ORCA Noise Trials for Transport Canada

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DRDC Work with Transport Canada

- As it happens, the Navy has one of the loudest vessels on the west coast, the ORCAs.
- TC and DRDC organized a trial to measure the underwater noise of ORCA-Class training vessels to develop:
  - An automated cavitation detection capability
  - A radiated noise prediction module

based on hull-mounted accelerometer data.

- DRDC will attempt to develop a simplified civilian monitoring system and suggest other noise reduction possibilities.

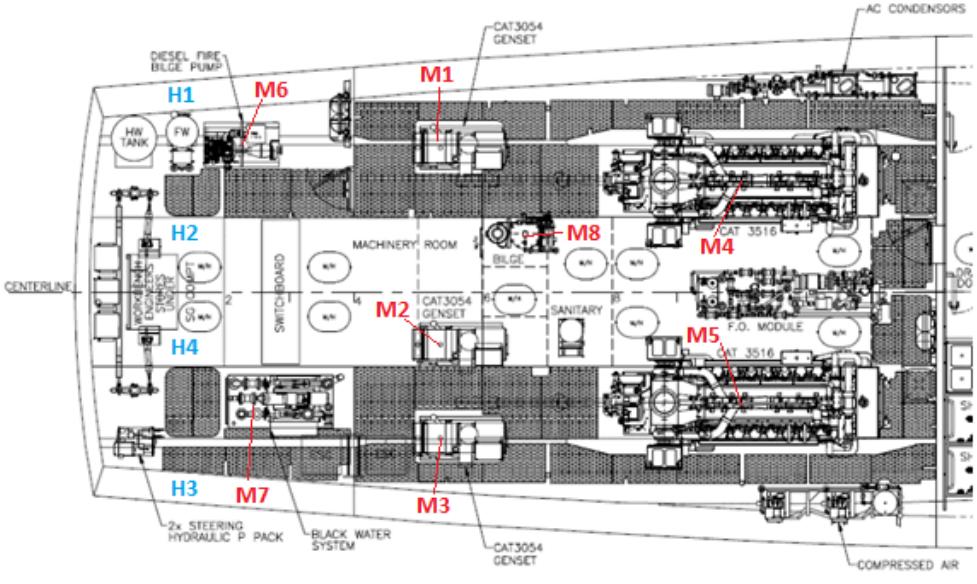
The Ship

- PCT (Patrol Craft, Training) MOOSE was selected as it was recently out of a work period.
- Ship parameters:
  - Length 33m, beam 8.34m, draft 2.6m
  - Displacement of 210 tons
  - Twin-screw (5-bladed propellers)
  - Two 2500HP Caterpillar diesels
  - Three diesel generator sets
  - Maximum speed of 20 knots

Sensors

- In Trial 1, 12 accelerometers were installed at machinery bases or on the hull above the props.
- In Trial 2, a similar set of sensors was moved run-to-run for more coverage.

Sensor Name	Position
H1	Outboard Prop – Port Side
H2	Inboard Prop – Port Side
H3	Outboard Prop – Stbd Side
H4	Inboard Prop – Stbd Side
M1	Genset – Port Side
M2	Genset – Centre
M3	Genset – Stbd Side
M4	Diesel – Port Side
M5	Diesel – Stbd Side
M6	Fire Pump
M7	Black Water Pump
M8	Bilge Pump



Trials

- Performed acoustic rangings in Jul 2019 and Feb 2020 at Pat Bay acoustic range near Victoria, BC (two hydrophones in ~40m of water).
- Performed both static (moored) and dynamic rangings, recording both onboard vibrations and offboard noise.
- Well over 100 dynamic runs performed, speeds from 3 to 20 knots, in a variety of machinery configurations.
- Very noisy ship with significant engine noise levels. Cavitation inception around 8.5 knots.
- Measurements also include shakers, speakers, impulsive sound sources, airborne noise, vibrations above and below engine mounts.

Data

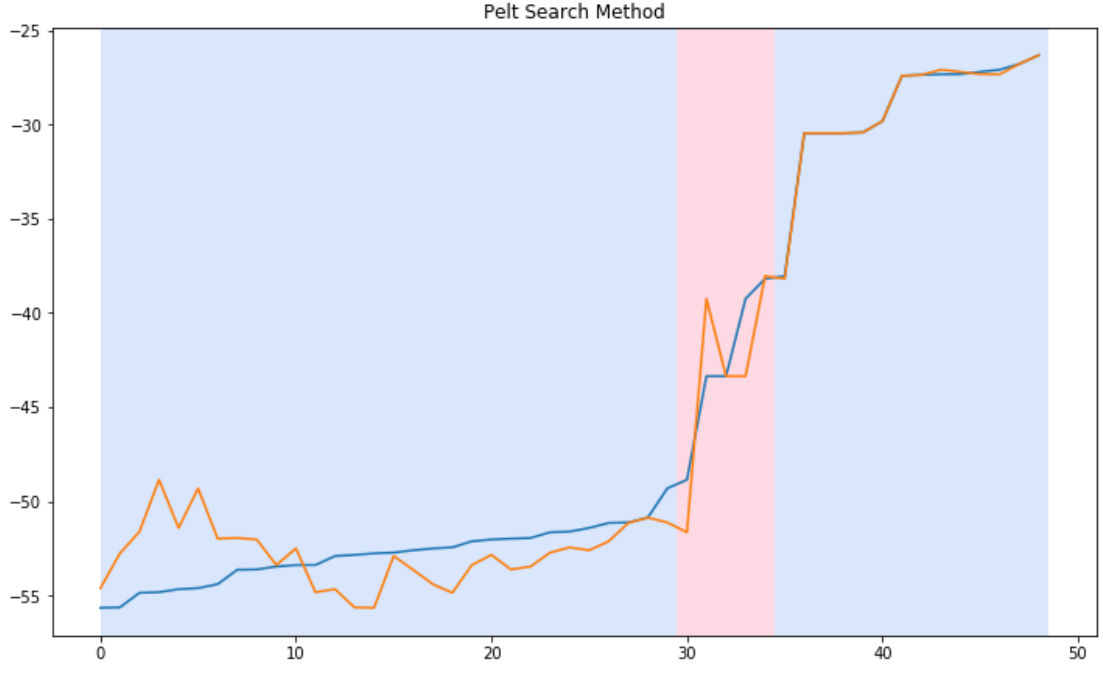
- All data (onboard and off) is unclassified and generally available.
- Data is available as time series, narrow band, and 1/3-octave. Dynamic range data covers 100m either side of CPA.
- Frequency range is DC to 80 kHz for acoustics, DC to 10 kHz for vibrations.
- Data available:
  - Offboard noise levels (raw and processed)
  - Hull vibrations
  - Machinery vibrations above and below mounts
  - Airborne noise in engine room
  - Other ship/environmental data (speed, heading, sound speed profiles)

ORCA Data Analysis

- Data sets are being analyzed in many projects, including internationally.
- Analyses include:
  - Detection of cavitation inception
  - Correlating offboard noise to onboard vibrations
  - Examining offboard noise from specific machinery
  - Examining vibration transfer through mounts
  - Correlating airborne noise levels (in engine room) to vibrations

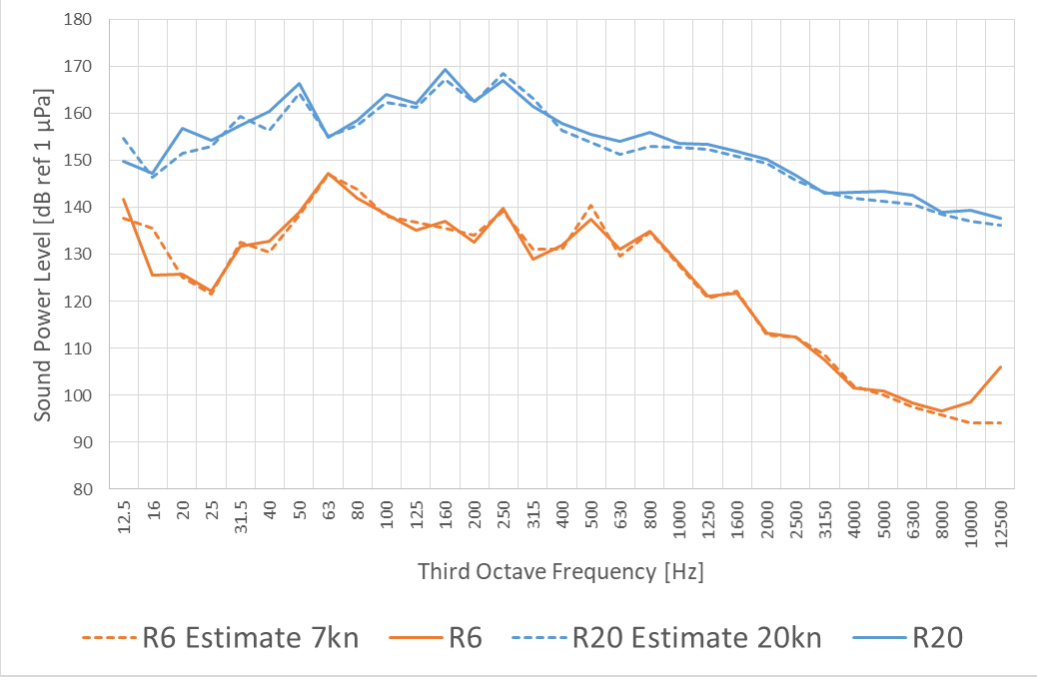
Example: Cavitation Detection

- Using a variety of changepoint detection algorithms, can we automatically detect cavitation inception?



Example: URN Prediction

- By correlating offboard noise to onboard vibrations, can we use only onboard vibrations to estimate radiated noise in real time?



Conclusion

- We now have an extensive data set of onboard ship vibrations and offboard radiated noise which is available for others to use.
- These data are currently being used in several national and international projects.
- We are setting up the Benchmark Underwater Radiated Noise Simulation (BURNSi) workshop to invite participants to:
  - Perform analyses of the onboard data
  - Together with models provided (FE model), predict noise from engines, gensets, and overall noise.
  - Compare with other participants and with actual measured offboard noise.

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