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Noise control of harbors

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ABSTRACT

Harbor areas are often sources of noise complaints especially during night-time, since the noise from harbors consists of short noise pulses caused, for example, by the handling of containers. The levels from such activities strongly depend on the operation modus making standard noise reduction measures impossible. One method to reduce the noise from such sources is to implement an active noise control. The noise control system consists of various measurement locations inside or close to the harbor area, noise measurements at the residential area and a central unit. In the central unit the data from the sensors will be processed and information about the noise status can be immediately send to the noise control manager if a given noise level threshold is exceeded. In this way immediate action can be taken to reduce the noise from the identified activity or area. For the identification of the noise sources a correlation analysis of the different signals as well as pattern recognition is used. This paper will report on the special requirements of a harbor noise monitoring system and the experience with an existing system, which is now running for the past 6 years at a harbor site in North Germany.

1. INTRODUCTION

During the last years shipping of containers throughout the world has steadily increased. Thus the size of container terminals has increased as well causing among other things more noise. Since the terminals are running also during night-time this will in most cases cause complaints from the close by neighborhood. To minimize the noise from harbor areas in the planning stage and to comply with national noise regulations, noise predictions/calculations are done. The calculations are based on available sound power data and standard propagation calculations, e.g. ISO 9613-2 [1]. These calculations are giving a decent picture of the expected average noise levels, but lack the ability to give an exact picture of short term noise events. These events rather than an average level are causing complaints and they are changing due to different equipment, variation in sound propagation conditions and differences in handling. In order to minimize the complaints an active noise control system has been established consisting of several microphones and a central unit allowing to localize noise events and to provide instance information of the levels to the operator. In the first step a general description of possible noise sources, there sound power levels and location within the harbor area will be

given, in order to demonstrate a possible set up of the system and the working frame of such a system.

2. NOISE SOURCES AT CONTAINER TERMINALS

Aside from the noise of the container terminal there are other noise sources which contribute to the overall levels. These sources are road, railroad traffic, windmills, industry etc. This makes it necessary, to set up a net of noise measuring systems and an evaluation algorithm to separate the different noise sources. For the container terminal typical noise sources are given in Table 1, in order to show the various noise sources and their annoyance potential, i.e. the sound power level and the number of sources.

Table 1: Typical noise sources

Noise source	Sound power level dB(A) min – max	Typical number Ø
Super-Post-Panmax- Container crane / Ship-to-shore crane	107 - 114	40
Straddle Carrier	103 - 110	200
Rail Mounted Gantry	100 - 105	3
Reefer	85 - 90	700
Train (l=700m) / h	Ø 1000m track	2-3/h
Ship	105 - 125	12

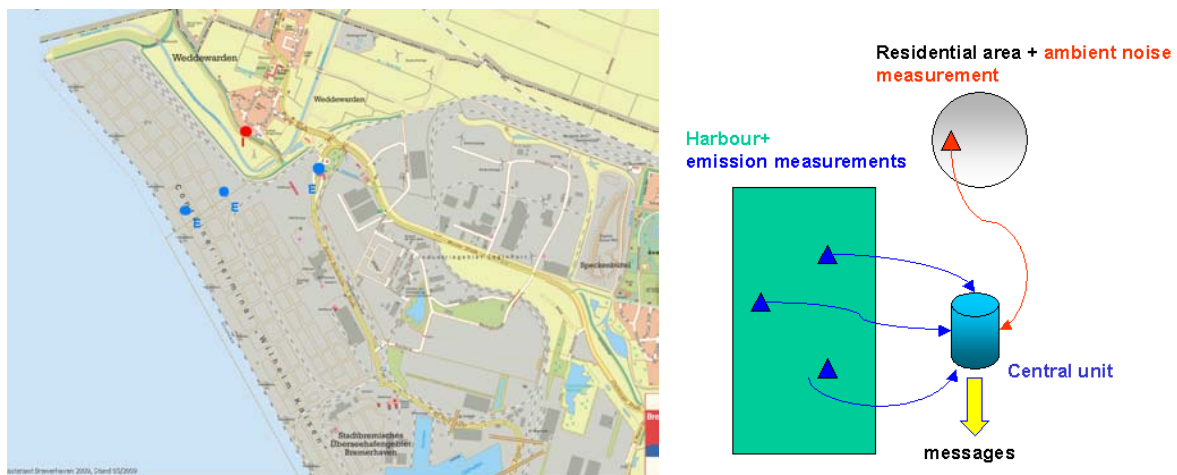


Figure 1: Noise sources harbor monitoring system (emission, immission)

3. DESCRIPTION OF THE NOISE MONITORING SYSTEM

The main goal of the noise monitoring system is to provide instant information about single, high level noise events which are the main causes of complaints especially during the night. Thus the system is taking measurements at the residential area as well as inside or close to the harbor area. The ambient noise measurement(s) and the emission noise measurement (inside the harbor area) are combined to relate noise at the receptor point to noise inside the harbor. This technique allows one to decide if the noise are extraneous noise from sources outside the harbor, like traffic noise for example, or from inside. Currently the system is set up in such a way, that ambient measurements are taken at just one place and emission measurements are taken at 3 locations with certain characteristic noise sources like transportation, container handling, etc. Since the main purpose of the system is to detect high level events, the time level records of the four locations – one ambient noise measurement and three emission measurements – are correlated in time, i.e. knowing the location of the measurement places and comparing the time difference between the four signals it is possible to estimate the location of the noise source. Once a noise event has been detected, a message like an email or fax will be send directly to the operator of the facility. Beside the detection of noisy events the system is able to measure also an increase in average levels from the harbor for example due to increase in operation or any deterioration of the equipment.

For the detection of noise events the measurement systems are using pattern recognition to separate different noise sources in terms of impulsive or tonal noise. The system is also able to identify other characteristic noise sources using the frequency spectra of the measured noise. An example of a time-level record with pattern recognition is show in Fig. 2 left. The different colors are representing different noise sources. Fig. 3 right shows a typical average spectrum taken at the receptor point.

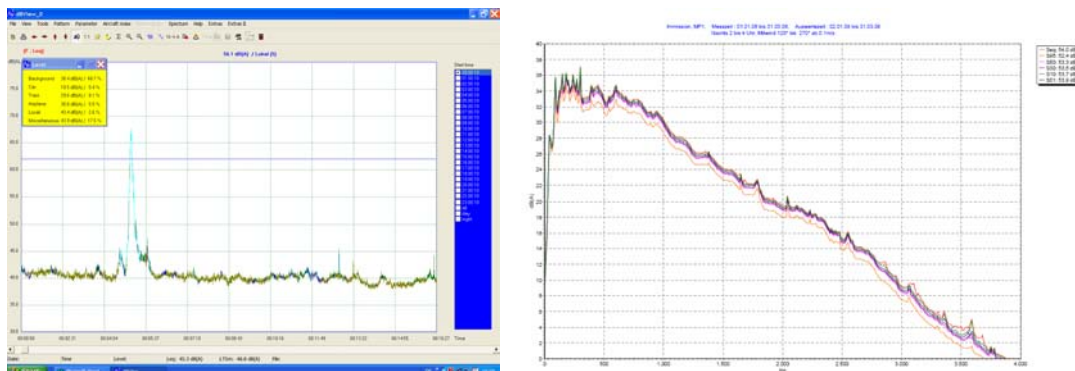


Figure 2: Example of pattern recognition and spectra

4. PROBLEMS AND FURTHER DEVELOPMENT

In the past emission measurements at three spots were sufficient. Due to the development during the past years, i.e. increase in size of the harbor area and the usage of the area by different independent operators more measurement spots must be used to be able to localize the origin of the noise. Also the requirements of data handling have to be improved, since more detailed information like narrow band spectra shall be included in the system. Thus the next generation of the noise monitoring system will have up to 10 emission measurement transmitting not only levels but will be able to generate for each site a narrow band spectrum. The narrow band spectrum is a fingerprint of noise sources and can be used to identify the sources and to check changes in levels and the noise characteristic, i.e. if tonal components are appearing or changing. The data from the measurements will be managed by the central unit which is storing the data in a database. The operator will then be able to check the noise levels

and performance from any place via internet. An example of an already existing system is shown in fig. 3. To check the overall development of the noise levels a statistical evaluation is carried out comparing the current noise measurement (one hour average) with the average noise levels measured in the past. Since short term measurements on an hourly basis strongly depend on meteorological noise propagation conditions, a correction for this influence also can be applied to give a better estimation of the 'true' noise levels from the harbor. The meteorological correction can be classified into 4 wind direction classes and 3 wind speed classes [2]. The values for each class can either be derived by measurements or any propagation model which incorporates the influence of meteorological conditions on noise propagation.

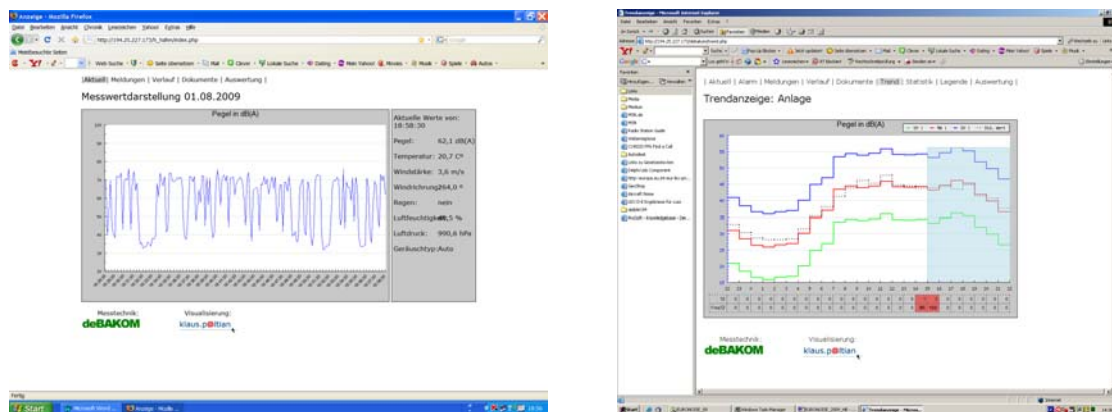


Figure 3: Examples of the noise management system (level + long-term level development)

5. CONCLUSIONS

During the past several years the noise control system at Bremerhaven has provided the operator with detailed information of the noise situation, especially for high level noise events during the night. The next generation of noise control systems will include more and detailed information about the location and characteristics of the noise sources.

REFERENCES

1. ISO 9613-2 Attenuation of sound during propagation outdoors – Part 2: General methods of calculation
2. Noise Management at Civil Shooting Ranges, D. Knauss, K.W. Hirsch, DAGA 2009 Rotterdam