

Impatto acustico per via aerea delle navi sull'ambiente

*Environmental impact of
airborne noise from ships*

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PORT&SHIPPINGTECH

PORT & SHIPPING TECH 2013
Summit on Green Shipping

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Is port noise pollution a relevant issue?

- Ship noise pollution markedly affects the quality of life of the exposed population
- Requirement of increased comfort and higher quality standards
- Mediterranean (and other) ports close to the urban areas
- Large number of exposed citizens
- Noise pollution is a risk hanging on the development of port cities

Ship and port noise emissions: general characteristics

- Multiplicity of the sound sources (ships, cranes, upload-download operations, shipyards,...)
- Different operative conditions
- Ships are complex noise sources
- Superimposition with other noise sources (railways, roads, industries, ...)
- Wide propagation field (complex analysis of outdoor noise propagation)
- High number of exposed receivers
- Tangled regulatory framework

Regulatory framework - 1

- EU legislation
 - European Directive 2003/44/EC

| Single engine power (KW) | Maximum sound pressure level @1m (dB(A)) |
|--------------------------|--|
| $P_N \leq 10$ | 67 |
| $10 < P_N \leq 40$ | 72 |
| $P_N > 40$ | 75 |

- European Directive 2006/87/EC

- European Directive 2002/49/EC

- Noise indicators: L_{den} , L_{night}

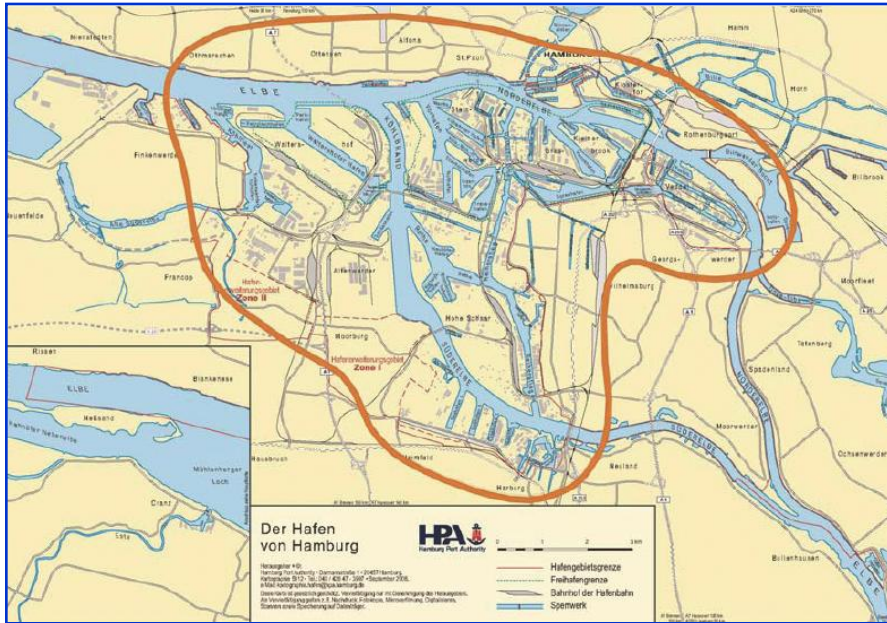
$$L_{den} = 10 \cdot \log \frac{1}{24} \cdot \left(12 \cdot 10^{\frac{L_{day}}{10}} + 4 \cdot 10^{\frac{L_{evening} + 5}{10}} + 8 \cdot 10^{\frac{L_{night} + 10}{10}} \right) \quad L_{night} = 10 \log_{10} \frac{1}{8h} \int_{22:00}^{6:00} \left(\frac{p_a(\tau)}{p_0} \right)^2 d\tau$$

Regulatory framework - 2

- Italian laws
 - L. 447/95
 - D.P.C.M. 14.11.1997
 - D.Lgs. 194/2005
- EU countries

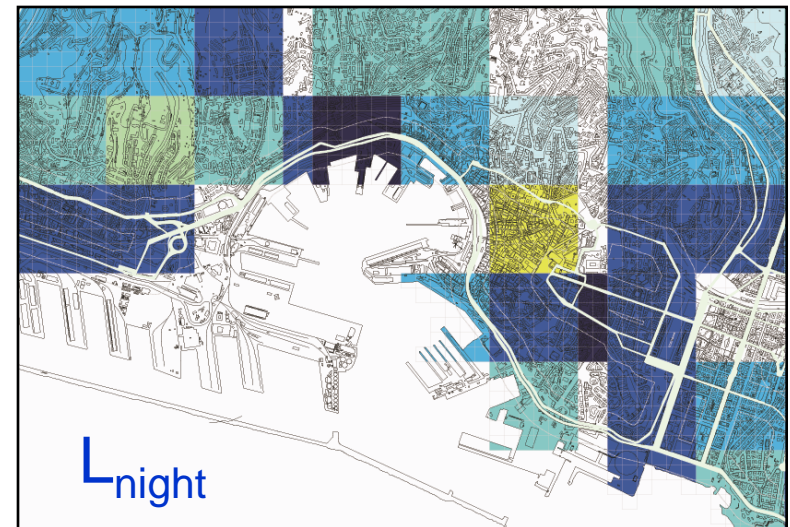
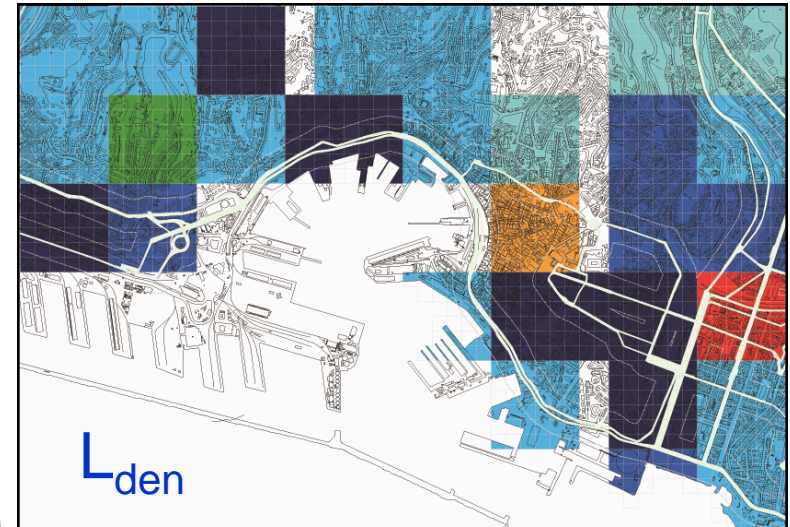
| State | Day | Evening | Night |
|--|--------------|--------------|--------------|
| Finland | 55 | 55 | 50 |
| Italy for industrial plants for areas with intense human activity | 70 65 | 70 65 | 70 55 |
| Spain | 65 | 65 | 55 |
| Sweden | 65 | 60 | 55 |

Noise Mapping of Ports in accordance to European Directive 2002/49/EC



Hamburg

Genoa



Regulatory framework - 3

- USA
 - Federal regulations
 - National regulations
 - Local regulations
- Asia
- Oceania
- International technical standards and regulations
 - ISO 2922:200049 for all vessel
 - ISO 14509-1:200833 and
ISO 14509-2:200632 for recreational crafts

Policies for airborne noise control

- Issuing of common regulations and limit values
- Definition of the authority responsible for the application of regulations
- Two different strategies can be followed.
 - a. attention can be focused on sources and their direct emissions can be subjected to limitations.
 - b. limits can be set to the noise perceived at the receiving positions i.e. in those locations where people are exposed to sound coming from the harbor
- Improve the knowledge



Ship oriented Innovative solutions to Reduce Noise and Vibrations

www.silenv.eu

FP7 – Theme TRANSPORT –



Co-Theme: the greening of surface transport



Collaborative Project n° 234182

| | | |
|-----------|-----------------|--------------------|
| Schedule: | Start: Oct.2009 | End: Nov. 2012 |
| Budget: | Total: 5 M€ | UE Funding: 3.5 M€ |

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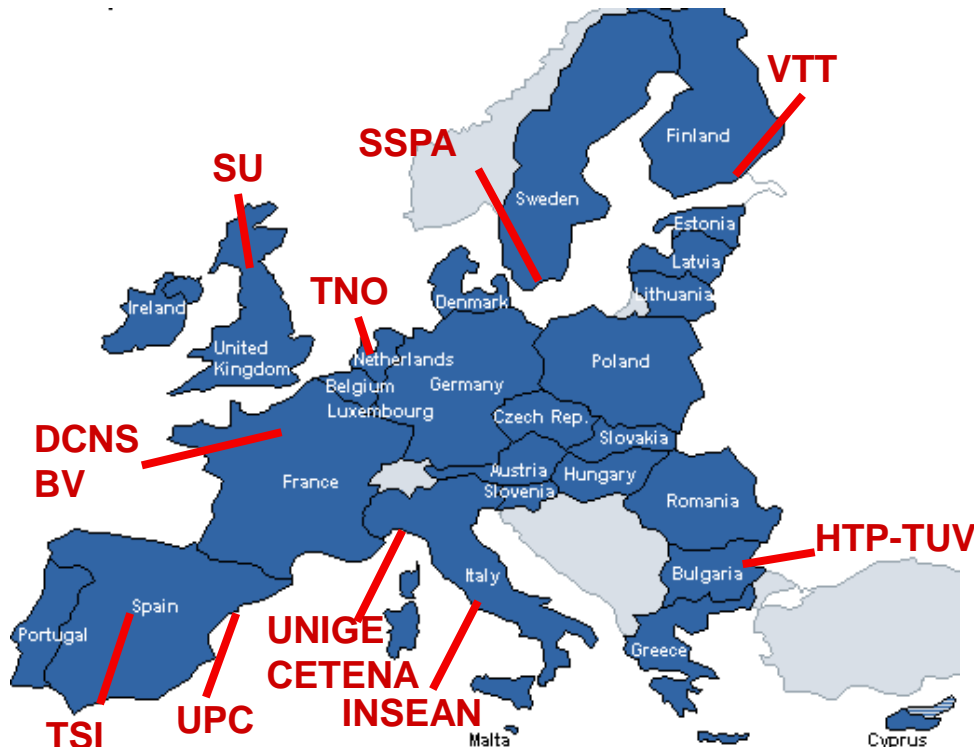
The Consortium

14 Partners involved from 8 Countries

- 4 Universities
- 4 Research Institutes
- 3 Towing Tanks
- 1 SME - consultant
- 1 Classification society
- 1 Ship owner

Expertise

- Ship designers
- Human factor specialists
- Bio-acoustic specialists



Overview of the Project

Objective: Holistic approach to the control of noise radiation from ships, including three main areas:

- Noise & Vibration on board ships
- Airborne Radiated Noise
- Underwater Radiated Noise

Expected result

Definition of a N&V green label

- Target levels for each topic (at a pre-normative level)
- Justifications and guidelines to reach the recommended targets

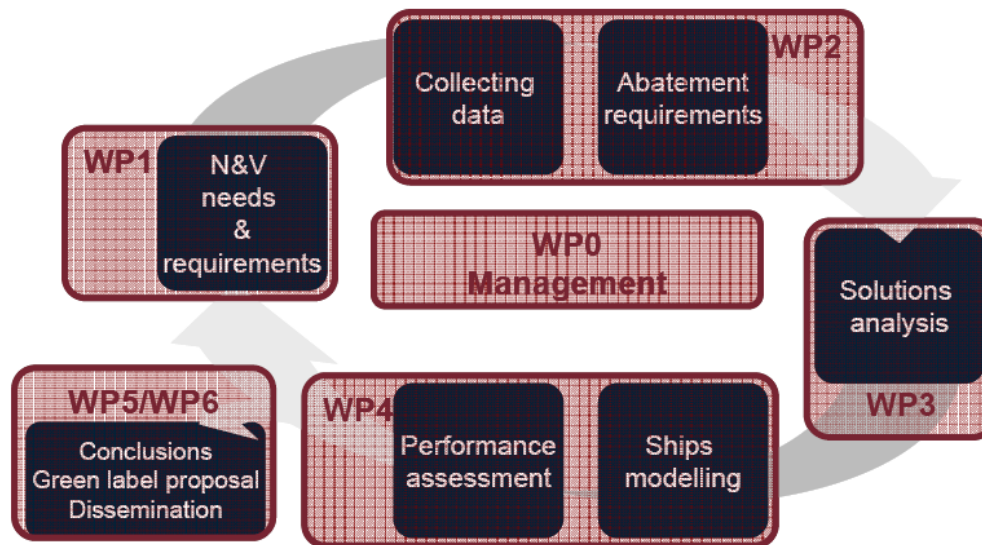
How:

- Detailed analysis of existing regulation
- Measurement database (existing data and further implementation)
- N&V modelling methods



Breakdown of activities

- Analysis of regulations and previous studies → Identification of targets for N&V **WP1 (5%** of total efforts allocated to the project)
- Analysis of existing data, surveys of new ones.
→ critical noise sources, discrepancies with the targets (**WP2, 33%**)
- Identification and analysis of solutions (**WP3, 24%**)
- Simulation of solutions on measured ships (**WP4, 24%**)
- Synthesis, conclusions and green label proposal (**WP5, 7%**)
- Dissemination, Management (**WP6+WP0, 7%**)



WP1: Needs and requirements

Leader: UNIGE

Purpose: Identification of the needs for noise and vibration control

- Review of existing requirements and regulatory frameworks
- Identification of the impact of N&V in the context of ships (and in similar fields)
- Tools and indicators for the quantification and assessment of N&V impact

Three different aspects covered:

- **N&V onboard (tasks 1.1 and 1.2)**
 - Crew (working environment on board, but also analysis of other requirement for industry.
 - Passengers (comfort requirements)
- **Airborne Radiated Noise (ARN) outside the ship (task 1.3)**
 - Radiation to harbours (ship at quay)
 - to areas along channels (ship sailing)
- **Underwater Radiated Noise (URN: task 1.4)**
 - Impact on marine fauna



WP2: Full Scale Measurements

Leader: TSI

Aims:

- collecting and analysing as many as possible **existing** experimental data related to the various aspects of noise emissions from ships
- performing **measurements campaigns** at sea on various types of ships to gather data not available from existing database
- performing dedicated measurements to feed other Work Packages of the project with specific data to check models.
- data analysis
 - Comparison of N&V from database with preliminary target levels
 - Identification of causes for deviations



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SILENV database

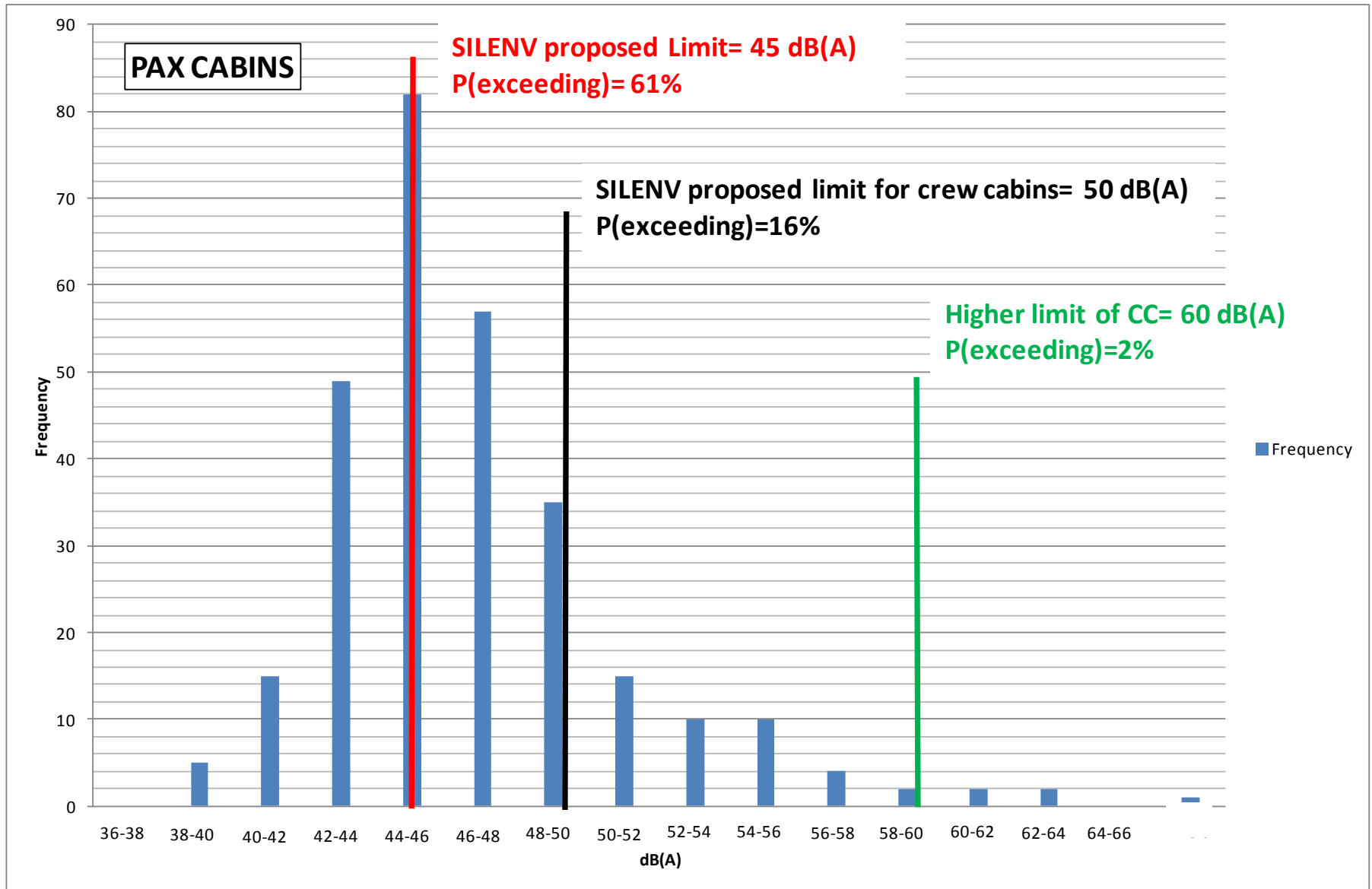
- The total SILENV- On-site Measurement Database combination of previously existing and new ones.
 - more than **12.000** N&V experimental data
 - **171** ships belonging to various vessel families, representing a significant sample of the European Fleet.
- **20** 'ad hoc' full scale measurements
- **10 N&V-Full Signatures** obtained

Full signature = complete characterisation of ship noise radiation, including:

- noise & vibration inside the vessel
- airborne noise radiation outside
- waterborne noise radiation into water



Comparison of data with preliminary limits (Ro-Pax)



WP3: Solution Analysis

Leader: SSPA

Purpose: to identify and analyze all solutions which could be proposed in design guidelines. For each solution proposed, technical and economical assessments carried out.

The topics covered regard:

- Propellers
- Machineries
- Exhaust and ventilation
- Hull and structures



WP4: Modelling and Assessment

Leader: CETENA

Purpose: develop models for the ship noise radiations and use them to assess the efficiency of the proposed solutions

- **Task 4.1: Modelling**

- Three aspects to be dealt with: N&V onboard, Noise outside ships
→ Airborne Radiated Noise and Underwater Radiated Noise
- Effects of N&V on human: Modelling of N&V effects on crews and passengers , **correlation with questionnaires**
- Effects of URN on marine fauna: behavioural changes, interference with mammals communications

- **Task 4.2: Assessment**

- Comparisons predictions – measurements
Results from numerical simulations (Task 4.1) vs. measurements (WP2).
Evaluation of the accuracy of the predictions
Critical analyses of discrepancies
- Comparisons predictions – Requirements
Assessment of adequacy of simulated performances with the requirements from WP1.



WP5: Green Label proposal

Leader: DCNS

Purpose: to summarise the technical conclusions and finalize the 'green label' requirements, including targets levels and associated guidelines for:

- **Noise and vibration on board** (target: crew and passengers)
- **Airborne radiated noise** (target: people living near ports or channels)
- **Waterborne radiated noise** (target: marine fauna)



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Airborne Radiated Noise (external to the ship)

Aim of the requirement :

Ensure acceptable living conditions in the inhabited areas around the port by controlling the global noise generated by all the machinery and equipment in operation on board the ship.

Criteria for setting the green label requirements:

- Existing requirements (evaluated in WP1)
- State-of-the-art of the European fleet (database: WP2)
- Ad hoc measurements of radiation patterns (WP2)
- Numerical investigations of radiation patterns (solution inventory: WP3)
- Feed-back from End-Users

Relevant operating conditions:

- **ship at quay (no cargo processing)**
- ship sailing (along the coast)
- *ship manoeuvring (entering/exiting the harbour)*
- *ship loading or unloading
(equipment for cargo processing in function)*

Existing requirements – ship at quay

- general noise limit levels in **urban areas** in dependence of land use (e.g. Italy's DPCM 1997)
 - general noise limit levels for different areas containing **industrial areas** (2002/49/EC).
 - limits on airborne noise emissions for **inland waterway vessels** (2006/87/EC).
- L_{Aeq}
- SPL

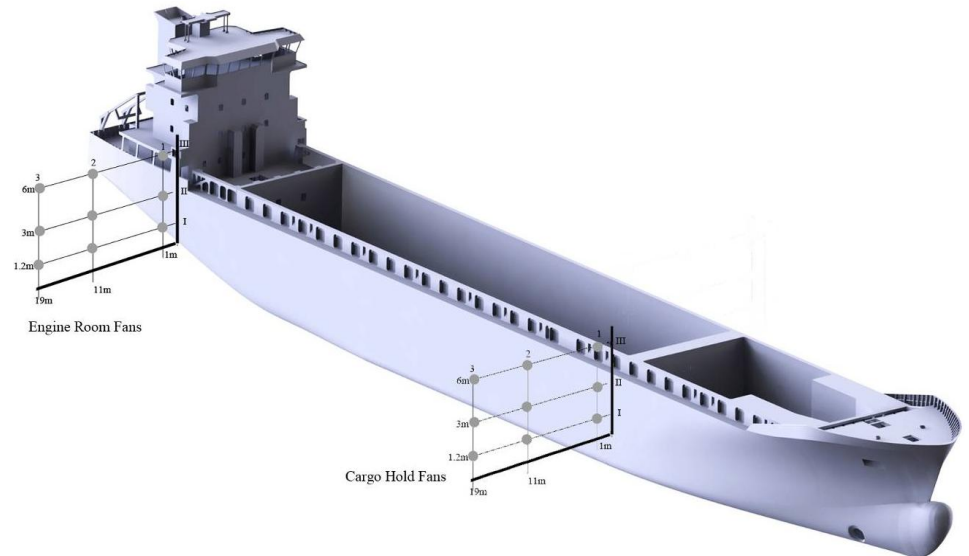
from Directive 2006/87/EC article 8.10

1. *The noise produced by a vessel under way, and in particular the engine air intake and exhaust noises, shall be damped by using appropriate means.*
2. *The noise generated by a **vessel under way** shall not exceed **75 dB(A)** at a lateral distance of **25 m from the ship's side**.*
3. *Apart from **transhipment operations** the noise generated by a **stationary vessel** shall not exceed **65 dB(A)** at a lateral distance of **25 m from the ship's side**.*



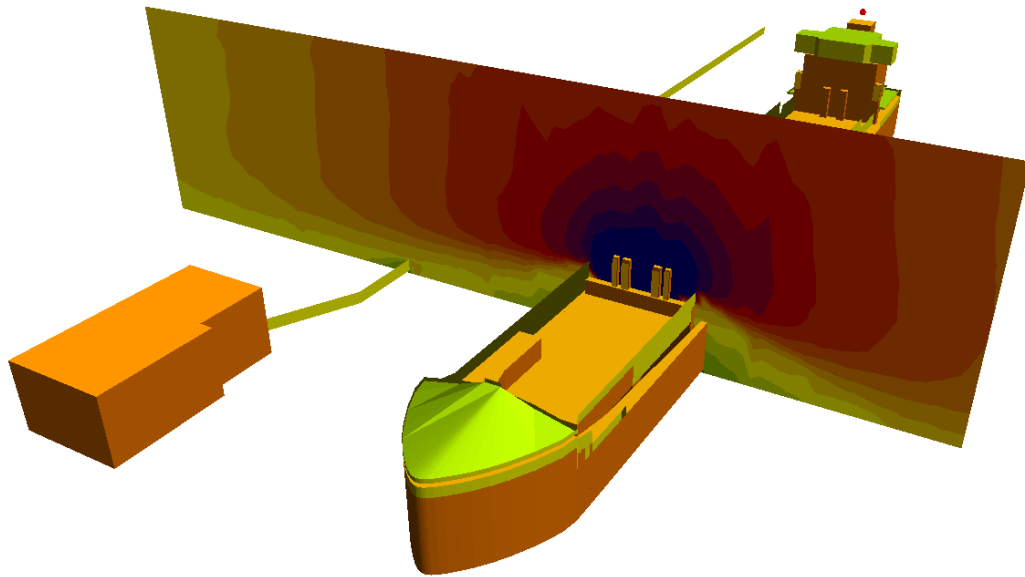
Experimental investigation of ARN patterns

| Position horizontal→ ↓ vertical | section in way of engine room fans (aft) | | | section in way of cargo hold fans (fore) | | |
|---------------------------------------|---|------|------|---|------|------|
| | 19m | 11m | 1m | 19m | 11m | 1m |
| 6m | 64.6 | 68.3 | 75.6 | 64 | 65.5 | 71.8 |
| 3m | 65.2 | 67.9 | 69.8 | 64.5 | 66.2 | 65.1 |
| 1.2m | 62.8 | 67.2 | 68.9 | 65.9 | 65.6 | 62.2 |



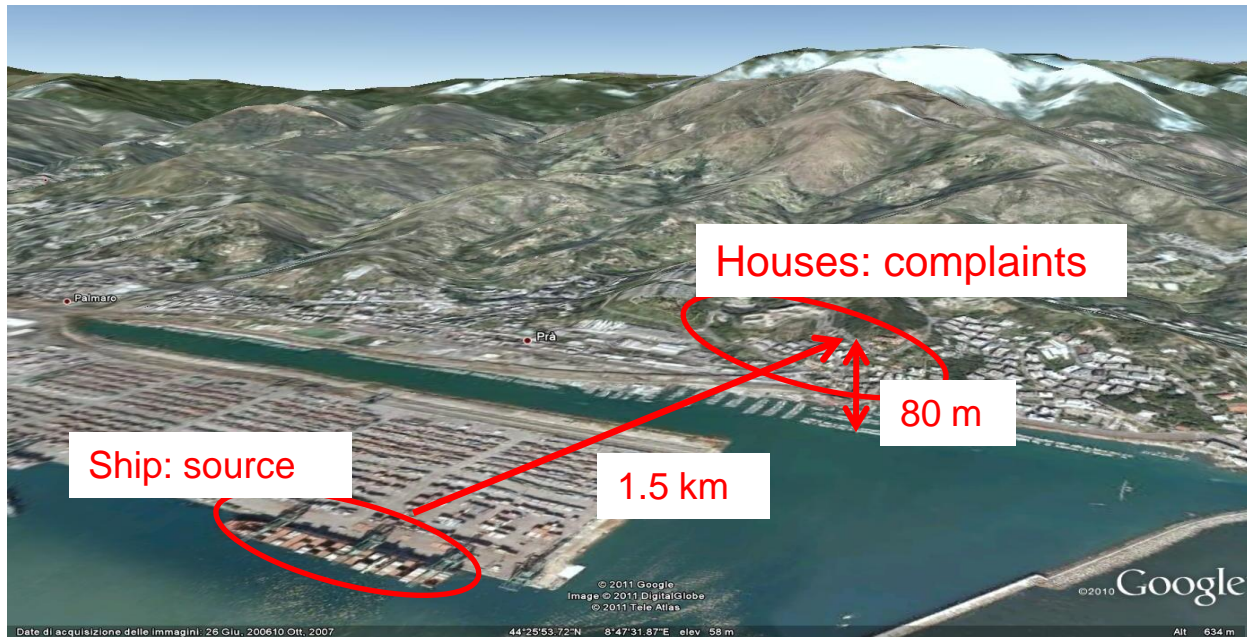
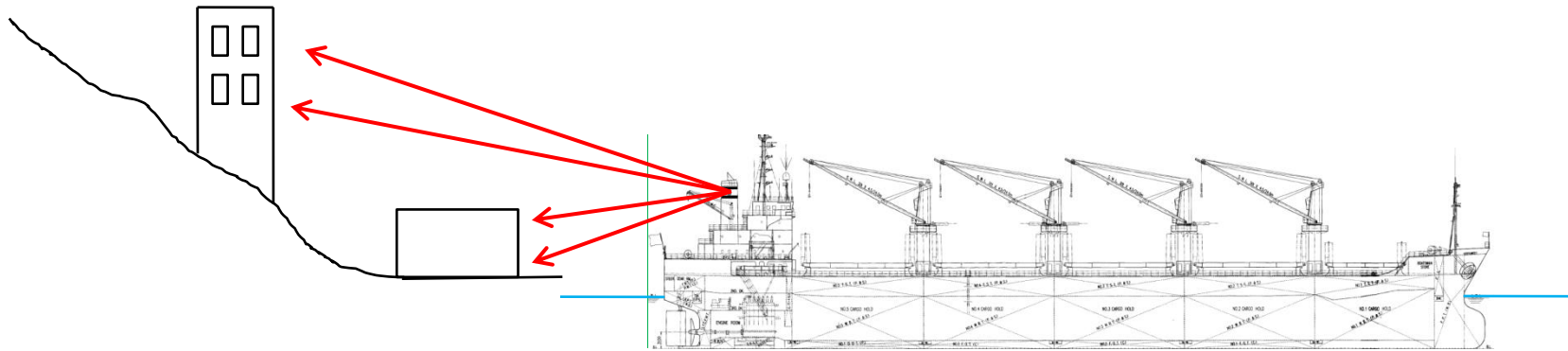
‘Shadow zone’ near the side for the sources on deck

Numerical investigation ARN patterns Ship at quay



Complex patterns, due to reflections, diffractions, etc.

Feed-back from End-Users

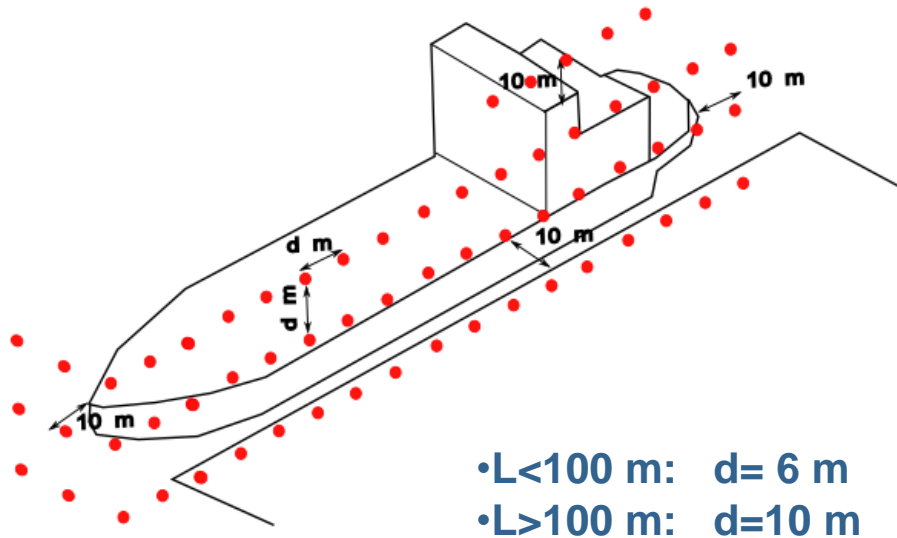


Real Case presented by
End-users during PM4

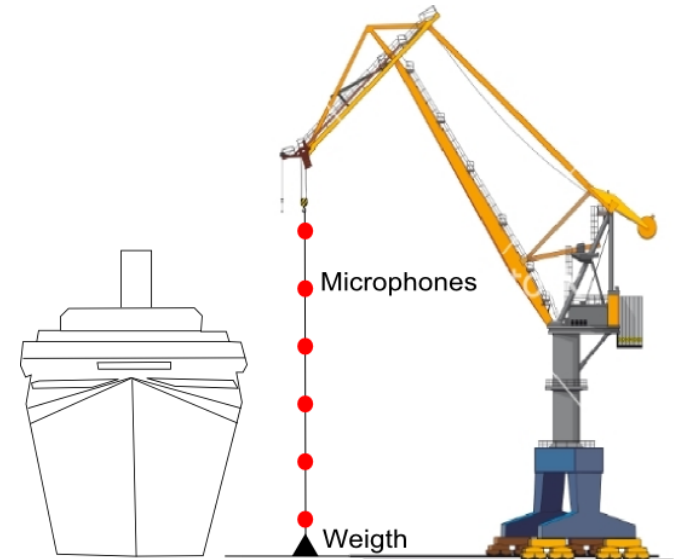
Port of Voltri – Genoa
Terminal VTE

Formulation of the new requirement – ship at quay

Grid resolution and extension



Possible arrangement



Limit value

70 dB(A) at 10±1 m

Comments

- While for onboard noise the general structure of requirements already reflects the receivers' perception, for ARN the challenge is to introduce a proper quantification of the impact of noise emissions
- Implementation of new requirements foreseeable in the next and far future covering new aspects or 'old' ones in a new way.
- European maritime community should be prepared to deal with these aspects in the design and operation of ships.
- Further efforts are needed in different directions:
 - Better competencies both at scientific and technical level
 - Dissemination of the knowledge to the different stakeholders
 - Shared and well-established regulatory framework

THANKS FOR YOUR ATTENTION !



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