Understanding and Evaluating Cooling Tower Sound Levels Among Manufacturers

HVAC Systems and Sound

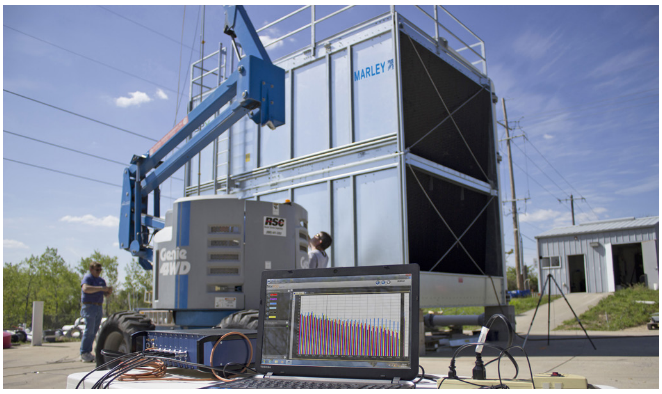
As populations in urban areas around the world continue to expand, the impact of sound from HVAC systems and industrial equipment has led municipalities to take increased measures to control and regulate sound levels. In order to provide equipment that meets these requirements, cooling tower manufacturers have developed innovative solutions to address sound levels of their cooling towers. However, sound reduction research and the resulting technologies can contribute to higher equipment costs. Factor in that currently there is no universally accepted standard or requirement for third-party sound verification. All of these issues contribute to the dissemination of incomplete, unverified, and misleading cooling tower sound data. The purpose of this white paper is to aid the reader in distinguishing between accurate and misleading sound data, and outline solutions to manage cooling tower sound levels.

CTI Code ATC-128

Marley® Cooling Towers have been independently sound tested and verified by a CTI-licensed sound consultant and acoustic engineer, using certified and calibrated ANSI S1.4 Type 1 precision sound test instruments, in accordance with CTI code ATC-128. This code defines in detail how sound pressure data for cooling towers are to be measured, and additionally defines the method for calculating the sound power for the tower. Unfortunately, even though the CTI ATC-128 code is widely accepted in North America, it is not yet considered to be the industry's global standard. Many other codes are in use, which create confusion throughout the industry (i.e. ISO 3744, AHRI 370, ARI 275, DIN 45635). It is important to specify that any sound data provided by a cooling tower manufacturer are wholly compliant with CTI ATC-128, as this will help lead to standardization within the industry. Additionally, it is equally important to specify that sound data be verified by a licensed third-party consultant to ensure that data being published by the manufacturer are not misleading.

Comparing Sound Data

When comparing sound data between manufacturers, cooling towers with similar configurations (crossflow/counterflow, induced/forced draft, model dimensions, fan diameter, fan speed and power) operating under similar conditions should result in very similar sound data. If the sound levels vary by 2dBA or less when measured with a precision sound instrument, this difference is essentially negligible. In other words, it is within typical measurement tolerances and an observer would be unlikely to perceive such a small sound variation. However, a deviation of 3dBA or more for comparable models is discernable and cause for investigation.



In an effort to verify the reliability of published sound data, SPX Cooling Technologies, Inc. independently tested crossflow and counterflow cooling towers from other leading manufacturers. In several instances, the sound data generated by the independent, third-party agency were at least 5dBA higher than published values. For additional test information, please see "Proof in Performance – Certified Sound."

Checking Reliability of Sound Data

One method for checking the reliability of sound data is to consider the differences in sound pressure levels at 1.5m vs 15m when comparing data between any two manufacturers. If similar cooling towers from two different manufacturers have comparable sound pressure levels when a precision sound receiver is placed 1.5m away from the source, then the sound pressure levels should also be comparable when the receiver is placed at a 15m distance. Sound will attenuate exactly the same way over distance travelled from similar sources when the ambient conditions are also the same. For a crossflow cooling tower with a nominal capacity of 3298kW, typical reductions from the air inlet and fan discharge from 1.5m to 15m should be less than 10dBA. However, on the cased-face side, the reduction is closer to 6dBA, as seen below in Figure 1. This is due to the cased-face side having much lower sound pressure levels than the inlet sides, or above the discharge. For a counterflow cooling tower with a nominal capacity of 1539kW, the 1.5m to 15m reduction is closer to 12dBA, as shown in Figure 2.

Figure 1: SOUND PRESSURE LEVELS (SPL)

In Crossflow Induced-Draft Cooling Tower

Figure 2: SOUND PRESSURE LEVELS (SPL)

In Counterflow Induced-Draft Cooling Tower

Multicell Cooling Tower Considerations

When considering multicell cooling towers, it is important to note that a two-cell tower does not necessarily result in a sound level that is double that of a single-cell tower of the same size. However, this contribution to the overall sound level of the cooling tower is still significant when adding additional cells and it must be considered. When sending specifications for sound level requirements to cooling tower manufacturers, it is important to stipulate whether the requested sound data are for all cells operating or on a per-cell basis. When not clearly stated in the specification, per-cell data may be provided and incorrectly represent cooling tower sound levels.

Fans and Their Effect on Sound

Fans are a significant contributor to the overall sound level of a cooling tower. Oversizing the tower thermally, with the intention of allowing a variable frequency drive (VFD) to reduce fan speed during normal operation, is a common strategy for improving sound levels. A VFD impacts the cooling tower's noise level during periods of reduced load and/or reduced ambient temperature without compromising the system's ability to maintain a constant cold water temperature. This solution is relatively economical with a payback in reduced energy costs.

The theoretical reduction will be no greater than $50\log_{10}$ (new speed/old speed). For example, if fan speed is reduced to 50% of its original speed, sound reduction of up to 15dBA could result. However, it is important to note that the overall sound level of the cooling tower can only be reduced as low as the "fans off/water only" test data. In Figures 3 and 4 below, the sound pressure level for each cooling tower can only be reduced to a certain extent by slowing the fans down before the "fans off/water only" limit is reached and the actual sound pressure level begins to plateau. It is worth noting that fan noise makes a far greater contribution to the overall sound level in crossflow cooling towers than it does in counterflow cooling towers, so there is a greater opportunity for sound reduction when slowing the fan down in a crossflow cooling tower. When discussing options for slowing down a fan to reduce the overall sound level of a cooling tower, it is imperative to request the "fans off/water only" data from the manufacturer. It is physically impossible to achieve sound levels lower than this limit, unless options for splash and/or inlet attenuation are considered.

Figure 3 Sound Pressure Level Reduction for a Crossflow Induced-Draft Tower

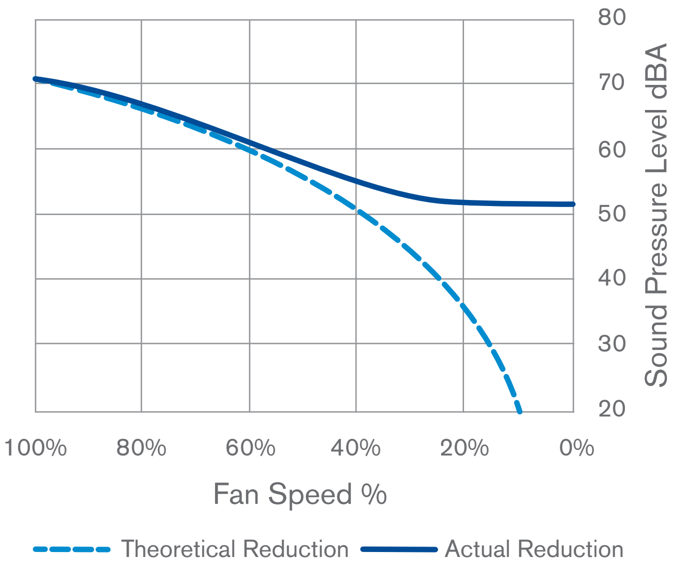
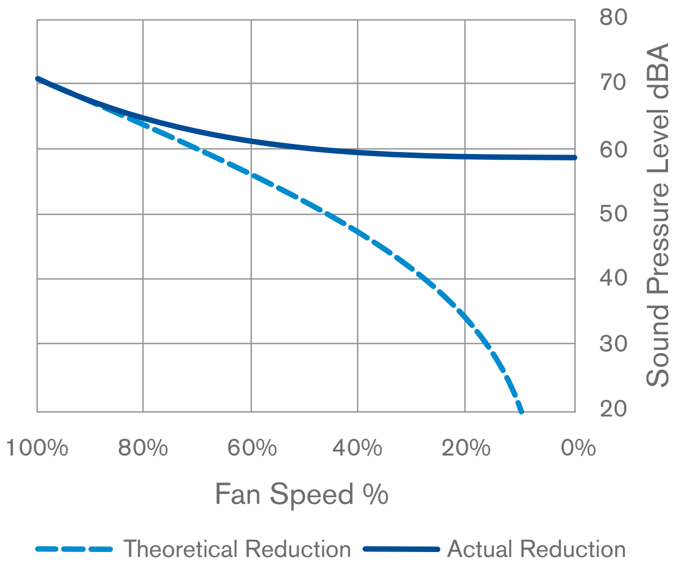
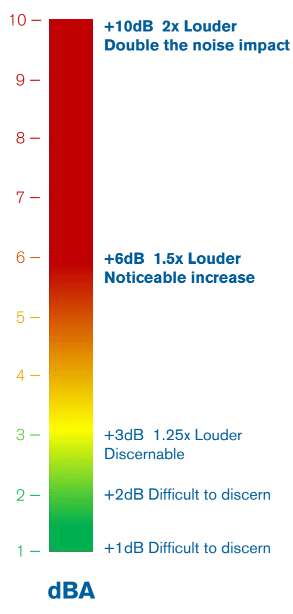


Figure 4 Sound Pressure Level Reduction for a Counterflow Induced-Draft Tower



Comparing Cooling Tower Sound Levels – Key Takeaways
Marley Cooling Towers are independently tested by a third-party, licensed sound consultant and acoustic engineer. All sound data comply with CTI ATC-128. Specify independent sound testing when evaluating cooling tower performance.
Cooling towers with similar configurations operating under similar conditions should result in similar sound data.
If similar cooling towers have equivalent sound data at 1.5m the data should be comparable at 15m.
For multicell cooling towers, request sound data for all cells operating, rather than on a per-cell basis.
Oversizing a cooling tower and allowing a VFD to slow the fan will only reduce sound levels as low as the "fans off/water only" data. Request these data from the cooling tower manufacturer.
Typical sound reduction methods and options are compared on page 4, ranked from least expensive to most expensive.



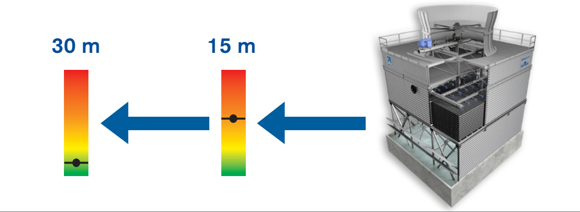
applications engineering – sound reduction methods

Reduction Method 1

For crossflow cooling towers, orient the cased-face side towards the receiver. In some instances, this orientation can be up to 12dBA quieter than the air inlet face.

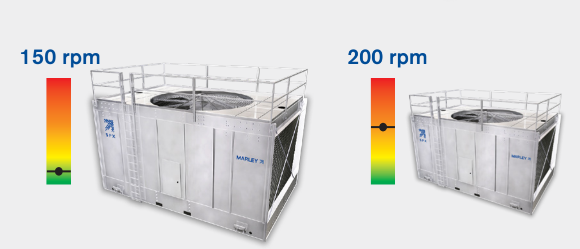
Reduction Method 2

Move the cooling tower further away from the receiver. In the far field there can be an approximately 6dBA reduction for doubling the distance from source to receiver.



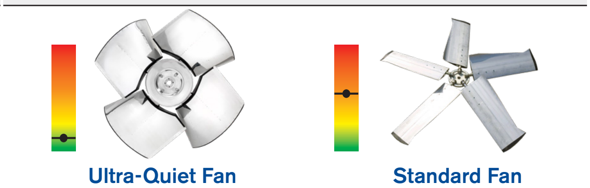
Reduction Method 3

Select a cooling tower with excess thermal capacity at design conditions. This strategy requires a VFD to reduce fan speed during normal operation. The cooling tower can achieve desired thermal conditions with reduced airflow and fan speed.



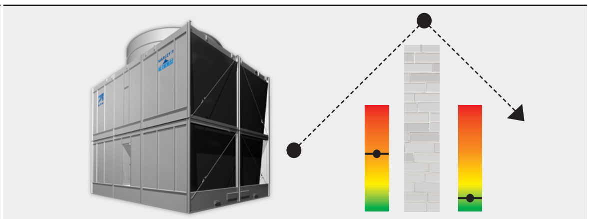
Reduction Method 4

Opt for “quiet” or “ultra-quiet” fans, which have higher solidity and can often achieve comparable airflow at lower fan tip speed.



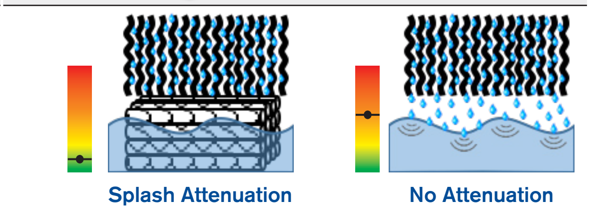
Reduction Method 5

Solid or acoustic barrier walls can be installed between the cooling tower and receiver. Resulting reduction can be significant, but this will vary with wall location, size, and construction.



Reduction Method 6

For counterflow cooling towers, installing splash attenuation can reduce air inlet sound levels up to 5dBA with no thermal performance impact.



Reduction Method 7

Installing inlet and/or discharge attenuation can reduce sound levels 5dBA or more. Outlet attenuation will typically incur a performance derate, but inlet attenuation may have no impact to performance.

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