Noisy machines in buildings

Olle Backteman
Ingemansson Technology AB, Instrumentvägen 31, Box 47321, 10074 Stockholm, Sweden

1. Introduction

A good acoustical environment both inside and outside houses is more and more appreciated by users and residents. There is a need for a quality declaration to be made for buildings, flats and non-residential premises so that acoustic qualities may be clear to all. Such quality classification is also recommended in the State Commission on Enquiry "Action Plan Against Noise".

In older days, artisans had their shops with rather noisy production gathered in "industry houses". Nowadays it is instead more common to have print shops and other noisy activities in buildings near to flats or offices and neighbours are really disturbed in their work by vibration and noise.

2. Noise criteria

In Sweden noise criteria are given in, for example, the "Acoustic Guide" distributed by the Swedish Council for Building Research. The Acoustic Guide is a classification system for acoustic quality within buildings based on standard classes. The classification system is co-ordinated with the Action Plan Against Noise and with the Building Regulations of the Swedish Board of Housing, Building and Planning.

By selecting a standard class and satisfying all the requirements in this class, the building, or premises, can be acoustically classified in the desired quality level.

There are proposals for the highest total acceptable noise levels in dB(A) from services and appliances, technical installations that cause noise with long duration within a house property. In Tables 1 and 2 the proposed highest levels in dB(A) in offices and departments are shown.

For noises of shorter duration, the acceptable total maximum sound level is 5 dB(A) higher.

Even if those proposals of maximum acceptable levels are fulfilled, people are still annoyed by the noise.

The Swedish Society for Health and Welfare has therefore prepared a proposal, SOSFS 1996:7, for low frequency noise

Space	Maximum total sound level dB(A) due to services and appliances
Acoustic class A	
Bedroom	20
Living room	25
Kitchen	30
WC, bathroom, etc	35
Acoustic class B	
Bedroom	25
Living room	30
Kitchen	35
WC, bathroom, etc	40
Acoustic class A	
Bedroom	30
Living room	30
Kitchen	35
WC, bathroom, etc	40
Acoustic class B	
Bedroom	30
Living room	35
Kitchen	40
WC, bathroom, etc	45

Table 1. Noise from services and appliances in residential buildings

Table 2. Noise from services and appliances in office buildings

Space	Maximum total sound level dB(A) due to services and appliances
Acoustic classes A and B	
Office rooms, small conference rooms, discussion rooms, rest rooms, terminal rooms, reception and despatch areas	35
Staff rooms, landscaped offices, shops etc	40
Corridors, entrances, WC, showers, changing rooms, data rooms etc	45
Parking decks, goods reception areas,store rooms, wind screens at entrance etc	55

levels in 1/3-octave bands. The guidelines are shown in Table 3.

Table 3. Recommendations for estimate of sanitary inconvenience caused by equivalent low frequency noise inside houses

1/3 octave band Hz	31.5	40	50	63	80	100	125	160	200
Equivalent SPL dB	56	49	43	41.5	40	38	36	34	32

3. Vibration criteria

In the Swedish Standard

"Measurement and guidelines for the evaluation of comfort in buildings", SS 460 48 61 weighted vibration velocity values in the frequency range 1–80 Hz are given for determining comfort in buildings, see Table 4. The standard is based upon the International Standard ISO 2631-2. The weighting curves are shown in figure 1.

The values are designed for the maxima of the measured RMS value.

The threshold of sensitivity for vibration velocity in buildings is quite near to 0.1 mm/s.

Table 4. Guidelines for vibrations in buildings in accordance with SS 460 48 61

Amount of disturbances	Vibration velocity mm/s
Very little	0.4–1.0
Probable	> 1.0

4. Some examples of different types of disturbances

Print shops

Complaints about annoying noise from a print shop had been made for a long time by the owner of a flat. The print shop was located on the same level in the neighbourhood in a nearby building. The noise source was a four colour offset press with its associated equipment. The measured noise level within the bedroom in the flat at normal printing speed, 10,000 ex/hour, was from the beginning about 35 dB(A). The dominating 1/3-octave band level for the dB(A) level was 125Hz but even levels at 40Hz and 80Hz had to be decreased. In accordance to the proposal from the Swedish Society for Health and Welfare, the low frequency noise levels were too high. From the measurements we could certify that the problem was the transmission of structure borne noise. The higher frequency part of the noise, 315Hz was generated by the main motor bolt mounted to the shop floor without any vibration isolation. The offset press itself had a vibration isolation with too high a mounting frequency, about 60 Hz. After vibration isolation of the main motor correctly with a rather soft isolation the noise level was decreased to 30–32 dB(A). In the next step with softer vibration isolation of the four print devices the noise level was decreased to 28 dB(A) and the low frequency noise levels proposed by the Swedish Society for Health and Welfare were met.

In another case where people in an office made complaints about a four colour offset press installed in a shop without any vibration isolation, we

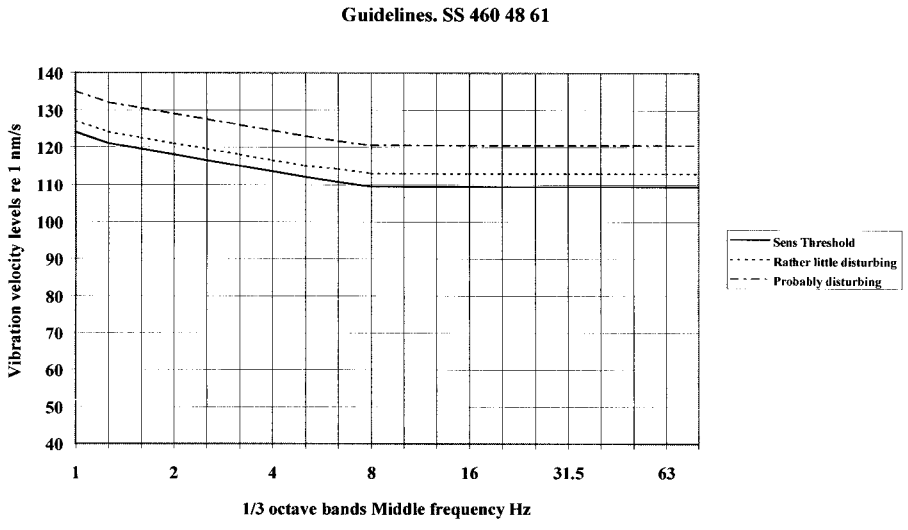

Figure 1. SS 460 48 61, guidelines

made comparison vibration measurements on a similar offset press that should have been installed with vibration isolation. The measurements were made in the vertical direction at 8 measuring positions on the concrete floor along with the press. Both concrete floors should have about the same thickness and the building construction should be quite similar.

The results in 1/3-octave bands indicated no significant differences in vibration velocity levels for the two presses. When we measured the vibration velocity levels we could see with our eyes the isolation of the two first print units, so we were convinced that the other two print units had the same vibration isolation.

The conclusion was that all of the print units were not vibration isolated. The level of the floor was not exactly the same over the area of the press installation. At the other end of the press the floor level was too high so they did not manage to install those units with any vibration isolation.

Case 1

In a dwelling where the family had moved down in the house to a bigger flat they made complaints of an annoying noise in their bedroom, normally coming once or twice at the end of the day or in the early part of the night. But it could also come early in the morning.

We installed a sound level meter and an accelerometer with a charge amplifier connected to a DAT-recorder, and the family had to start the DAT-recorder when they found the noise annoying. They made recordings during five days.

The results of the recordings showed a pure tone with a constant frequency of 49.06Hz, resolution 0.31Hz. This tone caused a noise level of 30–32 dB(A) in the bedroom. The duration of the tone could be in the range of 1–2 minutes. We have looked through all the house in order to try to find the source and been in contact with the subway personnel and others in the area around the house but we have not found the source.

Case 2

The attic in a five level living house had been built with a new flat in the attic. There was a problem for the family in the new flat. They were very annoyed by very sensitive vibrations in the floor of their living room.

We first started to put a long duration measuring device in the living room, measuring noise outside the window, inside in the living room and also the vertical vibration velocity levels on the floor. These results showed very high noise and vibration levels in the living room but no correlation with the noise outside the window.

The next step was to install a sound level meter and an accelerometer with a charge amplifier connected to a DAT-recorder. The family had to start the DAT-recorder when they found the noise annoying. When I installed the recording equipment I could myself feel the vibrations. The direction of the vibrations was indefinable. They made recordings during a rather long time, ten days.

The narrow band analyses of the recordings indicated a pure tone with the frequency of 8.9Hz. The duration was in the range of 60–90 seconds. The disturbing tone would start up 15 to 20 times a day with a vibration velocity higher than 1 mm/s but normally not during nights. The representative of the house told me in the beginning of our investigation that they had switched off the electricity in the whole house and the annoying tone was still there.

We have not been able to find the source. The recommendation we will give is to break the wooden floor and make it much stiffer.