



INTERNOISE 2024 – Workshop

Review of construction noise Monitoring and Management best practice in different countries

Dimitri CHAMARD-BOUDET

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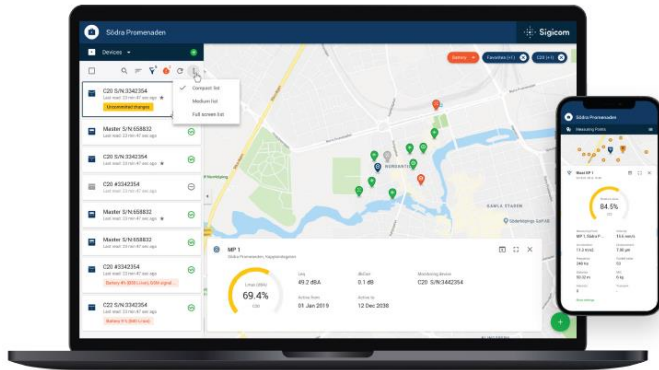
Introduction and Context

SIGICOM in a few words:

- ❖ Private and independent company created in 1981
- ❖ Supplier of environmental monitoring solution for construction sites or infrastructures
- ❖ No consultancy
- ❖ Autonomous Vibration and Noise sensors
- ❖ Over 30.000 devices sold over the World



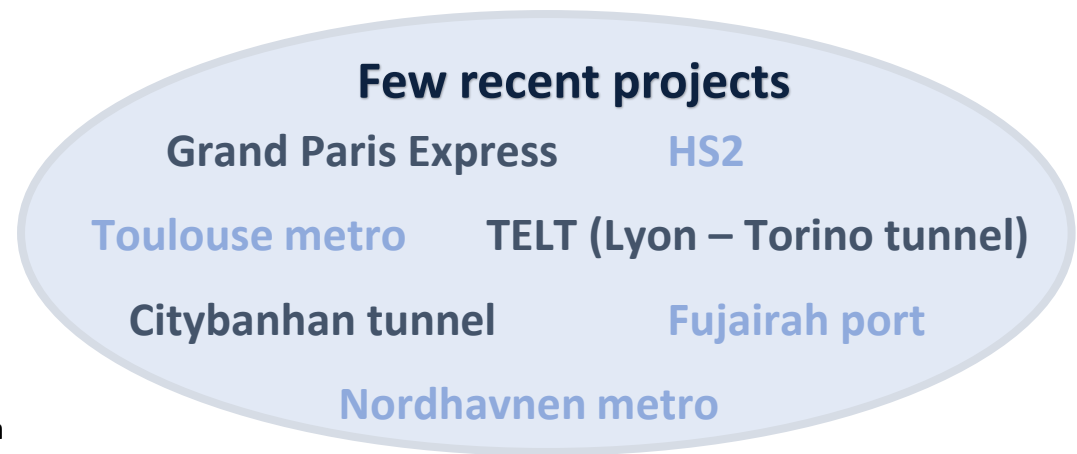
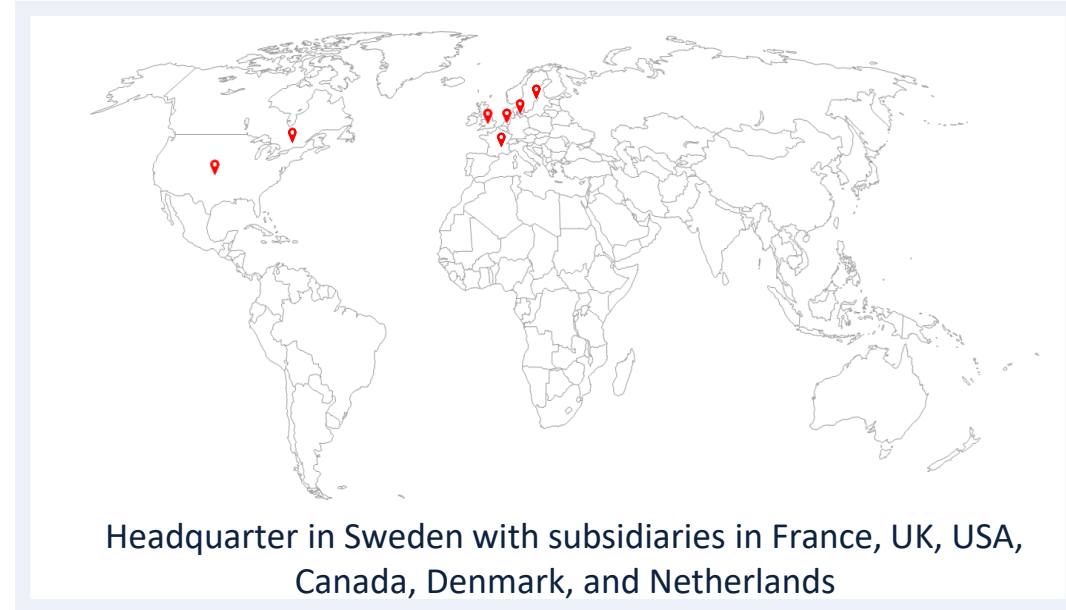
INFRA C22
Autonomous geophone



INFRA Net
Web platform



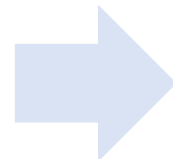
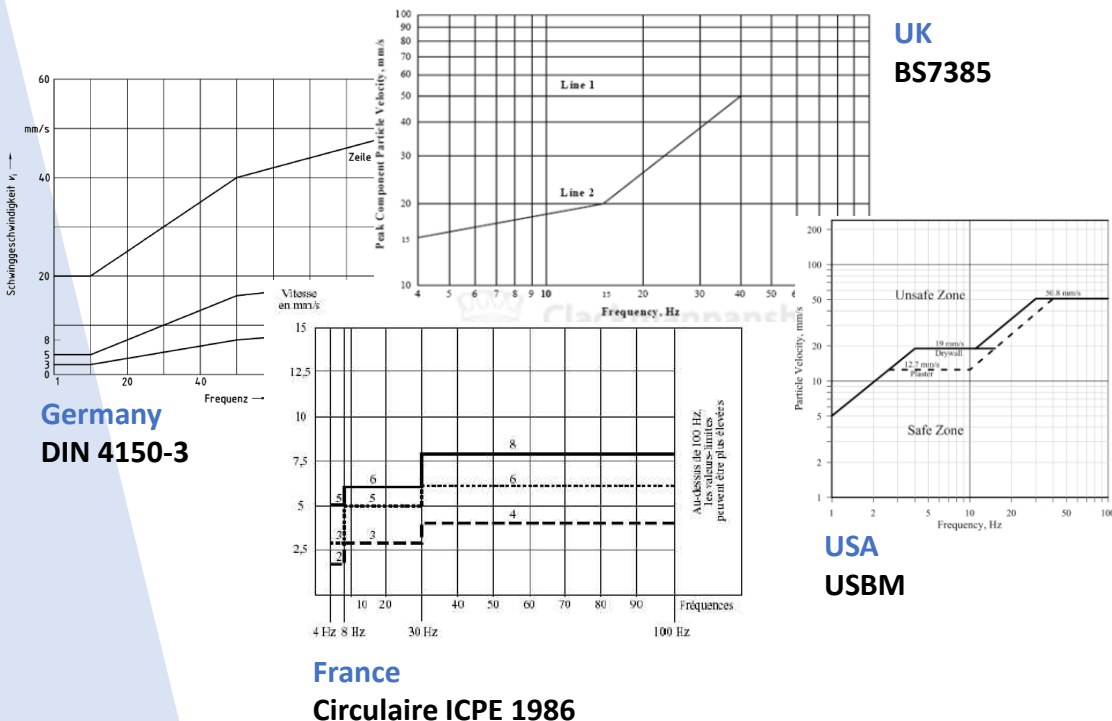
INFRA C50
Noise monitoring station



Context and background

As a **global supplier**, and with over 25 years experience in **vibration** monitoring, we know that consultant practices can be very different from one country to another: sensor setup, vibration limits, criterion, unity....

Every country has its own method and we need to adapt our solution to fit the needs and regulations.

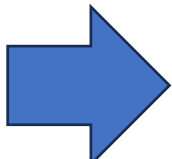


Requirements

- Peak / RMS value
- Acceleration / Velocity
- Level range
- Frequency weighting
- Time constant
- Filtering
- ...

Market needs


- Sensor setup technics
- Battery autonomy
- Communication protocol
- Consultants methodology
- ...



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Context and background

As we were working on our new **Noise monitoring station**, we reviewed all the regulations and practices across our different markets.

- 
- Each country (or state) has its own regulation – no standardized approach
 - Project specifications can vary a lot
 - **No existing literature on this topic**

After we had done this work internally, we thought this InterNoise Workshop would be a great occasion to share those outputs.

Purpose of our study:

Review the different approaches and the best practices for construction noise monitoring in different countries



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Noise monitoring station

Method

- To ensure objective inputs : we worked with **local consultants** - all experts in construction site noise monitoring
- We asked them the same questions (approx. 15) :
 - What are the applicable regulation for construction site noise?*
 - What do those regulation contain and how does that fit with construction noise?*
 - What do project specifications usually contain? ...*
- We gathered all the answers and compare the results

Today we'll present you the outcome of this study, keeping in mind:

- We asked the experts to focus on the "regular construction noise monitoring projects" - **This doesn't intend to cover all the project specs**
- The point is NOT to declare what's good or bad in each method – But to share the good practices and open the discussion

Local experts presentation

Canada 



Mr Nathan GARA
HGC ENGINEERING

France 



Mr Pascal GUITTAT
SIXENSE ENGINEERING

Germany 



Mr Robert BRAUN
PEUTZ

Monaco 



Mr Patrice ARNOULT
BUREAU VERITAS

Sweden 



Mr Daniel LINDMARK
EFTERKLANG

United Kingdom 



Mr Blake LUCAS
ACOUSTIC CONSULTANTS LTD

Review of the local regulations and Project specifications

Canada

Canada does not have a national regulation (neither federal nor provincial level).

Construction noise is often regulated by municipal by-laws.

Noise by time-of-day (e.g. “no construction between 7pm and 7am”), **no noise level limit**.

Large infrastructure projects are typically exempt from these by-laws and will often have their own environmental regulations.

Noise specifications are mostly set on a project level:

Preliminary assessment using **noise calculation** and **measurement**

- Estimate noise levels at nearby receptor
- Evaluate the need for mitigation and monitoring
- Define the criteria and limits

Noise criterion:

- L_{Aeq} for day, and night periods
- L_{Aeq} (xx minutes) – e.g. L_{Aeq} (10 min)
- L_{max} limits
- L_{10}

Example of noise limits from the METROLINX project in Toronto:

Table 15.3-1: Weekday (Monday to Friday) Maximum Airborne Noise Exposure Limits – City of Toronto

Land Use	L_{eq} (12 hour, 12 hour) (dBA)		L_{eq} (10-minute) (dBA)		L_{max} (dBA)	
	Day (7:00 to 19:00)	Night (19:00 to 7:00 the following day)	Day (7:00 to 19:00)	Night (19:00 to 7:00 the following day)	Day (7:00 to 19:00)	Night (19:00 to 7:00 the following day)
Residential	Louder of: 75 or Baseline+5	Louder of: 65 or Baseline+5	85	75	90	80
Institutional	Louder of: 70 or Baseline+5	Louder of: 60 or Baseline+5	75	65	90	80
Commercial	Louder of: 80 or Baseline+5	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Industrial	Louder of: 85 or Baseline+5	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Notes:

- L_{eq} (day) is the average energy equivalent noise level over a 12-hour period (7:00 – 19:00).
- L_{eq} (night) is the average energy equivalent noise level over an 8-hour period (19:00 – 7:00).
- L_{eq} (10-minute) is the average energy equivalent noise level over any 10-minute period.
- L_{max} represents the maximum allowable noise level.
- The sampling period of all noise measurements is 5 minutes.
- All noise measurements made with sound level meter set to slow-scale response.

France

The Noise Law n° 92-1444 from December 1992 referred in **Environment Code - Article R571-50**

Public Health Code contains **article R1336-10** dedicated to construction noise

Those texts give **qualitative** rules but **no quantitative** limits. 

Prior to the construction start, contractors shall provide a **“Noise Document”**, based on an acoustic study and including:

- Nature and duration of the construction
- Expected noise disturbance
- Noise mitigation solution (walls, enclosures,...)
- Background noise level (measured or calculated)
- Monitoring requirements

To define the admissible values, consultant often refer to other noise regulation:

- **“Neighbor noise law”**, based on emergence (background noise + XdB(A)...)
 - **“ICPE rule”** (23/01/1997) with a max value on site border (day: 70dB(A) – night: 60dB(A))

and emergence in the neighborhood

Public Health code – R1336-10:

Disturbances can be characterized by:

- “No compliance with the construction agreed **operations time** or the **equipment used...**”
- “The lack of **appropriate precautions** to limit noise from the construction site”
- **“Abnormally noisy behavior”**

Local administration (departments, cities, areas,...) can also add more limitations: limited activity periods, emergence limits, etc.

Noise criterion:

- L_{Aeq} for day, and night periods
- L_{Aeq} (xx minutes) – e.g L_{Aeq} (10 min)
- Rolling L_{Aeq}
- 1/3 octave bands recording

Germany

- General administrative regulation for protection against construction noise “AVV Baulärm” – August 1970

- The “Bundes-Immissionsschutzgesetz“ (or “BImSchg” - Federal Immission Control Act)

Those documents specify measurement methods and **guideline values** depending on the activities (residence, school, etc.).

Often, the AVV guidelines values (1970) are not usable anymore (higher background level)

Because of that, the "**70 dB(A) /60 dB(A) rule**" has become the *de facto* standard reference value.

This rule is based on an important **court ruling** who stated those levels of noise outside a window can be considered unreasonable for local residents:

- 70 dB(A) as daytime average
- 60 dB(A) as nighttime average

Guidelines values from the AVV Baulärm (1970)		
	Day 07-20 L_{AFTeq}	Night 20-07 L_{AFTeq}
Areas in which only commercial or industrial facilities and housing for owners and managers of the establishments	70 dB(A)	70 dB(A)
Areas where predominantly commercial facilities are located	65 dB(A)	50 dB(A)
Areas with commercial facilities and residential properties that are neither predominantly commercial nor predominantly residential	60 dB(A)	45 dB(A)
Areas where predominantly residential buildings are located	55 dB(A)	40 dB(A)
Areas where only residential buildings are located	50 dB(A)	35 dB(A)
Health resorts, hospitals and nursing homes	45 dB(A)	35 dB(A)

Noise criterion:

- L_{AFTeq} for day and night periods
- L_{max} limits during night period

What is L_{AFTeq} ?

- L_{AFT} = Lmax value recorded on a 5 seconds interval time
- L_{AFTeq} = Energetic average of all the L_{AFT} values on day or night periods

Monaco

Ministerial ruling 2021-107 from February 2021 relative to construction noise

Prior to the construction start, contractors shall provide a plan to mitigate construction noise, including:

- Spatial organization of the project (so the noisy equipment are kept far from the sensitive premises, etc)
- List of the engines used
- Presentation of the noise mitigation solution planned (walls, enclosures,...)
- Presentation of the monitoring solution

A **communication plan toward the neighborhood** must be settled

During the construction: noise report are done weekly and alarms are sent to the public service

Admissible noise values:

- $L_{Aeq,5min}$ = 85dB(A) in the neighborhood
- $L_{Aeq,15min}$ = 85dB(A) in the construction site property line

Noise criterion:

- L_{Aeq} (5min or 15min)
- 1/3 octave bands have to be recorded



« Rolling Leq » (France & Monaco)

When using the « rolling » method, the Leq value is not reset at the end of the interval.

The rolling $L_{Aeq,15min}$ is updated every time a new value is available (ex: 1 minute) and will always keep the history of the latest 15 minutes.

Sweden

Swedish Environmental Protection Agency's general advice on noise from construction sites (NFS 2004:15)

This document gives **guideline values** depending on the activities (residence, school, etc.).

Those values intend to serve as guide and may be modified in specific cases (higher or lower).

- If the outdoors guidelines are met -> no need to monitor indoor.

- Short term events can also be higher levels

Events occurring no more than 5 minutes per hour = permitted levels up to 10dB(A) higher than the guidelines.

- Traffic within the site is considered as construction noise. Traffic from and to the site should be treated as traffic noise.

Noise criterion:

- L_{Aeq} for day, evening and night periods

- L_{AFmax} for night period

Guideline values from Swedish Environmental Protection Agency – NFS 2004:15

		Weekdays		Weekends and holidays		All days	
		Day 07-19 L_{Aeq}	Evening 19-22 L_{Aeq}	Day 07-19 L_{Aeq}	Evening 19-22 L_{Aeq}	Night 22 – 07 L_{Aeq}	Night 22 – 07 L_{AFmax}
Residence	Outdoor at the facade	60 dB(A)	50 dB(A)	50 dB(A)	45 dB(A)	45 dB(A)	70 dB(A)
	Indoor in the living area	45 dB(A)	35 dB(A)	35 dB(A)	30 dB(A)	30 dB(A)	45 dB(A)
Reception area	Outdoor at the facade	60 dB(A)	50 dB(A)	50 dB(A)	45 dB(A)	45 dB(A)	-
	Indoor	45 dB(A)	35 dB(A)	35 dB(A)	30 dB(A)	30 dB(A)	45 dB(A)
Teaching premises	Outdoor at the facade	60 dB(A)	-	-	-	-	-
	Indoor	40 dB(A)	-	-	-	-	-
Workplaces	Outdoor at the facade	70 dB(A)	-	-	-	-	-
	Indoor	45 dB(A)	-	-	-	-	-



L_{AFmax}

The noise maximum value with Fast weighting (L_{AFmax}) is monitored at night only because sudden high levels can wake people up.

UK

Legislation - The Control of Pollution Act 1974: Sections 60 and 61

Guidance - BS5228: Code of practice for noise and vibration control on open construction site - Part 1 Noise

Legislation focusses on Best Practicable Means (BPM) and does not give noise limits.

BS5228: Part 1 gives guidance for the determination of BPM and noise limits.

Project owner has to submit a document to the Local Authority :

- Selection of the least noise intense construction methods which are practical, available and affordable
- Layout of the project site and Equipment list
- Presentation of any noise mitigation solution
- Prediction of construction noise and details of a monitoring solution

Noise criterion:

- L_{Aeq} (10hr) on weekdays
- L_{Aeq} (1hr) evenings and nights
- L_{AFmax} during the night time period

Table E.1 Example threshold of significant effect at dwellings

Assessment category and threshold value period (L_{Aeq})	Threshold value, in decibels (dB)		
	Category A ^{A)}	Category B ^{B)}	Category C ^{C)}
Night-time (23.00–07.00)	45	50	55
Evenings and weekends ^{D)}	55	60	65
Daytime (07.00–19.00) and Saturdays (07.00–13.00)	65	70	75

NOTE 1 A significant effect has been deemed to occur if the total L_{Aeq} noise level, including construction, exceeds the threshold level for the Category appropriate to the ambient noise level.

NOTE 2 If the ambient noise level exceeds the threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a significant effect is deemed to occur if the total L_{Aeq} noise level for the period increases by more than 3 dB due to construction activity.

NOTE 3 Applied to residential receptors only.

^{A)} Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.

^{B)} Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.

^{C)} Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.

^{D)} 19.00–23.00 weekdays, 13.00–23.00 Saturdays and 07.00–23.00 Sundays.

Admissible noise values:

Generally based upon the ambient noise climate following one of the two methods:

- The ABC Method
- The 5dB change method

Overview of the local regulation

Country	Regulation applicable for construction site noise	Dedicated to construction?	Does it set noise limits?	Do project specs refer to the local regulation?
CANADA	<ul style="list-style-type: none"> - No National regulation - Mostly city by-laws 	-	-	No - Noise monitoring specs are project-specific
FRANCE	<ul style="list-style-type: none"> - Environment code Article R571-50 (Noise Law 92-1444) - Public Health code article R.1336-10 - Local by-laws 	No , but it refers to	No	Yes - but needs to be complemented with a Noise Document
GERMANY	<ul style="list-style-type: none"> - AVV Baulärm - Bundes-Immissionsschutzgesetz or BImSchG (Federal Immission Control Act) 	Yes	Yes	Yes - but noise limits often refer to the "70/60dB(A)" court rule
MONACO	<ul style="list-style-type: none"> - Ministerial ruling n° 2021-107 from February 22021 - Ruling to limitate working hours 	Yes	Yes	Yes
SWEDEN	<ul style="list-style-type: none"> - NFS 2004:15 - Local binding regulations 	Yes	Yes	Yes
UNITED KINGDOM	<ul style="list-style-type: none"> - Control of Pollution Act 1974 - Local Authority policies - BS8233: Part 2 (guidance only) 	No	Yes - Local guidance usually does, CoPA does not	Yes – They also frequently include their own noise limits particularly infrastructure projects

Constraints for construction site

In case the **noise levels generated by a construction site exceed the limits** defined in the project specifications, **actions** can be taken by the local authorities:

- Removal of the special authorization to work during night time or holidays (if any)
- **Stop of the construction** until noise mitigation solution are installed
- **Financial fines** (per day, per noise alarm, ...)
- Neighbors **financial compensation** - inhabitants or businesses (restaurants, hotels, etc.)
- Neighbors **temporary rehousing**

Those are the same in all the areas.

Even in countries where the noise limits are not defined in a regulation, construction sites owners commit to respect the noise limits set in the project specs. Therefore they face the same legal actions.

Construction noise monitoring Usual practices

Measuring point location

Depending on the regulation, the consultants experience and the site context, sound level meters can be installed at different locations. The most frequent ones being:



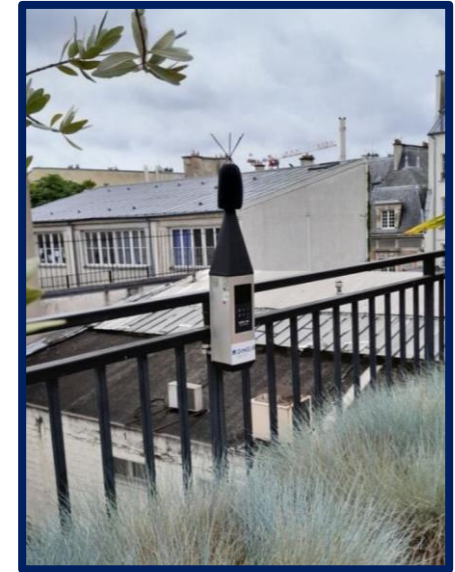
**CONSTRUCTION SITE FENCE /
PROPERTY LIMIT**



**LIGHT POLES
(PUBLIC AREA)**



**SURROUNDING FACADES
/ WALL**



NEIGHBOR'S PROPERTY

Measuring point location

COUNTRY	Noise measurement location		
	Sound level meter mounted on CONSTRUCTION SITE BOUNDARIES (site fence,...) or PUBLIC AREA (light poles)	Sound level meter mounted on surrounding buildings WALL / FACADE	Sound level meter in NEIGHBORHOOD PROPERTY (balcony, garden, ...)
CANADA	1 - Most frequent setup	Only in rare cases (dB correction : -3dB)	Only in rare cases
FRANCE	1 – Required / most frequent setup	2 - Frequent setup (no dB correction)	2 - Frequent setup
GERMANY	2 - Frequent setup (if neighborhood is not possible)	2 - Frequent setup (if neighborhood is not possible - dB correction : -3dB)	1 – Required / frequent setup (in front of a window)
MONACO	2 - Frequent setup (if neighborhood is not possible)	Only in rare cases	1 – Required / Most frequent setup
SWEDEN	2 - Frequent setup	1 – Required / most frequent setup	2 - Frequent setup
UNITED KINGDOM	1 - Frequent setup	2 - Less frequent but the ideal set-up where feasible	Only in rare cases

Comments from the experts:

- Countries with guidelines values often try to measure at neighbors location
- The site context always force to find compromises on the sensor location
- Measuring closer to the construction site can ease noise propagation calculation

Noise criterion

Most commonly measured noise parameters on construction site monitoring projects

COUNTRY	Long L_{Aeq} (Day / Night – Specific time period)	Short L_{Aeq} (X sec, min)	Rolling L_{Aeq} (X sec, min)	Lmax limits	L_{AFTeq}	Spectral (1/1 or 1/3 octave bands)	Statistics (L_{90}/L_{10} ...)	Audio recordings
CANADA	Yes Day/Night	Yes L_{Aeq} 10 minutes	No	Yes	No	No	Yes L_{10}	Yes
FRANCE	Yes Day/Night or multiple periods	Yes L_{Aeq} 5, 10 or 15 minutes	Yes	No	No	Yes	No	Yes
GERMANY	Yes Day/Night	No	No	Yes Night time	Yes Day/Night	No	No	Yes
MONACO	No	Yes L_{Aeq} 5 or 15 minutes	Yes	No	No	Yes	No	Yes
SWEDEN	Yes Day/Evening/Night	No	No	Yes Night time	No	No	No	Yes
UNITED KINGDOM	Yes Day/Evening/Night	Yes L_{Aeq} 5, 10 or 15 minutes	No	Yes Night time	No	No	No	Yes

Comments from the experts:

L_{Aeq} is the most frequent criterion.

- Long L_{Aeq} enables the project to manage its allowed "noise dose" along the day.

- Short L_{Aeq} can be more representative of the annoyance perceived

- "Rolling L_{Aeq} " always keeps the history on the measurement interval (no value reset)

- L_{AFTeq} is used only for construction site monitoring – hard to compare the values

- 1/3 octave bands are often measured but rarely used (i.e monitor a specific noise)

- Statistics: Difference between L_{10} et L_{Aeq} gives a quick look at the short high level noise

- Audio recordings are essential to keep an ear on site and exclude some non-construction noise

Data quantity comparison

Average data quantity generated on a regular project			
COUNTRY	Is the audio recording triggered by the L_{Aeq} limit value?	How would you define the number of audio recordings?	Number of audio recordings on a regular project
CANADA	Yes	Reasonable to Extreme (projects with L_{max} limits)	5 – several hundreds per day
FRANCE	Yes (or pre alert -3dB)	Reasonable to Extreme	10 - 200 per day
GERMANY	Audio recording is rarely used for construction noise. If used, threshold is set lower than the limit.	Reasonable	A few a day
MONACO	Yes	Reasonable	A few a day
SWEDEN	Yes	Reasonable	A few a day
UNITED KINGDOM	No	Reasonable	A few a day

Comments from the experts:

- Number of audio per day depends on the project specs and the context.
- In extreme cases, it gets impossible for consultants to listen to every audio.
 - It is hard to have the project specs reviewed after the construction start
 - AI tools can help deal with high data quantity
- In Monaco, the noise limits are among the highest (85dB(A)) – generate low number of alerts
- Data can sometimes exceed 10GB per month per sound level meter.
Environmental impact? (Data storage consumption: 0,130 kWh/GB/year)

Impact of a noise monitoring system

Every experts have the same feedback about the efficiency of a noise monitoring system around construction site:



Ease the relation with neighbors

- ✓ Calm some concerned neighbors (prior to the construction start)
- ✓ Reduce the number of complaints
- ✓ Less construction stops



Reduce the construction site noise

"If you can't measure it, you can't manage it"

- ✓ Change the construction workers behavior : try being less noisy, use radio instead of shouting...
- ✓ Better scheduling of the loud work
- ✓ Authorized working hours are controlled



Legal protection for the project owner

- ✓ Check if any complaint filed is justified
- ✓ Control that a noise alarm is due to the construction activity or not (audio recording)

New trends in construction noise monitoring

- **Noise monitoring on construction projects is more and more frequent** 
It is now a good practice than can simplify the project life
- **More and more transparency and communication toward the neighborhood** 
Communication prior the construction starts, web platform with noise reports, direct contact the neighbors can call...
- **New technologies can help with data management:**  
 - **Artificial Intelligence** algorithms for automatic audio recognition
 - **Automatic source location** system
- **Increasing complexity of noise limits** (more variables, more time periods, etc.) 

Conclusion

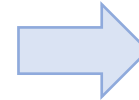
- **Noise monitoring is becoming the rule** as it brings lots of benefits for the project and the neighborhood
- Regulation vary in each country: from **Purely Qualitative** to **Specific and Quantitative**
Every construction project and context are different: **projects often start with preliminary study**
- Each country/state has its own method: Sensor setup, noise criterion, limits, etc.
- Many **initiatives** and **innovations** to keep improving this sector (PhD thesis, numerical tools, equipment...)

Sigicom presents the C50 – Wireless noise monitoring station



- ✓ Class 1
- ✓ Noise criterion: Leq (short, rolling and accumulated) - Lmax - Statistics (L_{90} , L_{50} & L_{10}) - 1/3 Octave bands
- ✓ Customizable time periods
- ✓ Audio recordings

- ✓ Wireless
- ✓ Up to **8 weeks of battery autonomy**
- ✓ Easy mounting (pole, wall, tripod,...)
- ✓ Ease of use
- ✓ Weatherproof
- ✓ Remotely controlled by **INFRA Net web platform**



On long-term monitoring project, the consultant #1 concern was power supply...
C50 was designed to solve this issue

Thank you!

Any question?

See you on Booth 55...

