



## SINGLE / MULTI-STAGE CENTRIFUGAL LIQUID CHILLERS

TECHNICAL DATA

Supersedes: 160.72-TD5 (202)

Form 160.72-TD5 (1204)

### FIELD SOUND TESTING PROCEDURE FOR SINGLE - AND MULTI - STAGE CENTRIFUGAL CHILLER PACKAGES

YORK International Corporation provides the option of performing a Field Sound Test on chiller systems that cannot be tested at the factory. If this option is selected, a field sound test is conducted on site simply to verify the chiller sound characteristics, or to verify contract specification compliance. Such field sound testing must be conducted by a professional experienced in chiller sound testing and with a thorough knowledge of the acoustics, instrumentation, and applicable testing standards involved. A general knowledge of the operational characteristics of these water-chilling systems and how they relate to the acoustic characteristics is also necessary.

This optional sound test requirement may be detailed by project specifications and quoted as part of the project bid package for new equipment. The Acoustics and Vibration Group at YORK (AVG), or a third party contractor designated by YORK, may provide the instrumentation and test engineer or technician (YORK Test Engineer) to perform this sound testing.

For this testing, AVG will be responsible only for testing equipment that is manufactured by YORK and installed and operated as recommended by YORK. Procedures and specifications found herein apply to field sound testing of YORK centrifugal chilling systems that are identified by YORK model designation OM, YK, YST, CYK, YD, YT, YB, & YG.

#### TEST STANDARDS

The Air Conditioning and Refrigeration Institute (ARI) Standard 575 details the requirements for sound testing for these water-chilling packages. This Standard is not a “rating” standard, in and of itself. It is a test and measurement standard that provides standardized procedures regarding the locations and methods of measurement of the sound pressure levels about a system, and defines procedures for determining the overall system sound pressure level from those measurements.

In general, ARI 575 describes a grid of many individual measurement locations about a given system. The actual number of measurements made will vary from system to system due to system physical size, orientation, and proximity of the system to building structure or other significant items. The sound levels recorded from the individual measurement locations are “averaged” by calculation defined in the Standard, and the result of this calculation is the sound level of the system. Sound measurements made at individual locations will be both higher and lower than this calculated “average,” and may also be above or below any ARI 575-based estimate or guarantee that may have been provided by YORK.

The requirements of ARI 575 will be followed as closely as practical. It must be recognized, however, that the typical machinery space may not provide a nominal acoustical environment, per the ARI Standard. Some examples of this follow:

- There can be acoustically reflective walls in the near field of the chiller to be tested.
- There can be physical space or other limitations at some measurement locations that do not allow “valid” (per the Standard) or safe placement of measuring devices at too many measurement locations.
- There can be sources of adjacent noise (like nearby chillers, pumps, manufacturing areas) that cannot be entirely eliminated during a sound test due to ongoing building cooling, process, or production needs.

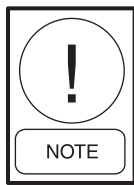
ARI Standard 550/590 applies for system operational measurements recorded during sound testing. Of primary concern is the determination of the chiller operating evaporator tonnage and leaving water conditions, and condenser head conditions at the time of a sound test. Site conditions may indicate the need to relax some of the tolerances or specifications defined by ARI 550/590 for determining the actual operating performance conditions. The following circumstances may prevail:

- If sound testing is not performed concurrently with performance testing (by YORK), chiller or site instrumentation may be used. Such instrumentation is generally not adequate for ARI 550/590 requirements. However, it may be acceptable to define load and head conditions for sound test reference purposes.
- The ability to achieve a particular system load condition for a sound test, and maintain it in a stable fashion for the duration of the test, is often a function of available building or process load, local weather conditions, and other variables that may be difficult to control at the time of the sound test. In order to perform an accurate sound test, the site must be able to provide the required operating load to sustain stable operation for the duration of the sound test. Refer to the appropriate Field Performance Test Procedure for applicable information regarding operating conditions and stability.
- Data acquisition for the sound test may require more time to complete than is necessary for the performance test data acquisition.

## GENERAL POLICY

- 1) Any *estimated* sound pressure levels that may have been provided by YORK at any point in time for a specific chiller *always* carry a tolerance of  $\pm 3$  dBA, and therefore *such estimates shall not be construed as sound level guarantees or not-to-exceed levels*.
- 2) YORK AVG may supply the sound testing services and instrumentation, but YORK reserves the right to designate a third party contractor to supply these services and/or instrumentation.
- 3) YORK reserves the right to make modifications to the test procedure when specific chiller selection, physical arrangement or other site-specific conditions warrant.
- 4) YORK reserves the right to request the Customer, while on site, to shut down adjacent equipment and/or stop adjacent activities not necessary for the operation of the chiller under test that, in the opinion of the YORK Test Engineer, will affect the results of the system sound measurements. Ambient (“background”) noise level that can not be eliminated, and is of an extent that it affects (per the ARI Standard) the results of the sound level test may require the reporting only of a “Representative High Limit” sound pressure level for the system. *Such result will not be compared to a rating or specification that may be in force for the purposes of determining compliance.*

- 5) At the conclusion of all necessary chiller-operating sound tests, the Customer shall be required to shut down the tested chiller for the purpose of measuring the actual ambient sound levels.
- 6) YORK reserves the right to request the Customer, while on site, to relocate any moveable items or devices not necessary for the operation of the chiller under test to allow the maximum number of identified (per the ARI Standard) sound level measurement points to be accessible, and/or to provide safe access to those locations.
- 7) Actual sound pressure levels measured during sound testing may be affected by the site-specific acoustical environment, which is not the responsibility of YORK.
- 8) Where sound testing is concurrent with performance testing (by YORK), the procedures, policies, and limitations set forth in the appropriate YORK field performance test procedure will govern the determination of chiller operating conditions. Where sound testing is not concurrent with performance testing (by YORK), the information provided by site-available performance instrumentation will be used and assumed to be accurate unless it is suspected by YORK, on a case-by-case basis, that performance instrumentation inaccuracies may contribute to sound level measurements that are substantially in error or above a sound specification that may be in force.
- 9) Instrumentation used for the sound testing is identified in the section SOUND TEST PROCEDURE in this document. YORK AVG (and/or its designee) will provide only the necessary instrumentation for measuring and documenting sound pressure levels.



***YORK AVG - supplied sound testing instrumentation is calibrated to NIST traceable standards at regular intervals. Any specification which requires before-, and after-test calibrations will incur increased test costs.***

## **CUSTOMER/OWNER RESPONSIBILITY**

The following is a list of items that the Customer/Owner must retain responsibility for successful completion of the required sound testing. The Customer should be considered an essential part of the test team. Successful acceptance of the test will not be achieved unless the Customer is engaged and involved in supporting the test. The Customer should:

- **Provide a single point of responsibility, “The Customer Representative”**
- **Schedule chiller availability**
- **Provide stable operating conditions**

The Customer/Owner shall be responsible to provide the load for the test chiller, shall control the water flows and temperatures to the design conditions as specified by the performance and/or sound Test Engineer.

A YORK technician shall monitor the system operating conditions for the duration of the performance and/or sound test. If the chiller operating conditions vary substantially from the stable conditions as defined above, all collection of official data will cease until the required conditions can be maintained.

- **Assume responsibility for and costs of all operating utilities during the testing**

Contracted testing delays or reschedules resulting from equipment supplied by others, will be charged on per-diem basis.

- **Understand the implications of less than ideal testing conditions.**

Customer should accept that physical space limitations, high background sound levels, less than ideal acoustical environments, and/or system stability will yield less than ideal accuracy and some level of relaxation of the test specifications may be required.

- **Accept the test results and report.**

## **SOUND TEST PROCEDURE**

### **1. SCOPE**

- 1.1 This procedure sets forth the methods of measurement and reporting that assure complete and accurate sound data acquisition from YORK Water Chilling Systems.

### **2. APPLICABLE SPECIFICATIONS**

- 2.1 ARI 550/590-98, Standard for “Water-Chilling Packages Using the Vapor Compression Cycle”
- 2.2 ARI 575-94, Standard for “Method of Measuring Machinery Sound Within an Equipment Space”
- 2.3 Calibration Work Instructions, Acoustics and Vibration Laboratory (for appropriate measurement instrument)
- 2.4 Calibration Record, Acoustics and Vibration Laboratory (for appropriate measurement instrument)

### **3. TEST INSTRUMENTATION USED**

- 3.1 Test instrumentation used to perform the sound test will be one of the following devices:
  - 3.1.1 Sound level meter capable of recording A-Weighted sound pressure levels and octave band sound pressure levels over a range of at least 40-130 dB.
    - 3.1.1.1 Examples of this type of instrument are the Bruel and Kjaer models 2215, 2230, and 2260.
  - 3.1.2 Spectrum analyzer with microphone input, overall system capable of recording A-Weighted sound pressure levels and octave band sound pressure levels over a range of at least 40-130 dB.
    - 3.1.2.1 Examples of this type of instrument are the Hewlett Packard model 3560A with microphone input.

### **4. CALIBRATION OF TEST INSTRUMENTATION**

- 4.1 All sound test instrumentation used will be calibrated, traceable to NIST, using procedures found in the Calibration Work Instructions Manual in the Acoustics and Vibration Laboratory.
- 4.2 All sound test instrumentation is calibrated at six-month or one-year intervals.
- 4.3 Calibration of all sound test instrumentation is recorded in the Calibration Records Manual in the Acoustics and Vibration Laboratory, on Form AC-400, shown in Figure 1.

## 5. TEST REQUIREMENTS – CHILLER SYSTEM TO BE TESTED

5.1 Chiller system will be operated at the system load capacity to be tested, which will be above ten percent system load.

5.1.1 System load condition is determined generally by ARI 550/590 (*version in effect at time of sale*), with attention to the following:

5.1.1.1 For conditions of 100% to 50% load:

5.1.1.1.1 A condenser water entering temperature of 85 degrees F. at 100% load, reduced by 4 deg. F. per 10% reduction in system load, evaporator leaving water temperature at design, evaporator entering/leaving water temperature split according to percent system load, design condenser and evaporator water flow rates.

5.1.1.2 For conditions less than 50% load:

5.1.1.2.1 A constant condenser water entering temperature of 65 degrees F., evaporator leaving water temperature at design, evaporator entering/leaving water temperature split according to percent system load, design condenser and evaporator water flow rates.

5.2 Chiller system will maintain the required system load condition in a steady, stable manner for the duration of the sound test.

## 6. TEST REQUIREMENTS – ENVIRONMENT

6.1 The test environment will be as close as practically possible to that defined in ARI 575. As a minimum, the following requirements must be met.

6.1.1 Ambient sound from sources adjacent to the test unit shall be minimized. Examples include, but are not limited to, the following:

6.1.1.1 Turn off adjacent chiller systems, pumps, fans, other associated equipment not absolutely required for the proper operation of the system to be tested, for the duration of the sound test.

6.1.1.2 Discontinue use of nearby production machinery, cranes, forklifts, and other similar equipment that creates sound, which may affect the sound test, for the duration of the sound test.

6.1.2 Enough free space must be available about the perimeter of the system to be tested to allow location of the measurement grid and placement of the sound-measuring device per the requirements of ARI 575. The test locations must allow for safe placement of equipment, and safe accessibility.

## 7. TEST METHOD

7.1 The sound test method is that described in ARI 575.

## 8. MEASUREMENT LOCATIONS

- 8.1 Sound measurement positions are located by the procedure described in ARI 575.
- 8.2 An example of the measurement position layout for a TITAN Chiller is shown in Figure 2. Figure 2 does not represent any specific chiller system or site, nor does it represent all possible configurations of chiller systems or measurement grid position placement. See Section 12.1.3.

## 9. RECORDING OF TEST DATA

- 9.1 Sound data is recorded by the procedure described in ARI 575
- 9.1.1 Sound measurements may be manually logged on Acoustics and Vibration Laboratory Form AC-617, shown in Figure 3, or similar, or may be recorded or stored digitally for later retrieval when using appropriate test instrumentation.

## 10. DETERMINING OVERALL SYSTEM SOUND LEVELS

- 10.1 The overall, A-weighted sound pressure level of the test system is calculated from measurements in the manner described in ARI 575.
- 10.2 The overall, octave band sound pressure levels of the test system is calculated from measurements in the manner described in ARI 575.
- 10.3 Ambient sound influence (from adjacent sources), and the effects of invalid measurement locations are taken into consideration by the procedure described in ARI 575, and applied where applicable to 10.1 and 10.2 above.
- 10.3.1 If ambient sound or the number of invalid measurement positions, as defined by ARI 575, prohibit the determination of “representative” A-weighted and/or octave band sound levels ( $A_R$  and  $OB_R$ , respectively), then “high-limit” values will be determined ( $A_H$  and  $OB_H$ , respectively).

## 11. APPLICATION TO SOUND ESTIMATES, RATING, SPECIFICATIONS

- 11.1 If a sound estimate or rating was made to the Customer, or a valid sound specification is in force with the Customer, then the final “representative” sound pressure results, determined per ARI 575 from the measured levels, will be compared to the sound estimate, rating or specification in force, as applicable.
- 11.1.1 In cases where “high limit” values are determined per ARI 575, ***these will not be compared or evaluated with respect to any sound estimate, rating or specification in force.***
- 11.1.2 In cases where “high limit” values are determined per ARI 575, and where technically reasonable, an approximation of the system sound levels may be attempted by log-subtraction of the measured background sound levels from the measured system sound levels. This data will not represent the actual sound levels of the system under test, but may be provided ***for information only*** as an indication of what the system sound levels might be if the sources of the interfering background levels were removed.

## 12. TEST INFORMATION TO BE REPORTED

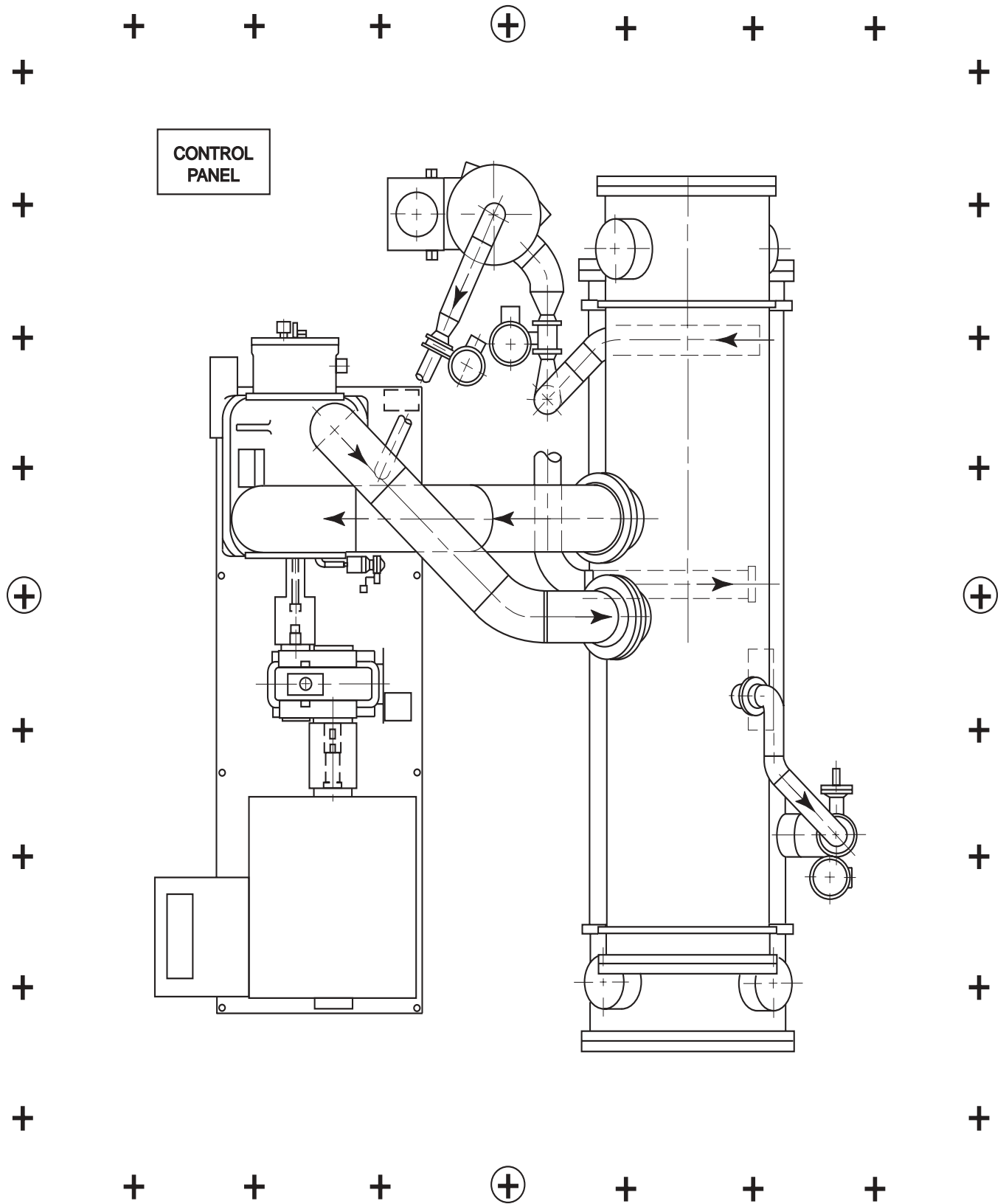
12.1 The following information will be provided in a timely fashion to the YORK Contract Engineer after reduction and analysis of the measured data is performed at YORK International Corp.

12.1.1 One copy of Form AC-617 (or similar), showing recorded information and final calculated results of the test.

12.1.2 One copy of the Calibration Record(s) Form AC-400 for the instrument(s) used for the sound test, only upon advance request.

12.1.3 One copy of the measurement point layout for each specific system tested.





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FIGURE 2 – SAMPLE LAYOUT, MEASUREMENT LOCATIONS FOR A YORK (OM) CHILLER

# MACHINERY SOUND DATA

## per ARI STANDARD 575

Form AC-617 4/90

Unit or Test Description:												
Test Conditions:												
Test Location:				Tested by:				Date:				
ARI Stn. #	dBA Unit ON	dBA Unit OFF	Freq. Hz.	Octave Band SPL at Key Measurement Points								Average O. B. Level
				Key Point ____		Key Point ____		Key Point ____		Key Point ____		
				ON	OFF	ON	OFF	ON	OFF	ON	OFF	
1			63									
2			125									
3			250									
4			500									
5			1000									
6			2000									
7			4000									
8			8000									
9			Sketch below showing microphone locations, orientation of test unit, Key Measurement Points and surroundings.									
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NOTE: \* indicates Uncertain Measurements (see 5.2.1 of Standard).  
 X indicates Invalid Measurement Point (see 5.1.4 of Standard).

**Acoustics and Vibration Laboratory**  
**YORK International**  
**Corporation**  
**York, Pennsylvania**

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FIGURE 3 – SAMPLE FORM, MACHINERY SOUND DATA PER ARI STANDARD 575

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