WHITE PAPER

Victaulic Vortex™ Fire Suppression System Study, Discharge Impact On Hard Disk Drives

By Robert Ballard
May 2012

Contents

Introduction

Since 2008 there have been documented cases, written studies, and investigations concerning fire suppressant discharges and their impact on hard disk drives. Published reports and online articles indicate that during suppressant discharges damage has occurred, such as data becoming temporarily unavailable or damage to sectors. Reference Ansul Bulletin No. 5688[1], Siemens Extinguishing White Paper[2], and The Availability Digest article[3].

With the expansion of applications for the Victaulic Vortex™ Fire Suppression System and its use within data centers and computer rooms, the system comes into contact with computers--be it desktop, laptops, or servers. How does this hybrid technology using nitrogen and water discharged at a low pressure effect the hard drives used in today's equipment?

For the purposes of this investigation, the hard drives are broken down into 3 classes: Enterprise, Desktop and Mobile. Enterprise class hard drives are typically used within server systems which require large capacity drives and must always be available and reliable. The reliability and speed factors of enterprise class hard drives require that the drives be installed in parallel and with redundancy. Due to the requirements of the drives, they are designed to be more robust, offering the best performance by allowing for faster data access and retrieval. The drives use heavier actuator magnets, faster spindle speeds, denser magnetic media, and faster drive components. In the Victaulic testing described below, The enterprise drives used had a rotational speed of 15,000 rpm.

Desktop class hard drives have different requirements and are designed for various applications. The drives have varying features depending on its use, be it gaming, data storage, or general use. Desktop hard drives typically operate 8 hours a day, 5 days a week. The drives are cost sensitive to the consumer. Data integrity, while desirable for the consumer, is not critical as compared to enterprise class hard drives. Desktop hard drives are usually a single drive system and experiencing a bad sector can be catastrophic. The desktop hard drive will spend time attempting to re-read the sectors to recover the data which can provide the appearance that the computer system has seized and times out. A drive working so diligently to recover data is desirable for the consumer but not desirable as an enterprise class hard drive, where a time out can crash a system or network. There are a wide range of desktop class hard drives available depending on the consumer's requirements. Rotational speeds can be found up to 10,000 rpm for the demanding consumer but the typical drives are found in the 7200 - 5400 rpm range. The drive used for testing had a rotational speed of 7200 rpm.

Mobile class hard drives are designed for portability and are used in devices such as netbooks, notebooks, laptops and audio video equipment. The drives are smaller, 2.5" form factor as opposed to the 3.5" form factor used for enterprise and desktop class hard drives. The mobile class drives are

[1] Study of System Discharge/Alarm on Sensitive Hard Disk Drives – Update, Ansul Bulletin No. 5688, September 30, 2010.
[2] Potential problems with computer hard disks when fire extinguishing systems are released, Seimens' Building Technologies Division White Paper, 2010.
[3] Fire Suppressant's Impact on Hard Disks, Availability Digest, February 2011.

powered by batteries so the equipment is designed for efficiency rather than performance. Mobile class hard drives are typically 5400 rpm; however, 7200 rpm is available for high end mobile equipment. The drives are built more rugged due to the environments the drives are exposed to and modern day drives feature protection against bumps and falls. When an event is detected, the drives can suspend the read and write operations, as well as park the heads. The mobile class drive used for testing had a rotational speed of 5400 rpm.

Problem Statement

Having studied the previous studies and in response to client inquiries regarding the effect of the discharge of suppression agents on hard disk drives, Victaulic conducted it's testing using the Victaulic Vortex™ Fire Suppression System. This document describes the current level of understanding by Victaulic as it pertains to the use of the Victaulic Vortex™ Fire Suppression System with enterprise, desktop and mobile class hard drives.

Test arrangement:

The described test scenario was performed at the Victaulic Research and Development Laboratory in Stewartsville, NJ, USA.

Testing occurred in a 2048 ft^3 room measuring 16’ x 16’ x 8’. Two 5/8” Victaulic Vortex™ emitters were ceiling mounted in the pendent position, each operating at 25 psi, each flowing ~250 cubic feet of nitrogen. Each emitter was equipped with a .26 gpm water flow cartridge. The room is constructed on a concrete floor with concrete blocks and wood framed walls and a drywall ceiling.

The computer equipment undergoing testing, was placed within a server cabinet and mobile cart that were exposed to the system discharge within the room.

A hybrid desktop / enterprise computer and laptop were used for test equipment and HD Tune Pro 4.60 software was selected to perform the benchmark testing. See below for equipment details.

Prior to testing, the hard drives underwent an error scan in which all drives were found to be free of defects. A random access and read and write file benchmark tests were used to determine the performance of the drives. The benchmark testing was conducted both with and without Victaulic Vortex™ Fire Suppression System discharging. While discharging the Victaulic Vortex™ Fire Suppression System, benchmark testing occurred with and without the water component to determine if either scenario provided any influence.

Figure 1 (Room Configuration)

Figure 2 (Hybrid Computer)

Equipment Details:

Hybrid Computer
- Hard Drives:
  - Hitachi Model HUS154530VLFS0 (B)
    300 GB Capacity
    SAS Interface
    15000 RPM

  - Western Digital Caviar Black
    Model: WD1002FAEX-00Z3A0
    1.0 TB Capacity
    SATA Interface
    7200 RPM

  - Western Digital Caviar SE
    Model: WD3200JS
    320 GB Capacity
    SATA Interface
    7200 RPM

IBM Lenovo R60
- Hard Drive:
  - Model: HTS54106069SA00
    60 GB Capacity
    EIDE Interface
    5400 RPM

EFD Software
- Software: HD Tune Pro
  - Version 4.60
    www.hdtune.com

Random Access Benchmark Testing

A random access benchmark test was performed on each hard drive. The random access benchmark transfers files of predetermined size, reading and writing the files. The average speed, gauged by throughput (MB/s) and the Input/Output Operations Per Second (IOPS) along with the average access time and maximum access time are all used to benchmark the performance of each drive. Each test was conducted 3 times to obtain an average.

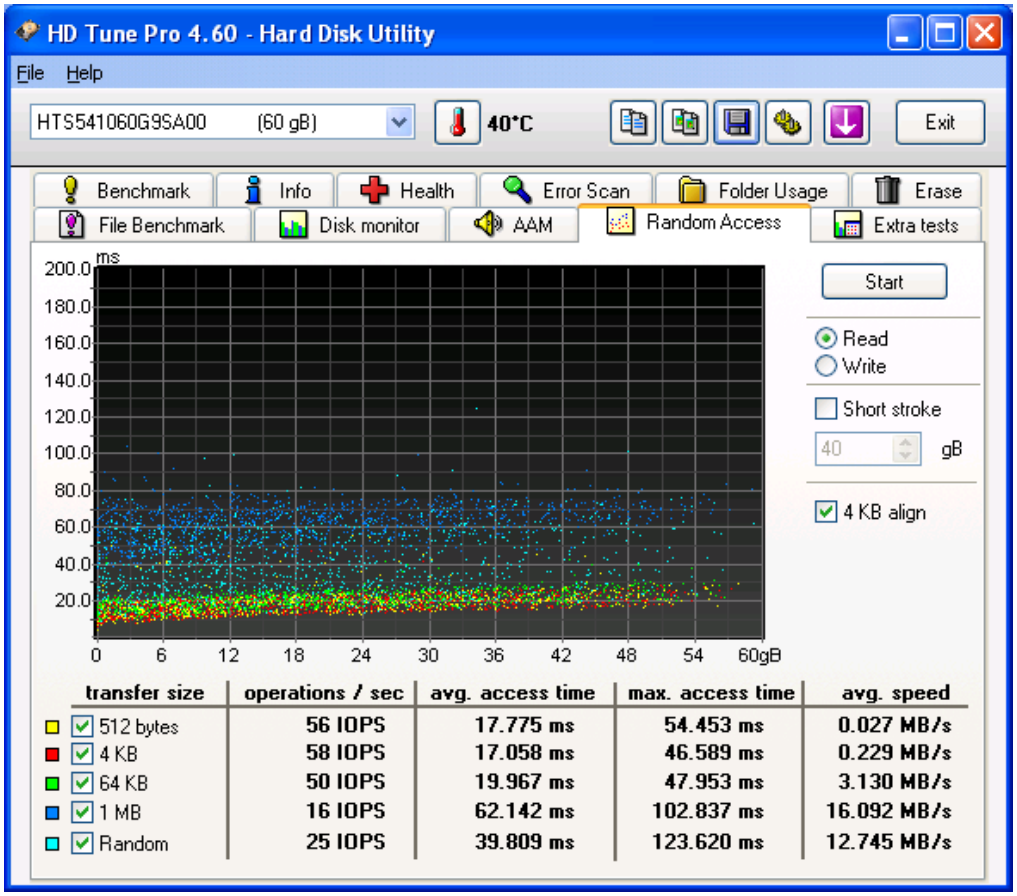


Figure 3 (Sample Random Access Mobile Class 60GB – Without Victaulic Vortex™ system)

File Size	operations / sec (IOPS)	avg. access time (ms)	max. access time (ms)	avg. speed (MB/s)
512 bytes	56	17.775	54.453	0.027
4 KB	58	17.058	46.589	0.229
64 KB	50	19.967	47.953	3.130
1 MB	16	62.142	102.837	16.092
Random	25	39.809	123.620	12.745

Table 1 (Average Random Access Mobile Class 60GB – Without Victaulic Vortex™ system)

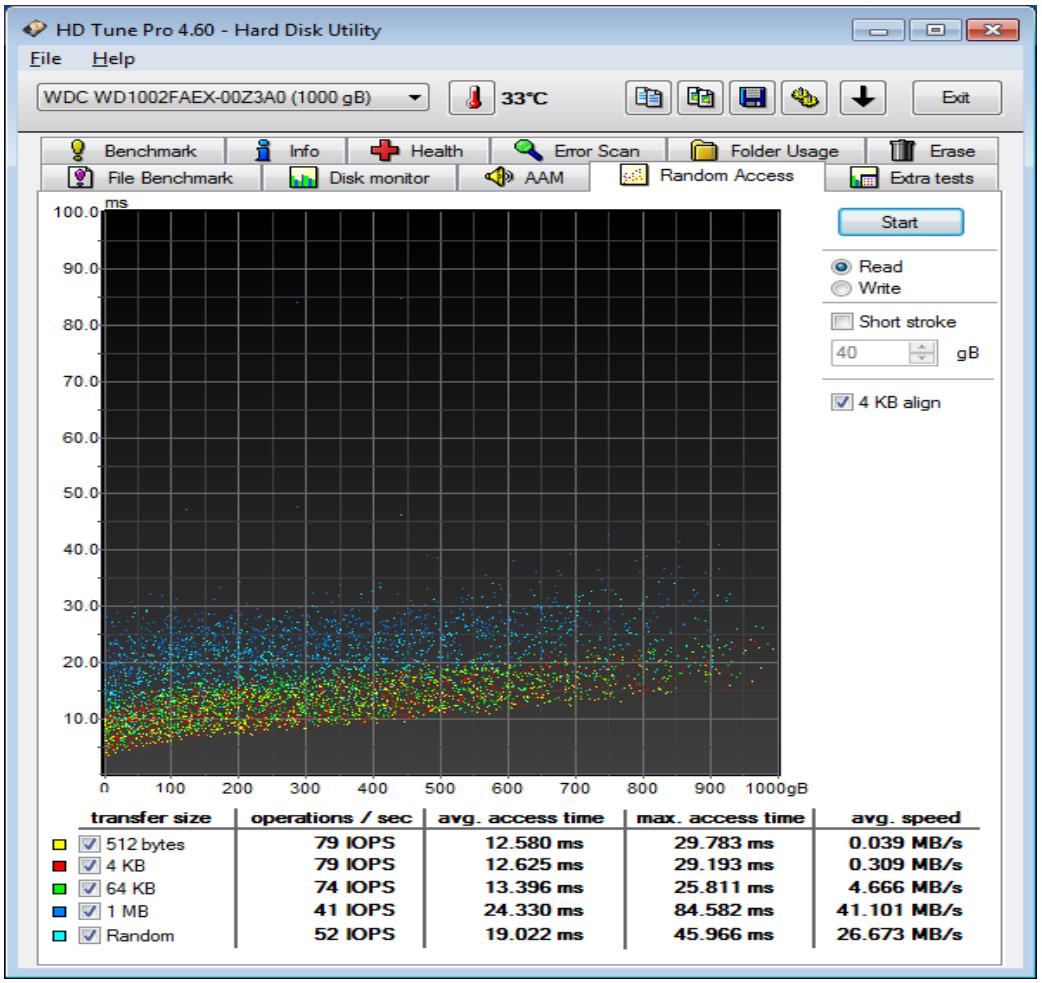


Figure 4 (Sample Random Access Desktop Class 1TB – Without Victaulic Vortex™ system)

File Size	operations / sec (IOPS)	avg. access time (ms)	max. access time (ms)	avg. speed (MB/s)
512 bytes	77	12.814	32.005	0.038
4 KB	78	12.708	29.364	0.307
64 KB	73	13.659	28.175	4.578
1 MB	41	24.226	84.565	41.277
Random	52	19.060	39.430	26.620

Table 2 (Average Random Access Desktop Class 1TB – Without Victaulic Vortex™ system)

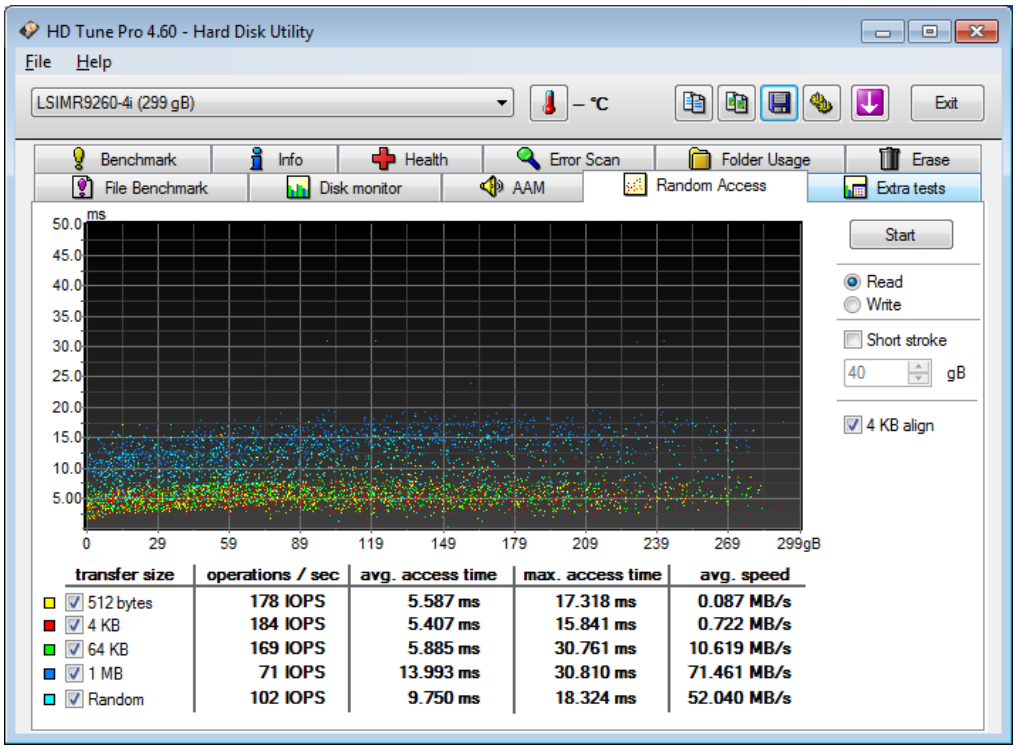


Figure 5 (Sample Random Access Enterprise Drives 300GB – Without Victaulic Vortex™ system)

File Size	operations / sec (IOPS)	avg. access time (ms)	max. access time (ms)	avg. speed (MB/s)
512 bytes	193	5.179	23.952	0.094
4 KB	193	5.162	17.600	0.757
64 KB	180	5.554	23.199	11.276
1 MB	73	13.589	29.541	73.621
Random	107	9.315	20.907	54.526

Table 3 (Average Random Access Enterprise Drives 300GB – Without Victaulic Vortex™ system)

The results of the tests establish base line performance values for each series of drives. The mobile class offered the least performance while the enterprise class offering the greatest performance.

Testing was repeated with the Victaulic Vortex™ system discharging. Each test was repeated 3 times to average the results.

File Size	operations / sec (IOPS)	avg. access time (ms)	max. access time (ms)	avg. speed (MB/s)
512 bytes	54	18.395	642.023	0.026
4 KB	57	17.358	70.826	0.225
64 KB	50	19.813	46.036	3.154
1 MB	15	64.075	151.657	15.614
Random	24	40.862	125.810	12.425

Table 4 (Random Access Laptop Class 60GB – With Victaulic Vortex™ system)

File Size	operations / sec (IOPS)	avg. access time (ms)	max. access time (ms)	avg. speed (MB/s)
512 bytes	74	13.496	38.848	0.036
4 KB	75	13.287	34.687	0.294
64 KB	66	15.169	44.965	4.138
1 MB	33	30.734	101.699	33.682
Random	45	22.570	76.882	22.904

Table 5 (Random Access Desktop Class 1TB – With Victaulic Vortex™ system)

File Size	operations / sec (IOPS)	avg. access time (ms)	max. access time (ms)	avg. speed (MB/s)
512 bytes	194	5.158	24.697	0.095
4 KB	192	5.195	20.865	0.754
64 KB	185	5.416	41.088	11.546
1 MB	74	13.493	32.042	74.129
Random	107	9.275	42.967	54.716

Table 6 (Random Access Enterprise Drives 300GB – With Victaulic Vortex™ system)

The results of the benchmark Random Access tests show that the Victaulic Vortex™ Fire Suppression System discharging has little effect on the performance of the drives as shown in figure 6 and 7.

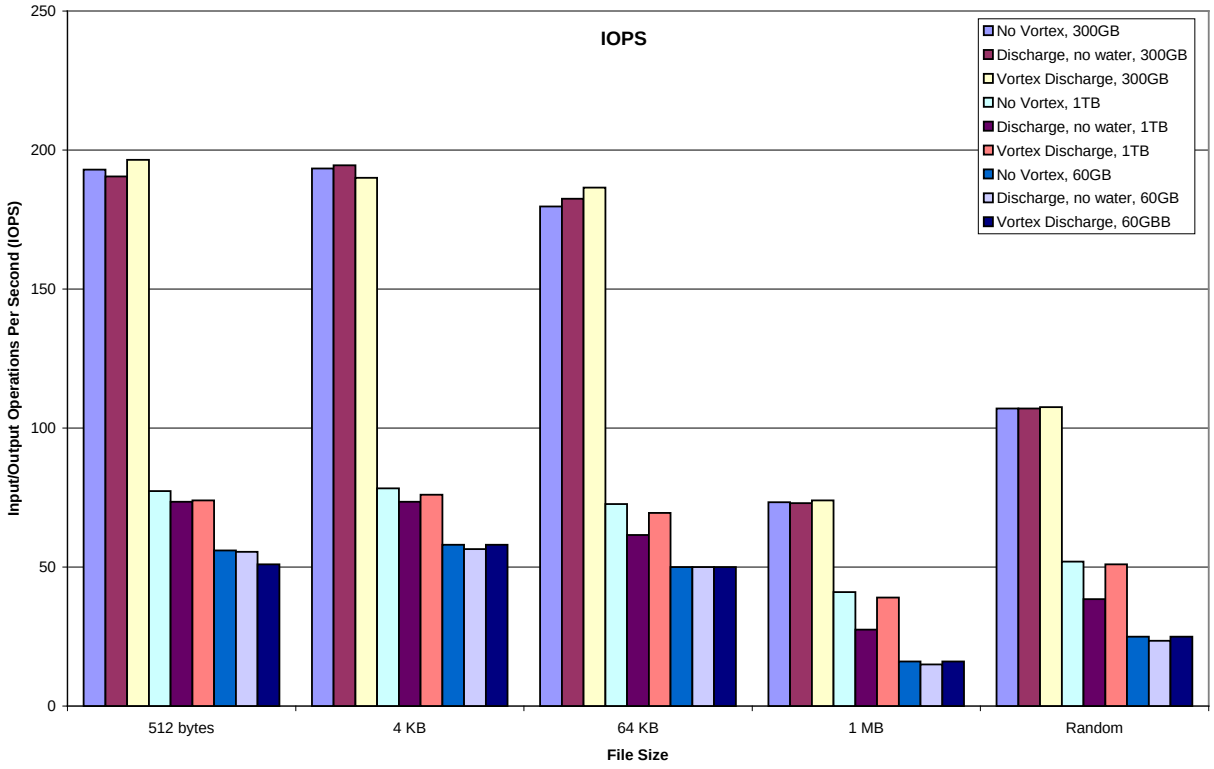


Figure 6 (Random Access IOPS)

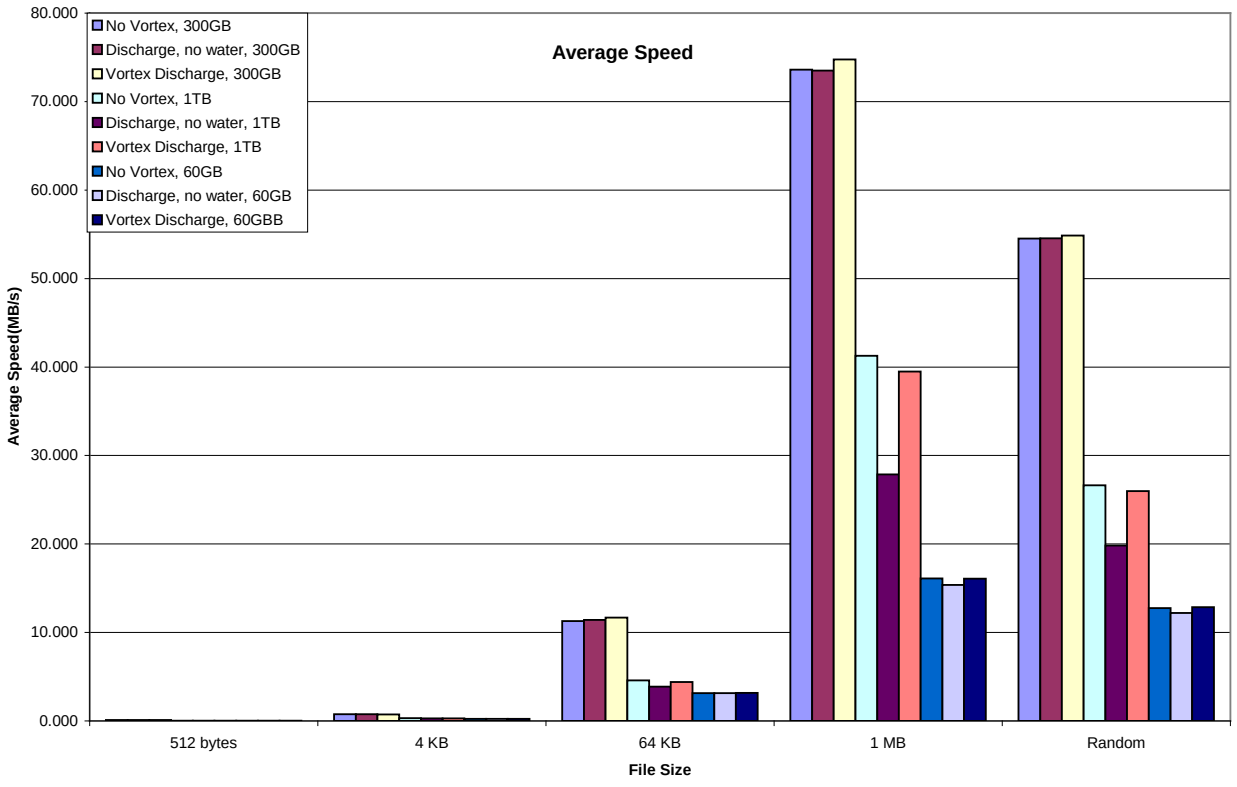


Figure 7 (Random Access, Average Speed)

File Benchmark Testing

The File Benchmark test selected reads and writes a 512MB file in blocks ranging from .5 kb to 8192 kb. The throughput is graphed in MB/s. Tests were conducted both with and without the Victaulic Vortex™ Fire Suppression System. Figures 8 and 9 provide the results for the 300 GB enterprise class hard drive. Figures 10 and 11 represent the 1TB desktop class hard drive and figures 12 and 13 are the mobile class hard drives.

Data for the enterprise class hard drives demonstrates that the throughput of the hard drive is affected very little when reading the files. Overall, a slight increase in performance was shown to occur during the discharge when compared to without. The opposite was observed however during the write sequence. The smaller size blocks were unaffected whereas the larger blocks experienced a decrease in data transfer speed. The average performance increase during the read was found to be 10% with a percent error of 2%, the average performance decrease was found to be 7% with a percent error of 1%.

The overall performance for the desktop class hard drive was less than the enterprise class hard drive which would be expected due to the rotational speed and component materials. During the read event, the desktop class hard drive experienced an increase in performance by 5% with a percent error of 1%. Like the enterprise class hard drive, it too saw a decrease in performance during the discharge by 13% with a percent error of 1%.

The mobile hard drive experienced the great change in performance. During the read event, the desktop class hard drive experienced a decrease in performance by 13%. Like the enterprise class hard drive, it too saw a decrease in performance during the discharge by 21%.

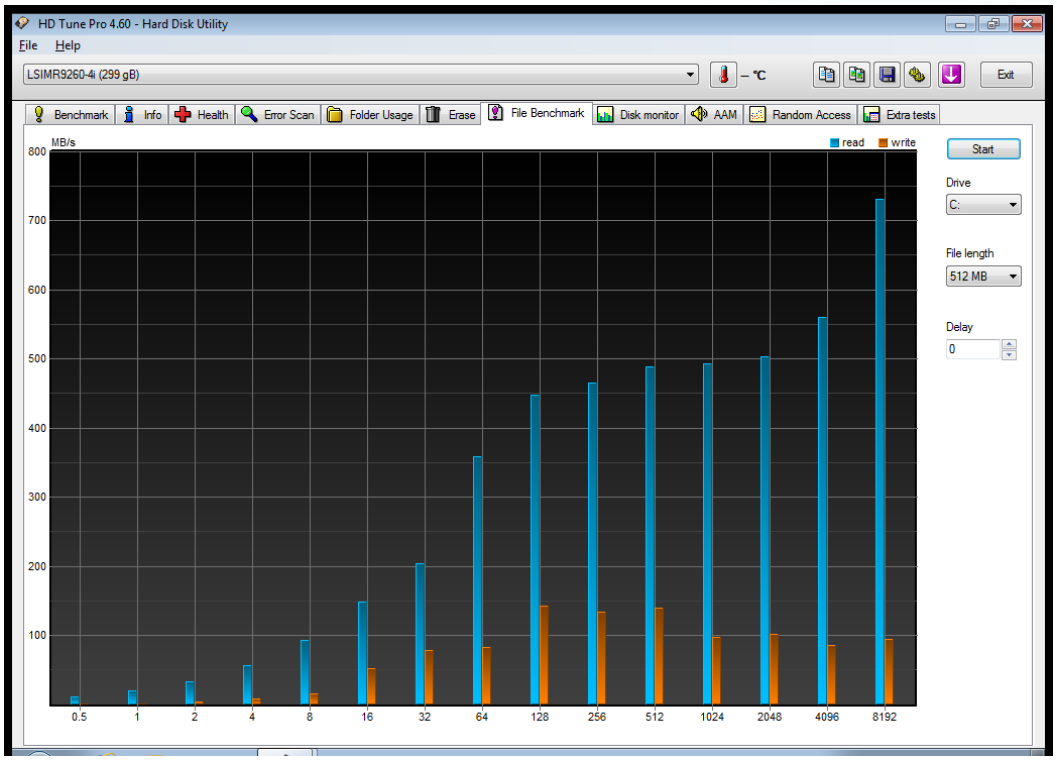


Figure 8 (300GB, Enterprise Drive, File Benchmark, Without Victaulic Vortex™ system)

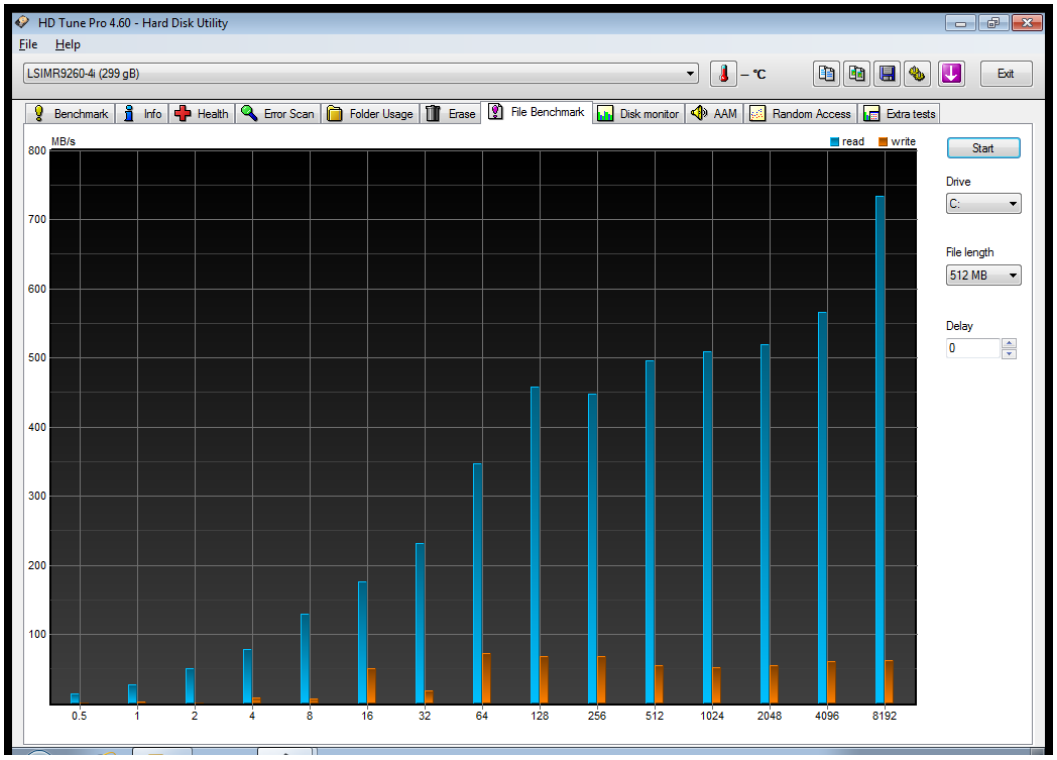


Figure 9 (300GB, Enterprise Drive, File Benchmark, With Victaulic Vortex™ system)

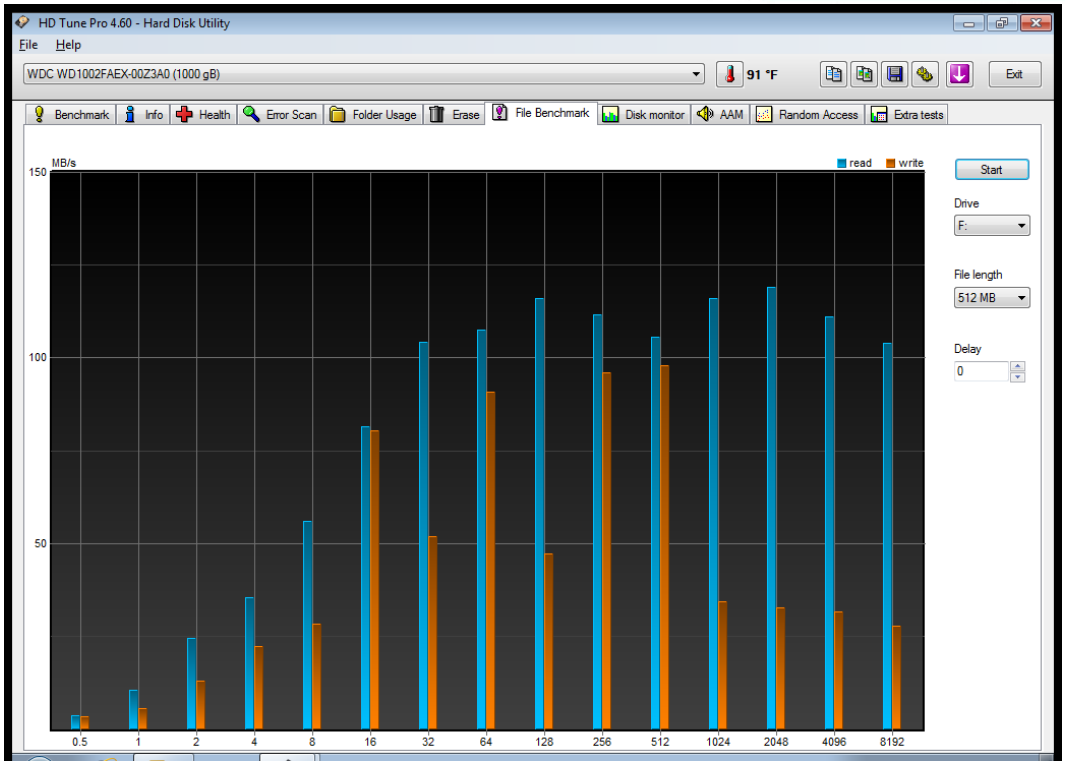


Figure 10 (1TB, Desk Top Drive, File Benchmark, Without Victaulic Vortex™ system)

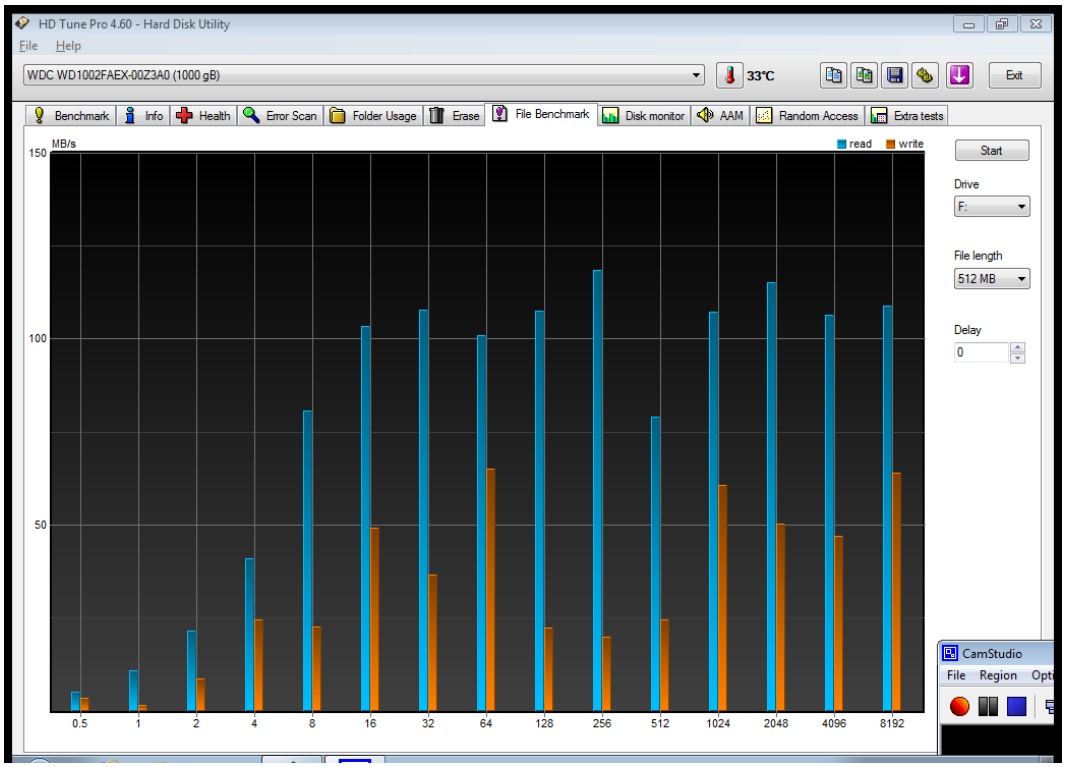


Figure 11 (1TB, Desk Top Drive, File Benchmark, With Victaulic Vortex™ system)

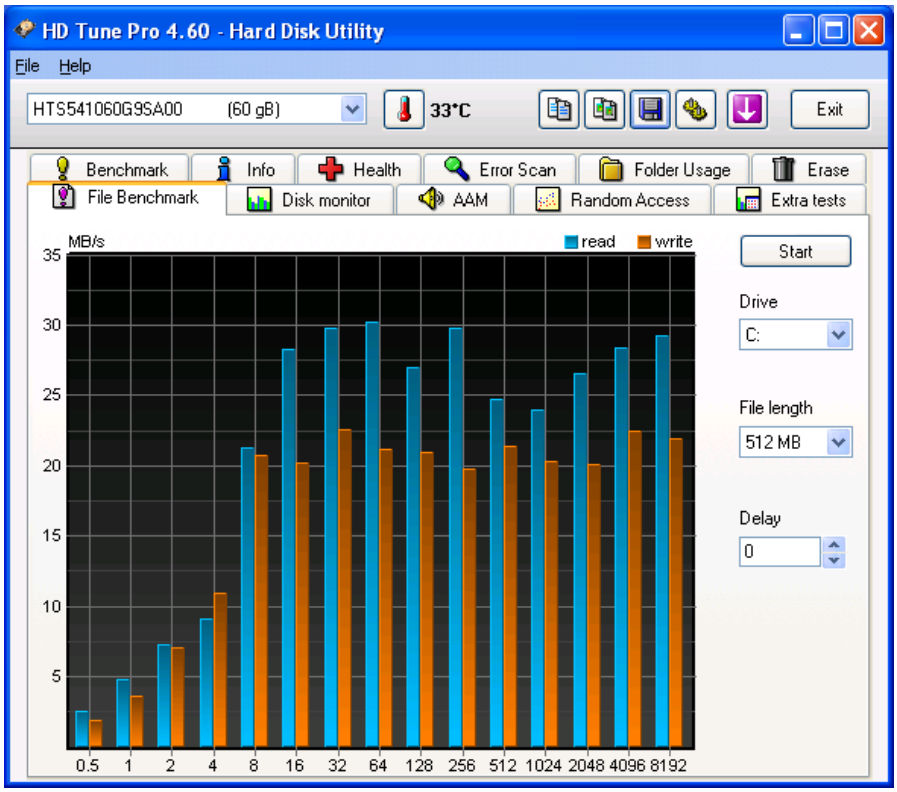


Figure 12 (60 GB, Lap Top Drive, File Benchmark, Without Victaulic Vortex™ system)

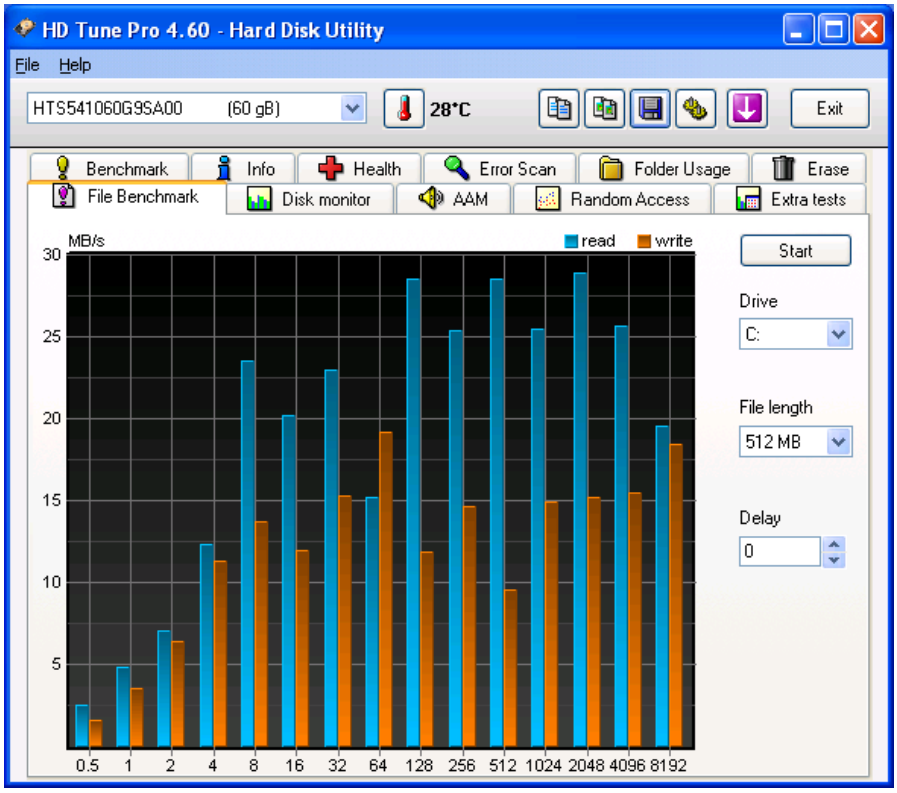
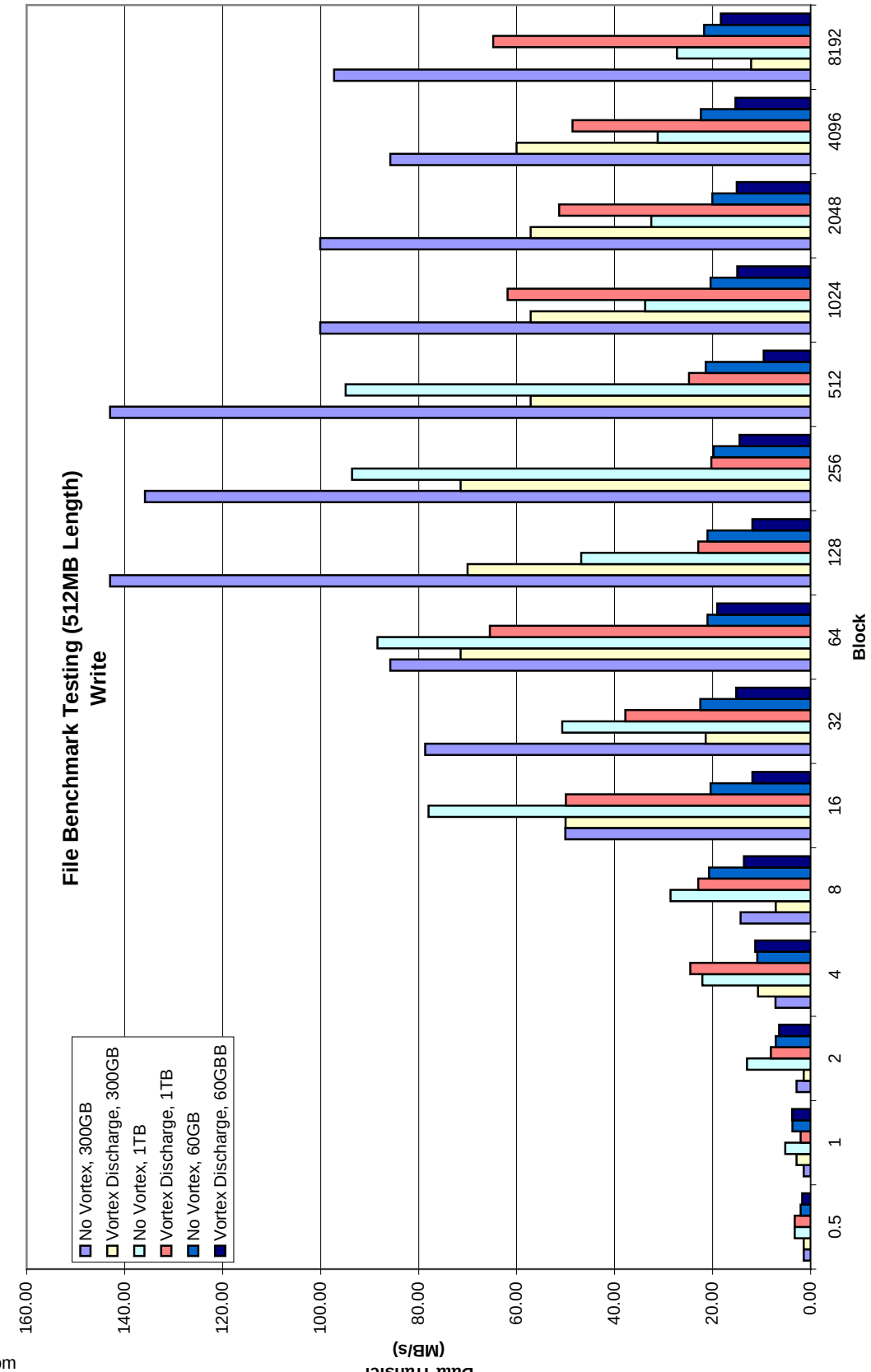
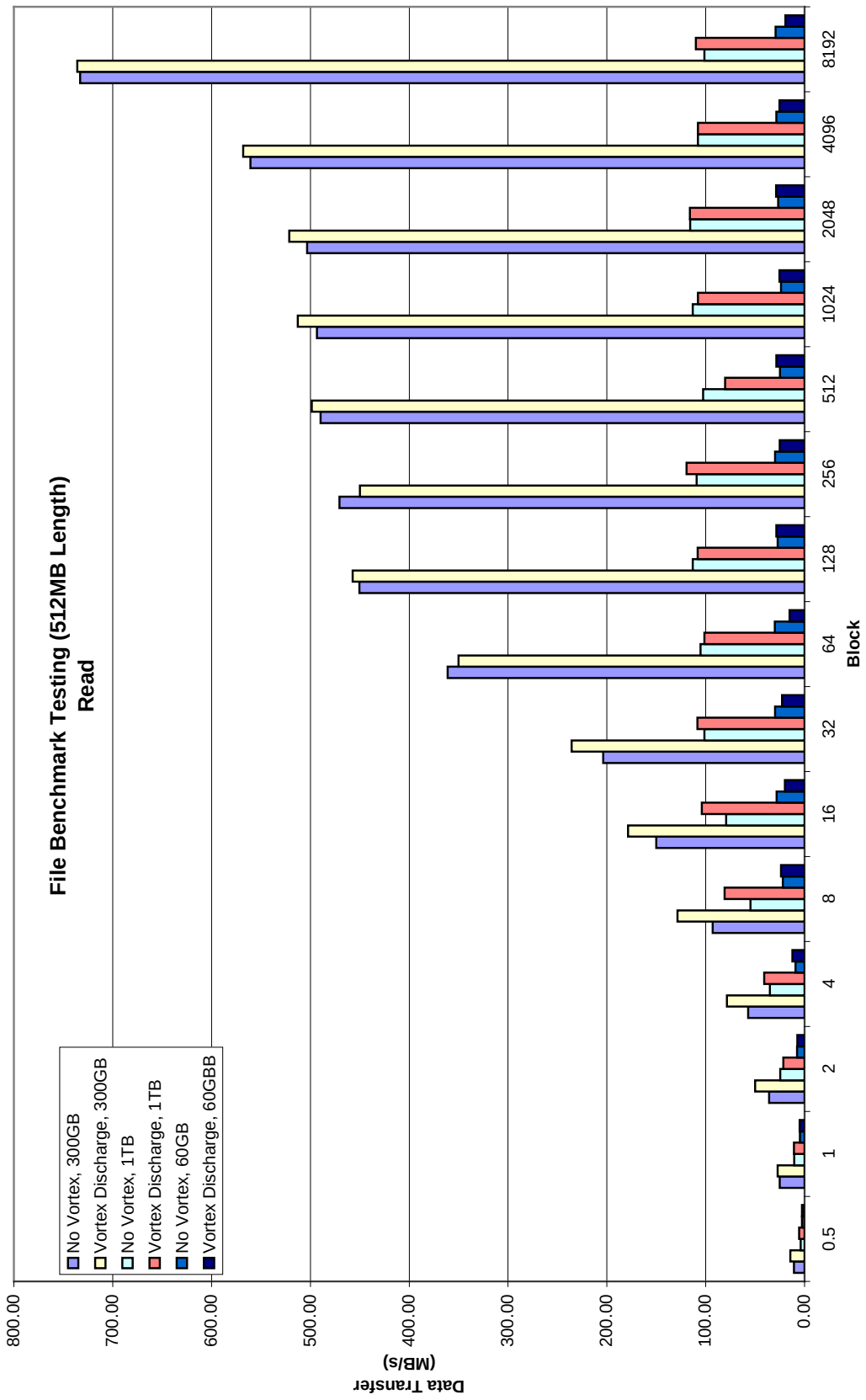


Figure 12 (60 GB, Lap Top Drive, File Benchmark, With Victaulic Vortex™ system)





Summary

Though the preconception exists that water cannot be used in Information Technology Equipment Areas, our testing has shown that, with innovative technology, water can be deployed in this hybrid nitrogen style discharge and be extremely effective, even in very small amounts and in very tiny particles. Throughout the Victaulic Vortex™ Fire Suppression System testing, data was not lost nor were any hard drives damaged due to the discharge from the suppression system. The performance of the drives was found to be enhanced during the read process but reduced during the write process thus slowing the data transfer. The Enterprise class hardware was found to be the least effected during the discharge. The dual agent Victaulic Vortex™ Fire Suppression System provides an innovative, safe and effective fire protection solution for installations which utilize enterprise class hardware such as data centers with minimal effect on computer hard drives.

Victaulic continues to perform demonstrations for customers, subjecting the same drives to the Victaulic Vortex™ Fire Suppression System discharge for long term exposure. Future Victaulic research and development activities include testing stand-alone mobile hard drives. Additional mobile class hard drives are being added to the hybrid computer. The mobile class hard drives will be equipped with shock, sudden motion sensors also known as Active Hard Drive protection. This style of hard drives may be found in current versions of laptops and A/V equipment utilizing compact hard drives. Preliminary testing has shown that discharge from a Victaulic Vortex™ Fire Suppression System will not damage the drives but may cause the drives to enter a parked state, mimicking a fall or drop.