Extinguishing

SIEMENS

White Paper

Potential problems with computer hard disks when fire extinguishing systems are released

Disclaimer

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In 2009 rumors started in the fire safety industry that computer hard disks drives (HDDs) may face problems when fire extinguishing systems are released. Siemens as the world leader in fire safety has a variety of different extinguishing systems in its portfolio and is highly interested to investigate this topic. This document describes the current state of knowledge of Siemens experts, which are based on tests as well as the discussions with customers, external specialists and approval bodies. Investigations are not finished at the moment. Therefore this document has a limited validity. If the working group is convinced that new facts are relevant enough to be published, an updated version of this document can be found at http://www.siemens.com/sinorix. Otherwise the validity of this document will be extended.

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Potential problems with computer hard disks when fire extinguishing systems are released

What is the problem?

Today it is state of the art to protect data centers or EDP rooms with dry extinguishing systems with inert gases or chemical agents, to ensure the intervention takes place as soon as possible after the automatic detection of a fire by a fire detection system. This is to minimize possible damages caused by a fire or smoke, to a level as low as ever possible. In very rare cases customers of dry extinguishing systems from different manufacturers reported problems with computer hard disk drives, after the release of the system. Problems ranged from automatic shutdown of a hard disk drive with no damage after restart, to hard disks which really could no longer be used. In case of a real fire this may be acceptable, and may be caused by the fire itself or the smoke. But there have been also cases reported when dry extinguishing systems have been released accidently or for test purposes. Even if the possible benefits of a dry extinguishing system by far outperforms this very seldom side effects, Siemens has a clear vision to identify if it is really the dry extinguishing system causing this effect, and if yes - to avoid or limit it as far as possible.

Is the overpressure generated by a dry extinguishing causing the problem?

Every dry extinguishing is generating an overpressure in the room protected. Inert gases (Nitrogen, Argon, CO_2, or blends of the before listed) base their extinguishing effect on the displacement of oxygen. Typically the used amount of inert gas is in the range of half of the room volume. Overpressure flaps are used to limit the overpressure by allowing the displacement of the correspondent air volume to the outside. Depending on the robustness of the room, design criteria for the overpressure flaps is typically between 1 and 10 mbar overpressure, 3 mbar for a normal building construction.

Chemical agents also need overpressure flaps. The dimensions are smaller, because less agent is needed, and therefore less air is to be displaced. The extinguishing principle is not the displacement of oxygen, its action is chemical and works by inhibiting the oxidation reactions produced between the combustible and the oxygen.

When discussing possible effects on Hard Disk Drives we assumed that it may be not the maximum overpressure controlled by the overpressure flaps, but the rate of rise (pressure gradient) which may cause problems. The overall amount of agent is for chemicals much smaller than for inert gases, but they are brought into the room in a much shorter time (typical for chemicals: 10s, typical for inert gases 60 – 120s), and chemical agents create an underpressure before they create an overpressure. Therefore differences on the pressure gradient may be closer between inerts and chemicals, as this would be the case or the maximum overpressure without overpressure flaps.

To check the effects of maximum overpressure and pressure gradient on Hard Disk Drives, Siemens performed a series of tests with typical HDDs[1] from different manufacturers. Figure 1 shows the test setup with 1 TB SATA HDDs from four different manufacturers typically used today in a lot of data centers. To monitor the effects during the test we set the HDDs under constant operation and recorded typical performance parameters (SMART information, data transfer performance, seek performance linear and random).

[1] 3.5" drives in the enterprise storage category, 1TB capacity, 24/7 operation, purchased in August 09

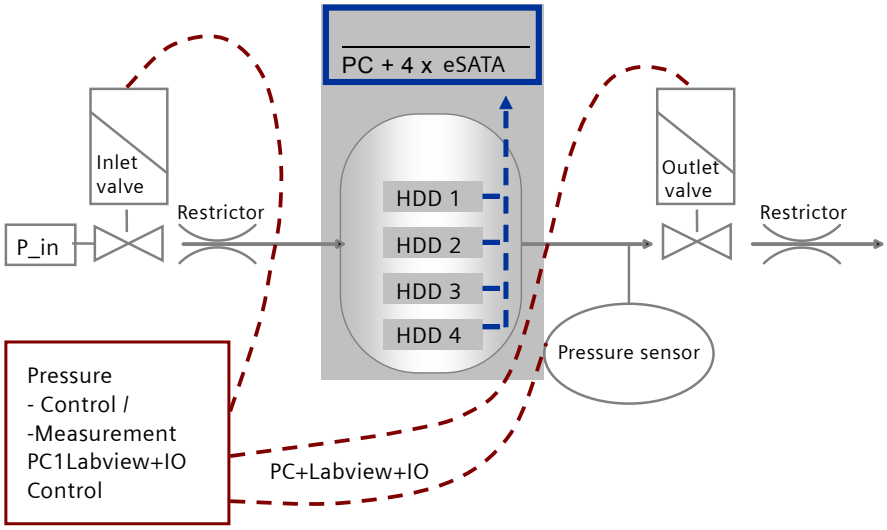

Figure 1: Test setup pressure

During the tests the pressure was increased via a nozzle, opened by a solenoid valve. The pressure was monitored by two pressure sensors: one for the absolute pressure and one sensitive differential pressure sensor. We performed series of tests increasing the maximum overpressure and the gradient stepwise. We tested up to a maximum overpressure of 170 mbar, and a maximum gradient of 30 mbar/s in the test chamber, which was the limit of the test setup. No irritation of the HDDs could be found after the test. To go even further we removed the flow limiting nozzle. Even at 220 mbar within 3s with a gradient up to 100mbar/s: No effect on performance or even damage was reported for all drives under test.

Conclusion: It is very unlikely that the overpressure created by a state of the art dry extinguishing system with overpressure flaps, or the pressure gradient in such a setup, has any negative effects on typical HDDs.

Is the noise generated by a dry extinguishing causing the problem?

There is some evidence that HDDs are sensitive to noise[2]. Dry extinguishing systems are a source of noise: Sounders and horns are activated to warn people before the agent is released, and the release itself is also a source of noise.

According to standards and codes alarming devices for dry extinguishing systems have to generate sound levels between 90 and 120 dB[3]. Electrical horns are typically on the lower end of the range, pneumatic horns are at the upper end.

During the release of a dry extinguishing system also high noise levels are produced when the agent expands and flows through the nozzle(s) into the room. This is true for inert gases as well as for chemical agents. The sound level created depends on several different design factors. It can even go above 120 dB.

To check the effects of sound on the same HDDs the following test setup was used:

[2] If you are looking for more information try to search the internet with the term "unusual disk latency"
[3] See for example EN 12094-12:2003 Fixed fire-fighting systems - Components for gas extinguishing systems - Part 12: Requirements and test methods for pneumatic alarm devices

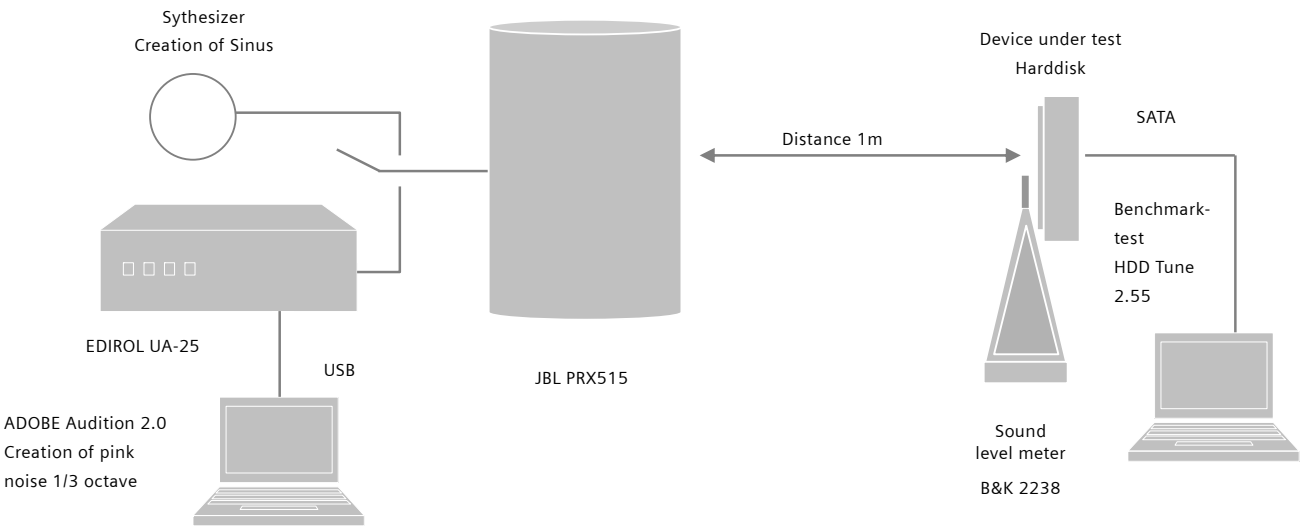

Figure 2 - Test setup sound

Performance measurement setup and HDDs used was identical with the one used for the over-pressure tests. Pink noise was created broadband (500 Hz – 10 kHz) and thirds (beginning from 353 Hz up to 10 kHz) using a sound generator with a loudspeaker placed in one meter distance from the HDDs. The sound levels have been measured in very close distance to the HDDs. Sounds created by dry extinguishing systems show the characteristics of white noise.

Note: Pink noise was chosen in the test not to damage the loudspeaker by the high frequency spectrum produced by white noise. The advantage of using a sound generator instead of a real extinguishing system is the high controllability and reproducibility of the test conditions. As you will see below, we also performed tests with real dry extinguishing systems.

Figure 3 shows the results on which noise level the performance of the HDDs is reduced to 50%. It was found, that excessive noise, at levels harmful to human health, can have also negative effects on HDD performance up to total temporary malfunction and damage of some sectors. The levels are typically 120dB, but may begin a little below 110 dB, at certain HDD types and frequencies (Figure 3). In our tests we did not come to a point, where a HDD was unusable afterwards. All tested HDDs showed to be sensitive at least in the frequency range of 500 Hz to 5 kHz. As expected some frequencies (resonance) with strong impact were found – not shown here.

As additional remark, please be aware that the tests we conducted were in the worst possible condition for noise impact, since the disks were directly exposed to the noise source, without being mounted in a rack or computer.

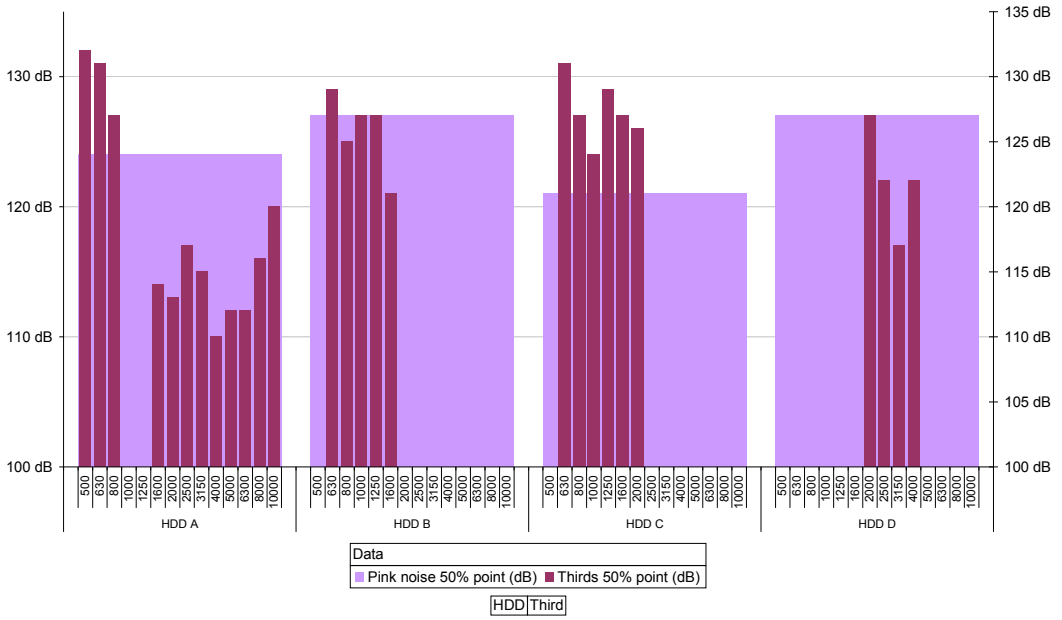

Figure 3 - Noise Sensitivity of tests HDDs (50% Performance reduction)

Conclusion: Noise levels created by the warning and / or the extinguishing process may have negative effects on typical HDDs, one effect could be a possible reduction in performance.

Are the laboratory results transferable to real extinguishing systems?

After the laboratory tests we went one step further and used the same performance measurement setup and HDDs, to observe the effects when exposed to full scale extinguishing discharges.

A series of tests was conducted with the following Siemens extinguishing technologies: Sinorix™ 1230 (agent FK-5-1-12 / 42bar cylinder pressure), Sinorix™ 227 (agent: HFC227ea / 42 bar and 25 bar cylinder pressure), Sinorix™ N_2 (agent: Nitrogen IG100 / 300 bar cylinder pressure), Sinorix™ CDT – Constant Discharge Technology (agent: Nitrogen IG100 / 300 bar cylinder pressure / regulated valve)

As expected, some negative effects on performance could be observed. After the discharge was finished, no loss of information or HDD destruction was registered in any of the tests.

What can be done to avoid potential problems?

There are three areas where measures can be taken: on the side of the Hard Disk Drives, on the side of the extinguishing systems and their alarming devices, and at the point where they come together – especially tests and test releases.

Select less sensitive HDDs or other less noise sensitive data storage technologies.

The problem of noise sensitive Hard Disk Drives may disappear on its own, when new technologies like Solid State Disks or Flash Memory Devices or whatever will replace the today's technologies. Probably you are looking for answers today. Our tests showed variances in the sensitivity of the HDDs tested. May be you contact your HDD-manufacturer to verify if they have information on this issue.

Improve existing HDDs by Firmware-Updates

We informed the manufacturers of the HDDs we tested about our observations and results. From one of the companies we then got an updated firmware version, which should improve the robustness of the HDDs. We did not test it because we will concentrate on the extinguishing side (see below). Maybe you contact your HDD-manufacturer to verify if they have information on this issue.

Minimize direct exposure of the HDDs to the sources of noise

Whenever possible choose noise isolated cabinets with closeable doors and keep them closed during operation. Every noise isolation measure will reduce the influence of noise on HDDs operation.

When designing the warning and extinguishing system, select siren and nozzle locations so that they don't irradiate the HDDs directly.

Use technologies like fault-tolerant RAID-systems to better immunize systems

For important data in many cases fault-tolerant data-storage systems are used anyway (RAID-systems, Mirroring, ...). Maybe you check your storage concepts and bring them on a level where the loss of HDDs will not lead to a loss of data. There are many reasons, why HDDs may fail.

Reduce test releases when systems are running

Sometimes customers and certification bodies require a flooding test after the extinguishing system is commissioned. Although we haven't experienced any loss of information or HDD destruction, be aware that in certain rare cases, malfunction of HDDs may be observed when warning and extinguishing systems are tested.

Be aware that testing warning systems might influence performance

As already described above, HDDs are sensitive to noise. Sirens and horns produce noise levels up to 120 dB and above. If such a warning system needs to be tested, we recommend reducing the noise level (e.g. by system configuration or by covering the warning devices).

Work on less noisy system concepts

Since the very beginning of the extinguishing technologies at Siemens, our systems have been designed to meet the highest standards in quality, reliability, performance and regulations. Among several other design parameters, noise was always considered to be one of the key attributes.

At the light of the latest facts and the development of the HDD technologies, noise has become a more sensitive attribute of the extinguishing system. Siemens, the innovation leader in dry extinguishing that for example introduced Sinorix™ CDT and Sinorix™ H_2O Gas, is currently working on concepts that will also show in the area discussed in this whitepaper the power of innovation of Siemens.

Are there any inert gases or chemical agents which are better?

The agent used in an extinguishing solution doesn't define per-se the noise level of the system overall. But, as mentioned before, it is the noise only, which can reduce the performance of the HDDs and not the influence of the special type or brand of a gas. Several design factors influence this noise level. Every gas nozzle used to distribute the agent into a room, will necessarily produce sound energy independently from

the type of agent. We believe it is not serious to conclude that using a certain type of agent will solve the problem.

Which reliability do test reports about releases without problems have?

Reports of test releases without problems describe the normal situation for all suppliers, all agents and all system technologies in dry extingsuihing systems today. Effects on hard disks have only been witnessed in very rare cases, they are the exception.

Are watermist-systems an alternative?

Spraying water inside the data center, no matter the size of the droplets, is something strange when thinking about the risks. Nevertheless it is sometimes discussed as an alternative to dry extinguishing systems, even if water mist systems cannot guarantee extinguishing a fire i.e. in spray shadow areas. Water mist systems are, like sprinkler systems, approved as “suppression only systems”.

When dry extinguishing systems are discharged, the agent is neutral to electronics and surfaces in general. In contrast, when a watermist system is discharged, thin layers of water cover all surfaces. On top the harmful substances of smoke, now diluted in the water, may be deposited on sensitive surfaces. Therefore the inherent risk of spraying water in a data center, may in case of a real fire, be increased due to the presence of smoke.

What should I do if I already installed a dry extinguishing system in my data center?

We discussed the whole issue with customers, specialists and approval bodies. Nobody sees any need for immediate action. Cases where problems have been reported are quite rare, and the advantages of the protection by dry extinguishing systems by far outperform the issue of noise sensitivity of HDDs. So we see no need for action for existing installations. Just be aware of the topic, when you are planning alarming or release tests. If you have any doubts, verify with your HDD manufacturers if they have information on this issue.

What should I plan to protect my data center by an extinguishing system?

As described above there is not at all any question mark behind the need of a dry extinguishing system to protect your valuable assets. Keep on going, and avoid getting other risks by not protecting your data center or using the wrong concepts.

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Abbreviations

dB	Decibel
EDP	Electronic data processing
HDD	Hard disk drive
Hz	Hertz
kHz	Kilohertz
mbar	Millibar
RAID	Redundant Array of Independent Disks

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