



Saturn

Developing Solutions for
Underwater Radiated Noise



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Underwater Radiated Noise from Vessels (SATURN)

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- Shipping noise and vessel URN (Christ)
- Machinery noise (Christ)
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URN = underwater radiated noise

general term, referring either to a property of a single vessel,
the sound field radiated by one or more vessels
or a property of that sound field (e.g., SPL, SEL)

Introduction

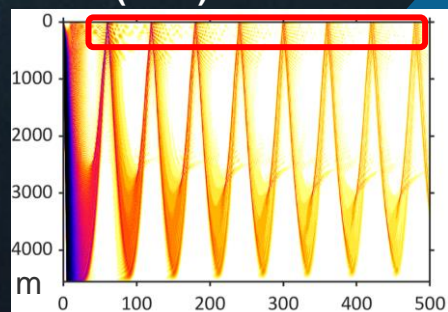
Concern about effects of international shipping on marine life:

Marine Mammals and Vessel Noise: Exposure, Impacts and Potential Solutions
DOSITS Webinar Charlotte Findlay & Dominik Nachtsheim, September 27, 2023
<https://dosits.org/decision-makers/webinar-series/2023-webinar/marine-mammals-vessel/>

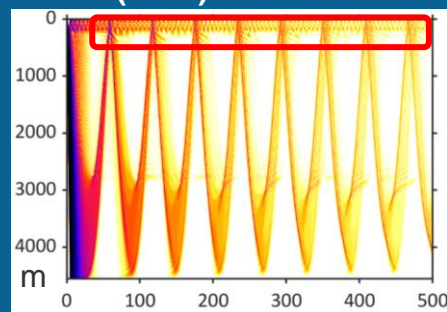
Future climate change may increase the problem:

- Predicting the contribution of climate change on North Atlantic underwater sound propagation. Possenti et al., PeerJ 11:e16208, 2023
<https://peerj.com/articles/16208/>
- The present and future contribution of ships to the underwater soundscape. Possenti et al., Frontiers in Marine Science, March 2024
<https://www.frontiersin.org/articles/10.3389/fmars.2024.1252901/full>

Sound propagation Northeast Atlantic Ocean:
winter (2022)



winter (2094) SP5-8.5



→ distance / km



Introduction (2)

Addressed by the EU Marine Strategy Framework Directive:

DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 17 June 2008

establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

(11) Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056>

and by the International Maritime Organization:

IMO INTERNATIONAL MARITIME ORGANIZATION

E

MEPC.1/Circ.906
22 August 2023

REVISED GUIDELINES FOR THE REDUCTION OF UNDERWATER RADIATED NOISE FROM SHIPPING TO ADDRESS ADVERSE IMPACTS ON MARINE LIFE

<https://wwwcdn.imo.org/localresources/en/OurWork/PartnershipsProjects/Documents/GloNoise-Library/MEPC.1-Circ.906-Revised-Guidelines-For-The-Reduction-Of-Underwater-Radiated-Noise-From-Shipping-to-address-Adverse-Impacts-on-Marine-Life-22-August-2023.pdf>



<https://www.portvancouver.com/environmental-protection-at-the-port-of-vancouver/maintaining-healthy-ecosystems-throughout-our-jurisdiction/echo-program/>



the International Maritime Organization is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships.

IMO Guidelines (2023)

1. provide an overview of approaches applicable to designers, shipbuilders and ship operators to reduce the URN of any given ship;
 - *SINGLE SHIP URN*
2. assist relevant stakeholders in establishing mechanisms and programmes through which noise reduction efforts can be realized.
 - *SHIPPING NOISE (URN)*

Proposed approach: **URN Management Planning**

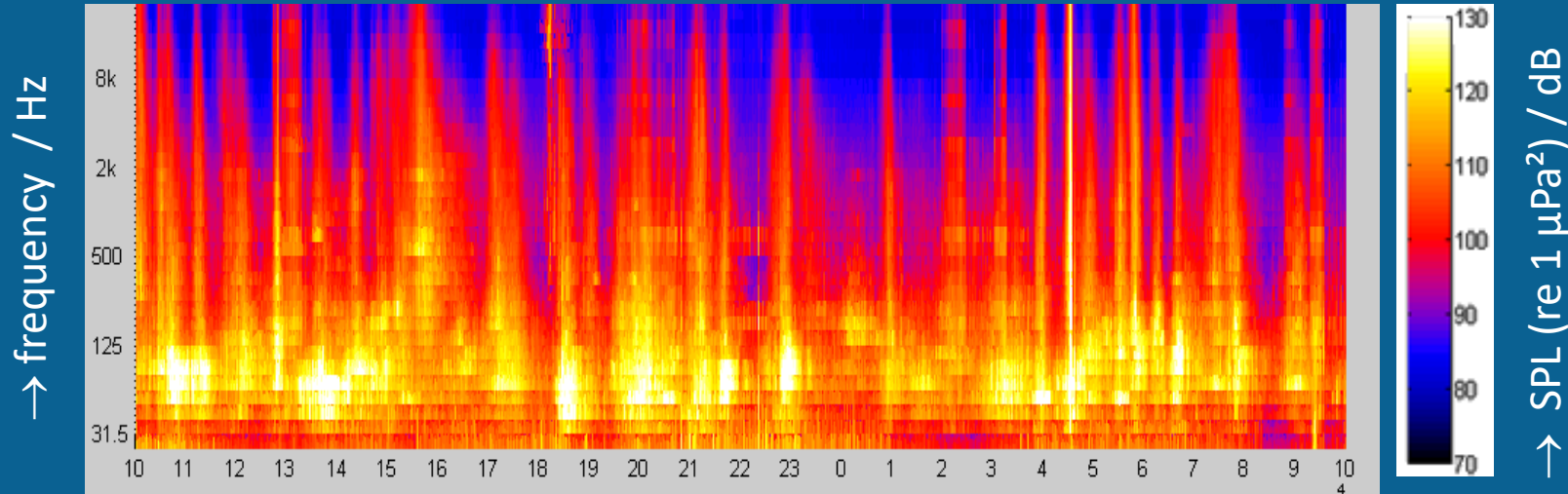
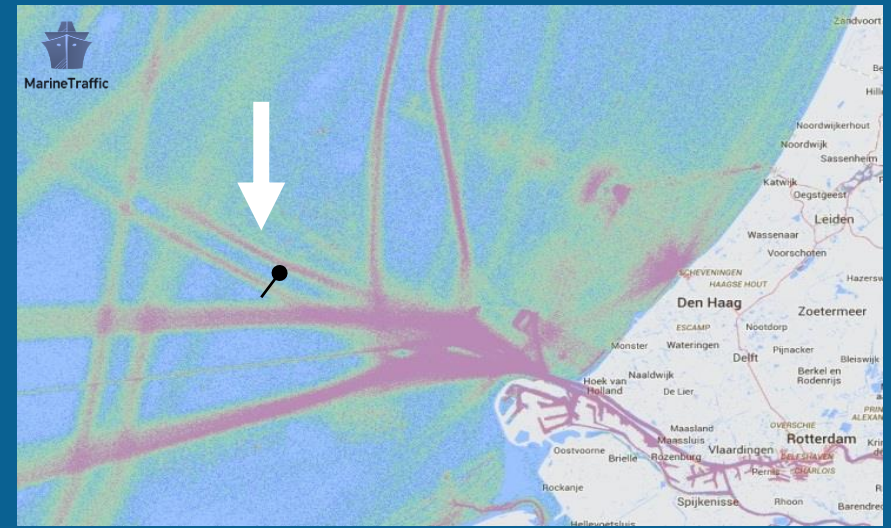


URN Management Planning

1. Baseline URN (single vessels) or Noise Sensitive Areas (shipping)
2. URN targets
3. URN reduction approaches and related actions (single vessels) or incentive programs to reduce URN (shipping)
4. Monitoring and evaluation
 - *To be developed*
 - *Consider effects on energy efficiency, biofouling reduction, ship safety, technical feasibility, cost-effectiveness, ...*

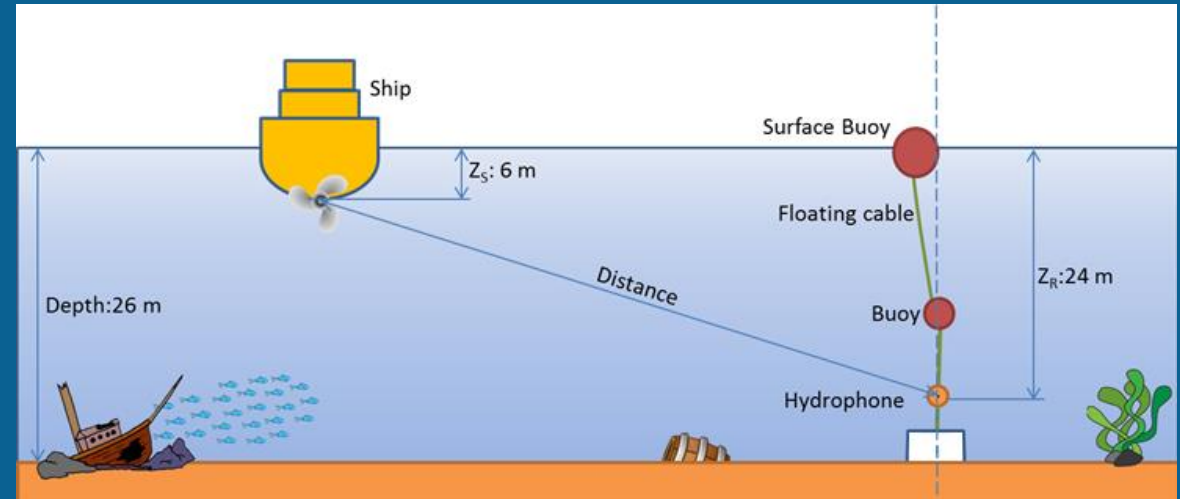


URN along a shipping lane



Vessel URN measurements

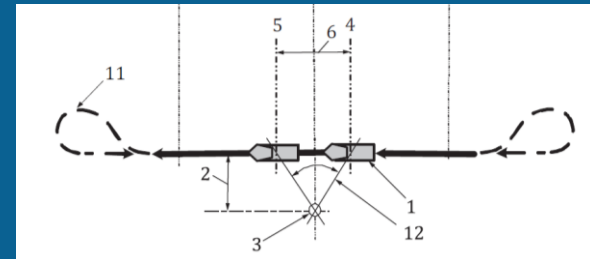
International standards since 2016



ISO 17208 “Quantities and procedures for description and measurement of underwater sound from ships”

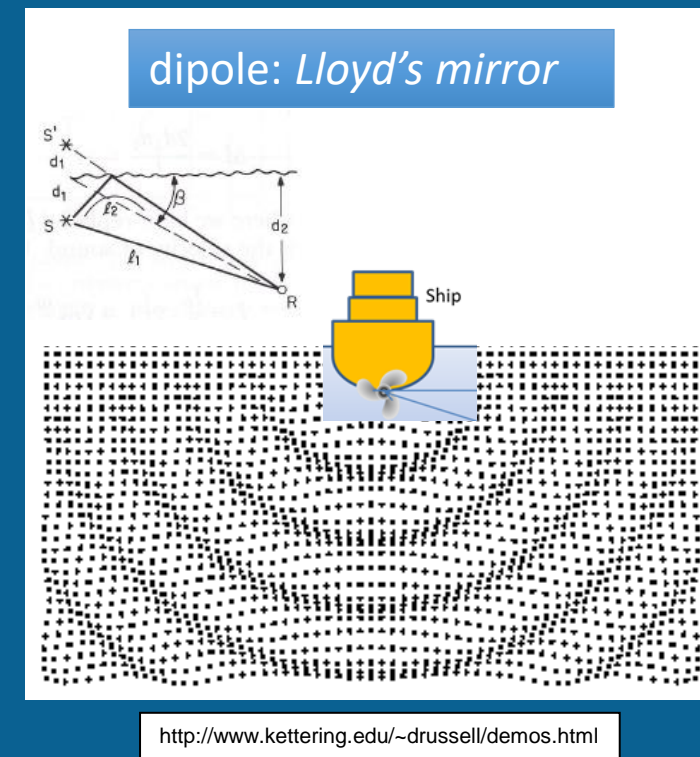
- Part 1: Requirements for precision measurements in deep water used for comparison purposes (2016)
- Part 2: Determination of source levels from deep water measurements (2019)
- Part 3: Requirements for measurements in shallow water (aim: end of 2024)

SATURN supports development of ISO 17208-3



Why are ship URN measurements so complex?

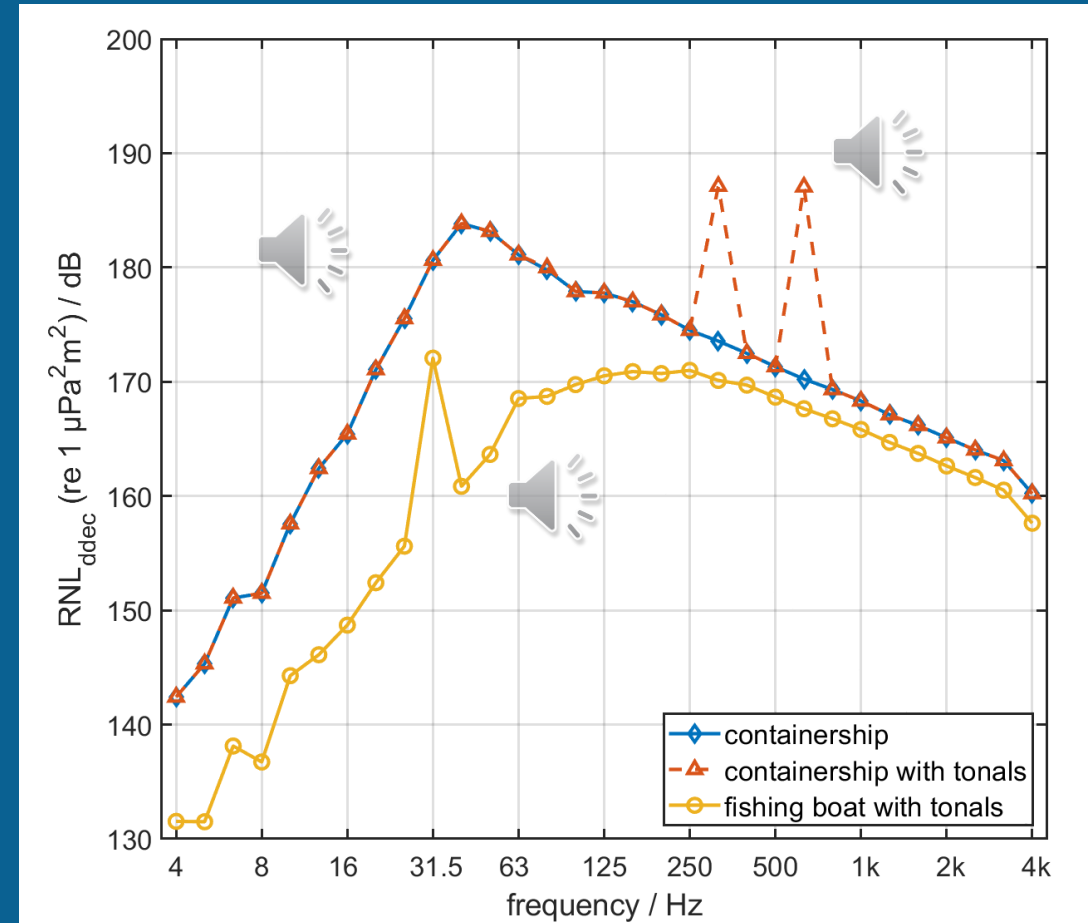
- URN output depends on ship operation (speed, draft, maneuvering)
- **Source level** = measured sound pressure level + propagation loss
 - in a specified direction, for a specified source depth
 - independent of environment and measurement geometry
 - *input for URN models, e.g. for sound maps*
- **Radiated noise level** = measured sound pressure level + $20 \log_{10}(\text{distance}/1\text{m})$ dB
 - for a specified measurement geometry
 - *for comparison with ship URN target values*



Vessel URN characteristics

- Ships are all individuals and
- Ship URN changes with condition (speed)
- Characteristics:
 - Broadband spectrum
 - Amplitude modulation
 - ‘Tonal’ peaks (e.g. ‘gearbox whine’)

Relationship between container ship underwater noise levels and ship design, operational and oceanographic conditions | Scientific Reports (nature.com)



<https://www.saturnh2020.eu/resources-1/harmonised-test-signals>

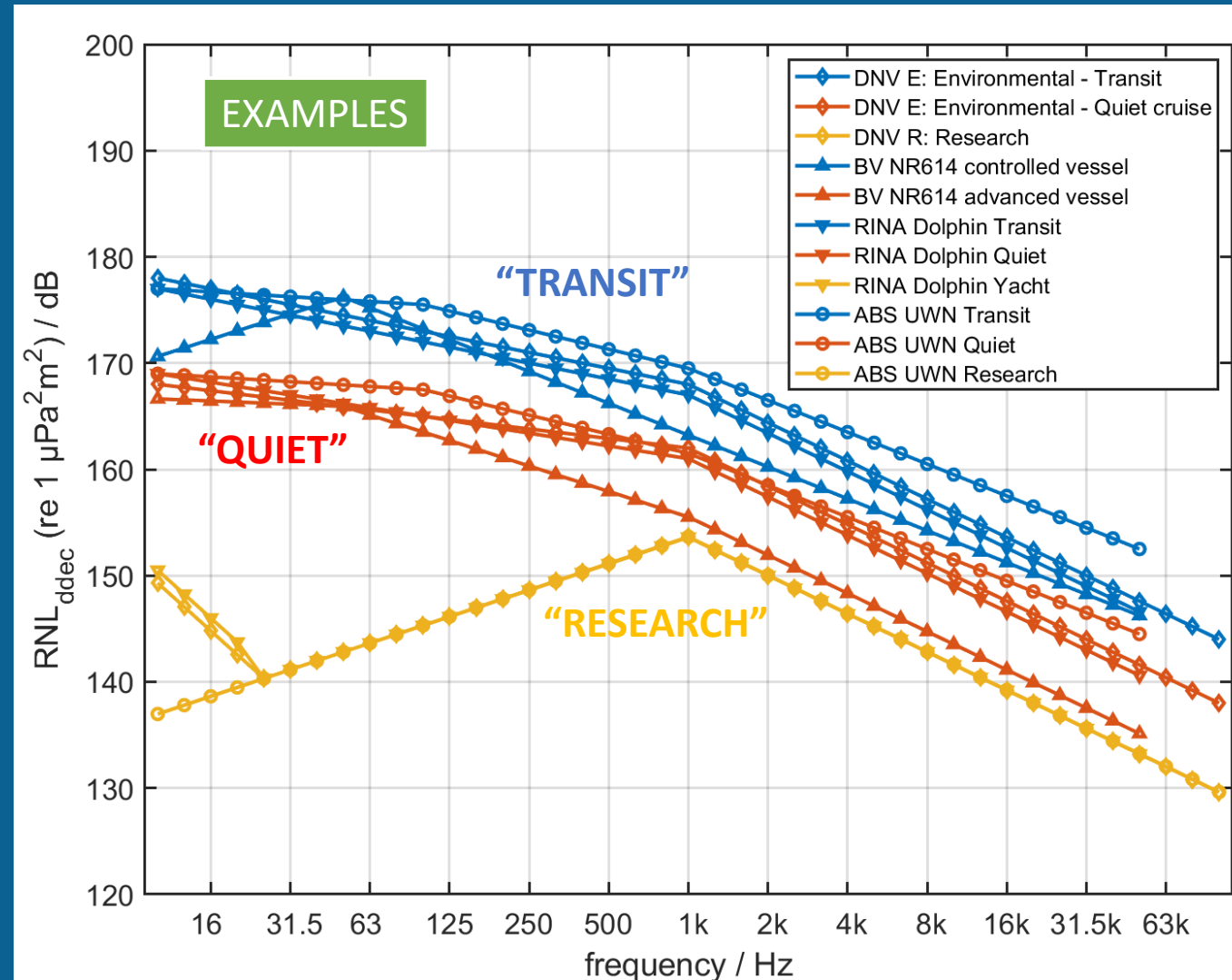
Vessel URN limits (max. allowable RNL)

Class Societies

- Different measurement procedures
- Harmonization being considered
→ IACS recommendation No.176 (Sep 2023)

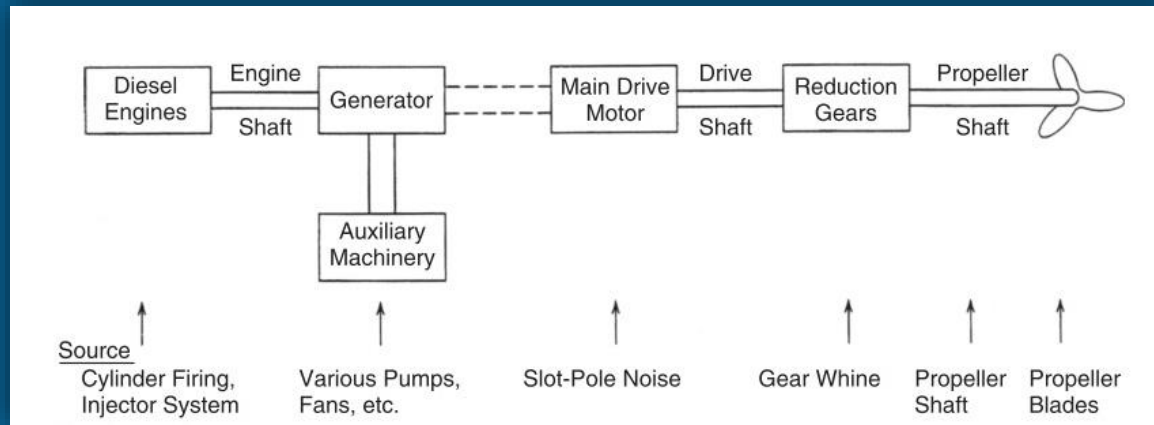
Benefit example:

- Port of Vancouver EcoAction:
discount on harbour dues for ships that are certified as quiet vessels by a ship classification society



Machinery noise sources

- Propulsion engine
- Generator
- Pump
- Gearbox
- Hydraulic system
- ...



R Urick 1983 Principles of underwater sound



Machinery noise reduction

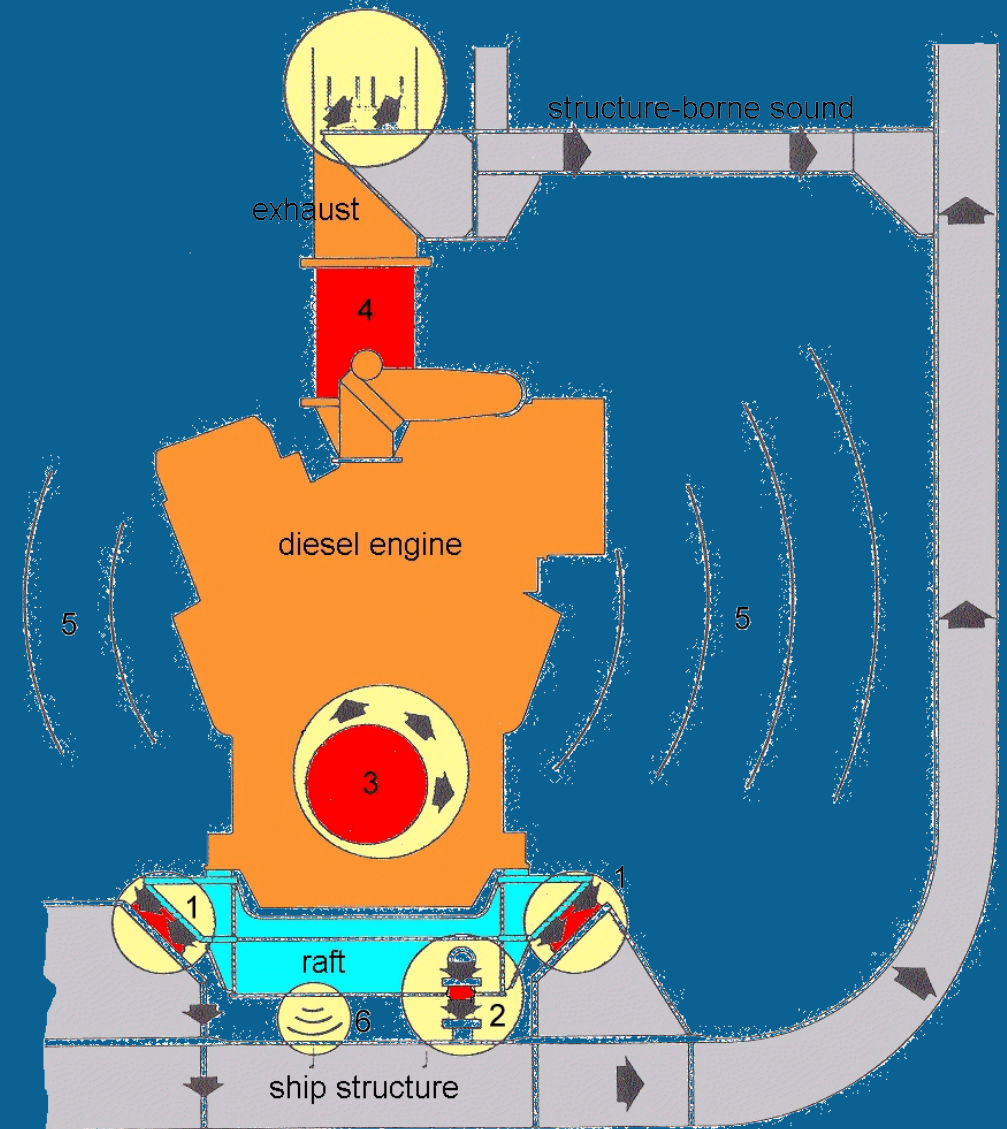
A. Select quiet machines

B. Reduce noise transmission

- Isolation (mounts, bellows, ...)
- Damping

C. Reduce noise radiation from the hull

- Coating materials
- Air bubble ('masker') systems

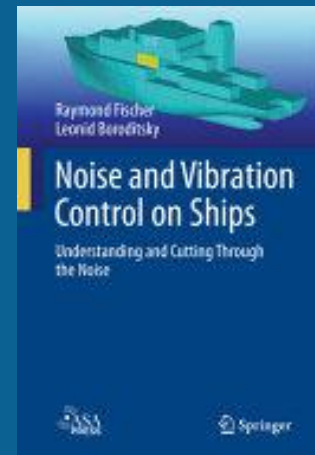
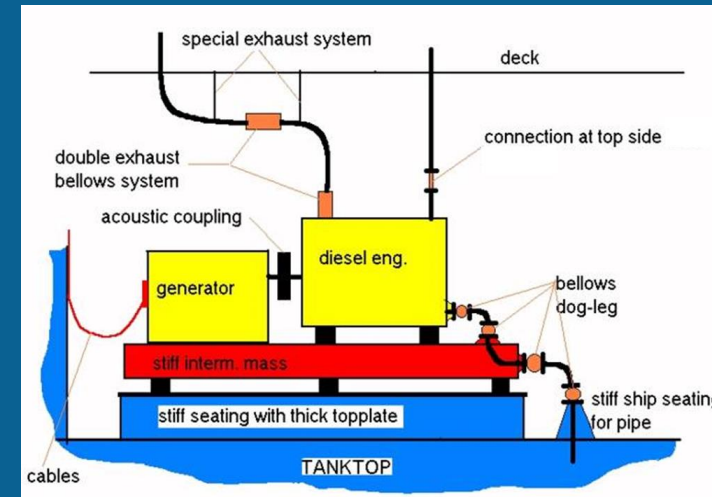
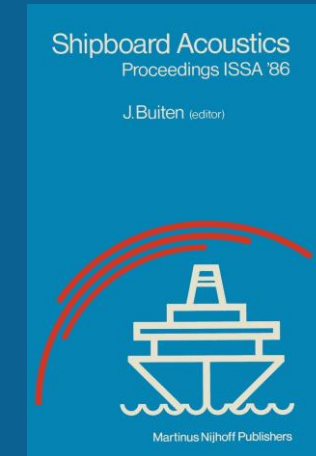
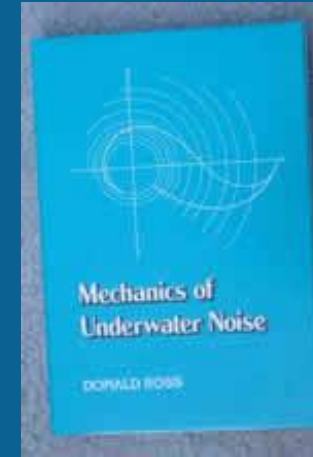
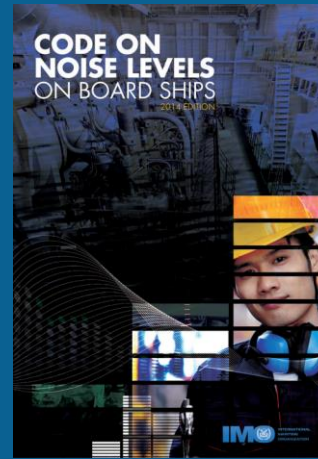


Machinery noise control

- Many years of experience
 - Navy ships and research vessels
 - On-board noise control

- Most efficient in the design stage

⇒ *Experience building needed for wider application to URN*





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Thank you!

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