



**SPC BENCHMARK 2C/ENERGY™
EXECUTIVE SUMMARY**

**SEAGATE TECHNOLOGY LLC
SEAGATE CONSTELLATION.2 (*ST91000640SS*)**

SPC-2C/E™ V1.3

Submitted for Review: October 19, 2011

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EXECUTIVE SUMMARY

Test Sponsor and Contact Information

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Auditor	Storage Performance Council – http://www.storageperformance.org Walter E. Baker – AuditService@StoragePerformance.org 643 Bair Island Road, Suite 103 Redwood City, CA 94063 Phone: (650) 556-9384 FAX: (650) 556-9385

Revision Information and Key Dates

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SPC-2 Specification revision number	V1.3
SPC-2 Workload Generator revision number	V1.0
Date Results were first used publicly	October 19, 2011
Date FDR was submitted to the SPC	October 19, 2011
Date the TSC will be available for shipment to customers	currently available
Date the TSC completed audit certification	October 19, 2011

Tested Storage Product (TSP) Description

Seagate Constellation.2 SAS SFF drives offer the best combination of enterprise reliability and power efficiency with high capacities supporting up to 1TB for mainstream servers and external storage arrays. The Constellation.2 drive gives you more than twice the number of drives over 3.5-inch products within the same rack configuration, and delivers system-level performance increase. The Constellation.2 drives are the world's first 1TB SAS drives to operate at 6-Gb/s transfer rates, which is part of the new SAS 2.0 feature set. SAS 2.0 was developed to provide additional signal and data integrity features to enable SAS to be ideally suited for use in high-end network storage applications. The 2.5-inch footprint enables the lowest power profile of any tier-2 capacity-optimized drive. The Constellation.2 drive with PowerChoice™ technology uses less power than 3.5-inch drives. The lower power footprint of 2.5-inch drives enables lower cooling costs. The 2.5-inch drive advantages translate into greater overall value and reduced total cost of ownership to IT organizations and administrators who want to optimize their data center power and performance efficiency.

SPC-2C Reported Data

SPC-2C Reported Data consists of three groups of information:

- The following SPC-2C Primary Metrics, which characterize the overall benchmark result:
 - SPC-2C MBPS™
 - Application Storage Unit (ASU) Capacity
- Supplemental data to the SPC-2C Primary Metrics.
 - Total Price
 - Data Protection Level
- Reported Data for each SPC-2C Test: Large File Processing (LFP), Large Database Query (LDQ), and Video on Demand Delivery (VOD) Test.

SPC-2C Reported Data			
Seagate Constellation.2™ (ST91000640SS)			
SPC-2C MBPS™	ASU Capacity (GB)	Total Price	Data Protection Level
815.42	19,993.073	\$8,971.68	Protected (RAID-5)
<i>The above SPC-2C MBPS™ value represents the aggregate data rate of all three SPC-2C workloads: Large File Processing, Large Database Query, and Video On Demand</i>			
SPC-2C Large File Processing (LFP) Reported Data			
	Data Rate (MB/second)	Number of Streams	Data Rate per Stream
LFP Composite	1,131.27		
Write Only:			
1024 KiB Transfer	1,482.22	5	296.44
256 KiB Transfer	1,478.60	5	295.72
Read-Write:			
1024 KiB Transfer	1,074.49	5	214.90
256 KiB Transfer	1,065.83	5	213.17
Read Only:			
1024 KiB Transfer	847.62	5	169.52
256 KiB Transfer	838.84	5	167.77
<i>The above SPC-2C Data Rate value for LFP Composite represents the aggregate performance of all three LFP Test Phases: (Write Only, Read-Write, and Read Only).</i>			
SPC-2C Large Database Query (LDQ) Reported Data			
	Data Rate (MB/second)	Number of Streams	Data Rate per Stream
LDQ Composite	843.13		
1024 KiB Transfer Size			
4 I/Os Outstanding	853.59	5	170.72
1 I/O Outstanding	847.70	5	169.54
64 KiB Transfer Size			
4 I/Os Outstanding	841.25	5	168.25
1 I/O Outstanding	829.96	5	165.99
<i>The above SPC-2C Data Rate value for LDQ Composite represents the aggregate performance of the two LDQ Test Phases: (1024 KiB and 64 KiB Transfer Sizes).</i>			
SPC-2C Video On Demand (VOD) Reported Data			
	Data Rate (MB/second)	Number of Streams	Data Rate per Stream
	471.86	600	0.79

SPC-2C MBPS™ represents the aggregate data rate, in megabytes per second, of all three SPC-2 workloads: Large File Processing (LFP), Large Database Query (LDQ), and Video on Demand (VOD).

ASU (Application Storage Unit) Capacity represents the total storage capacity read and written in the course of executing the SPC-2 benchmark.

A **Data Protection Level of Protected** using **RAID-5** provides data protection by distributing check data corresponding to user data across multiple disks in the form of bit-by-bit parity.

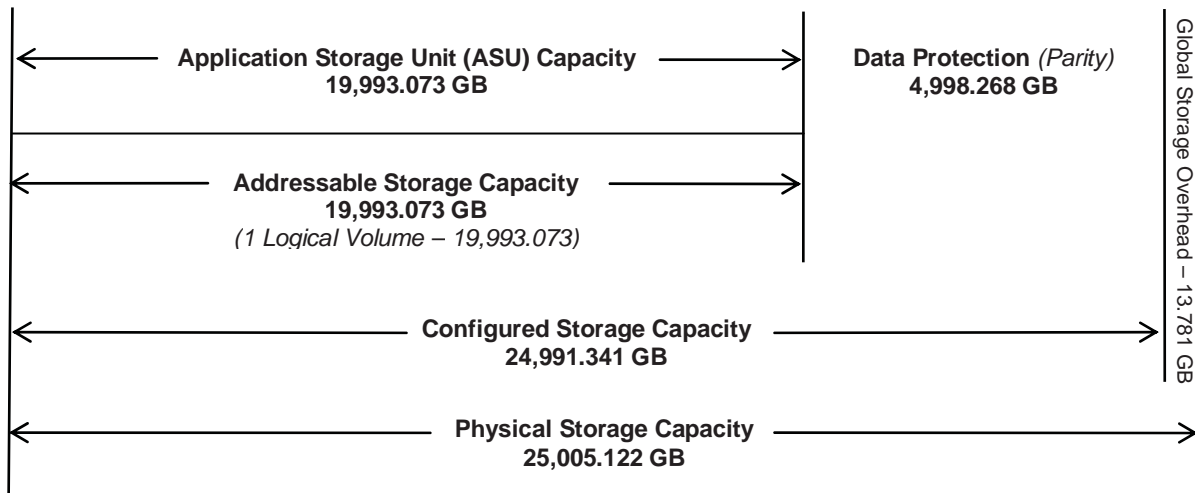
Storage Capacities and Relationships

The Tested Storage Configuration (TSC) must be configured so that there is either no Unused Storage or that the sum of ASU Capacity and storage required for data protection equals 50% (+-1 GiB) of the Physical Storage Capacity.

The TSC met the "no Unused Storage" requirement as documented below:

$$\begin{aligned}
 & \mathbf{25,005.122\ GB} \text{ (Physical Storage Capacity)} \\
 & \mathbf{19,993.073\ GB} \text{ (Total ASU Capacity) + } \mathbf{4,998.268\ GB} \text{ (data protection capacity)} \\
 & \mathbf{+ 13.781\ GB} \text{ (Global Storage Overhead) = } \mathbf{20,005.122\ GB}
 \end{aligned}$$

The following diagram (*not to scale*) documents the various storage capacities and their relationships, used in this SPC-2C benchmark measurement.



SPC-2C/E Reported Data

The initial temperature, recorded during the first one minute of the Idle Test was 23.1C (70.34F). The final temperature, recorded during the last one minute of the Video on Demand Delivery (VOD) Test was 23.3C (73.94F).

Power Environment

Average RMS Voltage:

203.26

Average Power Factor:

0.945

	Usage Profile			Nominal			
	Hours of Use per Day			Power watts	Traffic MBPS	Ratio MBPS/w	Heat BTU/hr
	Heavy	Moderate	Idle				
Low Daily Usage:	0	8	16	151.39	280.99	1.86	516.55
Medium Daily Usage:	4	14	6	184.05	634.24	3.45	628.01
High Daily Usage:	18	6	0	204.47	852.02	4.17	697.67
Composite Metrics:				179.97	589.08	3.27	
Annual Energy Use, kWh:	1,576.54						
Energy Cost, \$/kWh:	\$ 0.12			Annual Energy Cost, \$:	\$ 189.19		

HEAVY SPC-2C Workload: 204.89W at a data rate of 855.03 MB/s.

MODERATE SPC-2C Workload: 203.20W at a data rate of 842.98 MB/s

IDLE SPC-2C Workload: 125.48W at data rate of zero (0).

The above usage profile describes conditions in environments that respectively impose light (**Low Daily Usage**), moderate (**Medium Daily Usage**), and extensive (**High Daily Usage**) demands on the Tested Storage Configuration (TSC). The data in this profile represents the combined results of all three SPC-2C workloads: Large File Processing (LFP), Large Database Query (LDQ) and Video on Demand Delivery (VOD).

The detailed SPC-2C/E Reported Data and associated charts for each workload, including the Idle Test, are available in the associated SPC-2C/E Full Disclosure Report (FDR), in the sections of that document, which are listed below:

- SPC-2C/E Idle Test chart
- SPC-2C/E Large File Processing (LFP) Reported Data table and associated charts
- SPC-2C/E Large Database Query (LDQ) Reported Data table and associated charts
- SPC-2C/E Video on Demand Delivery (VOD) Reported Data table and associated charts

The definitions, listed below, for the remaining items in the above SPC-2C/E Reported Data table, are identical for the SPC-2C/E Reported Data tables for each of the three individual SPC-2 workloads: LFP, LDQ and VOD.

AVERAGE RMS VOLTAGE: The average supply voltage applied to the Tested Storage Product (TSP) as measured during the Measurement Intervals of the SPC-2C Tests.

AVERAGE POWER FACTOR: The ratio of average real power, in watts, to the average apparent power, in volt-amps flowing into the Tested Storage Product (TSP) during the Measurement Intervals of the SPC-2C Tests.

NOMINAL POWER, W: The average power consumption over the course of a day (*24 hours*), taking into account hourly load variations.

NOMINAL TRAFFIC, MBPS: The average data rate over the course of a day (*24 hours*), taking into account hourly load variations.

NOMINAL MBPS/W: The overall efficiency with which the reported data rate can be supported, reflected by the ratio of **NOMINAL TRAFFIC** versus the **NOMINAL POWER**.

NOMINAL HEAT, BTU/HR: The average amount of heat required to be dissipated over the course of a day (*24 hours*), taking into account hourly load variations. (*1 watt = 3.412 BTU/hr*)

COMPOSITE METRICS: The aggregated **NOMINAL POWER**, **NOMINAL TRAFFIC**, and **NOMINAL MBPS/W** for all three environments: **LOW**, **MEDIUM**, and **HIGH DAILY USAGE**.

ANNUAL ENERGY USE, KWH: An estimate of the average energy use across the three environments over the course of a year and computed as (**NOMINAL POWER** * 24 * 0.365).

ENERGY COST, \$/KWH: A standardized energy cost per kilowatt hour.

ANNUAL ENERGY COST: An estimate of the annual energy use across the three environments over the course of a year and computed as (**ANNUAL ENERGY USE** * **ENERGY COST**).

Priced Storage Configuration Pricing

Description	Part Numbers	Qty	Price	Extended Price
1TB SAS 2.5" SAS HDD	ST91000640SS	25	\$206.00	\$5,150.00
6Gb SAS 9265-8l RAID Controller	LSI00277	1	\$750.00	\$750.00
SAS 2.0 1M Cable	MiniSAS	2	\$43.34	\$86.68
Disk enclosure HP D2700	AJ941A	1	\$2,110.00	\$2,110.00
HOT SWAP Tray	371593-001	25	\$35.00	\$875.00
included 5 year warranty			Total	\$8,971.68

The following pricing includes the following:

- Acknowledgement of new and existing hardware and/or software problems within four hours.
- Onsite presence of a qualified maintenance engineer or provision of a customer replaceable part within four hours of the above acknowledgement for any hardware failure that results in an inoperative Priced Storage Configuration component.

Differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration

There were no differences between the TSC and Priced Storage Configuration.

Priced Storage Configuration Diagram

**25 – Seagate Constellation.2™
1 TB SAS Disk Drives
(ST91000640SS)**



HP StorageWorks 25-Bay D2700 Disk Enclosure

**2 – MiniSAS
Cables**



LSI 9285-8i RAID Controller



“Generic” Windows 2008 Server
ASUS P6T6 WS Revolution motherboard
1 – Intel® Xeon® Processor X5570
Windows Server 2008 R2

Priced Configuration Components

Priced Storage Configuration:
1 – LSI SAS9265-8i 6Gb SAS/SATA HBA
25 – Seagate Constellation.2™ (ST91000640SS) 1 TB 6 Gb SAS Disk Drives
1 – PCIe 2.0 x8 front-end connection
2 – 6Gb SAS backend connections (2 used)
25 – HP-Compaq 2.5” Hot Swap SAS/SATA Trays
1 – HP StorageWorks 25-Bay D2700 Storage Enclosure
2 – 1m external mini SAS cables