Note

Project	Develop and implement harmonised noise assessment methods		
Concerns	Source Modules Industry – Programming guide		
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Contact	Th.J.B. (Theo) Verheij	E-mail	ve@dgmr.nl

1. Introduction

This report provides the programming guide for the implementation of the source model for industrial noise as described in Chapter V of the JRC Reference Report "Stylianos Kephalopoulos, Marco Paviotti, Fabienne Anfosso-Lédée (2012), Common Noise Assessment Methods in Europe (CNOSSOS-EU), EUR 25379 EN".

The source model calculates the source power of an single industrial noise source, for a given type of source (point, line or area) and direction. The source model will only describe the calculation of the source power for a given period and direction.

Chapter 2 gives the file format for the look-up tables. These files contain all the static data needed for the calculation of the source power. Examples of static data are:
- Emitted sound power
- Correction on the sound emitted in each direction, relative to the source's direction.

Chapter 3 gives the file format for the input XML file and chapter 4 the file format for the output XML file.

Chapter 5 describes how the command line utility is used. Chapter 6 gives an overview of the source model DLL interface.

Annexes:
    A. example of the file CNOSSOS_Industry_Catalogue.xml
    B. example of the file CNOSSOS_Industry_Input.xml
    C. example of the file CNOSSOS_Industry_Output.xml
    D. example of the file CNOSSOS_Industry_Output.csv

2. Look-up tables

All data for the look-up tables is located in one XML file:

- CNOSSOS_Industry_Catalogue.xml

  contains all look-up tables needed for the calculation of the emission of industrial noise.

The format used is self-explanatory and the delivered files contain clarifying comments.

All XML files (including those for the user input) need to comply with the following:

- Decimal separator a point ('.')
- Date format yyyy-MM-dd
- Spectral information is given as
  - 8 values for octave information (63 Hz .. 8 kHz)
  - 24 values for 1/3 octave information (50 Hz .. 10 kHz)
  - values are separated by 1 or more spaces.

2.1 CNOSSOS_Industry_Catalogue.xml

All information is located within the main tag "CNOSSOS_Industry_Catalogue". As attribute the version of the file format is given, currently "X1.0".

```
<CNOSSOS_Industry_Catalogue version="X1.0">
    <!-- Contents -->
</CNOSSOS_Industry_Catalogue>
```

Within the main tag the following static data is given:

- Date

  Catalogue date, purely informative.
  ```
  <Date>2013-11-22</Date>
  ```
- Source definition (one or more)

  These sections contain the definitions of the supported sources. If a source is not defined in one of these sections, it is not calculated.
  ```
  <SourceDefinition>
      <!-- Contents -->
  </SourceDefinition>
  ```
- Directivity tables (zero or more)

  These sections contain the directivity definitions, references by the source definitions.
  ```
  <Directivity ID="0">
      <!-- Contents -->
  </Directivity>
  ```

2.1.1 Source definition

Example:

```xml
<SourceDefinition ID="95">
    <Description>Container repair</Description>
    <Date>1996-10-17</Date>
    <Drive>other</Drive>
    <Quality>poor</Quality>
    <Type>AreaSource</Type>
    <MeasurementType>HemiSpherical</MeasurementType>
    <Weighting>A</Weighting>
    <Height>5</Height>
    <Deviation>2</Deviation>
    <HeightVariation>2</HeightVariation>
    <Lw>44.97 51.97 57.97 61.97 66.97 62.97 54.97 47.97</Lw>
    <DirectivityRef>0</DirectivityRef>
</SourceDefinition>
```

Fields:

- Description

  A description of the source (purely informative).

- Date

  Purely informative.

- Drive

  Purely informative. Options:
    - internal combustion
    - electric
    - nuclear
    - wind/water/solar
    - steam
    - other

- Quality

  Purely informative. Options:
    - good
    - average
    - poor

- Type

  The type of the source. Options:
    - AreaSource
    - LineSource
    - PointSource

- MeasurementType

  Options:
    - HemiSpherical (=default)
    - FreeField
    - Unknown

- Weighting

  Options:
    - LIN

- A (=default)
- Height
  The height of the source, in meters.
- Deviation
  Purely informative.
- Height variation
  Purely informative.
- Sound power
  The sound power of the source, in 8 frequency bands.
- Directivity
  ```
  <DirectivityRef>0</DirectivityRef>
  ```
  Reference to the ID of a `Directivity` element.

2.1.2 Source directivity

This section describes the corrections applicable to the noise power, depending on the direction. Its contents define a matrix of power corrections, for each horizontal and vertical Euler angle (at a resolution of 10 degrees; vertical angles from -90° to 90° and horizontal angles from 0° to 350°).

```
<Directivity ID="0">
    <Angle horz="  0" vert="-90" values="0 0 0 0 0 0 0 0" />
    <Angle horz=" 10" vert="-90" values="0 0 0 0 0 0 0 0" />
    <!-- ... -->
    <Angle horz="340" vert="-90" values="0 0 0 0 0 0 0 0" />
    <Angle horz="350" vert="-90" values="0 0 0 0 0 0 0 0" />

    <Angle horz="  0" vert="-80" values="0 0 0 0 0 0 0 0" />
    <Angle horz=" 10" vert="-80" values="0 0 0 0 0 0 0 0" />
    <!-- ... -->
    <Angle horz="340" vert="-80" values="0 0 0 0 0 0 0 0" />
    <Angle horz="350" vert="-80" values="0 0 0 0 0 0 0 0" />

    <!-- ... -->

    <Angle horz="  0" vert=" 80" values="0 0 0 0 0 0 0 0" />
    <Angle horz=" 10" vert=" 80" values="0 0 0 0 0 0 0 0" />
    <!-- ... -->
    <Angle horz="340" vert=" 80" values="0 0 0 0 0 0 0 0" />
    <Angle horz="350" vert=" 80" values="0 0 0 0 0 0 0 0" />

    <Angle horz="  0" vert=" 90" values="0 0 0 0 0 0 0 0" />
    <Angle horz=" 10" vert=" 90" values="0 0 0 0 0 0 0 0" />
    <!-- ... -->
    <Angle horz="340" vert=" 90" values="0 0 0 0 0 0 0 0" />
    <Angle horz="350" vert=" 90" values="0 0 0 0 0 0 0 0" />
</Directivity>
```

0° horizontal and 0° vertical means in the source's direction (forward). -90° (or 270°) vertical means straight down, 90° vertical means straight up; in those two cases the horizontal angle is meaningless. In all other cases, horizontal 90° means to the left, at a perpendicular angle to the source's direction, and so horizontal -90° (or 270°) means to the right at a perpendicular angle to the source's direction.

3. User data

All user input is located in a single XML file: CNOSSOS_Industry_Input.xml. (The file name itself is variable).
The format used is self-explanatory, and the delivered files contain comments for clarification.

All information is located within the main element "CNOSSOS_Industry_Input". As attribute the version of the file format is given, currently "X1.0".

The main tag contains the following tags:

- Test
  If set to "false" only the calculated source power will be written to the specified output file (e.g. CNOSSOS_Industry_Output.xml). If set to "true", the intermediate results will also be written to a separate file named after the output file, but with a '.csv' extension (e.g. CNOSSOS_Industry_Output.csv).

- A sub-tag "Source".
  Example:

```xml
<Source Ref="95">
    <Height>0.05</Height>
    <Period>12</Period>
    <SourceTime>8</SourceTime>
    <Vehicles moving="true">
        <Count>1</Count>
        <Speed>15</Speed>
        <Length>100</Length>
    </Vehicles>
    <Directivity>
        <Angle horz="  0" vert="  0" />
    </Directivity>
</Source>
```

Within the tag "Source" the following data is given:

- A reference to the source definition
  ```xml
  <Source Ref="0">
  ```
  The "Ref" attribute must match the ID of one of the source definition sections located in the file CNOSSOS_Industry_Catalogue.xml.

- The source height, in meters. This element is optional; if omitted, the source height from the referenced definition is used.
  ```xml
  <Height>0.05</Height>
  ```

- Reference period of time in hours (T_0; day is 12 hours, evening is 4 hours, night is 8 hours).
  ```xml
  <Period>12</Period>
  ```

- Active source time per period (based on a yearly averaged situation), in hours.
  ```xml
  <SourceTime>8</SourceTime>
  ```

- Information pertaining to moving vehicles: whether the source consists of moving vehicles, and if so, the number and speed [km/h] of vehicles, and the total length of the source [m].

```
<Vehicles moving="true">
    <Count>1</Count>
    <Speed>15</Speed>
    <Length>1</Length>
</Vehicles>
```

If the source does not consist of moving vehicles, the attribute "moving" should be set to "false", and the tags for Count, Speed, and Length can be omitted.

- Direction of the source

The source's direction can be specified using *either* Euler angles *or* a vector.

```
<Directivity>
    <Angle horz="350" vert="-90" />
</Directivity>
```

or

```
<Directivity>
    <Vector x="1.0" y="0.0" z="0.0" />
</Directivity>
```

4. Calculated source power

The calculated source power is output to the given XML file name (e.g. CNOSSOS_Industry_Output.xml).

The format used is self-explanatory and the delivered files contain clarifying comments.

All information is located within the main tag "CNOSSOS_SourcePower". As attribute the version of the file format is given, currently "X1.0".

The main tag contains one or more subtags "SourcePower"; one for each source.

```xml
<?xml version="1.0" ?>
<CNOSSOS_SourcePower version="X1.0">
    <source>
        <h>0.05</h>
        <Lw sourceType="PointSource"
            measurementType="FreeField"
            frequencyWeighting="A">
            77.04 91.49 95.62 96.94 98.41 96.23 88.17 81.34</Lw>
    </source>
</CNOSSOS_SourcePower>
```

Within the tag "source" the following data is given:

- Source height in m.
      ```
      <h>0.05</h>
      ```
- Source type
  Possible source types are: "point", "line", "area", or "undefined".
      ```
      <SourceType>line</SourceType>
      ```
- Radiation type
  Possible radiation types are: "omnidirectional", "hemispheric", or "undefined".
      ```
      <RadiationType>hemispheric</RadiationType>
      ```
- The calculated source power (<u>linear</u>)
      ```
      <Spectrum>100 100 100 100 100 100 100 100</Spectrum>
      ```

If the value "Test" in the input file is set to "true" all intermediate results will be written to a file named after the output file, except with the extension '.csv'; e.g. CNOSSOS_Road_Output.csv.

5. Command line utility "CNOSSOS_DLL_CONSOLE.exe"

The command line utility can be used to calculate the source power using a XML file as input. The use is as follows:

```
CNOSSOS_DLL_CONSOLE.exe <-road | -rail | -industry> infile outfile
```

- **<-road | -rail | -industry>** describes which source model will be used. Currently only **road** and **industry** are supported.
- **infile** contains the location and name of the XML input file. Its format is described in chapter 3. If no location is specified, the location is assumed to be the current folder.
- **outfile** contains the location and name of the XML output file (and – if specified – the corresponding CSV file). Its format is described in chapter 4. If no location is specified, the location is assumed to be the current folder.

The source module DLLs (CNOSSOS_ROADNOISE_DLL.dll and CNOSSOS_INDUSTRIAL_NOISE_-DLL.dll) and the corresponding look-up tables (CNOSSOS_Road_Params.xml, CNOSSOS_Road_Surfaces.xml and CNOSSOS_Industry_Catalogue.xml) need to be located in the same folder as the command line utility "CNOSSOS_DLL_CONSOLE.exe".

6. Interface of "CNOSSOS_INDUSTRIAL_NOISE_DLL.dll"

This section defines all of the supported functions included in the CNOSSOS_INDUSTRIAL_NOISE_DLL. These are currently only the required functions to support XML input and output:

- InitDLL
- CalcFormFile
- ReleaseDLL.

6.1 InitDLL

Initializes the road noise model DLL, creates the required data structures and imports the look-up tables.

Usage:

```
int InitDLL();
```

Parameters:

-

Return values:

0 in case of succes

-1 in case of failure

6.2 CalcFromFile

Reads to road segment data from a user specified input file. Calculates the corresponding road segment source power and writes the results to a user specified output file.

Usage:

```
int CalcFromFile(const string infile, string outfile);
```

Parameters:

`infile`   the file which contains the road segment data

`outfile`   the file to which the calculated source power will be written

Return values:

0 in case of success

-1 in case of failure

6.3 ReleaseDLL

Release the active DLL and frees all active objects

Usage:

```
void ReleaseDLL();
```

Parameters:

-

Return values:

-

6.4   GetVersionDLL

Release the active DLL and frees all active objects

Usage:

```
char* GetVersionDLL();
```

Parameters:

-

Return values:

String encoded version of the shared library

Annex A -- example of the file CNOSSOS_Industry_Catalogue.xml

```xml
<?xml version="1.0"?>
<CNOSSOS_Industry_Catalogue version="X1.0">
    <!--
        CNOSSOS_Industry_Catalogue.xml contains all source definitions
        required for the calculation of the emission of industrial noise.

        Format:
        - Decimal separator is a period ('.')
        - Spectral information is given as
          - 8 values for octave information (63 Hz .. 8 kHz)
          - 24 values for 1/3 octave information (50 Hz .. 10 kHz)
          - values are separated by 1 or more spaces.
    -->

    <!-- Catalogue date (informative) -->
    <Date>2014-03-27</Date>

    <!--
        The following elements define the different sources.
    -->
    <SourceDefinition ID="0">
        <Description>Empty source</Description>
        <Date>2014-03-27</Date>
        <Drive>other</Drive>
        <Quality>poor</Quality>
        <Type>PointSource</Type>
        <MeasurementType>HemiSpherical</MeasurementType>
        <Weighting>A</Weighting>
        <Height>5</Height>
        <Deviation>2</Deviation>
        <HeightVariation>2</HeightVariation>
        <Lw>0 0 0 0 0 0 0 0</Lw>
        <DirectivityRef>0</DirectivityRef>
    </SourceDefinition>
    <SourceDefinition ID="95">
        <Description>Container repair</Description>
        <Date>1996-10-17</Date>
        <Drive>other</Drive>
        <Quality>poor</Quality>
        <Type>AreaSource</Type>
        <MeasurementType>HemiSpherical</MeasurementType>
        <Weighting>A</Weighting>
```

```xml
        <Height>5</Height>
        <Deviation>2</Deviation>
        <HeightVariation>2</HeightVariation>
        <Lw>44.97 51.97 57.97 61.97 66.97 62.97 54.97 47.97</Lw>
        <DirectivityRef>0</DirectivityRef>
    </SourceDefinition>

<!-- ... -->

<Directivity ID="0">
    <Angle horz="  0" vert="-90" values="0 0 0 0 0 0 0 0" />
    <Angle horz=" 10" vert="-90" values="0 0 0 0 0 0 0 0" />
    <!-- ... -->
    <Angle horz="340" vert="-90" values="0 0 0 0 0 0 0 0" />
    <Angle horz="350" vert="-90" values="0 0 0 0 0 0 0 0" />

    <Angle horz="  0" vert="-80" values="0 0 0 0 0 0 0 0" />
    <Angle horz=" 10" vert="-80" values="0 0 0 0 0 0 0 0" />
    <!-- ... -->
    <Angle horz="340" vert="-80" values="0 0 0 0 0 0 0 0" />
    <Angle horz="350" vert="-80" values="0 0 0 0 0 0 0 0" />

    <!-- ... -->

    <Angle horz="  0" vert=" 80" values="0 0 0 0 0 0 0 0" />
    <Angle horz=" 10" vert=" 80" values="0 0 0 0 0 0 0 0" />
    <!-- ... -->
    <Angle horz="340" vert=" 80" values="0 0 0 0 0 0 0 0" />
    <Angle horz="350" vert=" 80" values="0 0 0 0 0 0 0 0" />

    <Angle horz="  0" vert=" 90" values="0 0 0 0 0 0 0 0" />
    <Angle horz=" 10" vert=" 90" values="0 0 0 0 0 0 0 0" />
    <!-- ... -->
    <Angle horz="340" vert=" 90" values="0 0 0 0 0 0 0 0" />
    <Angle horz="350" vert=" 90" values="0 0 0 0 0 0 0 0" />
</Directivity>
</CNOSSOS_Industry_Catalogue>
```

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Annex B -- example of the file CNOSSOS_Industry_Input.xml

```xml
<?xml version="1.0"?>
<CNOSSOS_Industry_Input>
    <Test>true</Test>                   <!-- Create file with intermediate results -->
    <Source Ref="0">                    <!-- References SourceDefinition ID in CNOSSOS_Industry_Catalogue -->
        <Height>0.05</Height>           <!-- Source height, in m (optional; if omitted, the referenced source height is used) -->
        <Period>12</Period>             <!-- T0 = Reference period of time in hours (e.g. day is 12 hours, evening is 4 hours, night is 8 hours) -->
        <SourceTime>8</SourceTime>      <!-- t = Active source time per period based on a yearly averaged situation, in hours -->
        <Vehicles moving="true">        <!-- Whether the source consists of moving vehicles -->
            <Count>1</Count>            <!-- Number of vehicles passages per period -->
            <Speed>15</Speed>           <!-- Speed of the vehicle [km/h] -->
            <Length>100</Length>        <!-- Total length of the source [m] -->
        </Vehicles>
        <Directivity>                   <!-- The direction of the source.
                                             This can be specified using either Euler angles or a
                                             vector, where 0° by 0° is equivalent to (1, 0, 0). -->
            <Angle horz="  0" vert="  0" />
        </Directivity>
    </Source>
    <Source Ref="1">                    <!-- References SourceDefinition ID in CNOSSOS_Industry_Catalogue -->
        <Height>0.05</Height>           <!-- Source height, in m -->
        <Period>8</Period>              <!-- Reference period of time in hours (e.g. day is 12 hours, evening is 4 hours, night is 8 hours) -->
        <SourceTime>8</SourceTime>      <!-- Active source time per period based on a yearly averaged situation, in hours -->
        <Vehicles moving="false"/>      <!-- Whether the source consists of moving vehicles -->
        <Directivity>
            <Vector x="1.0" y="0.0" z="0.0" />
        </Directivity>
    </Source>
</CNOSSOS_Industry_Input>
```

Annex C -- example of the file CNOSSOS_Industry_Output.xml

```xml
<?xml version="1.0" ?>
<CNOSSOS_SoundPower version="X1.0">
    <source>
        <h>0.05</h>
        <Lw sourceType="PointSource"
            measurementType="HemiSpherical"
            frequencyWeighting="LIN">
            32.5527 32.5527 32.5527 32.5527 32.5527 32.5527 32.5527 32.5527
        </Lw>
    </source>
</CNOSSOS_SoundPower>
```

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Annex D -- example of the file CNOSSOS_Industry_Output.csv

```
Sep=
source_def      height    Lw;63   Lw;125  Lw;250  Lw;500  Lw;1.000 Lw;2.000 Lw;4.000 Lw;8.000 period  src_time moving_vehicles count   speed   length
        horz_angle        vert_angle      def_height      type     radiation
0       0,05    0         0       0       0       0        0        0        0        12      8        yes      1       15      100     0       0       0,05
        point   hemispheric
1       0,05    0         0       0       0       0        0        0        0        8       8        no       -       -       -       0       0       0,05
        point   hemispheric


source_def      name    63Hz    125Hz   250Hz   500Hz   1.000Hz 2.000Hz 4.000Hz 8.000Hz
0       delta_Cw 32,5527
0       delta_Dir        0       0       0       0       0       0       0       0
0       Lw      -32,5527 -32,5527 -32,5527 -32,5527 -32,5527 -32,5527 -32,5527 -32,5527
1       delta_Cw 0
1       delta_Dir        0       0       0       0       0       0       0       0
1       Lw       0       0       0       0       0       0       0       0
```

Or, as imported into a spreadsheet:

source_def	height	Lw;63	Lw;125	Lw;250	Lw;500	Lw;1.000	Lw;2.000	Lw;4.000	Lw;8.000	period	src_time	moving_vehicles	count	speed	length	horz_angle	vert_angle	def_height	type	radiation
0	0,05	0	0	0	0	0	0	0	0	12	8	yes	1	15	100	0	0	0,05	point	hemispheric
1	0,05	0	0	0	0	0	0	0	0	8	8	no	-	-	-	0	0	0,05	point	hemispheric

source_def	name	63Hz	125Hz	250Hz	500Hz	1.000Hz	2.000Hz	4.000Hz	8.000Hz
0	delta_Cw	32,5527							
0	delta_Dir	0	0	0	0	0	0	0	0
0	Lw	-32,5527	-32,5527	-32,5527	-32,5527	-32,5527	-32,5527	-32,5527	-32,5527
1	delta_Cw	0							
1	delta_Dir	0	0	0	0	0	0	0	0
1	Lw	0	0	0	0	0	0	0	0