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 systems.

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*

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

* 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

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

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


by JASCO Applied Sciences for Alaska Department of Transportation and Public Facilities.

References Consulted (Not Directly Used in Guidance)