

Employer  
**SAKO BRNO A.S.**

Project  
**High-efficient combined heat and power facility utilizing renewable sources (OHB  
II - line K1)**

Date  
**February 2021**

# **PART III, APPENDIX A14.3**

## **ACOUSTIC NOISE AND VIBRATIONS**



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Project name **High-efficient combined heat and power facility utilizing renewable sources  
(OHB II - line K1)**  
Version **1**  
Date **2021-02-25**  
Documentation **Procurement documentation – Part III – Employer’s Requirements**

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## 1. ACOUSTIC NOISE AND VIBRATIONS

These technical conditions determine the maximum permissible values for acoustic noise and vibrations from machines and components used internally or externally. The conditions must be observed under all operating conditions.

### 1.1 Authorities Requirements

The Contractor is subjected to the following:

All unnecessary noise shall be avoided. Therefore, the noise level, including the level for infra-sound and ultrasound, during the work shall be as low as possible, considering the technical development. Furthermore, the acoustic conditions shall also be satisfactory.

The noise load for a person is stated as the energy equivalent. A weighted sound pressure level at the place of work for a working day of 8 hours measured in dB(A), with regard to impulse, noise corrections should be carried out.

No person may be exposed to noise levels higher than 85 dB(A) during the work.

The overall noise emission, including both noises from the electromechanical equipment and the building installations to neighbouring areas shall comply with the maximum permissible values determined in the integrated permit which is of mandatory nature.

External noise shall be calculated and measured in accordance with local Legal Regulation.

## 2. NOISE REQUIREMENTS

The general philosophy for the Line regarding noise is that this shall be brought to a minimum.

Small installations may not protrude the general noise perception.

### 2.1 Internal Noise Requirements

The sound pressure level  $L_{Aeq}$  from the Line may not exceed:

- 75 dB(A) re.  $2 \times 10^{-5}$  Pa at any point in open connection with the boiler hall or the flue gas hall or in process rooms which are in open connection with the polycarbonate façade.
- 80 dB(A) re.  $2 \times 10^{-5}$  Pa at any place in the remaining part of the Line.

A sound pressure level  $L_{Aeq}$  from the Line of up to 85 dB(A) can be accepted in the following dedicated confined rooms (not valid if equipment is integrated into the boiler hall):

- Room for district heating main circulation pumps
- Room for feed water pumps and condensate pumps
- Room for district heating condensers and bypass condensers
- Room for ID-fan
- Room for primary air fans

- Room for secondary air fans
- Room for emergency generator during operation of the emergency generator

For the control room,  $L_{Aeq}$  from the Line may not exceed 35 dB(A).

For offices and meeting rooms,  $L_{Aeq}$  from the Line may not exceed 35 dB(A).

In respect to the sound pressure level the Contractor shall take due consideration to any contributions from surface reflections (low sound absorption) from any surfaces of construction and machinery etc. including reflections from the polycarbonate façade.

$L_{Aeq}$  should be measured and averaged during a time period of one (1) minute.

This requirement shall be complied with at any point at a distance of one (1) meter or more from machine surfaces and installations. The requirements shall be complied with under the actual building installation conditions, meaning that any reflection contributions shall be included in the measurements.

Measuring points shall be arranged at a distance of 1.0 m or more from floors and walls.

The noise requirements shall be complied with under all normal operating conditions.

### 2.1.1 EXEMPTIONS

The above noise requirements do not apply within specific noise enclosures.

In special cases, deviations from the noise requirements are acceptable. This will be relevant concerning intermittent noise, e.g. from safety valves. The exemption is conditioned that the intermittent noise source and peak values are explicitly specified in the Contract.

If the Contractor during the design phase discovers areas with higher maximum values than stated, this shall be clearly stated to the Employer. Any change in permissible noise loads is only valid after obtaining the Employer's written approval.

The noise requirements do not apply to acoustic alarms and similar safety equipment required by the authorities.

### 2.1.2 CONTROL MEASUREMENTS

Due to the measuring uncertainty, it is acceptable that the measuring post-correction result exceeds the required value by up to 1.0 dB(A).

### 2.1.3 SPECIAL INFORMATION

The Contractor shall in a report to the Employer specify and document the noise-reducing measures used to ensure the compliance with the stated maximum permissible values.

Should the noise emitted be of a varying character (intermittent, impulse related, etc.) or the noise contains audible pure tone components, this shall be explained in detail and approved by the Employer.

If peak values of the C weighted or A weighted sound pressure level at 115 dB re.  $2 \times 10^{-5}$  Pa in work areas might occur, this shall be stated by the Contractor in the Contract. Such rooms should be sealed from personnel access in order to avoid sudden hearing damage.

#### **2.1.4 GENERAL REQUIREMENTS FOR ACOUSTIC HOODS AND ENCLOSURES**

The use of noise hoods and enclosures is only acceptable in cases where a proper sound insulation of the individual noise source is not possible. Before the use of a noise hood can be accepted by the Employer, the Contractor is required to document, that it is technically impossible to comply with the noise requirements without a noise hood installed. No noise hoods shall be applied before full acceptance of the Employer.

The Contractor shall in the Contract state to which extent the Contractor wishes to use noise hoods and enclosures and state the noise level without the noise hood installed.

Noise hoods and enclosures shall be installed in sections with lifting devices making it easy to dismantle during an overhaul of the machinery/electric components.

Both internal and external noise hoods shall be equipped with a dirt- and oil-repellent surface.

Thermostatically controlled ventilation shall be incorporated where possible. Large noise hoods shall be provided with doors and internal lighting.

The noise hoods and enclosures etc. shall include all necessary inspection doors and windows for inspection of the bearing temperatures, oil levels, lubrication of bearings, etc.

All necessary installations, including ventilation, lighting, lifting devices etc. are included in the scope of Contract Object.

### **2.2 External Noise Requirements**

The Contractor shall comply with all requirements according to the permits issued by Authorities and Legal regulation. Refer to Part II.j *Planning and Permitting*.

In particular the Contractor shall pay attention to the noise study conducted by the Employer as part of the Authorities permit. The noise study is included as attachment to Part II.j *Planning and Permitting*. Figure 1 shows the maximum permitted sound pressure levels in dB(A) at the plot boundary of the SAKO Premises as specified in the permit.

If the noise limits of the permit are exceeded the Contractor shall, based on the noise study conducted by the Contractor, propose economical optimal mitigative actions for the Complete plant which may be taken to make the Complete plant comply with the noise limits of the permit.



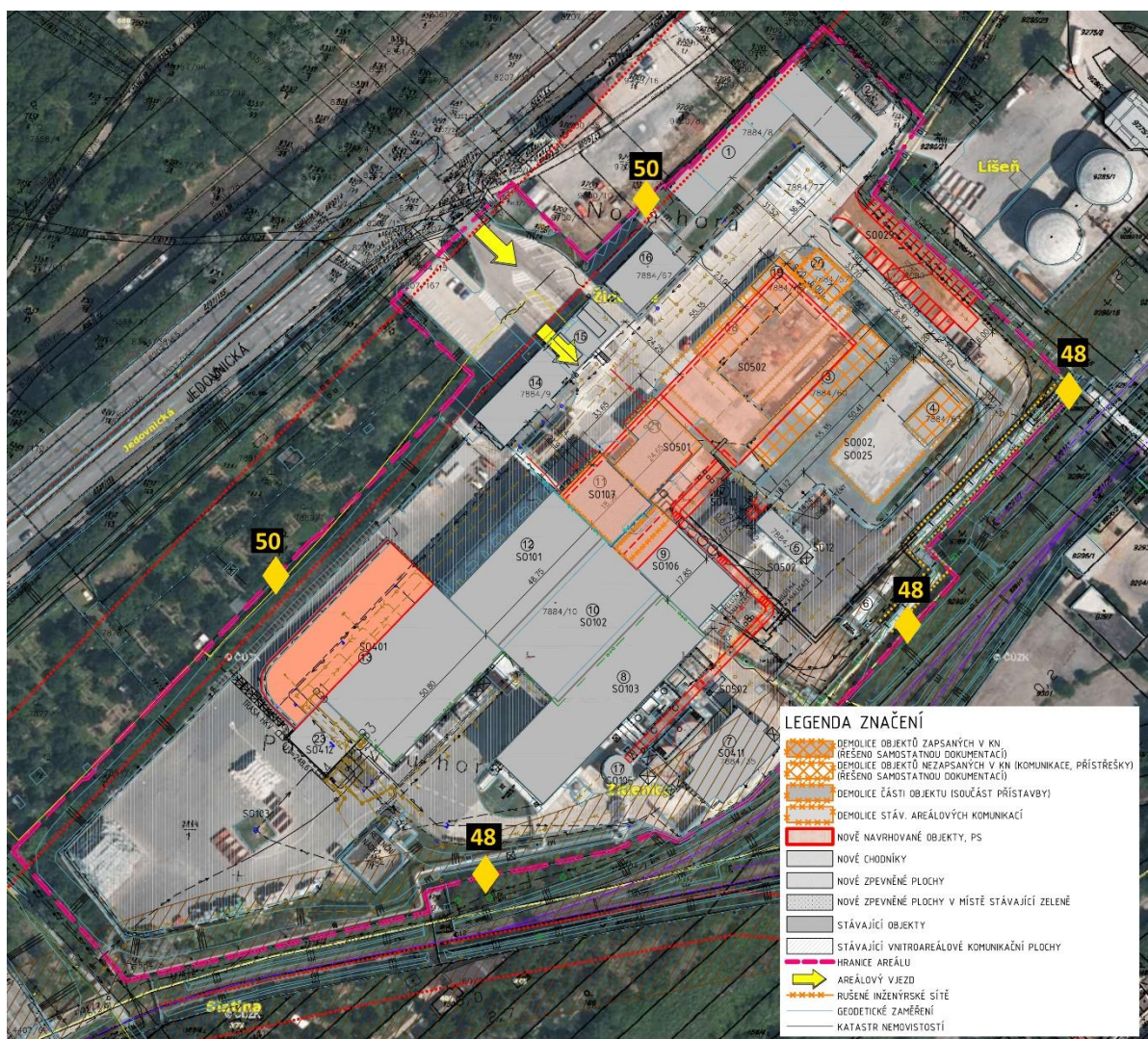


Figure 1, Maximum permitted sound pressure levels in dB(A) at plot boundary up to 35 m above ground.

In order to fulfil the permissible noise emission according to the Authorities permit for the Line, maximum emitted noise from individual systems, subsystems and equipment has to be regulated.

As a consequence, the external emitted noise from specific externally erected components and equipment etc. must be limited as stated in Table 1. Externally erected systems shall be understood as all sources of noise placed outside of buildings or sources of noise placed inside of buildings in such a way that the noise mostly is radiated through openings or the like.

In order to comply with the general requirement to bring noise to a minimum and secure that small installations do not protrude the general noise perception the following minimum noise requirement for components subject to contribution to the external noise shall furthermore be complied with in nearby areas.

- Maximum 20 dB(A) contribution from components and part systems.
- Maximum 25 dB(A) contribution from components and part systems where sound reduction can be executed at high costs.

- Maximum 30 dB(A) contribution any other components and part systems not included in the categories above.

Limitation of noise emitted from the above-mentioned equipment etc. does not exempt the Contractor from reducing noise emitted from any other possible internal and external source. Any significant source for internal and external noise shall be duly specified.

**Table 1, Maximum permissible Sound Power Level for various components**

Component description	Maximum permissible Sound Power Level ( $L_{WA}$ )
Stack (single flue gas pipe) <i>Maximum Sound Power Level (<math>L_{WA}</math>)</i>	85 dB(A)
Total summer cooler installation <i>Maximum Sound Power Level (<math>L_{WA}</math>) for summer coolers in total</i>	90 dB(A)
Total component cooler installation <i>Maximum Sound Power Level (<math>L_{WA}</math>) for components coolers in total</i>	85 dB(A)
Building ventilation in roof <i>Maximum Sound Power Level (<math>L_{WA}</math>) for building ventilation</i>	100 dB(A)
Building ventilation in north-west and north-east facades of the Line <i>Maximum Sound Power Level (<math>L_{WA}</math>) for building ventilation</i>	85 dB(A)
No ventilation openings or noise emitting equipment are allowed in the south-east and the south-west façade of the Line.	
All steam exhaust on roof from start-up, preheating and similar processes on boiler, turbine, by-pass systems, pumps and pipes etc. <i>Maximum Sound Power Level (<math>L_{WA}</math>) for each steam valve/pipe</i>	95 dB(A)
All steam exhaust on roof from safety valves <i>Maximum Sound Power Level (<math>L_{WA}</math>) for each steam valve/pipe</i>	110 dB(A)
Steam from deaerators, flash tanks etc. <i>Maximum Sound Power Level (<math>L_{WA}</math>) for each steam valve/pipe</i>	75 dB(A)

The noise limits apply to all contributions from the operation of the facility which includes all additional transport associated with the operation of the Line.

The planned position of the Line appears from the layout in appendix D, *Drawings*.

If the Contractor intends to add ventilation openings or air intakes in the south-east or south-west façade of the Line, then the written approval of the Employer shall be obtained. Any such



ventilation or air intakes shall be covered by the noise study for the Complete plant conducted by the Contractor.

Noise emitting equipment located on the roof of the Line shall be placed such that the edge of the roof provides a sound reducing barrier towards the south-east and south-west. This means that noise emitting equipment should not be placed close to the edge of the roof.

Regarding sound emission from buildings, it should be remarked that the Contractor is responsible for the compliance of the internal noise requirements stated in section 2.1, and that the building on this basis shall be engineered and constructed such that external noise requirements are kept.

Building engineering and construction itself, shall comply with requirements on facades and its minimal acoustic noise reduction properties stated by the Authorities permits and Legal regulation.

General requirements on minimal facades acoustic reduction are stated in Table 2.

Table 2, Minimal facade acoustic reduction properties

Component description	Acoustic reduction properties (dB)
Concrete basement (up to the 13,00 m)	50 dB
Polycarbonate cladding	29 dB
PUR panels	30 dB

The above-mentioned requirements for noise loads including all other significant sources for emitting noise must be fully documented based on measurements and calculations.

### 2.2.1 CONTROL MEASUREMENTS AND CALCULATION

Control measurements of noise level will be carried out by the Employer's technicians or technical adviser.

Expenses for noise measurements will be paid for by the Employer. Possible re-measurements due to non-compliance with the noise requirements shall be paid by the Contractor.

Before the measurements are carried out, the Contractor or his representative will be informed of this. Thus, the Contractor can attend and check the measurements.

## 3. VIBRATIONS

Machinery vibration from rigidly mounted equipment can be transferred to the supporting structure and travel large distances to be emitted as noise elsewhere in a building or structure. The use of vibration isolators is an important part of reducing noise and vibration from industrial Lines and from mechanical equipment. The aim of vibration isolation is to reduce the transfer of vibration to the supporting structure.

All rotating and vibrating machines must be equipped with a proper isolation against transmission of vibration energy to the building structure. The design of the vibration isolation system shall have a degree of vibration isolation to be greater than or equal to 95 %.

### **3.1 Rotating machines**

All rotating machines must be well balanced. Unless otherwise stated rotating machines shall in general be balanced to Grade G 2.5 or better according to ISO 1940. A balance grade on G 6.3 is however accepted for the ID Fan.

### **3.2 Effect on personnel**

Operating and maintenance staff may not be exposed to whole body vibrations which imply risks to the health. Vibrations are assessed according to ISO 2631.

The employees may not be exposed to hand-arm vibrations which are injurious. Vibrations are assessed according to ISO 5349. External vibrations from the facility may not exceed demands in the integrated permit. If such has not been indicated – guiding marginal values from environmental authorities must be met.

### **3.3 Effect on Machine Lines and Buildings**

The Contractor shall guarantee that the efficient vibration velocity for all machines and components with attached supports and connections to other machines or components comply with the requirements of quality A in ISO 10816/20816 with relevant sub-numbers.

If a machine or component cannot be referred to ISO 10816/20816, the maximum vibration velocity including tolerances shall not exceed 5.0 mm/s measured in accordance with the instructions in ISO 20816.

Machines and components built into a machine unit shall comply with the balancing requirements for rigid rotors in ISO 1940-1.

Building vibrations shall not exceed requirements in DIN 4150, part 3.

The above applies for the entire load range.

### **3.4 Vibration Protection**

All deliveries must include the necessary vibration damping facilities in order to assure that stated noise- and vibration conditions can be kept.