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SMNR 31

When is “Quiet”; Quiet Enough?

Understanding Sound Generation in Magnetic Bearing Machines

Presented by Kris Kollevoll



Learning Objectives

Understand the basics of acoustical terminology

Understand the basics of acoustic testing and sound level ratings

Understand the challenge of testing and reporting sound data for magnetic bearing centrifugal chillers

Explain the challenge of isolating the impact of refrigeration system components and unit configuration from compressor generated sound.

Understanding the modeling framework of acoustical engineering & objective and subjective design criteria

Learn how to plan around various acoustic levels and additional steps that can be taken in the field to mitigate unwanted sound

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Knowledge Foundation Required to
Determine when is “Quiet”; quiet enough?

Acoustics 101

Acoustical Engineering Model

Acoustics 101

- ***Loudness Vs Pitch***
- ***dB Vs. dBA***
- ***Octave Bands***
- ***Sound Power Vs. Sound Pressure***
- ***Noise Criteria NC***

Acoustical Engineering Model: Answer the Four Questions

- 1. Where are we now?***
- 2. Where do we need to be?***
- 3. What reductions are needed to get there?***
- 4. What attenuation measures can achieve the reductions?***

1) Where are we now?

- ***Equipment manufacturer's published baseline sound data***
- ***Test data should be to relevant AHRI Test Standard.***
- ***For Water Cooled Chillers the standard is AHRI-575-2008***

2) Where do we need to be?

- ***Subjective Vs Objective Design Criteria***
- ***ASHRAE Handbook Chapter 49***

3) What reductions are needed to get there?

Acoustical modeling is required to accurately assess the Basis of Design equipment noise output and the ability of the building shell natural attenuation to achieve the target noise level.

4) What attenuation measures can achieve the reductions?

- ***Lower the unit baseline levels***
- ***Increase mass of building envelope***
- ***Add acoustical treatments to the unit***
 - ***Source treatments***
 - ***Path treatments***
 - ***Room treatments***
- ***Combination of the above***

When is “Quiet”; quiet enough: Modeling Example

- ***500 Ton Water-cooled Chiller***
- ***Located in a basement mechanical room of a new High School with a noise sensitive space above***
- ***Examine (3) chiller selections to meet published ASHRAE Design Guidelines @ 100% load for (3) room types***
 - ***Core learning classroom (NC-30)***
 - ***Large lecture room (NC-25)***
 - ***Auditorium (NC-20)***
- ***Modeling assumes the floor /ceiling is 5” thick dense poured in place concrete on top of a fluted metal deck***

Baseline Sound Levels per AHRI-575

	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	dBA
Screw Chiller	76	70	78	80	80	72	63	61	83
Centrifugal	69	67	69	73	77	80	80	75	86
Magnetic Bearing	38	56	64	69	71	68	80	68	83

School Noise Criteria NC Design levels by Octave Band for modeled Spaces

	NC	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Core Learning Classroom	30	57	48	41	35	31	29	28	27
Large Lecture Room	25	54	44	37	31	27	24	22	21
Auditorium	20	51	40	33	26	22	19	17	16

Attenuation Values for 5" thick concrete

	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
5" Thick Concrete on Fluted Deck	-35	-36	-36	-41	-45	-50	-54	-58

Analysis Results for each Chiller Type in each of the 3 room spaces compared to the Target NC. Values shown are reductions to meet NC target

	Screw Chiller				Centrifugal Chiller				Magnetic Bearing Chiller			
Hz	dB (Base)	NC-30	NC-25	NC-20	dB (Base)	NC-30	NC-25	NC-20	dB (Base)	NC-30	NC-25	NC-20
63	76	-	-	-	69	-	-	-	38	-	-	-
125	70	-	-	-	67	-	-	-	56	-	-	-
250	78	-	-4	-8	69	-	-	-	64	-	-	-
500	80	-4	-8	-13	73	-	-1	-6	69	-	-	-2
1000	80	-4	-8	-13	77	-1	-5	-10	71	-	-	-4
2000	72	-	-	-3	80	-1	-6	-11	68	-	-	-
4000	63	-	-	-	80	-	-4	-9	80	-	-4	-9
8000	61	-	-	-	75	-	-	-1	68	-	-	-
dBA	83				86				83			

Water-cooled Chiller Acoustical Treatments using Removable Acoustical Jackets: *Reductions of 4 to 6 dBA Overall*



Water-cooled Chiller Treatments using Freestanding Acoustical Curtain Enclosures: *Reductions of 10 to 12 dBA*



Water-cooled Chiller Treatments combining Removable Jackets with Curtain Enclosures: *Reductions of 13 to 15 dBA*



Water-cooled Chiller Treatments using Double Skin Steel Acoustical Panel Enclosures: *Reductions of 18 to 20 dBA*



Specification Strategies to Manage Acoustical Performance

- Specify the Basis of Design (BOD) with the lowest baseline sound
- Specify all factory available sound options for BOD Chiller
- Specify the recommended NC levels and let construction figure out how to achieve it
- Specify the Chiller used on the last project where there were no noise issues or complaints
- Over attenuate the equipment
- Address any issues on the back end after occupancy if there are issues
- Write a prescriptive design specification for acoustical treatment needed with performance accountability and embed it in the equipment specification to assure equipment compatibility and minimal operational impact.

When is “Quiet”; quiet enough?

Only a process which considers reliable equipment sound data, project specific construction and reasonable objective acceptance criteria will answer the question for you!

Questions?

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