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Silent Extinguishing

Disruptions to hard disk drives caused by inert gas extinguishing systems – analysis and measures for the safe operation of storage systems

White paper | September 2015

Sinorix™ Silent Extinguishing Technology provides measures designed to ensure the safe operation of storage systems before, during and after the discharge of an inert gas extinguishing system.

When the fire protection industry became aware of the potential disruptions to magnetic hard disk drives and storage systems during the discharge of automated inert gas extinguishing systems, Siemens analyzed the problem, introduced products and developed additional measures.

This white paper describes Silent Extinguishing for inert gas extinguishing systems and how the Sinorix Silent Nozzle operates in conjunction with additional measures. The Silent Nozzle and associated measures can prevent noise-induced disruptions to hard disk drives and entire storage systems in data centers.

Content

1 Disruptions to hard disk drives caused by inert gas extinguishing systems

Data centers are the indispensable backbone of today's online society. The failure of a data center causes significant problems in a very short time. As a result, the most important objective in data centers is to ensure maximum availability. Data centers need to be designed, implemented and operated in such a way that availability can be guaranteed, even in the event of a fire. A comprehensive fire safety concept is needed to ensure business continuity, personal safety and damage mitigation in the event of fire.

That's why dry extinguishing systems are recommended for data centers with their diverse electrical hazards and high availability requirements.

Several years ago the fire protection industry became aware of potential disruptions to magnetic hard disk drives and storage systems during the discharge of inert gas extinguishing systems.

This white paper is organized into three sections:

- What causes disruptions to hard disk drives and storage systems?
- Sinorix Silent Extinguishing – an holistic approach
- Questions, answers and term definitions

1.1 What can disrupt hard disk drives?

1.1.1 Pressure

The delivery of a large amount of extinguishing agent into a protected area in a short period of time generates overpressure in the room. The first question Siemens addressed was whether overpressure caused the reported disruptions to the hard disk drives (HDDs).

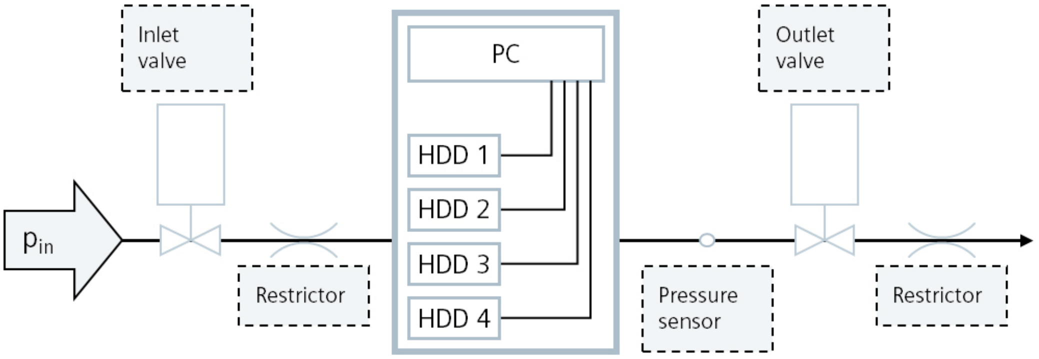


Figure 1: Test setup to evaluate the pressure sensitivity of hard disk drives, Siemens Corporate Technology, 2009

Inert gas extinguishing systems are strongly recommended for data centers because of the highly sensitive server room equipment.

For example, the extinguishing properties of inert gas extinguishing systems are based on displacing oxygen in the protected area (inertization) which reliably extinguishes the fire and prevents reignition. Depending on the risk of fire and national regulations the oxygen level will be reduced to a value between 13.8 vol-% and 10 vol-% which allows the design of a system that is safe for people.

Overpressure flaps are used to limit pressure by allowing the corresponding air volume to be displaced outside the room. Depending on the pressure resistance of the room, the design criterion for the overpressure flaps is typically from 1 to 3 mbar for normal building construction.

Test setup: Siemens performed a series of tests with typical HDDs[1] from several manufacturers. The figure above shows the test setup with 1 terabyte SATA hard disk drive from four different manufacturers that were commonly used in data centers in 2009. To monitor the effects during the test, Siemens recorded typical performance parameters such as data transfer performance, access time, the read rate for a linear or random access pattern and S.M.A.R.T.[2] parameters.

During the tests, the pressure was increased via valves and flow-determining restrictors. The pressure was then monitored by two pressure sensors, one for absolute pressure and a dynamic one for differential pressure.

[1] 3.5" enterprise hard disk drives, 1 TB capacity, 24/7 operation, technology status August 2009.
[2] Self-Monitoring, Analysis and Reporting Technology (S.M.A.R.T.) is a standard interface in hard disk drives for self-monitoring, analysis and status reporting.

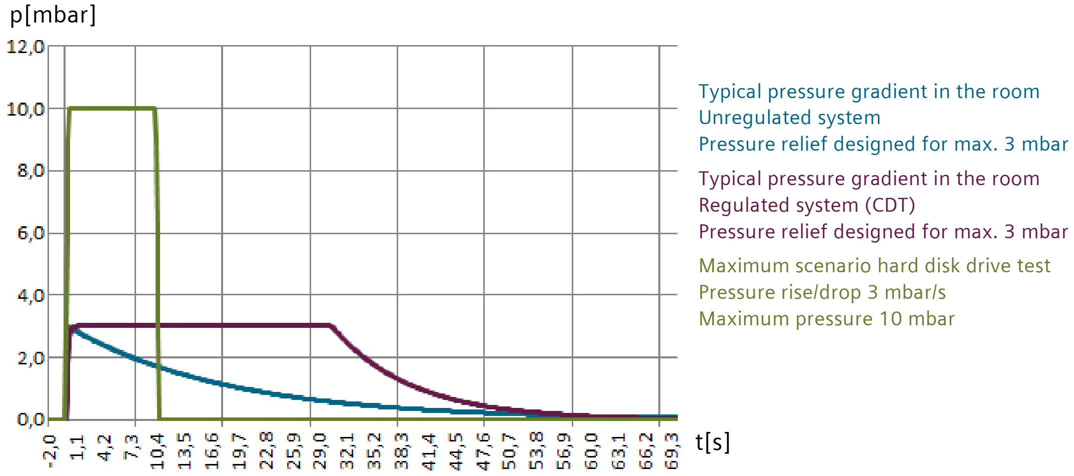


Figure 2: Pressure gradient in the evaluation of the pressure sensitivity of hard disk drives, Siemens Corporate Technology, 2009

After the hard disk drives demonstrated no particular sensitivity to the pressure changes of 1-3 mbar that are typical for discharge, the pressures and pressure gradients were increased to the maximum allowed by the test setup. Even with an overpressure of 170 mbar and an increase in pressure of up to 30 mbar/s, which would never occur in practice, no negative impact to the hard disk drives and their performance was observed.

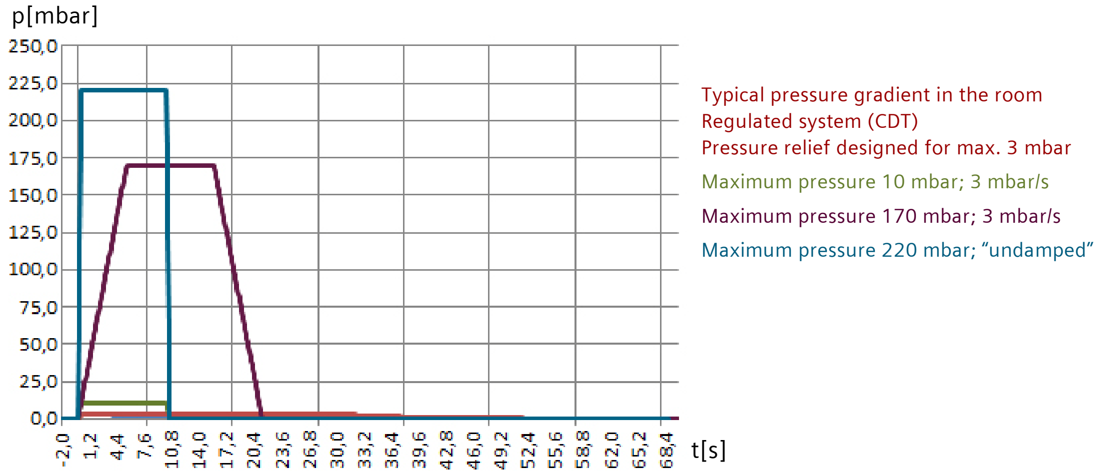


Figure 3: Pressure gradient of the extreme test and the highest agreed rating, Siemens Corporate Technology, 2009

Conclusion

Even with unrealistically high pressures and pressure gradients, no negative impact to the hard disk drives or their performance was observed.

The test proved that typical extinguishing systems with overpressure relief do not negatively impact hard disk drives.

1.1.2 Temperature

The temperature drop caused by an inert gas extinguishing discharge is only a few degrees Celsius, which disappears within a few minutes. The thermal mass of a hard disk drive body will equalize this minor drop in temperature and make it insignificant for the drive's sensitive mechanics. In addition, the temperature drop and the dry agent introduced to the room's atmosphere do not cause any condensation except on the surface of the discharge pipe network.

There is no indication from either discussions in the industry or from tests performed by Siemens that temperature/condensation could be a factor of significant influence.

1.1.3 Noise

Extinguishing systems have two main sources of noise: the acoustical alarm devices used to warn people to leave the area before the extinguishing agent is released and the flooding that refers to the discharge of the extinguishing agent through a nozzle at high pressure. In the second test, the effects on the HDDs when exposed to high noise levels were evaluated.

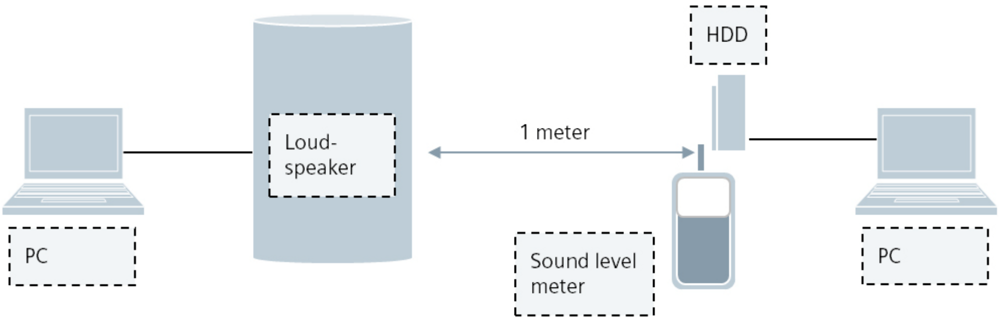


Figure 4: Test setup for noise sensitivity evaluation of hard disk drives, Siemens Corporate Technology, 2009

According to standards and regulations, alarm devices for inert gas extinguishing systems must generate a noise level between 90 and 120 dB[3]. Electric alarm sounders are typically at the lower end of the range and pneumatic ones at the upper end.

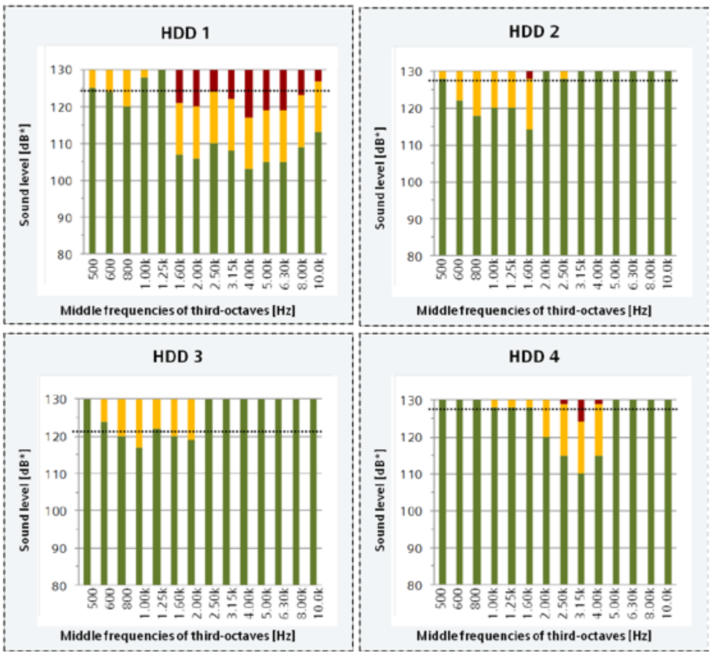
During the discharge of an inert gas extinguishing system, high noise levels are produced when the agent flows through the nozzle into the protected area. With some applications, the noise level can exceed 120 dB.

Test setup: The figure above shows the test setup used to evaluate the noise sensitivity of the hard disk drives. The HDDs were operated in the same way as in the overpressure tests, and performance was measured in the same way.

A sound generator with a loudspeaker was placed at a distance of one meter from the HDDs. In the first test, the HDDs were exposed to a pink noise, a broadband noise in the frequency range from 500 Hz to 10 kHz. The second test involved the exposure of the HDDs to third-octave noise between 353 Hz to 10 kHz. The noise levels were measured by a sound-level meter located at a short distance from the HDDs.

The advantage of using a sound generator instead of a real inert gas extinguishing system was the reproducibility of the test conditions. Although the discharge noise generated by an inert gas extinguishing system has the characteristics of white noise, pink noise was chosen for the tests in order to avoid damage to the loudspeaker from the high-frequency spectrum of white noise. Because the HDDs were directly exposed to the noise source without being mounted in a rack or in a computer, the tests were conducted in the worst possible conditions for noise impact.

[3] Example: EN 12094-12:2003 Fixed firefighting systems – Components for gas extinguishing systems – Part 12: Requirements and test methods for pneumatic alarm devices.



Noise sensitivity of HDDs during tests

Normal performance

Reduced performance

Temporarily out of order

Dotted line =
50 percent performance when exposed to pink noise at this level in dB(Z)

Figure 5: Noise sensitivity of four 1 TB nearline storage HDDs, Siemens Corporate Technology, 2009
*) LZFmax per third-octave band

The figure above shows the sound level at which the performance of the HDDs was reduced by 50 percent (yellow). The test results show that excessive noise can have a negative impact on HDD performance (red). For hard disk drives, this level typically starts at 120 dB (within a third octave), but for certain HDD types and frequencies, the negative impact may begin at levels below 110 dB. All the HDDs were found to be highly sensitive to noise in the frequency range of 500 Hz to 8 kHz and above. As expected, some resonating frequencies were found to have an even stronger impact (not shown here).

Random tests in the first quarter of 2014 with current 2 TB to 4 TB HDDs confirmed the sensitivity parameters determined in 2009.

1.1.4 Vibration/structure-born sound

Vibration is closely linked to the noise issue. The hypothesis is that sound causes vibrations in the HDD case that are ultimately transmitted to the disc spindle and head assembly, causing misalignment of the read/write heads to the data tracks.

Vibration caused by imbalance and the head motion of HDDs as well as by the imbalance of ventilators exposes HDDs to structure-born vibration in the storage system chassis and cabinets. These vibrations alone can cause additional stress to the HDDs or can even reach critical levels.

Because there are many different designs of storage system chassis and cabinets on the market, the issue of vibration caused by noise as well as structure-borne vibration has not yet been fully investigated.

1.2 Conclusion drawn from the analyzed potential disturbance variables of pressure, temperature, noise and vibration/structure-born sound

It can now be established with a high degree of certainty that the faults in storage systems as a result of an inert gas extinguishing systems discharge were caused by the impact of high noise levels on the hard disk drives.

Based on the knowledge acquired at Siemens, a typical noise sensitivity profile was defined for 3.5″ hard disk drives for storage systems. It is important to note, however, that the noise sensitivity of hard disk drives is not a specification provided by the manufacturer and might change over time due to technological enhancements.

Because the noise sensitivity of hard disk drives is not specific to any particular HDD, Siemens developed an empirical noise sensitivity scale that reflects currently known HDD sensitivity.

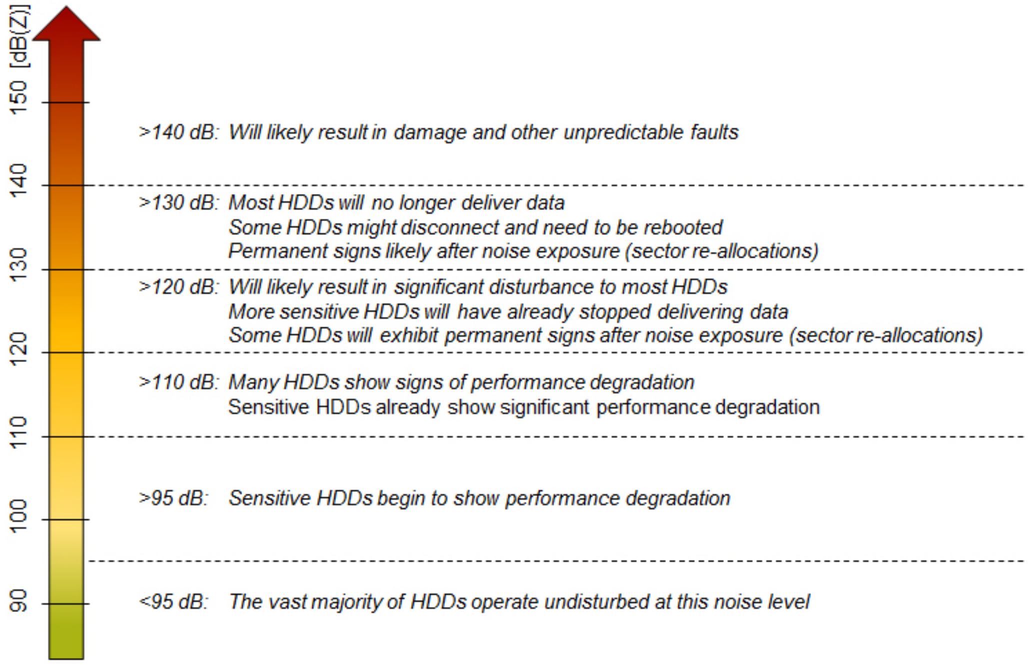


Figure 6: Empirically determined sensitivity profile of HDDs (summary)

With the capture and evaluation of the sensitivity profiles of hard disk drives in the frequency spectrum, a maximum noise sensitivity of the hard disk drives tested has been found in the middle audible frequency range. Each hard disk drive, however, has a typical sensitivity profile with characteristic performance degradations at a specific resonance frequency and multiples thereof.

Siemens defined the different sensitivity levels of hard disk drives in the sound spectrum:

- Hard disk drives are **not sensitive** to noise in frequencies **below 500 Hz**
- **Certain** hard disk drives demonstrate a **sensitivity** to noise in frequencies **from 500 Hz to 1.6 kHz**
- The range from **1.6 kHz to 8 kHz is the most critical range** in the spectrum
- **Certain** hard disk drives demonstrate a **sensitivity** to noise in frequencies from **8 kHz to 12.5 kHz**
- Hard disk drives **are not sensitive** to noise in frequencies **above 12.5 kHz**

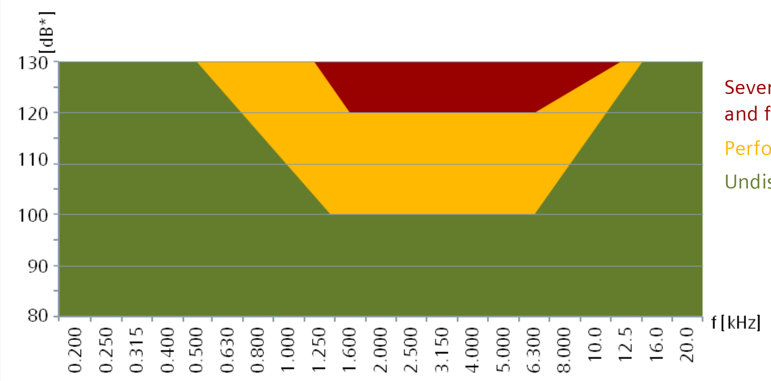


Figure 7: Empirically determined frequency-specific sensitivity profile of HDDs

*) LZFmax per third-octave band

1.3 Are the laboratory results transferable to actual installations?

In order to observe the effects on HDDs exposed to full-scale extinguishing discharges, Siemens performed more tests using the same performance measurement setup and HDDs during actual extinguishing discharges.

A series of tests was conducted using the following inert gas extinguishing systems from Siemens:

- Sinorix N_2 unregulated system with nitrogen at 300 bar cylinder pressure
- Sinorix CDT regulated system with nitrogen at 300 bar cylinder pressure, CDT valve

Conclusion

The noise of an inert gas extinguishing system may impair the performance of a hard disk drive during the extinguishing process. However, neither data loss nor permanent damage to a HDD was ever observed in a test.

1.4 Cause analysis

An IT storage system is a complex system that is optimized by manufacturers for the following key parameters:

- Storage capacity
- Performance
- Reliability (in normal operating conditions)
- Cost per capacity

Exceptional events like the discharge of a gas extinguishing system are outside the scope and specification of hard disk drives and IT storage systems, but in actual practice they do have an impact on the drives' operation.

At least two levels of severity need to be evaluated separately:

a. **Disturbance** to parts or to the entire IT storage system (in ascending severity level)

- Temporary drop in performance
- Temporarily offline
- Shutdown (requiring reboot)
- Data inconsistency

According to the Siemens Corporate Technology study in 2009, minor disturbances need to be taken into account for noise values exceeding approximately 95 dB; noise levels exceeding 110 dB are likely to cause significant performance degradation.

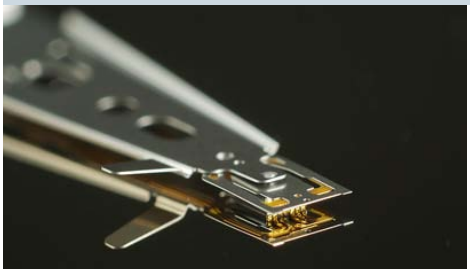
b. **Damage** to parts or to the entire IT storage system (in ascending severity level)

- Physical damage to an individual component (that can be compensated by redundancy mechanisms)
- Systematical, physical damage to multiple components that leads to a total system and data loss

Excessive noise levels (>>140 dB) like those generated by the direct-discharge jet of a standard nozzle are potentially fatal for micro-mechanical systems like HDDs. This magnitude of noise level has never been included in the scope of silent extinguishing evaluations and therefore never systematically investigated.

Noise sensitivity from hard disk to data center

Physical storage: head and disk assembly



Disturbance:

- Head to track misalignment that leads to problems in properly reading/writing the information from the magnetic layer at the disk surface

Possible damage:

- Vibration could cause head crash that scratches the disk surface

Single hard disk drive

Disturbance:

- Raw data read by the head from the disc discarded by ECC errors: disk will go offline after certain period of persistent ECC errors

Possible damage:

- Particles from the initial head crash quickly result in subsequent head crashes, ultimately leading to total abrasion of the disk surfaces

Storage system chassis

Disturbance:

- A drop in performance of a single hard disk drive will also result in a performance drop of the storage system chassis
- A single disk going offline will be properly managed by the RAID storage system controller after a timeout of a few seconds
- A systematic drop in performance or multiple disks going offline at the same time will cause severe problems and unpredictable behavior of the RAID algorithm/storage system chassis

Possible damage:

- No damage expected at the level of the storage system chassis

Storage system

Disturbance:

- The storage system will basically behave in the same manner as the combination of multiple storage system chassis

Possible damage:

- No damage expected at the storage system level

Main/backup data center

Disturbance:

- Risk of disturbance or limited service availability caused by the main-to-backup handover (which is complex per se and has limited testability)

Possible damage:

- No damage expected at the data center level

2 Silent Extinguishing – an holistic approach

After concluding that high noise levels may disrupt hard disk drives, Siemens initiated the development of the Silent Extinguishing Technology. The goal of the development process was to devise concepts that would provide the same extinguishing performance at a significantly lower noise level.

2.1 Extinguishing agent selection

Extinguishing agent	Environment, personal safety and secondary damage	Preferred application in data centers	Noise emission
Nitrogen Argon Mixtures	++ Very environmentally friendly ++ Not hazardous to humans ++ Residue-free extinguishing; no damage to IT equipment, buildings and facilities ++ No disruption to hard disk drives and storage systems when using Silent Extinguishing	Medium to large protection volume	High to very high noise emission with conventional systems Moderate noise emission with use of silent nozzles and additional measures
CO_2	+ Environmentally friendly -- Hazardous to humans	Not common	Unknown
HFC-227ea	- Subject to environmental requirements or already banned in some countries 0 Poses little hazard to humans ++ No damage to electric and electronic equipment and building facilities	Small to medium protection volume	High noise emission, no silent solutions available
Novec 1230	+ Most sustainable chemical extinguishing agent + Highest safety factor for humans ++ No damage to electric and electronic equipment and building facilities		Medium noise emission Low noise emission with use of silent solutions
Water mist	++ Very environmentally friendly ++ No hazard to humans -- Can cause damage to electric and electronic equipment and building facilities -- Electrical hazard	Building protection	Low noise emission

2.2 Silent Nozzle

The focus of all silent extinguishing concepts for inert gas extinguishing systems is the nozzle, the place where most of the discharge energy is converted to acoustic noise.

Some concepts add silencers to conventional nozzles; Sinorix Silent Nozzle reduces the noise level at the source without affecting the performance (gas flow rate and distribution) of the nozzle.

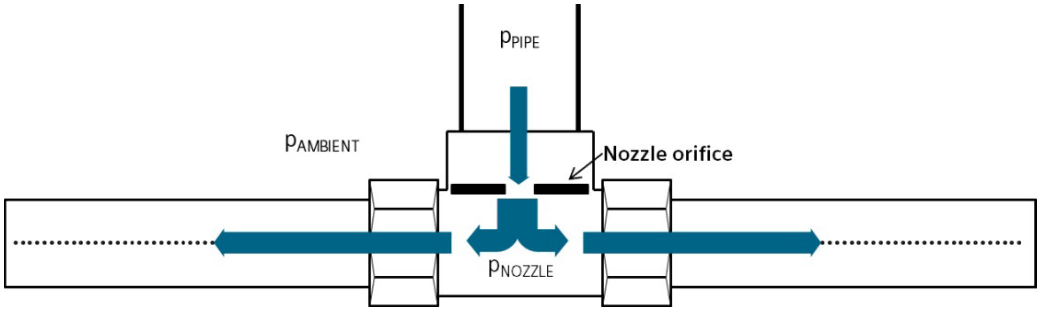


Figure 8: Principle of Sinorix Silent Nozzle

Sinorix Silent Nozzle operates on the principle of a two-stage gas flow expansion. The orifice at the inlet of the nozzle determines the hydraulic resistance and hence the flow capacity of the nozzle. The pipe network pressure p_{PIPE} is significantly reduced to the nozzle inside pressure p_{NOZZLE}. This first expansion releases a significant amount of the energy but keeps the associated expansion noise inside the nozzle. The second expansion from the nozzle inside pressure p_{NOZZLE} to the ambient $p_{AMBIENT}$ represents a much lower level of pressure drop.

Another benefit of the Silent Nozzle's design is that the total noise generated by the numerous small discharge jets is lower than that generated by a few large ones, and the emission spectrum of small jets is shifted to higher frequencies.

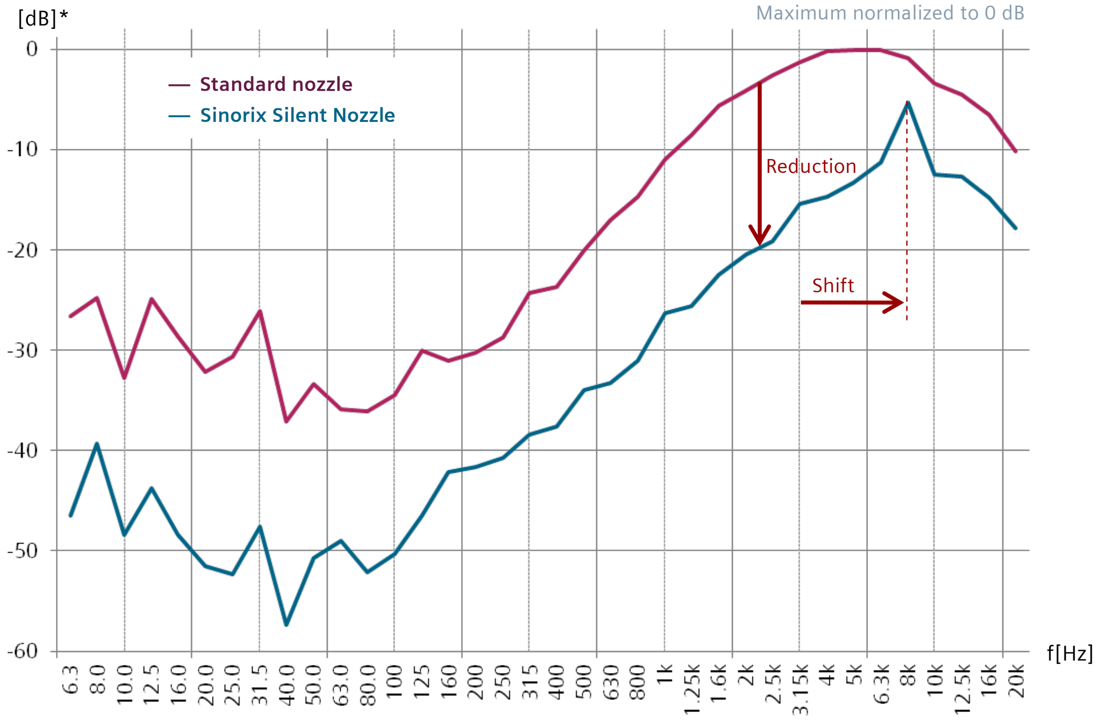
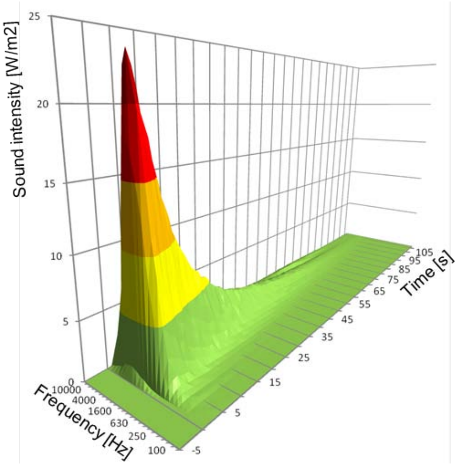


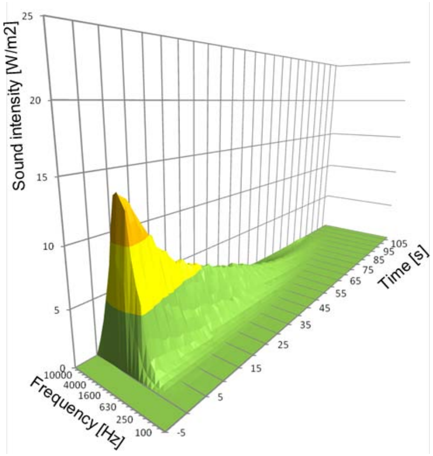
Figure 9: Spectral behavior of Sinorix Silent Nozzle vs. standard nozzle

*) LZFmax per third-octave band

Standard nozzle, unregulated



Standard nozzle, CDT



Sinorix Silent Nozzle, CDT

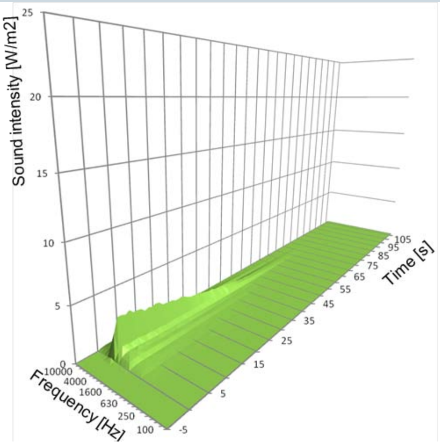


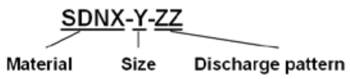
Figure 10: Sound intensity and spectrum over time of different nozzle types/extinguishing systems

In addition to the noise reduction properties of the Silent Nozzle, it is important to mention the much smoother diffusion of the gas into the room atmosphere. The widely diversified jet pattern consisting of many tiny jets dramatically reduces the direct noise compared to a standard nozzle.

The design of an inert gas extinguishing system always depends on numerous parameters, and many trade-offs need to be made. The flow characteristics of the Silent Nozzle is very similar to conventional nozzles, hence no special consideration of Silent Nozzle is needed in the hydraulic design.

The Sinorix Silent Nozzle is ideally suited for use with Sinorix CDT systems and nitrogen, argon, or mixtures. These extinguishing agents are environmentally friendly, offer outstanding extinguishing properties for electrical hazards and do not leave any residue when deployed.

The Sinorix Silent Nozzle is available in a variety of materials, sizes, and different discharge patterns.



X: Material

- **SDN** Brass
- **SDNS** Stainless steel
  VdS component certification (G 314001)

Y: Size

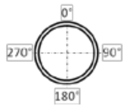
- **S** Small
  Nozzle orifice ∅3.0 mm-8.4 mm
- **M** Medium
  Nozzle orifice ∅8.6 mm-15.4 mm
- **L** Large
  Nozzle orifice ∅15.6 mm-20.0 mm

For manufacturing reasons, the diameters of the orifice plates are graduated in 0.2 mm increments.

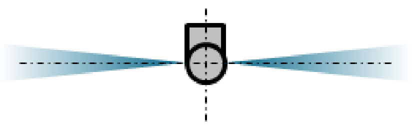
If necessary (and exclusively for inert gas applications), all types can be made with orifice diameters ≥ 3.0 mm. The type-specific maximum diameter should never be exceeded.

ZZ: Discharge pattern

All SDNS variants are intended for room protection applications, but they do have special characteristics with regard to maximum orifice diameter and spray pattern.



SDN(S)-S



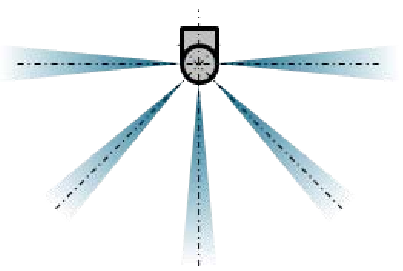
Hanging nozzle, horizontal discharge pattern 90°/270° to the pipe axis

Applications with small (partial) volumes and/or where an exclusively horizontal spray pattern is important

Examples:

- Directly above server cabinets
- Inside cold-aisle enclosures
- In false floors/false ceilings

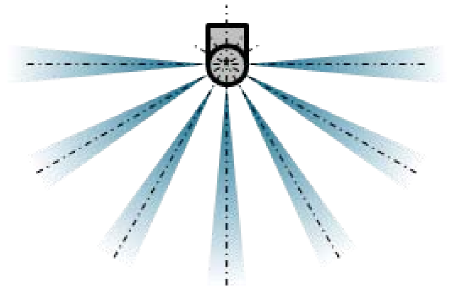
SDN(S)-M



Hanging nozzle, radial discharge pattern 90°/135°/180°/225°/270° to the pipe axis

Applications with medium (partial) volumes

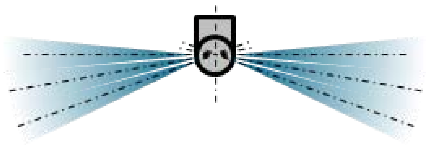
SDN(S)-L



Hanging nozzle, radial discharge pattern
90°/120°/150°/180°/210°/240°/270° to the pipe axis

Applications with the largest possible (partial) volumes

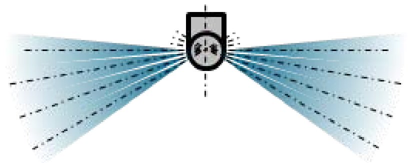
SDN(S)-M-H



Hanging nozzle, horizontal discharge pattern
90°/100°/110°/250°/260°/270° to the pipe axis

Applications with medium (partial) volumes

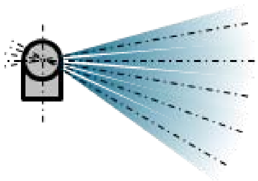
SDN(S)-L-H



Hanging nozzle, horizontal discharge pattern
90°/100°/110°/120°/240°/250°/260°/270° to the pipe axis

Applications with the largest possible (partial) volumes

SDN(S)-M-SC



Standing nozzle, horizontal discharge pattern
60°/70°/80°/90°/100° in relation to hanging pipe axis

Wall installation

2.2.1 Application with inert gas extinguishing systems

The following sections present the total noise reduction potential of Silent Nozzle and additional measures, summarized as Silent Extinguishing.

a) Sinorix Silent Nozzle lowers the noise level by 14 dB

Discharge noise of Sinorix inert gas extinguishing systems over time

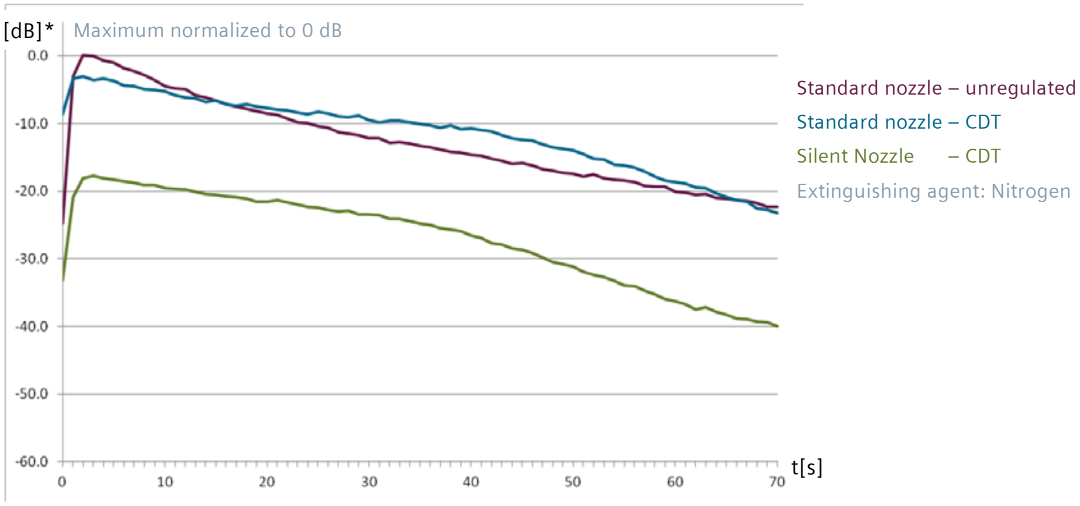


Figure 11: Noise reduction when using the Silent Nozzle with inert gas extinguishing systems

*) dB("HDD"): dB value with HDD sensitivity weighting as defined in Figure 14

Using Sinorix Silent Nozzle instead of a standard nozzle reduces the emitted noise by over 20 dB, depending on the frequency, and by an average of 14 dB in the frequency spectrum from 500 Hz-8 kHz. A noise reduction of 20 dB is equivalent to a reduction of the noise energy by 99% to one-hundredth, 14 dB by 96% to one twenty-fifth – a significant reduction.

b) Sinorix CDT reduces the maximum noise level by 4 dB

Thanks to a constant mass flow over the discharge time, using a regulated (CDT) system also lowers the maximum noise level. Our tests showed that using a regulated system results in a noise reduction of approximately 4 dB compared to an unregulated system.

c) Extended discharge time lowers the noise level by 3 dB

Depending on local codes and practices, doubling the discharge time from 60 to 120 seconds can be appropriate for fire scenarios in data centers. The expected fire scenario in a data center is more likely to be a smoldering fire arising from the electrical equipment than a rapidly developing open fire. When the discharge time is doubled from 60 seconds to 120 seconds, the noise level can be lowered by 3 dB, halving the energy of the discharge.

d) Room acoustics: direct noise and reflected noise

The noise level at any given point in the room consists of two components: direct noise and reflected noise. Direct noise refers to sound arriving directly from the source, while reflected noise describes sound that is reflected multiple times and which is increasingly dampened in the room over the course of the reverberation time.

Direct noise vs. reflected noise: standard nozzle	Direct noise vs. reflected noise: Silent Nozzle

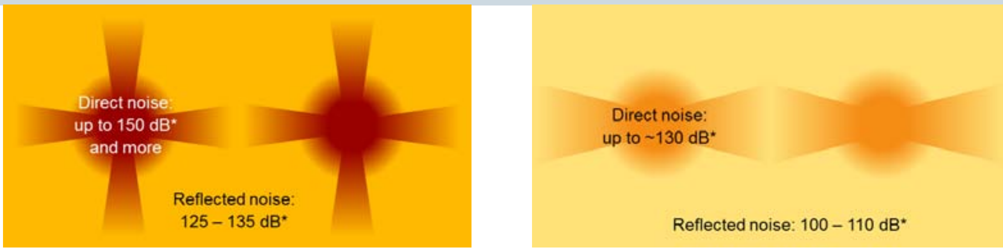


Figure 12: Comparison of direct noise and reflected noise from standard nozzles and Silent Nozzle
*) LZFmax per third-octave band

d1) Direct noise can reach a destructive level

The flow direction of a nozzle pointing directly at the equipment enclosure (for example, a storage system cabinet) can create an incredibly high noise level. Measurements taken directly in the flow direction of standard nozzles at a distance of one meter have caused measurement devices with a range of 150 dB to exceed their range. It is important to ensure that sensitive equipment is not located in the direct discharge area of standard nozzles. A distance of two meters for small orifices and three meters for large orifices should be observed whenever possible. In general, the greater the distance the better.

Although the discharge behavior of the Silent Nozzle is much gentler, it is still better to avoid direct noise whenever possible and maintain a minimum distance of at least 1.5 meters between the nozzle and sensitive equipment.

d2) Reflected noise – improvements in room acoustics reduce the noise level by 3 dB

Each room has its own acoustic fingerprint. This means that the noise absorption characteristics are dependent on the frequency spectrum. The reverberation time RT60 is the time needed to deplete the sound level by 60 dB, which is one-millionth of the original level. A typical reverberation time for rooms with bare concrete or glass surfaces is 2.0 seconds; for offices it is about 0.5 seconds. When the reverberation time is cut by half, the noise level is lowered by 3 dB. Therefore, lowering a room's reverberation time from 1.2 to 0.6 seconds would reduce the noise level by 3 dB.

2.3 Operational precautions

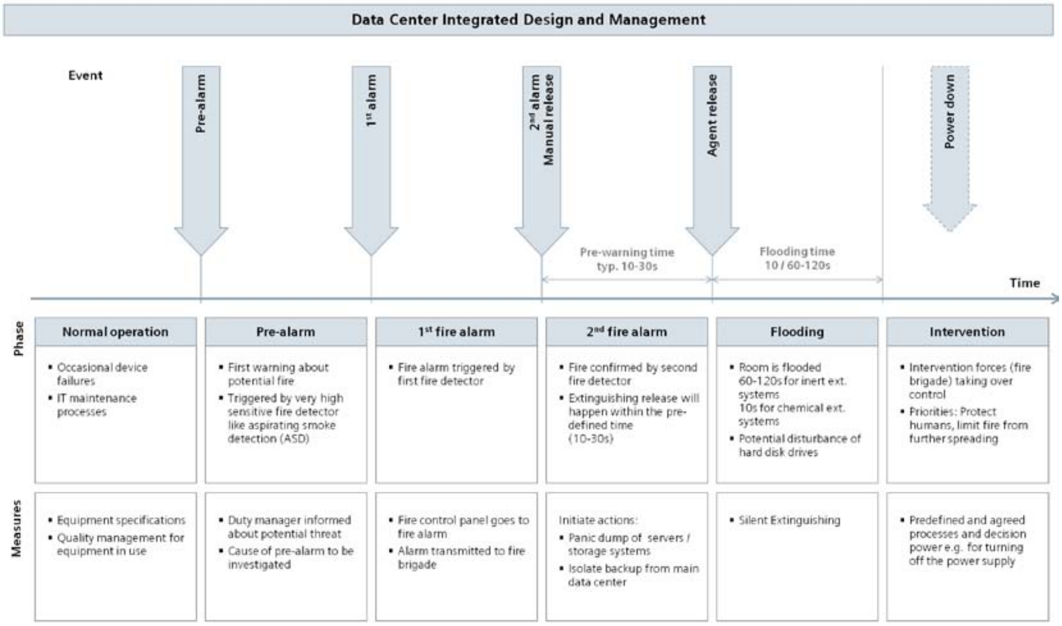


Figure 13: Measures to limit "stress escalation" in the event of fire

a) Design measures

Implementation of the Silent Extinguishing measures, including the use of an appropriate extinguishing agent, CDT systems, Silent Nozzles, a 120-second discharge time and optimal nozzle placement.

b) Operational management system

A Data Center Integrated Management System to present and prioritize all decision-relevant data, alarm handling and measure plans for all IT- and technical building management systems.

Normal operation

Selection and qualification of the hard disk drives used in accordance with a predefined checklist → for example, new generations of hard disk drives/technologies will be qualified in terms of their noise sensitivity.

Pre-alarm

Determine the reason for the pre-alarm as quickly as possible in order to lay the foundation for subsequent decisions. If possible, prevent escalation to a fire alarm.

1st fire alarm

When the fire alarm is triggered, the event escalates massively. The fire alarm is transmitted to the fire brigade which appears within minutes.

This is the ideal time to change over from main- to backup data center operation.

2nd fire alarm

There are only a few seconds pre-warning time left during which final measures must be performed in order to limit disruption.

- Evacuate people from the flooding area.
- Optimally prepare storage systems for the impending discharge by initiating a “panic dump.”

Flooding

During the flooding, Silent Extinguishing prevents the sensitive IT equipment from being exposed to excessive noise levels.

Intervention

The measure plans for operation critical tasks, such as switching off the main power supply, should be agreed in advance by the involved parties and implemented in the Data Center Integrated Management System.

3 Questions and answers

Basics of sound measurement in decibels (dB)

dB values are frequently seen in discussions related to Silent Extinguishing. dB values are often used in conjunction with a so-called weighting curve when the discussion concerns audible evaluations.

The objective of the dB(A) curve is to represent the sensitivity of the human ear. The use of an A-weighted dB value/curve does not reflect the HDD type-specific spectral sensitivity, which makes the use of dB(A) values for HDD sensitivity not very meaningful.

- dB(A): The most common weighting that is used in noise measurement is A-weighting. Like the human ear, this effectively cuts off the lower and higher frequencies that the average person cannot hear.
  Defined in the sound-level meter standards (IEC 60651, IEC 60804, IEC 61672, ANSI S1.4), a graph of the frequency response can be seen below.
- dB(C): The response of the human ear varies with the sound level. At higher levels, 100 dB and above, the ear’s response is flatter, as shown in the C-weighted response below.
  Although the A-weighted response is used for most applications, C-weighting is also available on many sound-level meters. C-weighting is usually used for peak measurements as well as in some entertainment noise measurement, where the transmission of bass noise can be a problem.
- dB(“HDD”): This weighting curve would need to be used to depict the sound sensitivity of magnetic hard disk drives (status of technology in 2009). The sensitivity curve has been empirically determined by Siemens.
- dB(Z): Z-weighting is a flat frequency response of 10 Hz to 20 kHz ±1.5 dB. This response replaces the older “linear” or “unweighted” responses because these did not define the frequency range over which the meter would be linear.

Siemens prefers to discuss noise values in spectral resolution, normally in a third-octave resolution.

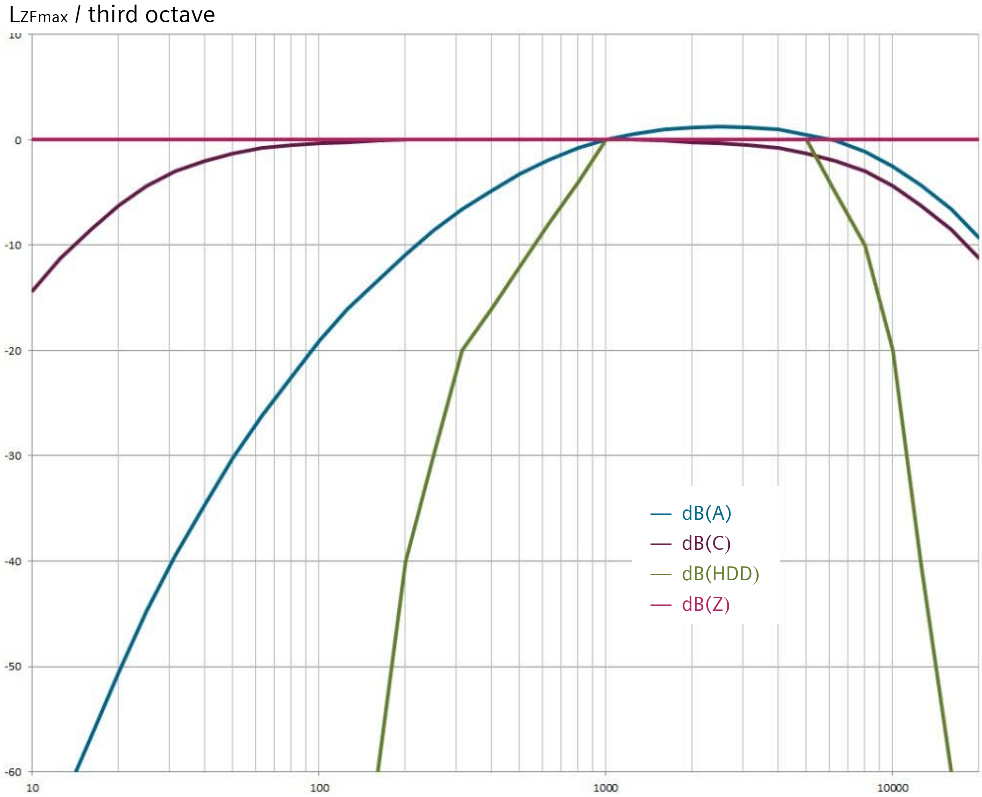


Figure 14: dB (A, C, “HDD,” Z) evaluation curves

White noise/pink noise

White noise is noise with a constant power spectral density in a specific frequency range. White noise is perceived as noise in the higher frequency range. White noise that is limited in bandwidth is frequently used in engineering and the natural sciences.

Pink noise, also referred to as 1/f noise, is noise that decreases as the frequency increases. In acoustics, pink noise is perceived as noise in which an average person perceives all frequency ranges of the audible sound spectrum as equal in volume.

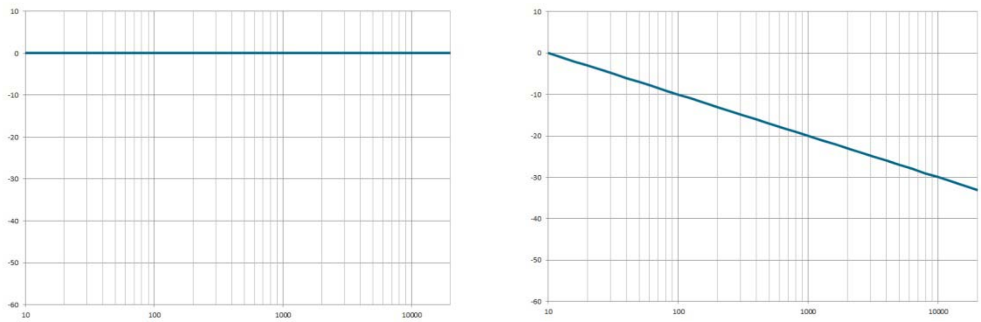


Figure 15: White noise/pink noise

Why should I protect my data center with an extinguishing system?

There is no question about the need for an gas extinguishing system to protect your valuable assets: The biggest risk is always the risk of fire. Siemens recommends installing an inert gas extinguishing system to protect your data center against the risk of fire.

Will solid-state drives solve the problem?

When alternative technologies like solid-state drives replace today's technologies, the problem of disruptions to HDDs caused by discharge noise may disappear on its own. However, because our tests showed variances in the sensitivity of the HDDs tested, Siemens recommends contacting the manufacturer to check the technology or to obtain additional information.

Is background noise in your data center already disturbing the HDDs?

Strong ventilation and air-conditioning flow rates make data centers, and especially the cabinets where HDDs are located, a very noisy environment. The background noise level typically reaches 80 to 85dB(A). HDDs are designed to operate in this noisy environment at full performance. A discharge noise of about 100dB(A) is 15 to 20dB above the background noise (30 to 100 times the noise energy) which means that the ordinary background noise is a minor factor.

What is the correlation between room size and sound level?

The mass flow needed for a certain protection volume and the sound energy density increase linearly with the room volume. This means that the noise level is independent of the protection volume and is instead primarily a function of nozzle acoustics, room acoustics, discharge time and mass flow. The flow direction may be an additional optimization measure, but it only has a local effect.

Is it better to use one large nozzle rather than several small ones?

As mentioned above, the noise level generated is primarily dependent on the mass flow. This means that one nozzle with an orifice of a particular diameter generates the same noise level as two nozzles with orifices of half that diameter.

Careful placement of the nozzles in relation to the room layout should determine the selection of the nozzle size and orifice.

Can the Sinorix Silent Nozzle be used in rooms with false floors or ceilings?

False floors and ceilings are typically not acoustically separated from the room. The small version of Sinorix Silent Nozzle (SDN(S)-S) has a dedicated drilling pattern to limit the gas flow to the horizontal plane, and is therefore especially appropriate for false floors or ceilings.

Converting existing systems to Silent Nozzle

Existing systems can be converted to Silent Nozzles if the following factors are taken into consideration:

1. Recalculation of the system: Just as with any other inert gas extinguishing system, it is necessary to calculate and implement the nozzle cross-sections on a project-specific basis. For Sinorix Silent Nozzle, the coefficients are available for the VdS calculation software for nitrogen, argon and mixtures. As a first estimation, the cross-section of the nozzle orifice in the Silent Nozzle can be assumed to be the same as the total orifice cross-section of a standard nozzle.
2. Where possible, the discharge time should be increased to 120 seconds. This reduces the noise level and permits smaller pipe diameters to be used.
3. It may be necessary to adjust the positions of the nozzles due to the discharge pattern of the Silent Nozzle (for example, using a 90° drilled nozzle in a corner). It is always important to ensure that the discharge jet of a nozzle is never aimed directly at sensitive equipment (control cabinet with hard disk drives).

3.1 Abbreviations

CDT	Constant Discharge Technology
dB	decibels
EPD	Electronic Data Processing
ECC	Error Correcting Code
HDD	Hard Disk Drive
Hz	hertz
kHz	kilohertz
mbar	millibar
RAID	Redundant Array of Independent Disks
RT60	Reverberation time

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