Water-cooled Chiller Sound Power Rating using AHRI Standard 1280, *Sound Power Rating of Water-cooled Chillers*

Based on discussions in 2010, the AHRI Liquid Chillers Product Section tasked the Technical Committee on Sound (TCoS) with development of a sound power rating method for water-cooled chillers that would address customer demand for more accurate and comparable sound ratings.

For over 40 years, AHRI Standard 575, *Method of Measuring Machinery Sound within an Equipment Space*, has provided a method of measurement that has been traditionally applied to water-cooled chillers. The Standard produces an average sound pressure level which is dependent on the test environment and should not be used for comparison or rating purposes. The TCoS revisited the Standard's current use and examined the influences on the industry from external standards, ratings organizations as well as customers and has developed a companion standard to 575 that meets the demands of a global market.

Current Need:

Several AHRI member companies are seeing mounting pressure from EU and Asian customers to provide sound power level information for water-cooled chillers. Furthermore, several manufacturers are receiving requests from acoustical consultants for sound power level information. These requests are being met by manufacturers using their own proprietary methodologies to estimate sound power levels. These factors drove AHRI to consider developing a sound power level rating standard that would allow direct unit-to-unit comparison and provide a common rating methodology for chillers in a global market place.

Current Situation:

The current standard (AHRI Standard 575) only provides a method of test, although it has evolved into a de-facto rating standard. Interestingly, beginning with the 1987 edition of the standard, the purpose has included the line: "It is not the intent of this standard to be used for the sound rating of equipment." This line has been included in every version of the standard published since then. According to some of the framers of the standard, the original intent was to provide a uniform test method that could be used to help evaluate hearing exposure criteria for Occupational Safety and Health Administration (OSHA) regulations that were being developed in the late 1960's and early 1970's.

Each of the revisions of AHRI Standard 575, including 2008, provides a sound pressure level value which is a function of both the device under test and the measurement environment. The reasons for this can be seen in drawing a simple analogy between thermal performance measurements and acoustics. Consider a space heater operating in an insulated room. The temperature at a given point in the room is a function of the heat output of the machine (Btu/hr) and the insulating properties of the walls of the room. The temperature at the same relative location away from the space heater in another room with different insulation properties will yield a different temperature. The temperature is analogous to the sound pressure of the chiller. The heat output is analogous to the sound power and is independent of the environment. From a practical perspective this means that sound values obtained in different measurement environments cannot be compared against each other even though in practice they often are. This apples to oranges approach does not allow for an accurate comparison of chiller sound levels between manufacturers.

The future:

AHRI Standard 1280 provides a choice among well-established test methods to provide sound power ratings for water-cooled chillers:

- Reverberation room technique. This method has been included in AHRI sound power standards since the technique's inception. The reverberation room technique uses an acoustic test chamber that has been qualified in accordance with AHRI Standard 220. The method involves the measurement of the sound pressure in the chamber produced by a calibrated device called a reference sound source (RSS). The measured sound pressure due to the RSS is subtracted from the sound power of the RSS to compute a chamber transfer function. The sound pressure levels of the chiller are then measured and the chamber transfer function is added to these values to compute the sound power.
- Free-field over a reflecting plane technique. This method involves measurements made in a chamber qualified per Appendix H of AHRI Standard 1280 or outdoors in a large open area. Sound pressure level measurements are made at numerous locations as defined in AHRI Standard 1280. Using the dimensions of the measurement grid, an area correction term is calculated then added to the sound pressure level result to determine sound power.
- Sound Intensity. This method involves the use of a dedicated probe with two phase and amplitude matched microphones. This probe produces a vector quantity known as sound

intensity, which provides magnitude and direction of energy flow. AHRI has recently developed a standard method for applying this technique to HVAC/R products, AHRI Standard 230, *Sound Intensity Testing Procedures for Determining Sound Power of HVAC Equipment*. The results of the sound intensity measurements can be converted to sound power by adding a conversion factor based on the area of the measurement surface similar to the free-field technique. The vector properties of the method allow testing in a broad variety of environments.

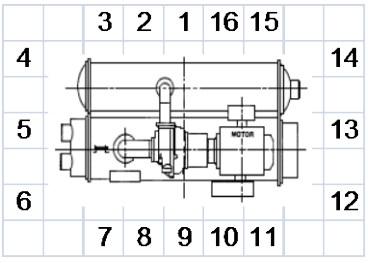
Differences:

AHRI Standard 575 sound levels have been used for the past forty years to specify water-cooled chillers. The consulting engineering community has developed a feel for what are considered to be high and low levels based on compressor type and chiller operating points. Since these values are based upon average sound pressure levels at a distance of a meter from the chiller, the AHRI Standard 575 sound level does not vary greatly with chiller size.

With AHRI Standard 1280, and the rating of water-cooled chillers with sound power, this may not always be the case and the numerical values of the sound power levels will be significantly higher than the numerical values of the sound pressure levels. Consider the following two chillers:

400 Ton Chiller:

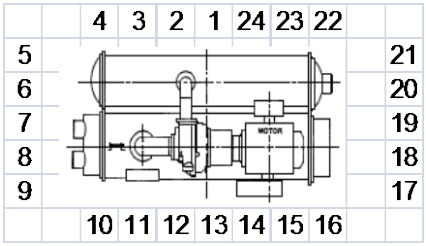
- 400 ton centrifugal chiller, operating at AHRI Standard 550/590, *Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle* operating conditions, fully loaded – AHRI Standard 575 sound pressure level = 85 dBA
- 16 point AHRI Standard 575 grid:



- AHRI Standard 1280 sound power rating = 101 dBA.

2000 Ton Chiller:

- 2000 ton centrifugal chiller, operating at AHRI Standard 550/590 thermal rating conditions, fully loaded – AHRI Standard 575 sound pressure level = 86 dBA
- 24 point AHRI Standard 575 grid:



- AHRI 1280 sound power rating = 105 dBA.

Further, AHRI Standard 575 has no requirements on the type of space in which the measurements are made resulting in a variation of sound pressure levels. The sound power measurement methods will result in much smaller test-to-test and lab-to-lab variations. The reduced variation makes sound power a more suitable value for sound rating purposes.

Several member companies of the AHRI TCoS conducted basic research on the methods used in the standard. This research provided a qualification method for the free -field environment that would accommodate the testing needs of this type of equipment and indicates agreement among the test methods. A current research project is being undertaken by AHRI to investigate the magnitude of uncertainty and any bias that may be present among the test methods and facilities.

Moving forward, AHRI will continue to maintain AHRI Standard 575 after AHRI Standard 1280 is released. AHRI Standard 575 will continue to be a valuable tool for measuring chillers that are too large for AHRI Standard 1280 or have other constraints that prevent the measurement of sound power. Furthermore, the initial purpose of using AHRI Standard 575 as an indication of occupation exposure is still a good use of the information.

It is anticipated that AHRI Standard 1280 will provide the sound power level information required by acoustical consultants for their design purposes and will serve to allow direct comparison of chiller sound levels among manufacturers.