, identify noise problems by comparing predicted values to legal limits, and establish the most effective plan to reduce noise.

There are various tables and graphics available for showing noise results:

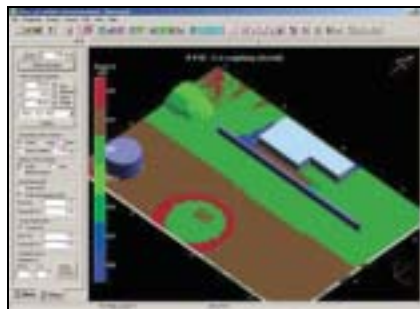
- Tables of results presenting the sound power level of individual sources and room noise levels
- Tables and graphics showing outdoor noise levels at receiving points for any operating scenarios of sources and compared results
- Graphics showing ranked sources in noise contribution at receiving points
- Noise spectrums of sources, room and receiving points

Problem Identification, Noise Reduction and Reporting

Problem Identification – Ranking and Switching Off Sources

In complex noise environments, it can be difficult with traditional techniques to identify exactly how much noise each source contributes to the total noise, and what sources cause the noise problems. ENPro can do this by ranking individual sources by their contribution for all receiving points (see Fig. 5). You can also see the level contributed from the ranked source at each receiver point. This unique “source rank map” feature of ENPro helps you to intuitively and easily identify problematic noise sources for any receiver.

Fig. 5
*Noise map with
source “switched
off” showing which
source contributes
most at each
receiver position
(source rank)*

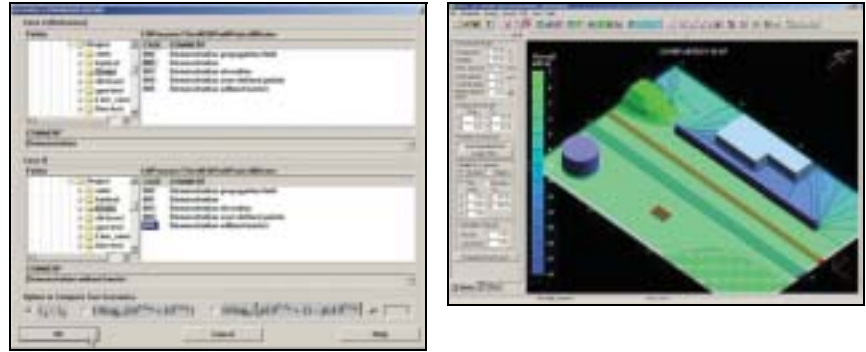


Moreover, you can see colour-coded, sound-pressure contours on your model with specific sources “switched off” (see Fig. 5). This enables you to evaluate noise contributions from selected sources, to simulate time-variant noise situation at multi-source areas, and to evaluate the noise impact of newly constructed industry plants, roads, railways, etc.

Noise Reduction – Fast Recalculation and Scenario Comparison

Establishing the most effective noise reduction plan for existing or prospective noise problems often requires many simulations for different models. With ENPro's file manager and powerful 3D graphic user interfaces, you can easily create and modify new models, based on a copy of an existing model and its noise results, so that you can assign proposed noise reductions to different sources, change the locations of individual sources, and add new sources to see the effects.

Fig. 6
Scenario comparison command window and an example of a comparison map. The map shows noise reduction after barrier construction in front of the building



The noise levels in a newly modified model can be quickly predicted by recalculating the contribution from the modified sources and utilising the existing results for the other sources. This remarkably reduces calculation time.

ENPro also allows you to compare two different models of the same area not only in tabular form but, more intuitively and comprehensively, as colour-coded graphics (see Fig. 6). Results at a receiver point can also be compared as a spectrum. Three types of comparison between two different scenarios at receiver points are available:

- Difference – the change at each receiving point of one model compared with another
- Combination – the combined noise level from both models
- Occurrence – average noise levels of two different noise environments with specified probability

Reporting – Print, Export and Report Wizard

Once a set of results has been calculated, it can be printed or exported into a presentation program or spreadsheet. ENPro can also export your model and its results in ASCII, RTF and DXF formats. ENPro data exported in RTF format, readable in MS[®]-Word, is represented in tabular and graphical form to save time when making documents.

Moreover, ENPro's unique "Report Wizard" function helps you to make an RTF format document file including acoustic data and results of your model and technical backgrounds used in ENPro calculations. You are able to select export items, generated in the form of equations, pictures, tables and sentences.

ENPro exports model items and sound-pressure contour lines into CAD software packages in DXF format. You can also select groups of model items to be exported.

Software Maintenance Agreement

By entering into a Software Maintenance Agreement all valid holders are ensured unlimited access to improved features, added functionality and enhancements made to ENPro, and are entitled to the following benefits for one full year:

- Automatic receipt of latest software enhancements and improved functionality in the form of upgrades
- Access to technical application support within 2 working days after receipt of request

Renting ENPro

You can also rent ENPro on a one-year basis. Contact your local sales representative for further information.

Specifications – ENPro Type 7811

Specifications

CALCULATION METHODS

The algorithms for calculating the sound propagation from source to receiver via intermediate items are based on:

- ISO 9613.1, 9613.2 for outdoor sound attenuation
- NMPB–1996 (French road method) for mean ground profile estimation of undulating terrain
- ASJ–1998 (Japanese road method) for estimation of wind effect and sound power of road traffic
- Diffuse field theory and practical formula for indoor noise
- SNAME (The Society of Naval Architects and Marine Engineers) empirical formula for sound power estimation of seven types of industrial machinery

ACOUSTIC DATABASES

Acoustic data stored in data managers are available via its identification number or filename

Stationary Source: Eight kinds of industrial machinery (compressor, diesel engine, fan, generator, motor, pump, radiator, etc.), dimensions, 1/1-oct. bands (63 Hz to 8 kHz) or overall level with internal spectral composition estimation, L_w (dB(A) or dB(L)) or L_p plus sound radiation area (m^2) or particulars to estimate L_w using empirical formula, reduction (dB) due to additional attachments, notes

Line Source: 1/1-oct. bands from 63 Hz to 8 kHz, L_w per metre (dB(A) or dB(L)), notes

Road: Number of vehicles and speed in two or four types, notes

Directivity Index: Applicable for stationary and line sources, 2D and 3D directivity, non-symmetric, symmetric, axisymmetric, directivity pattern, 1/1-oct. bands (63 Hz to 8 kHz) or overall level, numbers of data points in xy- and yz- or zx-planes, 3D display

Material: Absorption coefficients and transmission loss (dB), 1/1-oct. bands (63 Hz to 8 kHz), BMP import, notes

Site: Attenuation (dB or dB/m) in foliage, industrial sites, housings, 1/1-oct. bands from (63 Hz to 8 kHz), notes

2260 Measurement: Measured L_w and L_{eq} (octave spectra), and L10 and L90 (broad-band) from 2260 Investigator, measurement information, GPS positional data, BMP import, notes

MODEL PROPERTIES

Model Area: Expressed in metres to three decimal places; defined by user when a new area is created. Maximum size in x and y direction is unlimited

Model Items: Only limited by computer RAM capacity

MODEL ITEMS

(Including important item parameters)

Stationary Sources: Source data filename, 3D position, directivity, rotation angle, L_w variation (dB) or no emission per hour, optional L_w estimation

Line Source: Source data filename, 3D position, breadth, height, directivity, segmentation, L_w variation (dB) or no emission per hour

Road (ASJ 1998): Traffic flow data filename, 3D position, breadth, segmentation in length and breadth, surface type, speed limit, traffic flow state, L_w variation (dB) or no emission per hour

Terrain and Ground Type: Heights at user-defined points, automatic generation of triangular segments and 3D terrain and height line contour, hard or soft ground per segment

Building: Parallelepiped and its combined shapes, length, breadth, height, floor, rotation angle, 1/1-oct. bands, absorption coefficient and transmission loss for each wall by material ID, automatic connectivity between rooms

Barrier: 3D position on ground, user-definable multi-stages, height and slope and absorption property at two surfaces per

stage, automatic connectivity identification for buildings and other barriers

Cylindrical Tower: Reflection factor evaluation by ISO 9613.2, diameter, height

Housing Region: Any shape, surface density (%), façade ratio (%), mean height (m), user-definable attenuation or ISO 9613.2, limitation to maximum attenuation

Industrial Site: Any shape, mean height (m), user-definable 1/1-oct. bands attenuation or ISO 9613.2, limitation to maximum attenuation

Foliage Region: Same as Industrial site

Point Receiver: Height above ground level

Grid Receivers: User-defined area in plan or elevation within the model area, distance between adjacent receivers, height above ground level or absolute height

Decoration Items: Text, line, arc, circle, user-defined colour and font size or width

VIEW PROPERTIES

3D View: User-defined viewpoint, solid and/or line view for building and barrier and cylindrical tower, solid and/or line and/or point view for terrain, solid view for source, hatched view for sites, height line contour of terrain with user-defined interval, any combination of view options

Cross-section: Elevation view at a defined horizontal line, variable scale ratio

Zoom: In and out of specified rectangular area, mouse-pointed region, any viewpoint

Scroll: Movement of current 3D or cross-section view to any direction

Rotation: Change of viewpoint in 3D view

Snap: User-optional constraint of mouse movement for specifying item position, user-defined interval in two direction

Grid and Label: User-optional grids and text labels in two directions, user-definable intervals

Background: Multiple topographical maps in DXF and/or BMP format, specification of origin, scale ratio and rotation angle

Items: User-definable colour for all the items on screen, symbol

Status: 3D coordinates at mouse-pointed position, type, ID and size of a mouse-selected item

CALCULATION

Calculations: Source L_w , Outdoor SPL and/or Indoor SPL

Fast Calculation Option: Automatic identification of difference from the previous model – utilises the previous results if no changes except sources, limiting sound propagation distance from source, neglecting reflection

Calculation Parameters:

Ground Type: Hard or soft

Wind: Velocity (m/s), direction (re ASJ–1998)

Source Directivity: dB in 1/1-oct. bands (63 Hz to 8 kHz) or total
Absorption Coefficient: Factor from 0.000 to 1.000 in 1/1-oct. bands (63 Hz to 8 kHz), optional for each building and barrier surface

Transmission Loss: dB in 1/1-oct. bands (63 Hz to 8 kHz), optionally defined for each wall of buildings and barriers

Site Attenuation: dB or dB/m in 1/1-oct. bands (63 Hz to 8 kHz), ISO 9613.2 recommended or user-defined attenuation for industrial site, housing and foliage regions

Calculation Features:

Geometrical Divergence: Automatic determination of attenuation from point, line and planar source treatment for a source depending on source dimension and sound propagation distance, ISO 9613.2 compliant method in far-field from source
Source Directivity (Outdoor only): Specified 2D or 3D directivity index

Air Absorption: ISO 9613.1

Ground Attenuation: ISO 9613.2 plus NMPB-1996 for mean ground profile estimation of undulating terrain, automatic extraction of ground factors at source, receiver and middle regions by identifying the composition of hard and soft grounds on sound propagation path

Diffraction: Vertical and horizontal screening of multi-stage and/or sloped barrier, building, cylindrical tower, vertical screening of undulating terrain, screening in visible zones above top edge, identification of the two most effective screening structures from diffracted path angles

Reflection: Single reflection by vertical planes of multi-stage barrier, building and cylindrical tower

Meteorological Effect: Meteorological correction factor

Indoor Sound: Direct and reverberant sound for source rooms, sound transmitted through a room boundary wall from adjacent source rooms and outdoors

Room Constant: Calculated by specifying absorption coefficients of room boundary walls and area ratios of typical hard and soft non-boundary surfaces with respect to boundary surface area

RESULTS DISPLAY

Period: User-defined time-period within a day, user-defined time-penalty factor (dB) per hour, L_p , L_{eq} , L_n with specified %

On Screen Maps: Annotated maps in any 3D viewpoint, colour-shaded and/or line contour maps with a specified contour interval, 3D maps with a zooming factor in z-direction, octave or overall (dB(A) or dB(L), SPL results of any combination of source ON/OFF scenarios – a "what if" tool, compared results between two scenarios of the model (difference, summation, occurrence) – "before and after" or "what if" tools, ranked source maps at receivers – a "problem identification" tool

Table of Source L_w : 1/1-oct. bands and overall (dB(A) and dB(L)), stationary source and secondary outdoor source due to indoor stationary source (dB), road and line sources (dB/m)

Table of Indoor SPL: Calculated results at specified rooms, 1/1-oct. bands and overall (dB(A) and dB(L))

Table of Outdoor SPL: Calculated results at all the specified receivers, source ON/OFF scenario results, 1/1-oct. bands and overall (dB(A) and dB(L))

Table of Comparison: Compared values between two models at the same area, difference, summation, average considering occurrence (%), 1/1-oct. bands and overall (dB(A) and dB(L))

Graph: L_w of a source, SPL at a specified receiver, compared results between two scenarios, 1/1-oct. bands and overall (dB(A) and dB(L)), user-definable text label, user-definable colour, axis scale and graph type (line, bar, shadow bar, solid)

INPUT TO MODEL

Mouse: Item position coordinates, creation, selection, move, modification, copy and deletion of items, 3D coordinates to

specify undulating terrain and ground type, specification of ground type, industrial site, housing and foliage regions having any shape, snap and grid functions are supported

DXF File Import: 3D coordinates extracted from DXF layers to create background map, multiple files import

BMP File Import: Coloured pixel map, multiple files import

OUTPUT

On Screen: Results displayed in tabular or graphical form

Clipboard: Screen pictures (model in 3D and cross-section view, noise contour maps, 2D and 3D source directivity, sound spectrum, etc.) and results displayed in tables can be copied for inclusion in other Windows® program

ASCII File Export: Model, text data registered at material, site attenuation and directivity databases, results displayed in tables

RTF File Export: text data and pictures registered or generated in ENPro databases, results in tables

DXF File Export: View-option compliant on screen model pictures, 3D and cross-section, colour-coded line contour maps, user-selectable export group items

Printing: On screen model and maps to all standard Windows® output devices

Print Model: Print preview, view-option compliant

REPORT WIZARD

Generates RTF file containing text, table and picture

Technical Background: User-selectable contents from ENPro technical manual

Model: Active sources, calculation and evaluation parameters

Calculated Result: Calculated values for source L_w , indoor and outdoor SPL, source ranks, compared results between two scenarios, 1/1-oct. bands and overall, user-specified results

Computer System

RECOMMENDED MINIMUM REQUIREMENTS

Pentium® II 350 MHz with Windows NT®

128 MB RAM

At least 80 MB of free disk space, plus the disk space used as a working area

CD-ROM drive

4 MB or more RAM graphics display/adaptor supporting OpenGL

Mouse, Keyboard

For larger ENPro models, these requirements should be greatly exceeded in order to improve data handling speed.

Operating System: ENPro works with Windows NT® 4.0 (service pack 6.0a) and Windows® 2000

Ordering Information

7811-A	ENPro Environmental Noise Prediction and Design Software
7811-B	ENPro 1-year User Licence
7811-A-MS1	ENPro Software Maintenance Agreement

TRADEMARKS

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Brüel & Kjær reserves the right to change specifications and accessories without notice.

Optional Accessories

2260 Investigator™, BZ 7210, BZ 7201, BZ 7202, BZ 7206, BZ 7205
AO 1442 Serial Interface Cable