SPC BENCHMARK 2C/ENERGY™
FULL DISCLOSURE REPORT

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

SPC-2C/E™ V1.3

Submitted for Review: October 19, 2011
Submission Identifier: DE00001

First Edition – October 2011

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AUDIT CERTIFICATION

Craig Parris
Seagate Technology LLC
1280 Disc Drive
Shakopee, MN 55379

October 19, 2011

The SPC Benchmark 2C/Energy™ Reported Data listed below for the Seagate Constellation.2™ *(ST91000640SS)* were produced in compliance with the SPC Benchmark 2C/Energy™ V1.3 Onsite Audit requirements.

SPC Benchmark 2C/Energy™ V1.3 Reported Data	
Tested Storage Product (TSP) Name: Seagate Constellation.2™ *(ST91000640SS)*	
Metric	**Reported Result**
SPC-2 MBPS™	815.42
ASU Capacity	19,993.073 GB
Data Protection Level	Protected *(RAID 5)*
Total Price	$8,971.68

Power Environment

Average RMS Voltage: 203.26 Average Power Factor: 0.945

	Usage Profile: Hours of Use per Day			Nominal			
	Heavy	Moderate	Idle	Power watts	Traffic MBPS	Ratio MBPS/w	Heat BTU/hr
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

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AUDIT CERTIFICATION *(CONT.)*

The following SPC Benchmark 2C/Energy™ Onsite Audit requirements were reviewed and found compliant with V1.3 of the SPC Benchmark 2C/Energy™ Specification:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified by physical inspection and documentation supplied by Seagate Technology LLC:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of the Application Storage Unit (ASU) and requirements.
- The Application Storage Unit (ASU) Capacity was filled with random data using Vdbench 5.03 Beta prior to the execution of the SPC-2C/E™ Tests.
- An appropriate diagram of the Benchmark Configuration/Tested Storage Configuration.
- Physical verification of the components to match the above diagram
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters that were changed from default values.
- The following Host System items were verified by physical inspection and documentation supplied by Seagate Technology LLC:
  - ✓ Required Host System configuration information.
  - ✓ The TSC boundary within the Host System.
- The following SPC-2 Workload Generator information was verified by physical inspection and documentation supplied by Seagate Technology LLC:
  - ✓ The presence and version number of the Workload Generator on each Host System.
  - ✓ Commands and parameters used to configure the SPC-2 Workload Generator.
- The execution of each Test, Test Phase, and Test Run was observed and found compliant with all of the requirements and constraints of Clauses 6, 7 and 12 of the SPC-2 Benchmark Specification.
- The Test Results Files and resultant Summary Results Files received from Seagate Technology LLC for each of the following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 6, 7 and 12 of the SPC Benchmark 2C/Energy™ Specification:
  - ✓ Idle Test
    - Pre-Idle Phase
    - Idle Phase
    - Post-Idle Phase
  - ✓ Data Persistence Test
  - ✓ Large File Processing Test
  - ✓ Large Database Query Test
  - ✓ Video on Demand Delivery Test
- The Yokogawa WT210 Digital Power Meter, used to record power consumption, was verified as an SPC approved "Power Extension apparatus" with a current calibration certificate.

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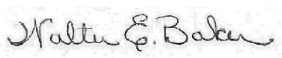
AUDIT CERTIFICATION *(CONT.)*

- All power supplies present in the Tested Storage Configuration were verified as active.
- Seagate Technology LLC provided documentation of the following:
  - ✓ Voltage *(220)*, amperage *(30)*, and phase characteristics *(single)* of the AC inputs used for powering the Tested Storage Configuration.
  - ✓ The configured power supplies were configured for mutual failover.
- Concurrent power measurements were taken at each active AC input so that the total power requirement of the Tested Storage Configuration was recorded.
- The ambient temperature was recorded at the following times in near proximity to the Tested Storage configuration with a precision of at least ±0.1°C:
  - ✓ During the first one minute of the Idle Test *(Initial Energy Extension temperature)*.
  - ✓ During the last one minute of the Video on Demand Delivery Test *(Final Energy Extension temperature)*.
- The Benchmark Configuration/Tested Storage Configuration diagram included the electrical metering, which illustrates the measurement apparatus used and the relationship between the active AC inputs and the associated measurement apparatus inputs.
- There were no differences between the Tested Storage Configuration and Priced Storage Configuration.
- The submitted pricing information met all of the requirements and constraints of Clause 9 of the SPC Benchmark 2C/Energy™ Specification.
- The Full Disclosure Report *(FDR)* met all of the requirements in Clauses 10, 11 and 12 of the SPC Benchmark 2C/Energy™ Specification.
- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

Audit Notes:

The Measurement Interval for the Pre-Idle and Post-Idle Test Runs was 420 seconds rather than 600 seconds. The specified Stream count for the Pre-Idle Test Run was 3 rather that 5. Neither of these items had any effect on the reported benchmark measurements and the validity of those measurements.

Respectfully,



Walter E. Baker
SPC Auditor

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LETTER OF GOOD FAITH

Seagate Technology
1280 Disc Drive
Shakopee MN 55379

Date: *Oct. 17th 2011*

From: Carla Kennedy

To: *Walter Baker*

Subject: SPC-2CE Letter of Good Faith for Seagate's Constellation.2™ SAS ST91000640SS

Seagate Technology is the SPC-2CE Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-2CE benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with ***V1.3*** of the SPC-2CE benchmark specification.

In addition, we have reported any items in the Benchmark Configuration and execution of the benchmark necessary to reproduce the reported results even if the items are not explicitly required to be disclosed by the above SPC-2CE benchmark specification.

Signed: Carl Kennedy Date: Oct 17, 2011

Carla Kennedy
Vice President, Enterprise Compute PLM

Seagate Techology
1280 Disc Drive
Shakopee, MN 55379

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

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

Revision Information and Key Dates	
SPC-2C Specification revision number	V1.3
SPC-2C 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)*
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			
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
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).			
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
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).			
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-2C 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-2C benchmark.

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

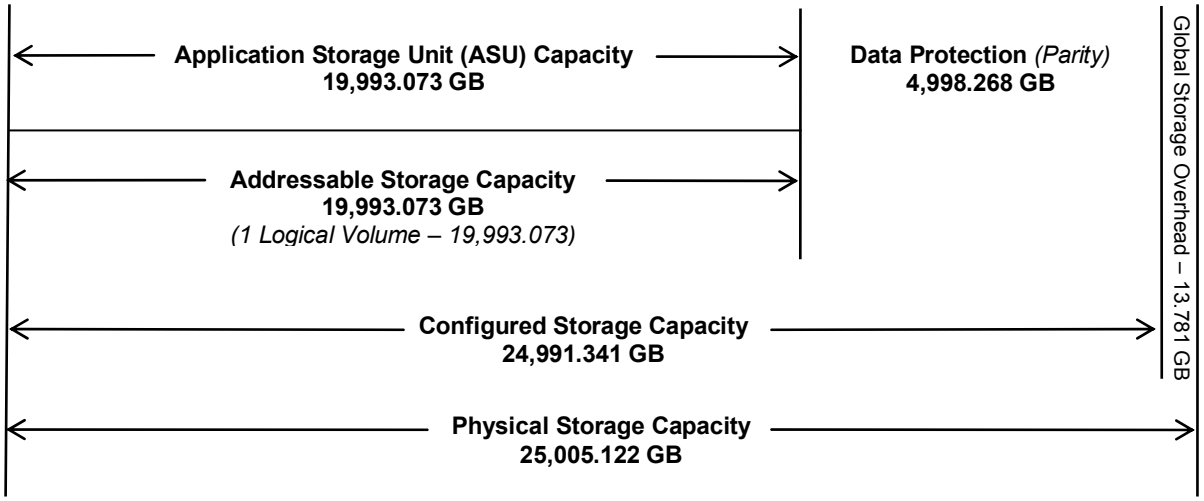
Storage Capacities and Relationships

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:

25,005.122 GB *(Physical Storage Capacity)*
19,993.073 GB *(Total ASU Capacity)* **+ 4,998.268 GB** *(data protection capacity)*
+ 13.781 GB *(Global Storage Overhead)* **= 20,005.122 GB**

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	Traffic	Ratio	Heat
	Heavy	Moderate	Idle	watts	MBPS	MBPS/w	BTU/hr
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 if 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 this document, via the hyperlinks 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

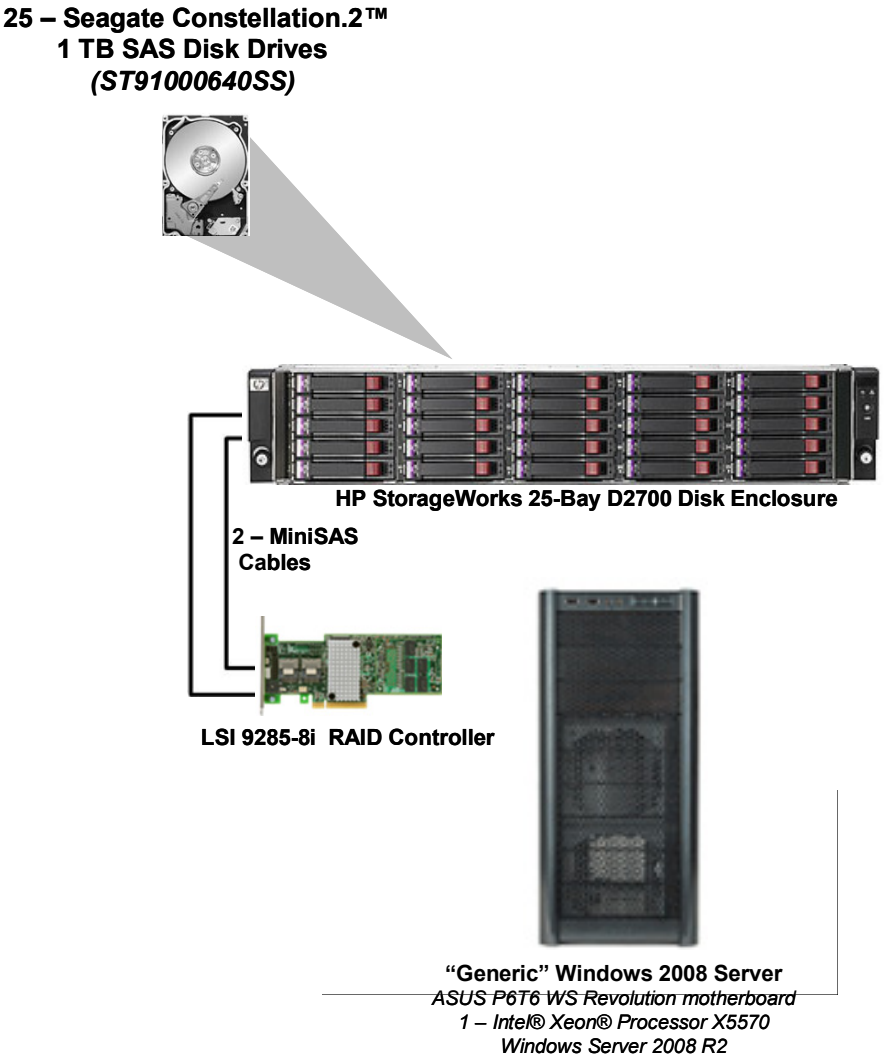
Description		Part Numbers		Qty		Price		Extended Price
1TB SAS 2.5" SAS HDD		ST91000640SS		25		$206.00		$5,150.00
6Gb SAS 9265-8I RAID Controller		LSI00277		1		$750.00		$750.00
SAS 2.0 1M Cable		MiniSAS		2		$43.34		$86.68
Disk enclosure HP D2700		AJ941A		1		$2,110.00		$2,110.00
HOT SWAP Tray		371593-001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

All components are priced from third-party suppliers with an included 5-year warranty. See Appendix E for the required third-party quote.

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

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

Priced Storage Configuration Diagram



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

CONFIGURATION INFORMATION

This portion of the Full Disclosure Report documents and illustrates the detailed information necessary to recreate the Benchmark Configuration (BC), including the Tested Storage Configuration (TSC), so that the SPC-2C benchmark result produced by the BC may be independently reproduced.

In each of the following sections of this document, the appropriate Full Disclosure Report requirement, from the SPC-2C benchmark specification, is stated in italics followed by the information to fulfill the stated requirement.

Benchmark Configuration (BC)/Tested Storage Configuration (TSC) Diagram

Clause 10.4.5.9

The Executive Summary will contain a one page BC/TSC diagram that illustrates all major components of the BC/TSC.

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 21 ***(****Benchmark Configuration/Tested Storage Configuration Diagram****).***

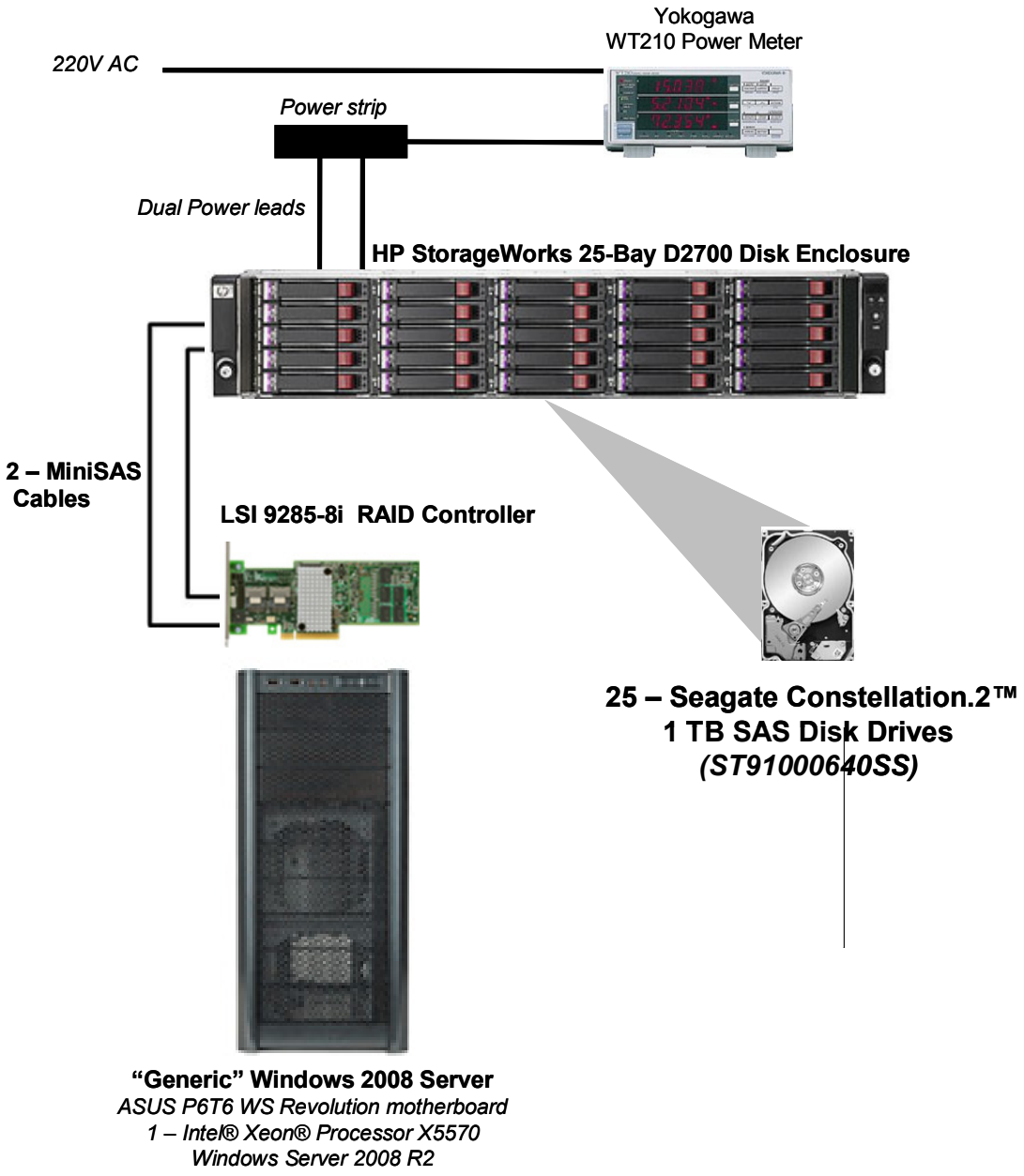
Host System and Tested Storage Configuration Table

Clause 10.4.5.10

The Executive Summary will contain a table that lists the major components of each Host System and the Tested Storage Configuration.

The components that comprise each Host System and the Tested Storage Configuration are listed in the table that appears on page 22 ***(****Benchmark Configuration/Tested Storage Configuration Components****)***.

Benchmark Configuration/Tested Storage Configuration Diagram



Benchmark Configuration/Tested Storage Configuration Components

<table>
<tr><th>Host System:</th><th>Tested Storage Configuration (TSC):</th></tr>
<tr><td rowspan="3">“Generic” Windows 2008 Server
ASUS P6T6 WS Revolution motherboard
1 – Intel® Xeon® Processor X5570
4 Cores, 2.93 GHz,
8 MB Intel® Smart Cache</td><td>1 – LSI SAS9265-8i 6Gb SAS/SATA HBA</td></tr>
<tr><td>25 – Seagate Constellation.2™ (ST91000640SS)
1 TB 6 Gb SAS Disk Drives</td></tr>
<tr><td>1 – PCIe 2.0 x8 front-end connection</td></tr>
<tr><td>6 GB main memory</td><td>2 – 6Gb SAS backend connections (2 used)</td></tr>
<tr><td>Windows Server 2008 R2</td><td>25 – HP-Compaq 2.5” Hot Swap SAS/SATA Trays</td></tr>
<tr><td>PCIe 2.0</td><td>1 – HP StorageWorks 25-Bay D2700 Storage Enclosure</td></tr>
<tr><td>Other BC Components:</td><td>2 – 1m external mini SAS cables</td></tr>
<tr><td>1 – Yokogawa WT210 Digital Power Meter</td><td></td></tr>
</table>

Customer Tunable Parameters and Options

Clause 10.4.6.1

All Benchmark Configuration (BC) components with customer tunable parameter and options that have been altered from their default values must be listed in the FDR. The FDR entry for each of those components must include both the name of the component and the altered value of the parameter or option. If the parameter name is not self-explanatory to a knowledgeable practitioner, a brief description of the parameter's use must also be included in the FDR entry.

"Appendix B: Customer Tunable Parameters and Options" on page 90 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Creation and Configuration

Clause 10.4.6.2

The Full Disclosure Report must include sufficient information to recreate the logical representation of the Tested Storage Configuration (TSC). In addition to customer tunable parameters and options (Clause10.6.6.1), that information must include, at a minimum:

- *A diagram and/or description of the following:*
  - *All physical components that comprise the TSC. Those components are also illustrated in the BC Configuration Diagram in Clause 10.6.5.7 and the Storage Network Configuration Diagram in Clause 10.4.5.9.*
  - *The logical representation of the TSC, configured from the above components that will be presented to the SPC-2C Workload Generator.*
- *Listings of scripts used to create the logical representation of the TSC.*
- *If scripts were not used, a description of the process used with sufficient detail to recreate the logical representation of the TSC.*

"Appendix C: Tested Storage Configuration (TSC) Creation" on page 91 contains the detailed information that describes how to create and configure the logical TSC.

SPC-2C Workload Generator Storage Configuration

Clause 10.4.6.3

The Full Disclosure Report will include all SPC-2C Workload Generator storage configuration commands and parameters used in the SPC-2C benchmark measurement.

The SPC-2C Workload Generator storage configuration commands and parameters for this measurement appear in "Appendix D: SPC-2C Workload Generator Storage Commands and Parameters" on page 91.

SPC-2C DATA REPOSITORY

This portion of the Full Disclosure Report presents the detailed information that fully documents the various SPC-2C storage capacities and mappings used in the Tested Storage Configuration. "SPC-2C Data Repository Definitions" on page 85 contains definitions of terms specific to the SPC-2C Data Repository.

In each of the following sections of this document, the appropriate Full Disclosure Report requirement, from the SPC-2C benchmark specification, is stated in italics followed by the information to fulfill the stated requirement.

SPC-2C Storage Capacities and Relationships

Clause 10.4.7.1

Two tables and an illustration documenting the storage capacities and relationships of the SPC-2C Storage Hierarchy (Clause 2.1) shall be included in the FDR.

SPC-2C Storage Capacities

SPC-2C Storage Capacities		
Storage Hierarchy Component	**Units**	**Capacity**
Total ASU Capacity	Gigabytes (GB)	19,993.073
Addressable Storage Capacity	Gigabytes (GB)	19,993.073
Configured Storage Capacity	Gigabytes (GB)	24,991.341
Physical Storage Capacity	Gigabytes (GB)	25,055.122
Data Protection *(RAID-5)*	Gigabytes (GB)	4,998.268
Required Storage	Gigabytes (GB)	0.000
Global Storage Overhead	Gigabytes (GB)	13.781
Total Unused Storage	Gigabytes (GB)	0.000

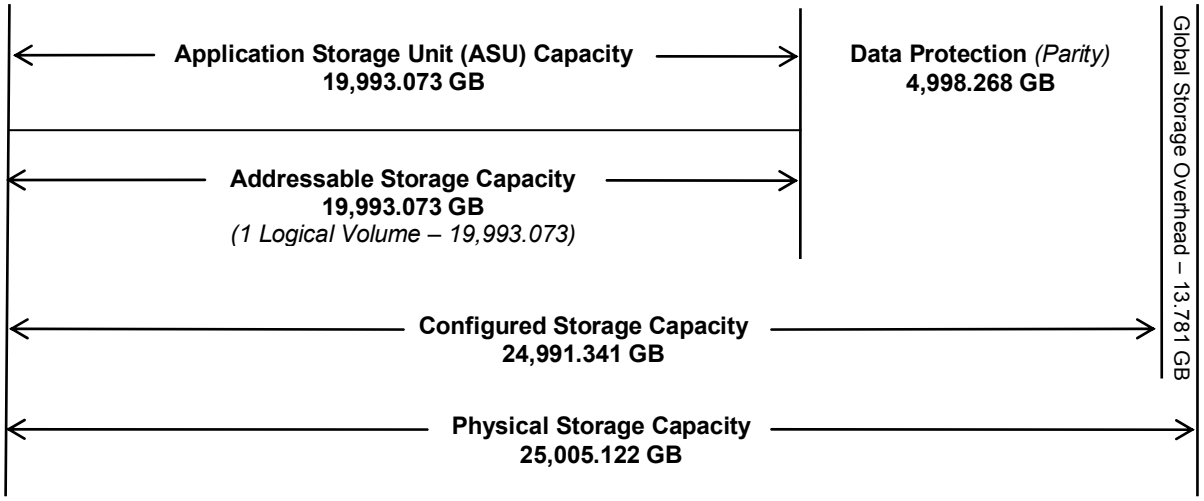
SPC-2C Storage Hierarchy Ratios

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	100.00%	80.00%	79.96%
Data Protection *(RAID-5)*		20.00%	19.99%
Addressable Storage Capacity		80.00%	79.96%
Required Storage		0.00%	0.00%
Configured Storage Capacity			99.94%
Global Storage Overhead			0.06%
Unused Storage:			
Addressable	0.00%		
Configured		0.00%	
Physical			0.00%

The Physical Storage Capacity consisted of 25,005.122 GB distributed over 25 disk drives each with a formatted capacity of 1,000.205 GB. There was 0.000 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 13.781 GB (0.06%) of Physical Storage Capacity. There was 0.000 GB (0.00%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 100.00% of the Addressable Storage Capacity resulting in 0.000 GB (0.00%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(RAID-5)* capacity was 4,998.268 GB of which 4,998.268 GB was utilized. The total Unused Storage was 0.000 GB.

SPC-2C Storage Capacities and Relationships Illustration

The various storage capacities configured in the benchmark result are illustrated below (not to scale).



Logical Volume Capacity and ASU Mapping

Clause 10.4.7.2

A table illustrating the capacity of the Application Storage Unit (ASU) and the mapping of Logical Volumes to ASU will be provided in the FDR. Capacity must be stated in gigabytes (GB) as a value with a minimum of two digits to the right of the decimal point. Each Logical Volume will be sequenced in the table from top to bottom per its position in the contiguous address space of the ASU. Each Logical Volume entry will list its total capacity, the portion of that capacity used for the ASU, and any unused capacity.

Logical Volume (LV) Capacity and Mapping			
ASU (19,993.073 GB)			
	Total Capacity *(GB)*	Capacity Used *(GB)*	Capacity Unused *(GB)*
Logical Volume 1	19,993.073 per LV	19,993.073 per LV	0.000 per LV

See the Storage Definition (sd) entries in "Appendix D: SPC-2C Workload Generator Storage Commands and Parameters" on page 91 for more detailed configuration information.

SPC-2C TEST EXECUTION RESULTS

This portion of the Full Disclosure Report documents the results of the various SPC-2C Test, Test Phases, Test Run Sequences, and Test Runs. "SPC-2C Test Execution Definitions" on page 86 contains definitions of terms specific to the SPC-2C Data Repository.

In each of the following sections of this document, the appropriate Full Disclosure Report requirement, from the SPC-2C benchmark specification, is stated in italics followed by the information to fulfill the stated requirement.

SPC-2C Tests, Test Phases, Test Run Sequences, and Test Runs

The SPC-2C benchmark consists of the following Tests, Test Phases, Test Run Sequences, and Test Runs:

- **Large File Processing Test**
  - WRITE ONLY Test Phase
    - Test Run Sequence 1
      - ✓ Test Run 1 – 1024 KiB Transfer – maximum number of Streams
      - ✓ Test Run 2 – 1024 KiB Transfer – 50% of Test Run 1's Streams value
      - ✓ Test Run 3 – 1024 KiB Transfer – 25% of Test Run 1's Streams value
      - ✓ Test Run 4 – 1024 KiB Transfer – 12.5% of Test Run 1's Streams value
      - ✓ Test Run 5 – 1024 KiB Transfer – single (1) Stream
    - Test Run Sequence 2
      - ✓ Test Run 6 – 256 KiB Transfer – maximum number of Streams
      - ✓ Test Run 7 – 256 KiB Transfer – 50% of Test Run 6's Streams value
      - ✓ Test Run 8 – 256 KiB Transfer – 25% of Test Run 6's Streams value
      - ✓ Test Run 9 – 256 KiB Transfer – 12.5% of Test Run 6's Streams value
      - ✓ Test Run 10 – 256 KiB Transfer – single (1) Stream
  - READ-WRITE Test Phase
    - Test Run Sequence 3
      - ✓ Test Run 11 – 1024 KiB Transfer – maximum number of Streams
      - ✓ Test Run 12 – 1024 KiB Transfer – 50% of Test Run 11's Streams value
      - ✓ Test Run 13 – 1024 KiB Transfer – 25% of Test Run 11's Streams value
      - ✓ Test Run 14 – 1024 KiB Transfer – 12.5% of Test Run 11's Streams value
      - ✓ Test Run 15 – 1024 KiB Transfer – single (1) Stream
    - Test Run Sequence 4
      - ✓ Test Run 16 – 256 KiB Transfer – maximum number of Streams
      - ✓ Test Run 17 – 256 KiB Transfer – 50% of Test Run 16's Streams value
      - ✓ Test Run 18 – 256 KiB Transfer – 25% of Test Run 16's Streams value
      - ✓ Test Run 19 – 256 KiB Transfer – 12.5% of Test Run 16's Streams value
      - ✓ Test Run 20 – 256 KiB Transfer – single (1) Stream

- **Large File Processing Test *(continued)***
  - READ ONLY Test Phase
    - Test Run Sequence 5
      - ✓ Test Run 21 – 1024 KiB Transfer – maximum number of Streams
      - ✓ Test Run 22 – 1024 KiB Transfer – 50% of Test Run 21's Streams value
      - ✓ Test Run 23 – 1024 KiB Transfer – 25% of Test Run 21's Streams value
      - ✓ Test Run 24 – 1024 KiB Transfer – 12.5% of Test Run 21's Streams value
      - ✓ Test Run 25 – 1024 KiB Transfer – single (1) Stream
    - Test Run Sequence 6
      - ✓ Test Run 26 – 256 KiB Transfer – maximum number of Streams
      - ✓ Test Run 27 – 256 KiB Transfer – 50% of Test Run 26's Streams value
      - ✓ Test Run 28 – 256 KiB Transfer – 25% of Test Run 26's Streams value
      - ✓ Test Run 29 – 256 KiB Transfer – 12.5% of Test Run 26's Streams value
      - ✓ Test Run 30 – 256 KiB Transfer – single (1) Stream

- **Large Database Query Test**
  - 1024 KIB TRANSFER SIZE Test Phase
    - Test Run Sequence 1
      - ✓ Test Run 1 – 4 I/O Requests Outstanding – maximum number of Streams
      - ✓ Test Run 2 – 4 I/O Requests Outstanding – 50% of Test Run 1's Streams value
      - ✓ Test Run 3 – 4 I/O Requests Outstanding – 25% of Test Run 1's Streams value
      - ✓ Test Run 4 – 4 I/O Requests Outstanding – 12.5% of Test Run 1's Streams value
      - ✓ Test Run 5 – 4 I/O Requests Outstanding – single (1) Stream
    - Test Run Sequence 2
      - ✓ Test Run 6 – 1 I/O Request Outstanding – maximum number of Streams
      - ✓ Test Run 7 – 1 I/O Request Outstanding – 50% of Test Run 6's Streams value
      - ✓ Test Run 8 – 1 I/O Request Outstanding – 25% of Test Run 6's Streams value
      - ✓ Test Run 9 – 1 I/O Request Outstanding – 12.5% of Test Run 6's Streams value
      - ✓ Test Run 10 – 1 I/O Request Outstanding – single (1) Stream
  - 64 KIB TRANSFER SIZE Test Phase
    - Test Run Sequence 3
      - ✓ Test Run 11 – 4 I/O Requests Outstanding – maximum number of Streams
      - ✓ Test Run 12 – 4 I/O Requests Outstanding – 50% of Test Run 11's Streams value
      - ✓ Test Run 13 – 4 I/O Requests Outstanding – 25% of Test Run 11's Streams value
      - ✓ Test Run 14 – 4 I/O Requests Outstanding – 12.5% of Test Run 11's Streams value
      - ✓ Test Run 15 – 4 I/O Requests Outstanding – single (1) Stream
    - Test Run Sequence 4
      - ✓ Test Run 16 – 1 I/O Request Outstanding – maximum number of Streams
      - ✓ Test Run 17 – 1 I/O Request Outstanding – 50% of Test Run 16's Streams value
      - ✓ Test Run 18 – 1 I/O Request Outstanding – 25% of Test Run 16's Streams value
      - ✓ Test Run 19 – 1 I/O Request Outstanding – 12.5% of Test Run 16's Streams value
      - ✓ Test Run 20 – 1 I/O Request Outstanding – single (1) Stream

- **Video on Demand Delivery Test**
  - Video on Demand Delivery Test Run

- **Data Persistence Test**
  - Data Persistence Test Run 1
  - Data Persistence Test Run 2

Each Test is an atomic unit that must be executed from start to finish before any other Test, Test Phase, or Test Run may be executed.

The results from each Test, Test Phase, and Test Run are listed below along with a more detailed explanation of each component.

Large File Processing Test

Clause 6.4.3.1

The Large File Processing Test consists of the I/O operations associated with the type of applications, in a wide range of fields, which require simple sequential processing of one or more large files. Specific examples of those types of applications include scientific computing and large-scale financial processing

Clause 6.4.3.2

The Large File Processing Test has three Test Phases, which shall be executed in the following uninterrupted sequence:

1. *WRITE ONLY*
2. *READ-WRITE*
3. *READ ONLY*

The BC shall not be restarted or manually disturbed, altered, or adjusted during the execution of the Large File Processing Test. If power is lost to the BC during this Test all results shall be rendered invalid and the Test re-run in its entirety.

Clause 10.4.8.1

The Full Disclosure Report will contain the following content for the Large File Processing Test:

1. *A listing of the SPC-2C Workload Generator commands and parameters used to execute each of the Test Runs in the Large File Processing Test.*
2. *The human readable SPC-2C Test Results File for each of the Test Runs in the Large File Processing Test.*
3. *A table that contains the following information for each Test Run in all three Test Phases of the Large File Processing Test:*
    - *The number Streams specified.*
    - *The Ramp-Up duration in seconds.*
    - *The Measurement Interval duration in seconds.*
    - *The average data rate, in MB per second, for the Measurement Interval.*
    - *The average data rate, in MB per second, per Stream for the Measurement Interval.*
4. *Average Data Rate and Average Data Rate per Stream graphs as defined in Clauses 10.1.1 and 10.1.2.*

SPC-2C Workload Generator Commands and Parameters

The SPC-2C Workload Generator commands and parameters for the Large File Processing Test Runs are documented in "Appendix E: SPC-2C Workload Generator Execution Commands and Parameters" on Page 96.

SPC-2C Test Results File

A link to the SPC-2C Test Results file generated from the Large File Processing Test Runs is listed below.

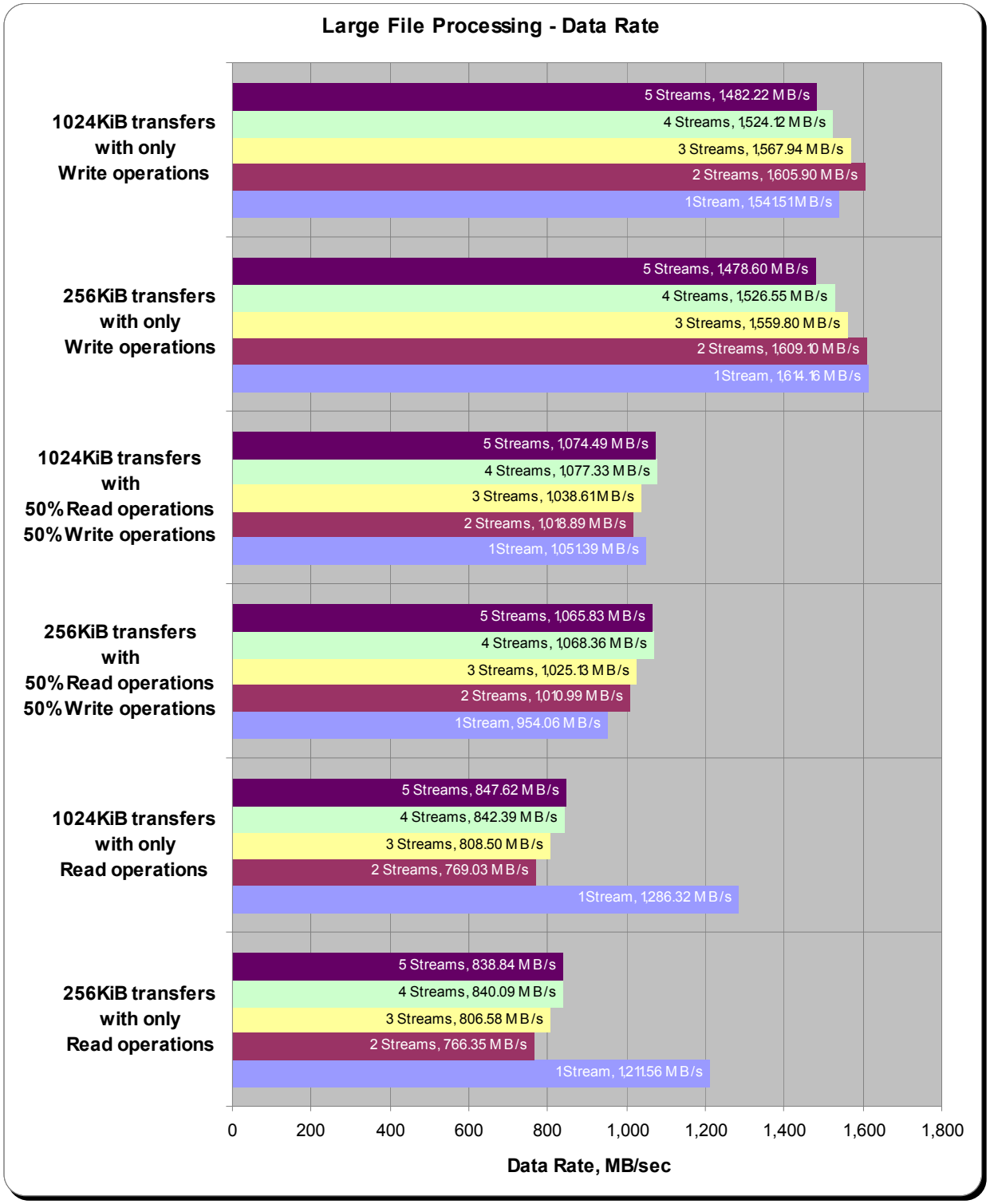
SPC-2C Large File Processing Test Results File

SPC-2C Large File Processing Average Data Rates (MB/s)

The average Data Rate (MB/s) for each Test Run in the three Test Phases of the SPC-2C Large File Processing Test is listed in the table below as well as illustrated in the following graph.

Test Run Sequence	1 Stream	2 Streams	3 Streams	4 Streams	5 Streams
Write 1024KiB	1,541.51	1,605.90	1,567.94	1,524.12	1,482.22
Write 256KiB	1,614.16	1,609.10	1,559.80	1,526.55	1,478.60
Read/Write 1024KiB	1,051.39	1,018.89	1,038.61	1,077.33	1,074.49
Read/Write 256KiB	954.06	1,010.99	1,025.13	1,068.36	1,065.83
Read 1024KiB	1,286.32	769.03	808.50	842.39	847.62
Read 256KiB	1,211.56	766.35	806.58	840.09	838.84

SPC-2C Large File Processing Average Data Rates Graph

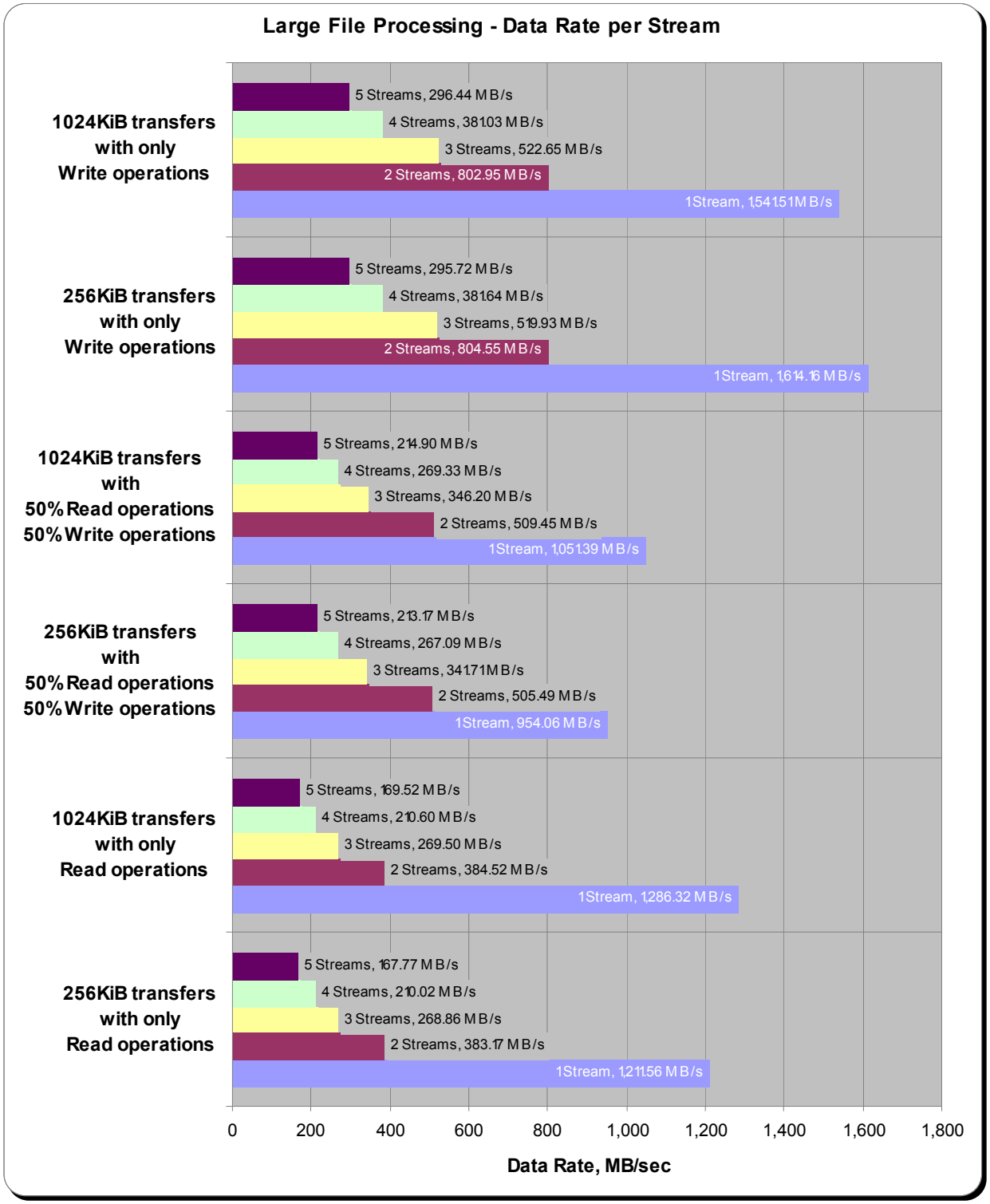


SPC-2C Large File Processing Average Data Rate per Stream

The average Data Rate per Stream for each Test Run in the three Test Phases of the SPC-2C Large File Processing Test is listed in the table below as well as illustrated in the following graph.

Test Run Sequence	1 Stream	2 Streams	3 Streams	4 Streams	5 Streams
Write 1024KiB	1,541.51	802.95	522.65	381.03	296.44
Write 256KiB	1,614.16	804.55	519.93	381.64	295.72
Read/Write 1024KiB	1,051.39	509.45	346.20	269.33	214.90
Read/Write 256KiB	954.06	505.49	341.71	267.09	213.17
Read 1024KiB	1,286.32	384.52	269.50	210.60	169.52
Read 256KiB	1,211.56	383.17	268.86	210.02	167.77

SPC-2C Large File Processing Average Data Rate per Stream Graph

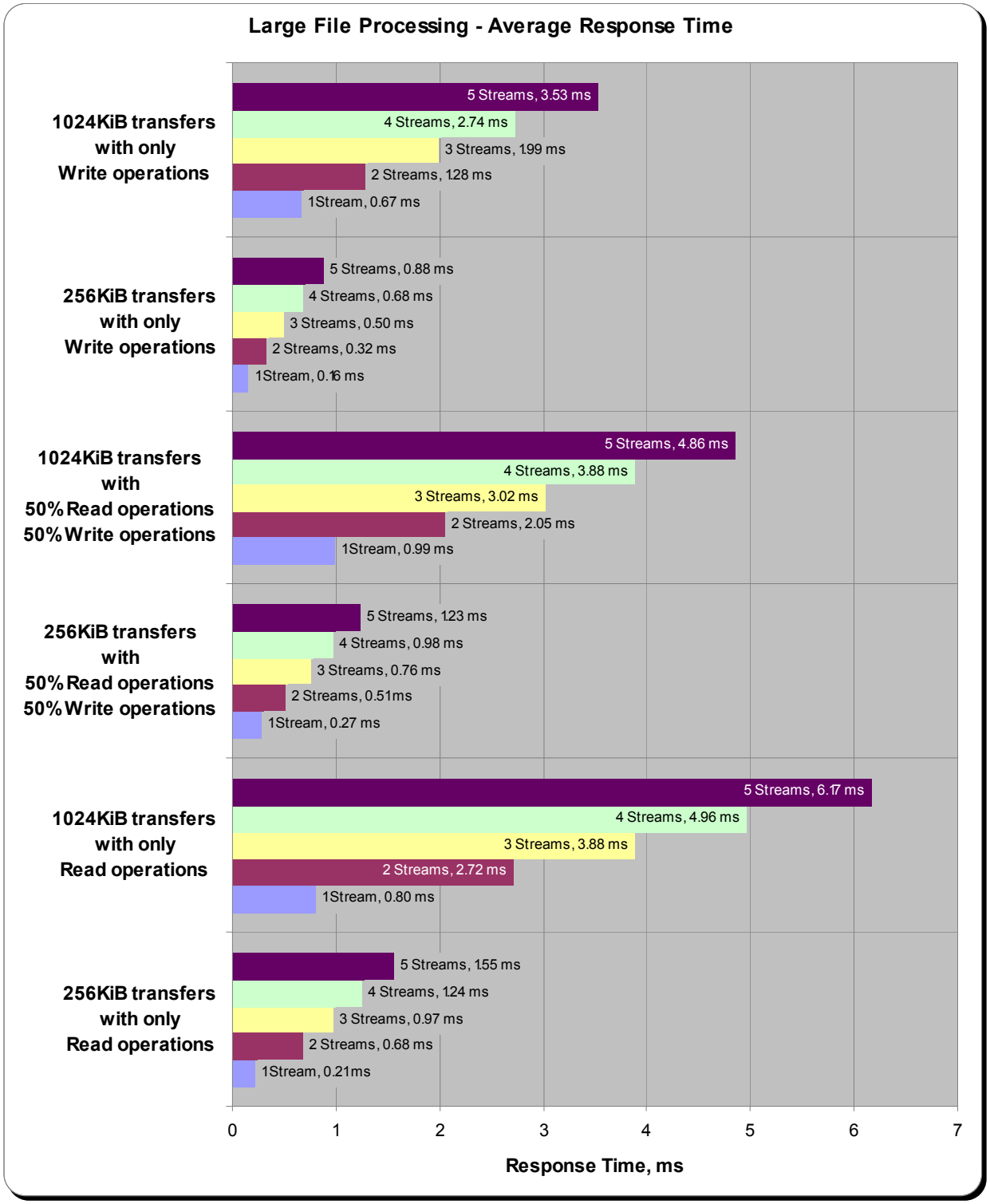


SPC-2C Large File Processing Average Response Time

The average Response Time, milliseconds (ms), for each Test Run in the three Test Phases of the SPC-2C Large File Processing Test is listed in the table below as well as illustrated in the following graph.

Test Run Sequence	1 Stream	2 Streams	3 Streams	4 Streams	5 Streams
Write 1024KiB	0.67	1.28	1.99	2.74	3.53
Write 256KiB	0.16	0.32	0.50	0.68	0.88
Read/Write 1024KiB	0.99	2.05	3.02	3.88	4.86
Read/Write 256KiB	0.27	0.51	0.76	0.98	1.23
Read 1024KiB	0.80	2.72	3.88	4.96	6.17
Read 256KiB	0.21	0.68	0.97	1.24	1.55

SPC-2C Large File Processing Average Response Time Graph



Large File Processing Test – WRITE ONLY Test Phase

Clause 10.4.8.1.1

1. *A table that will contain the following information for each "WRITE ONLY, 1024 KiB Transfer Size" Test Run:*
   - *The number of Streams specified.*
   - *The average data rate, average data rate per stream, and average Response Time reported at five second intervals.*
2. *Average Data Rate (intervals), Average Data Rate per Stream (intervals), and Average Response Time (intervals) graphs for the "WRITE ONLY, 1024 KiB Transfer Size" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*
3. *A table that will contain the following information for each "WRITE ONLY, 256 KiB Transfer Size" Test Run:*
   - *The number of Streams specified.*
   - *The average data rate, average data rate per stream, and average Response Time reported at five second intervals.*
4. *Average Data Rate (intervals), Average Data Rate per Stream (intervals), and Average Response Time (intervals) graphs for the "WRITE ONLY, 256 KiB Transfer Size" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*

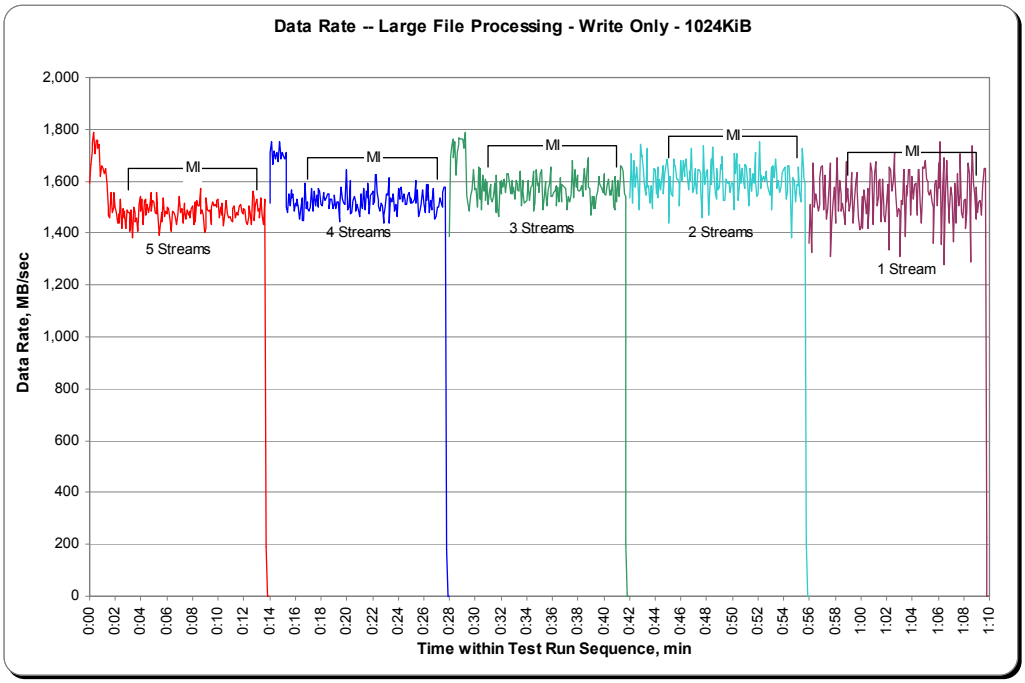
The SPC-2C "Large File Processing/WRITE ONLY/1024 KiB Transfer Size" and "Large File Processing/WRITE ONLY/256 KiB Transfer Size" data tables are not embedded in this document due to size. The tables are available via the URLs listed below:

SPC-2C "Large File Processing/Write Only/1024 KiB Transfer Size" Test Run Data

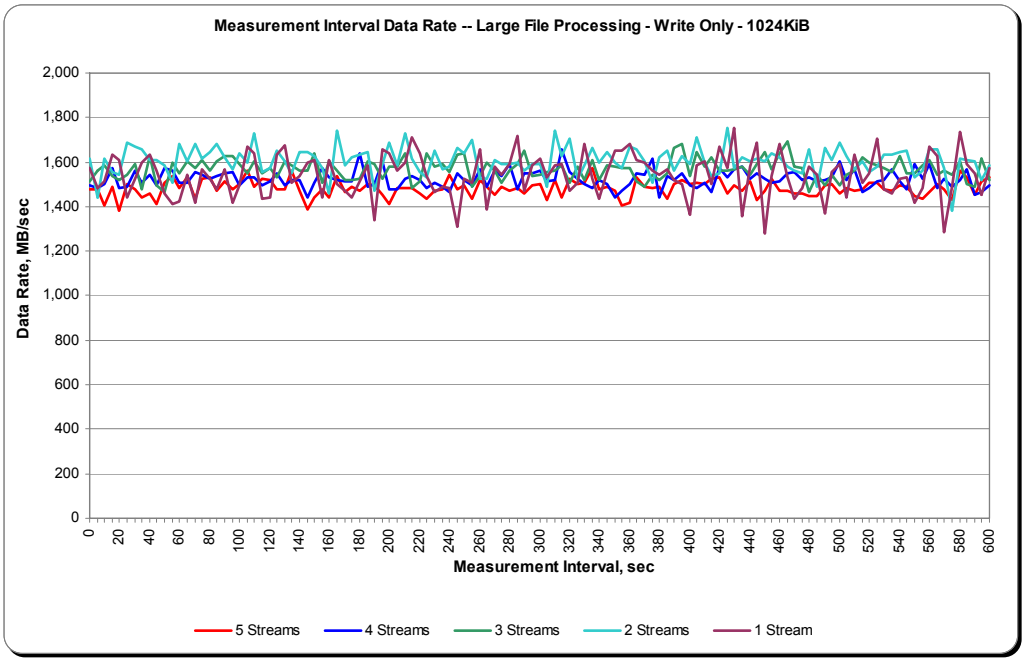
SPC-2C "Large File Processing/Write Only/256 KiB Transfer Size" Test Run Data

The corresponding graphs to illustrate the average Data Rate, average Data Rate per Stream, and average Response Time produced by each of the Test Runs appear on next four pages.

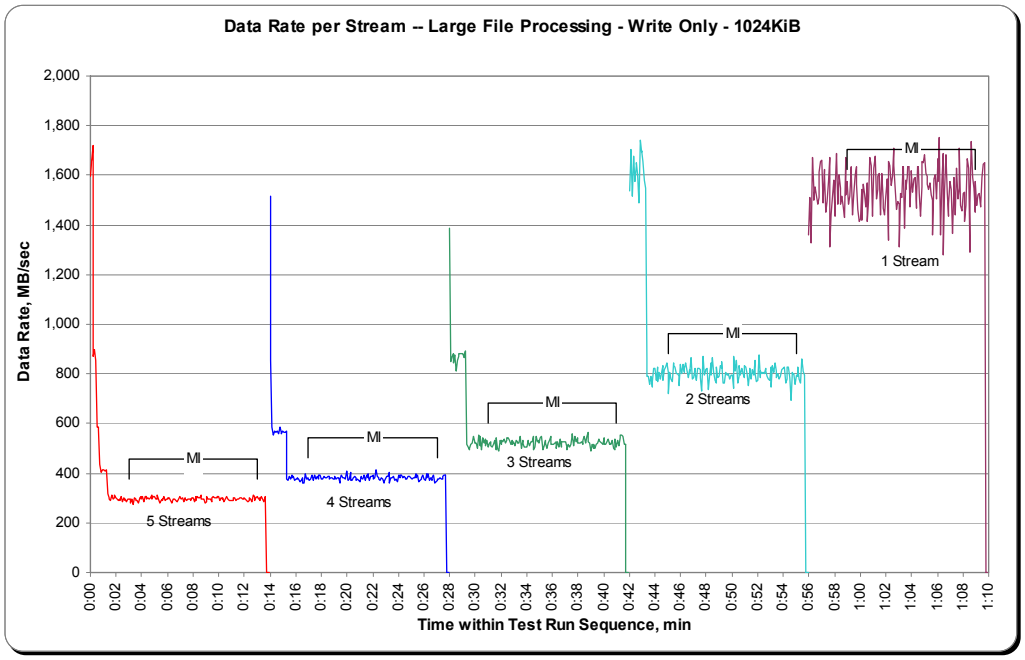
SPC-2C "Large File Processing/WRITE ONLY/1024 KiB Transfer Size" Average Data Rate Graph – Complete Test Run



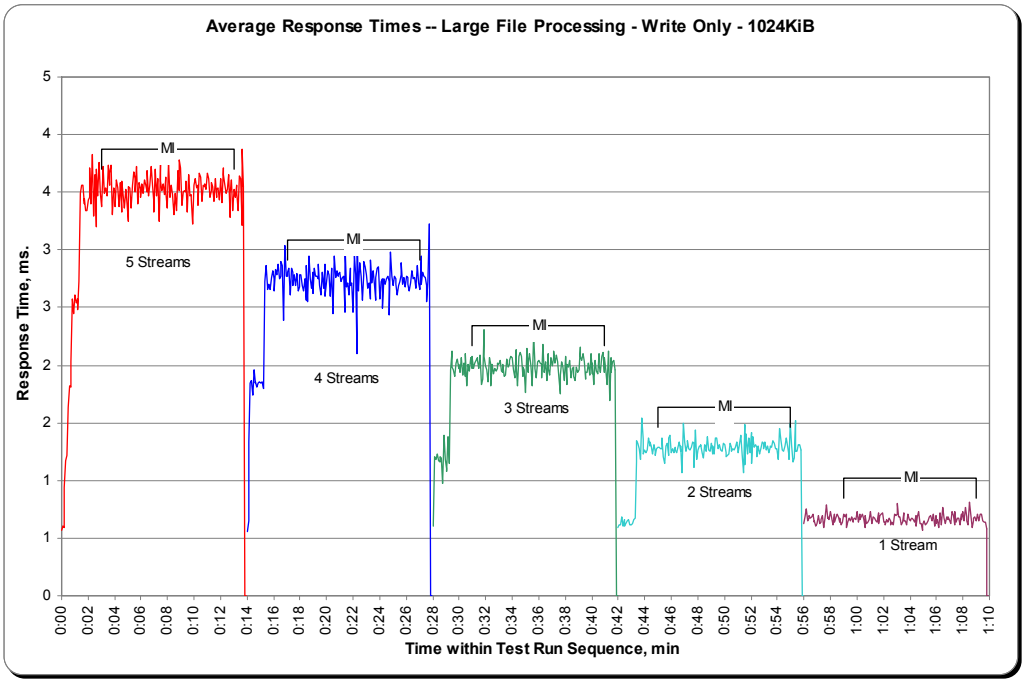
SPC-2C "Large File Processing/ WRITE ONLY /1024 KiB Transfer Size" Average Data Rate Graph – Measurement Interval (MI) Only



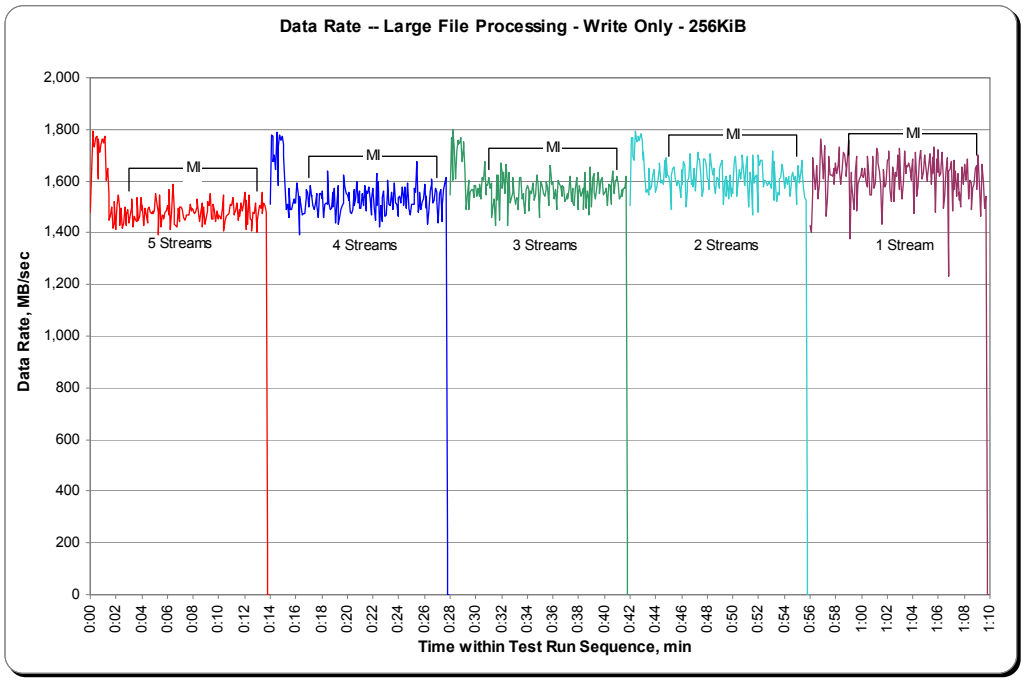
SPC-2C "Large File Processing/ WRITE ONLY /1024 KiB Transfer Size" Average Data Rate per Stream Graph



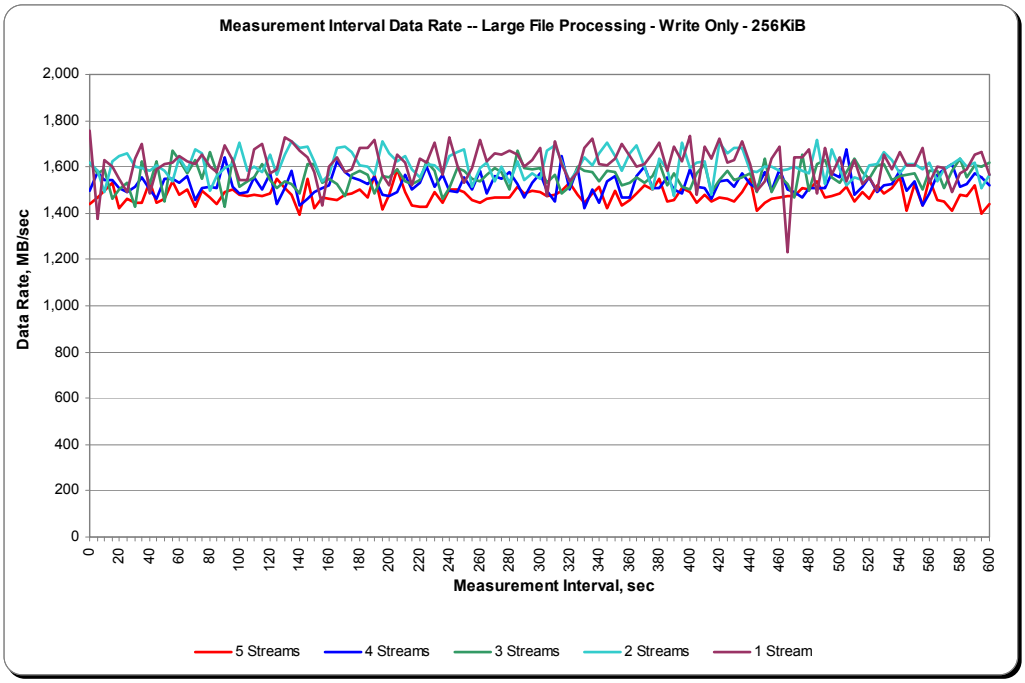
SPC-2C "Large File Processing/ WRITE ONLY /1024 KiB Transfer Size" Average Response Time Graph



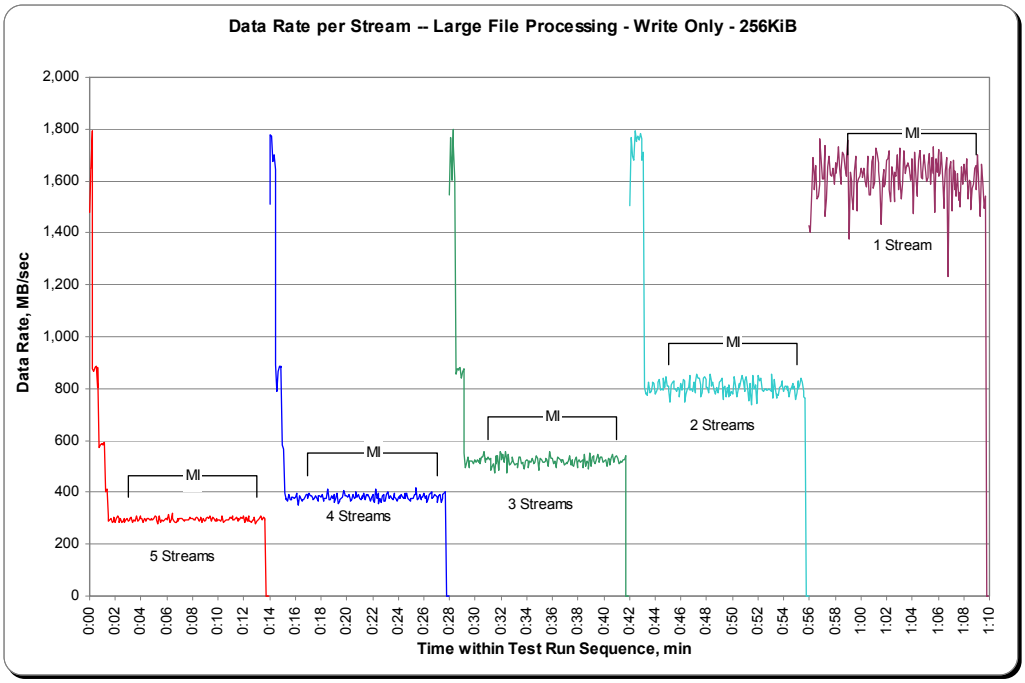
SPC-2C "Large File Processing/ WRITE ONLY /256 KiB Transfer Size" Average Data Rate Graph – Complete Test Run



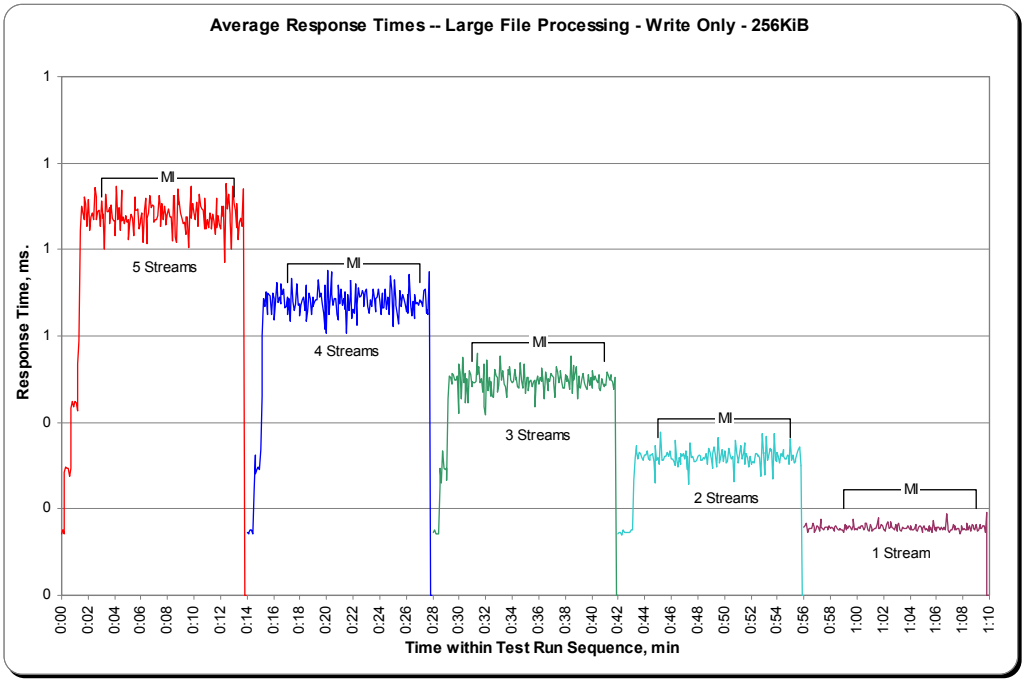
SPC-2C "Large File Processing/ WRITE ONLY /256 KiB Transfer Size" Average Data Rate Graph – Measurement Interval (MI) Only



SPC-2C "Large File Processing/ WRITE ONLY /256 KiB Transfer Size" Average Data Rate per Stream Graph



SPC-2C "Large File Processing/ WRITE ONLY /256 KiB Transfer Size" Average Response Time Graph



Large File Processing Test – READ-WRITE Test Phase

Clause 10.4.8.1.2

1. *A table that will contain the following information for each "READ-WRITE, 1024 KiB Transfer Size" Test Run:*
   - *The number of Streams specified.*
   - *The average data rate, average data rate per stream, and average Response Time reported at five second intervals.*
2. *Average Data Rate (intervals), Average Data Rate per Stream (intervals), and Average Response Time (intervals) graphs for the "READ-WRITE, 1024 KiB Transfer Size" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*
3. *A table that will contain the following information for each " READ-WRITE, 256 KiB Transfer Size" Test Run:*
   - *The number of Streams specified.*
   - *The average data rate, average data rate per stream, and average Response Time reported at five second intervals.*
4. *Average Data Rate (intervals), Average Data Rate per Stream (intervals), and Average Response Time (intervals) graphs for the "READ-WRITE, 256 KiB Transfer Size" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*

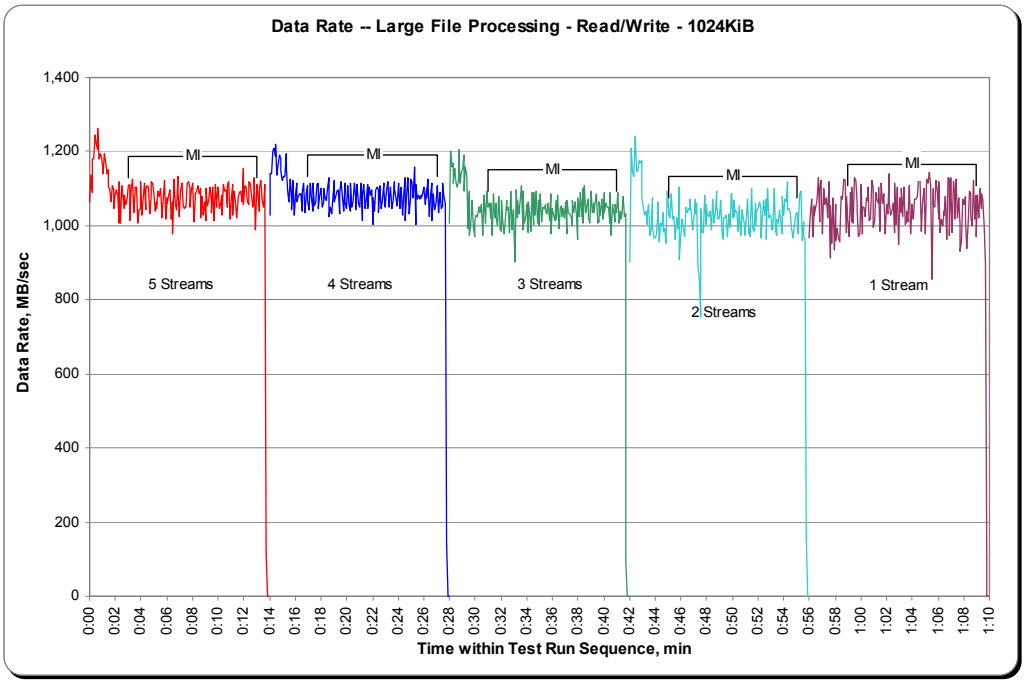
The SPC-2C "Large File Processing/READ-WRITE/1024 KiB Transfer Size" and "Large File Processing/ READ-WRITE /256 KiB Transfer Size" data tables are not embedded in this document due to size. The tables are available via the URLs listed below:

SPC-2C "Large File Processing/Read-Write/1024 KiB Transfer Size" Test Run Data

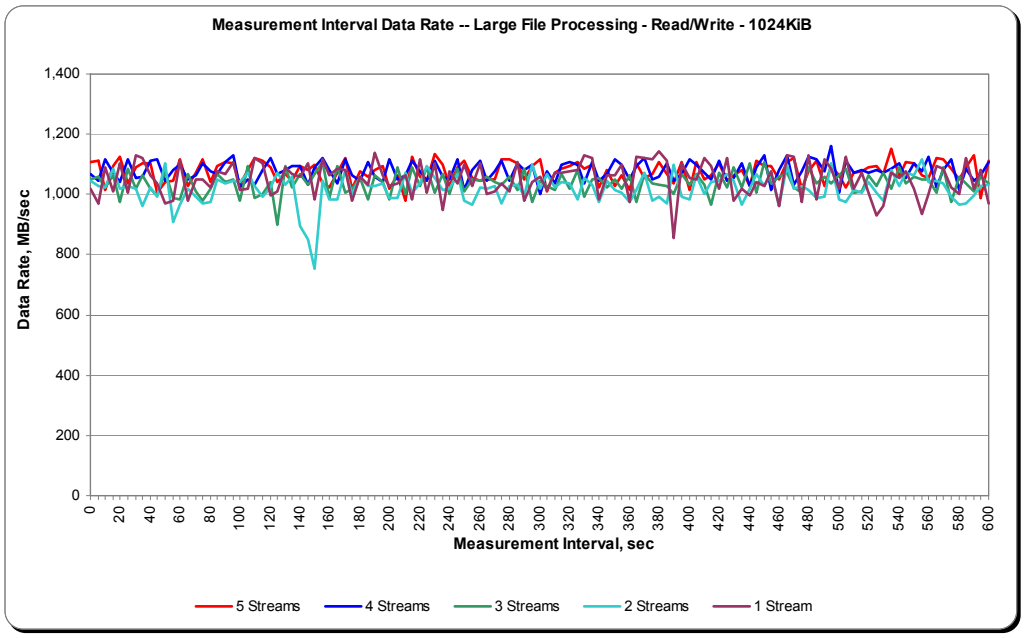
SPC-2C "Large File Processing/ Read-Write /256 KiB Transfer Size" Test Run Data

The corresponding graphs to illustrate the average Data Rate, average Data Rate per Stream, and average Response Time produced by each of the Test Runs appear on next four pages.

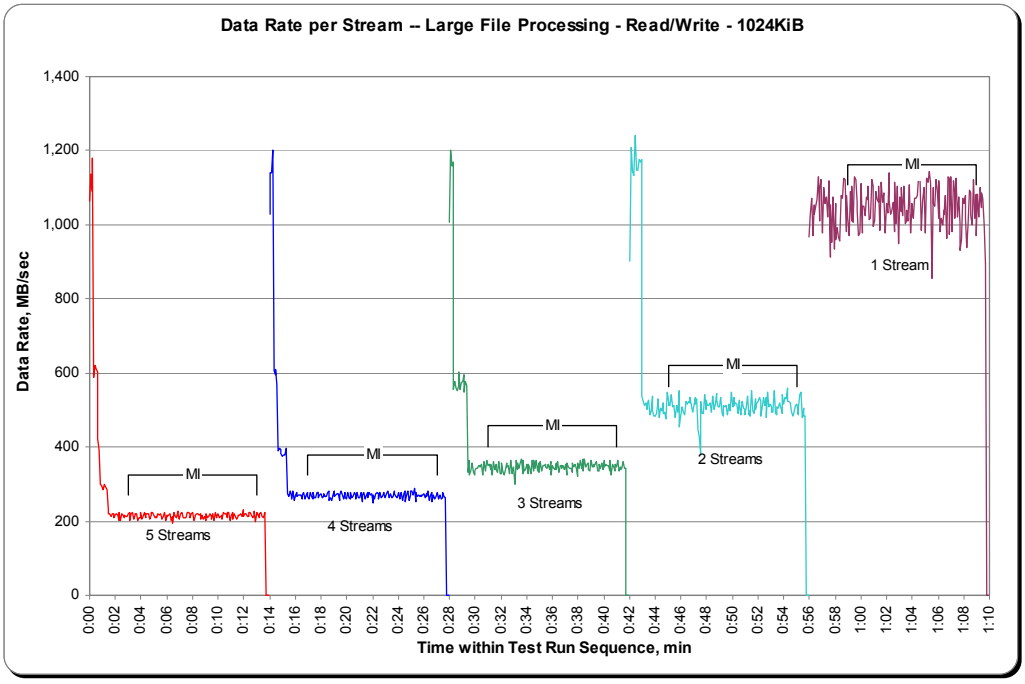
SPC-2C "Large File Processing/ READ-WRITE/1024 KiB Transfer Size" Average Data Rate Graph – Complete Test Run



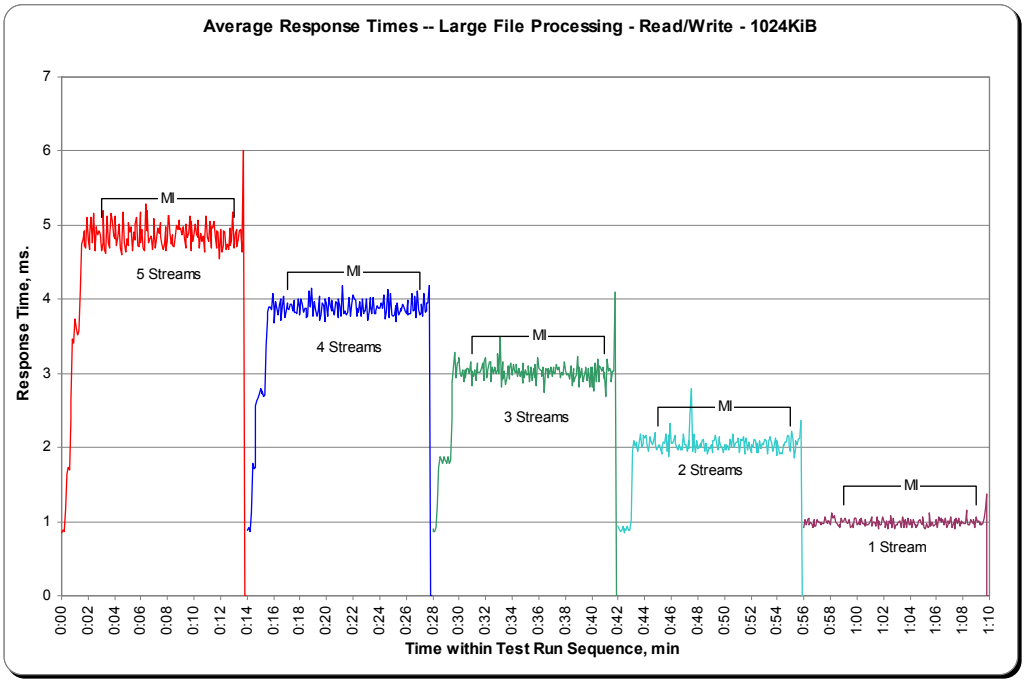
SPC-2C "Large File Processing/ READ-WRITE/1024 KiB Transfer Size" Average Data Rate Graph – Measurement Interval (MI) Only



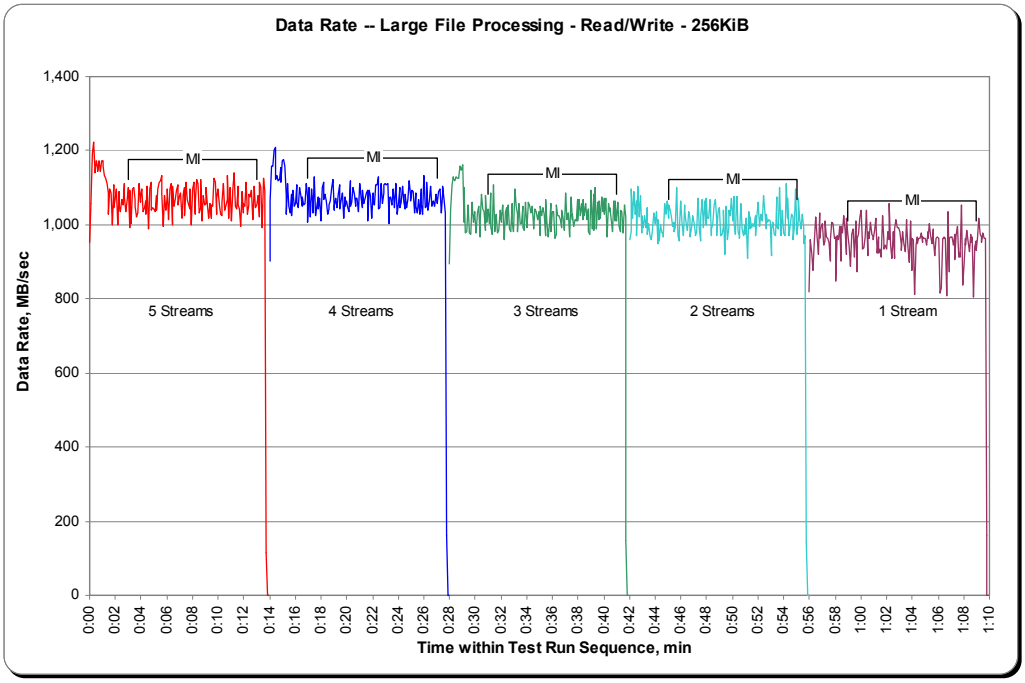
SPC-2C "Large File Processing/READ-WRITE/1024 KiB Transfer Size" Average Data Rate per Stream Graph



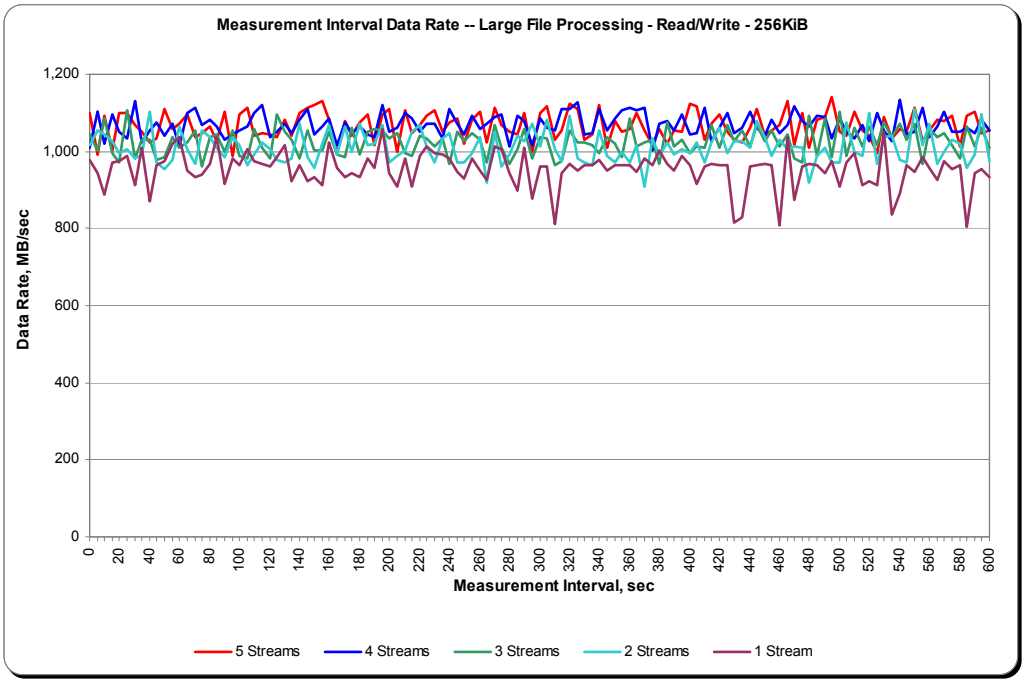
SPC-2C "Large File Processing/READ-WRITE/1024 KiB Transfer Size" Average Response Time Graph



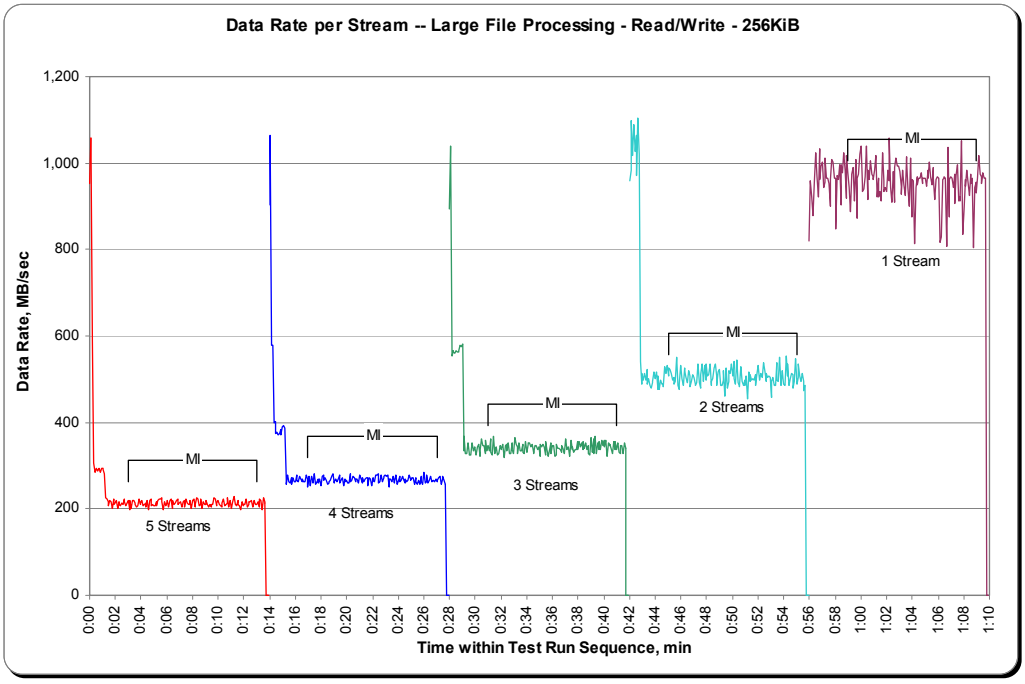
SPC-2C "Large File Processing/READ-WRITE/256 KiB Transfer Size" Average Data Rate Graph – Complete Test Run



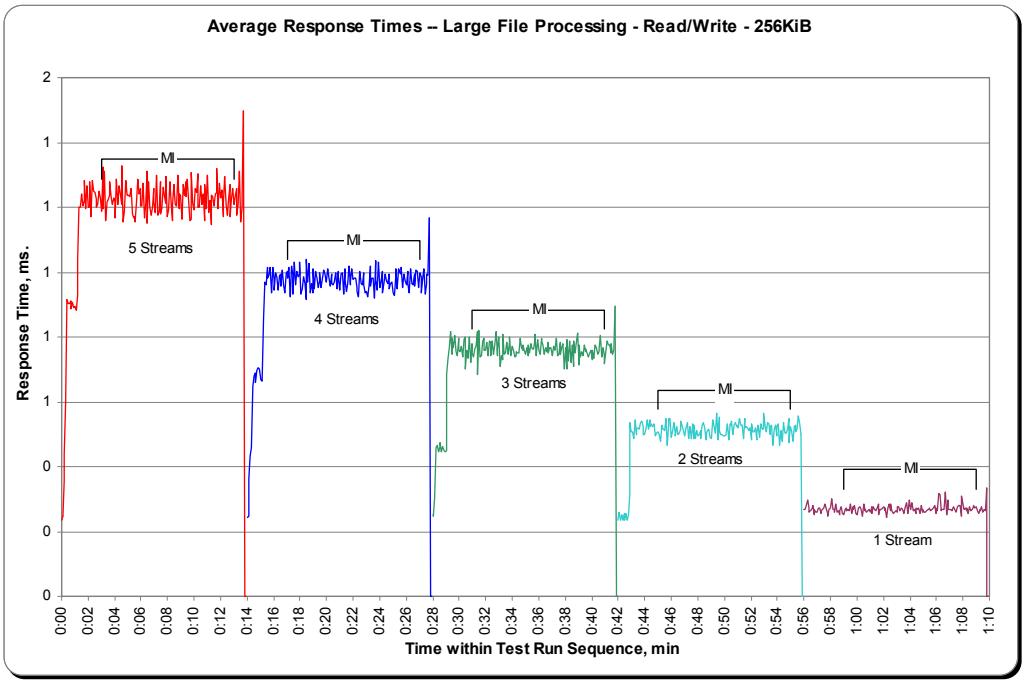
SPC-2C "Large File Processing/READ-WRITE/256 KiB Transfer Size" Average Data Rate Graph – Measurement Interval (MI) Only



SPC-2 "Large File Processing/READ-WRITE/256 KiB Transfer Size" Average Data Rate per Stream Graph



SPC-2 "Large File Processing/READ-WRITE/256 KiB Transfer Size" Average Response Time Graph



Large File Processing Test – READ ONLY Test Phase

Clause 10.4.8.1.3

1. *A table that will contain the following information for each "READ ONLY, 1024 KiB Transfer Size" Test Run:*
   - *The number of Streams specified.*
   - *The average data rate, average data rate per stream, and average Response Time reported at five second intervals.*
2. *Average Data Rate (intervals), Average Data Rate per Stream (intervals), and Average Response Time (intervals) graphs for the "READ ONLY, 1024 KiB Transfer Size" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*
3. *A table that will contain the following information for each "READ ONLY, 256 KiB Transfer Size" Test Run:*
   - *The number of Streams specified.*
   - *The average data rate, average data rate per stream, and average Response Time reported at five second intervals.*
4. *Average Data Rate (intervals), Average Data Rate per Stream (intervals), and Average Response Time (intervals) graphs for the "READ ONLY, 256 KiB Transfer Size" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*

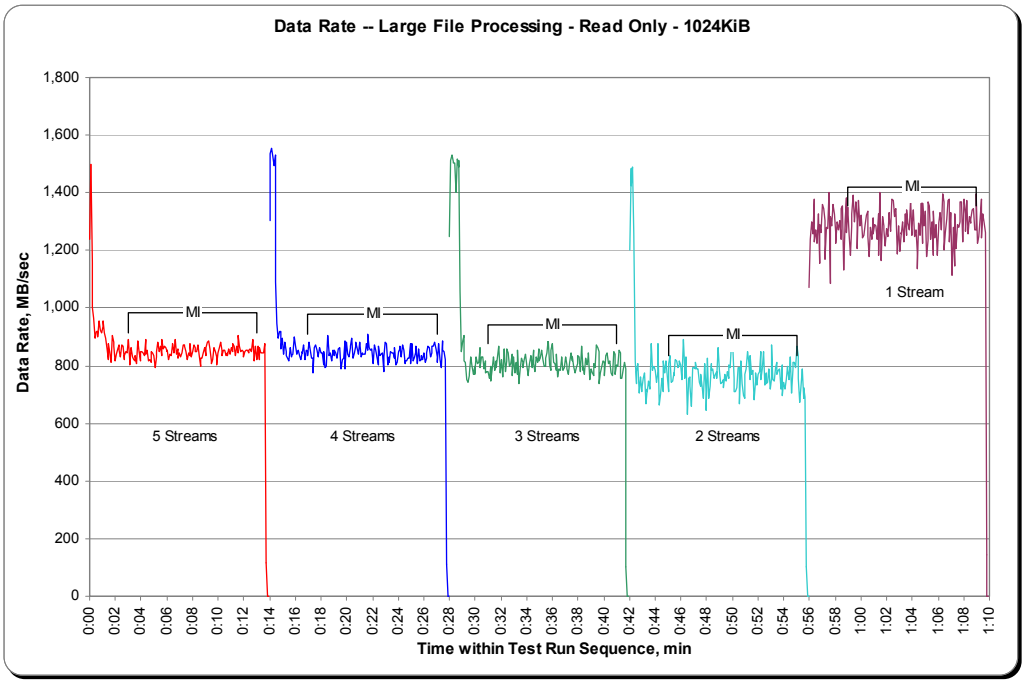
The SPC-2C "Large File Processing/READ ONLY/1024 KiB Transfer Size" and "Large File Processing/ READ ONLY/256 KiB Transfer Size" data tables are not embedded in this document due to size. The tables are available via the URLs listed below:

SPC-2C "Large File Processing/Read Only/1024 KiB Transfer Size" Test Run Data

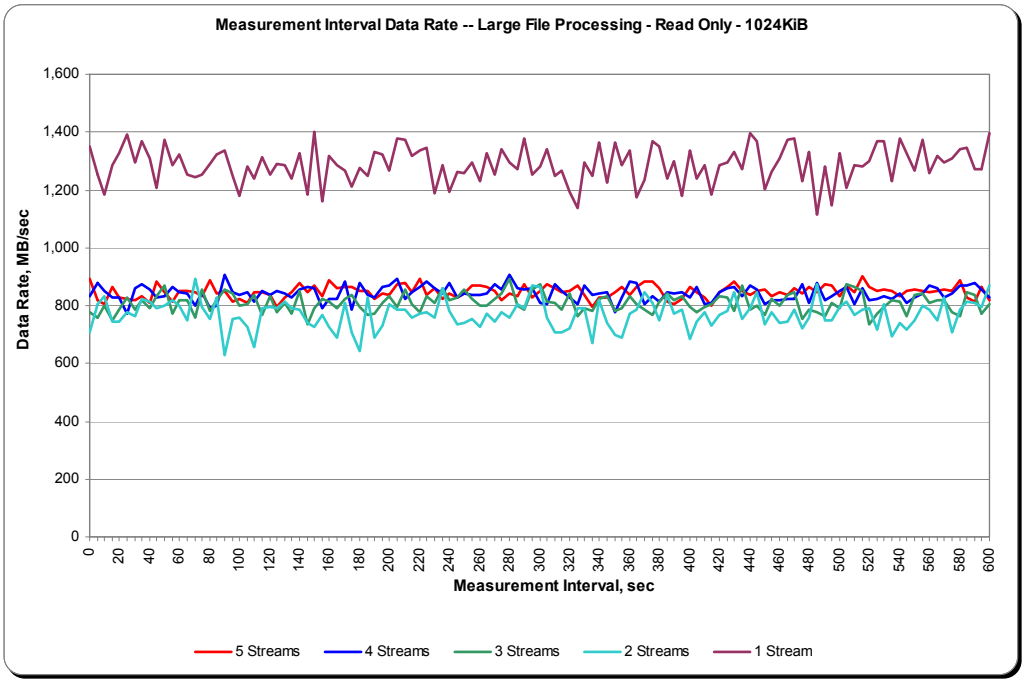
SPC-2C "Large File Processing/Read Only/256 KiB Transfer Size" Test Run Data

The corresponding graphs to illustrate the average Data Rate, average Data Rate per Stream, and average Response Time produced by each of the Test Runs appear on next four pages.

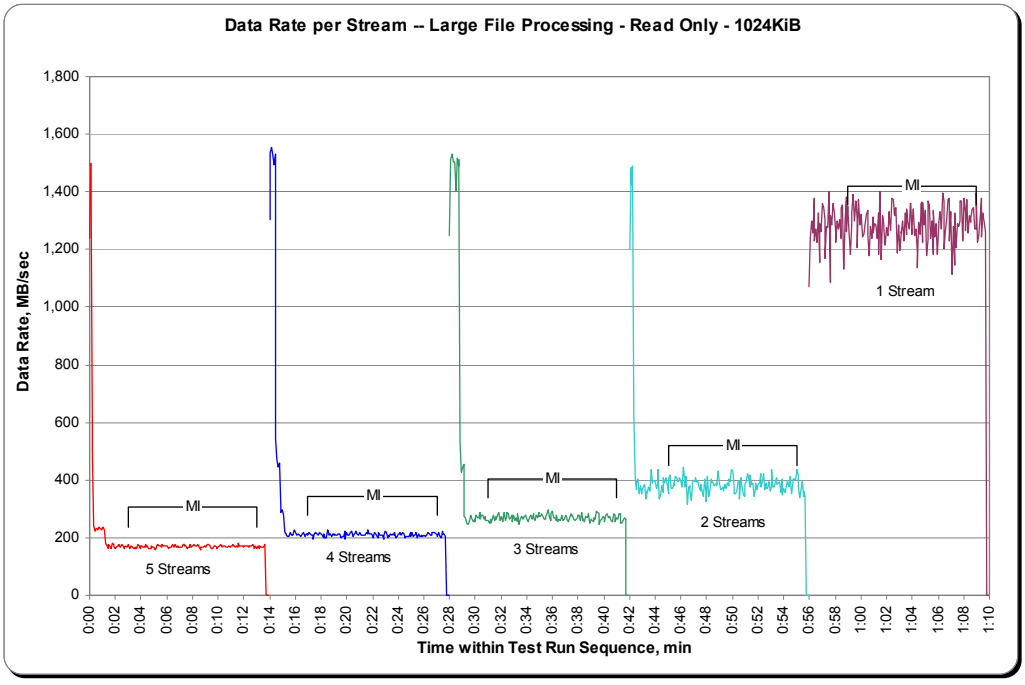
SPC-2C "Large File Processing/READ ONLY/1024 KiB Transfer Size" Average Data Rate Graph – Complete Test Run



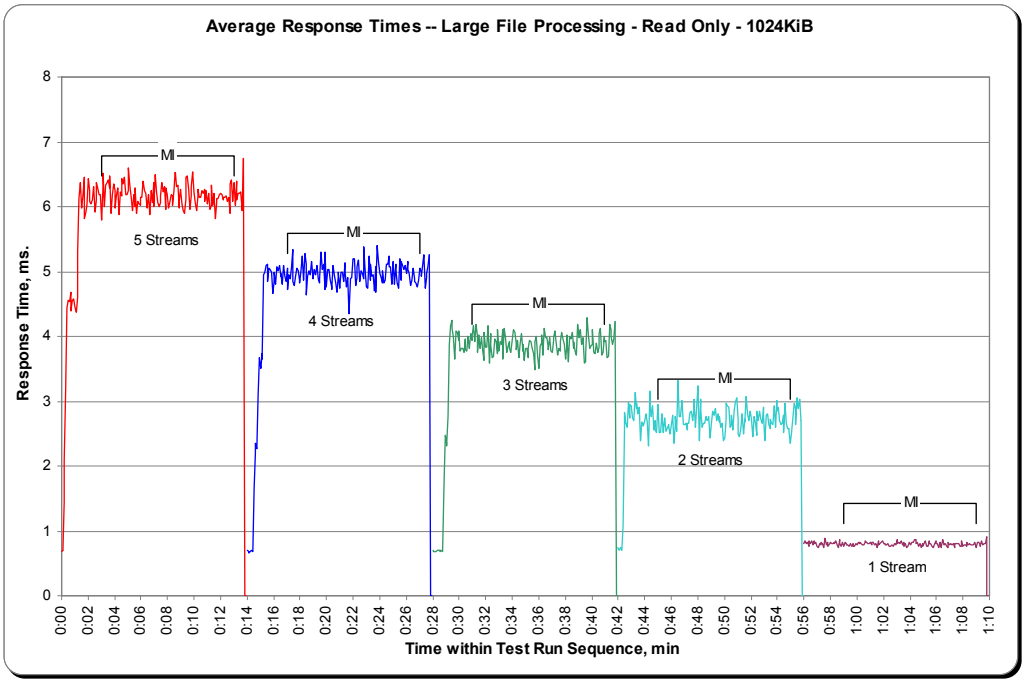
SPC-2C "Large File Processing/READ ONLY/1024 KiB Transfer Size" Average Data Rate Graph – Measurement Interval (MI) Only



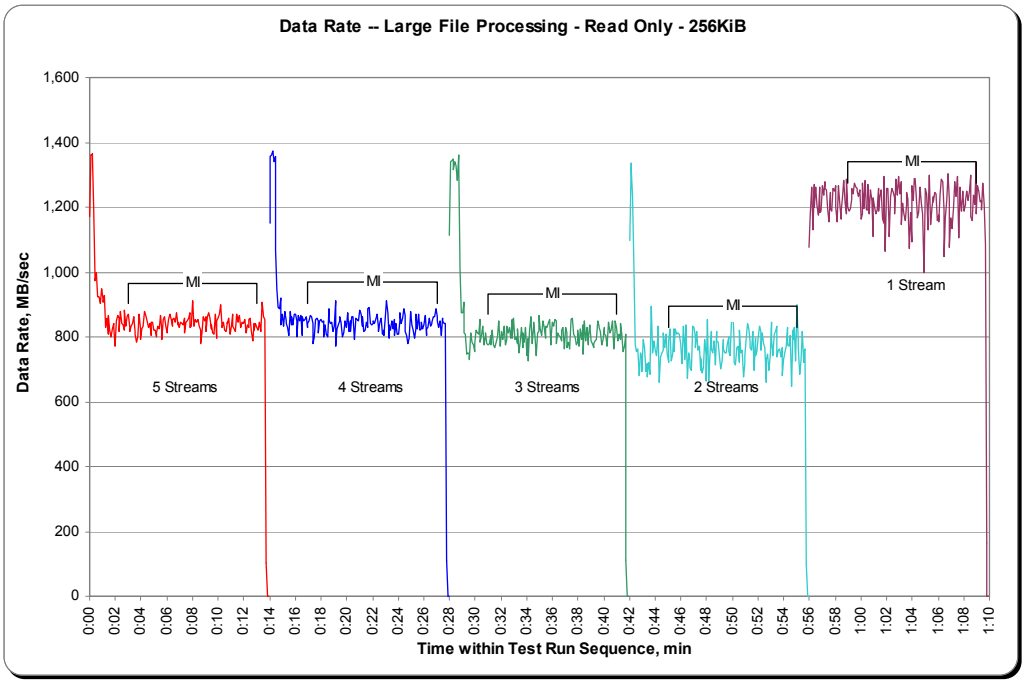
SPC-2C "Large File Processing/READ ONLY/1024 KiB Transfer Size" Average Data Rate per Stream Graph



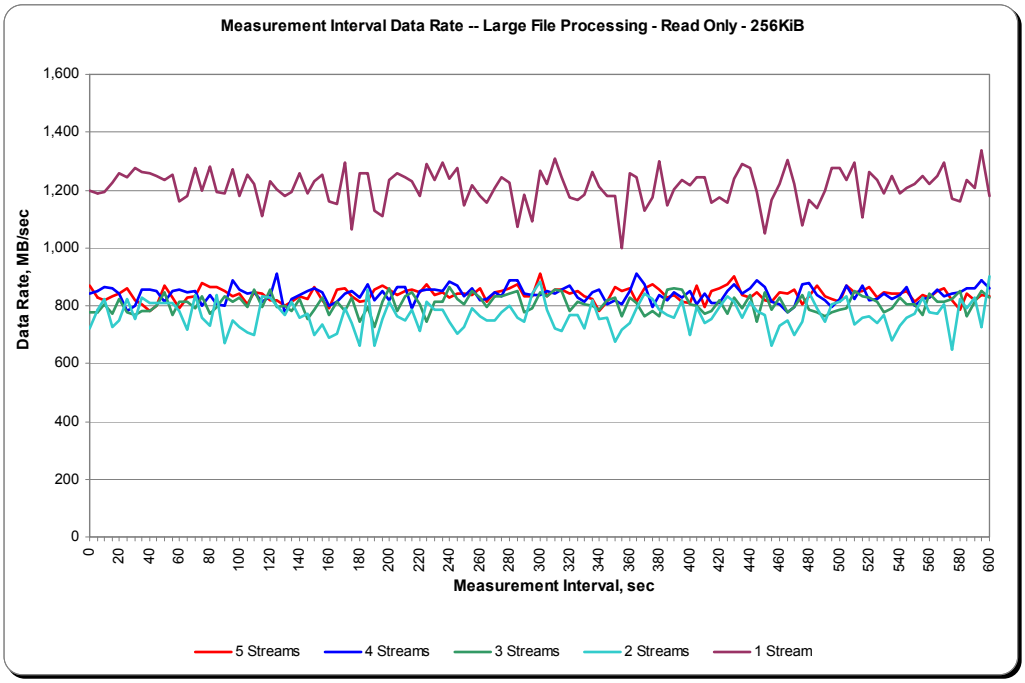
SPC-2C "Large File Processing/READ ONLY/1024 KiB Transfer Size" Average Response Time Graph



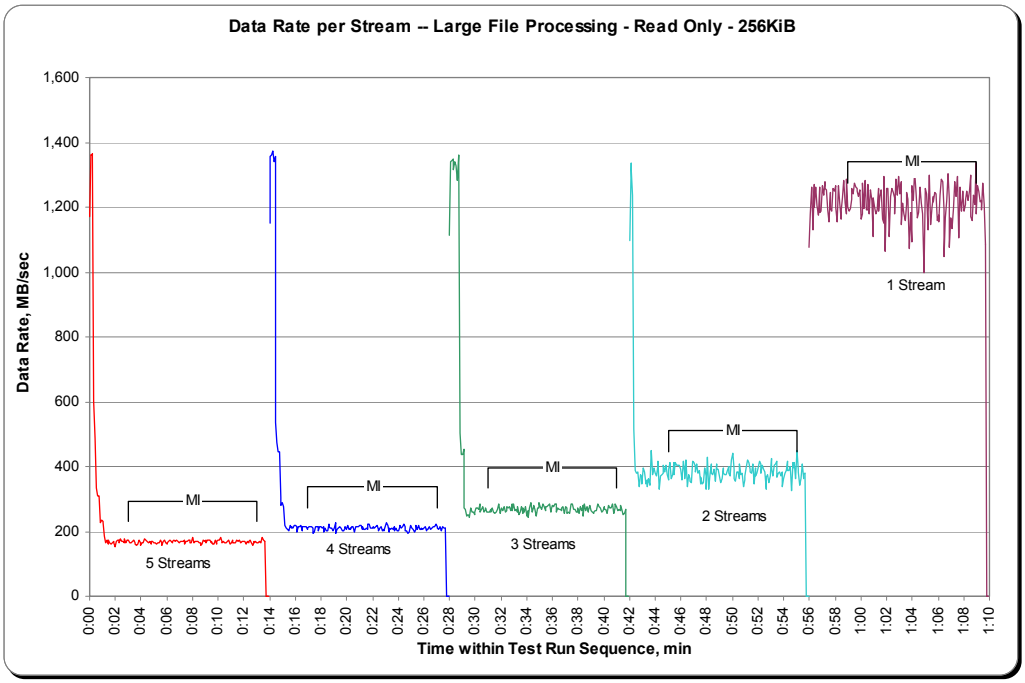
SPC-2 "Large File Processing/READ ONLY/256 KiB Transfer Size" Average Data Rate Graph – Complete Test Run



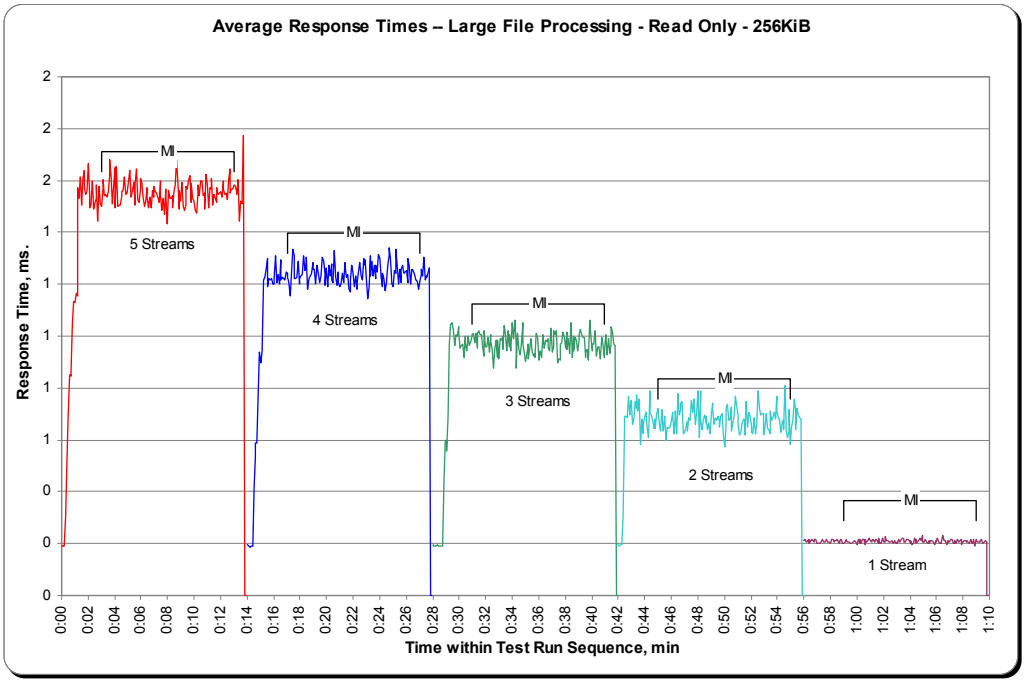
SPC-2 "Large File Processing/READ ONLY/256 KiB Transfer Size" Average Data Rate Graph – Measurement Interval (MI) Only



SPC-2 "Large File Processing/READ ONLY/256 KiB Transfer Size" Average Data Rate per Stream Graph



SPC-2 "Large File Processing/READ ONLY/256 KiB Transfer Size" Average Response Time Graph



Large Database Query Test

Clause 6.4.4.1

The Large Database Query Test is comprised of a set of I/O operations representative of scans or joins of large relational tables such as those performed for data mining or business intelligence.

Clause 6.4.4.2

The Large Database Query Test has two Test Phases, which shall be executed in the following uninterrupted sequence:

1. *1024 KIB TRANSFER SIZE*
2. *64 KIB TRANSFER SIZE*

The BC shall not be restarted or manually disturbed, altered, or adjusted during the execution of the Large File Processing Test. If power is lost to the BC during this Test all results shall be rendered invalid and the Test re-run in its entirety.

Clause 10.4.8.2

The Full Disclosure Report will contain the following content for the Large Database Query Test:

1. *A listing of the SPC-2C Workload Generator commands and parameters used to execute each of the Test Runs in the Large Database Query Test.*
2. *The human readable SPC-2C Test Results File for each of the Test Runs in the Large Database Query Test.*
3. *The following three tables, defined in Clauses 10.1.1 – 10.1.3.:*
   - *Average Data Rate: This table will will contain the average Data Rate, in MB per second, for the Measurement Interval of each Test Run in the Large Database Query Test.*
   - *Average Data Rate per Stream: This table will will contain the average Data Rate per Stream, in MB per second, for the Measurement Interval of each Test Run in the Large Database Query Test.*
   - *Average Response Time: This table will contain the average Response Time, in milliseconds (ms), for the Measurement Interval of each Test Run in the Large Database Query Test.*

   Each table will also include the following information for each Test Run:
   - *The number of Streams specified.*
   - *The Ramp-Up duration in seconds.*
   - *The Measurement Interval duration in seconds.*
4. *Average Data Rate, Average Data Rate per Stream, and Average Response Time graphs as defined in Clauses 10.1.1, 10.1.2, and 10.1.3.*

SPC-2C Workload Generator Commands and Parameters

The SPC-2C Workload Generator commands and parameters for the Large Database Query Test Runs are documented in "Appendix E: SPC-2C Workload Generator Execution Commands and Parameters" on Page 96.

SPC-2C Test Results File

A link to the SPC-2C Test Results file generated from the Large Database Query Test Runs is listed below.

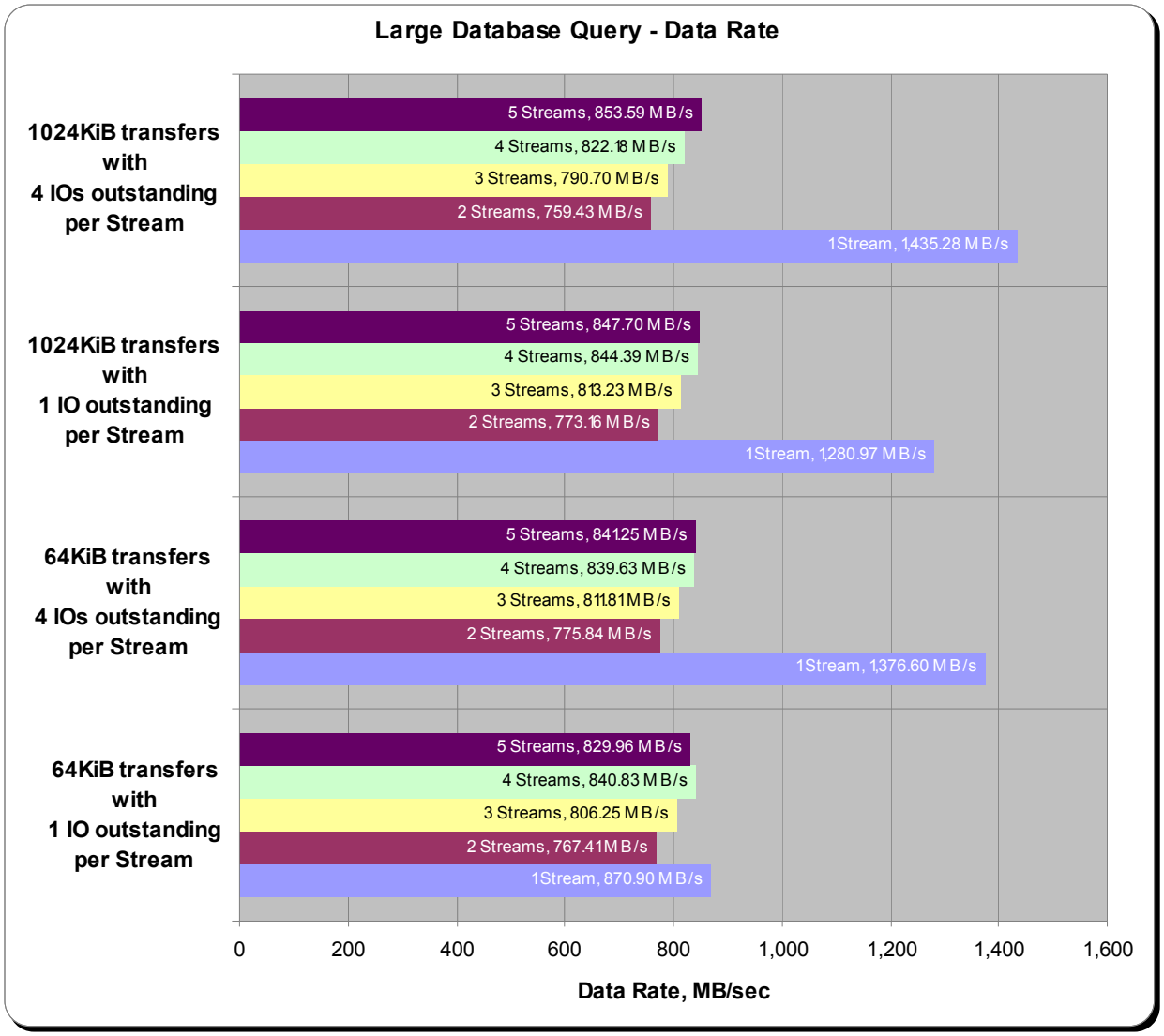
SPC-2C Large Database Query Test Results File

SPC-2C Large Database Query Average Data Rates (MB/s)

The average Data Rate (MB/s) for each Test Run in the two Test Phases of the SPC-2C Large Database Query Test is listed in the table below as well as illustrated in the following graph.

Test Run Sequence	1 Stream	2 Streams	3 Streams	4 Streams	5 Streams
1024KiB w/ 4 IOs/Stream	1,435.28	759.43	790.70	822.18	853.59
1024KiB w/ 1 IO/Stream	1,280.97	773.16	813.23	844.39	847.70
64KiB w/ 4 IOs/Stream	1,376.60	775.84	811.81	839.63	841.25
64KiB w/ 1 IO/Stream	870.90	767.41	806.25	840.83	829.96

SPC-2C Large Database Query Average Data Rates Graph

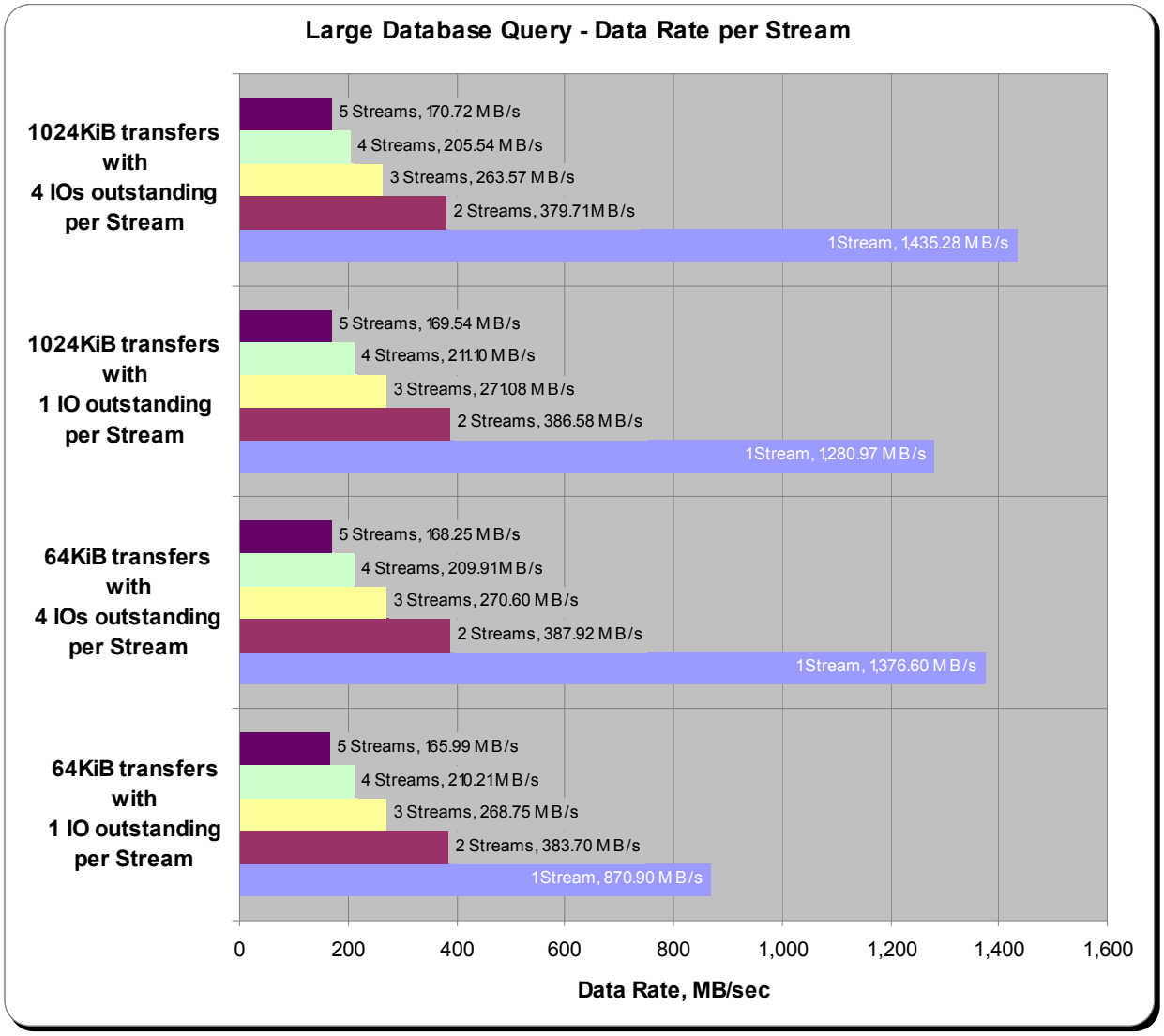


SPC-2C Large Database Query Average Data Rate per Stream

The average Data Rate per Stream for each Test Run in the two Test Phases of the SPC-2C Large Database Query Test is listed in the table below as well as illustrated in the following graph.

Test Run Sequence	1 Stream	2 Streams	3 Streams	4 Streams	5 Streams
1024KiB w/ 4 IOs/Stream	1,435.28	379.71	263.57	205.54	170.72
1024KiB w/ 1 IO/Stream	1,280.97	386.58	271.08	211.10	169.54
64KiB w/ 4 IOs/Stream	1,376.60	387.92	270.60	209.91	168.25
64KiB w/ 1 IO/Stream	870.90	383.70	268.75	210.21	165.99

SPC-2C Large Database Query Average Data Rate per Stream Graph

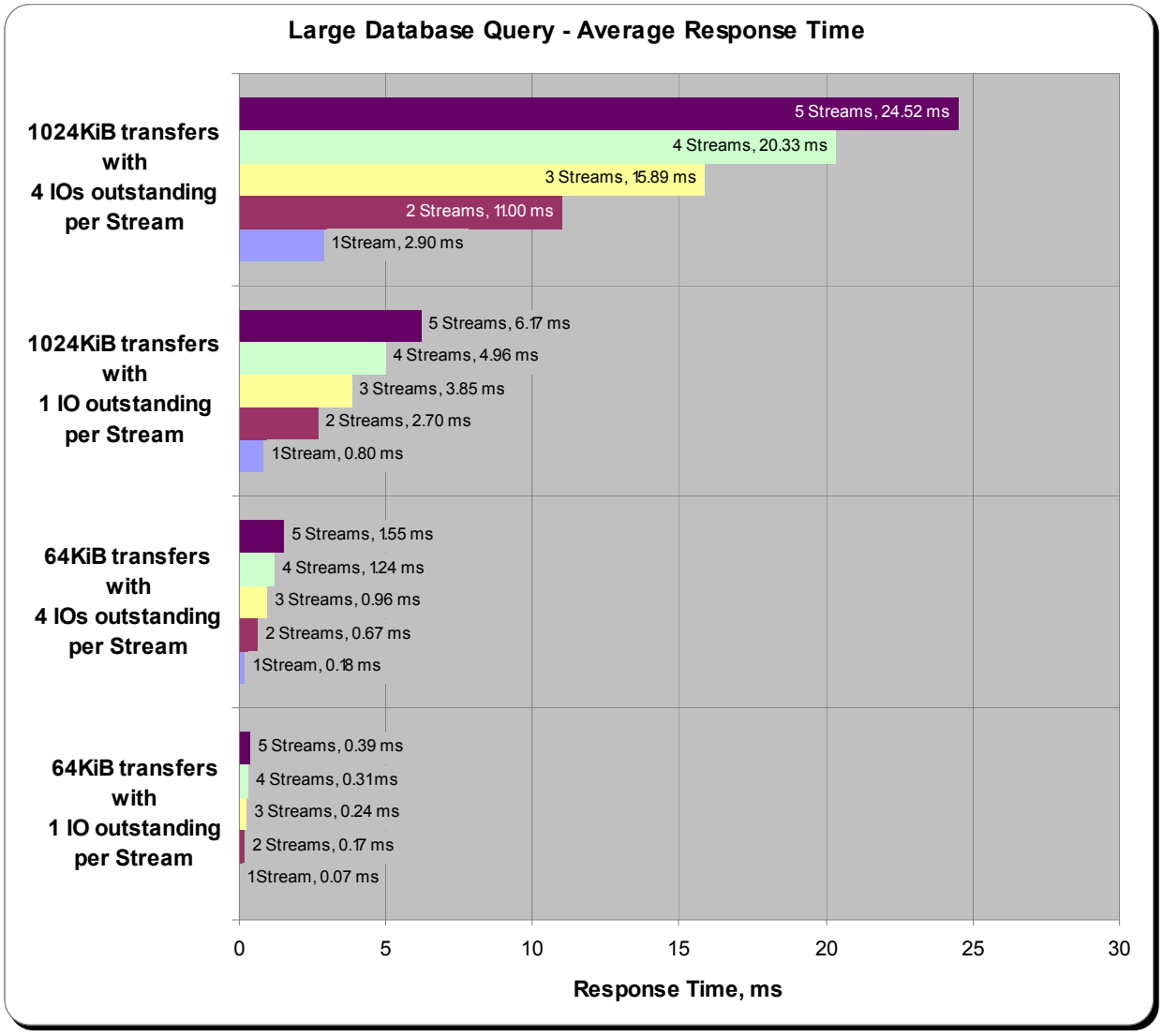


SPC-2C Large Database Query Average Response Time

The average Response Time, in milliseconds, for each Test Run in the two Test Phases of the SPC-2C Large Database Query Test is listed in the table below as well as illustrated in the following graph.

Test Run Sequence	1 Stream	2 Streams	3 Streams	4 Streams	5 Streams
1024KiB w/ 4 IOs/Stream	2.90	11.00	15.89	20.33	24.52
1024KiB w/ 1 IO/Stream	0.80	2.70	3.85	4.96	6.17
64KiB w/ 4 IOs/Stream	0.18	0.67	0.96	1.24	1.55
64KiB w/ 1 IO/Stream	0.07	0.17	0.24	0.31	0.39

SPC-2C Large Database Query Average Response Time Graph



Large Database Query Test – 1024 KIB TRANSFER SIZE Test Phase

Clause 10.4.8.2.1

1. *A table that will contain the following information for each "1024 KiB Transfer Size, 4 Outstanding I/Os" Test Run:*
   - *The number of Streams specified.*
   - *The average data rate, average data rate per stream, and average Response Time reported at five second intervals.*
2. *Average Data Rate by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by Intervals graphs for the "1024 KIB TRANSFER SIZE, 4 Outstanding I/Os" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*
3. *A table that will contain the following information for each "1024 KiB Transfer Size, 1 Outstanding I/O" Test Run:*
   - *The number of Streams specified.*
   - *The average data rate, average data rate per stream, and average Response Time reported at five second intervals.*
4. *Average Data Rate by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by Intervals graphs for the "1024 KIB TRANSFER SIZE, 4 Outstanding I/Os" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*

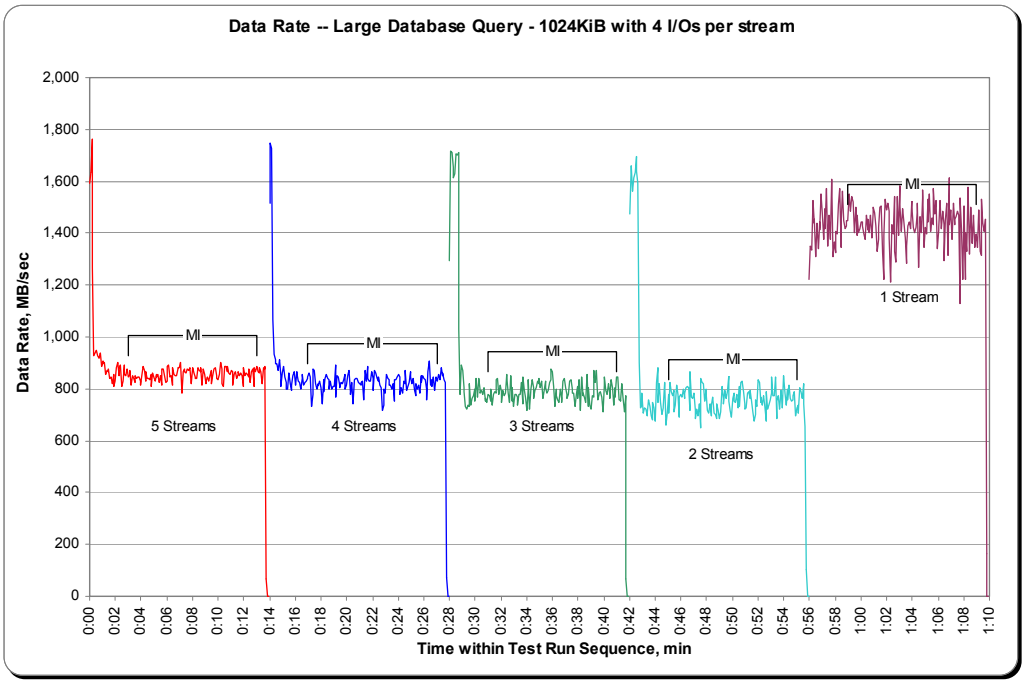
The SPC-2C "Large DatabaseQuery/1024 KIB TRANSFER SIZE/4 Outstanding I/Os" and "Large DatabaseQuery/1024 KIB TRANSFER SIZE/1 Outstanding I/O" data tables are not embedded in this document due to size. The tables are available via the URLs listed below:

Large DatabaseQuery/1024 KIB TRANSFER SIZE/4 Outstanding I/Os

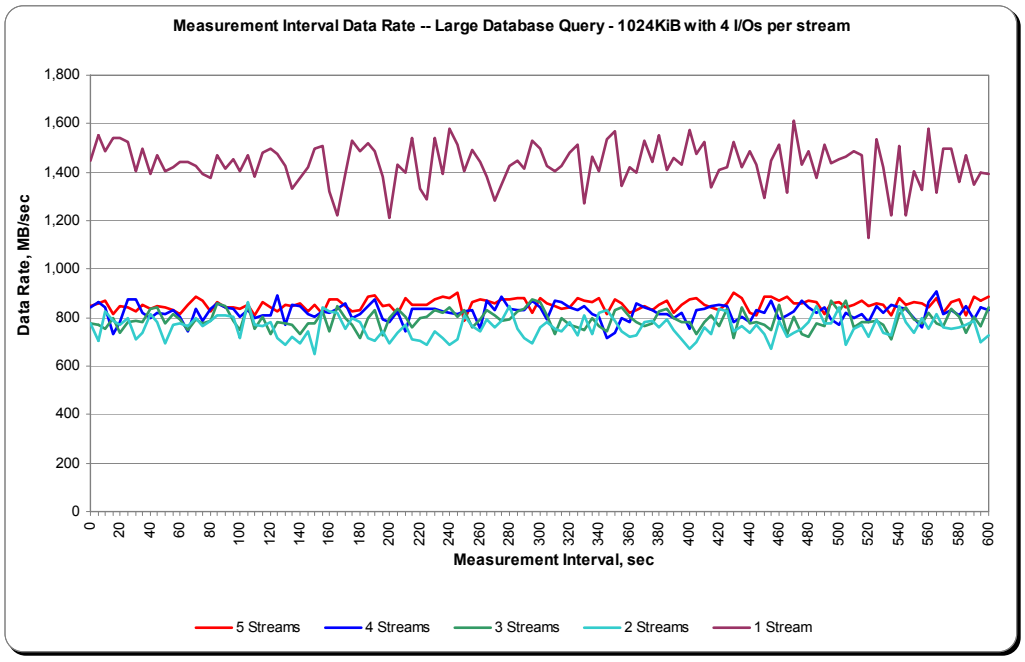
Large DatabaseQuery/1024 KIB TRANSFER SIZE/1 Outstanding I/O

The corresponding graphs to illustrate the average Data Rate, average Data Rate per Stream, and average Response Time produced by each of the Test Runs appear on next four pages.

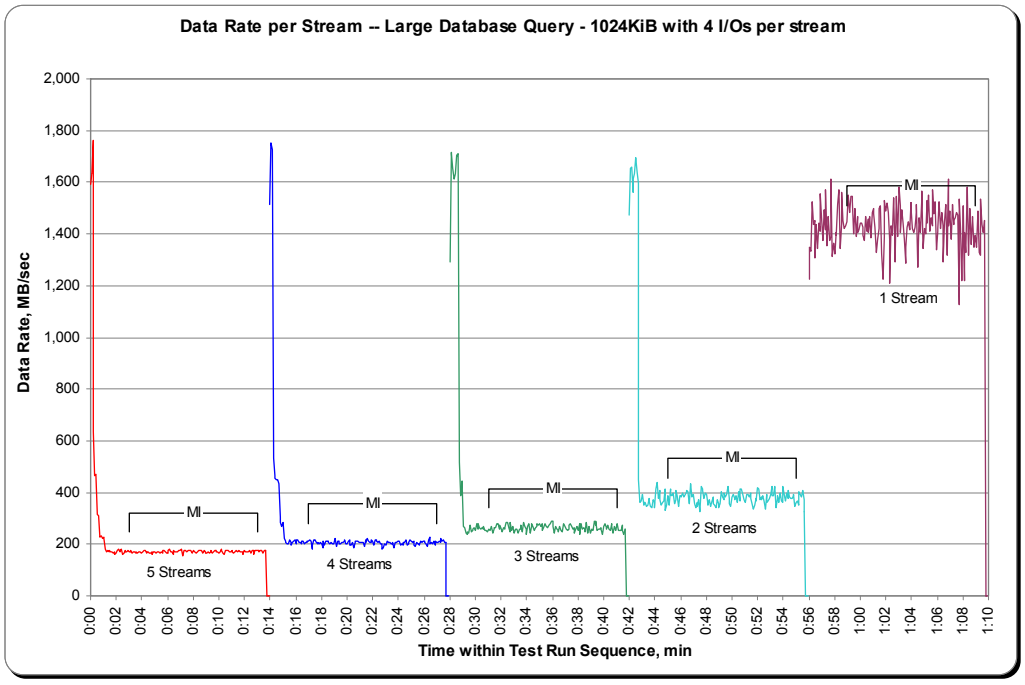
SPC-2C "Large Database Query/1024 KiB Transfer Size/4 Outstanding I/Os" Average Data Rate Graph – Complete Test Run



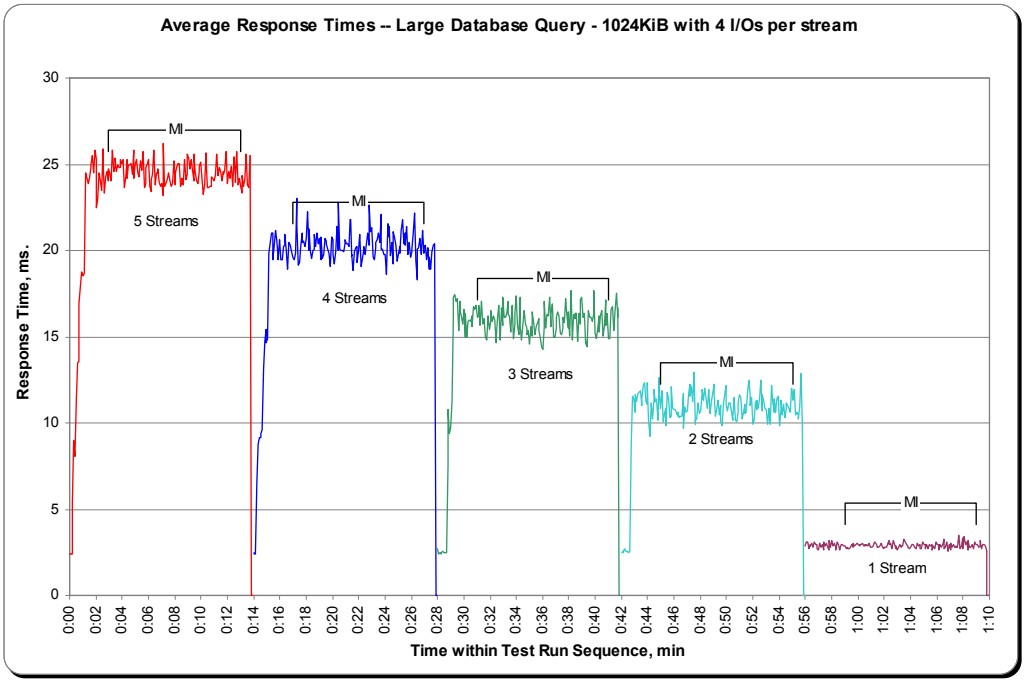
SPC-2C "Large Database Query/1024 KiB Transfer Size/4 Outstanding I/Os" Average Data Rate Graph – Measurement Interval (MI) Only



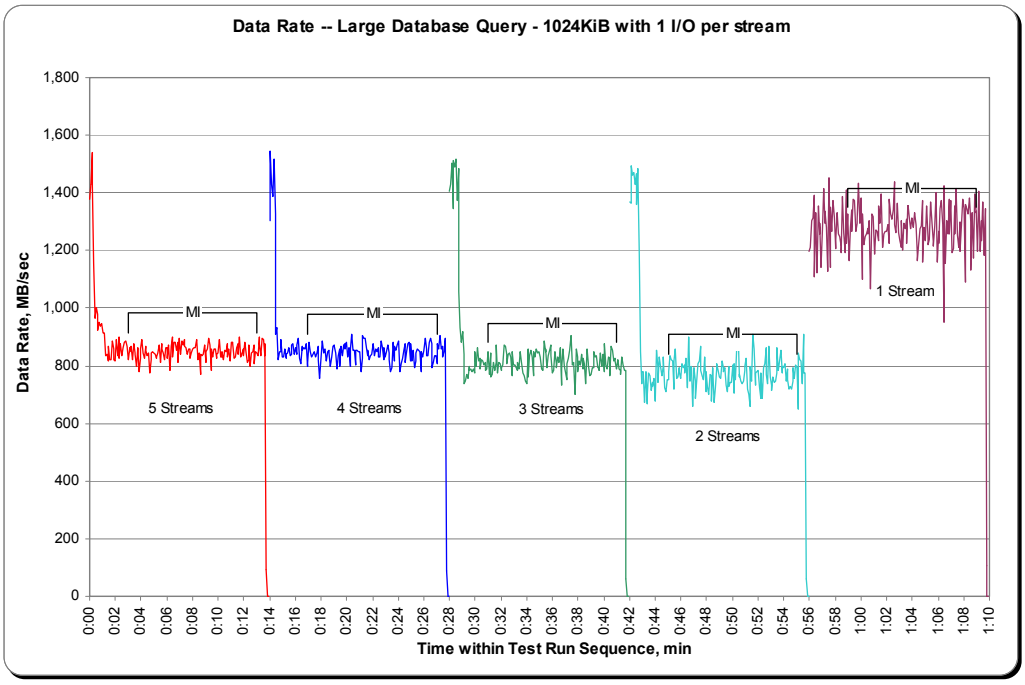
SPC-2C "Large Database Query/1024 KiB Transfer Size/4 Outstanding I/Os" Average Data Rate per Stream Graph



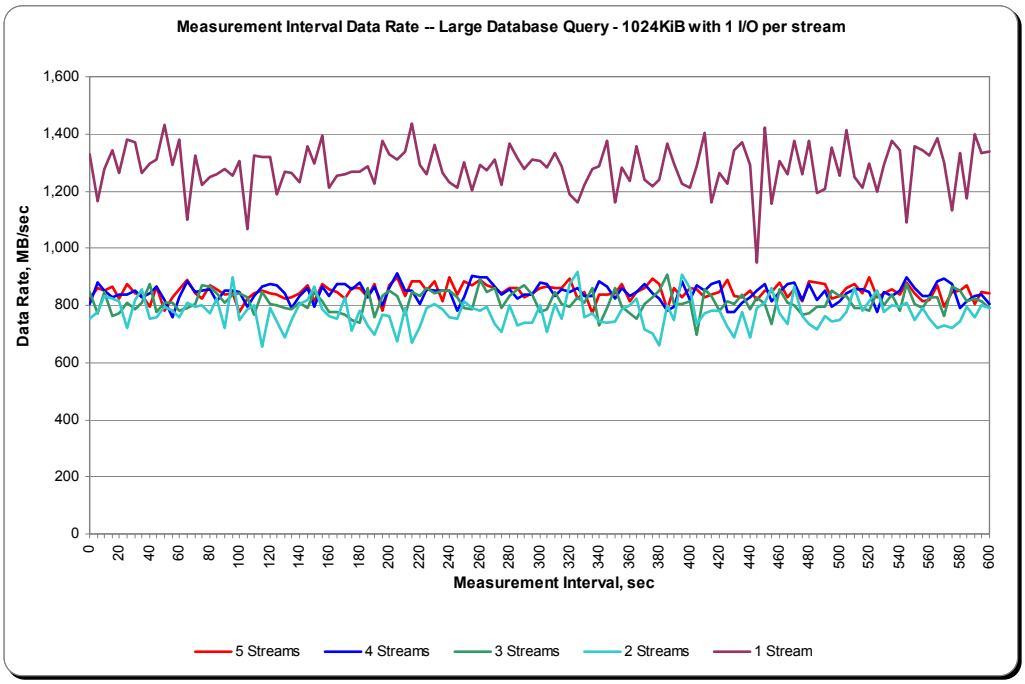
SPC-2C "Large Database Query/1024 KiB Transfer Size/4 Outstanding I/Os" Average Response Time Graph



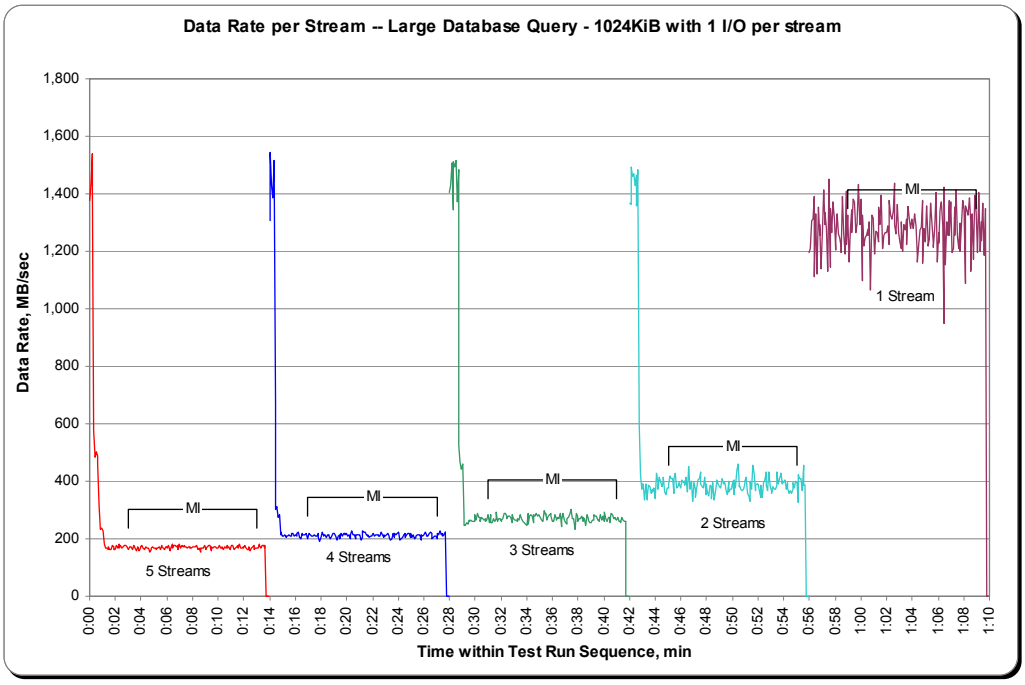
SPC-2C "Large Database Query/1024 KiB Transfer Size/1 Outstanding I/O" Average Data Rate Graph – Complete Test Run



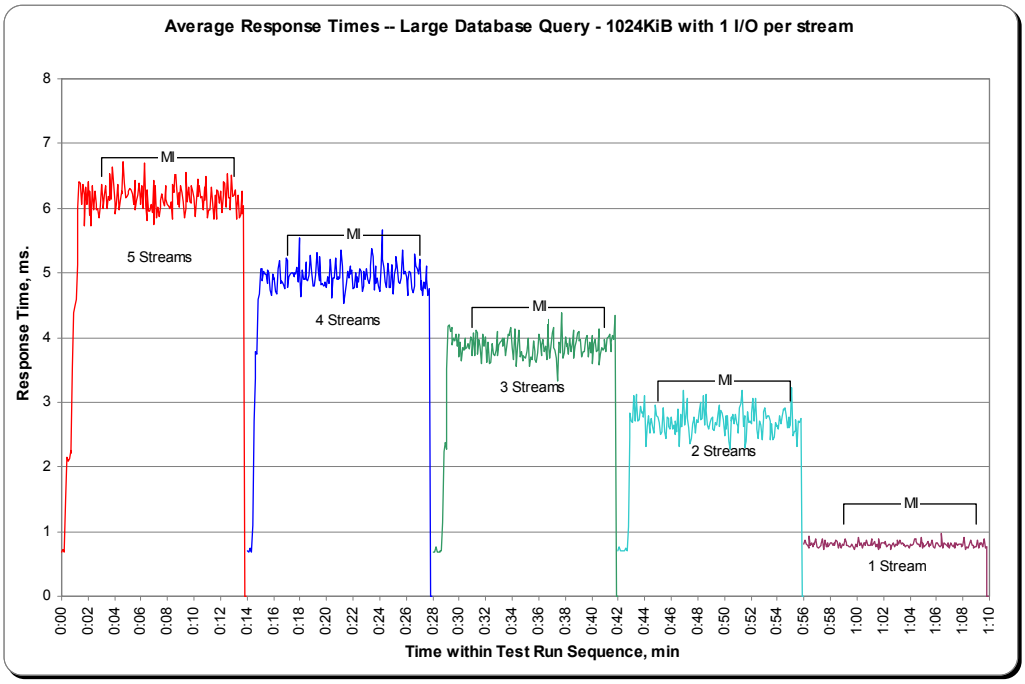
SPC-2C "Large Database Query/1024 KiB Transfer Size/1 Outstanding I/O" Average Data Rate Graph – Measurement Interval (MI) Only



SPC-2C "Large Database Query/1024 KiB Transfer Size/1 Outstanding I/O" Average Data Rate per Stream Graph



SPC-2C "Large Database Query/1024 KiB Transfer Size/1 Outstanding I/O" Average Response Time Graph



Large Database Query Test – 64 KIB TRANSFER SIZE Test Phase

Clause 10.4.8.2.2

1. *A table that will contain the following information for each "64 KiB Transfer Size, 4 Outstanding I/Os" Test Run:*
   - *The number of Streams specified.*
   - *The average data rate, average data rate per stream, and average Response Time reported at five second intervals.*
2. *Average Data Rate by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by Intervals graphs for the "64 KIB TRANSFER SIZE, 4 Outstanding I/Os" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*
3. *A table that will contain the following information for each "64 KiB Transfer Size, 1 Outstanding I/O" Test Run:*
   - *The number of Streams specified.*
   - *The average data rate, average data rate per stream, and average Response Time reported at five second intervals.*
4. *Average Data Rate by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by Intervals graphs for the "64 KIB TRANSFER SIZE, 4 Outstanding I/Os" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*

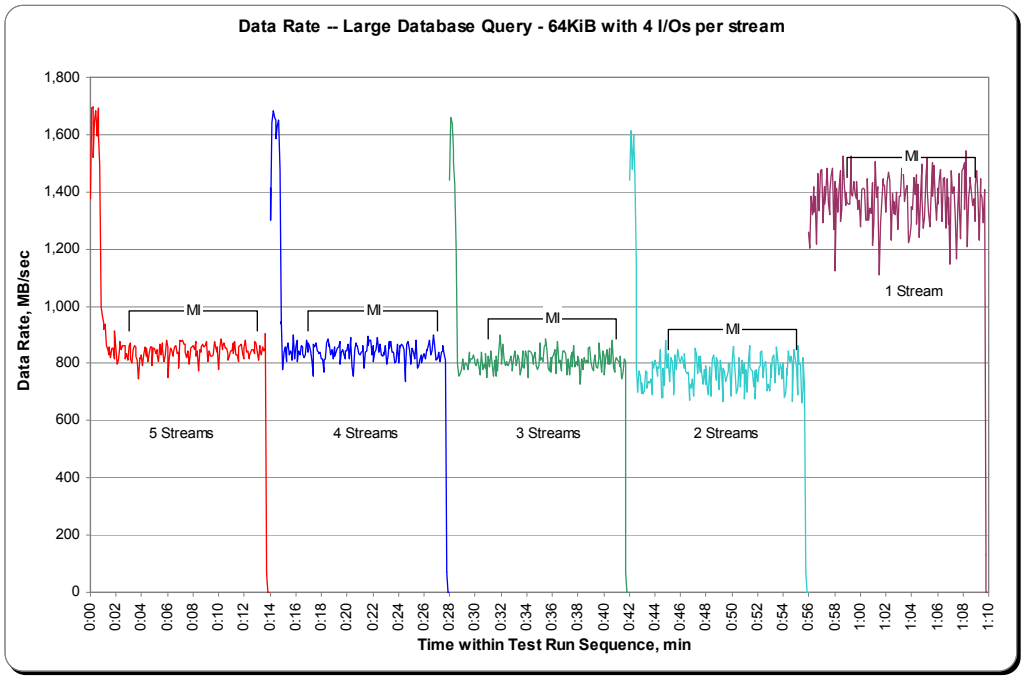
The SPC-2C "Large DatabaseQuery/64 KIB TRANSFER SIZE/4 Outstanding I/Os" and "Large DatabaseQuery/64 KIB TRANSFER SIZE/1 Outstanding I/O" data tables are not embedded in this document due to size. The tables are available via the URLs listed below:

Large DatabaseQuery/64 KIB TRANSFER SIZE/4 Outstanding I/Os

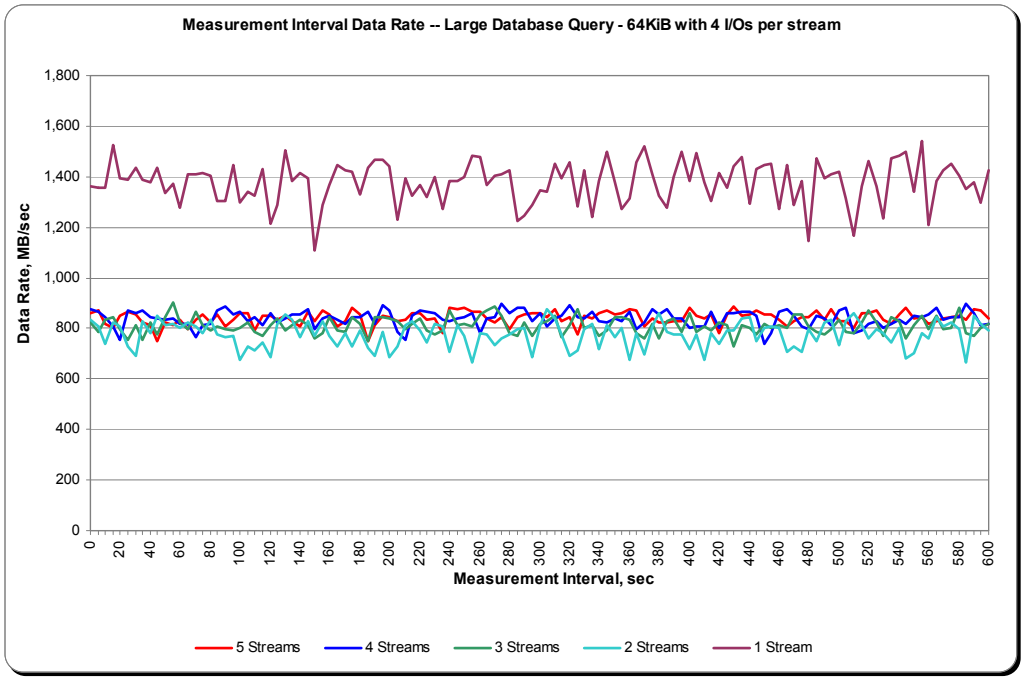
Large DatabaseQuery/64 KIB TRANSFER SIZE/1 Outstanding I/O

The corresponding graphs to illustrate the average Data Rate, average Data Rate per Stream, and average Response Time produced by each of the Test Runs appear on next four pages.

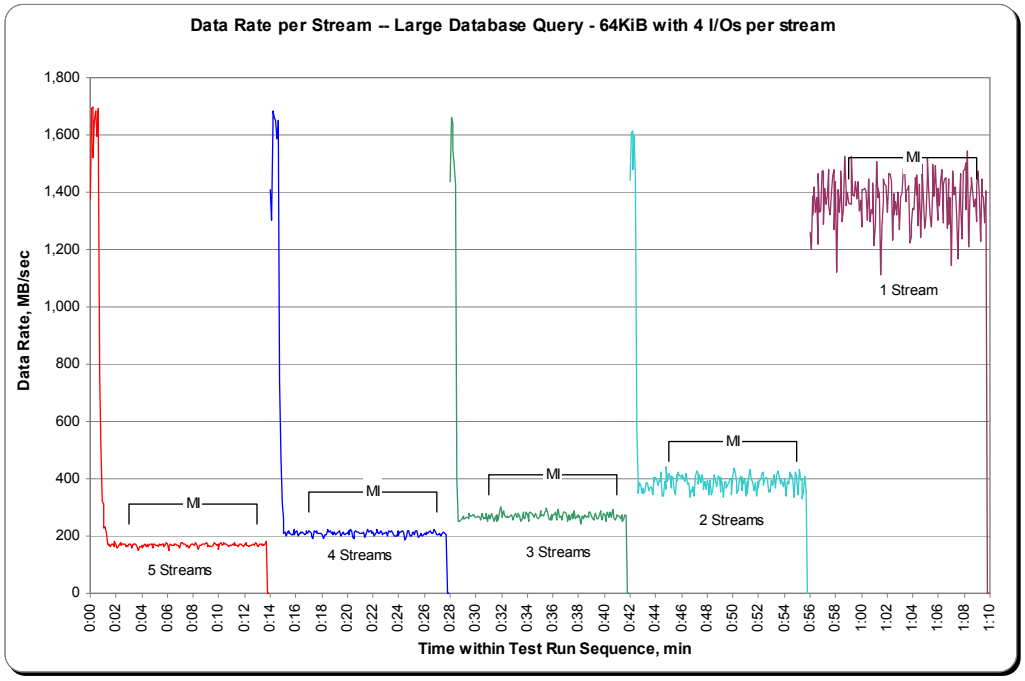
SPC-2C "Large Database Query/64 KiB Transfer Size/4 Outstanding I/Os" Average Data Rate Graph – Complete Test Run



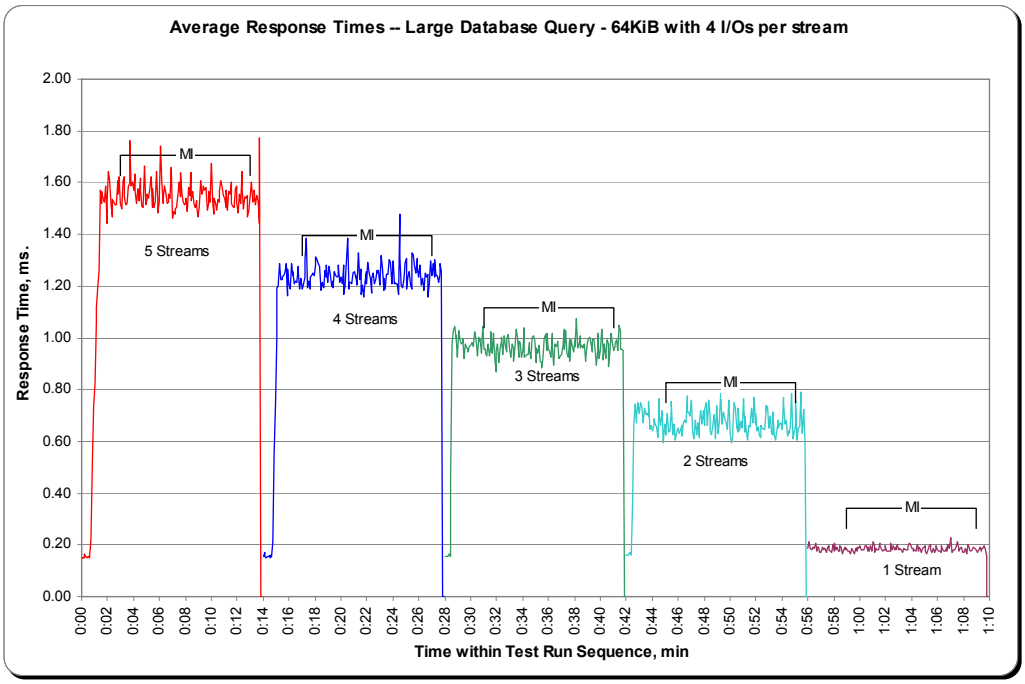
SPC-2C "Large Database Query/64 KiB Transfer Size/4 Outstanding I/Os" Average Data Rate Graph – Measurement Interval (MI) Only



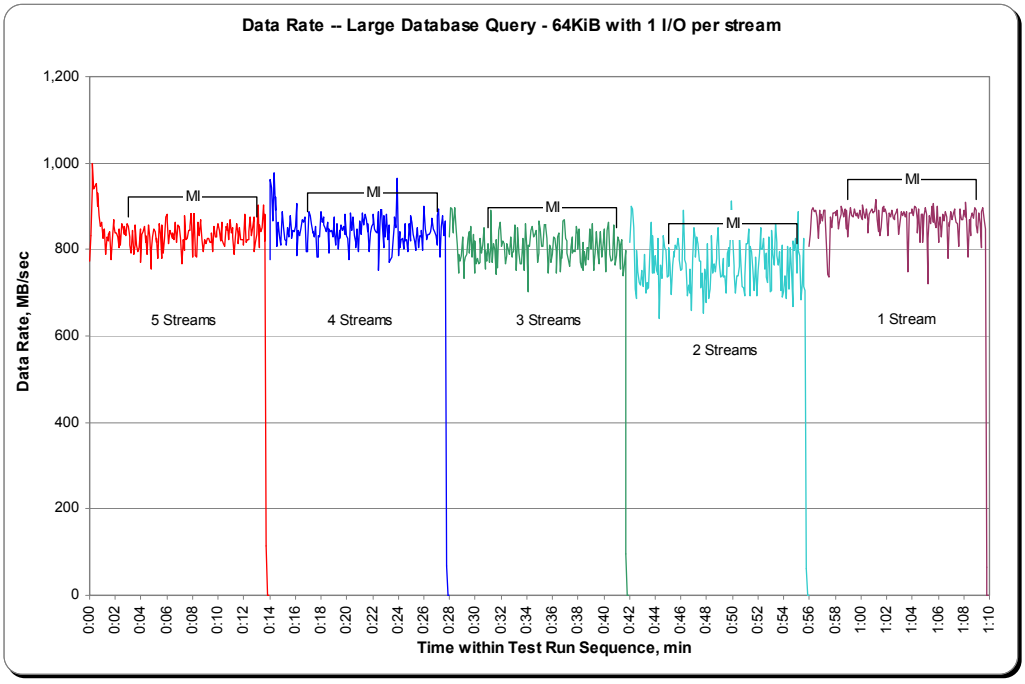
SPC-2C "Large Database Query/64 KiB Transfer Size/4 Outstanding I/Os" Average Data Rate per Stream Graph



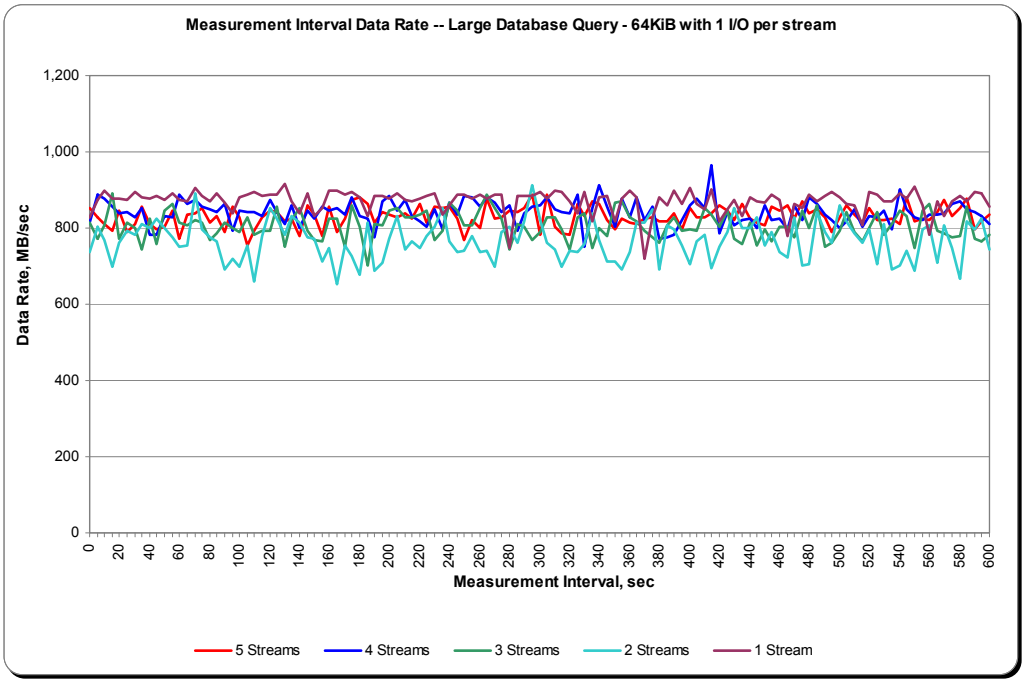
SPC-2C "Large Database Query/64 KiB Transfer Size/4 Outstanding I/Os" Average Response Time Graph



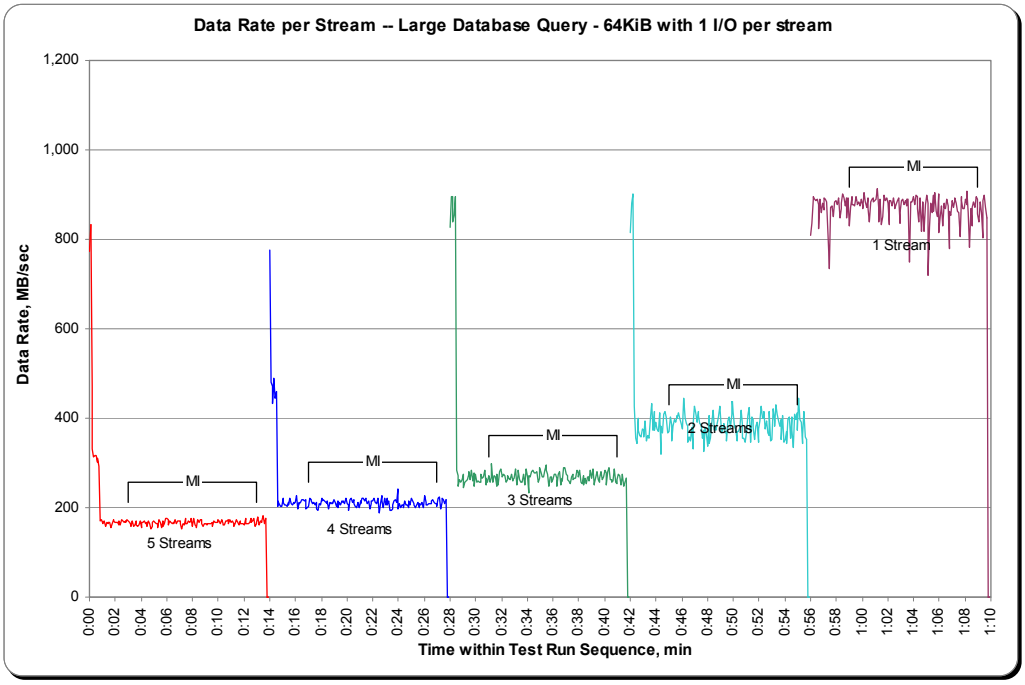
SPC-2C "Large Database Query/64 KiB Transfer Size/1 Outstanding I/O" Average Data Rate Graph – Complete Test Run



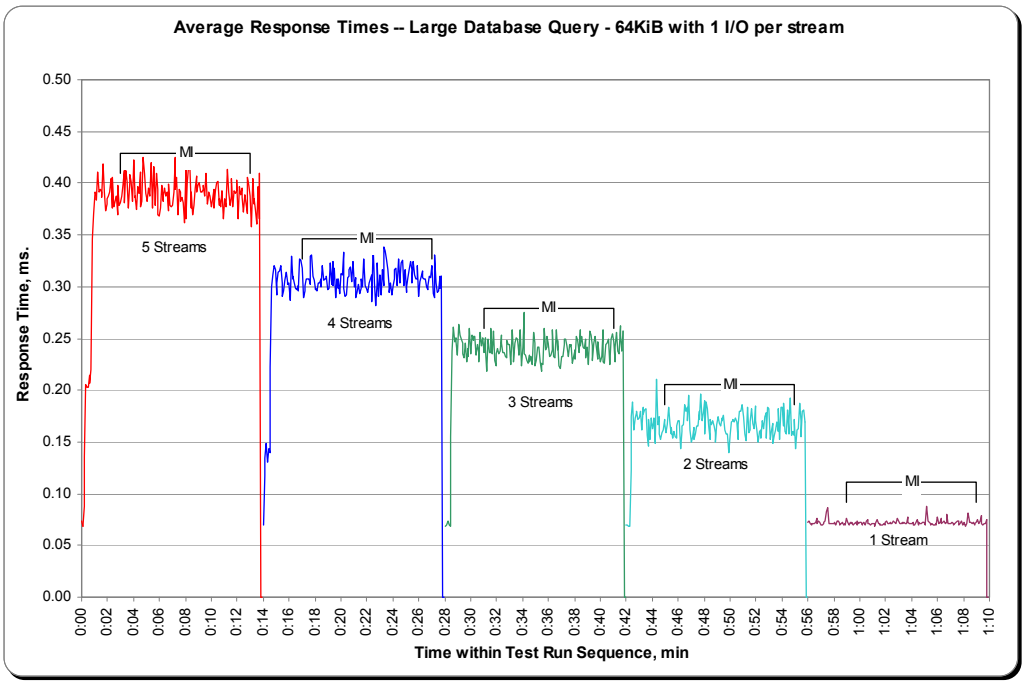
SPC-2C "Large Database Query/64 KiB Transfer Size/1 Outstanding I/O" Average Data Rate Graph – Measurement Interval (MI) Only



SPC-2C "Large Database Query/64 KiB Transfer Size/1 Outstanding I/O" Average Data Rate per Stream Graph



SPC-2C "Large Database Query/64 KiB Transfer Size/1 Outstanding I/O" Average Response Time Graph



Video on Demand Delivery Test

Clause 6.4.5.1

The Video on Demand Delivery Test represents the I/O operations required to enable individualized video entertainment for a community of subscribers, which draw from a digital film library.

Clause 6.4.5.2

The Video on Demand Delivery Test consists of one (1) Test Run.

The BC shall not be restarted or manually disturbed, altered, or adjusted during the execution of the Video on Demand Delivery Test. If power is lost to the BC during this Test all results shall be rendered invalid and the Test re-run in its entirety.

Clause 10.4.8.3

The Full Disclosure Report will contain the following content for the Video on Demand Delivery Test:

1. *A listing of the SPC-2C Workload Generator commands and parameters used to execute the Test Run in the Video on Demand Delivery Test.*
2. *The human readable SPC-2C Test Results File for the Test Run in the Video on Demand Delivery Test.*
3. *A table that contains the following information for the Test Run in the Video on Demand Delivery Test:*
    - *The number Streams specified.*
    - *The Ramp-Up duration in seconds.*
    - *The Measurement Interval duration in seconds.*
    - *The average data rate, in MB per second, for the Measurement Interval.*
    - *The average data rate, in MB per second, per Stream for the Measurement Interval.*
4. *A table that contains the following information for the single Video on Demand Delivery Test Run:*
    - *The number Streams specified.*
    - *The average data rate, average data rate per stream, average Response Time, and Maximum Response Time reported at 60 second intervals.*
5. *Average Data Rate by Interval and Average Response Time by Interval graphs for the single Video on Demand Delivery Test Run as specified in Clauses 10.1.4-2-10.1.6.*
6. *A Maximum Response Time (intervals) graph as specified in Clause 10.1.9.*

SPC-2C Workload Generator Commands and Parameters

The SPC-2C Workload Generator commands and parameters for the Video on Demand Delivery Test Run are documented in "Appendix E: SPC-2C Workload Generator Execution Commands and Parameters" on Page 96.

SPC-2C Test Results File

A link to the SPC-2C Test Results file generated from the Video on Demand Delivery Test Run is listed below.

SPC-2C Video on Demand Delivery Test Results File

SPC-2C Video on Demand Delivery Test Run Data

The number of Streams specified, Ramp-Up duration in seconds, Measurement Interval duration in seconds, average Data Rate for the Measurement Interval, and average Data Rate per Stream for the Measurement Interval are listed in the following table.

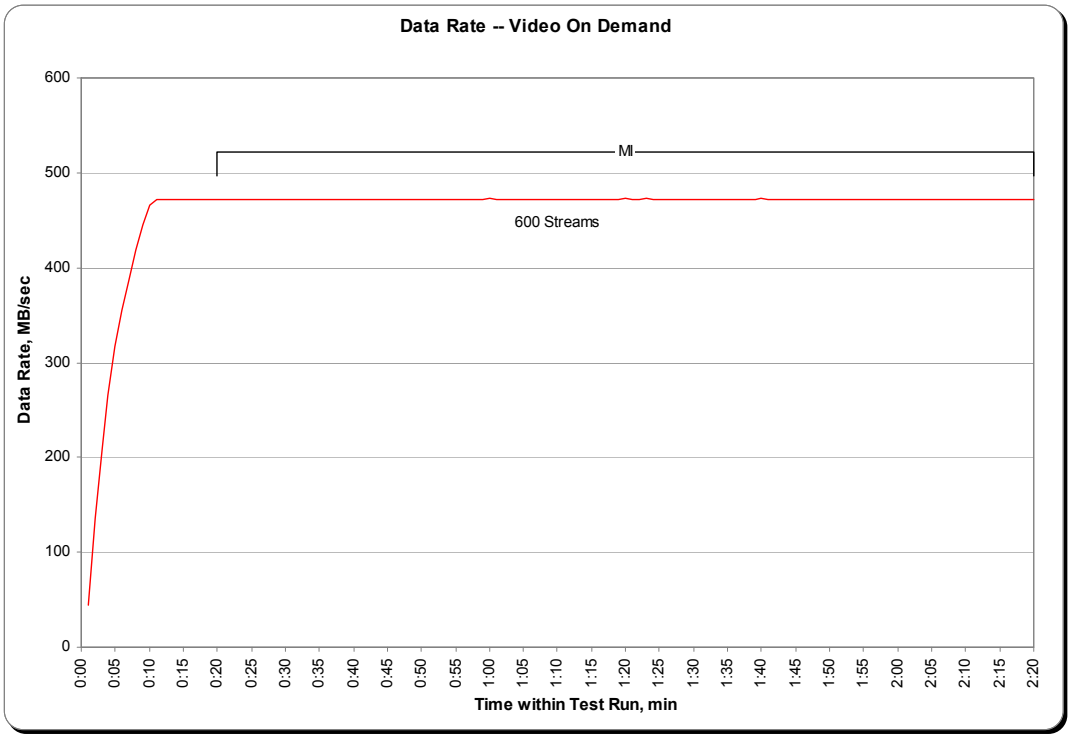
SPC-2-VOD	TR1
Number of Streams	600
Ramp-up Time, sec	1200
Measurement Interval, sec	7200
Average Data Rate, MB/sec	471.86
Per Stream Data Rate, MB/sec	0.79
Average Response Time, ms	63.55
Average Max Response Time, ms	1,026.28

Video on Demand Delivery Test – TEST RUN DATA BY INTERVAL

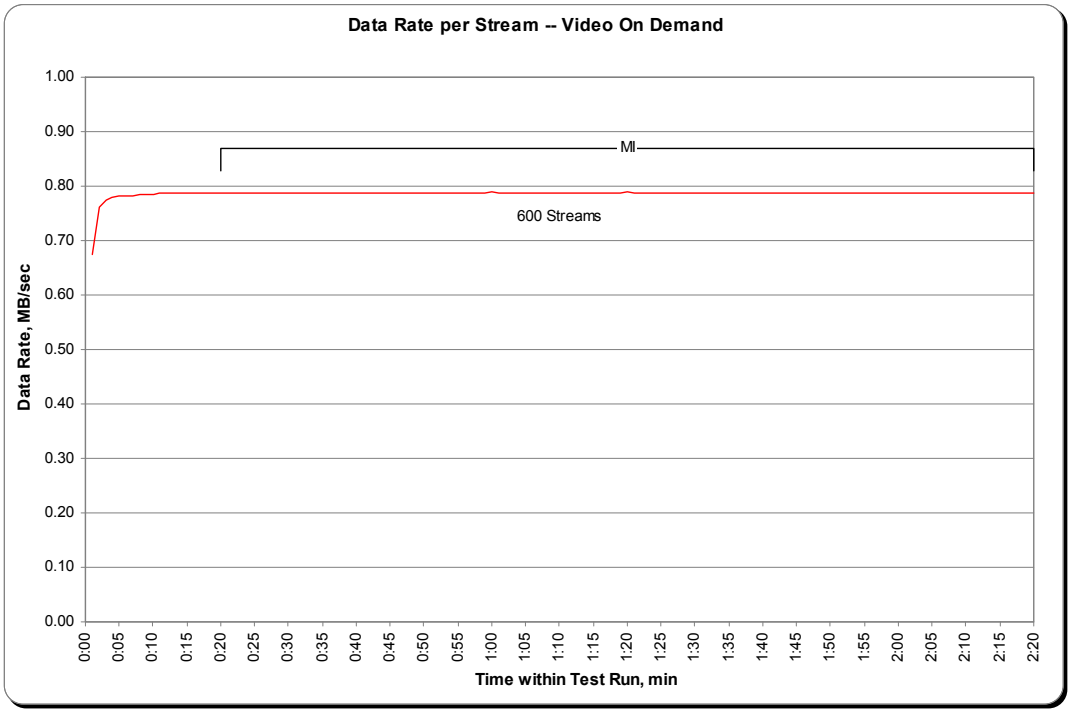
The SPC-2C Video on Demand Delivery Test Run data is contained in the table that appears on the next page. That table is followed by graphs illustrating the average Data Rate and average Data Rate per Stream produced by the same Test Runs. The table and graphs present the data at sixty second intervals.

TR1	600 Streams				TR1	600 Streams				TR1	600 Streams			
Test Run Sequence Time	Data Rate, MB/sec	Data Rate / Stream, MB/sec	Response Time, ms	Maximum Response Time, ms	Test Run Sequence Time	Data Rate, MB/sec	Data Rate / Stream, MB/sec	Response Time, ms	Maximum Response Time, ms	Test Run Sequence Time	Data Rate, MB/sec	Data Rate / Stream, MB/sec	Response Time, ms	Maximum Response Time, ms
0:01:00	44.35	0.67	8.23	54.71	0:51:00	471.86	0.79	89.34	1,462.21	1:41:00	471.89	0.79	56.62	638.59
0:02:00	135.65	0.76	7.41	62.76	0:52:00	471.82	0.79	90.10	1,482.60	1:42:00	471.89	0.79	56.66	865.33
0:03:00	209.59	0.78	8.42	89.39	0:53:00	471.84	0.79	89.94	1,500.91	1:43:00	471.83	0.79	55.12	790.54
0:04:00	264.81	0.78	11.76	155.75	0:54:00	471.92	0.79	89.53	1,501.61	1:44:00	471.84	0.79	56.15	854.53
0:05:00	317.54	0.78	17.58	299.57	0:55:00	471.88	0.79	89.94	1,471.63	1:45:00	471.80	0.79	57.23	764.94
0:06:00	355.11	0.78	22.75	384.61	0:56:00	471.95	0.79	90.23	1,486.21	1:46:00	471.86	0.79	59.49	824.56
0:07:00	385.85	0.78	29.84	528.04	0:57:00	471.84	0.79	90.84	1,498.91	1:47:00	471.87	0.79	60.18	1,072.26
0:08:00	419.06	0.78	38.98	713.40	0:58:00	471.86	0.79	90.33	1,487.85	1:48:00	472.08	0.79	61.09	945.49
0:09:00	445.77	0.78	48.71	804.52	0:59:00	471.89	0.79	90.02	1,505.83	1:49:00	471.82	0.79	62.64	1,151.55
0:10:00	465.62	0.79	57.72	980.18	1:00:00	473.20	0.79	90.56	1,486.75	1:50:00	471.93	0.79	61.96	1,253.15
0:11:00	471.84	0.79	61.10	1,090.16	1:01:00	472.06	0.79	79.57	1,463.64	1:51:00	471.84	0.79	60.87	1,125.42
0:12:00	471.91	0.79	61.60	1,059.77	1:02:00	471.89	0.79	65.71	1,308.23	1:52:00	471.78	0.79	60.32	1,130.48
0:13:00	471.92	0.79	61.42	1,072.71	1:03:00	472.33	0.79	57.89	1,010.52	1:53:00	471.88	0.79	61.86	1,235.02
0:14:00	471.83	0.79	61.20	983.14	1:04:00	471.84	0.79	53.91	943.05	1:54:00	471.88	0.79	61.13	1,163.67
0:15:00	471.84	0.79	61.88	1,086.32	1:05:00	471.92	0.79	56.29	980.80	1:55:00	471.86	0.79	61.58	1,119.80
0:16:00	471.81	0.79	61.41	1,107.05	1:06:00	471.91	0.79	56.45	974.64	1:56:00	471.80	0.79	60.73	1,231.99
0:17:00	471.84	0.79	61.04	995.72	1:07:00	471.85	0.79	56.64	924.11	1:57:00	471.95	0.79	61.62	1,264.65
0:18:00	471.82	0.79	61.28	969.55	1:08:00	471.90	0.79	54.79	897.26	1:58:00	471.79	0.79	61.74	1,184.71
0:19:00	471.88	0.79	61.31	1,075.68	1:09:00	471.88	0.79	56.45	855.66	1:59:00	471.87	0.79	60.96	1,094.36
0:20:00	471.84	0.79	61.95	1,059.86	1:10:00	471.89	0.79	57.02	1,003.97	2:00:00	471.85	0.79	62.14	1,276.54
0:21:00	471.89	0.79	61.22	962.21	1:11:00	471.88	0.79	57.79	1,007.26	2:01:00	471.83	0.79	63.64	1,268.01
0:22:00	471.80	0.79	59.33	914.38	1:12:00	471.87	0.79	58.42	1,128.72	2:02:00	471.86	0.79	63.53	1,178.99
0:23:00	471.82	0.79	60.54	846.16	1:13:00	471.82	0.79	57.86	1,196.22	2:03:00	471.83	0.79	63.79	1,156.33
0:24:00	471.93	0.79	63.79	1,003.21	1:14:00	471.82	0.79	58.50	1,127.46	2:04:00	471.85	0.79	64.74	1,158.50
0:25:00	471.93	0.79	63.87	1,037.51	1:15:00	471.83	0.79	57.98	988.84	2:05:00	471.86	0.79	62.23	1,009.28
0:26:00	471.88	0.79	61.02	944.57	1:16:00	471.87	0.79	57.85	1,110.92	2:06:00	471.86	0.79	60.64	880.46
0:27:00	471.92	0.79	61.71	849.94	1:17:00	471.88	0.79	58.35	1,123.84	2:07:00	471.87	0.79	59.67	749.43
0:28:00	471.89	0.79	59.73	949.13	1:18:00	471.90	0.79	58.45	1,070.90	2:08:00	471.90	0.79	58.97	776.34
0:29:00	471.85	0.79	58.26	795.55	1:19:00	471.89	0.79	57.70	1,018.45	2:09:00	471.88	0.79	57.29	857.04
0:30:00	471.92	0.79	57.85	869.04	1:20:00	473.25	0.79	58.24	1,125.88	2:10:00	471.85	0.79	55.93	920.57
0:31:00	471.89	0.79	57.85	825.84	1:21:00	471.84	0.79	58.79	980.14	2:11:00	471.93	0.79	54.60	791.74
0:32:00	471.91	0.79	58.24	858.74	1:22:00	471.93	0.79	61.83	1,054.28	2:12:00	471.89	0.79	54.89	781.26
0:33:00	471.96	0.79	58.59	944.58	1:23:00	472.50	0.79	61.50	1,059.47	2:13:00	471.88	0.79	54.81	751.01
0:34:00	471.88	0.79	58.17	961.12	1:24:00	471.88	0.79	62.43	822.44	2:14:00	471.90	0.79	54.98	747.00
0:35:00	471.81	0.79	58.34	957.05	1:25:00	471.87	0.79	59.61	770.94	2:15:00	471.90	0.79	55.19	927.64
0:36:00	471.88	0.79	58.32	902.78	1:26:00	471.90	0.79	58.94	841.02	2:16:00	471.86	0.79	55.16	842.61
0:37:00	471.88	0.79	57.98	875.45	1:27:00	471.89	0.79	58.44	778.45	2:17:00	471.89	0.79	55.30	890.92
0:38:00	471.85	0.79	57.68	841.76	1:28:00	471.94	0.79	56.34	684.55	2:18:00	471.88	0.79	55.68	861.69
0:39:00	471.87	0.79	57.90	848.45	1:29:00	471.80	0.79	58.31	729.90	2:19:00	471.91	0.79	55.45	824.90
0:40:00	471.81	0.79	57.98	971.53	1:30:00	471.90	0.79	57.30	706.64	2:20:00	471.89	0.79	55.55	842.00
0:41:00	471.82	0.79	63.01	912.57	1:31:00	471.86	0.79	57.17	757.20					
0:42:00	471.86	0.79	74.43	1,238.67	1:32:00	471.83	0.79	57.15	731.63					
0:43:00	471.83	0.79	81.51	1,480.50	1:33:00	471.84	0.79	57.53	740.48					
0:44:00	471.85	0.79	80.46	1,452.96	1:34:00	471.94	0.79	57.33	725.03					
0:45:00	471.81	0.79	83.48	1,427.91	1:35:00	471.87	0.79	57.43	680.65					
0:46:00	471.90	0.79	89.08	1,514.96	1:36:00	471.96	0.79	57.57	681.72					
0:47:00	471.78	0.79	89.90	1,439.57	1:37:00	471.83	0.79	57.33	707.16					
0:48:00	471.83	0.79	89.97	1,482.23	1:38:00	471.86	0.79	57.16	650.71					
0:49:00	471.85	0.79	91.46	1,495.50	1:39:00	471.88	0.79	57.06	760.36					
0:50:00	471.88	0.79	90.26	1,506.98	1:40:00	472.56	0.79	57.36	764.16					

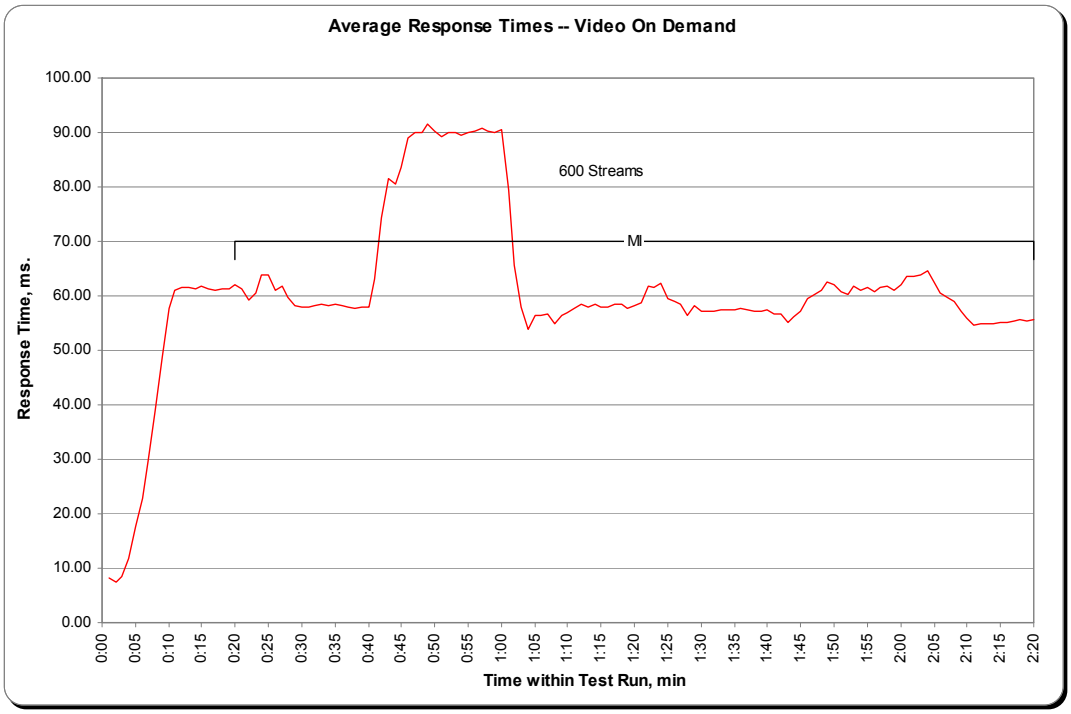
SPC-2C Video on Demand Delivery Average Data Rate Graph



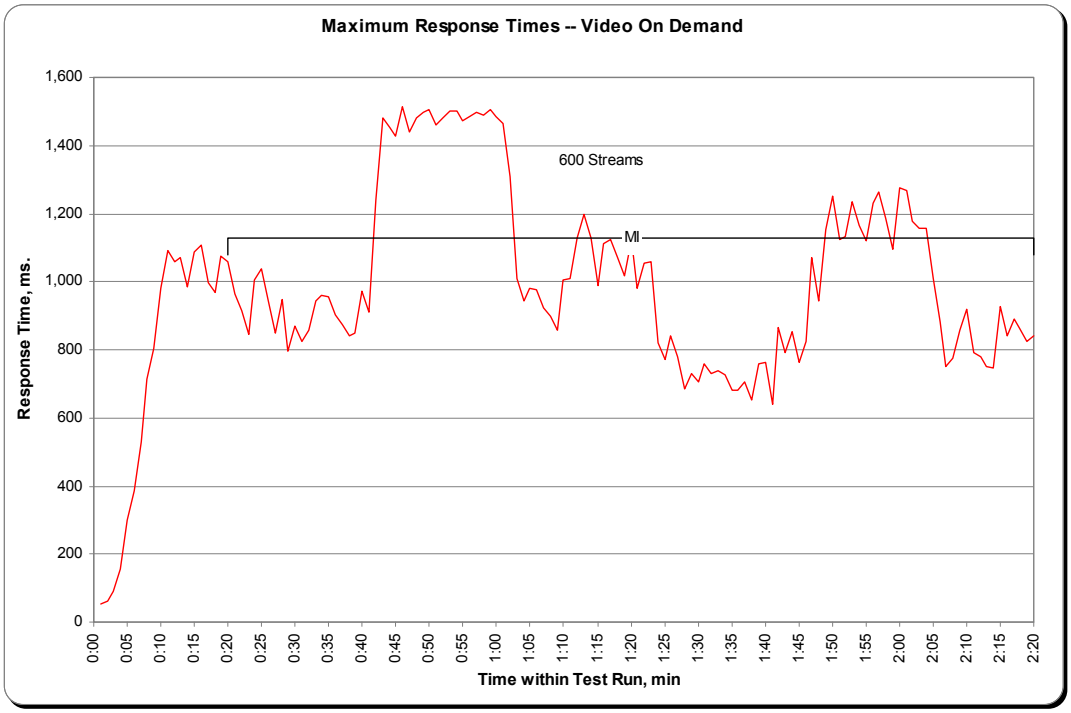
SPC-2C Video on Demand Delivery Average Data Rate per Stream Graph



SPC-2C Video on Demand Delivery Average Response Time Graph



SPC-2C Video on Demand Delivery Maximum Response Time Graph



Data Persistence Test

Clause 7

The Data Persistence Test demonstrates the Tested Storage Configuration (TSC):

- *Is capable of maintain data integrity across a power cycle.*
- *Ensures the transfer of data between Logical Volumes and host systems occurs without corruption or loss.*

The SPC-2C Workload Generator will write a specific pattern at randomly selected locations throughout the Total ASU Capacity (Persistence Test Run 1). The SPC-2C Workload Generator will retain the information necessary to later validate the pattern written at each location.

The Tested Storage Configuration will be shutdown and restarted using a power off/power on cycle at the end of the above sequence of write operations. In addition, any caches employing battery backup must be flushed/emptied.

Restart the TSC, and if the Host System(s) were shutdown and powered off, restart the Host System(s).

The SPC-2C Workload Generator will utilize the retained data from Persistence Test Run 1 to verify (Persistence Run 2) the bit patterns written in Persistence Test Run 1 and their corresponding location.

Clause 10.4.8.4

The Full Disclosure Report will contain the following content for the Data Persistence Test:

1. *A listing of the SPC-2C Workload Generator commands and parameters used to execute each of the Test Runs in the Persistence Test.*
2. *The human readable SPC-2C Test Results File for each of the Test Runs in the Data Persistence Test.*
3. *A table from the successful Persistence Test, which contains the results from the test.*

SPC-2C Workload Generator Commands and Parameters

The SPC-2C Workload Generator commands and parameters for the Persistence Test Runs are documented in "Appendix E: SPC-2C Workload Generator Execution Commands and Parameters" on Page 96.

Data Persistence Test Results File

A link to the test result file generated from each Data Persistence Test Run is listed below.

Persistence 1 Test Run Results File

Persistence 2 Test Run Results File

Data Persistence Test Results

Data Persistence Test Results	
Data Persistence Test Number: 1	
Total Number of Logical Blocks Written	130,300
Total Number of Logical Blocks Re-referenced	442
Total Number of Logical Blocks Verified	129,858
Total Number of Logical Blocks that Failed Verification	0
Number of Failed I/O Requests in the process of the Test	0

PRICED STORAGE CONFIGURATION AVAILABILITY DATE

Clause 10.4.9

The committed delivery date for general availability (Availability Date) of all products that comprise the Priced Storage Configuration must be reported. When the Priced Storage Configuration includes products or components with different availability dates, the reported Availability Date must be the date at which all components are committed to be available. All availability dates, whether for individual components or for the Priced Storage Configuration as a whole, must be disclosed to a precision of one day.

The Availability Date shall be stated in the FDR by either a combination of specific alphanumeric month, numeric day, and numeric year or as "Currently Available" in the case where all components that comprise the PSC are currently available for customer order and shipment.

The Seagate Constellation.2™, as documented in this SPC-2C Full Disclosure Report, is currently available for customer purchase and shipment.

ANOMALIES OR IRREGULARITIES

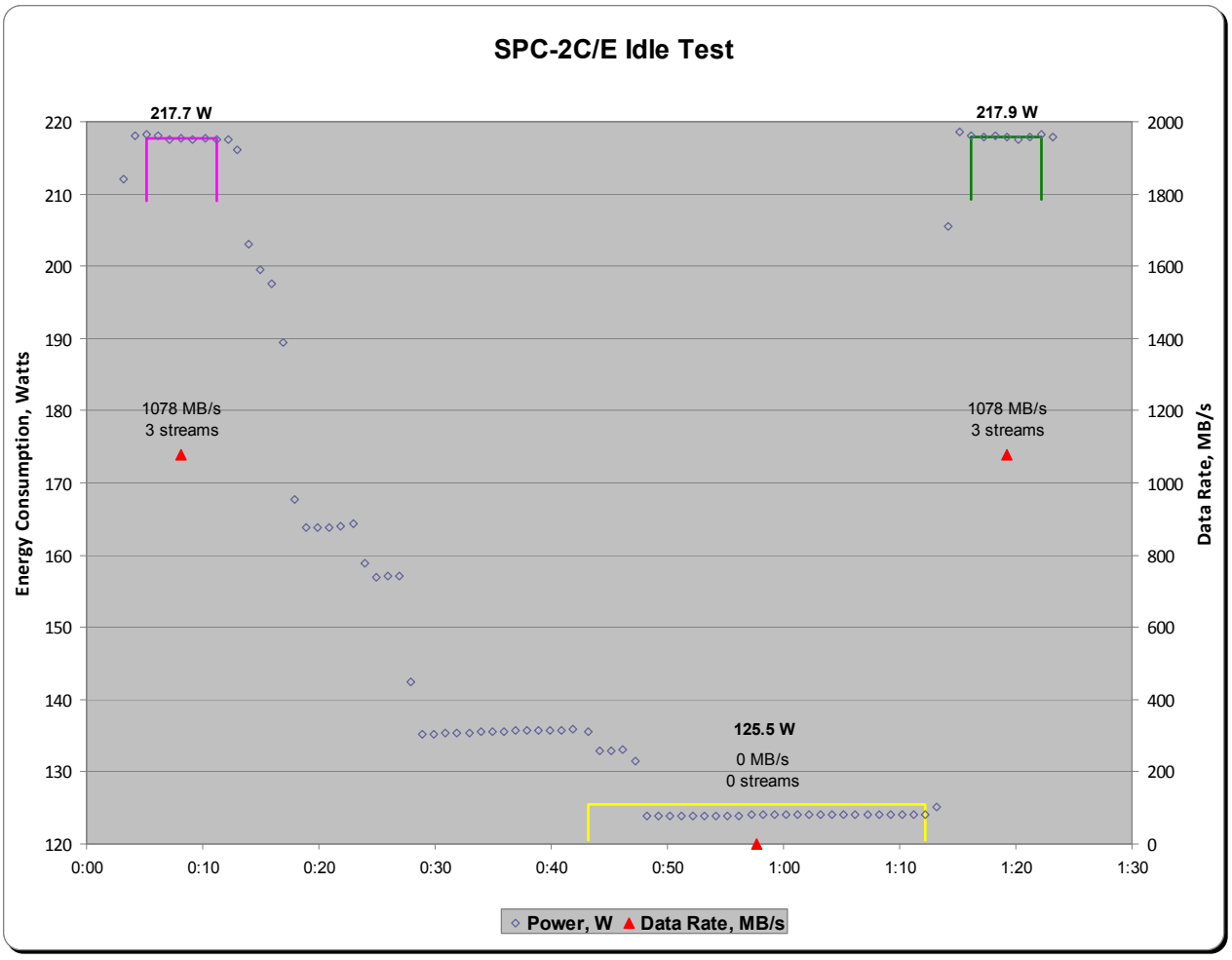
Clause 10.4.11

The FDR shall include a clear and complete description of any anomalies or irregularities encountered in the course of executing the SPC-2C benchmark that may in any way call into question the accuracy, verifiability, or authenticity of information published in this FDR.

There were no anomalies or irregularities encountered during the SPC-2C Onsite Audit of the Seagate Constellation.2™.

SPC-2C/E REPORTED DATA AND CHARTS

SPC-2C/E Idle Test Chart and Data Table



Test Run	Average Power Watts	Data Rate MB/s
Pre Idle - 3 streams, Read/Write	217.7	1,078
Idle - 0 streams,	125.5	0
Post Idle - 3 streams, Read/Write	217.9	1,078

SPC-2C/E Large File Processing (LFP) Reported Data

Power Environment

Average RMS Voltage: 202.99 Average Power Factor: 0.954

	Usage Profile Hours of Use per Day			Nominal			
	Heavy	Moderate	Idle	Power watts	Traffic MBPS	Ratio MBPS/w	Heat BTU/hr
Low Daily Usage:	0	8	16	155.19	396.51	2.55	529.53
Medium Daily Usage:	4	14	6	192.85	891.60	4.62	658.04
High Daily Usage:	18	6	0	216.98	1187.05	5.47	740.36
Composite Metrics:				188.34	825.05	4.38	

Annual Energy Use, kWh: 1,649.87

Energy Cost, $/kWh: $ 0.12

Annual Energy Cost, $: $ 197.98

HEAVY SPC-2C LFP Workload: 217.77W at a data rate of 884.08 MB/s.

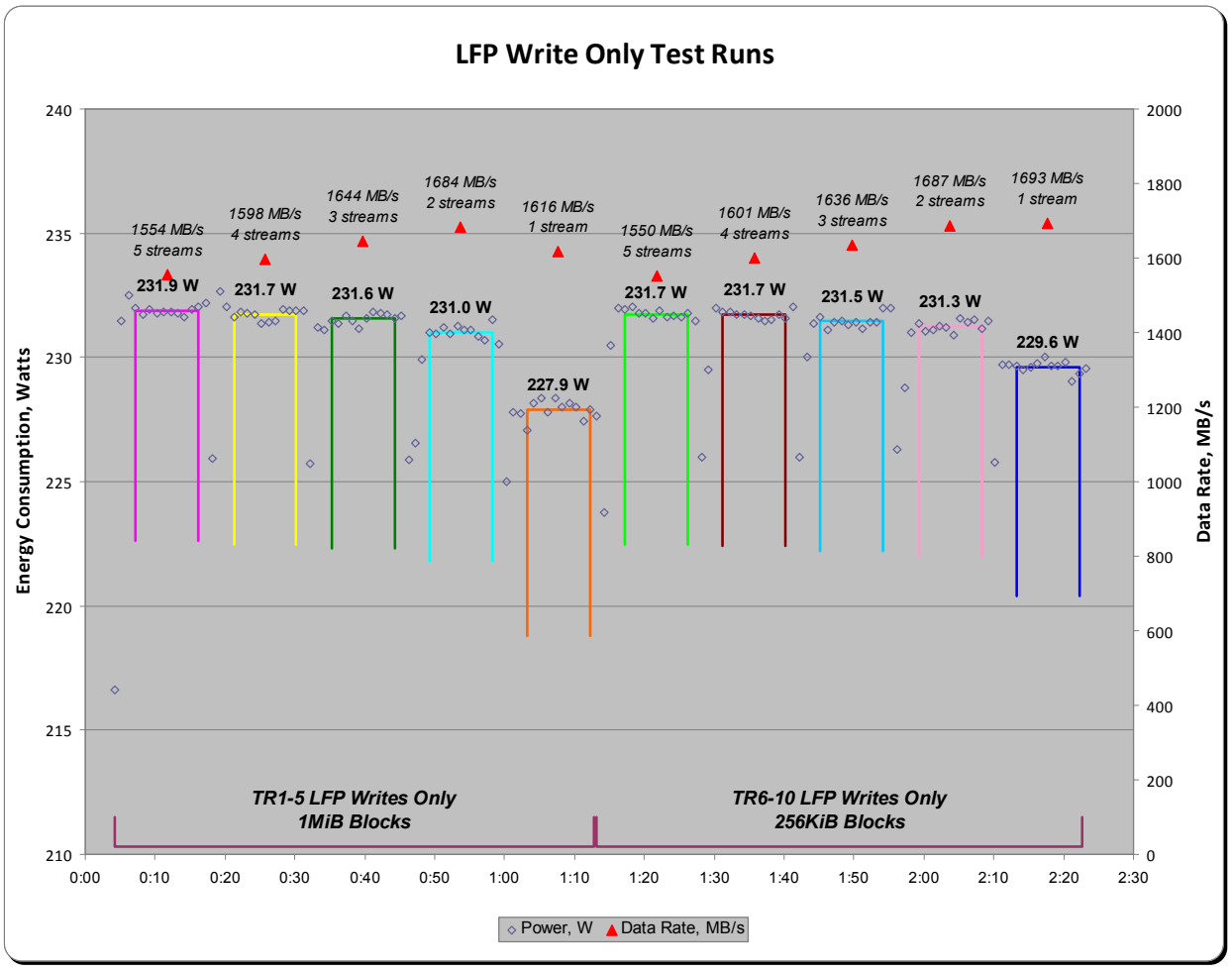
MODERATE SPC-2C LFP Workload: 201.61W at a data rate of 844.63 MB/s.

IDLE SPC-2C LFP Workload: 125.48W at a 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) while executing only the SPC-2C Large File Processing (LFP) workload.

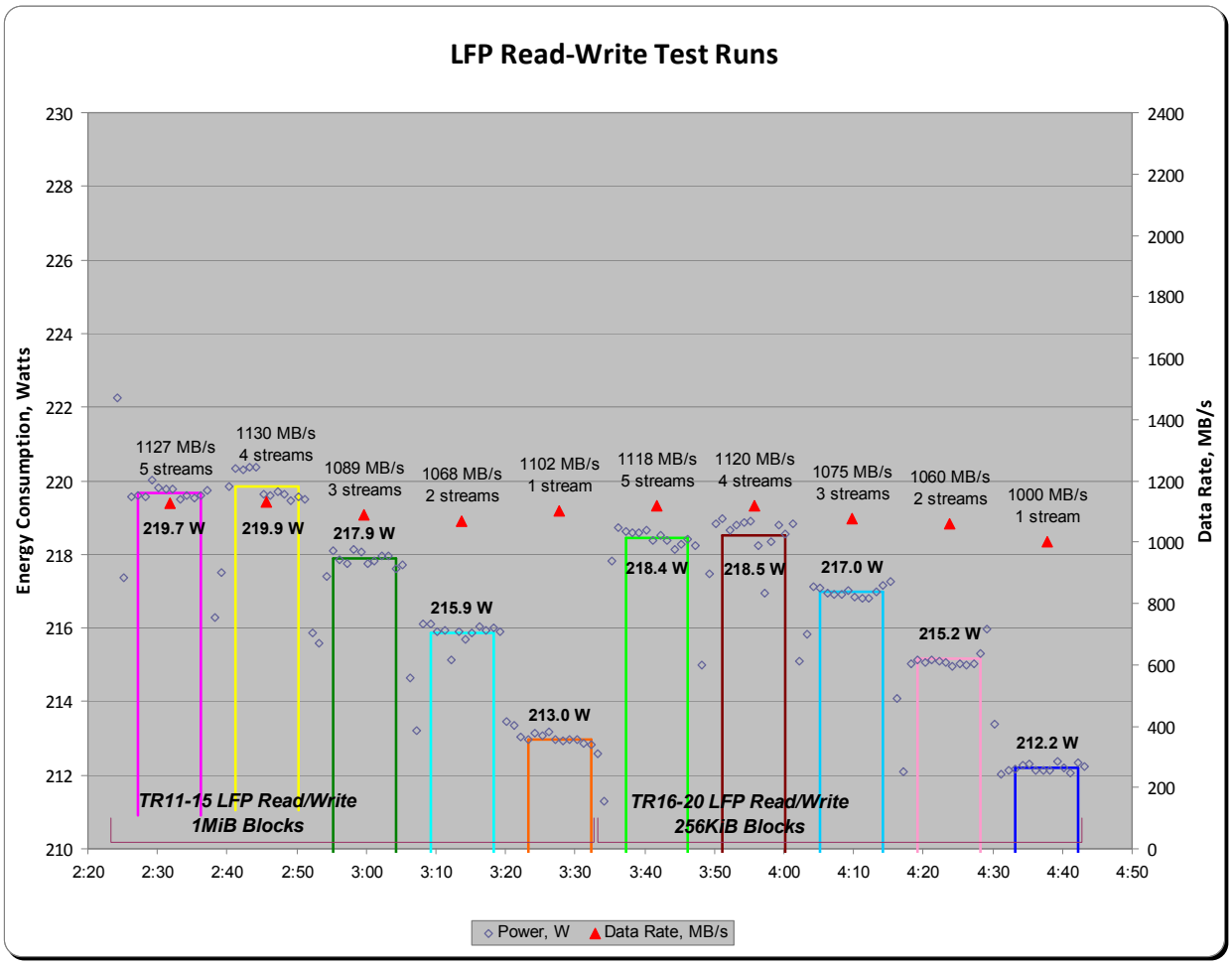
The definitions for the remaining items in the above LFP SPC-2C/E Reported Data table are available on at the following location in the Executive Summary portion of this document: reported data definitions.

SPC-2C/E Large File Processing (LFP) WRITE ONLY Chart and Data Table



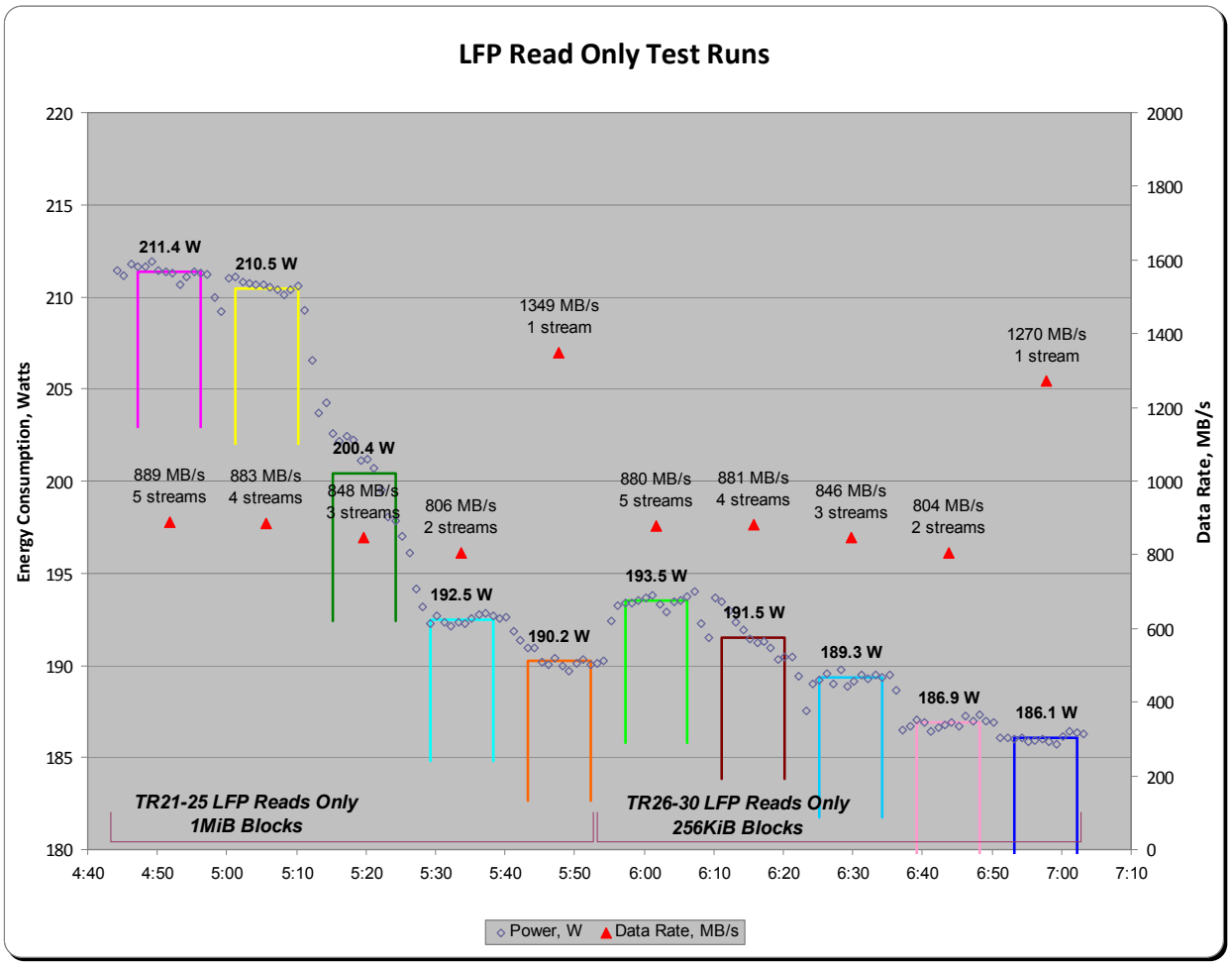
Test Run (TR)	Average Power Watts	Data Rate MB/s
TR1 - 5 streams, 1MB Writes	231.9	1,554
TR2 - 4 streams, 1MB Writes	231.7	1,598
TR3 - 3 streams, 1MB Writes	231.6	1,644
TR4 - 2 streams, 1MB Writes	231.0	1,684
TR5 - 1 streams, 1MB Writes	227.9	1,616
TR6 - 5 streams, 256KB Writes	231.7	1,550
TR7 - 4 streams, 256KB Writes	231.7	1,601
TR8 - 3 streams, 256KB Writes	231.5	1,636
TR9 - 2 streams, 256KB Writes	231.3	1,687
TR10 - 1 streams, 256KB Writes	229.6	1,693

SPC-2C/E Large File Processing (LFP) READ-WRITE Chart and Data Table



Test Run (TR)	Average Power Watts	Data Rate MB/s
TR10 - 1 streams, 256KB Writes	229.6	1,693
TR11 - 5 streams, 1MB Read/Writes	219.7	1,127
TR12 - 4 streams, 1MB Read/Writes	219.9	1,130
TR13 - 3 streams, 1MB Read/Writes	217.9	1,089
TR14 - 2 streams, 1MB Read/Writes	215.9	1,068
TR15 - 1 streams, 1 MB Read/Writes	213.0	1,102
TR16 - 5 streams, 256KB Read/Writes	218.4	1,118
TR17 - 4 streams, 256KB Read/Writes	218.5	1,120
TR18 - 3 streams, 256KB Read/Writes	217.0	1,075
TR19 - 2 streams, 256KB Read/Writes	215.2	1,060
TR20 - 1 streams, 256 KB Read/Writes	212.2	1,000

SPC-2C/E Large File Processing (LFP) READ ONLY Chart and Data Table



Test Run (TR)	Average Power Watts	Data Rate MB/s
TR21 - 5 streams, 1MB Reads	211.4	889
TR22 - 4 streams, 1MB Reads	210.5	883
TR23 - 3 streams, 1MB Reads	200.4	848
TR24 - 2 streams, 1MB Reads	192.5	806
TR25 - 1 streams, 1MB Reads	190.2	1,349
TR26 - 5 streams, 256KB Reads	193.5	880
TR27 - 4 streams, 256KB Reads	191.5	881
TR28 - 3 streams, 256KB Reads	189.3	846
TR29 - 2 streams, 256KB Reads	186.9	804
TR30 - 1 streams, 256KB Reads	186.1	1,270

SPC-2C/E Large Database Query (LDQ) Reported Data

Power Environment Average RMS Voltage:	203.62	Average Power Factor:	0.949

	Usage Profile Hours of Use per Day			Nominal			
	Heavy	Moderate	Idle	Power watts	Traffic MBPS	Ratio MBPS/w	Heat BTU/hr
Low Daily Usage:	0	8	16	**150.86**	**281.54**	**1.87**	**514.73**
Medium Daily Usage:	4	14	6	**182.89**	**640.05**	**3.50**	**624.04**
High Daily Usage:	18	6	0	**203.03**	**874.22**	**4.31**	**692.76**
Composite Metrics:				**178.93**	**598.60**	**3.35**	

Annual Energy Use, kWh:	1,567.39		
Energy Cost, $/kWh:	$ 0.12	**Annual Energy Cost, $:**	**$ 188.09**

HEAVY SPC-2C LDQ Workload: 203.50W at a data rate of 884.08 MB/s.

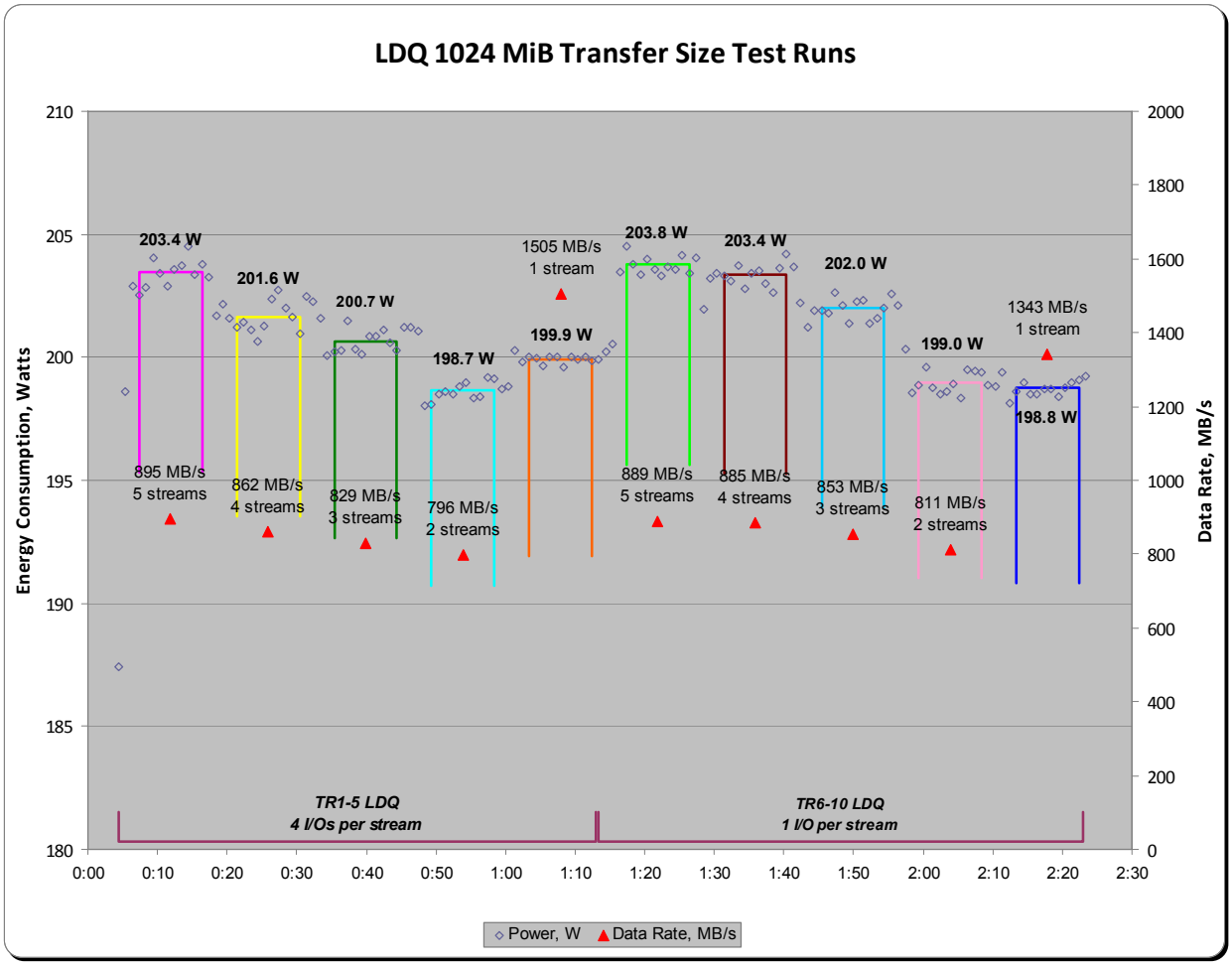
MODERATE SPC-2C LDQ Workload: 201.61W at a data rate of 884.63 MB/s.

IDLE SPC-2C LDQ Workload: 125.48W at a 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) while executing only the SPC-2C Large Database Query (LDQ) workload.

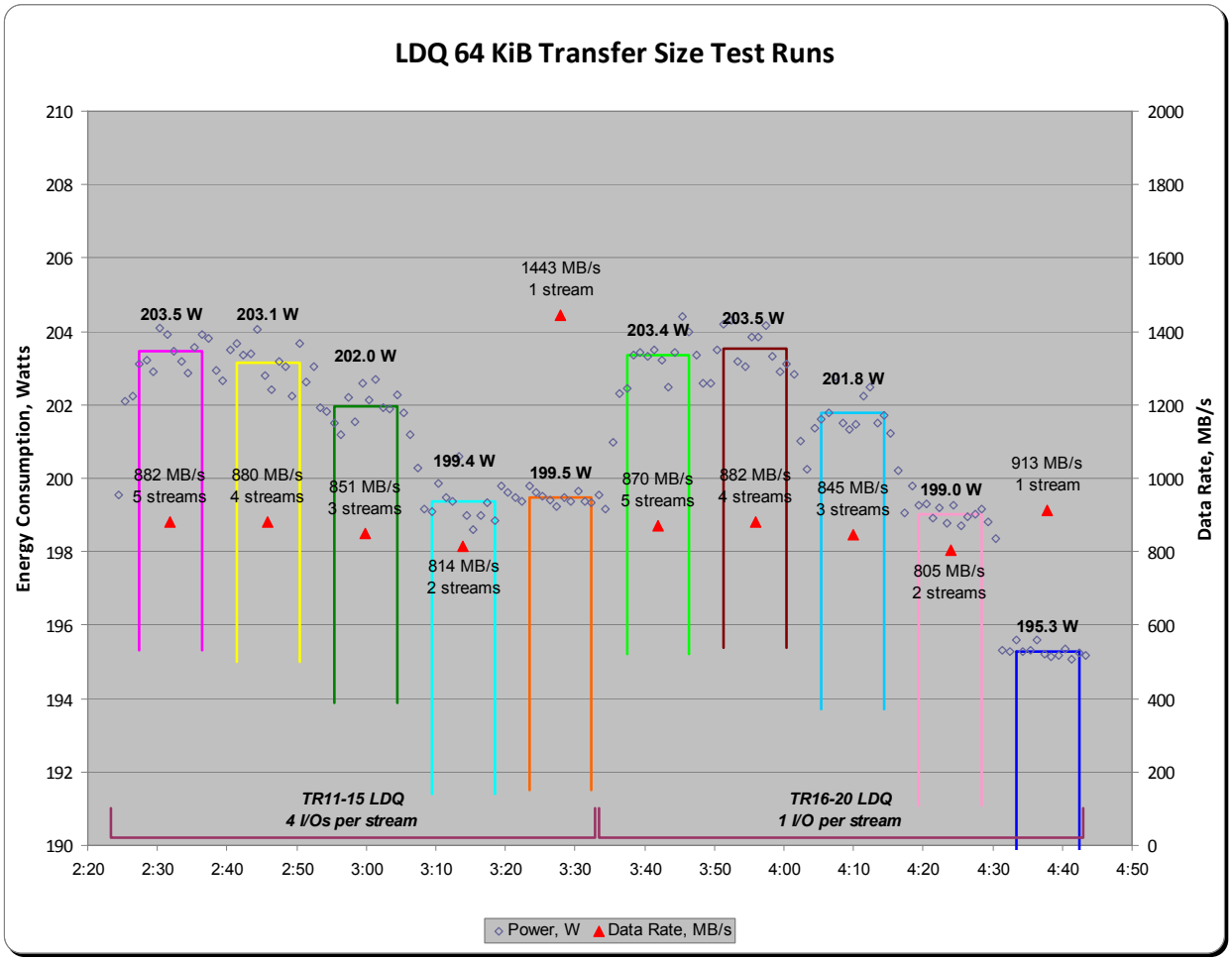
The definitions for the remaining items in the above LDQ SPC-2C/E Reported Data table are available on at the following location in the Executive Summary portion of this document: reported data definitions.

SPC-2C/E Large Database Query (LDQ)
1024 KIB TRANSFER SIZE Chart and Data Table



Test Run (TR)	Average Power (Watts)	Data Rate (MB/s)
TR1 - 5 streams, 4x1MB I/Os	203.4	895
TR2 - 4 streams, 4x1MB I/Os	201.6	862
TR3 - 3 streams, 4x1MB I/Os	200.7	829
TR4 - 2 streams, 4x1MB I/Os	198.7	796
TR5 - 1 streams, 4x1MB I/Os	199.9	1,505
TR6 - 5 streams, 1x1MB I/Os	203.8	889
TR7 - 4 streams, 1x1MB I/Os	203.4	885
TR8 - 3 streams, 1x1MB I/Os	202.0	853
TR9 - 2 streams, 1x1MB I/Os	199.0	811
TR10 - 1 streams, 1x1MB I/Os	198.8	1,343

SPC-2/E Large Database Query (LDQ)
64 KIB TRANSFER SIZE Chart and Data Table



Test Run (TR)	Average Power (Watts)	Data Rate (MB/s)
TR11 - 5 streams, 4x1MB I/Os	203.5	882
TR12 - 4 streams, 4x1MB I/Os	203.1	880
TR13 - 3 streams, 4x1MB I/Os	202.0	851
TR14 - 2 streams, 4x1MB I/Os	199.4	814
TR15 - 1 streams, 4x1MB I/Os	199.5	1,443
TR16 - 5 streams, 1x1MB I/Os	203.4	870
TR17 - 4 streams, 1x1MB I/Os	203.5	882
TR18 - 3 streams, 1x1MB I/Os	201.8	845
TR19 - 2 streams, 1x1MB I/Os	199.0	805
TR20 - 1 streams, 1x1MB I/Os	195.3	913

SPC-2C/E Video on Demand Delivery (VOD) Reported Data

Power Environment
Average RMS Voltage: 203.87 Average Power Factor: 0.945

	Usage Profile Hours of Use per Day			Nominal			
	Heavy	Moderate	Idle	Power watts	Traffic MBPS	Ratio MBPS/w	Heat BTU/hr
Low Daily Usage:	0	8	16	148.12	164.93	1.11	505.40
Medium Daily Usage:	4	14	6	176.42	371.09	2.10	601.96
High Daily Usage:	18	6	0	193.40	494.78	2.56	659.89
Composite Metrics:				172.65	343.60	1.99	

Annual Energy Use, kWh: 1,512.37
Energy Cost, $/kWh: $ 0.12
Annual Energy Cost, $: $ 181.48

HEAVY SPC-2C VOD Workload: 193.40W at a data rate of 494.78 MB/s.

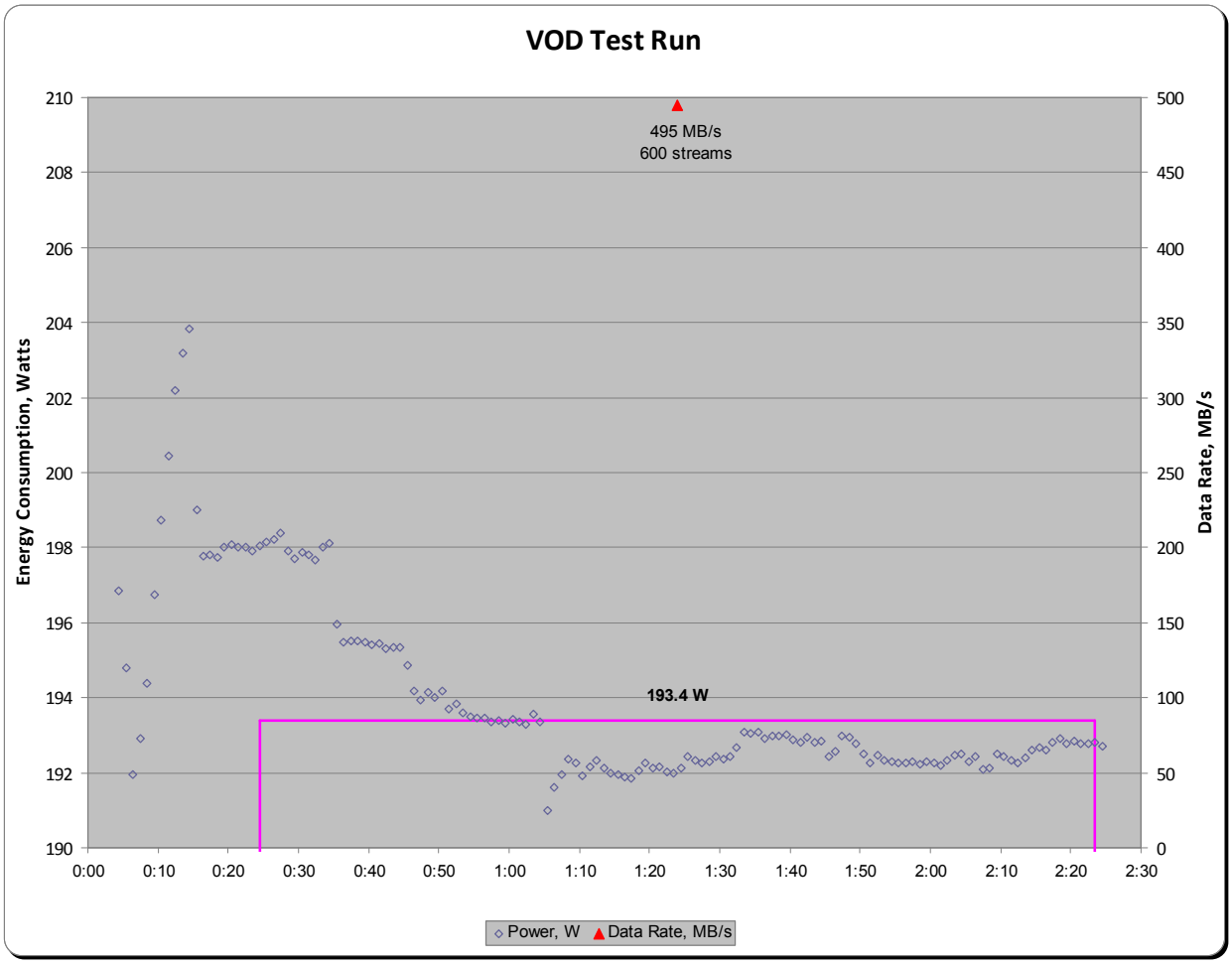
MODERATE SPC-2C VOD Workload: 193.40W at a data rate of 494.78 MB/s.

IDLE SPC-2C VOD Workload: 125.48W at a 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) while executing only the SPC-2C Video on Demand Delivery (VOD) workload.

The definitions for the remaining items in the above VOD SPC-2C/E Reported Data table are available on at the following location in the Executive Summary portion of this document: reported data definitions.

SPC-2C/E Video on Demand Delivery (VOD) Chart and Data Table



Test Run (TR)	Average Power (Watts)	Data Rate (MB/s)
TR1 - 600 streams,	193.4	495

APPENDIX A: SPC-2C GLOSSARY

"Decimal" *(powers of ten)* Measurement Units

In the storage industry, the terms "kilo", "mega", "giga", "tera", "peta", and "exa" are commonly used prefixes for computing performance and capacity. For the purposes of the SPC workload definitions, all of the following terms are defined in "powers of ten" measurement units.

- A kilobyte (KB) is equal to 1,000 (10^3) bytes.
- A megabyte (MB) is equal to 1,000,000 (10^6) bytes.
- A gigabyte (GB) is equal to 1,000,000,000 (10^9) bytes.
- A terabyte (TB) is equal to 1,000,000,000,000 (10^{12}) bytes.
- A petabyte (PB) is equal to 1,000,000,000,000,000 (10^{15}) bytes
- An exabyte (EB) is equal to 1,000,000,000,000,000,000 (10^{18}) bytes

"Binary" *(powers of two)* Measurement Units

The sizes reported by many operating system components use "powers of two" measurement units rather than "power of ten" units. The following standardized definitions and terms are also valid and may be used in this document.

- A kibibyte (KiB) is equal to 1,024 (2^{10}) bytes.
- A mebibyte (MiB) is equal to 1,048,576 (2^{20}) bytes.
- A gigibyte (GiB) is equal to 1,073,741,824 (2^{30}) bytes.
- A tebibyte (TiB) is equal to 1,099,511,627,776 (2^{40}) bytes.
- A pebibyte (PiB) is equal to 1,125,899,906,842,624 (2^{50}) bytes.
- An exbibyte (EiB) is equal to 1,152,921,504,606,846,967 (2^{60}) bytes.

SPC-2C Data Repository Definitions

Total ASU Capacity: The total storage capacity read and written in the course of executing the SPC-2C benchmark.

Application Storage Unit (ASU): The logical interface between the storage and SPC-2C Workload Generator. The ASU is implemented on one or more Logical Volume.

Logical Volume: The division of Addressable Storage Capacity into individually addressable logical units of storage used in the SPC-2C benchmark. Each Logical Volume is implemented as a single, contiguous address space.

Addressable Storage Capacity: The total storage (sum of Logical Volumes) that can be read and written by application programs such as the SPC-2C Workload Generator.

Configured Storage Capacity: This capacity includes the Addressable Storage Capacity and any other storage (parity disks, hot spares, etc.) necessary to implement the Addressable Storage Capacity.

Physical Storage Capacity: The formatted capacity of all storage devices physically present in the Tested Storage Configuration (TSC).

Data Protection Overhead: The storage capacity required to implement the selected level of data protection.

Required Storage: The amount of Configured Storage Capacity required to implement the Addressable Storage Configuration, excluding the storage required for the ASU.

Global Storage Overhead: The amount of Physical Storage Capacity that is required for storage subsystem use and unavailable for use by application programs.

Total Unused Storage: The sum of unused storage capacity within the Physical Storage Capacity, Configured Storage Capacity, and Addressable Storage Capacity.

SPC-2C Data Protection Levels

Protected: Data protection is provided in the event of a single point of failure of any of the configured storage devices. A brief descripton of the data protection must be included in the FDR.

Unprotected: There is no data protection provided.

SPC-2C Test Execution Definitions

Completed I/O Request: An I/O Request with a Start Time and a Completion Time *(see "I/O Completion Types" illustrated below).*

Completion Time: The time recorded by the Workload Generator when an I/O Request is completed by the Tested Storage Configuration (TSC) as signaled by System Software.

Data Rate: The data volume, in MB, transferred by all Measured I/O Requests in an SPC-2C Test Run divided by the length of the Test Run in seconds.

Failed I/O Request: Any I/O Request issued by the SPC-2C Workload Generator that meets one of the following conditions *(see "I/O Completion Types" illustrated below)*:

- The I/O Request was signaled as failed by System Software.
- The I/O Request started within the Measurement Interval, but did not complete prior to the end of the appropriate Run-Out period..
- The I/O Request started within the Run-Out period, but did not complete prior to the end of the appropriate Ramp-Down period.

I/O Request Throughput: The total number of Measured I/O Requests in an SPC-2C Test Run divided by the duration of the Measurement Interval in seconds.

Measured I/O Request: A Completed I/O Request that begins (Start Time) within a Measurement Interval and completes (Completion Time) prior to the end of the appropriate Ramp Down *(see "I/O Completion Types" illustrated below).*

Measurement Interval: A specified, contiguous period of time, after the TSC has reached Steady State, when data is collected by the Workload Generator to produce the test results for a SPC-2C Test Run *(see "SPC-2C Test Run Components" illustrated below, Test Run 1: T_2-T_3 and Test Run 2: T_7-T_8).*

Outstanding I/O Requests: The Outstanding I/O Requests parameter specifies the maximum number of concurrent I/O Requests, associated with a give Stream, which have been issued but not yet completed. *(Clause 3.4.4 of the SPC-2C Benchmark Specification).*

Ramp-Down: A specified, contiguous period of time in which the TSC is required to complete I/O Requests started but not completed during the preceding Run-Out period. Ramp-Down begins at the end of the preceding Run-Out period *(see "SPC-2C Test Run Components" illustrated below, Test Run 1: T_4-T_5 and Test Run 2: T_9-T_{10}).* The Workload Generator will not submit any I/O Requests during the Ramp-Down.

Ramp-Up: A specified, contiguous period of time required for the Benchmark Configuration (BC) to produce Steady State throughput after the Workload Generator begins submitting I/O Requests to the TSC for execution. The Ramp-Up period ends at the beginning of the Measurement Interval *(see "SPC-2C Test Run Components" illustrated below, Test Run 1: T_0-T_2 and Test Run 2: T_5-T_7).*

Response Time: The Response Time of a Measured I/O Request is its Completion Time minus its Start Time.

Run-Out: A specified, contiguous period of time in which the TSC is required to complete I/O Requests started but not completed during the preceding Measurement Interval. The Run-Out period begins at the end of the preceding Measurement Interval and is a component of the Steady State period *(see "SPC-2C Test Run Components" illustrated below, Test Run 1: T_3-T_4 and Test Run 2: T_9-T_{10}).* The Workload Generator will continue to submit I/O Requests at the Test Run's specified rate during the Run-Out period.

Start Time: The time recorded by the Workload Generator when an I/O Request is submitted, by the Workload Generator, to the System Software for execution on the TSC.

Steady State: The period during which the workload presented to the TSC by the SPC-2C Workload Generator is constant and the resulting TSC I/O Request Throughput is both consistent and sustainable. The Steady State period includes both the Measurement Interval and Run-Out periods *(see "SPC-2C Test Run Components" illustrated below, Test Run 1: T_1-T_4 and Test Run 2: T_6-T_9).*

Steady State is achieved only after caches in the TSC have filled and as a result the I/O Request Throughput of the TSC has stabilized.

Stream: A collection of Stream Segments that started within a Test Run.

Stream Segment: A sequentially organized pattern of I/O requests, which transfers a contiguous range of data.

Test: A collection of Test Phases and or Test Runs sharing a common objective.

Test Phase: A collection of one or more SPC-2C Test Runs sharing a common objective and intended to be run in a specific sequence.

Test Run: The execution of SPC-2C that produces specific SPC-2C test results. SPC-2C Test Runs have specified, measured Ramp-Up, Measurement Interval, Run-Out and Ramp-Down periods. "SPC-2C Test Run Components" *(see below)* illustrates the Ramp-Up, Steady State, Measurement Interval, Run-Out, and Ramp-Down components contained in two uninterrupted SPC-2C Test Runs *(Test Run 1: T_0-T_5 and Test Run 2: T_5-T_{10})*.

Test Run Sequence: A related sequence of Large File Processing (LFP) or Large Database Query (LDQ) Test Runs. Each Test Run Sequence will consist of five Test Runs, which vary the number of Streams as follows:

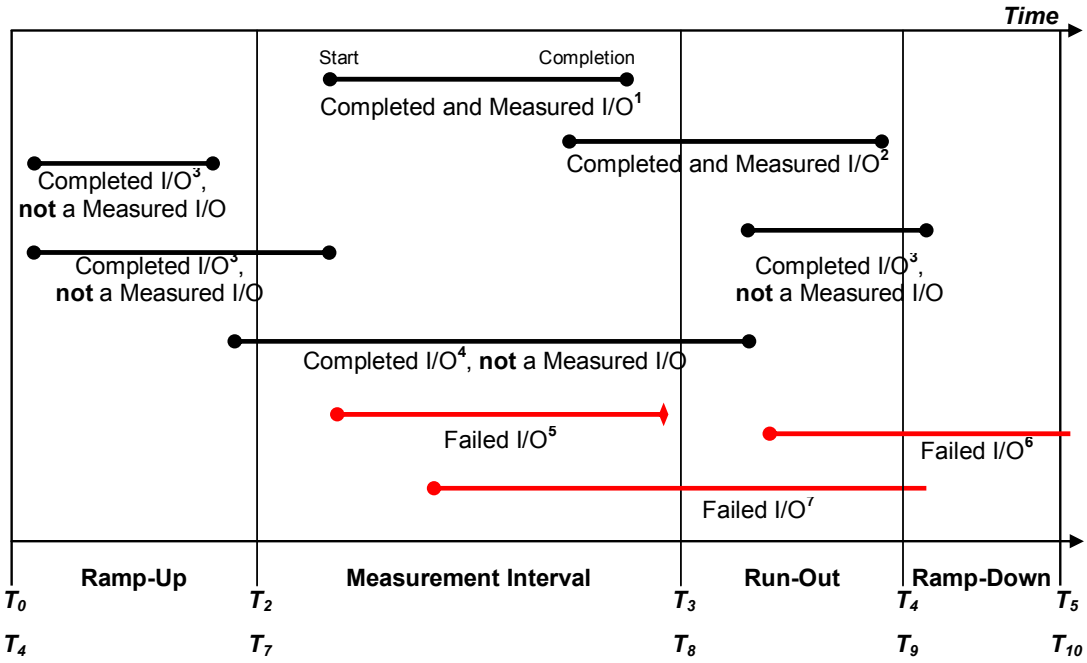
- Test Run 1: Maximum number of Streams, which is selected by the Test Sponsor
- Test Run 2: 50% of the maximum number of Streams used in Test Run 1.
- Test Run 3: 25% of the maximum number of Streams used in Test Run 1.
- Test Run 4: 12.5% of the maximum number of Streams used in Test Run 1.
- Test Run 5: 1 Stream.

Each of the five Test Runs in a Test Run Sequence will share the same attributes with the exception of the number of Streams. For example:

- Large File Processing, Read, 1024 KiB Transfer Size: Maximum Streams
- Large File Processing, Read, 1024 KiB Transfer Size: 50% of Maximum Streams
- Large File Processing, Read, 1024 KiB Transfer Size: 25% of Maximum Streams
- Large File Processing, Read, 1024 KiB Transfer Size: 12.5% of Maximum Streams
- Large File Processing, Read, 1024 KiB Transfer Size: 1 Stream

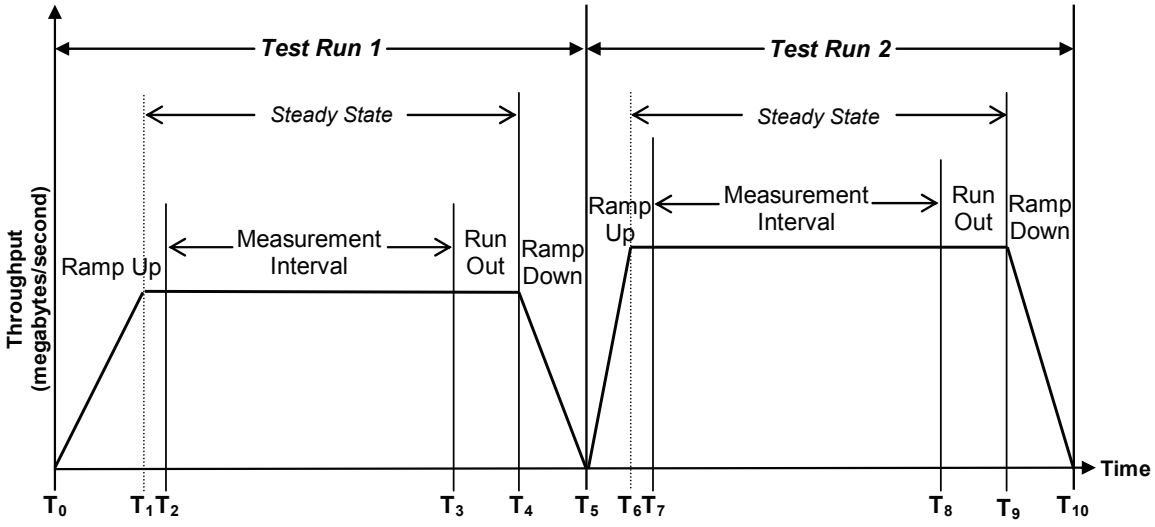
Transfer Size: The Transfer Size parameter specifies the number of bytes in KiB to transfer. *(Clause 3.4.7 of the SPC-2C Benchmark Specification)*

I/O Completion Types



Completed and Measured I/O[1]: *I/O started and completed within the Measurement Interval.*
Completed and Measured I/O[2]: *I/O started within the Measurement Interval and completed within Ramp Down.*
Completed I/O[3]: *I/O started before or after the Measurement Interval – not measured.*
Completed I/O[4]: *I/O started before and completed after the Measurement Interval – not measured.*
Failed I/O[5]: *Signaled as failed by System Software.*
Failed I/O[6]: *I/O did not complete prior to the end of Ramp-Down.*
Failed I/O[7]: *I/O did not complete prior to the end of Run-Out.*

SPC-2C Test Run Components



APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

The following customer tunable parameters/option were set on the HBA as documented in Appendix C.

```
REM abort any background Initialization
MegaCLI64 -LDBI -abort -Lall -aALL

REM Disk Cache Policy : enabled
MegaCLI64 -LDSetProp -EnDskCache -Lall -aALL

REM enable writeback cache
MegaCLI64 -LDSetProp  -forcedWB -Lall -aALL

REM disable load balance i.e.configure as failover mode
MegaCLI64 -AdpSetProp -LoadBalanceMode 1 -aALL

REM powersaving let disks do power savings
MegaCli64 -AdpSetProp -DefaultLdPSPolicy -none -aALL

REM disable background Initialization
MegaCLI64 -LDBI -dsbl -Lall -aALL
```

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

The LSI MegaCLI utility was used to execute the following scripts. The utility is available at:

http://www.lsi.com/downloads/Public/MegaRAID%20Common%20Files/8.02.16_MegaCLI.zip

Create RAID-5 Ranks and SPC-2C Logical Volume

The following script created the RAID-5 ranks and the single SPC-2C Logical Volume.

RB01.cmd

```
echo off
REM ******Clear All ****************************
MegaCLI64 -cfgclr -aALL
REM
REM Phys HDD List : 0,1,2,3 etc
REM Spares : NO
REM RAID Level : 50
REM Stripe Size : 1MB
REM Array set Name :A0-A4
REM LD Read Policy : Read look ahead
REM LD Write Policy : Write Back, Bad BBU
REM LD IO Policy : Direct IO
REM Access Policy : Read / Write
REM ************************************************************
set adptr=0
set A0=-Array0[:14,:16,:24,:25,:26]
set A1=-Array1[:27,:33,:39,:40,:41]
set A2=-Array2[:42,:43,:44,:45,:46]
set A3=-Array3[:47,:48,:49,:54,:55]
set A4=-Array4[:56,:64,:120,:143,:144]
set Arraylist=%A0% %A1% %A2% %A3% %A4%
set level=50
set stripe=1024
set ReadCache=RA
Set BBU=CachedBadBBU
set IOpolicy=Direct
set access=RW
@echo on
REM ************* Create RAID 50 ***************************
MegaCli64 -CfgSpanAdd -r%level% %ArrayList% %WriteCache% %ReadCache% %IOpolicy%
%BBU% -strpsz%stripe% -a%adptr%
```

Set HBA Parameters

The following script set the HBA parameters documented in Appendix B.

TuneParm.cmd

```
REM abort any background Initialization
MegaCLI64 -LDBI -abort -Lall -aALL
REM Disk Cache Policy : enabled
MegaCLI64 -LDSetProp -EnDskCache -Lall -aALL
REM enable writeback cache
MegaCLI64 -LDSetProp  -forcedWB -Lall -aALL
REM disable load balance i.e.configure as failover mode
MegaCLI64 -AdpSetProp -LoadBalanceMode 1 -aALL
REM powersaving let disks do power savings
MegaCli64 -AdpSetProp -DefaultLdPSPolicy -none -aALL
REM disable background Initialization
MegaCLI64 -LDBI -dsbl -Lall -aALL
```

APPENDIX D: SPC-2C WORKLOAD GENERATOR STORAGE COMMANDS AND PARAMETERS

The following SPC-2C Workload Generator command and parameters files were used for execution of the SPC-2C Pre-Idle and Post Idle Phases, as well as the Large File Processing (LFP), Large Database Query (LDQ), Video on Demand Delivery (VOD) and Persistence Tests.

Pre-Idle Phase

```
* Large File Processing Test (LFP)
host=localhost,spc2=c:\spc\spc2c,jvms=1,maxstreams=100,java=c:\java\jre6\bin\java
sd=default,host=localhost
sd=sd1,lun=\\.\physicaldrive0,size=19993072762880
maxlatestart=1
reportinginterval=5
segmentlength=512m
rd=default,rampup=180,periods=90,measurement=420,runout=45,rampdown=15,buffers=1
* LFP, "read-write" Test Phase
* Test pre-idle Run Sequence 1
rd=default,rdpct=50,xfersize=1024k
rd=PreIdle_SPC-2-FP,streams=3
```

Post-Idle Phase

```
* Large File Processing Test (LFP)
host=localhost,spc2=c:\spc\spc2c,jvms=1,maxstreams=100,java=c:\java\jre6\bin\java
sd=default,host=localhost
sd=sd1,lun=\\.\physicaldrive0,size=19993072762880
maxlatestart=1
reportinginterval=5
segmentlength=512m
rd=default,rampup=180,periods=90,measurement=420,runout=45,rampdown=15,buffers=1
* LFP, "read-write" Test Phase
* Test post-idle Run Sequence 1
rd=default,rdpct=50,xfersize=1024k
rd=PostIdle_SPC-2-FP,streams=3
```

Large File Processing Test *(LFP)*

```
* Large File Processing Test (LFP)
host=localhost,spc2=c:\spc\spc2c,jvms=1,maxstreams=100,java=c:\java\jre6\bin\java
sd=default,host=localhost
sd=sd1,lun=\\.\physicaldrive0,size=19993072762880
maxlatestart=1
reportinginterval=5
segmentlength=512m
rd=default,rampup=180,periods=90,measurement=600,runout=45,rampdown=15,buffers=1
* LFP, "write" Test Phase
* Test Run Sequence 1
rd=default,rdpct=0,xfersize=1024k
rd=TR1-s5_SPC-2-FP,streams=5
rd=TR2-s4_SPC-2-FP,streams=4
rd=TR3-s3_SPC-2-FP,streams=3
rd=TR4-s2_SPC-2-FP,streams=2
rd=TR5-s1_SPC-2-FP,streams=1
* Test Run Sequence 2
rd=default,xfersize=256k
```

```
rd=TR6-s5_SPC-2-FP,streams=5
rd=TR7-s4_SPC-2-FP,streams=4
rd=TR8-s3_SPC-2-FP,streams=3
rd=TR9-s2_SPC-2-FP,streams=2
rd=TR10-s1_SPC-2-FP,streams=1
* LFP, "read-write" Test Phase
* Test Run Sequence 3
rd=default,rdpct=50,xfersize=1024k
rd=TR11-s5_SPC-2-FP,streams=5
rd=TR12-s4_SPC-2-FP,streams=4
rd=TR13-s3_SPC-2-FP,streams=3
rd=TR14-s2_SPC-2-FP,streams=2
rd=TR15-s1_SPC-2-FP,streams=1
* Test Run Sequence 4
rd=default,xfersize=256k
rd=TR16-s5_SPC-2-FP,streams=5
rd=TR17-s4_SPC-2-FP,streams=4
rd=TR18-s3_SPC-2-FP,streams=3
rd=TR19-s2_SPC-2-FP,streams=2
rd=TR20-s1_SPC-2-FP,streams=1
* LFP, "read" Test Phase
* Test Run Sequence 5
rd=default,rdpct=100,xfersize=1024k
rd=TR21-s5_SPC-2-FP,streams=5
rd=TR22-s4_SPC-2-FP,streams=4
rd=TR23-s3_SPC-2-FP,streams=3
rd=TR24-s2_SPC-2-FP,streams=2
rd=TR25-s1_SPC-2-FP,streams=1
* Test Run Sequence 6
rd=default,xfersize=256k
rd=TR26-s5_SPC-2-FP,streams=5
rd=TR27-s4_SPC-2-FP,streams=4
rd=TR28-s3_SPC-2-FP,streams=3
rd=TR29-s2_SPC-2-FP,streams=2
rd=TR30-s1_SPC-2-FP,streams=1
```

Large Database Query Test *(LDQ)*

```
* Large File Processing Test (LDQ)
host=localhost,spc2=c:\spc\spc2c,jvms=1,maxstreams=100,java=c:\java\jre6\bin\java
sd=default,host=localhost
sd=sd1,lun=\\.\physicaldrive0,size=19993072762880
maxlatestart=0
reportinginterval=5
segmentlength=512m
rd=default,rdpct=99,rampup=180,periods=90,measurement=600,runout=45,rampdown=15
rd=default,xfersize=1024k,buffers=4
rd=TR1-s5_SPC-2-DQ,streams=5
rd=TR2-s4_SPC-2-DQ,streams=4
rd=TR3-s3_SPC-2-DQ,streams=3
rd=TR4-s2_SPC-2-DQ,streams=2
rd=TR5-s1_SPC-2-DQ,streams=1
rd=default,buffers=1
rd=TR6-s5_SPC-2-DQ,streams=5
rd=TR7-s4_SPC-2-DQ,streams=4
rd=TR8-s3_SPC-2-DQ,streams=3
rd=TR9-s2_SPC-2-DQ,streams=2
rd=TR10-s1_SPC-2-DQ,streams=1
rd=default,xfersize=64k,buffers=4
rd=TR11-s5_SPC-2-DQ,streams=5
rd=TR12-s4_SPC-2-DQ,streams=4
rd=TR13-s3_SPC-2-DQ,streams=3
```

```
rd=TR14-s2_SPC-2-DQ,streams=2
rd=TR15-s1_SPC-2-DQ,streams=1
rd=default,buffers=1
rd=TR16-s5_SPC-2-DQ,streams=5
rd=TR17-s4_SPC-2-DQ,streams=4
rd=TR18-s3_SPC-2-DQ,streams=3
rd=TR19-s2_SPC-2-DQ,streams=2
rd=TR20-s1_SPC-2-DQ,streams=1
```

Video on Demand Delivery Test *(VOD)*

```
* Video on Demand
host=localhost,spc2=c:\spc\spc2c,jvms=2,maxstreams=500,java=c:\java\jre6\bin\java
sd=default,host=localhost
sd=sd1,lun=\\.\physicaldrive0,size=19993072762880
maxlatestart=0
videosegmentduration=1200
maxlatevod=0
reportinginterval=5
rd=default,rampup=1200,periods=600,measurement=7200,runout=45,rampdown=15,buffers=8
rd=TR1-s600_SPC-2-VOD,streams=600
```

Persistence Test Run 1 *(write phase)*

```
* Persistence Test Run 1
host=localhost,spc2=c:\spc\spc2c,jvms=1,maxstreams=500,java=c:\java\jre6\bin\java
sd=default,host=localhost
sd=sd1,lun=\\.\physicaldrive0,size=19993072762880
maxlatestart=1
reportinginterval=5
segmentlength=512m
rd=default,rampup=180,periods=90,measurement=300,runout=0,rampdown=0,buffers=1
rd=default,rdpct=0,xfersize=1024k
rd=TR1-5s_SPC-2-persist-w,streams=5
```

Persistence Test Run 2 *(read phase)*

```
* Persistence Test Run 1
host=localhost,spc2=c:\spc\spc2c,jvms=1,maxstreams=500,java=c:\java\jre6\bin\java
sd=default,host=localhost
sd=sd1,lun=\\.\physicaldrive0,size=19993072762880
maxlatestart=1
reportinginterval=5
segmentlength=512m
rd=default,buffers=1,rdpct=100,xfersize=1024k
rd=TR1-5s_SPC-2-persist-r
```

APPENDIX E: SPC-2C WORKLOAD GENERATOR EXECUTION COMMANDS AND PARAMETERS

Video on Demand Delivery, Large File Processing Test, Large Database Query Tests, and Persistence Test Run 1

The following script was used to execute the Video on Demand Delivery, Large File Processing and Large Database Query Tests, and Persistence Test Run 1 in an uninterrupted sequence.

```
@echo off
REM ****************************************************************
REM set variables
REM set the configuration name
set configs=spc2ce_R50_Run_Audit01
REM set java path
set java=C:\Java\jre6\bin\java
REM set classpath
set cpdir=c:\spc\spc2c
REM set java attributes
set jattributes=-Xmx1024m -Xms1024m -Xss48k
REM set idle period
set idletime= 3600
REM ****************************************************************
echo Pre-power sampling
echo Please ensure the WT210/WT230 is sampling
Pause
echo please ensure WT210/WT230 is measuring
REM
REM **Run Pre-IDLE**
%java% %jattributes% -cp %cpdir% vdbench -f spc2pre.lfp -o %configs%_IDLE_PRE
REM IDLE Phase
sleep %idletime%
REM **Run Post-IDLE
%java% %jattributes% -cp %cpdir% vdbench -f spc2post.lfp -o %configs%_IDLE_Post
REM **Run Large File Processing**
%java% %jattributes% -cp %cpdir% vdbench -f spc2.lfp -o %configs%_LFP
REM **Run Large Database Query**
%java% %jattributes% -cp %cpdir% vdbench -f spc2.ldq -o %configs%_LDQ
REM **Run Video On Demand**
%java% %jattributes% -cp %cpdir% vdbench -f spc2.vod -o %configs%_VOD
REM over run 10 mins then kill power sampling
sleep 600
taskkill /F /IM wtviewerfree.exe
REM **Run Persistence Test 1**
%java% %jattributes% -cp %cpdir% vdbench -f spc2.per1 -o %configs%_PER1
echo ========================================
echo  Please Power Cycle Complete System then run per2
echo ========================================
```

Persistence Test Run 2

The following script was used to execute Persistence Test Run 2 after the required power cycle of the TSC.

```
@echo off
REM set the configuration name
set configs=spc2ce_R50_Run_Audit01
REM set java path
set java=C:\Java\jre6\bin\java
REM set classpath
set cpdir=c:\spc\spc2c
set jattributes=-Xmx1024m -Xms1024m -Xss48k
echo ======================================
echo  Please Power Cycle Complete System then run per2
echo ======================================
pause
REM **Run Persistence Test 2**
%java% %jattributes% -cp %cpdir% vdbench -f spc2.per2 -o %configs%_PER2
```

APPENDIX F: THIRD-PARTY QUOTES

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- Item Image -
** Image may not exactly match product **

ST91000640SS - SEAGATE - NEW WITH FULL MFG WARRANTY. CONSTELLATION.2 1TB(1000 GB) 7200 RPM SAS 6-GBPS 64 MB BUFFER 2.5 INCH INTERNAL HARD DISK DRIVE (ST91000640SS). IN STOCK.

Original Item	Select	Quantity	Cost
ST91000640SS	☐	1	$206.00

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MANUFACTURER PART NUMBER: ST91000640SS
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PRODUCT LINE : CONSTELLATION.2
INTERFACE : SAS 6-GBPS
CACHE : 64MB
CAPACITY : 1-TB(1000 - GB)

PHYSICAL:
COMPATIBLE DRIVE BAY WIDTH: 2.5
COMPATIBLE DRIVE BAY HEIGHT: 1/3H
HEIGHT: 1.7
WIDTH: 6.4
DEPTH: 9.1
WEIGHT (APPROXIMATE): 0.65 LB

PERFORMANCE:
MAXIMUM EXTERNAL DATA TRANSFER RATE: 600 MBPS
ROTATIONAL SPEED: 7200 RPM
BUFFER: 64 MB

CONDITION : NEW WITH FULL MANUFACTURER WARRANTY.
AVAILABILITY : IN STOCK.
SHIPPING : SAME DAY.
OUR WARRANTY : 30 DAYS.

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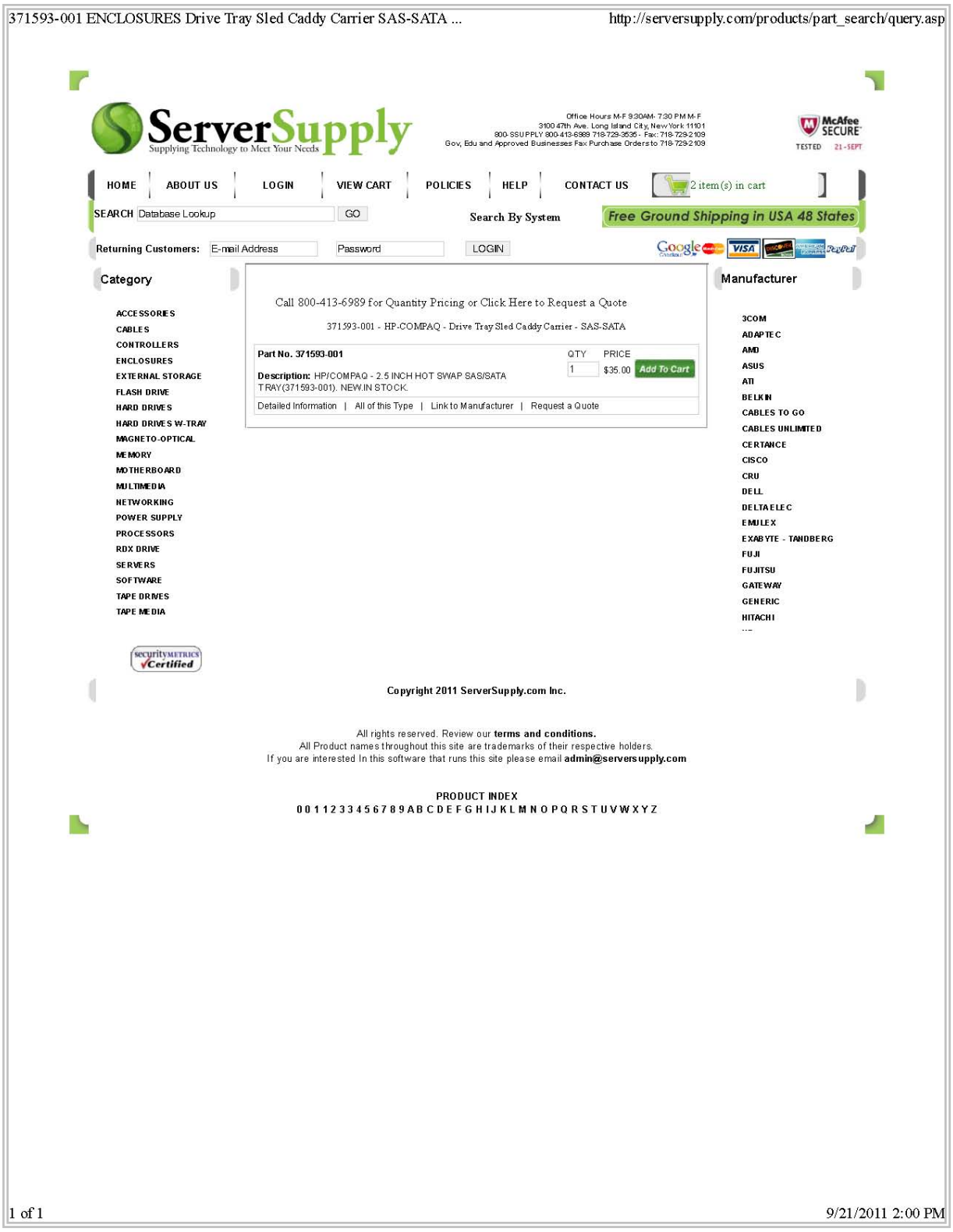
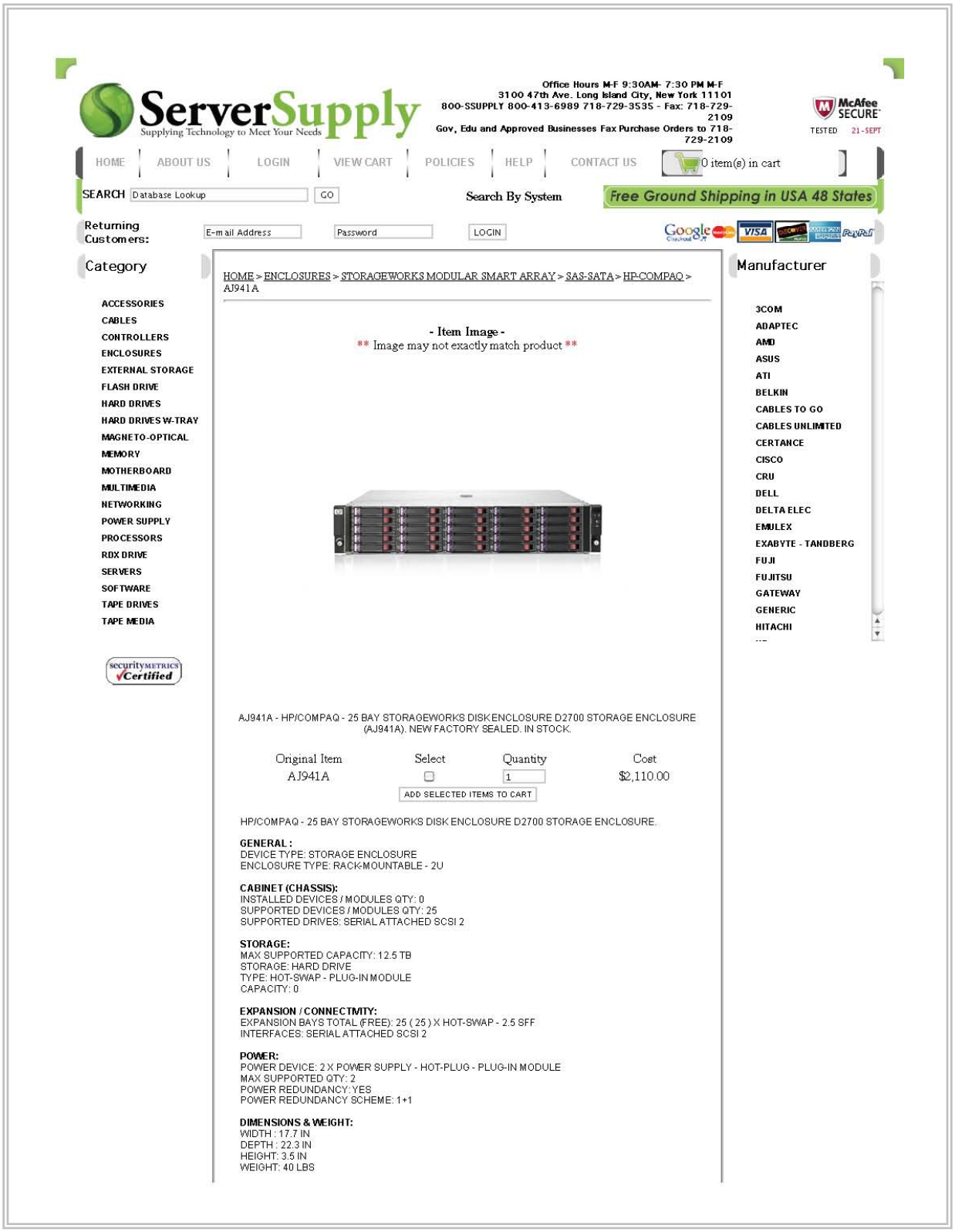
http://www.serversupply.com/HARD%20DRIVES/SAS-6GBITS/1000GB-7200RPM/SEAGATE/ST91000640SS.htm Page 1 of 2

HP-Compaq Drive Tray Seld Caddy Carrier SAS-SATA *(hot swap tray)*



HP/Compaq StorageWorks 25-Bay Disk Enclosure



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HOME > ENCLOSURES > STORAGEWORKS MODULAR SMART ARRAY > SAS-SATA > HP-COMPAQ > AJ941A

- Item Image -
** Image may not exactly match product **

AJ941A - HP/COMPAQ - 25 BAY STORAGEWORKS DISK ENCLOSURE D2700 STORAGE ENCLOSURE (AJ941A). NEW FACTORY SEALED. IN STOCK.

Original Item	Select	Quantity	Cost
AJ941A	☐	1	$2,110.00

ADD SELECTED ITEMS TO CART

HP/COMPAQ - 25 BAY STORAGEWORKS DISK ENCLOSURE D2700 STORAGE ENCLOSURE.

GENERAL :
DEVICE TYPE: STORAGE ENCLOSURE
ENCLOSURE TYPE: RACK-MOUNTABLE - 2U

CABINET (CHASSIS):
INSTALLED DEVICES / MODULES QTY: 0
SUPPORTED DEVICES / MODULES QTY: 25
SUPPORTED DRIVES: SERIAL ATTACHED SCSI 2

STORAGE:
MAX SUPPORTED CAPACITY: 12.5 TB
STORAGE: HARD DRIVE
TYPE: HOT-SWAP - PLUG-IN MODULE
CAPACITY: 0

EXPANSION / CONNECTIVITY:
EXPANSION BAYS TOTAL (FREE): 25 (25) X HOT-SWAP - 2.5 SFF
INTERFACES: SERIAL ATTACHED SCSI 2

POWER:
POWER DEVICE: 2 X POWER SUPPLY - HOT-PLUG - PLUG-IN MODULE
MAX SUPPORTED QTY: 2
POWER REDUNDANCY: YES
POWER REDUNDANCY SCHEME: 1+1

DIMENSIONS & WEIGHT:
WIDTH : 17.7 IN
DEPTH : 22.3 IN
HEIGHT: 3.5 IN
WEIGHT: 40 LBS

Manufacturer

3COM
ADAPTEC
AMD
ASUS
ATI
BELKIN
CABLES TO GO
CABLES UNLIMITED
CERTANCE
CISCO
CRU
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HITACHI

LSI Logic MegaRAID 9265-81 SAS RAID Controller

LSI00277 CONTROLLERS SAS-SATA 8 PORT LSI LOGIC http://serversupply.com/CONTROLLERS/SAS-SATA/8 PORT/LSI LOGI...

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HOME > CONTROLLERS > SAS-SATA > 8 PORT > LSI LOGIC > LSI00277

- Item Image -
** Image may not exactly match product **

LSI00277 - LSI LOGIC - MEGARAID 9265-8I SAS RAID CONTROLLER - SERIAL ATTACHED SCSI, SERIAL ATA/600 - PCI EXPRESS 2.0 X8 - PLUG-IN CARD (LSI00277). NEW BULK. IN STOCK.

Original Item	Select	Quantity	Cost
LSI00277		1	$750.00

ADD SELECTED ITEMS TO CART

DESCRIPTION

THE MEGARAID SAS 9265-8I, WITH EIGHT INTERNAL PORTS, DELIVERS TWO 800MHZ POWERPC PROCESSOR CORES AND A 72-BIT DDRIII INTERFACE THAT DRIVES 1GB CACHE MEMORY. THIS SECOND-GENERATION 6GB/S SATA+SAS CONTROLLER, BUILT ON THE LSISAS2208 DUAL-CORE ROC, OFFERS UNMATCHED I/O PERFORMANCE FOR DATABASE APPLICATIONS AND DIGITAL MEDIA ENVIRONMENTS. USERS CAN DEPLOY THE MEGARAID SAS 9265-8I IN EXISTING HDD-BASED SERVER ENVIRONMENTS FOR SIGNIFICANT PERFORMANCE GAINS. ALTERNATIVELY, FOR USERS IMPLEMENTING SERVER PLATFORMS BASED ON SOLID-STATE STORAGE, THESE NEXT-GENERATION MEGARAID CONTROLLERS HELPS EXPLOIT THE POTENTIAL OF SSDS FOR UNSURPASSED PERFORMANCE AND ENTERPRISE-CLASS RELIABILITY.

KEY FEATURES

- DEVICE TYPE: SAS RAID CONTROLLER
- CONTROLLER INTERFACE TYPE: SERIAL ATTACHED SCSI , SERIAL ATA/600.
- INTERFACE TYPE : PCI EXPRESS X8 2.0
- DATA TRANSFER RATE: 6GB/S THROUGHPUT PER PORT
- FORM FACTOR: LOW-PROFILE PLUG-IN CARD
- BUFFER SIZE: 1GB DDRIII CACHE (1333MHZ)
- RAID LEVEL: RAID 0, RAID 1, RAID 5, RAID 6, RAID 10, RAID 50, RAID 60
- DRIVE SUPPORT: CONNECT UP TO 128 SATA AND/OR SAS DEVICE
- PORTS: EIGHT INTERNAL SATA+SAS PORTS

CONDITION : NEW BULK.
AVAILABILITY : IN STOCK.
MFG WARRANTY : NONE.
OUR WARRANTY : 30 DAYS.

Manufacturer

3COM
ADAPTEC
AMD
ASUS
ATI
BELKIN
CABLES TO GO
CABLES UNLIMITED
CERTANCE
CISCO
CRU
DELL
DELTA ELEC
EMULEX
EXABYTE - TANDBERG
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SAS 2.0 1m Cable

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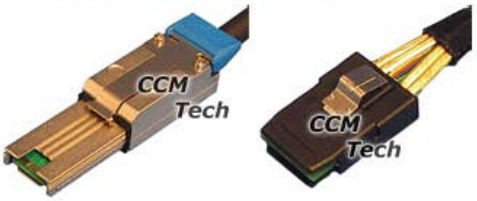
SCSI - LVD/SE
Security
Serial Cables
SFP+ Cables
SUN
Transceivers

SAS Cables, Adapters, Enclosures, Mobile Racks : SAS Cables : External Mini SAS 26 to Internal Mini SAS 36 : SAS Cable - 1 Meter External Mini SAS 26 (Host) to Internal Mini SAS 36 (Target) - SFF-8088 to SFF-8087



SAS Cable - 1 Meter External Mini SAS 26 (Host) to Internal Mini SAS 36 (Target) - SFF-8088 to SFF-8087
Part#: SAS-5636-1M

Price: $43.34
Buy 2: $41.17
Buy 5: $40.74
Buy 10: $40.31
Buy 25: $39.87

Qty: 1

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Description:

1 Meter External Mini SAS 26 pin (Host) to Internal Mini SAS 36 (Target) Cable.

- SFF-8088 to SFF-8087.
- The Mini SAS 26 has the universal key.
- MADISON 28 AWG CABLE
- ROHS COMPLIANT

SAS Help

NOTE 1:
The host is your controller and the target is your drives.

NOTE 2:
A SAS controller can control SAS and SATA drives.
A SATA controller can control SATA drives only.