



# Measured Radiated Sound from Large Commercial Vessels

Controlling sources of radiated noise from large modern cruise ships and dependence on propulsion type and vessel speed.

For NOAA Vessel Quieting Symposium – 1 May 2007  
Presented by Blair Kipple of NSWC Carderock Division





# Cruise Ship Radiated Sound

- Eight Vessels
- Measured at Navy's SEAFAC Facility
- 1999-2004
- Cooperative Project Between NSWC, NPS, and Cruise Lines



# Vessel Types

- Length: 620 to 960 ft
- Displacement: 23 to 92 thousand ton gross
- Vintage: 1958, and 1995 through 2002
- Propulsion:
  - Steam turbine
  - Diesel
  - Diesel-electric
  - Diesel-gas turbine-electric



# Why cruise ships in this forum?

1. Propulsion systems used by large vessels are represented
2. Propulsion systems account for most of the noise issues of concern with large vessels in general
3. Solid data set exists

# What we will cover

- Show typical radiated sound spectra
- Identify important sound sources
- Compare sound between ships
- Discuss speed dependence
- Compare large vessels to other types

# Importance of Controlling Sound Sources

Symposium focus is on “potential application of vessel quieting technology”

Relevant questions:

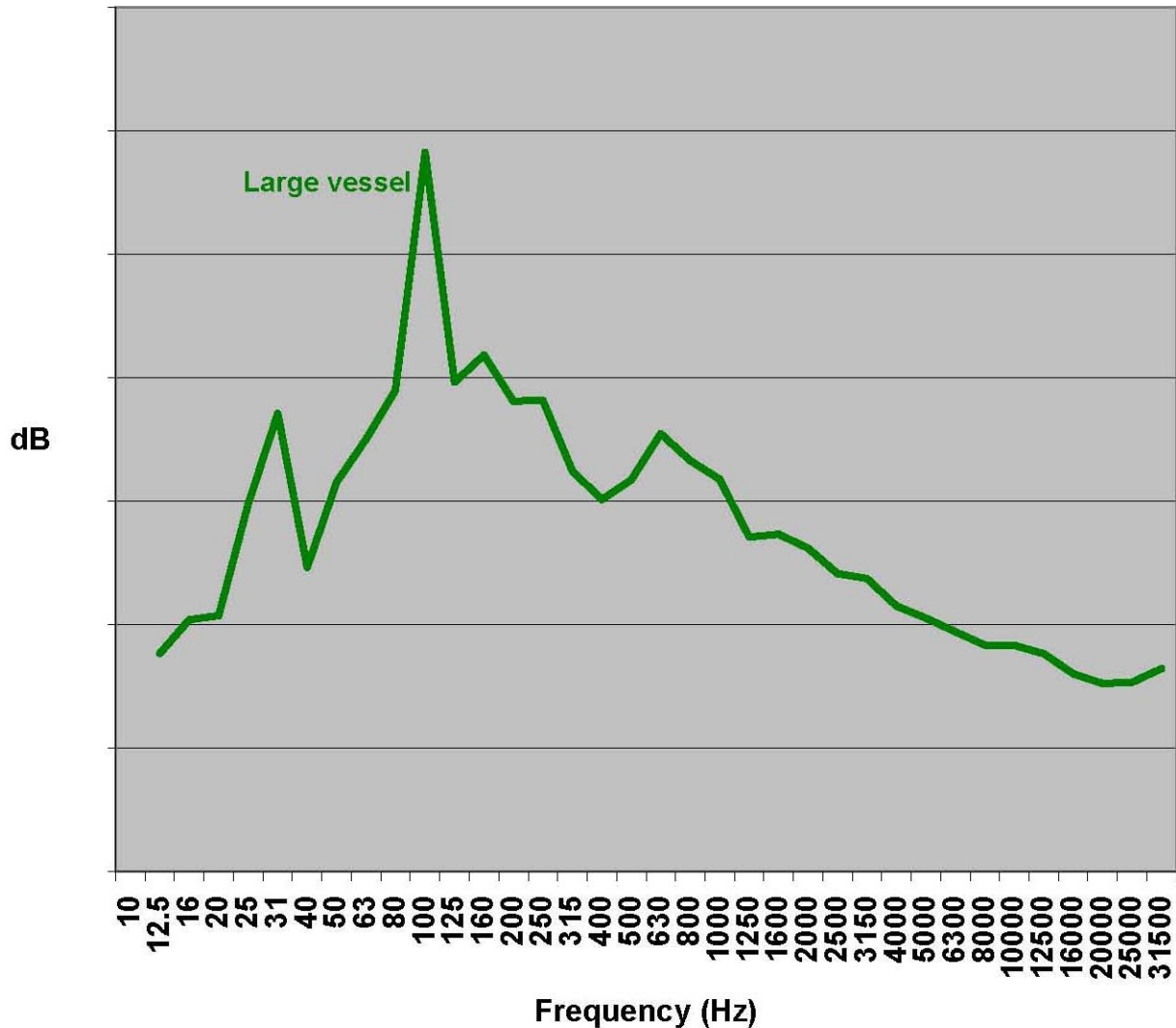
1. What acoustic energy is most important (consider both level and frequency)?
2. What are the sources of these energies?



# Typical Cruise Ship Noise Spectra

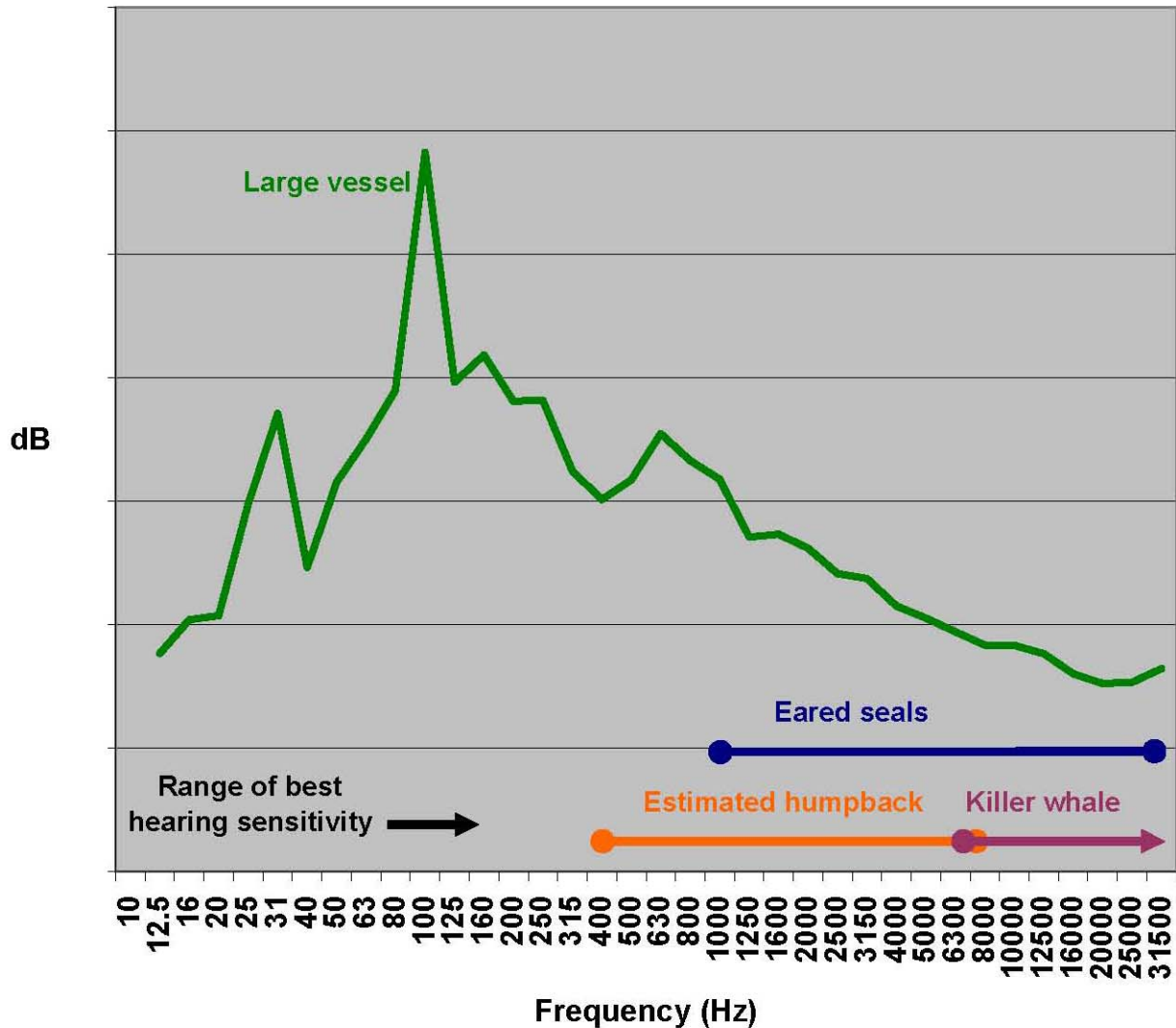
# Frequency Spectrum

Representative Underwater Sound Spectra



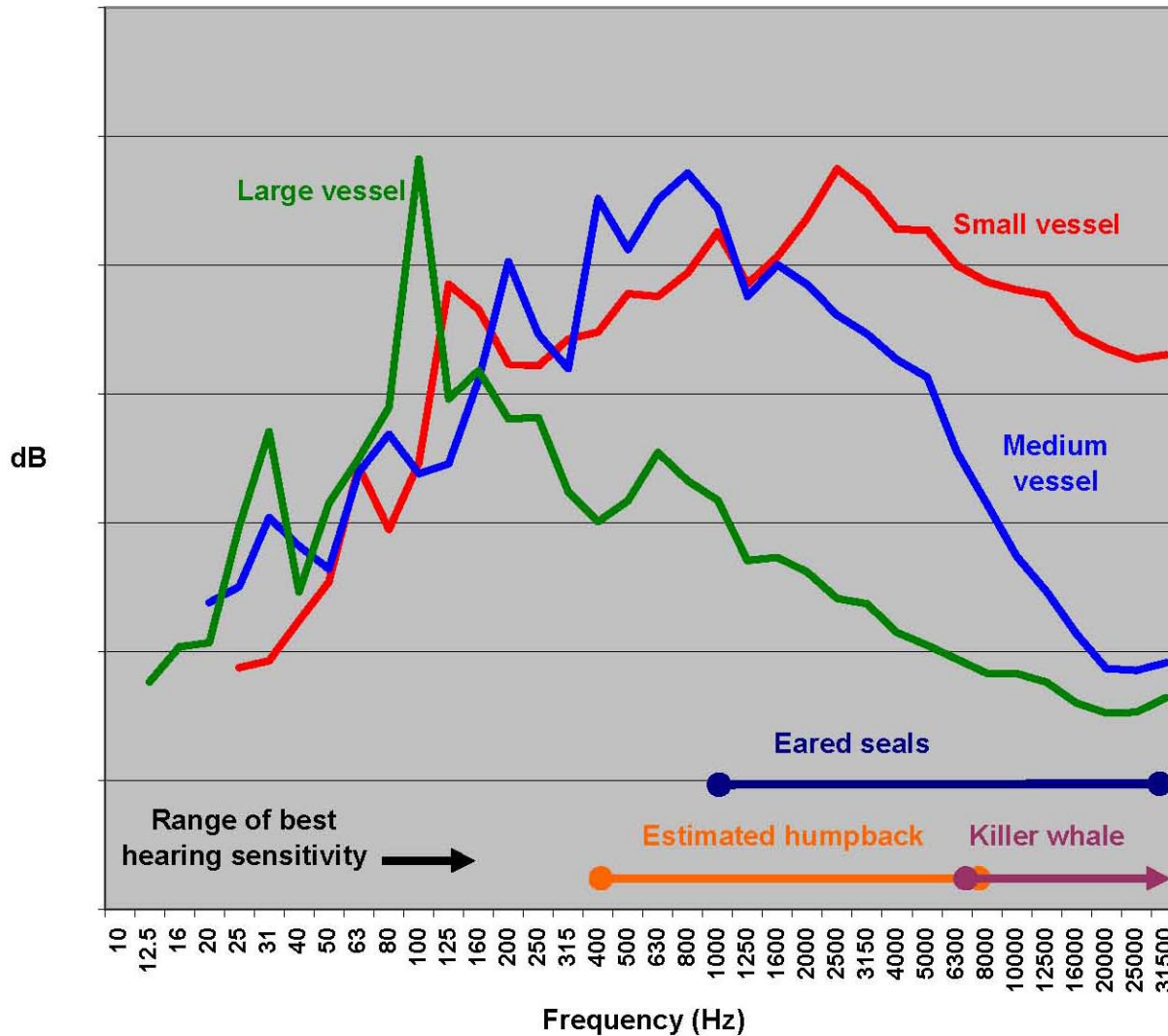
# Frequency Spectrum

Representative Underwater Sound Spectra

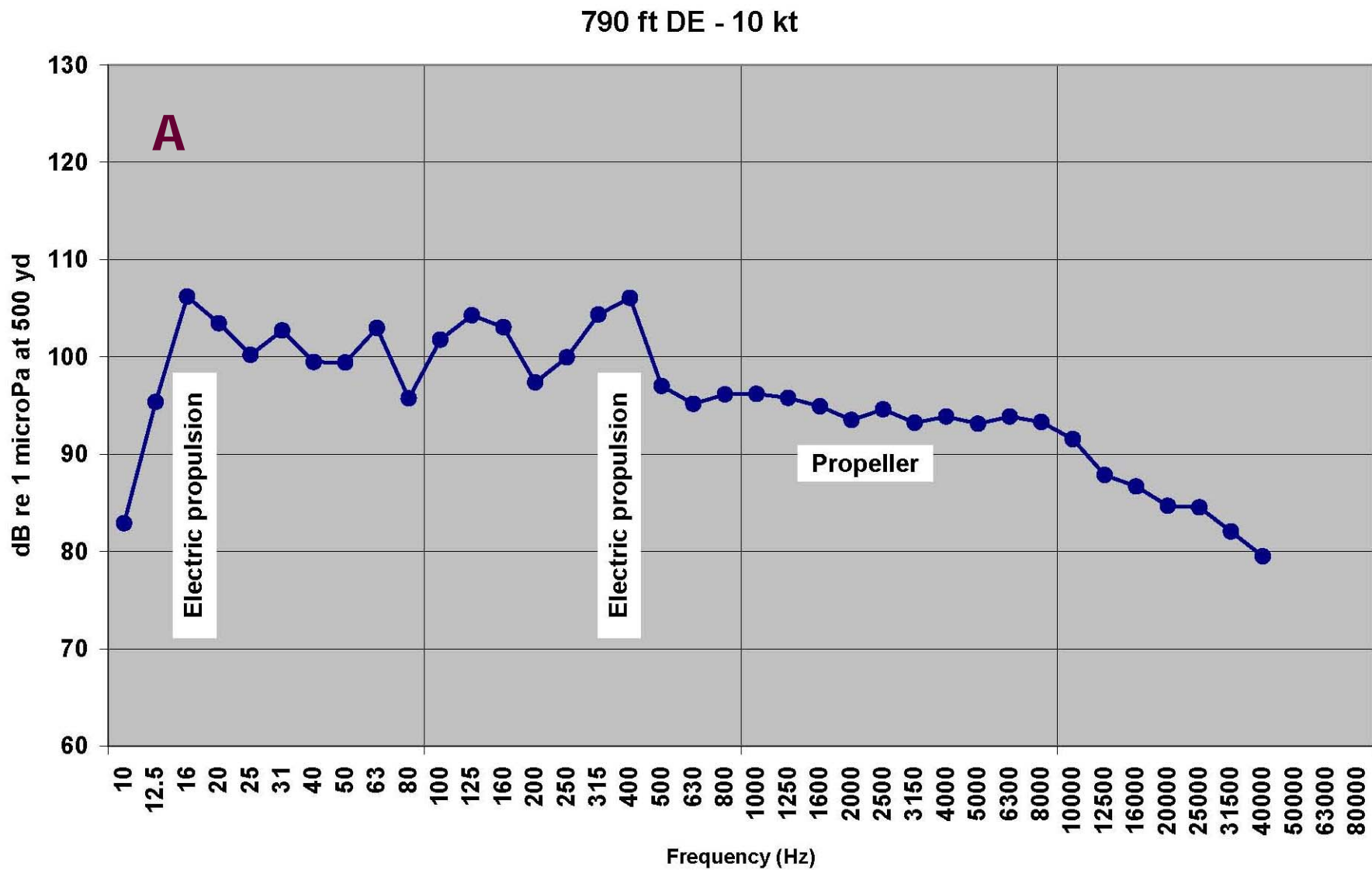


# Frequency Spectrum

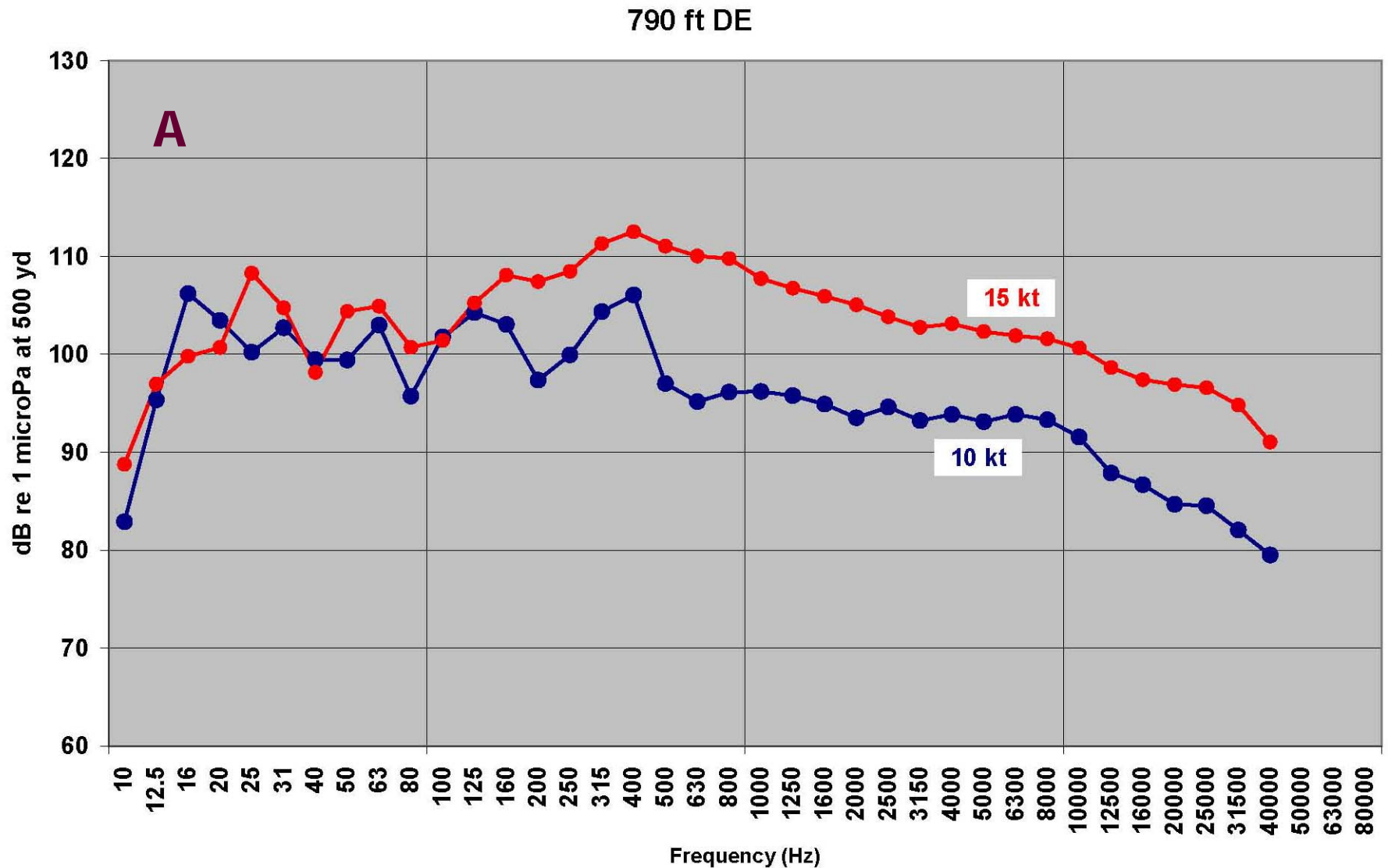
Representative Underwater Sound Spectra



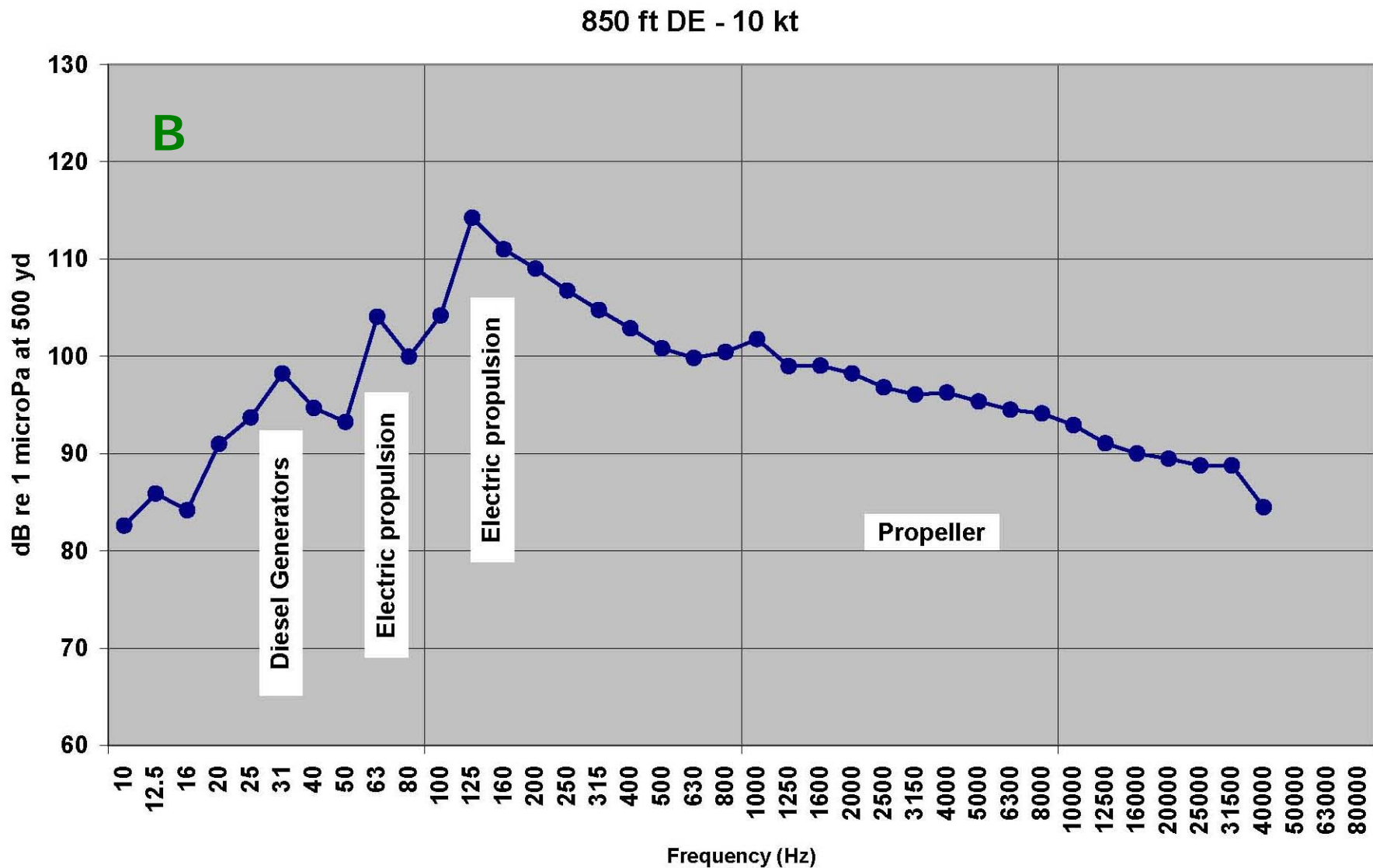
# Diesel electric – 10 kt



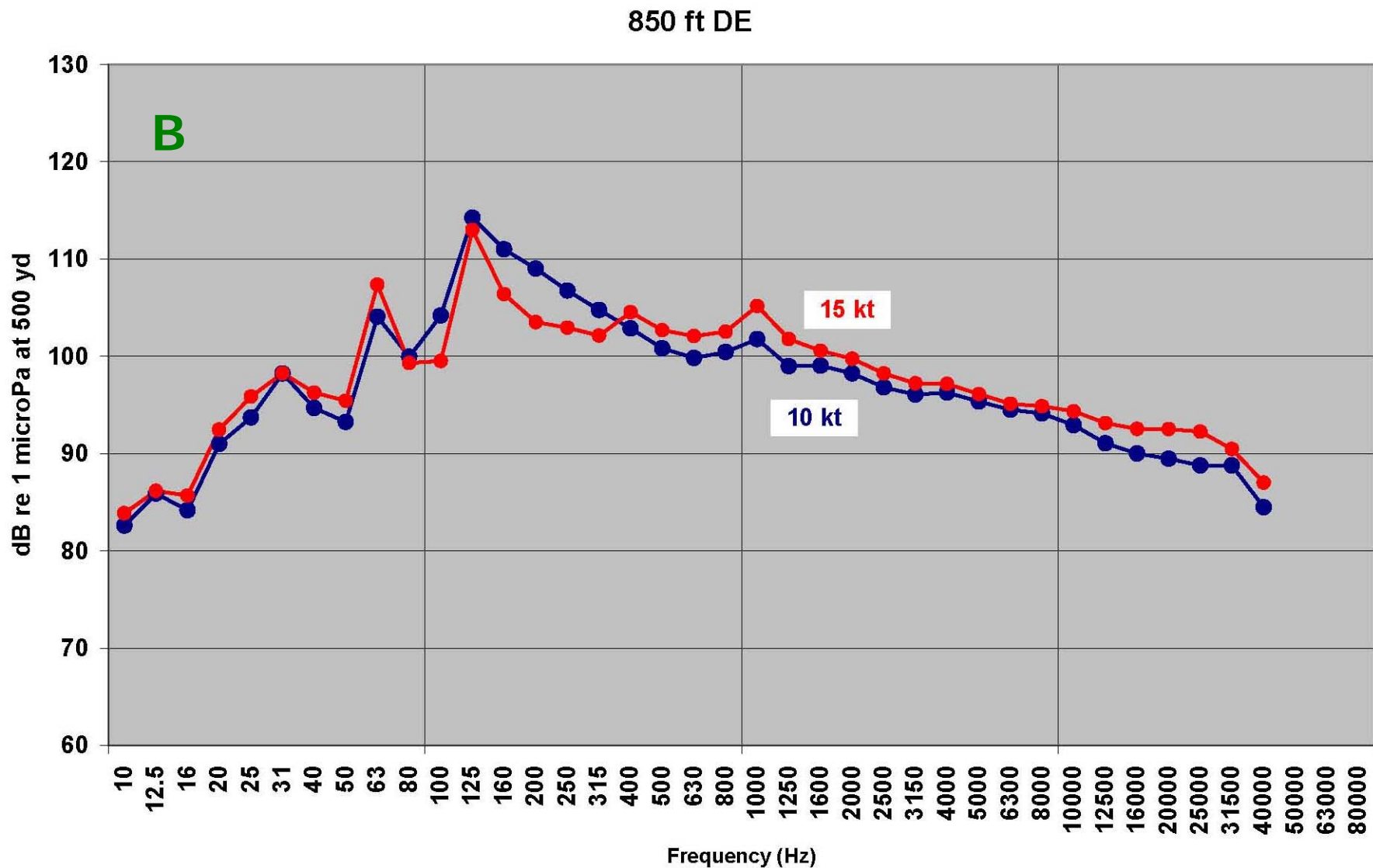
# Diesel electric – 10 and 15 kt



# Diesel electric – 10 kt

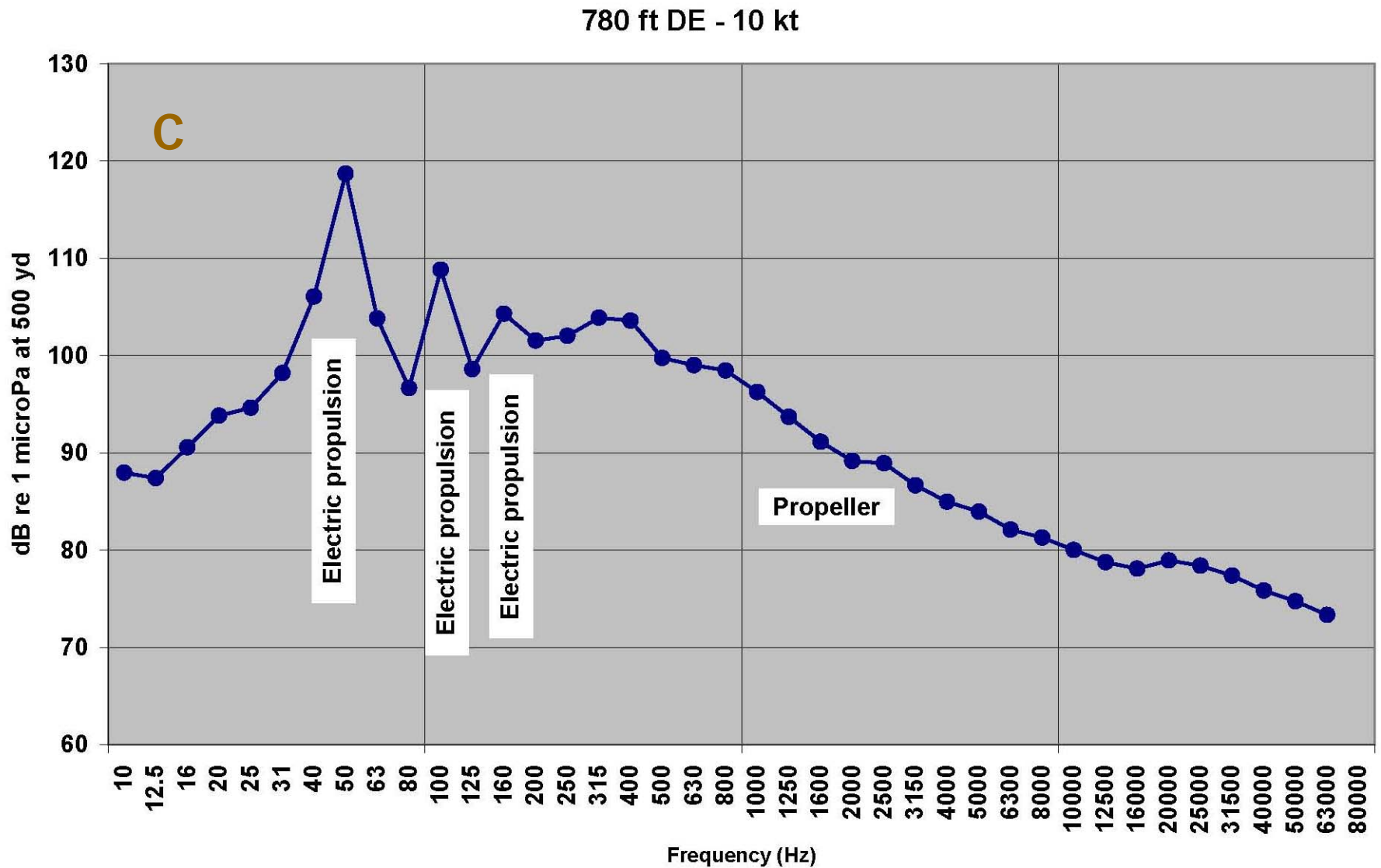


# Diesel electric – 10 and 15 kt

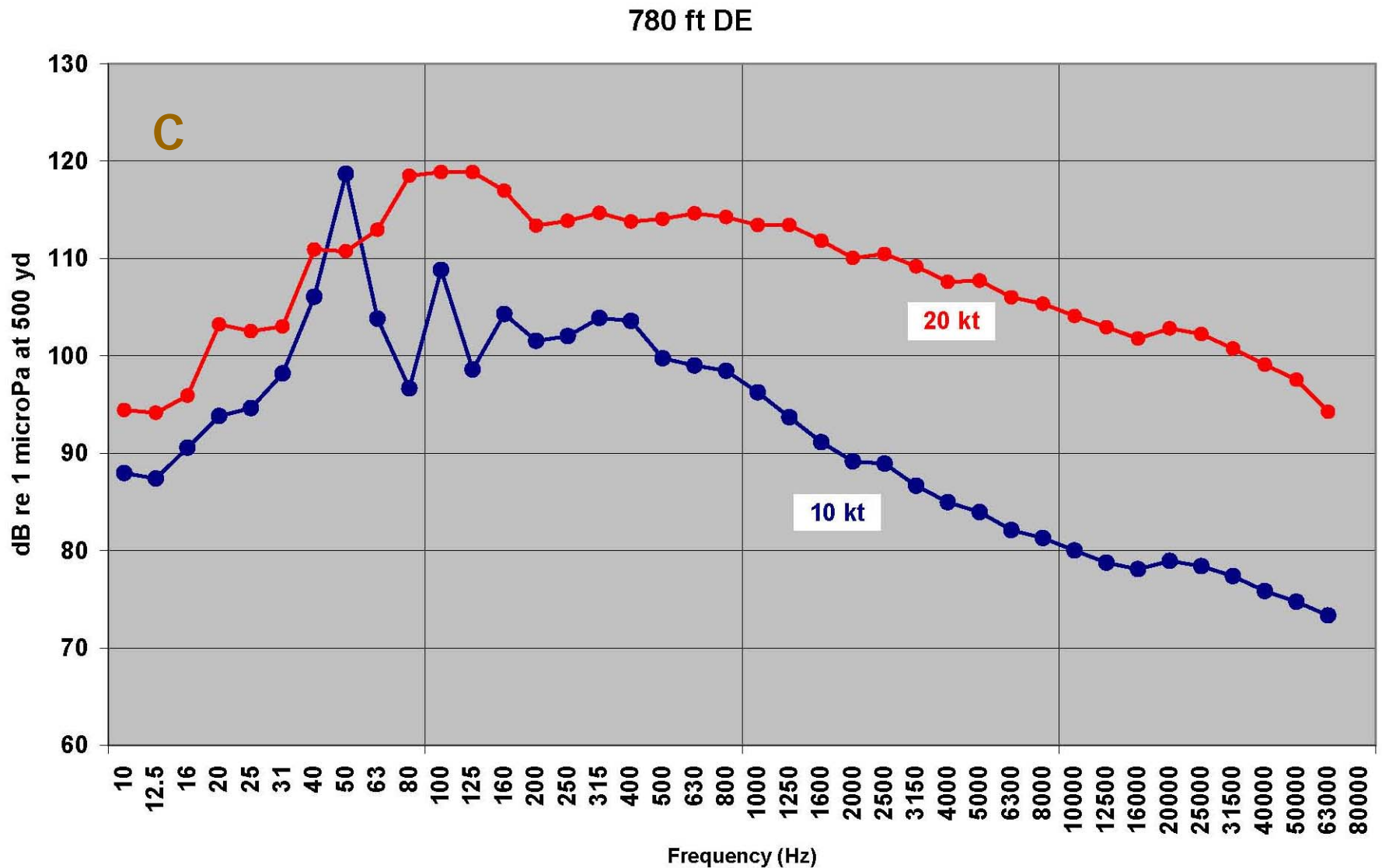




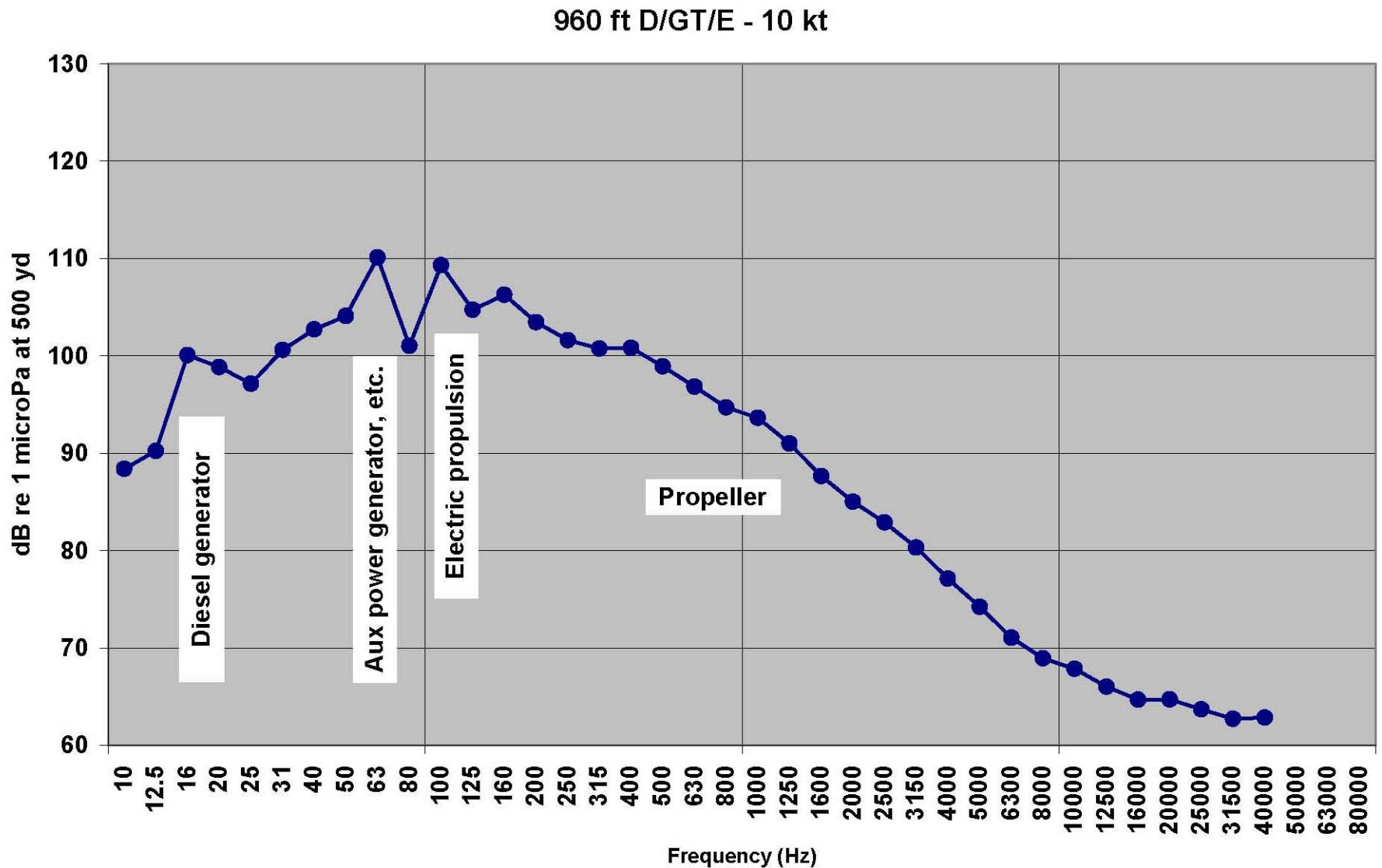
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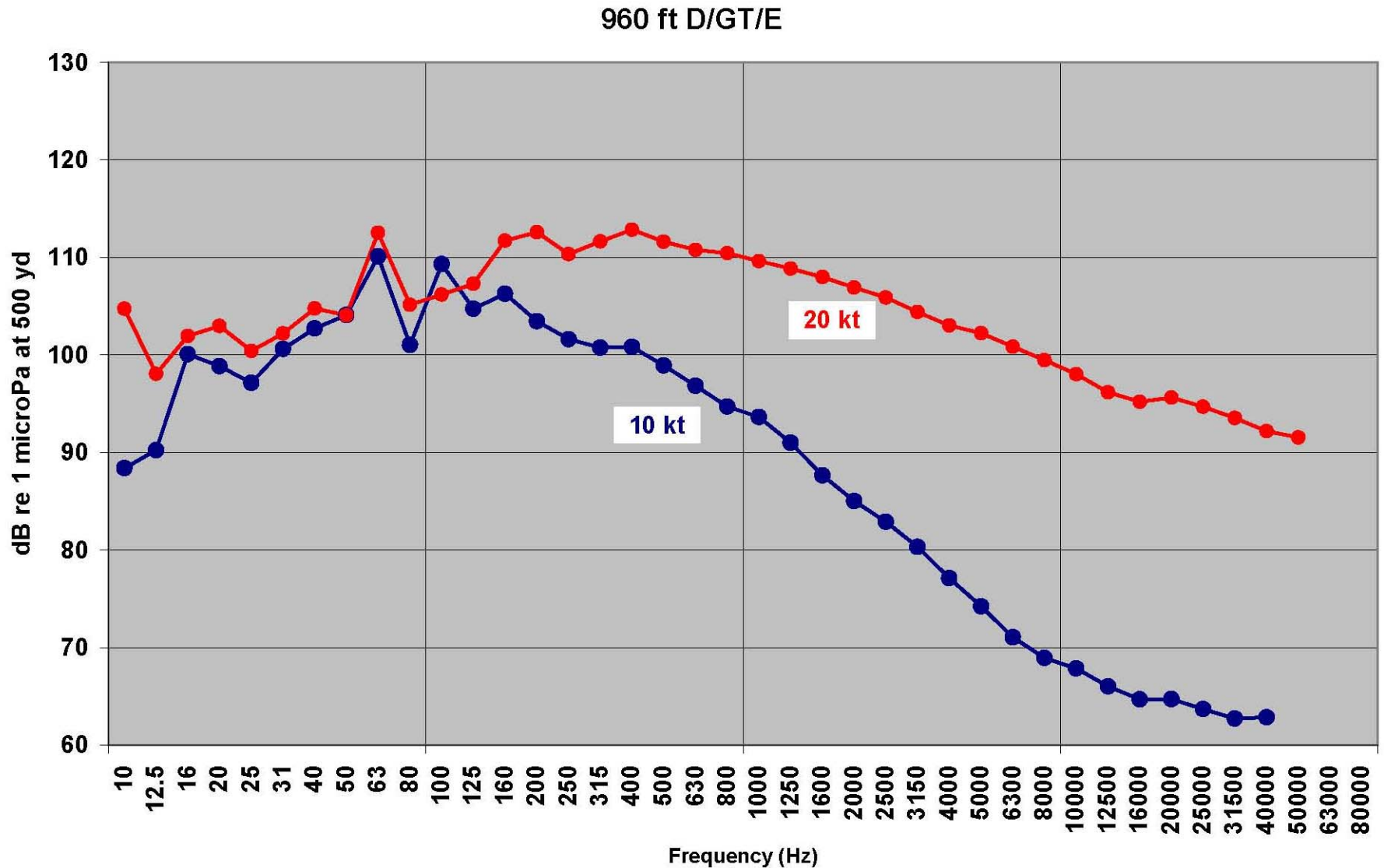
# Diesel electric – 10 and 20 kt



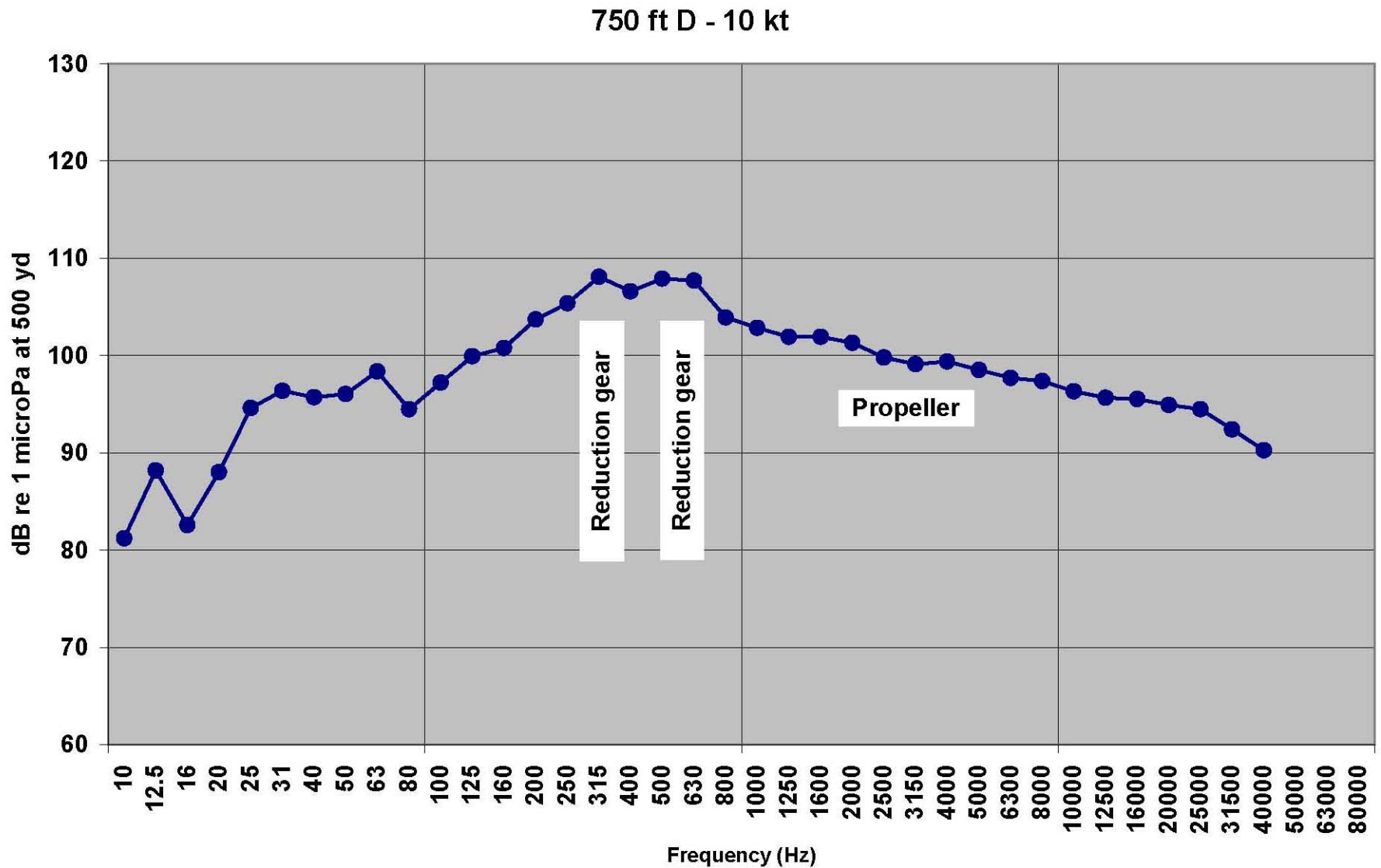
# Diesel/gas turbine/electric – 10 kt



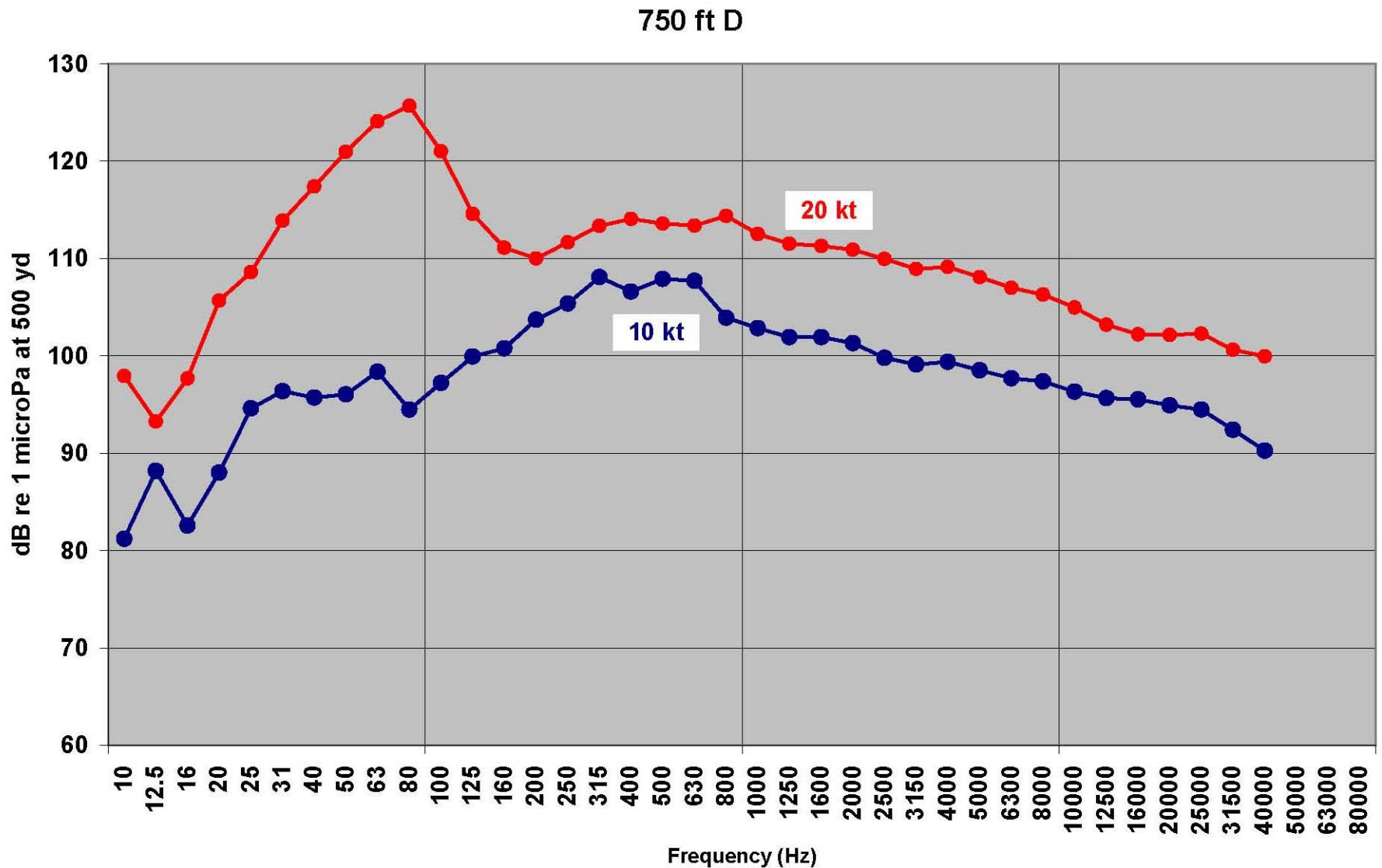
# Diesel/gas turbine/electric – 10 and 20 kt



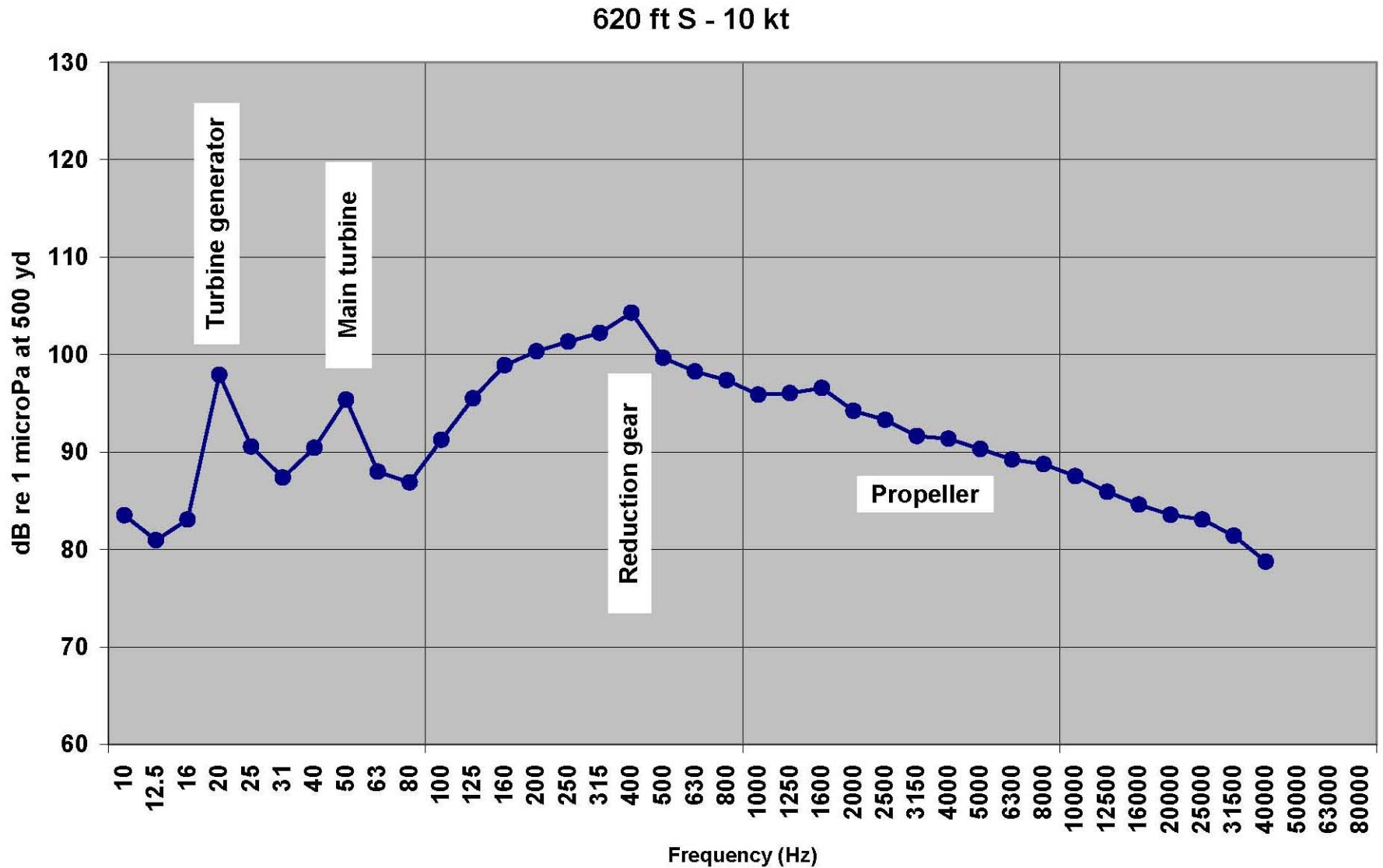
# Diesel – 10 kt



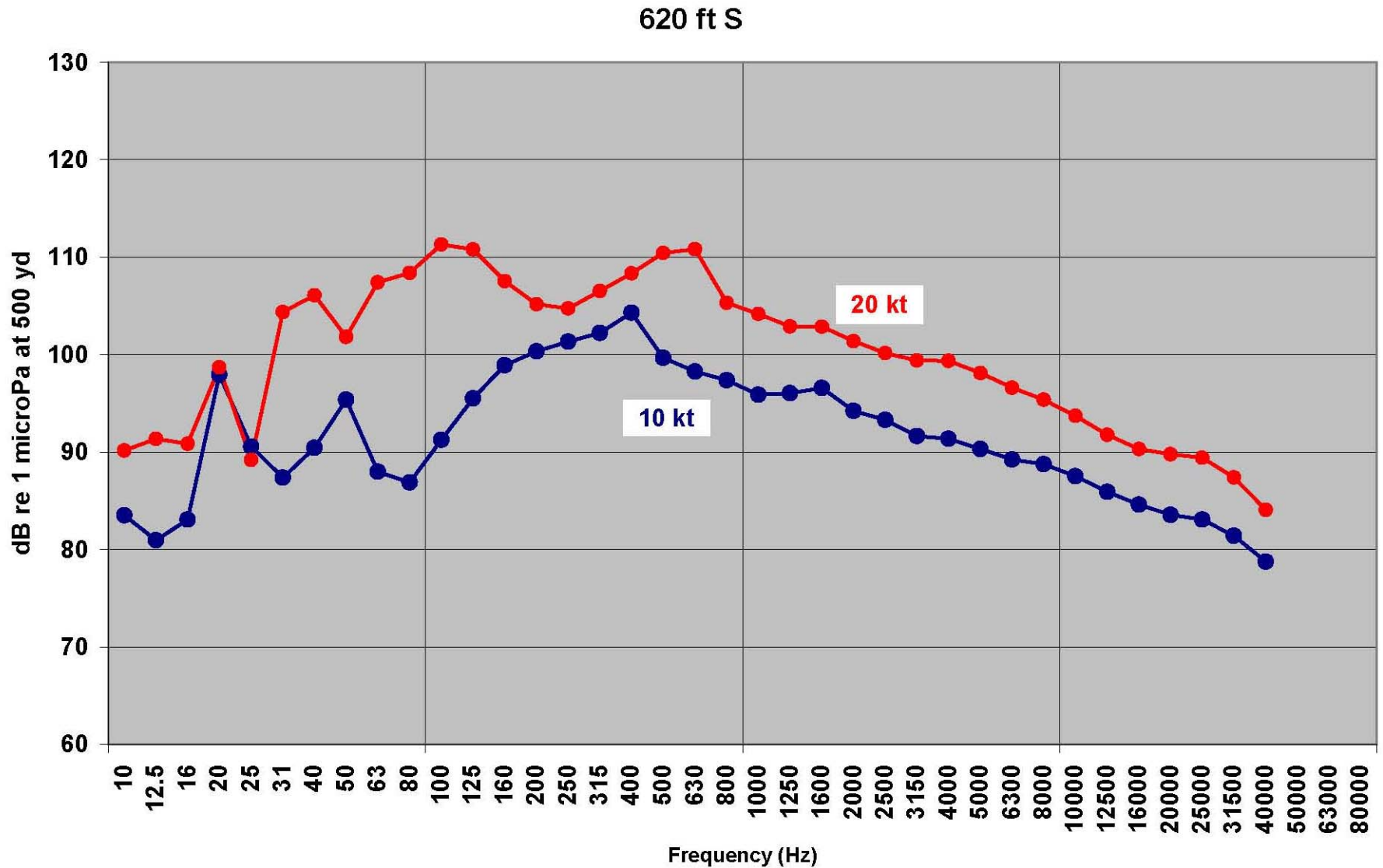
# Diesel – 10 and 20 kt



# Steam – 10 kt



# Steam – 10 and 20 kt





# Controlling Sources

- Diesel electric: electric propulsion motors, generator engines, propeller
- Diesel: propulsion engines, generator engines, reduction gear, propeller
- Steam: turbines, reduction gear, propeller

# Controlling Sources

- Auxiliary systems apparently not as important
- Ship specific sources can be significant

# Sound Sources and Quieting Efforts

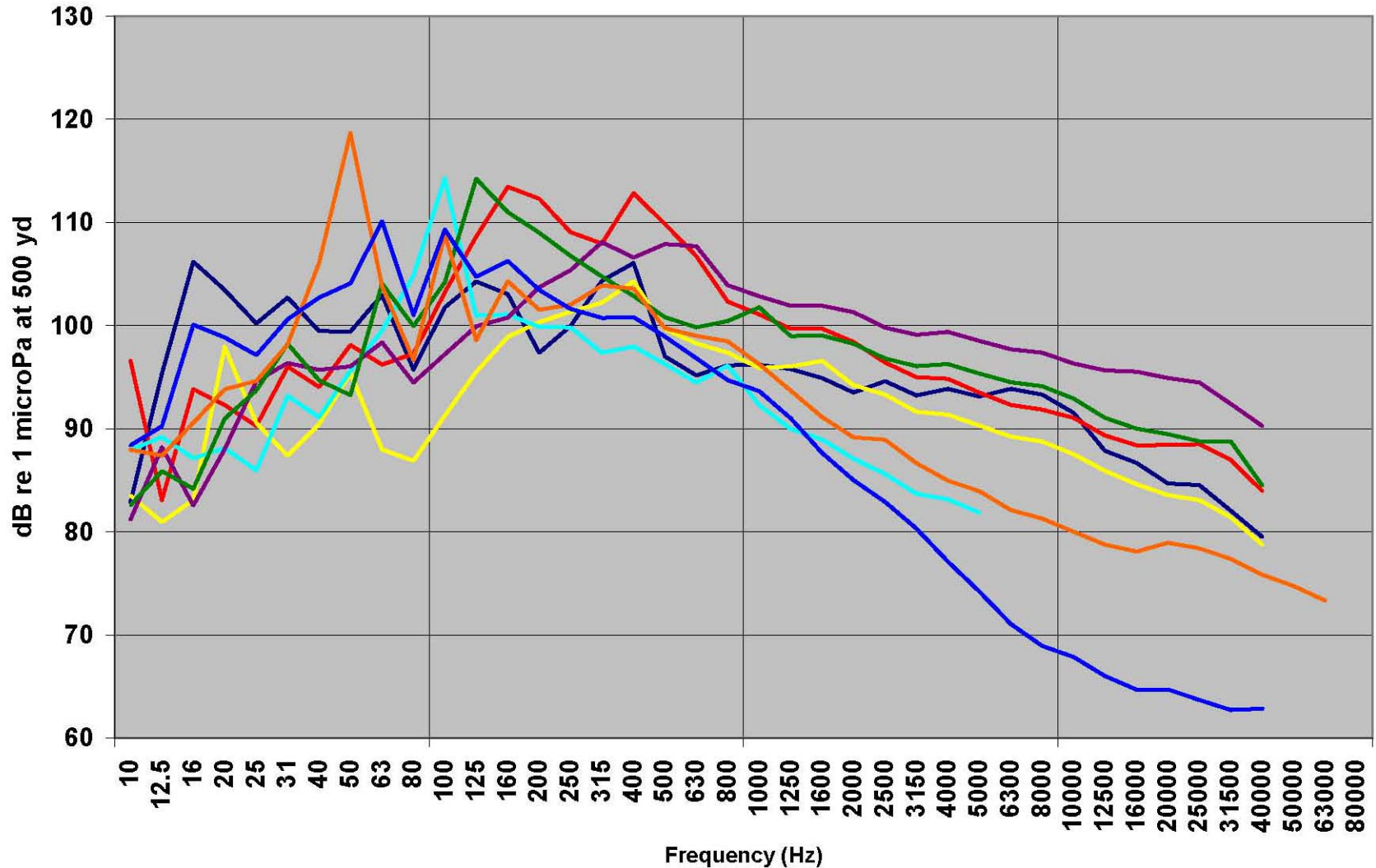
- Important to identify and focus efforts on primary sources
- From a silencing standpoint, there is often little to be gained by silencing second order sources

# Comparability

Compare sound levels and character  
between vessels

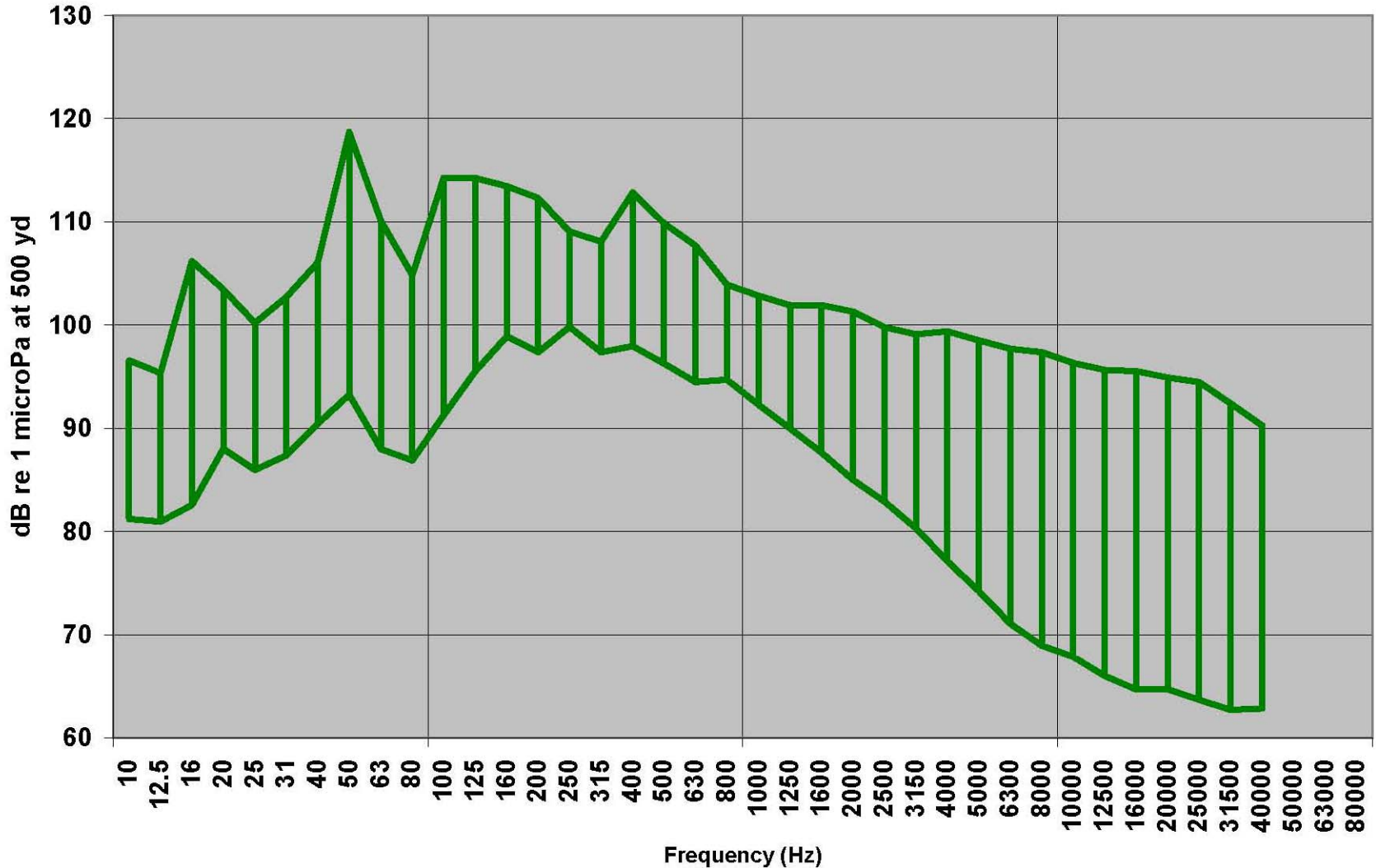
# Comparability

Eight vessels - 10 kt



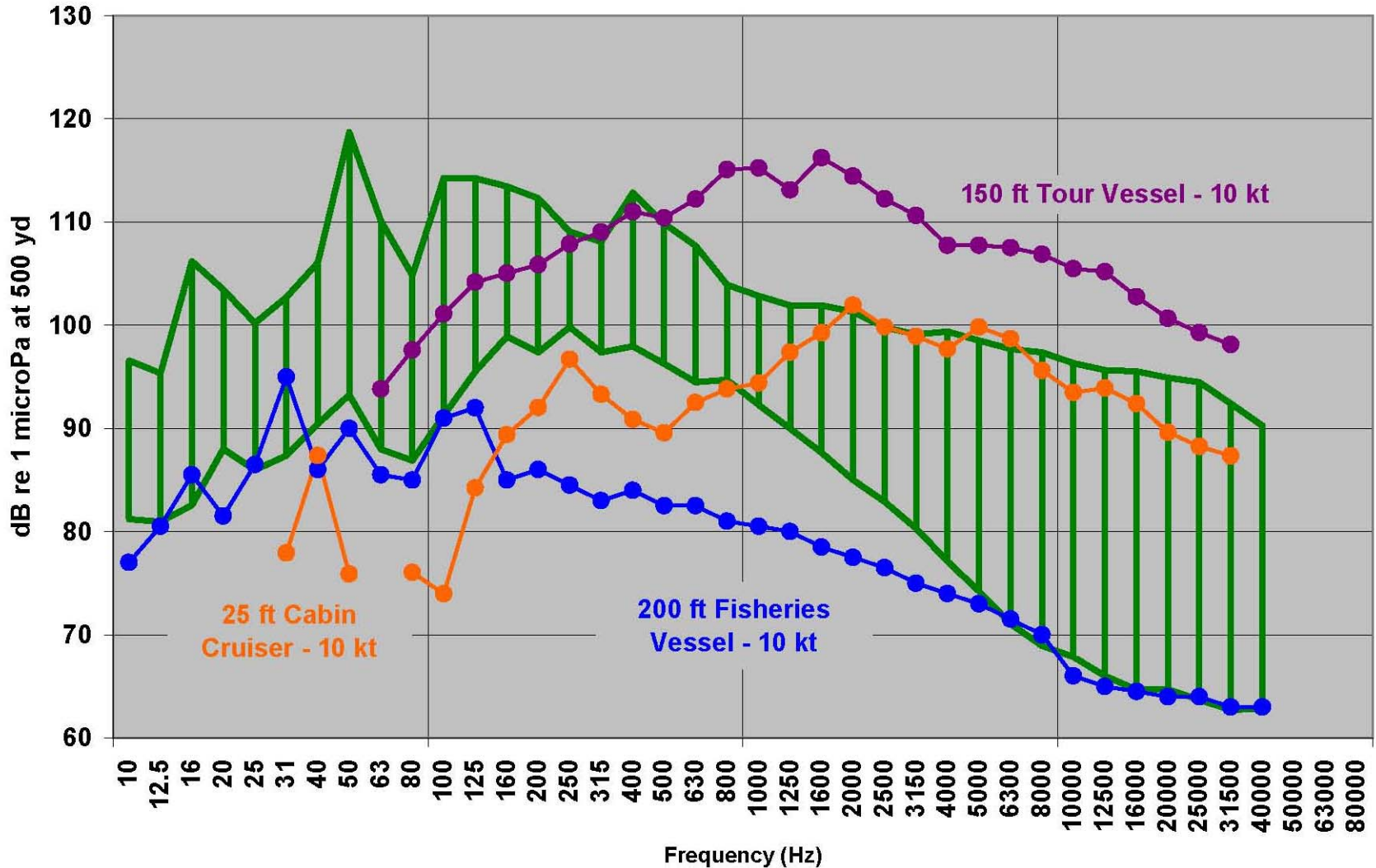
# Comparability – Cruise Ships Envelope

Eight vessels - 10 kt



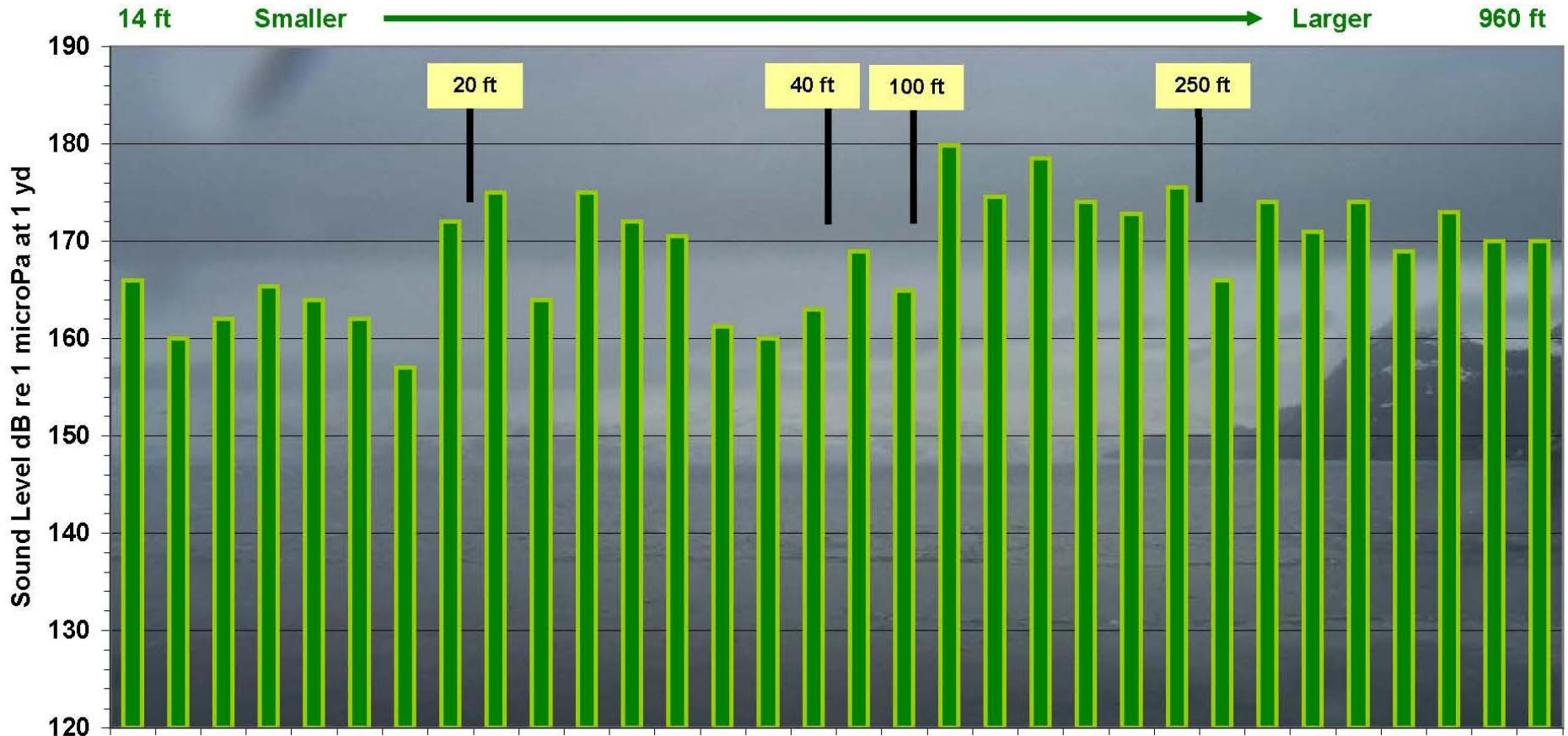
# Cruise Ships Vs Other Vessels

Cruise Ship Envelope vs. Other Vessels - 10 kt



# Radiated Sound Level by Vessel Size

10 kt Sound Level by Vessel

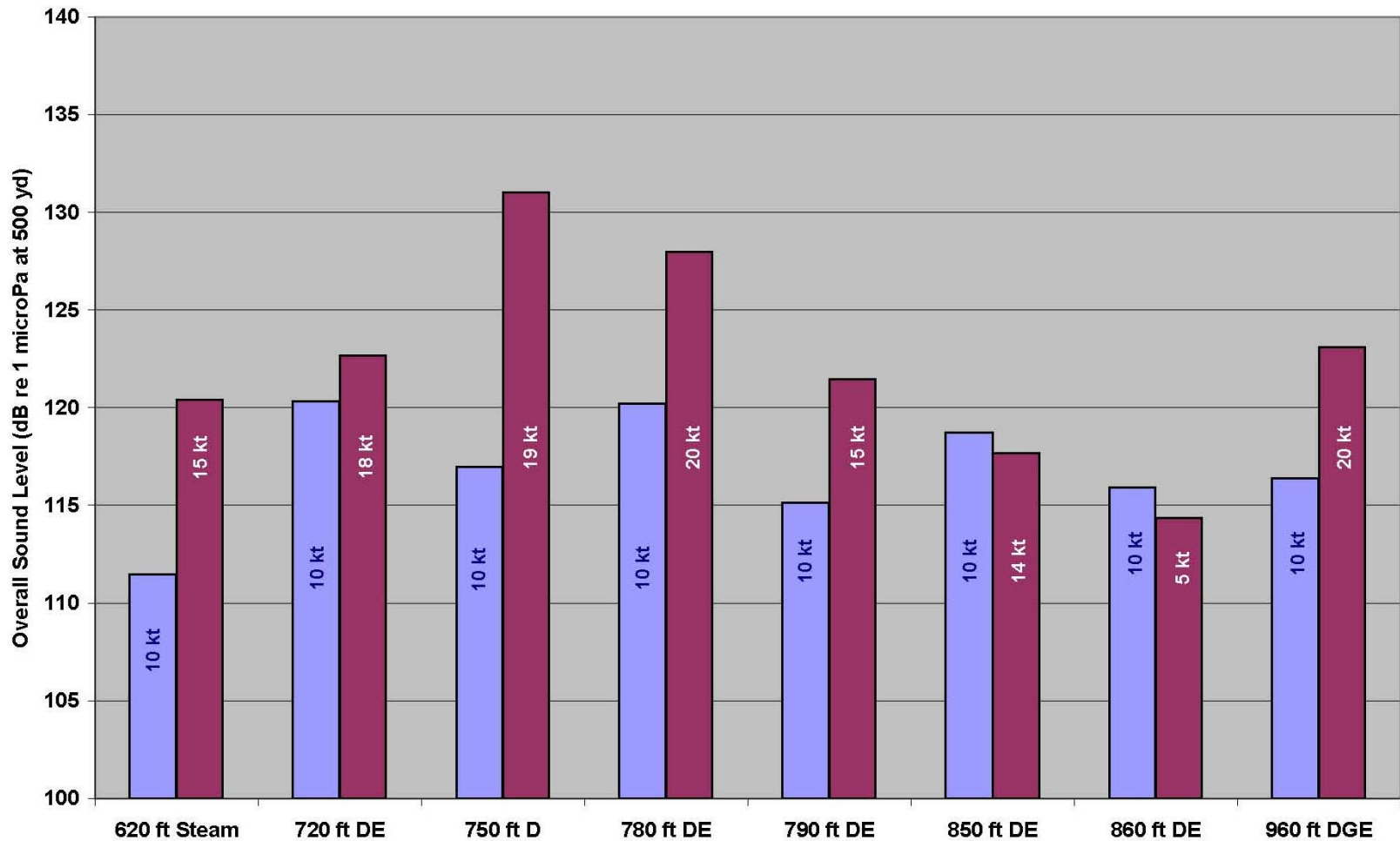




# Speed Dependence

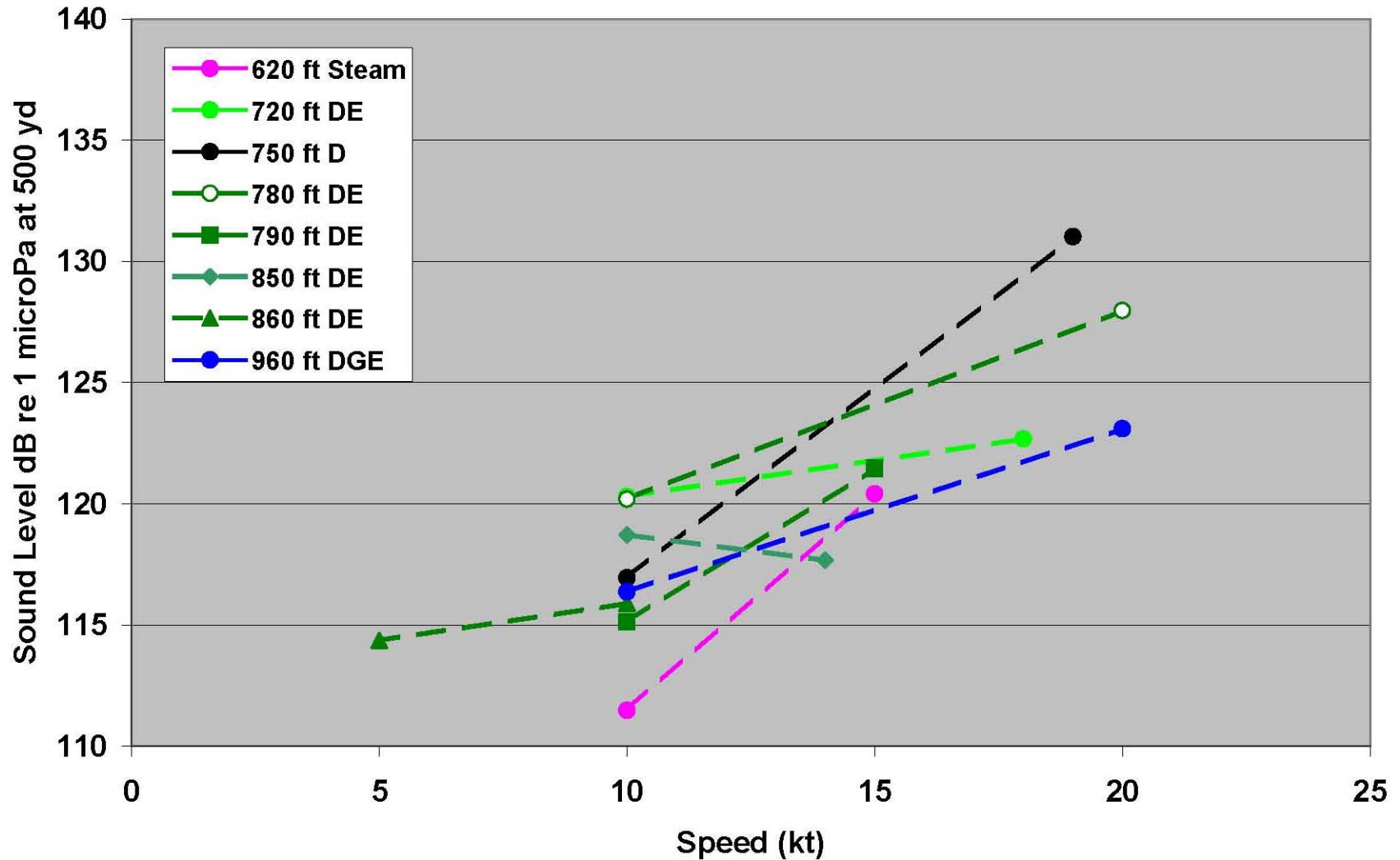
# Speed Dependence

Overall Sound Level at Two Speeds at 500 yds by Ship



# Speed Dependence – Eight Vessels

Overall sound level vs. ship speed



# Speed Dependence

- Sound from some electric propulsion ships can be fairly speed independent
- However in some cases electric propulsion noise components can be highly speed dependent
- Propeller related noise can be highly speed dependent (role of propeller pitch setting?)

# Re-cap

- Cruise ship sound (level, character, and controlling sources) is vessel dependent
- Propulsion system related, power generation, and propeller are typically most important sources
- Noise from several vessels showed significant speed dependence, but others exhibited less speed dependence



Questions?

