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Event monitoring system to control the sound emission of loud musical events

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ABSTRACT

Loud musical events, pop concerts, dance events, are often tolerated within limits concerning the maximal sound levels near dwellings, the maximal number of events per year, and the period of time during a day. Local authorities set limits in permits and demand control of it. To minimize control measurement effort and provide online sound information to the operator during the event, a system has been developed by which:

- from the sound limits near dwellings the allowable sound levels in the (different rooms of a) venue are derived from the measured sound attenuation between venue and dwellings;
- the measured sound levels in the venue during the event are real time assessed in relation to the permit limits; exceeding of allowable sound levels generates feedback to the sound crew to adjust the output levels of the sound system;
- real time sound level information to local authorities can be provided.

In a simple way the event monitoring system provides insight to parties about the occurring sound levels in every room of the event venue and possible exceeding of the permit limits. This paper describes backgrounds and goals of this event monitoring system and the practical experience.

1 INTRODUCTION

In general sound limits are part of environmental permits of event venues. These environmental permits contain sound limits concerning “normal” activities. Often permits also contain more specific sound limits for special loud musical events with a more incidental character (large popconcerts, dance parties a.s.o.). These occasional activities demand special attention because of possible complaints from people living in the adjacent area of the venue. Local authorities are willing to allow higher sound limits than for the regular activities if only the organiser of the event proves to be able to control the sound levels during the event. This control is more complicated if different activities take place simultaneously (indoor) in different parts of the venue as is becoming more often the case.

To be able to control the sound emission during the event a system is developed by which the organiser can determine the maximum allowable sound levels inside the different venues and assess continuously during the event whether the sound limits as stated by the authorities are met or not. Furthermore this system provides directly after the event a written report stating the relevant sound levels during the event and assessment whether the sound limits are met or not.

This event monitoring system provides:

- to the operator in a simple way clear insight in the occurring sound levels in relevant area of the event venue;

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- to local authorities immediate and real time sound level information due to the event, when requested.

This paper describes this event monitoring system as well as the practical experience with it in one of the relative large venues for (among others) pop concerts and dance events in Rotterdam (Ahoy').

2 SOUND LIMITS

Within certain limits loud musical events, such as large pop concerts and dance events, are tolerated. These limits concern the maximal sound levels near adjacent dwellings, the maximal number of events per year, and the period of time during a day that these maximal sound levels may occur. The allowable sound levels near dwellings are usually prescribed by the local authorities in specific permits.

An example of such sound limits are those for Ahoy' Rotterdam, a mayor event venue in Rotterdam (see also figure 1). Different sound limits are valid for:

- normal activities;
- incidental activities (not occurring more than 12 times a year);
- a special event (in this case the well known North Sea Jazz Festival)

Table 1 shows the sound limits for these specific activities.

Table 1: Example of sound limits concerning event venue (Ahoy' Rotterdam)

Description	$L_{Ar,LT}$ in dB(A) *								
	Position 1			Position 2			Position 3		
	day	evening	night	day	evening	night	day	evening	night
Normal activities	50	50	40	50	50	40	50	50	40
Incidental activities**	60	60	60	54	54	54	60	60	60
Tractor pulling	60	60	-	55	55	-	60	60	-
North Sea Jazz Festival**	18.30 – 02.00 hrs 60			18.30 – 02.00 hrs 58			18.30 – 02.00 hrs 60		

* day: 07.00 – 19.00 hrs
evening: 19.00 – 23.00 hrs
night: 23.00 – 07.00 hrs

** Additional limit: $L_{Ari,10\ min}$ (10 minutes equivalent sound levels) shall not exceed the sound limits in this table with more than 5 dB.

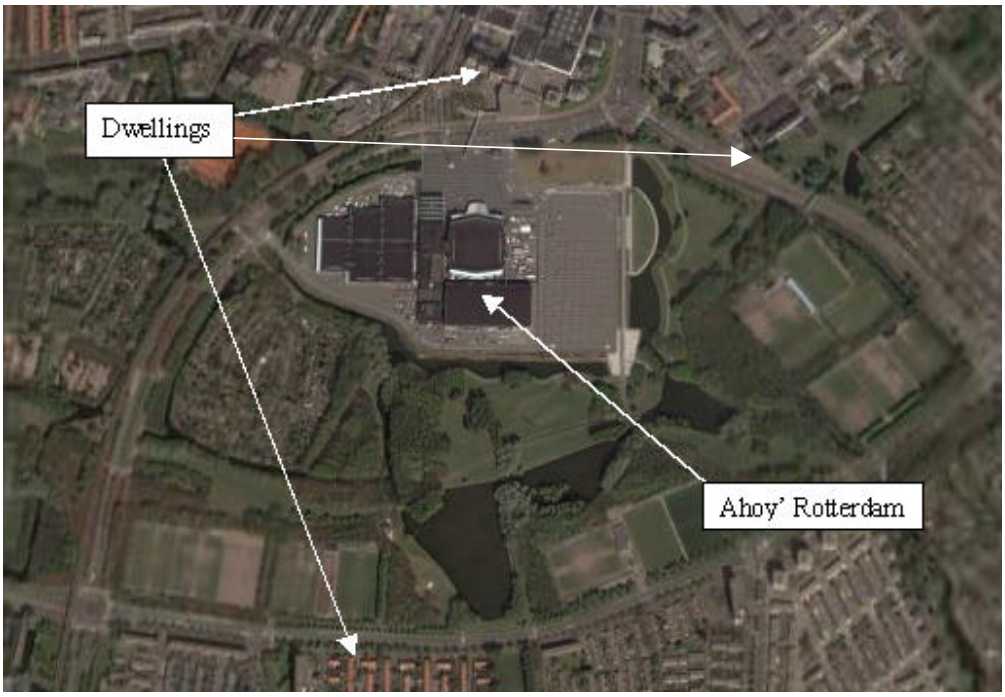


Figure 1: Bird view of Ahoy' event center in Rotterdam and location of nearby dwellings

3 MANAGEMENT OF SOUND CONTROL

Local authorities demand control of these kind of loud events. Normally this is done in two alternative ways:

- sound immission measurements near dwellings (or other useful reference positions)

or

- sound levels measurements in the venue itself during the event(s). Combination of sound limits near dwellings and the determined sound attenuation between venue and nearby dwellings the maximal allowable sound levels in the venue itself has been derived.

However, both methods are costly in terms of man hours needed. Furthermore, accurate measurements near dwellings in urban situations are often hindered by back ground noise due to traffic noise, giving rise to discussion about the measurement results.

To minimise the effort of control measurement and provide online sound information to the operator during the event, a system has been developed by which:

- the maximal allowable sound levels near dwellings are correlated with the allowable sound levels in the venue, for which the sound attenuation between specific venue room and nearby dwellings has to be determined;
- the maximal allowable sound levels in the (different areas of a multi event) venue are calculated;
- the measured sound levels in the venue during the event are real time assessed in relation to the sound limits in the permit;

- if an exceeding of allowable sound levels in the venue is about to happen when no actions are taken, the system generates feedback (in)directly to the sound crew to adjust the output levels of the sound system.

The sound attenuation between venue and dwellings can be measured using artificial sound sources or by measurements during an event. This includes the sound reduction properties of facade and roof of the venue rooms.

4 RELATION INSIDE - OUTSIDE SOUND LEVELS

When different loud activities take place simultaneously in different rooms of the venue, a distribution of allowable sound levels in these areas has to be determined in order to guarantee that the combination of different sound contributions will not exceed the sound limit near dwellings. For that purpose the determined sound attenuation between each room and nearby dwellings is incorporated in a special spreadsheet. This will calculate the total sound level near dwellings using expected sound levels inside the different rooms as input and will also assess the calculated total sound levels to the sound limits in the environmental permit. If exceeding of the sound limits has to be expected, the required reduction of the sound levels in each room can be derived. These derived sound levels are the maximal allowable sound levels in the different areas.

The spreadsheet can be used by the event organiser to assess different set-ups in musical performance per room and optimise the event in such a way that the sound limits can be met.

In principal two possible sound spectra are applied in these calculations, e.g. standardized pop spectrum (sps) and house spectrum (shs). Table 2 shows these two relative spectra [1].

Table 2: Relative spectra regarding the standardized pop and house music spectra

Frequency (Hz)	63	125	250	500	1k	2k	4k
standardized pop spectrum (sps)	-27	-14	-9	-6	-5	-6	-10
standardized house spectrum (shs)	-13	-8	-8	-7	-7	-9	-10

Choosing one of these spectra for each venue room, the sound contribution to positions near dwellings is calculated spectrally. From that maximal allowable sound levels in each venue room is derived. For the sake of simplicity these allowable sound limits are represented as linear and A-weighted values. The question arises whether this simplification agrees with practical sound spectra of different musical events. To answer that question the equivalent sound spectra during the total duration of different types of musical events were determined and compared with one of the two spectra as mentioned before. Figure 2 and 3 show the results of this comparison. The shown spectra concern equivalent sound levels regarding the total duration of the event (figure 2) or representative periods of time (figure 3); determined in Ahoy'.

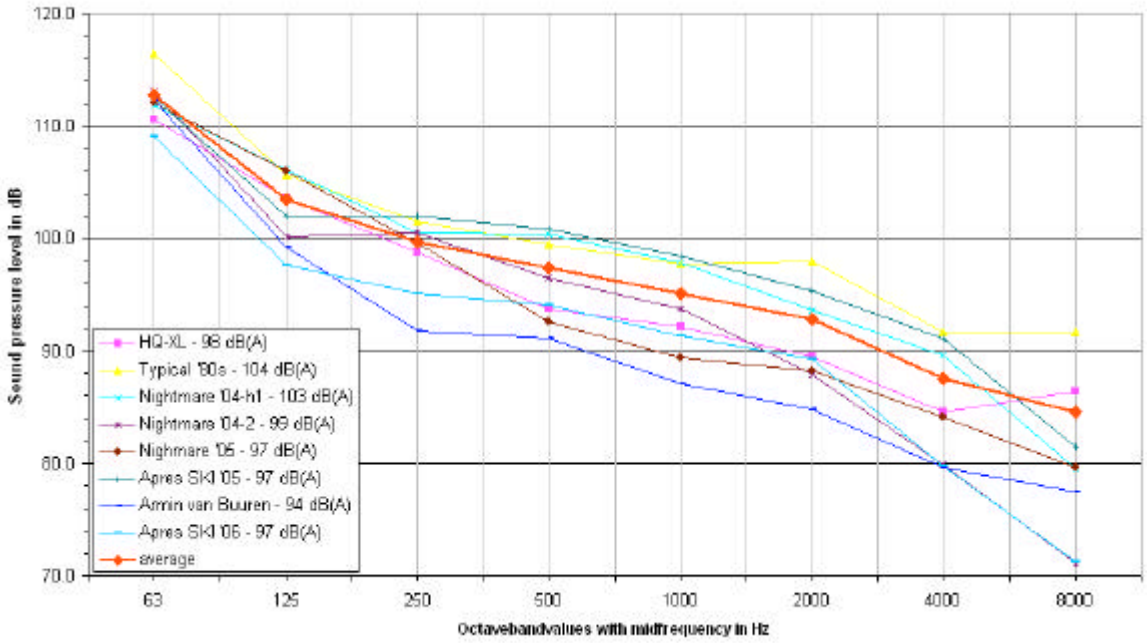


Figure 2: Sound spectra of different musical events (total duration), house music like events

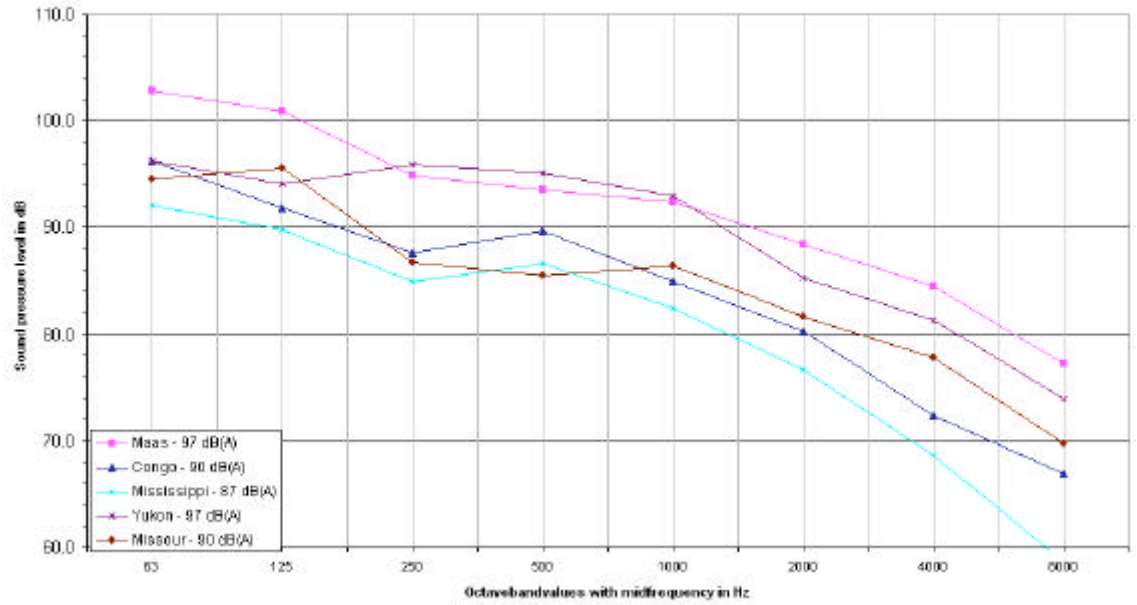


Figure 3: Sound spectra of different musical events, North Sea Jazz Festival

To be able to compare these spectra more easy the spectra of figure 2 and 3 are normalised to a sound level of 115 dB(LIN) respectively 106 dB(LIN); see figure 4 and 5. These values are equal to the sound limits in certain rooms of the venue regarding specific events.

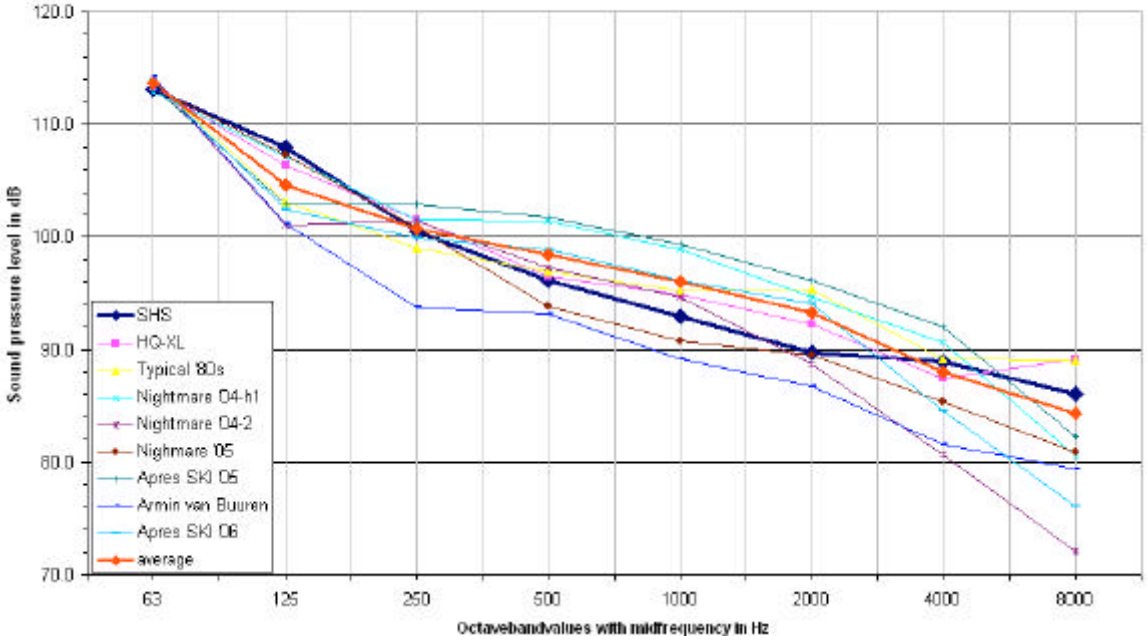


Figure 4: Sound spectra of figure 2, normalised at 115 dB(LIN)

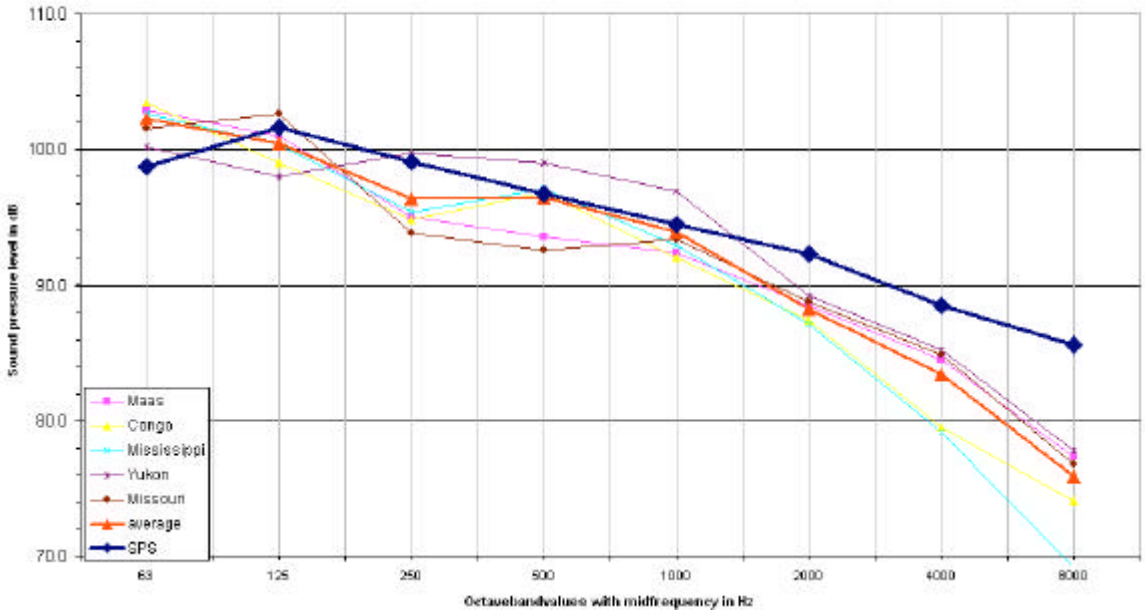
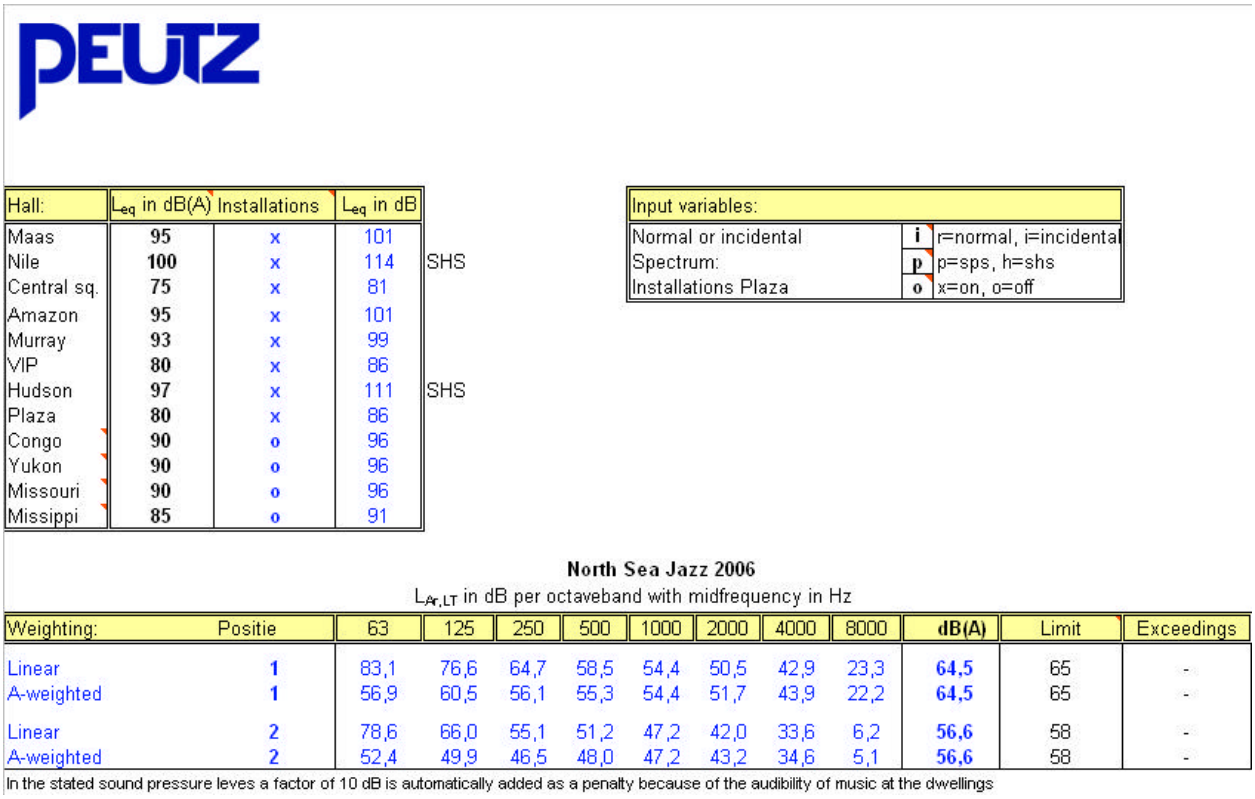


Figure 5: Sound spectra of figure 3, normalised at 106 dB(LIN)

To distinguish between musical events with only the two spectra of table 3 appears to provide - within certain limits - a sufficient approximation of reality. A very important consideration in this conclusion is that the sound immission levels near dwellings (and even more inside the dwellings) are caused by the indoor sound levels in the 63 till 250 Hz octavebands. The sound insulation of the facade and roof construction of the buildings behave like low pass filters to the sound. To apply a sound limit inside the venue areas related to dB(LIN) value, based on the linear sound levels in these 3 octave bands, is most appropriate to control the sound levels near dwellings. Nevertheless, this sound limit is combined with a sound limit in dB(A) because the sound crew is far more familiar with that unit.

As an example the results of the prognosis calculations regarding the North Sea Jazz Festival are shown in figure 6. During the North Sea Jazz Festival 12 different rooms of Ahoy', including temporarily tents, were used.

A penalty of 10 dB because of the musical character of the sound is included in these values.



Hall:	L_{eq} in dB(A)	Installations	L_{eq} in dB	
Maas	95	x	101	
Nile	100	x	114	SHS
Central sq.	75	x	81	
Amazon	95	x	101	
Murray	93	x	99	
VIP	80	x	86	
Hudson	97	x	111	SHS
Plaza	80	x	86	
Congo	90	o	96	
Yukon	90	o	96	
Missouri	90	o	96	
Missippi	85	o	91	

Input variables:		
Normal or incidental	i	r=normal, i=incidental
Spectrum:	p	p=sps, h=shs
Installations Plaza	o	x=on, o=off

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$L_{Ar,LT}$ in dB per octaveband with midfrequency in Hz

Weighting:	Positie	63	125	250	500	1000	2000	4000	8000	dB(A)	Limit	Exceedings
Linear	1	83,1	76,6	64,7	58,5	54,4	50,5	42,9	23,3	**64,5**	65	-
A-weighted	1	56,9	60,5	56,1	55,3	54,4	51,7	43,9	22,2	**64,5**	65	-
Linear	2	78,6	66,0	55,1	51,2	47,2	42,0	33,6	6,2	**56,6**	58	-
A-weighted	2	52,4	49,9	46,5	48,0	47,2	43,2	34,6	5,1	**56,6**	58	-

In the stated sound pressure leves a factor of 10 dB is automatically added as a penalty because of the audibility of music at the dwellings

Figure 6: Calculation results regarding maximal allowable sound levels in different rooms

Figure 7 shows the schematic layout of Ahoy' and the names of the areas as mentioned in figure 6.

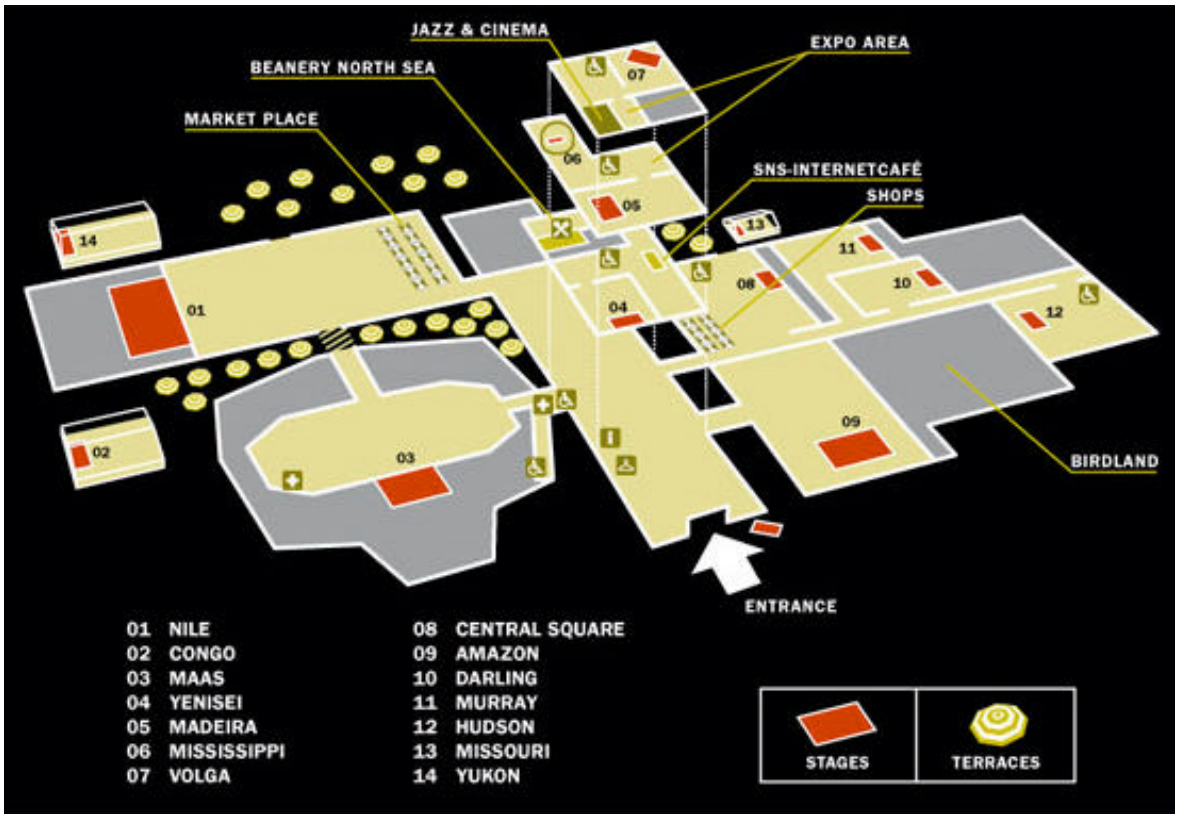

Figure 7: Schematic lay out of Ahoy' as used for the North Sea Jazz Festival

5 SYSTEM DESCRIPTION

The eventual set-up of an event with sound limits for each room is to be monitored by the event monitoring system (EMS) system.

EMS can be separated in three main parts, e.g. the measuring part, the analysing part and the reporting part.

EMS is formed by a combination of hardware and software, containing the following parts:

- ½"-microphone of sufficient accuracy;
- amplifier;
- acoustical calibration tool of the system;
- computer (PC or laptop) with adequate operating system, and printer if required;
- separate professional sound card;
- specific measuring software, developed by Peutz, with digital real time analyzing techniques;.

The complete system is set up in a way that the user can install, calibrate and operate it in a simple way.

On start-up of the EMS event parameters such as the event's name, venue, date etceteras and the in that specific venue applicable sound limits have to be entered. After a sound calibration of

the system the analysing part is started. The software is developed in such a way that it provides simultaneously:

- equivalent sound level during the whole measuring period in dB(LIN) as well as dB(A);
- the ongoing 10 minutes equivalent sound level also in dB(LIN) as well as dB(A);
- the ongoing 1 minutes equivalent sound level also in dB(LIN) as well as dB(A).

Besides that the system provides the applicable sound limit and – if applicable – the exceeding of this sound limit. The 1-minute equivalent sound level is used by the organiser to, if necessary, inform the sound crew that adjustments in the musical event must take place.

All obtained data is recorded in the computer.
At the end of the musical session EMS starts its reporting activities, stating:

- name and date of the event;
- equivalent sound level during the whole measuring period in dB(LIN) as well as dB(A);
- the ongoing 10 minutes equivalent sound level related to the whole event in dB(LIN) as well as dB(A).

If desired the data can be reported in print on the connected printer.

6 TEST PHASE

The system has been tested at a specific event by measuring simultaneously with EMS and in a “classical” way with sound level measurements in the venue as well as near adjacent dwellings.

Besides verifying the system this was also done to convince the local authorities about the accuracy of the system.

7 RESULTS

After the test phase EMS was used officially during the well known “North Sea Jazz Festival” (for the first time to be held in Rotterdam). The results are shown in figure 8.

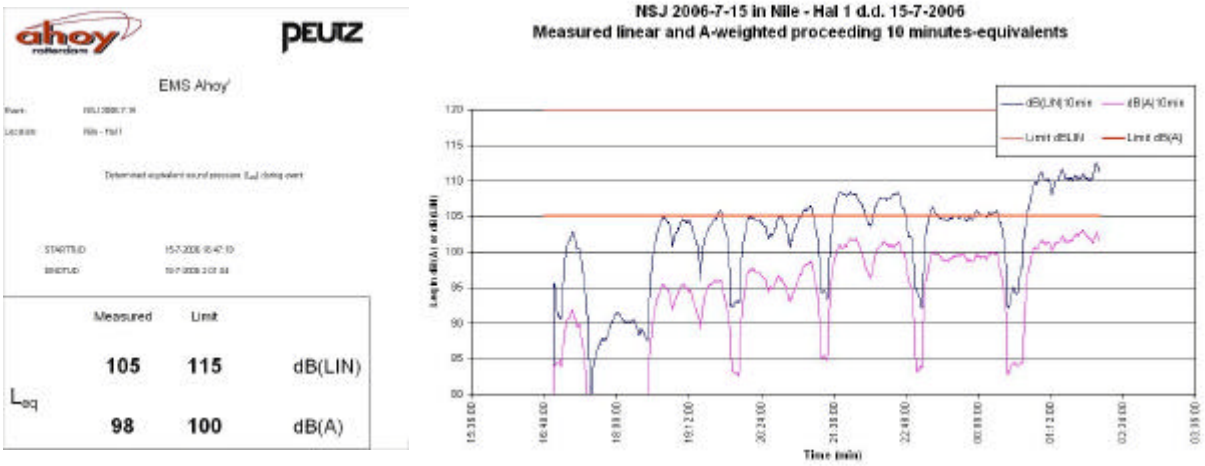

Figure 8: Results EMS system of North Sea Jazz event

In former studies it appeared that performances in mainly two rooms during this event were causing the total sound levels near dwellings. So EMS was installed in these two rooms. The sound levels in the other rooms used during this event were checked by hand held measurements, more or less at random. If more simultaneously used rooms should be responsible for the total sound levels near dwellings, EMS-systems should be installed in all these rooms.

8 CONCLUSION

The EMS system has proven its usefulness in practice. Because the measured data is real time visible the sound crew can also make use of the system to contain an acceptable sound level in the venue without the organiser having to demand adjustments. Using a laptop the EMS system is mobile enough to easily change to different venues in a multiday event.

9 REFERENCES

[1] Handreiking industrielawaai en vergunningverlening (Guideline industrial noise and environmental permit), Dutch Ministry of Environmental Affairs, 1999.