

National Marine Fisheries Services: Acoustic Guidance for Assessment of Down-the-Hole (DTH) Systems

November 2022

Down-the-hole (DTH) systems use a combination of percussive and drilling mechanisms, with the hammer acting directly on the rock to advance a hole into the rock, and also advance the pile into that hole. Drill cuttings and debris at the rock face are removed by an air-lift exhaust up the inside of the pile. (Guan and Miner 2020).

Based on different mechanisms applied by several industrial entities, DTH pile driving activities also have been referred to as “DTH drilling” (e.g., (Dazey et al. 2012; Warner and Austin 2016)), “DTH hammering” (e.g., Denes et al. 2019), “rock socket drilling” (e.g., Denes et al., 2016; Reyff and Heyvaert 2019), and “rock anchor drilling” (e.g., Reyff and Heyvaert, 2019; Guan and Miner 2020). For the purposes of this guidance, we will refer to DTH pile driving activities as DTH systems¹.

Acoustic Thresholds

DTH systems include both impulsive and continuous components. Given the limited data currently available regarding both the operations of these systems and their impact on marine mammals, we are recommending application of the lower of the two thresholds for each of the impact categories, Level A and Level B harassment. Specifically, the following thresholds should be used for assessment of the indicated effects:

- Level A harassment: Impulsive thresholds by marine mammal hearing group (both cumulative sound exposure level, SEL_{cum} , and peak sound pressure level, PK SPL; NMFS 2018)
- Level B harassment: Continuous threshold (i.e., root-mean-square sound pressure level, RMS SPL, 120 dB)

Level A Assessment:

Until new data become available (or the applicant has conducted site-specific sound source verification (SSV) studies for the proposed source that are reviewed and deemed acceptable by NMFS), NMFS recommends the following levels (referenced 10 m from source) using the single strike sound exposure level (SEL_{ss}) and PK SPL (Table 1) be used for assessing **Level A harassment**:

¹ Guan et al. 2022a makes a distinction between DTH pile *drilling* and DTH pile *driving*. With DTH pile driving, the DTH hammer directly strikes the steel pile shoe, while with DTH pile drilling, the hammer does not make contact with the pile.

Table 1: Level A Recommended DTH System Levels*

Pile/Hole diameter	SEL_{ss} (at 10 m)	PK SPL (at 10 m)	Reference
8" and smaller	144 dB	170 dB	Reyff 2020
9" to 18"	146 dB	172 dB	Guan & Miner 2020
19" to 24"	159 dB	184 dB	Heyvaert & Reyff 2021**
25" to 42"	164 dB	194 dB	Denes et al. 2019; Reyff & Heyvaert 2019; Reyff 2020
> 42"	No measurements are currently available. Please contact NMFS for recommended levels.		

* These levels are for single hammer (i.e., mono-hammer) DTH operations. For activities involving cluster DTH, please consult NMFS for appropriate recommended levels.

Within NMFS's optional User Spreadsheet tool, there is a specific tab for DTH systems (i.e., Tab E.2). For DTH systems, a weighting factor adjustment of 2 kHz should be assumed, unless more complete spectral data are available. The following information is needed from the applicant to use the DTH tab:

- SEL_{ss} and PK SPL Levels: See Table 1
- Strike rate (average strikes per second)
- Duration to drive pile/drill hole (minutes)
- Number of piles/holes per day
- Transmission loss coefficient (See section below on this topic, if site-specific information is not available)
- Distance associated with SEL_{ss} and PK SPL levels (In Table 1, all levels are referenced to 10 m)

Level B Assessment

Until new data become available (or the applicant has conducted site-specific sound source verification (SSV) studies for the proposed source that are reviewed and deemed acceptable by NMFS), NMFS recommends the following levels (referenced 10 m from source) (Table 2) be used for assessing **Level B harassment**:

Table 2: Level B Recommended DTH System Levels

Pile/Hole diameter	RMS SPL (at 10 m)	Reference
8" and smaller	156 dB	Reyff & Heyvaert 2019; Reyff 2020
9" to 24"	167 dB	Heyvaert & Reyff 2021
25" to 42"	174 dB	Reyff & Heyvaert 2019; Reyff 2020
> 42"	No measurements are currently available. Please contact NMFS for recommended levels.	

Simultaneous Sources

If the proposed activity involves the use of simultaneous source, please consult NMFS on the best way to consider this type of activity in terms of Level A and Level B acoustic harassment thresholds.

Recommended Transmission Loss Coefficient

Sound propagation/transmission loss through the environment can be complicated and depend on a multitude of factors, which can vary temporally and spatially. Many of these factors that affect sound propagation/transmission loss can be site-specific. This is particularly the case for shallow water.

Sound propagation/transmission loss can be measured directly or modeled. The more site-specific data available, the greater chance of accurately predicting sound propagation/transmission loss through the environment via modeling and ultimately the level at the receiver. Thus, NMFS recommends that when site-specific information on propagation/transmission loss is available, it be used.

For coastal activities, if area-specific information on propagation/transmission loss is not available, NMFS typically recommends practical spreading 15 ($TL=15 \log R2/R1$).

New Data/Measurements or DTH System Guidance Questions

As more data become available, these recommended levels will be further refined. Before starting a new project, please consult NMFS to confirm these recommended levels.

If you are aware of additional available DTH measurements or have questions about this guidance, please contact Cara Hotchkin (cara.hotchkin@noaa.gov).

References

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- Guan, S., Brookens, T., and Miner, R. (2022a). Acoustic characteristics from an in-water down-the-hole pile drilling activity. *Journal of the Acoustical Society of America* 151:310-320.
- Heyvaert, C., and Reyff, J. (2021). Tenakee Ferry Terminal Improvements Project; Pile Driving and Drilling Sound Source Verification, Tenakee Springs, Alaska. Technical report by Illingworth & Rodkin, Inc., Cotati, CA for the Alaska Department of Transportation and Public Facilities. 217 pp.
- National Marine Fisheries Service. 2018. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.
- Reyff, J. (2020). Review of Down-the-Hole Rock Socket Drilling Acoustic Data Measured for White Pass and Yukon Route (WP&YR) Mooring Dolphins. Illingworth & Rodkin, Inc., Cotati, CA. 8 pp.
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- Warner, G. and Austin, M. (2016). Alaska DOT Hydroacoustic Pile Driving Noise Study: Kodiak Monitoring Results. JASCO Document 01167, Version 2.0. Technical report

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References Consulted (Not Directly Used in Guidance)

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Miner, R. (2018). Sound source verification for Biorka Island Dock Replacement Project, Southeast Alaska. Manchester, Washington: Robert Miner Dynamic Testing of Alaska.