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Noise Measurement 2

Continuous Noise Monitoring for Environmental Applications

The increasing awareness of the public of environmental issues such as CO2 emissions, carbon footprints and waste recycling has brought the issue of environmental noise to the fore.

Many of the demands of modern society result in the creation of noise sources such as larger airports, additional power stations and higher road traffic levels.

In addition to this, the expansion of towns and cities, driven by the demand for housing, has often resulted in the development of land near to existing noise sources.

These trends have meant that many more industries are now required to monitor their environmental noise impact and where operations are 24 hours, to carry out continuous noise monitoring.
Environmental noise, caused by traffic, industrial and recreational activities is one of the main local environmental problems in Europe and the source of an increasing number of complaints from the public.

Generally however action to reduce environmental noise has had a lower priority than that taken to address other environmental problems such as air and water pollution.

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In 1996, data from the EU Green Paper on Future Noise Policy[1] estimated that around 20% of the European Union's population, or close to 80 million people, suffer from noise levels that scientists and health experts consider to be unacceptable, where most people become annoyed, where sleep is disturbed and where adverse health effects are to be feared.
An additional 170 million citizens are living in so-called "grey areas" where the noise levels are such to cause serious annoyance during the daytime.

The expansion of the EU, with the associated increase in population, since this paper was published will have increased these numbers significantly.

For more than 20 years environmental noise policy in the EU and the European Community has essentially consisted of legislation fixing maximum sound levels for vehicles, aeroplanes and machines with a single market aim, or to implement international agreements in the case of aircraft, linked to certification procedures to ensure that new vehicles and equipment are, at the time of manufacture complying with the noise limits laid down in the directives.

Thanks to this legislation and technological progress, significant reductions of noise from individual sources have been achieved.

"for example the noise from individual cars has been reduced by 85% since 1970 and the noise from Lorries by 90%"

Likewise for aircraft footprint around an airport made by a modern jet has been reduced by a factor of 9 compared to an aircraft with 1970s technology.

Controlling environmental noise through legislation

In the 25 EU countries, the noise impact of large industrial sites is regulated under the Council Directive 96/61/EC2 which is more commonly known as the IPPC Directive.

This has been recently codified as Directive 2008/1/EC which includes all of the previous amendments as well as adaptations. The purpose of the Directive is the control the impact of industry on the environment outside of the facility. The Directive applies to all new sites and existing sites will have had to have been included by 2007.

The Directive covers all aspects of 'pollution' in the industrial context from the sites including gases, solids, liquids, noise, vibration and the use of raw materials.

The IPPC Directive requires the use of 'best available techniques, (BAT) with cost considerations included in the meaning of 'best available. With respect to noise, the directive requires controls of the noise emitted from a site during operations.

The IPPC Directive explicitly requires emission monitoring and this relates to noise as well as other pollutants. Therefore noise monitoring, and for larger sites with continual operations permanent noise monitoring, is often required.

Although the noise measurement instrumentation used in these applications is usually the same, there are often some significant differences which can change the way in which the system is specified and the information ultimately used.

In many of these applications, the aim of the system is to measure the noise generated by a specific source and to provide information to the user.

This may be as a result of a specific requirement such as a planning application or a condition placed upon the operator to ensure that the noise levels at the boundary of the site do not exceed a set limit.

For many airports and within this we would include larger international airports as well as regional airports and smaller airfields, the use permanent noise level monitoring can be key issue as noise is often the number one complaint from the surrounding population.

Typically the noise generated by individual aircraft as well as the overall noise impact is measured and the data retrieved from the noise monitor(s) to a central PC.

Reporting software, usually provided with the system, is used to generate regular reports and this information is used for compliance with any limits and controls placed upon the airport.

Power stations, petrochemical plants, construction sites, motorsport circuits, entertainment venues, military firing ranges, industrial and manufacturing sites as well as a number of other noise sources such as road and rail traffic are typical of the type of application where continuous noise monitoring is now being specified and used for real time control of noise levels.

What type of system is appropriate?

In simplistic terms, there are two types of noise monitoring system.

The first is a real time control system that uses the noise levels from remote locations to allow the operators to take immediate action. This type of system is commonly used where the noise levels from a facility are consistent but there are situations where higher noise levels may occur. Venting of steam or the lighting of stack flares are some example of this.

In this type of system having access to the noise levels as they occur is essential. However, it may also be useful to have historical and trend data available for reporting and complaint handling.

This type of system would also require a continuous connection between the noise monitor and the central control system which makes a dial-up connection, such as a Landline or GSM modem, unsuitable.

In industrial installations, there is often a need to integrate the noise monitors into an existing infrastructure. This is often a DCS or SCADA system of some type. However, this type of system is often used with simple input signals such as 4-20mA or DC voltages.

Although noise monitoring system can often provide this simple information, it is more usual for a noise monitor to provide its information as a data stream such as RS232.

An example of this type of installation uses a pair of remote noise monitoring units which are connected via RS232 and Ethernet to a control system. The noise monitors are continually transmitting the live noise levels at their respective locations as well as providing long term information on demand from the control system.

The live noise data is used in the control room along with other data to such as wind speed and direction with the long term noise data used for reference and complaint handling.

The second type of system could be considered to be 'on-demand'. In this type of system, which is more typical of airport noise monitoring where the monitoring locations are often remote from the control location and where it is not essential to have the noise information in real time, the noise monitors can be connected using landline or GSM modems.

Software provided with the system would be able to routinely download data from the monitors and store this data locally to allow reports to be created.

What noise parameters are required?

One of the most important aspects that must be considered is what information is required from the system and how will this be communicated to any regulatory authorities or third party stake holders.

It is essential that this is specified at the start of the development as modern noise monitors can measure, record and report the noise levels in a wide range of ways.

Where the aim of the system is to identify noise sources such as aircraft, the ability of the noise monitor to detect

and record data about specific events is often used. For each noise event, a set of data can be stored.

An example of the type of data that is available is shown below.

Start date
Start time
LASmax
LAE
LAeq,t
Maximum 1second LAeq,t
Time of LASmax
Duration of noise event
Wind speed
Wind direction
Air temperature
Humidity

For applications where noise events are not the focus, and this is typical of noise monitoring at industrial sites and power stations, longer term noise data measured over specific time periods can be used.

This type of data will produce more information but this can be used to create graphs and reports showing noise trend data.

An example of a 1 hour measurement is shown below.

Measurement Number	1/1		
Start date	22/10/2002		
Start time	15:06:00		
L5	50.4	L10	50.3
L15	50.2	L20	50.1
L25	50.0	L30	50.0
L35	49.9	L40	49.9
L45	49.8	L50	49.8
L55	49.7	L60	49.6
L65	49.6	L70	49.5
L75	49.5	L80	49.4
L85	49.4	L90	49.3
L95	49.3		
L1.0	50.4	L1.1	50.4
L89.2	49.3	L99.0	49.3
LAeq,t	54		
LASmax	64.6		
LASmax time	15:06:37		
Duration	01:00:00		

In addition to these two types of processed data, it is often useful to be able to view the noise profile, or Time History, data. This is often stored a set of 1 second samples which can be used for configuration, analysis or diagnostic purposed.

As can be seen from the information above, and this is just a simple example of the type of data available, there are many different parameters and different methods of measuring the same noise.

Ensuring that any requirements are specified at the start of a project can prove vital to the success and usefulness of such a system.

It has been said that for many users, the noise monitor itself is not the important part of the system.

Although it is often the most expensive part and it is the part that converts the sound energy into information that is more easily understood, once the system is installed and running how many users will actually see the noise monitor?

Where the instruments are remote from the control location, there may be little if any contact between the end user and the noise monitor other than for servicing and calibration.

Surviving in the environment

Many large industrial sites will already have weather measurement capabilities. Where there are fumes, gases or dusts being produced, information about the prevailing wind direction and wind speed is essential.

However, for locations where this information is not already available, the measurement of environmental conditions, such as the wind speed and direction, can be very useful.

Although the microphones used with permanent noise monitoring system would include a windshield and rain shield of some form, there is a point at which the noise generated by wind hitting the windshield may be higher than the actual noise being measured.

"to make sure that the recorded noise information is valid, logging the weather conditions along with the noise levels will be very useful"

Consideration should be given to integrating the weather measurements with the noise information so that high wind speeds indicated.

A separate but equally important aspect of the weather that should be considered is temperature. Although the ambient temperature will not usually affect the noise levels themselves, there may be some effects upon the noise measurement equipment itself from adverse or extreme weather.

As has been previously stated, high wind speeds will often increase the overall noise levels record and so the noise data recorded at this time is usually discarded. Heavy rainfall can also increase the overall noise levels, particularly where the noise monitor is located near to trees.

The weather conditions that a system will be used in should be considered when specifying the type of equipment to be used.

A purpose designed noise monitoring system will often provide a higher level of environmental protection and security than a system that uses a sound level meter in a box. The IP (Ingress Protection) rating of the enclosures should be as high as possible to ensure that any adverse weather does not find its way to the internal systems and electronics.

Calibration & Servicing

As with any noise measurement equipment, regular calibration is essential. Although a system will often have the capability to calibrate itself using an internal reference such as an electrostatic actuator, the entire measurement chain should be calibrated in the same way that a handheld sound level meter would be.

However as the noise monitors used in these applications are often permanently installed and cannot be removed for calibration, it must be possible to access both the microphone and system electronics to allow for an on-site calibration to be carried out.

As the noise monitor is often exposed to the elements, it is essential that this is done regularly to ensure the continuing performance and accuracy of the system.

Location, location, location

Choosing a suitable location can often be difficult. What would appear to be the best "acoustic" position may not be suitable in terms of access for both installation and servicing.

Selecting a location that cannot be access without specialist equipment such as lifts or scaffolding can dramatically increase the cost of the system and any associated maintenance.

One suggested location for an airport noise monitor, which looked ideal in the winter when the site survey was done, was rejected.

In the spring the noise levels from local trees and vegetation was significant and so the location would not have been suitable. In addition to this the position of the noise monitor would have meant that any servicing would have to have been done through a beech hedge.

Other than any environmental hazards, the connection of power and communications to the noise monitor are the two issues that cause the most headaches.

Power requirements

Modern noise monitors, and particularly those which are purpose designed, require very little power. A typical noise monitor would take around 25w of power, much less than the average light bulb.

However, the power must be available 24 hours a day to allow for noise measurements to be made continuously. Although battery backup may be available, this will often only support the noise monitor for a few days.

Alternative power sources may be available but again care must be taken in the specification of these options. Solar power is one option that is often discussed. The combination of solar power and a GSM modem gives a noise monitor total freedom from fixed services and utilities.

However the power requirements of the GSM modem often mean a large solar panel is required to guarantee 24/7 operation.

The location of the noise monitor must be included in any calculations to ensure that there is sufficient daylight to recharge the battery pack which will then be used to provide power during darkness or low light conditions.

Communications

Any noise monitoring system is only as good as the information it provides. Retrieving the noise measurement data from the noise monitor is often the most complicated part of the installation and specification of a system.

The ideal solution would be a fixed, dedicated link between the noise monitor and the control location. There are some examples where this type of connection has been used such as motorsport circuits where it has been possible to install a cable between the two points.

This often requires the use of line drivers to provide a consistently high quality signal where the cable length is over 50m for example but this is a relatively low cost and efficient option.

However, there are very few applications where this is possible due to a number of factors. Where the distance between the noise monitor and the control location is longer, an alternative solution must be used. Examples of some of these are shown below:

Communications	Advantages	Disadvantages
Direct RS232	Very low cost, very simple	Maximum length of cable <10m
Serial Line Driver	Low cost Ideal for real time noise level display	Requires dedicated cable Only one noise monitor per cable High cable costs over long distances
PSTN (Landline) Modem	Low cost connections Allows remote access for download from any location Multiple noise monitors can be connected to the control location	Requires a telephone line to be available at the noise monitor On going line rental costs
GSM Cellular Modem	Portable Does not require cables to be installed Allows remote access for download from any location Multiple noise monitors can be connected to the control location	Not ideal for real time noise levels due to high call costs On going contract and call costs
GPRS (3G) Cellular Data	High speed connection Portable	Advanced technology requiring software and support Not available in many countries High call & data costs On going contract and call costs
Radio Modem	No call costs Ideal for real time display	May require line of sight between transmitters
Leased Line	Low cost Ideal for real time noise level display	Relatively uncommon Expensive Requires analogue telephone exchange
Ethernet/WiFi	High speed Low cost installation	Requires existing IT infrastructure and support

Conclusions

There are an increasing number of applications where permanent noise monitoring can be used.

Traditional applications such as airport noise have been overtaken by new uses, often driven by legislation and directive.

The increasing awareness of the population to noise and environmental issues in general has driven the demand for continuous monitoring, measurement and control.

A permanent noise monitoring system can provide a solution to a number of different needs, be it for real time control of noise levels or as method to respond to complaints and noise limits.

References

1. The Green Paper on Future Noise Policy (COM(96) 540)

2. COUNCIL DIRECTIVE 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control

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