


RSP

Who is RSP?

RSP

FIRM OVERVIEW

SINCE 1978

45 YEARS

Rich History

375+ PEOPLE

Expert Resources

7 US OFFICES

National Presence

30" HIGH

Opus, our mascot

RSP

KEY MARKETS

Mission Critical

Corporate

Distribution

Education

Multi-Family

Science + Technology

Retail + Mixed Use

Health + Life Sciences

Hospitality

SERVICES

- Architecture
- Interior Design
- Engineering
- Master planning
- Branding + Env. Graphic Design
- Workplace Strategy
- Facility Information Consultancy

Rajan Battish, PE, ATD, LEED AP

- Principal, Mission Critical.
- 30 years experience in innovative design.
- Pioneered Battery Storage Systems for data centers.
- Published numerous papers on energy efficiency and data center resiliency.

Data has become the currency of our generation, so our goal is to create secure, resilient and flexible facilities that safeguard a way forward
-Rajan Battish

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Background Noise

Basics of Noise Transmissions

- Sound Levels: Measured in Decibels (dB).
- Frequency Dependent
  - Lower frequencies travel further than higher frequencies.
  - Signal power decreases at higher frequencies.
- Conversation speech 60 dB.

Table 17.1 Typical Sound Pressures and Sound Pressure Levels
[2021F, Ch 8, Tbl 1]

Source	Sound Pressure, Pa	Sound Pressure Level, dB re 20 μPa	Subjective Reaction
Military jet takeoff at 100 ft	200	140	Extreme danger
Artillery fire at 10 ft	63.2	130	
Passenger jet takeoff at 50 ft	20	120	Threshold of pain
Loud rock band	6.3	110	Threshold of discomfort
Automobile horn at 10 ft	2	100	
Unmuffled large diesel engine at 130 ft	0.6	90	Very loud
Accelerating diesel truck at 50 ft	0.2	80	
Freight train at 100 ft	0.06	70	
Conversational speech at 3 ft	0.02	60	
Window air conditioner at 3 ft	0.006	50	Moderate
Quiet residential area	0.002	40	
Whispered conversation at 6 ft	0.0006	30	
Buzzing insect at 3 ft	0.0002	20	
Threshold of good hearing	0.00006	10	Faint
Threshold of excellent youthful hearing	0.00002	0	Threshold of hearing

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Basics of Noise Transmissions

- CDC recommends 65 dB.
- Above 85 dB can lead to hearing damage.
- OSHA requires hearing protection at 85 dB and greater.

Everyday sounds and noises	Average sound level (dB)	Typical response (after routine or repeated exposure)
Softest sounds that can be heard	0	Sounds at these level typically don't cause any hearing damage
Normal breathing	10	
Ticking watch	20	
Soft whisper	30	
Refrigerator hum	40	
Normal conversation, air conditioner	60	
Washing machine, dishwasher	70	You may feel annoyed by the noise
City traffic (inside the car)	80-85	You may feel very annoyed
Gas-powered lawnmowers and leaf blowers	80-85	Damage to hearing possible after 2 hours of exposure
Motorcycle	95	Damage to hearing possible after about 50 minutes of exposure
Approaching subway train, car horn at 16 feet (5 meters), and sporting events (such as hockey playoffs and football games)	100	Hearing loss possible after 15 minutes
The maximum volume level for personal listening devices; a very loud radio, stereo, or television; and loud entertainment venues (such as nightclubs, bars, and rock concerts)	105-110	Hearing loss possible in less than 5 minutes
Shouting or barking in the ear	110	Hearing loss possible in less than 2 minutes
Standing beside or near sirens	120	Pain and ear injury
Firecrackers	140-150	Pain and ear injury

Source: Centers for Disease Control and Prevention. Public domain.

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Technical Background

Table 17.2 Combining Two Sound Levels [2021F, Ch 8, Tbl 3]

Difference between levels to be combined, dB	0 to 1	2 to 4	5 to 9	10 and More
Number of decibels to add to highest level to obtain combined level	3	2	1	0

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# of Chillers	Sound Pressure (dB)
1	105
2	108
3	111
4	114
5	117
6	120

Combination of sound levels is not additive

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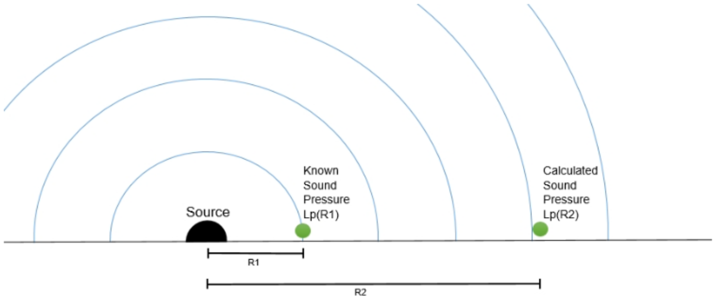
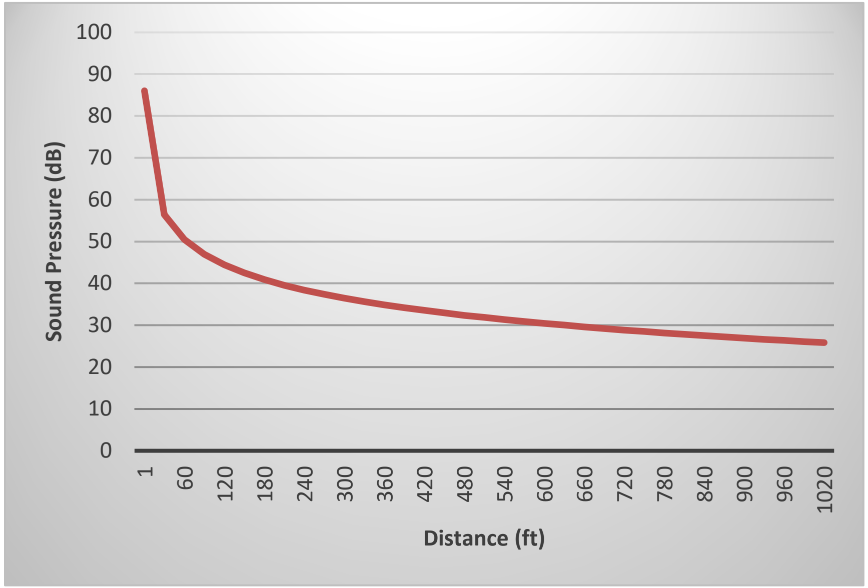
Technical Background

$Lp(R2) = Lp(R1) - 20 \cdot Log_{10}(R2/R1)$

Where:
Lp(R1) = Known sound pressure level at the first location (typically measured data or equipment vendor data)
Lp(R2) = Unknown sound pressure level at the second location Location
R1 = Distance from the noise source to location of known sound pressure level
R2 = Distance from noise source to the second location





Sound levels decrease logarithmically over distance (Inverse Square Law)

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Sound Reduction

MEP Equipment – Typical Noise

500 Ton Air Cooled Chiller up to 105 dB

2 MW Generator up to 126 dB

500 Ton Cooling Tower up to 82 dB

2 MW Load Bank up to 95 dB

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Sound Mitigation Techniques

- Cooling Tower Enclosure
  - Acoustic Paneling and walls on all sides of towers.
  - Provides up to 17 dB reduction in sound.
- Chiller Sound Enclosure
  - A sound enclosure with 4 walls and intake/exhaust silencers.
  - Provides up to 30 dB reduction in sound.

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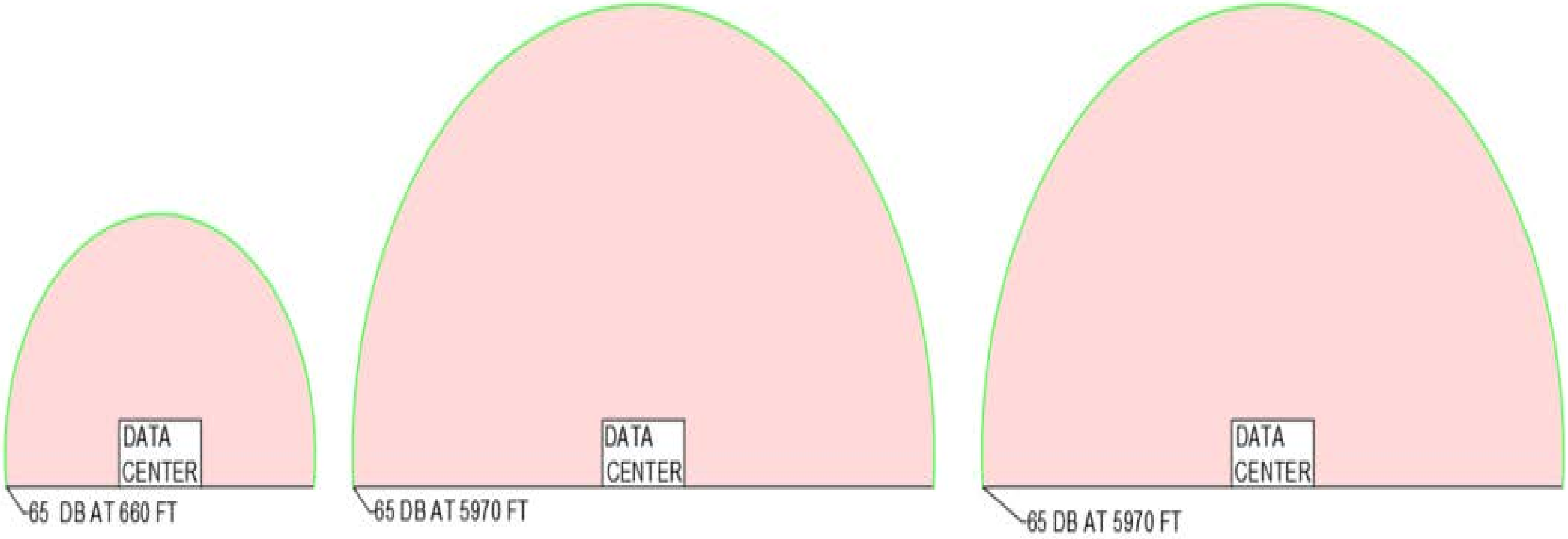
Sound Mitigation Techniques

- Generator Level 2 Enclosure
  - Generator installed within full enclosure
  - Provides up to 45 dB reduction in sound
- Load Bank
  - No standard sound mitigation

Sound Mitigation Techniques

- Sound Engineering Study
- Identify high noise areas
- Evaluate mitigation strategies
  - Noise Barriers
  - Custom Equipment Enclosures
  - Site Layout Recommendations

Sound Over a Distance



Steady State

Emergency Operation

Maintenance Operation

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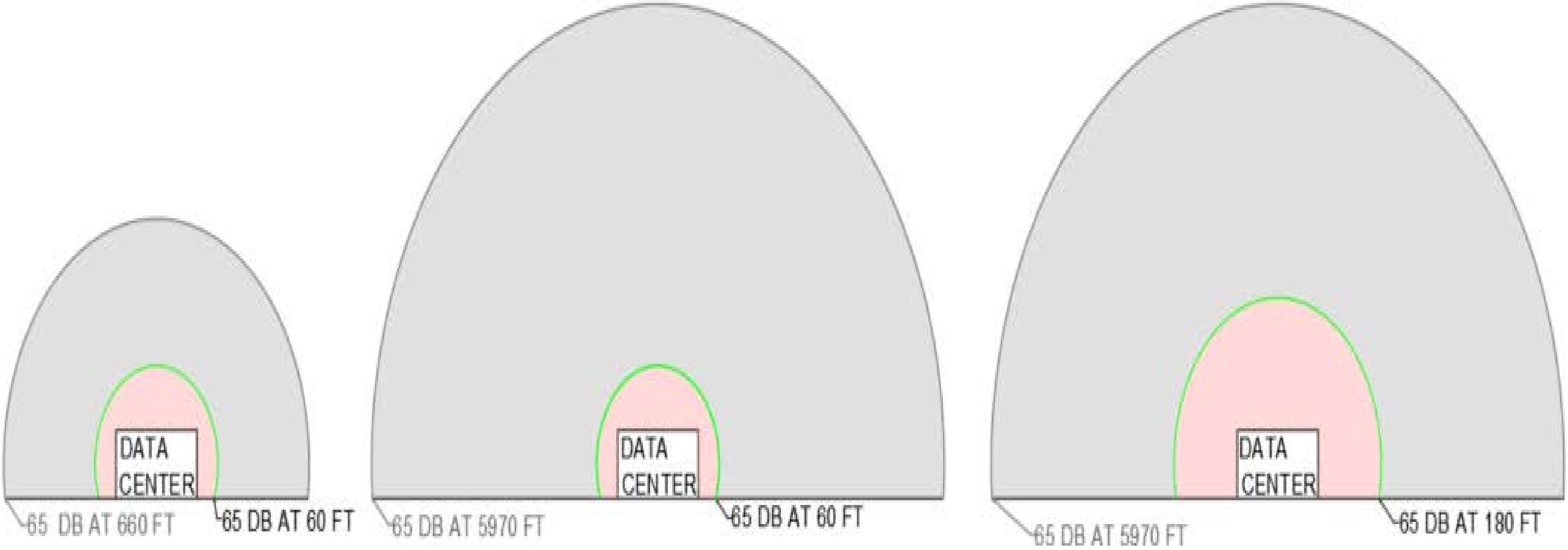
Sound Over a Distance w/ Sound Attenuation



Steady State

Emergency Operation

Maintenance Operation

Efficiency Metrics

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Power Usage Effectiveness (PUE)

- Quantifies energy efficiency.
- Ratio of total power use vs IT dedicated power - (Power (in)/ Power (IT).
- Impact on Efficiency.
  - Mechanical Systems
  - Parasitic Loads
  - Electrical Systems
  - IT Load Profile

PUE	Level of Efficiency
≤1.15	Very Efficient
1.15-1.4	Efficient
1.4-1.7	Average
1.7-2	Inefficient
>2.0	Very Inefficient

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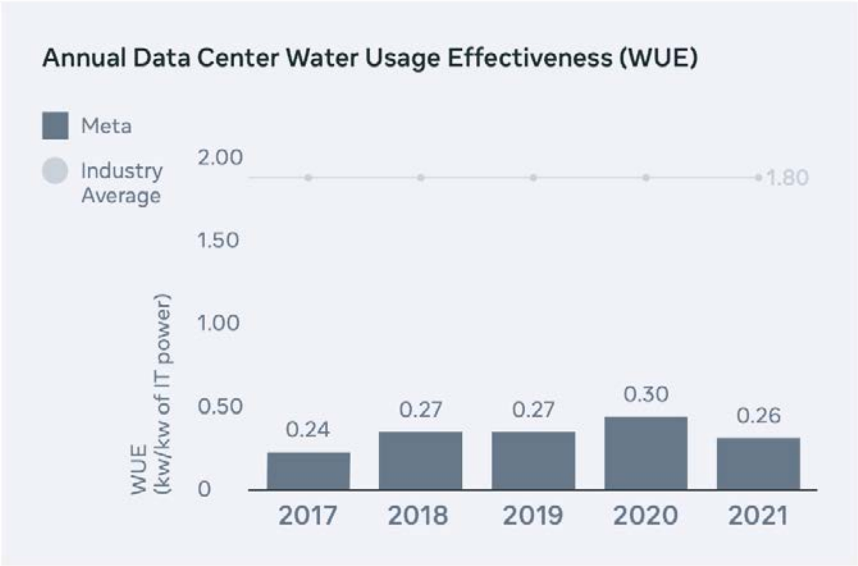
Water Usage Effectiveness (WUE)

- ➢ Quantifies water needed for IT power
- ➢ Ratio of water usage annually vs IT power consumption
- ➢ Air-cooled chillers provide improved WUE vs Water-cooled chiller solution



Water Usage Effectiveness (WUE)

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Future of Data Centers

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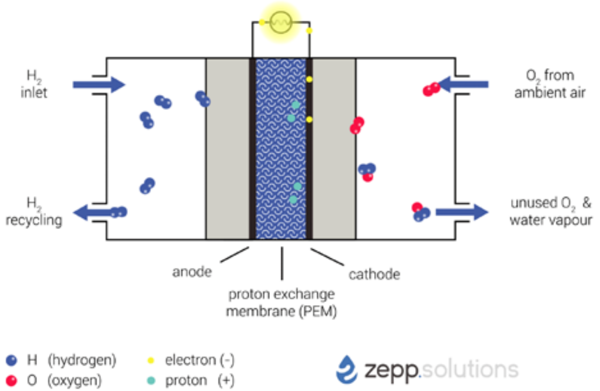
Fuel Cells

- DER application
- Hydrogen powered
- Used for backup generation
- Zero- carbon emissions
- COGEN possibilities

Bloom Energy Fuel Cell



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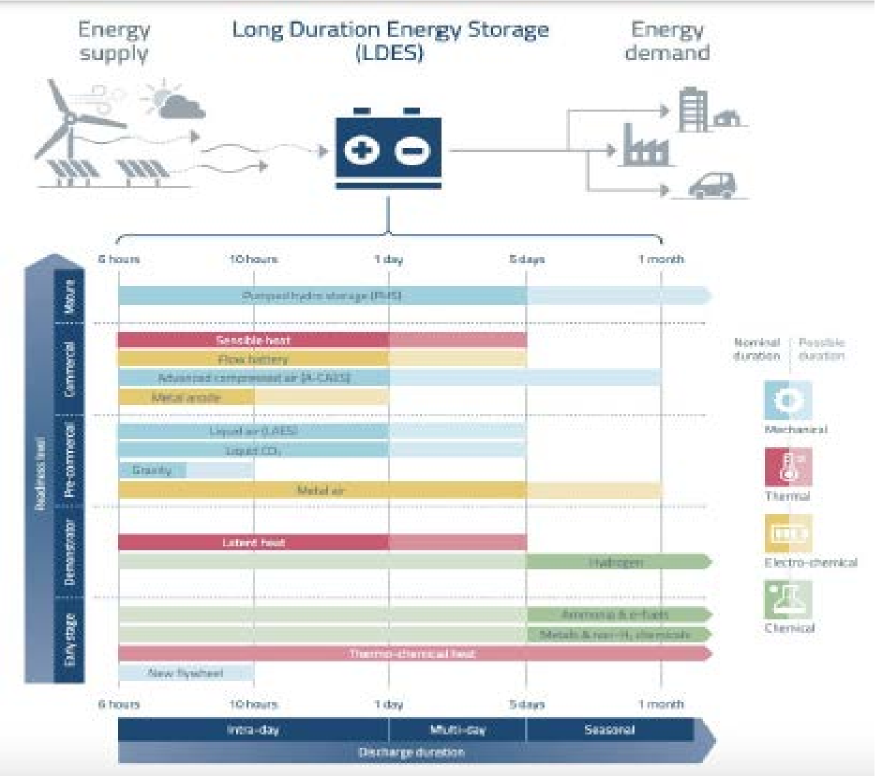
Long Duration Battery Storage

- Multi Day
  - Pumped Hydro
  - Hydrogen

- Intra-day
  - Metal Anode
  - Flow Battery



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Battery Storage System

- Reduces utility demand
- Lithium-ion batteries (Sodium?)
- 24/7 "always on" power
- Integrated with renewable resources

AES Battery Storage System

Advanced Small Modular Reactors

- Generate 10MW to 300 MW
- Operate up to 10 years w/o refueling
- Up to 60-year life expectancy
- Self-adjusting - passive safety systems

NuScale Power Reactor Building

NuScale Power Reactors. ©NuScale Power, LLC, All Rights Reserved

Thank You

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