Field	Study Information
Title	Sound Source Characterization of Dynamic Positioning Systems: Field Verification (NT-25-01)
Administered by	Office of Environmental Programs
BOEM Contact(s)	Molly Reeve (molly.reeve@boem.gov)
Procurement Type(s)	Contract
Performance Period	FY 2025–2026
Final Report Due	TBD
Date Revised	April 4, 2024
Problem	Dynamic positioning (DP) systems are used during offshore construction across many of BOEM's programs. These systems generate underwater noise which may have the potential to negatively impact marine life and ecosystems.
Intervention	The proposed study would provide insight into the scope of the potential impacts to marine fauna from DP systems by providing calibrated measurements of the sound field of a variety of vessel types and multiple DP systems in various operational states and water depths.
Comparison	There are few dedicated studies that have thoroughly characterized DP systems as sources of underwater noise. A selection of vessels representing a range of systems and operational states will be tested to broaden the applicability of the results of this work.
Outcome	This study will facilitate the assessment of potential acute and chronic acoustic impacts of DP sources to marine fauna. The knowledge gained from this study will be used by several BOEM programs and regional offices in assessing impacts of BOEM activities.
Context	Nation-wide relevance for activities involving marine construction.

BOEM Information Need(s): Improved understanding of the acoustic characteristics of DP systems is crucial to predict potential impacts on marine species, and to determine appropriate mitigation, as required under the National Environmental Policy Act (NEPA), Marine Mammal Protection Act (MMPA), and Endangered Species Act (ESA). Currently, there are limited data on the underwater source levels of these systems, and nearly all data collected thus far have been focused on oil and gas activities and related system applications. Further, representative sound field measurements from the use of DP are difficult to obtain because the sound transmitted is often highly directional and context specific. The direction of sound propagation may change as different DP configurations are applied. Of the available data, most reports do not identify the direction in which noise was measured, nor do they provide multiple measurements based on bearing.

The information acquired from this proposed study will be used by BOEM to make more informed assessments of the impacts of its permitted activities, which will include species of ecological and commercial importance. The results will directly inform BOEM's Center for Marine Acoustic's acoustic

impact model, as well as technical content made available to other offices within BOEM to better inform environmental impact assessments, biological assessments, and decisions related to the NEPA and ESA processes. Finally, the information will be used by the Center for Marine Acoustics to make recommendations to regulators responsible for updating acoustic impact thresholds with the best available science.

Background: DP systems are used to control a vessel's position with propellers and thrusters for station-keeping (e.g., holding station over a specific seafloor location), docking, and other precise maneuvering during operations. DP uses input from gyrocompasses, motion sensors, GPS, active acoustic positioning systems, and wind sensors to determine relative movement and environmental forces at work. DP systems typically do not have a high peak sound pressure and rapid rise time compared to impulsive sounds but can still produce significant acoustic energy most of which is below 1000 Hz, with tones related to engine and propeller size and type (ANSI 1995; NIOSH 1998). The sound can vary directionally, and this directionality is more pronounced at higher frequencies. Because this is a dynamic operation, the sound levels produced will vary based on the specific operation, DP system used (e.g., jet or propeller rotation, versus a rudder or steering mechanism), and factors such as the blade rate, blade pitch and cavitation, and material condition of the system.

Most of the noise generated by DP systems (low frequency and high amplitude) comes from the vessel thrusters. As with propulsion, source levels during the use of DP vary greatly based on size and type of vessel, type of thruster, and operational conditions including both weather and oceanographic conditions. Generally, a wider variety of thruster types are used in DP than in standard propulsion. Some drive types include transverse tunnel thrusters, Z-drives, L-drives, azipull thrusters, and retractable thrusters (Warner and McCrodan 2011). Transverse tunnel thrusters can be located on the ship's bow or stern, or in both locations. Because the impeller is usually closer to one side or the other, the thrusters produce sound that is both directionally variable and differing depending on which direction they are pushing. The design also makes them more prone to cavitation at relatively low operational speeds, leading to much higher source levels relative to their thrust (Fischer 2000). It is difficult to provide a realistic range of source levels from the data thus far because most reports do not identify the direction from which sound was measured relative to the vessel.

The use of DP is rapidly increasing in shallow water environments for prolonged periods of time due, in part, to the Jones Act, and expeditious offshore wind development. To date, limited field measurements exist regarding source levels, spectrum and directivity from wind turbine installation vessels and other associated construction and service vessels using DP. These sources produce noise at an intensity and frequency which may impact marine mammals and adversely affect their behavior. The focus for this study is directed toward DP systems currently employed in renewable energy construction and operations to inform potential acoustic impacts on marine life. The results of this study may also help to inform and define the aggregate acoustic impact from multiple vessels simultaneously operating DP systems in close proximity. Information garnered from this project will benefit many BOEM program areas (oil/gas, renewable energy, marine minerals) and all BOEM planning areas.

Objective(s): The collection of acoustic measurements of DP systems in field environments, along with basic environmental characterizations, fills a critical knowledge gap about acoustic impacts. The specific objectives of this study are to:

1. Identify a range of vessel types and DP systems to be measured.

2. Develop adequate measurement techniques to successfully characterize source level, spectrum, and directivity of these systems.
3. Perform intentional measurements on a variety of vessel types and DP systems in various operational states and conditions.
4. Provide reliable underwater acoustic measurements of DP systems to multiple stakeholders resulting from comprehensive data analysis which incorporates various operational states and conditions.

Methods: Due to the acoustic nature and availability of actual operating systems, the proponent will need to design and complete the necessary preliminary preparation and field work to:

1. Identify the appropriate study area(s), capitalizing or coordinating with ongoing project development. This will include where and how DP systems are being used, how the optimization of measurements specific for DP will be achieved, and any restrictions or issues in obtaining accurate measurements. The study design and proposed measurement system will be contingent on this information.
2. Characterize the signal and/or sound field, accommodating the nature of the signal to be captured and the study area (e.g., bathymetry, geologic environment, oceanographic properties, and processes at the field site), using the best available science.

Recognizing the challenge of obtaining representative field measurements from DP systems, the objectives may be achieved through one or a combination of dedicated measurements or target of opportunity to reduce cost, and optimize the assets needed. Ideal measurements will include several different systems, for multiple azimuths of the sound field produced from the source, under varying operational conditions. If this cannot be achieved, the study design will need to address contingencies and redundancies to succeed in the measurement and data analysis. The proponent will be expected to consider a variety of approaches, and cost estimates to obtain adequate measurements, potentially including but not limited to sonobuoys, fixed receivers, ship-based receivers, unmanned surface vehicles (USVs), and autonomous underwater vehicles (AUVs).

Specific Research Question(s):

1. What are the signal characteristics, including source level, estimated directionality pattern, and received levels at various ranges and radials, of DP systems from multiple vessel types (e.g., wind turbine installation vessels (WTIVs), crew transfer vessels (CTVs), construction service operation vessels (CSOVs), installation support vessels (ISVs), service operations vessels (SOVs), feeder support vessel (FSVs), field development vessels (FDVs), and Liftboats) in various operational states?
2. How do DP sound characteristics respond to the in situ changes of weather and oceanographic conditions?

Current Status: N/A

Publications Completed: N/A

Affiliated WWW Sites: N/A

References:

[ANSI] American National Standards Institute. S3.20-1995. American national standard: bioacoustical terminology. NY (NY): Acoustical Soceity of America.

[NIOSH] National Institute for Occupational Safety and Health. 1998. Criteria for a recommended standard: Occupational noise exposure. Revised criteria. Cincinnati (OH): US Department of Health and Human Services, NIOSH. 122 p.

Fischer R. 2000. Bow thruster induced noise and vibration. In: Dynamic Positioning Conference, Marine Techology Society; Oct 17–18.

Warner GA, McCrodan A. 2011. Underwater sound measurements. In: Hartin KG, Bisson LN, Case SA, Ireland DS, Hannay DE, editors. Marine mammal monitoring and mitigation during site clearance and geotechnical surveys by Statoil USA E&P Inc in the Chukchi Sea, August-October 2011: 90-day report LGL Rep P1193. Report by LGL Alaska Research Associates, Inc. and JASCO Research Ltd. for Statoil USA E&P Inc., NMFS, and USFWS. 3; 202 p. + appendices.