Is your HDDs & Data Centers truly safe?

...Acoustic solutions for Gaseous Systems

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Tyco Fire Protection Products
Content

• Data Centre Risks
• HDD Sensitivity and Acoustic Challenges
• HDD Study with Michigan Technological University
• Risk Reduction Solutions
Understanding Data Centres Risks

Common Hazard Considerations

• Equipment sensitivity
  • Fire
  • Water
  • Noise
  • Heat
• Process continuity
• Redundancy
  • Both process and protection
• Room Integrity
  • Enclosure strength
  • Pressure relief
• Ventilation / Air movement / Temperature
• Life safety
• Security
• Building codes
HDD Sensitivity and Acoustic Challenges
Rotating HDD Development

**HDD development:**
First introduced by IBM in 1956

Size of two fridges, 1000 Kg, capacity 3.75 Megabytes

**Current day technology:**
60 Grams, capacity 10 Terabytes

This is an increase of 2.7 million to one which is comparable to Moore's law*

*Moore's law: Over the history of computing hardware, the number of transistors in a dense integrated circuit has doubled approximately every two years.
## HDD Technology

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>No vacuum, no fluid, just air inside the HDD</td>
<td></td>
</tr>
<tr>
<td>HDD are sealed/labyrinth prevents particles to enter</td>
<td></td>
</tr>
<tr>
<td>HDD environment constant/typical 40 – 50% RH</td>
<td></td>
</tr>
<tr>
<td>ALTITUDE change: 0 m.o.s.l (1,013 hPa) to 3,000 m.o.s.l (700 hPa)</td>
<td></td>
</tr>
<tr>
<td>Spindle motor spins at 10k to 15k RPM</td>
<td></td>
</tr>
<tr>
<td>6 – 8 nm normal fly height: kinematic energy might break the air bearing (head crash)</td>
<td></td>
</tr>
<tr>
<td>Storage capacity grows 30 – 40%/year Nominal fly heights decrease constantly!</td>
<td></td>
</tr>
</tbody>
</table>
HDDs are sensitive to noise and vibration

- When the gas is released from the pressurized cylinders it moves through the pipes at a very high velocity.
- On exit through multiple nozzles in the data centre, it generates high-level Sound Power.
- When the Sound waves reach the HDDs causes **vibration**, which causes the read/write heads to go off the data track.

**Gas systems are not getting noisier…**
**…HDD’s have become more sensitive!**
Noise level

- Quiet room: 40 dB
- Air conditioner: 60 dB
- Vacuum cleaner: 70 dB
- Audible notification appliance: 90 dB
- Baby crying: 115 dB
- Balloon popping: 125 dB
- Jet plane taking off: 140 dB

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Gas Suppression Nozzle

Exit Velocity: Supersonic
Exit Temperature: Below Freezing (but Dry)

Source: future facilities
IT infrastructure sensitive to Sound Energy

- Increasing capacity of HDDs
- Increasing noise sensitivity of HDDS
- Suppression System Release
- Noise

Risk of HDD Damage

Potential Data loss and business disruption

Acoustic footprint of Gas Suppression system

- Sound Power Level dB (W; 12 Watts)
- OTO Center Frequency (Hz)

- Hard Drive 50% Performance Degradation
- Standard Nozzle
HDD Study with Michigan Technological University
HDD Study with MTU

Joint Research in Partnership with Michigan Technological University’s Dynamic Systems group.

MTU School Rankings

- 7\textsuperscript{th} for BSME Enrolment
- 51\textsuperscript{st} for Ph.D. granting
- Dynamics Systems group focuses on innovative solutions in dynamics, vibrations, acoustics and controls
- \$14 Million USD in research expenditures per year (ranked 19\textsuperscript{th} by National Science Foundation)

Dr. Andrew Barnard
Ph.D., Acoustics, The Pennsylvania State University

Trinoy Dutta – Graduate Student
Results of HDD Study

- The results of the 12 enterprise HDD study revealed a rapid decay in read/write speeds when exposed to 110 dBZ.

- Variation observed across the different HDDs

- Some HDDs begin to have a reduction in read/write speeds while exposed to as low as 85 dBZ
Details of HDD Study

Description of the HDDs used for the study

• 12 different models of enterprise HDDs selected to represent those entered in Data Centres.
• All drives were 3.5” form with SATA interface.
• Drive capacities range from 320 GB to 10 TB.
• Drive rotational speeds: 7200 RPM.
• Manufactured Date Ranges: 2009 to 2016.

<table>
<thead>
<tr>
<th>Brand</th>
<th>Memory Size</th>
<th>Helium filled?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8 TB</td>
<td>YES</td>
</tr>
<tr>
<td>B</td>
<td>320 GB</td>
<td>NO</td>
</tr>
<tr>
<td>B</td>
<td>2 TB</td>
<td>NO</td>
</tr>
<tr>
<td>B</td>
<td>1 TB</td>
<td>NO</td>
</tr>
<tr>
<td>C</td>
<td>500 GB</td>
<td>NO</td>
</tr>
<tr>
<td>C</td>
<td>500 GB</td>
<td>NO</td>
</tr>
<tr>
<td>D</td>
<td>6 TB</td>
<td>NO</td>
</tr>
<tr>
<td>D</td>
<td>6 TB</td>
<td>NO</td>
</tr>
<tr>
<td>D</td>
<td>10 TB</td>
<td>YES</td>
</tr>
<tr>
<td>E</td>
<td>6 TB</td>
<td>NO</td>
</tr>
<tr>
<td>E</td>
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<td>NO</td>
</tr>
<tr>
<td>E</td>
<td>10 TB</td>
<td>YES</td>
</tr>
</tbody>
</table>
HDD Noise Test Setup

- HDDs placed in Anechoic Chamber (Sound proof Chamber)

- Noise applied over One-Third Octaves from 500Hz to 10K Hz.

- SPL range was 80-130 dBZ.

- Test Performance limit set at 50% reduction in either of the read / write speeds.
Results Compilation of All HDDs

Enterprise HDD 50% performance curves (500 Hz to 10k Hz)

Enterprise Hard Drive Performance average 50% curve (500 Hz to 10k Hz)

The average of the 12 HDDs achieved 50% performance between 110 and 120 dBZ across the 500-10K range.

Blue box represents variation across tested HDDs
Sample Noise Exposure Plots

Vacuum filled HDDs

Green = near 100% of baseline read/write
Red = less than 50% of baseline read/write
Black line indicates 50% read/write performance

Helium filled HDDs

Hard Drive Performance Sensitivity to Sound
Minimum Read/Write speed of HDD 9(%)
Key Takeaways from HDD Study

• Observed noise performance variation across HDD models

• New Helium Drives perform well **ONLY** at low frequencies

• HDDs can only achieve **50% performance** at 110 dBZ from 500Hz to 10K Hz.

• Any sustained noise **at ~110dBZ or higher will likely disrupt or damage** HDD operations.

**Data Centres should make acoustic provisions to reduce the risk of HDD performance reduction.**
Source-Path-Receiver Paradigm

- A source generates sound.
- Sound travels from the source to the receiver through various paths.
- The sound observed by the receiver has changed as compared to when it left the source.
- Sound Pressure level (Lp) is calculated by the formula:

\[ L_p = L_w + 10 \log_{10} \left( \frac{Q_\theta}{4\pi r^2} + \frac{4}{R} \right) + C \]
Measuring Sound at a Receiver

Sound at a receiver is experienced as a pressure change, **Sound Pressure Level**.

The **dBA** scale is used when human ears is the receiver.

**dBZ** should be used to measure Sound Pressure levels at a HDD.
Source-Path-Receiver Paradigm in Data Centres

1. The fire suppression system nozzle generates sound. *Sound Power*

2. The paths includes the walls, ceiling, racks...

3. The sound is observed by the HDD as *Sound Pressure* (dBZ)
Risk Reduction Solutions
HDD Noise Risk Reduction Suggestions

1. Select appropriate suppression nozzle
2. Calculate Room Acoustics and estimated HDD Sound Pressure Level
3. Increase Path absorption
4. Rack and HDD mounting
5. HDD location
Tyco Acoustic Nozzle

- TFPP Acoustic Nozzles brings sound power to under 105 dBZ
- Available with iFLOW technology and retrofit for existing valves
- Beginning development of an Acoustic Nozzle Solution for Halocarbon Systems
Hear the difference

Acoustic footprint of Gas Suppression system with Acoustic Nozzle

- **Std nozzle**
- **Acoustic nozzle**

![Diagram showing acoustic footprint comparison between Std nozzle and Acoustic nozzle](image-url)
## Tyco Acoustic Nozzle – Perfect for Retrofits

<table>
<thead>
<tr>
<th>Other “Muffler” Solutions</th>
<th>Tyco Acoustic Nozzle</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Measurement of Sound Power</td>
<td>Takes into account the full scientific measurement of Sound Power</td>
</tr>
<tr>
<td>Unclear Sound Reduction</td>
<td>Case by case Sound Calculation</td>
</tr>
<tr>
<td>Limited Area Coverage</td>
<td>100 m² which is the same coverage as traditional nozzles</td>
</tr>
<tr>
<td>2 – 4 nozzles to replace one traditional nozzle</td>
<td>1 – 1 replacement for a traditional nozzle</td>
</tr>
<tr>
<td>N/A</td>
<td>Acoustic Calculator to determine the Sound Pressure Levels at the HDD</td>
</tr>
</tbody>
</table>

Selecting the right nozzles is essential to prevent data loss
Tyco Acoustic Calculation Software

- We can provide you with an accurate prediction of the Sound Pressure Level profile for an actual room with its HDD location
  - Input of room design (path materials)
  - Input of gaseous system design parameters (nozzle sound power)
  - Provides output for estimated HDD Sound Pressure Levels
Data Centre Fire Protection System Layout
HDD Noise Risk Reduction Suggestions ~110dBz

• Calculate Room Acoustics, estimated Sound Power and Sound Pressure Level on HDD

• Select appropriate suppression nozzle with scientifically proven noise reduction
  ▪ Ensure sound power at given frequencies is specified for required installation agent flow rate, discharge time, and required area coverage.

• Increase Path absorption
  ▪ Room construction materials (softer materials = more absorption)
  ▪ Install sound absorption panels

• HDD location
  ▪ Locate HDDs as far from sound sources as possible
  ▪ Do not place HDD in close proximity to Agent discharge path from nozzle

• Rack and HDD mounting
  ▪ Use HDD isolation mounts (prevent rack vibrations from transmitting to HDD)