



**SPC BENCHMARK 2/ENERGY™
FULL DISCLOSURE REPORT**

**IBM CORPORATION
IBM XIV® STORAGE SYSTEM GEN3**

SPC-2/E™ V1.4

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AUDIT CERTIFICATION



Bruce McNutt
 IBM Corporation
 650 Harry Road
 San Jose, CA 95120

October 19, 2011

The SPC Benchmark 2/Energy™ Reported Data listed below for the IBM XIV® Storage System Gen3 were produced in compliance with the SPC Benchmark 2/Energy™ V1.4 Onsite Audit requirements.

| SPC Benchmark 2/Energy™ V1.4 Reported Data | |
|--|--------------------------------|
| Tested Storage Product (TSP) Name: | |
| IBM XIV® Storage System Gen3 | |
| Metric | Reported Result |
| SPC-2 MBPS™ | 7,467.99 |
| ASU Capacity | 154,618.823 GB |
| SPC-2 Price-Performance™ | \$152.34 |
| Data Protection Level | Protected (<i>Mirroring</i>) |
| Total Price | \$1,137,641.30 |

| Power Environment | | | | | | | |
|-------------------------|----------------------|----------|------|-----------------------|--------------|-------------------------------------|-------------|
| Average RMS Voltage: | | 209.83 | | Average Power Factor: | | 0.978 | |
| Usage Profile | | | | Nominal | | | |
| | Hours of Use per Day | | | Power watts | Traffic MBPS | Ratio MBPS/w | Heat BTU/hr |
| | Heavy | Moderate | Idle | | | | |
| Low Daily Usage: | 0 | 8 | 16 | 6049.33 | 2185.53 | 0.36 | 20,640.91 |
| Medium Daily Usage: | 4 | 14 | 6 | 6134.88 | 5129.80 | 0.84 | 20,932.84 |
| High Daily Usage: | 18 | 6 | 0 | 6209.13 | 7512.21 | 1.21 | 21,186.16 |
| Composite Metrics: | | | | 6,131.11 | 4,942.51 | 0.81 | |
| Annual Energy Use, kWh: | | | | 53,708.55 | | | |
| Energy Cost, \$/kWh: | | | | \$ 0.12 | | Annual Energy Cost, \$: \$ 6,445.03 | |

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AUDIT CERTIFICATION (CONT.)

IBM XIV® Storage System Gen3
SPC-1 Audit Certification

Page 2

The following SPC Benchmark 2/Energy™ Onsite Audit requirements were reviewed and found compliant with V1.4 of the SPC Benchmark 2/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 IBM Corporation:
 - ✓ 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-2/ETM 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 IBM Corporation:
 - ✓ 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 IBM Corporation:
 - ✓ 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 IBM Corporation 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 2/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 WT230 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.)

IBM XIV® Storage System Gen3
SPC-1 Audit Certification

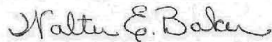
Page 3

- All power supplies present in the Tested Storage Configuration were verified as active.
- IBM Corporation 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 $\pm 0.1^{\circ}\text{C}$:
 - ✓ 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 2/Energy™ Specification.
- The Full Disclosure Report (*FDR*) met all of the requirements in Clauses 10, 11 and 12 of the SPC Benchmark 2/Energy™ Specification.
- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

Audit Notes:

The number of Stream specified for SPC-2 Persistence Test Run1 was less than the required value. After review of the measurement data generated by the test and review of various pre-audit measurements, it is my opinion that the pre-audit measurements combined with the audit measurement provided sufficient evidence to meet the requirement of the Persistence Test.

Respectfully,



Walter E. Baker
SPC Auditor

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LETTER OF GOOD FAITH



Vice President and Disk Storage Business Line Executive

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Phone: 1-919-643-6345
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September 30, 2011

Mr. Walter E. Baker, SPC Auditor
Gradient Systems, Inc.
643 Bair Island Road, Suite 103
Redwood City, CA 94063

Subject: SPC-2/E Letter of Good Faith for the IBM XIV Storage System.

IBM Corporation is the SPC-2/E Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-2 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with Version 1.4 of the SPC-2/E benchmark specification.

Our disclosure of the Benchmark configuration and execution of the benchmark includes all items that, to the best of our knowledge and belief, materially affect the reported results, regardless of whether such items are explicitly required to be disclosed by the SPC-2 benchmark specification.

Sincerely,

A handwritten signature in cursive script that reads "Doug Balog".

Doug Balog

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

| Test Sponsor and Contact Information | |
|---|--|
| Test Sponsor Primary Contact | IBM Corporation – http://www.ibm.com Bruce McNutt bmcnuft@us.ibm.com 650 Harry Road San Jose, CA 95120 Phone: (408) 927-2717 FAX: (408) 927-2050 |
| Test Sponsor Alternate Contact | IBM Corporation – http://www.ibm.com Yijie Zhang yijie@us.ibm.com 9000 Rita Road IBM Mail Drop 9042-2 Tucson, AZ 85744 Phone: (520) 799-5843 FAX: (520) 799-2009 |
| 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-2 Specification revision number | V1.4 |
| SPC-2 Workload Generator revision number | V1.0 |
| Date Results were first used publicly | October 19, 2011 |
| Date FDR was submitted to the SPC | October 19, 2011 |
| Date the TSC will be available for shipment to customers | October 31, 2011 |
| Date the TSC completed audit certification | October 19, 2011 |

Tested Storage Product (TSP) Description

The IBM XIV® Storage System Gen3 is a versatile, high-end disk storage solution with an innovative grid architecture that can provide clients excellent performance and scalability while significantly reducing costs and complexity. XIV includes automated data placement that needs no tuning as application workloads change.

SPC-2 Reported Data

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

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

| SPC-2 Reported Data | | | | |
|--|-------------------------|-------------------|----------------------|-----------------------|
| IBM XIV® Storage System | | | | |
| SPC-2 MBPS™ | SPC-2 Price-Performance | ASU Capacity (GB) | Total Price | Data Protection Level |
| 7,467.99 | \$152.34 | 154,618.823 | \$1,137,641.30 | Protected (Mirroring) |
| <i>The above SPC-2 MBPS™ value represents the aggregate data rate of all three SPC-2 workloads: Large File Processing (LFP), Large Database Query (LDQ), and Video On Demand (VOD)</i> | | | | |
| SPC-2 Large File Processing (LFP) Reported Data | | | | |
| | Data Rate (MB/second) | Number of Streams | Data Rate per Stream | Price-Performance |
| LFP Composite | 8,259.94 | | | \$137.73 |
| Write Only: | | | | |
| 1024 KiB Transfer | 6,724.35 | 576 | 11.67 | |
| 256 KiB Transfer | 6,766.87 | 576 | 11.75 | |
| Read-Write: | | | | |
| 1024 KiB Transfer | 8,246.33 | 576 | 14.32 | |
| 256 KiB Transfer | 8,197.50 | 576 | 14.23 | |
| Read Only: | | | | |
| 1024 KiB Transfer | 9,416.48 | 576 | 16.35 | |
| 256 KiB Transfer | 10,208.08 | 576 | 17.72 | |
| <i>The above SPC-2 Data Rate value for LFP Composite represents the aggregate performance of all three LFP Test Phases: (Write Only, Read-Write, and Read Only).</i> | | | | |
| SPC-2 Large Database Query (LDQ) Reported Data | | | | |
| | Data Rate (MB/second) | Number of Streams | Data Rate per Stream | Price-Performance |
| LDQ Composite | 9,740.03 | | | \$116.80 |
| 1024 KiB Transfer Size | | | | |
| 4 I/Os Outstanding | 9,496.90 | 576 | 16.49 | |
| 1 I/O Outstanding | 9,422.03 | 576 | 16.36 | |
| 64 KiB Transfer Size | | | | |
| 4 I/Os Outstanding | 10,069.26 | 576 | 17.48 | |
| 1 I/O Outstanding | 9,971.93 | 576 | 17.31 | |
| <i>The above SPC-2 Data Rate value for LDQ Composite represents the aggregate performance of the two LDQ Test Phases: (1024 KiB and 64 KiB Transfer Sizes).</i> | | | | |
| SPC-2 Video On Demand (VOD) Reported Data | | | | |
| | Data Rate (MB/second) | Number of Streams | Data Rate per Stream | Price-Performance |
| | 4,404.00 | 5,600 | 0.79 | \$258.32 |

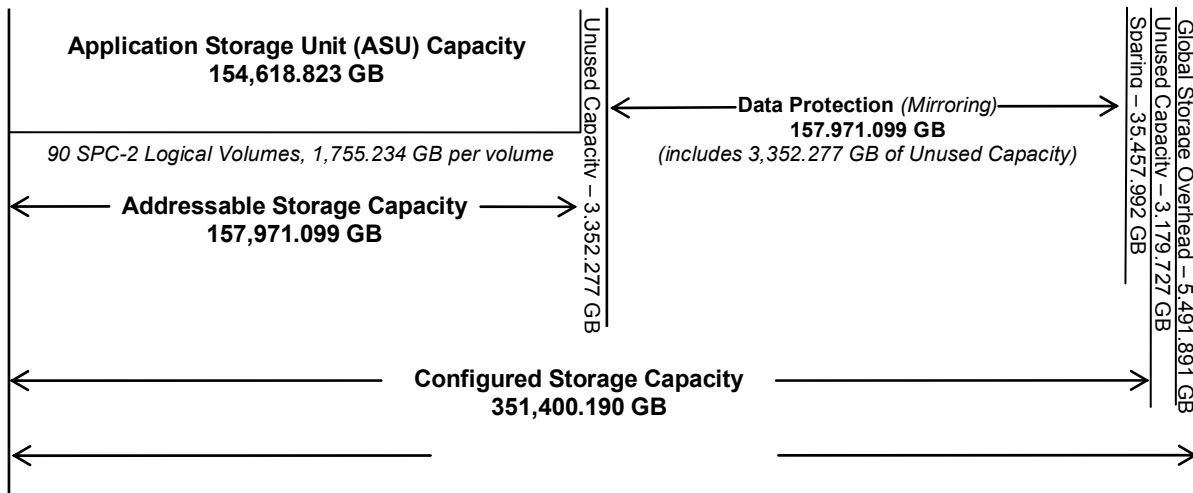
SPC-2 MBPS™ represents the aggregate data rate, in megabytes per second, of all three SPC-2 workloads: Large File Processing (LFP), Large Database Query (LDQ), and Video on Demand (VOD).

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

A **Data Protection Level of Protected** using **Mirroring** configures two or more identical copies of user data.

Storage Capacities and Relationships

The following diagram (*not to scale*) and table document the various storage capacities, used in this benchmark, and their relationships, as well as the storage utilization values required to be reported.



| SPC-1 Storage Capacity Utilization | |
|---|--------|
| Application Utilization | 42.94% |
| Protected Application Utilization | 85.55% |
| Unused Storage Ratio | 2.75% |

Application Utilization: Total ASU Capacity (*154,618.823 GB*) divided by Physical Storage Capacity (*360,071.808 GB*)

Protected Application Utilization: (Total ASU Capacity (*154,618.823 GB*) plus total Data Protection Capacity (*157,971.099 GB*) minus unused Data Protection Capacity (*3,352.277 GB*) divided by Physical Storage Capacity (*360,071.808 GB*).

Unused Storage Ratio: Total Unused Capacity (*9,884.280 GB*) divided by Physical Storage Capacity (*360,071.808 GB*) and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 24-25 of this document.

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

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

SPC-2/E Reported Data

The initial temperature, recorded during the first one minute of the SPC-2/E Idle Test was 72F. The final temperature, recorded during the last one minute of the SPC-2/E Large Database Query (LDQ) Test was 67F.

Power Environment

Average RMS Voltage:

209.83

Average Power Factor:

0.978

| | Usage Profile | | | Nominal | | | |
|--------------------------------|----------------------|----------|------|--------------------------------|--------------------|-----------------|----------------|
| | Hours of Use per Day | | | Power watts | Traffic MBPS | Ratio MBPS/w | Heat BTU/hr |
| | Heavy | Moderate | Idle | | | | |
| Low Daily Usage: | 0 | 8 | 16 | 6049.33 | 2185.53 | 0.36 | 20,640.91 |
| Medium Daily Usage: | 4 | 14 | 6 | 6134.88 | 5129.80 | 0.84 | 20,932.84 |
| High Daily Usage: | 18 | 6 | 0 | 6209.13 | 7512.21 | 1.21 | 21,186.16 |
| Composite Metrics: | | | | 6,131.11 | 4,942.51 | 0.81 | |
| Annual Energy Use, kWh: | 53,708.55 | | | | | | |
| Energy Cost, \$/kWh: | \$ 0.12 | | | Annual Energy Cost, \$: | \$ 6,445.03 | | |

HEAVY SPC-2 Workload: 6,220.98W at a data rate of 7,830.75 MB/s.

MODERATE SPC-2 Workload: 6,556.58W at a data rate of 6,556.58 MB/s

IDLE SPC-2 Workload: 5,987.20W 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-2 workloads: Large File Processing (LFP), Large Database Query (LDQ) and Video on Demand Delivery (VOD).

The detailed SPC-2/E Reported Data and associated charts for each workload, including the Idle Test, are available in this document, via the hyperlinks listed below:

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

The definitions, listed below, for the remaining items in the above SPC-2/E Reported Data table, are identical for the SPC-2/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-2 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-2 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 | Qty | Unit Price | Discount | Extended Price with discount |
|--|-----|--------------|----------|---------------------------------|
| IBM XIV Storage System Model GEN3 | 1 | \$183,195.00 | 70.00% | \$54,958.50 |
| 2TB Interface Module w/12 2 TB drives | 6 | \$122,430.00 | 70.00% | \$220,374.00 |
| 2TB Data Module w/12 2 TB drives | 9 | \$122,430.00 | 70.00% | \$330,561.00 |
| Modem | 1 | \$1,000.00 | 70.00% | \$300.00 |
| US/CA/LA/AP 60A pin cord | 1 | \$3,000.00 | 70.00% | \$900.00 |
| Module Software License | 15 | \$41,800.00 | 60.00% | \$250,800.00 |
| Module Software Maintenance (3 years) | 15 | \$16,720.00 | 60.00% | \$100,320.00 |
| Monthly maintenance (XIV hardware) | 36 | \$8,511.00 | 70.00% | \$91,918.80 |
| 8 Gbps FC switch w/24 port active, 24 SFPs | 2 | \$12,870.00 | 20.00% | \$20,592.00 |
| 3 year warranty extension (switch) | 2 | \$2,330.00 | 20.00% | \$3,728.00 |
| Short wave 25 m fibre channel cable | 36 | \$189.00 | 20.00% | \$5,443.20 |
| HBA (dual port 8 Gbps FC) | 18 | \$4,583.00 | 30.00% | \$57,745.80 |
| Total price | | | | \$1,137,641.30 |

The following pricing includes the following:

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

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

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

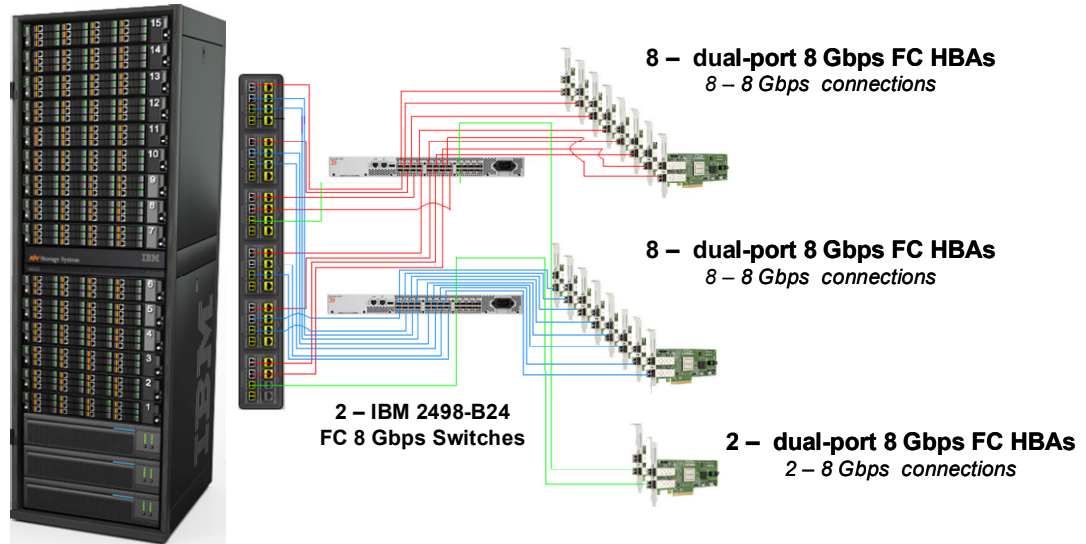
Priced Storage Configuration Diagram

IBM XIV® Storage System

6 – 2TB Interface Modules

9 – 2TB Data Modules
(12 – disk drives/module)

180 – 2 TB 7200 RPM SAS disk drives



Priced Storage Configuration Components

| Priced Storage Configuration |
|--|
| 18 – dual-port 8 Gbps FC HBAs |
| IBM XIV® Storage System 360 GiB memory/cache 6 – 2 TB Interface Modules 9 – 2 TB Data Modules 24 – 8 Gbps FC front-end connections (18 used) 30 – 4x6 Gbps SAS backend connections (30 used) |
| 180 – 2 TB 7200 RPM SAS disk drive (12 per interface and data module) |
| 2 – IBM 2498-B24 FC 8Gbps switches |
| 36 – Short Wave 25m fibre channel 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-2 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-2 benchmark specification, is stated in italics followed by the information to fulfill the stated requirement.

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

Clause 10.6.6

The FDR 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 22.

Storage Network Configuration

Clause 10.6.6.1

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration described in Clause 10.6.6 contains a high-level illustration of the network configuration, the Executive Summary will contain a one page topology diagram of the storage network as illustrated in Figure 10.11.

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) was configured with local storage and, as such, did not employ a storage network.

Host System and Tested Storage Configuration Table

Clause 10.6.6.2

The FDR 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.

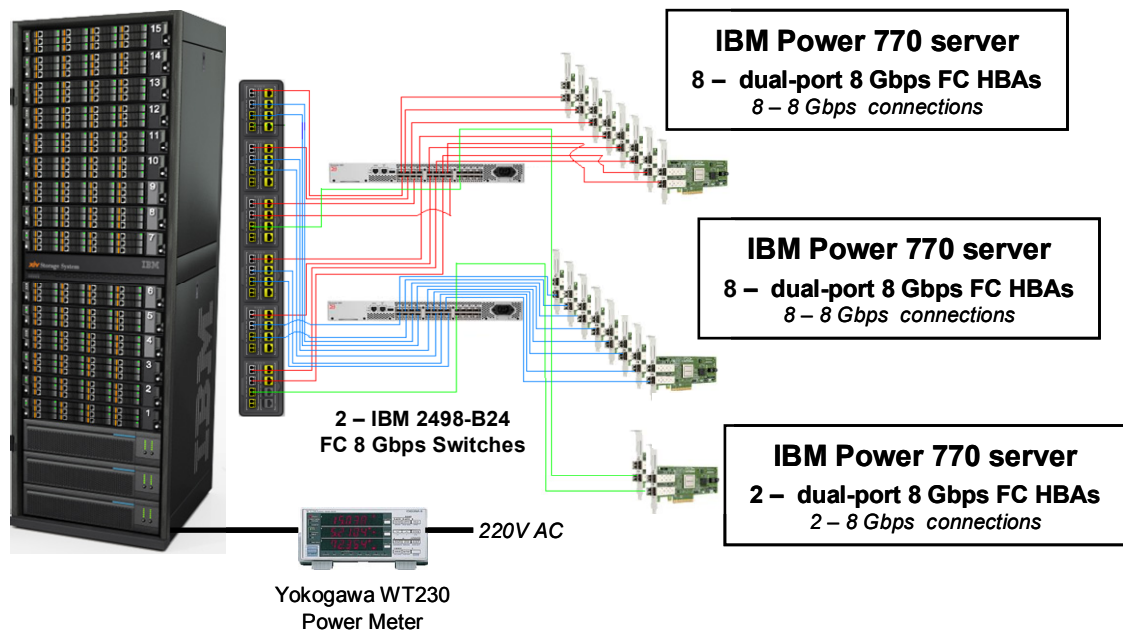
Benchmark Configuration/Tested Storage Configuration Diagram

IBM XIV® Storage System

6 – 2TB Interface Modules

9 – 2TB Data Modules
(12 – disk drives/module)

180 – 2 TB 7200 RPM SAS disk drives



Host System and Tested Storage Configuration Components

| Host System3: | Tested Storage Configuration (TSC): |
|---|---|
| 3 – IBM Power 770 servers , each with 8 – 3.3 GHz Power7 processor modules 8 cores per processor modules 256 KB L2 cache per core 4 MB L3 cache per core (eDram) 256 GiB main memory AIX 7.1 PCIe | 18 – dual-port 8 Gbps HBAs (8 HBAs in each of 2 Host Systems 2 HBAs in the third Host System) |
| Other BC Components: | IBM XIV® Storage System 360 GiB memory/cache 6 – 2 TB Interface Modules 9 – 2 TB Data Modules 24 – 8 Gbps FC front-end connections (18 used) 30 – 4x6 Gbps SAS backend connection (30 used) |
| 1 – Yokogawa WT230 Digital Power Meter | 180 – 2 TB, 7200 RPM, SAS disk drives (12 disk drives per interface and data module) |
| | 2 – IBM 2498-B24 FC 8 Gbps switches |
| | 36 – Short Wave 25m fibre channel cables |

Customer Tunable Parameters and Options

Clause 10.6.6.1

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 89 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Description

Clause 10.6.6.2

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 (Clause 10.6.6.1), 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 10.6.5.8.*
 - *The logical representation of the TSC, configured from the above components that will be presented to the SPC-2 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 90 contains the detailed information that describes how to create and configure the logical TSC.

SPC-2 Workload Generator Storage Configuration

Clause 10.6.6.3

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

The SPC-2 Workload Generator storage configuration commands and parameters for this measurement appear in “Appendix D: SPC-2 Workload Generator Storage Commands and Parameters” on page 97.

SPC-2 DATA REPOSITORY

This portion of the Full Disclosure Report presents the detailed information that fully documents the various SPC-2 storage capacities and mappings used in the Tested Storage Configuration. “SPC-2 Data Repository Definitions” on page 84 contains definitions of terms specific to the SPC-2 Data Repository.

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

SPC-2 Storage Capacities and Relationships

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

SPC-2 Storage Capacities

| SPC-2 Storage Capacities | | |
|--------------------------------------|----------------|-----------------|
| Storage Hierarchy Component | Units | Capacity |
| Total ASU Capacity | Gigabytes (GB) | 154,618.823 |
| Addressable Storage Capacity | Gigabytes (GB) | 157,971.099 |
| Configured Storage Capacity | Gigabytes (GB) | 351,400.190 |
| Physical Storage Capacity | Gigabytes (GB) | 360,071.808 |
| Data Protection (<i>Mirroring</i>) | Gigabytes (GB) | 157,971.099 |
| Required Storage (<i>sparing</i>) | Gigabytes (GB) | 35,457.992 |
| Global Storage Overhead | Gigabytes (GB) | 5,491.891 |
| Total Unused Storage | Gigabytes (GB) | 9,884.280 |

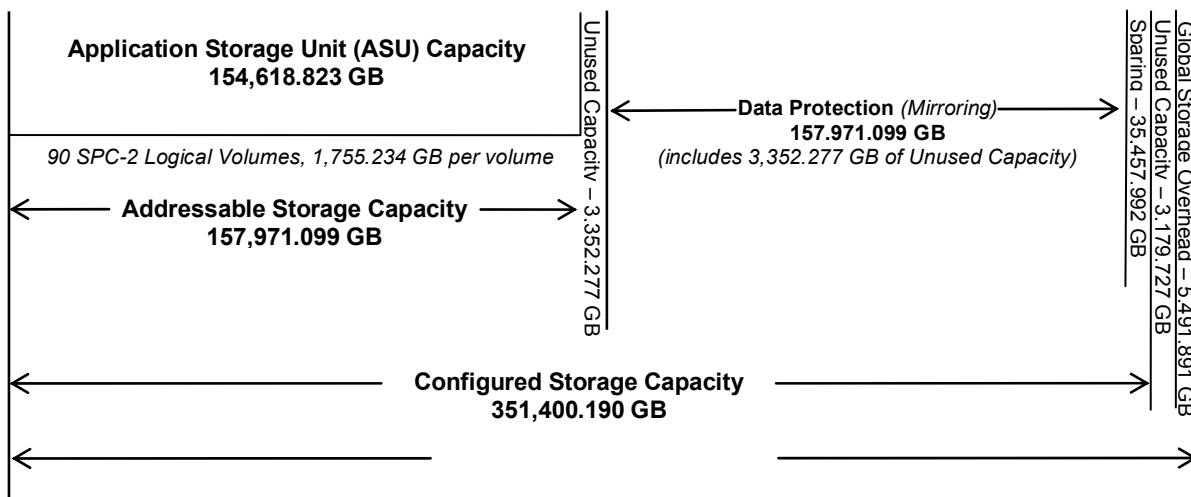
SPC-2 Storage Hierarchy Ratios

| | Addressable Storage Capacity | Configured Storage Capacity | Physical Storage Capacity |
|---|------------------------------|-----------------------------|---------------------------|
| Total ASU Capacity | 97.88% | 44.00% | 42.94% |
| Data Protection (<i>Mirroring</i>) | | 44.95% | 43.87% |
| Addressable Storage Capacity | | 44.95% | 43.87% |
| Required Storage (<i>sparing</i>) | | 10.09% | 9.85% |
| Configured Storage Capacity | | | 97.59% |
| Global Storage Overhead | | | 1.53% |
| Unused Storage: | | | |
| Addressable | 2.12% | | |
| Configured | | 0.00% | |
| Physical | | | 0.88% |

The Physical Storage Capacity consisted of 360,071.080 GB distributed over 180 disk drives each with a formatted capacity of 2,000.399 GB. There was 3,179.727 GB (0.88%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 5,491.891 GB (1.53%) of the Physical Storage Capacity. There was 0.000 GB (0.00%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 97.88% of the Addressable Storage Capacity resulting in 3,352.277 GB (2.12%) of Unused Storage within the Addressable Storage Capacity. The Data Protection (*Mirroring*) capacity was 157,971.099 GB of which 154,618.823 GB was utilized. The total Unused Storage was 9,884.280 GB.

SPC-2 Storage Capacities and Relationships Illustration

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



Storage Capacity Utilization

Clause 10.6.8.2

The FDR will include a table illustrating the storage capacity utilization values defined for Application Utilization (Clause 2.8.1), Protected Application Utilization (Clause 2.8.2), and Unused Storage Ratio (Clause 2.8.3).

Clause 2.8.1

Application Utilization is defined as Total ASU Capacity divided by Physical Storage Capacity.

Clause 2.8.2

Protected Application Utilization is defined as (Total ASU Capacity plus total Data Protection Capacity minus unused Data Protection Capacity) divided by Physical Storage Capacity.

Clause 2.8.3

Unused Storage Ratio is defined as Total Unused Capacity divided by Physical Storage Capacity and may not exceed 45%.

| SPC-1 Storage Capacity Utilization | |
|------------------------------------|--------|
| Application Utilization | 42.95% |
| Protected Application Utilization | 85.88% |
| Unused Storage Ratio | 2.75% |

Logical Volume Capacity and ASU Mapping

Clause 10.6.7.2

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 (154,618.823 GB) | | | |
| | Total Capacity (GB) | Capacity Used (GB) | Capacity Unused (GB) |
| Logical Volumes 1-90 | 1,755.234 per LV | 1,717.987 per LV | 37.248 per LV |

See the Storage Definition (*sd*) entries in “Appendix D: SPC-2 Workload Generator Storage Commands and Parameters” on page 97 for more detailed configuration information.

SPC-2 TEST EXECUTION RESULTS

This portion of the Full Disclosure Report documents the results of the various SPC-2 Test, Test Phases, Test Run Sequences, and Test Runs. “SPC-2 Test Execution Definitions” on page 85 contains definitions of terms specific to the SPC-2 Data Repository.

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

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

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

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

- **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

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 Tests may be executed in any sequence.

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 6.4.2.1

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 6.4.2.2

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 10.6.8.1

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

1. *A listing of the SPC-2 Workload Generator commands and parameters used to execute each of the Test Runs in the Large File Processing Test.*
2. *The human readable SPC-2 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-2 Workload Generator Commands and Parameters

The SPC-2 Workload Generator commands and parameters for the Large File Processing Test Runs are documented in “Appendix E: SPC-2 Workload Generator Execution Commands and Parameters” on Page 105.

SPC-2 Test Results File

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

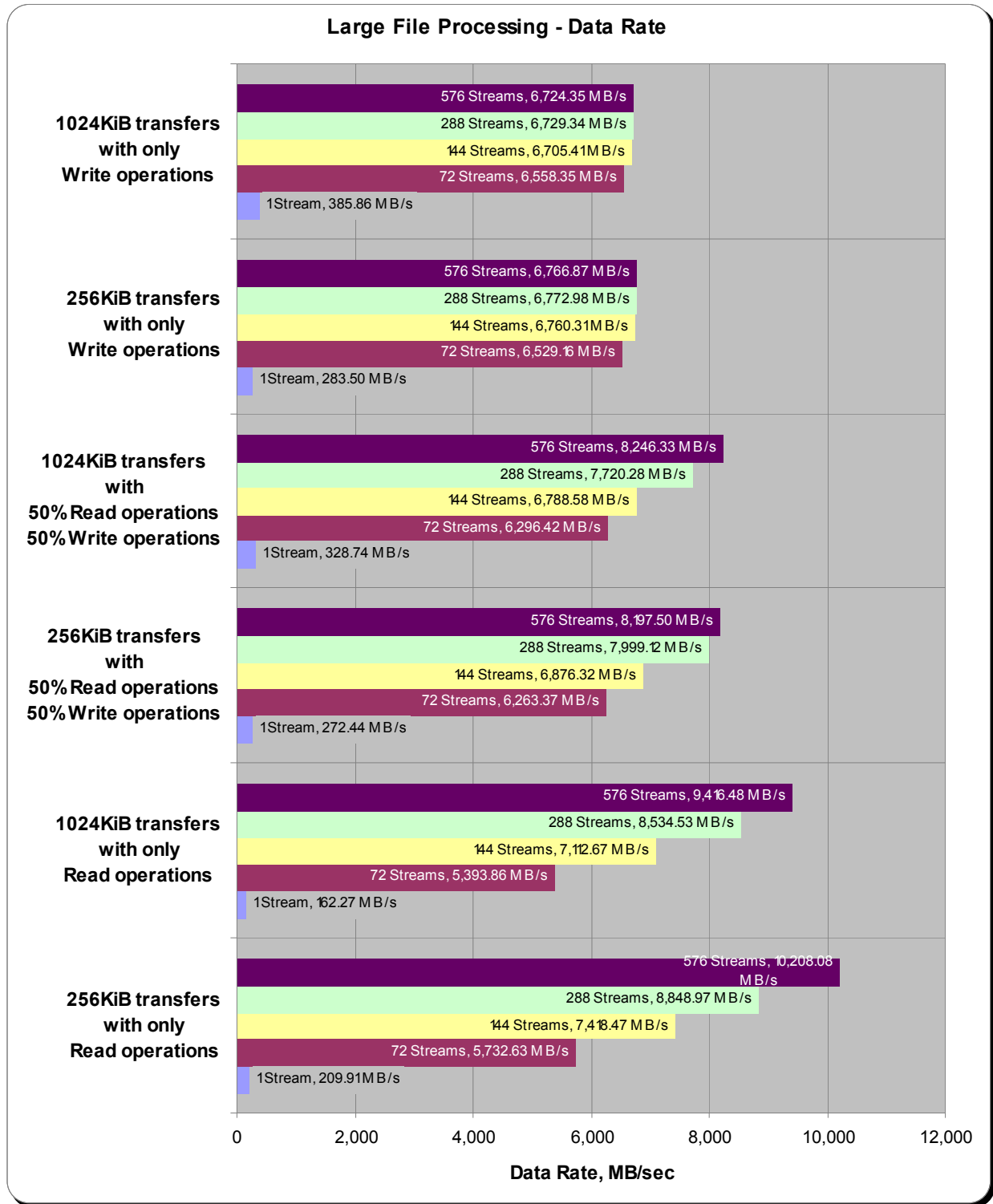
[SPC-2 Large File Processing Test Results File](#)

SPC-2 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-2 Large File Processing Test is listed in the table below as well as illustrated in the following graph.

| Test Run Sequence | 1 Stream | 72 Streams | 144 Streams | 288 Streams | 576 Streams |
|--------------------|----------|------------|-------------|-------------|-------------|
| Write 1024KiB | 385.86 | 6,558.35 | 6,705.41 | 6,729.34 | 6,724.35 |
| Write 256KiB | 283.50 | 6,529.16 | 6,760.31 | 6,772.98 | 6,766.87 |
| Read/Write 1024KiB | 328.74 | 6,296.42 | 6,788.58 | 7,720.28 | 8,246.33 |
| Read/Write 256KiB | 272.44 | 6,263.37 | 6,876.32 | 7,999.12 | 8,197.50 |
| Read 1024KiB | 162.27 | 5,393.86 | 7,112.67 | 8,534.53 | 9,416.48 |
| Read 256KiB | 209.91 | 5,732.63 | 7,418.47 | 8,848.97 | 10,208.08 |

SPC-2 Large File Processing Average Data Rates Graph

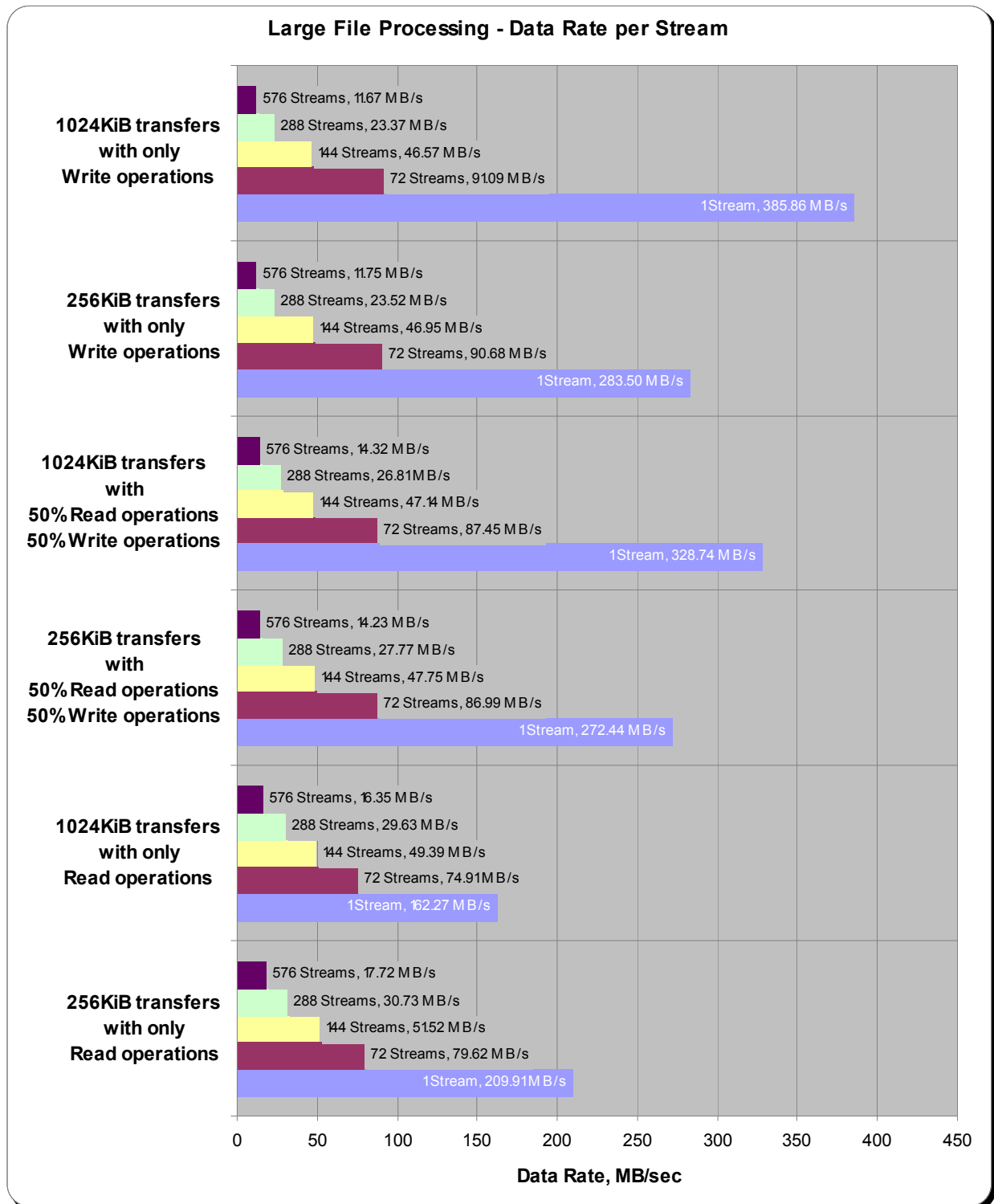


SPC-2 Large File Processing Average Data Rate per Stream

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

| Test Run Sequence | 1 Stream | 72 Streams | 144 Streams | 288 Streams | 576 Streams |
|--------------------------|-----------------|-------------------|--------------------|--------------------|--------------------|
| Write 1024KiB | 385.86 | 91.09 | 46.57 | 23.37 | 11.67 |
| Write 256KiB | 283.50 | 90.68 | 46.95 | 23.52 | 11.75 |
| Read/Write 1024KiB | 328.74 | 87.45 | 47.14 | 26.81 | 14.32 |
| Read/Write 256KiB | 272.44 | 86.99 | 47.75 | 27.77 | 14.23 |
| Read 1024KiB | 162.27 | 74.91 | 49.39 | 29.63 | 16.35 |
| Read 256KiB | 209.91 | 79.62 | 51.52 | 30.73 | 17.72 |

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

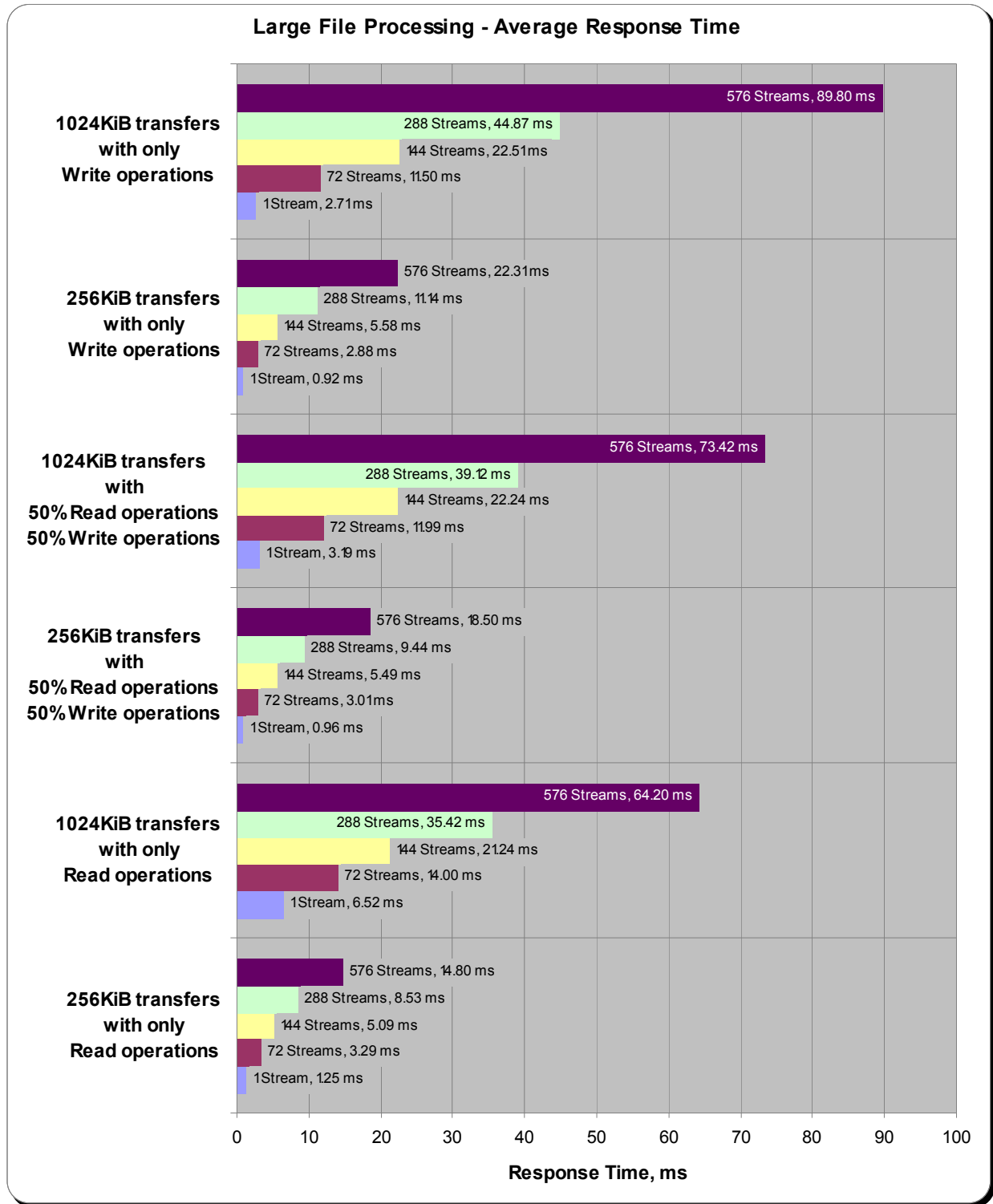


SPC-2 Large File Processing Average Response Time

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

| Test Run Sequence | 1 Stream | 72 Streams | 144 Streams | 288 Streams | 576 Streams |
|--------------------|----------|------------|-------------|-------------|-------------|
| Write 1024KiB | 2.71 | 11.50 | 22.51 | 44.87 | 89.80 |
| Write 256KiB | 0.92 | 2.88 | 5.58 | 11.14 | 22.31 |
| Read/Write 1024KiB | 3.19 | 11.99 | 22.24 | 39.12 | 73.42 |
| Read/Write 256KiB | 0.96 | 3.01 | 5.49 | 9.44 | 18.50 |
| Read 1024KiB | 6.52 | 14.00 | 21.24 | 35.42 | 64.20 |
| Read 256KiB | 1.25 | 3.29 | 5.09 | 8.53 | 14.80 |

SPC-2 Large File Processing Average Response Time Graph



Large File Processing Test – WRITE ONLY Test Phase

Clause 10.6.8.1.1

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.

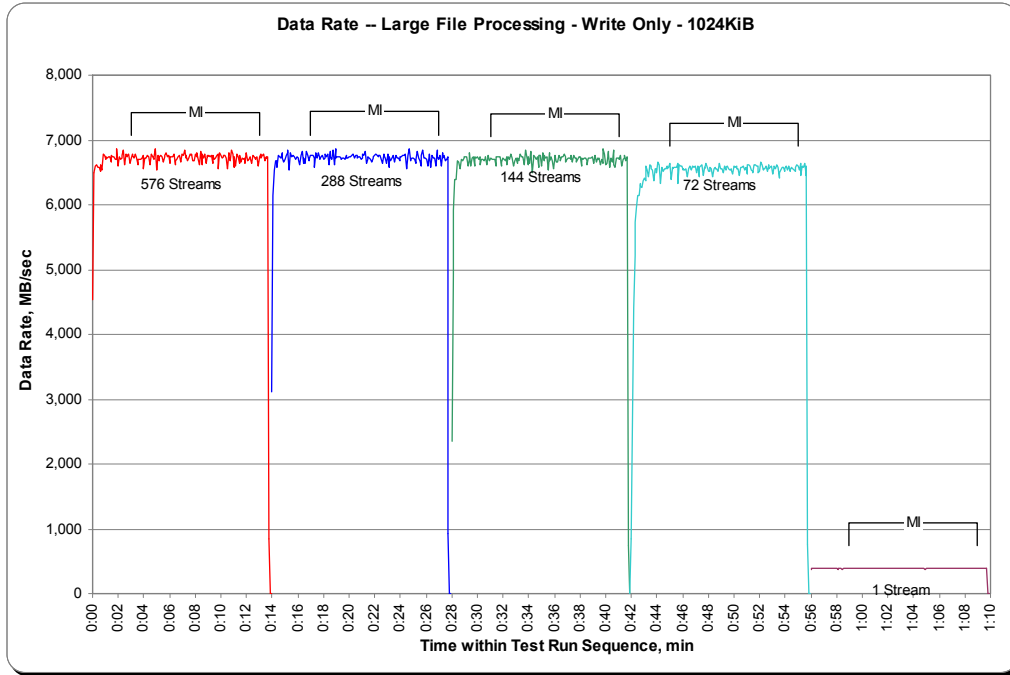
The SPC-2 "Large File Processing/WRITE ONLY/1024 KiB Transfer Size" and "Large File Processing/WRITE ONLY/256 KiB Transfer Size" data tables are not embedded in this document due to size. The tables are available via the URLs listed below:

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

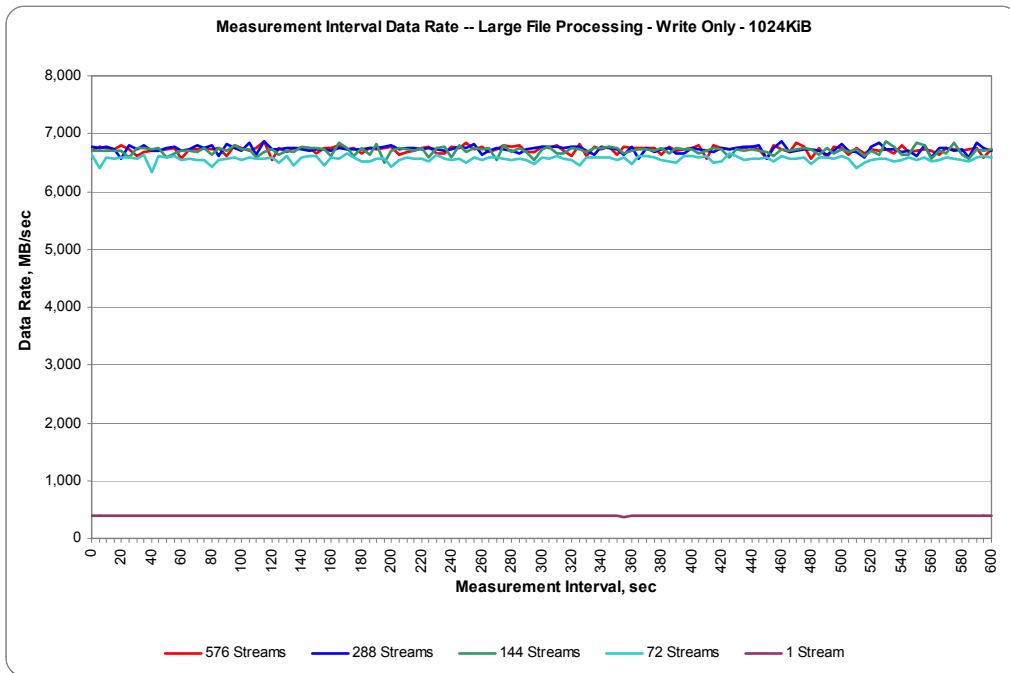
SPC-2 "Large File Processing/Write Only/256 KiB Transfer Size" Test Run Data

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.

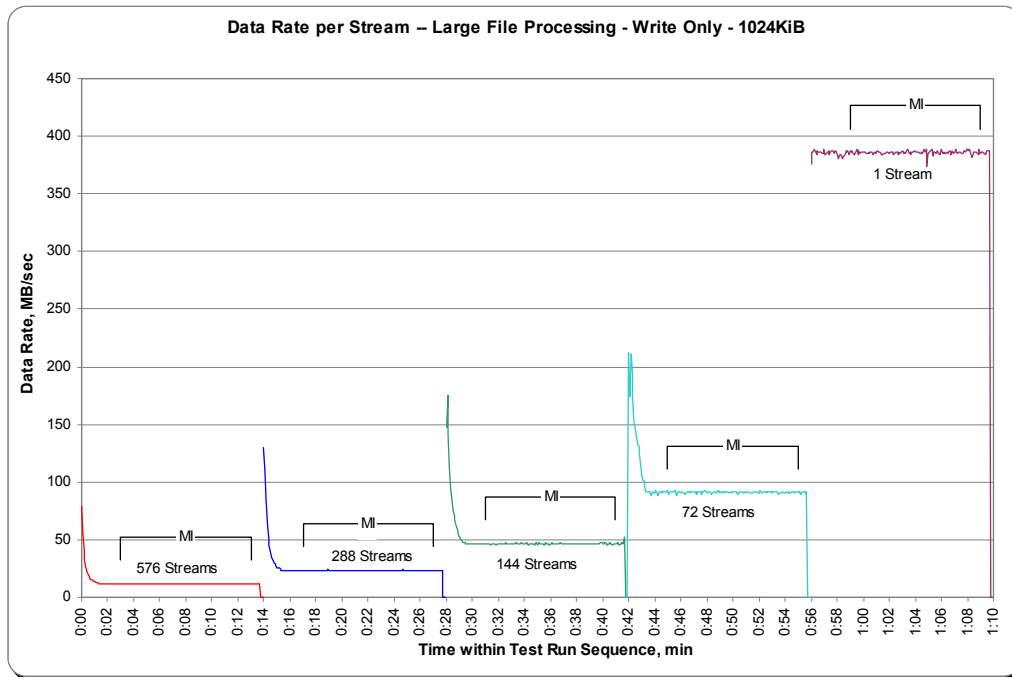
SPC-2 “Large File Processing/WRITE ONLY/1024 KiB Transfer Size” Average Data Rate Graph – Complete Test Run



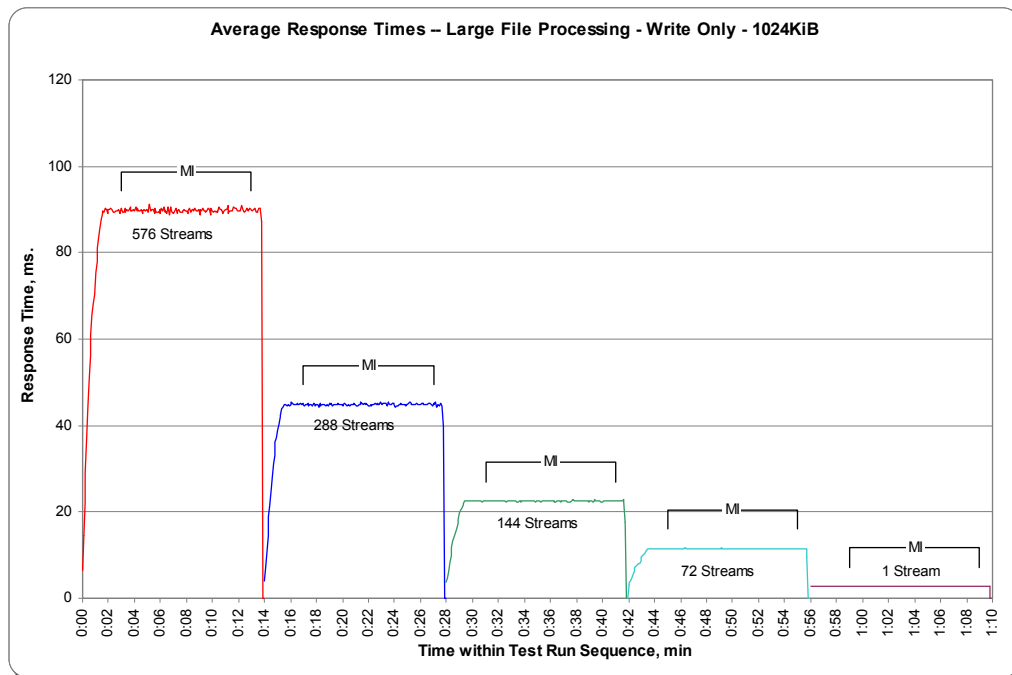
SPC-2 “Large File Processing/ WRITE ONLY /1024 KiB Transfer Size” Average Data Rate Graph – Measurement Interval (MI) Only



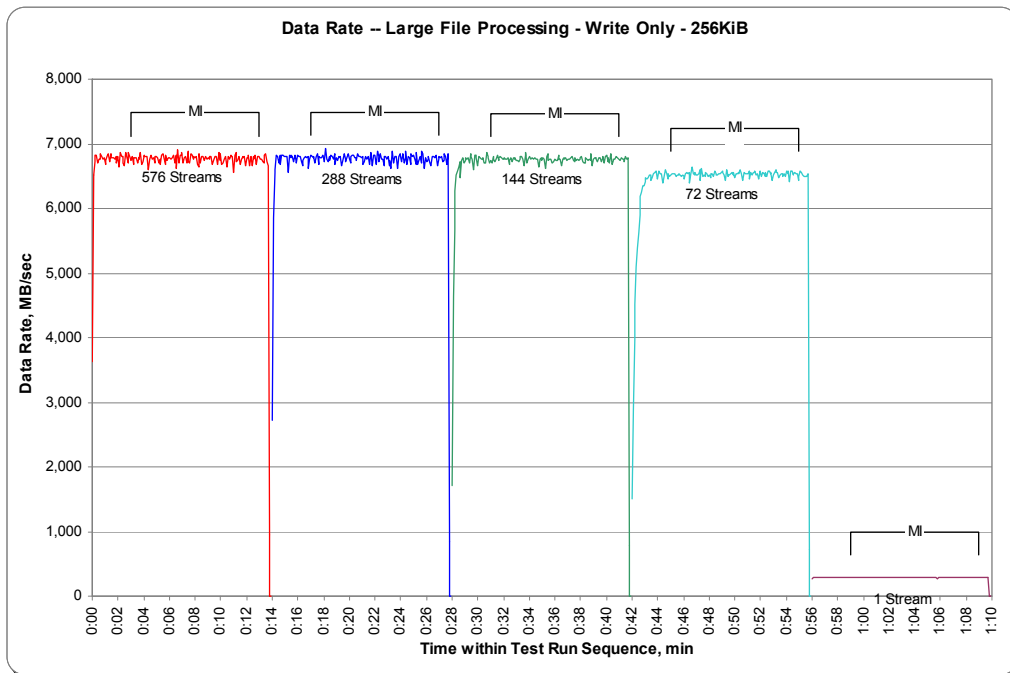
SPC-2 “Large File Processing/ WRITE ONLY /1024 KiB Transfer Size” Average Data Rate per Stream Graph



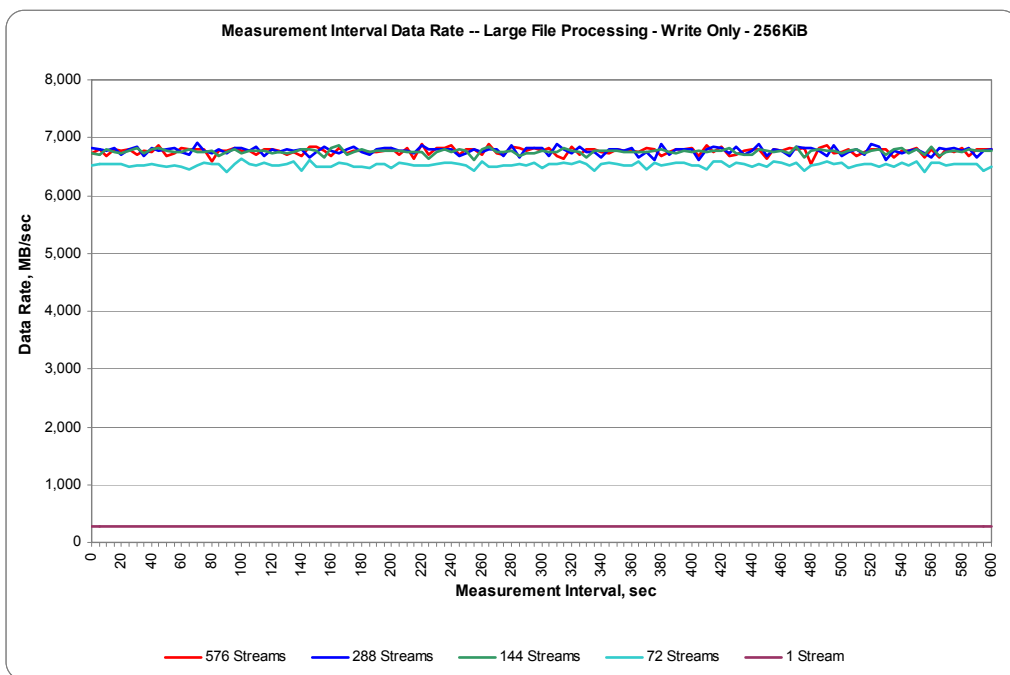
SPC-2 “Large File Processing/ WRITE ONLY /1024 KiB Transfer Size” Average Response Time Graph



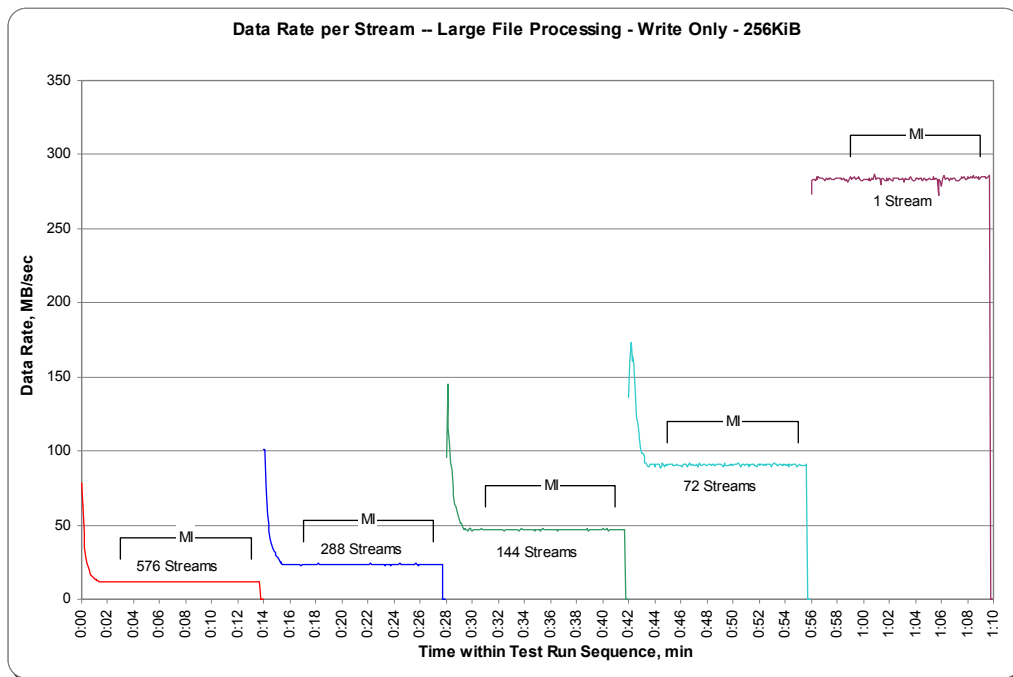
SPC-2 “Large File Processing/ WRITE ONLY /256 KiB Transfer Size” Average Data Rate Graph – Complete Test Run



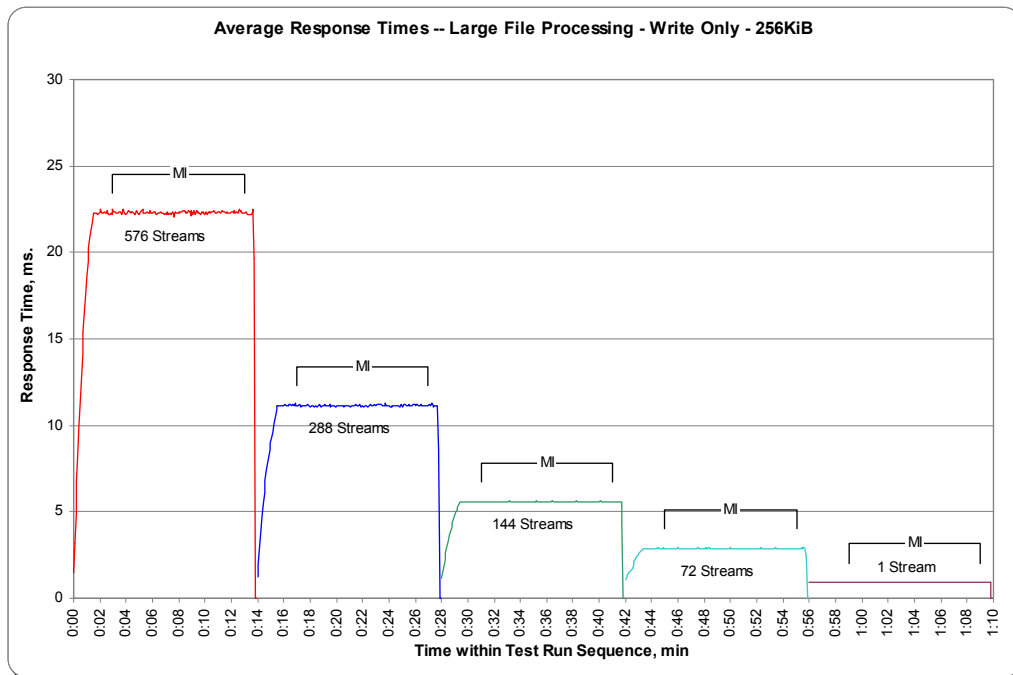
SPC-2 “Large File Processing/ WRITE ONLY /256 KiB Transfer Size” Average Data Rate Graph – Measurement Interval (MI) Only



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



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



Large File Processing Test – READ-WRITE Test Phase

Clause 10.6.8.1.2

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.*

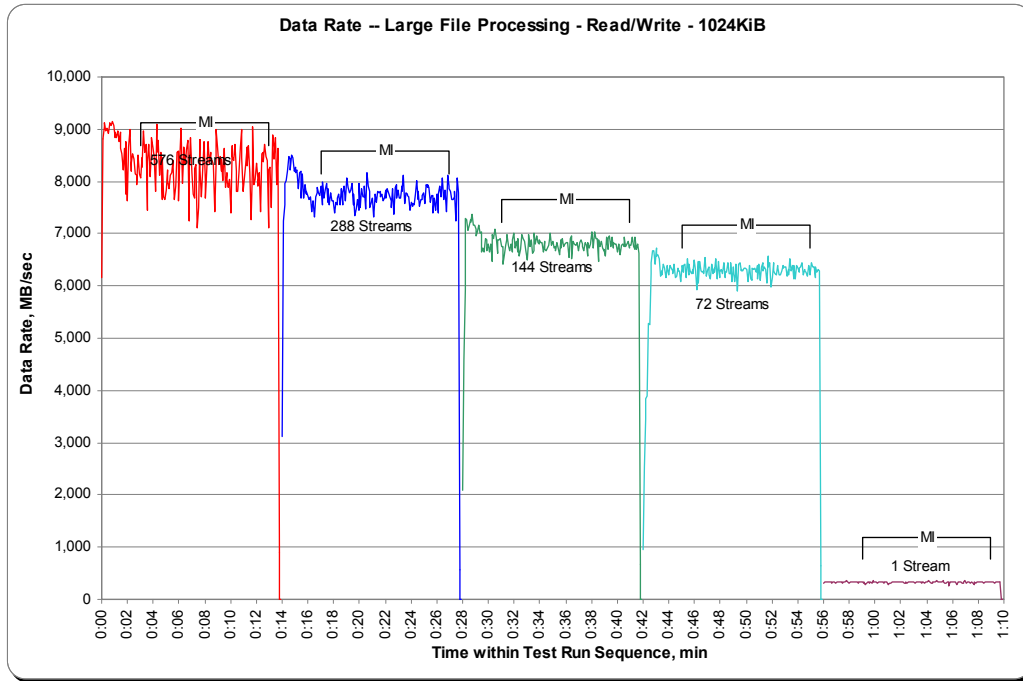
The SPC-2 "Large File Processing/READ-WRITE/1024 KiB Transfer Size" and "Large File Processing/ READ-WRITE /256 KiB Transfer Size" data tables are not embedded in this document due to size. The tables are available via the URLs listed below:

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

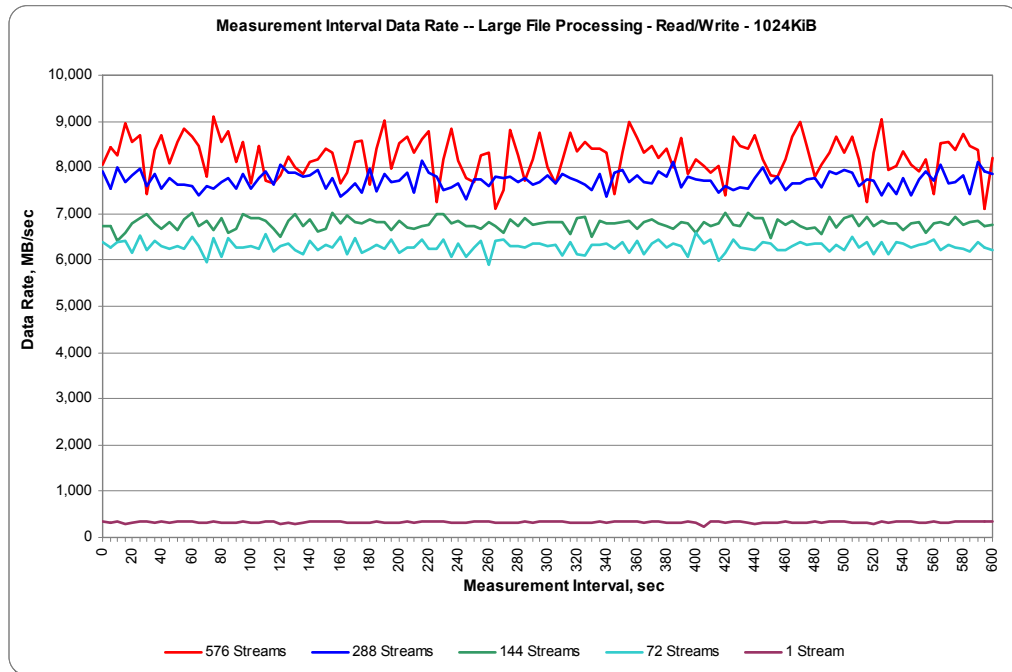
SPC-2 "Large File Processing/ Read-Write /256 KiB Transfer Size" Test Run Data

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.

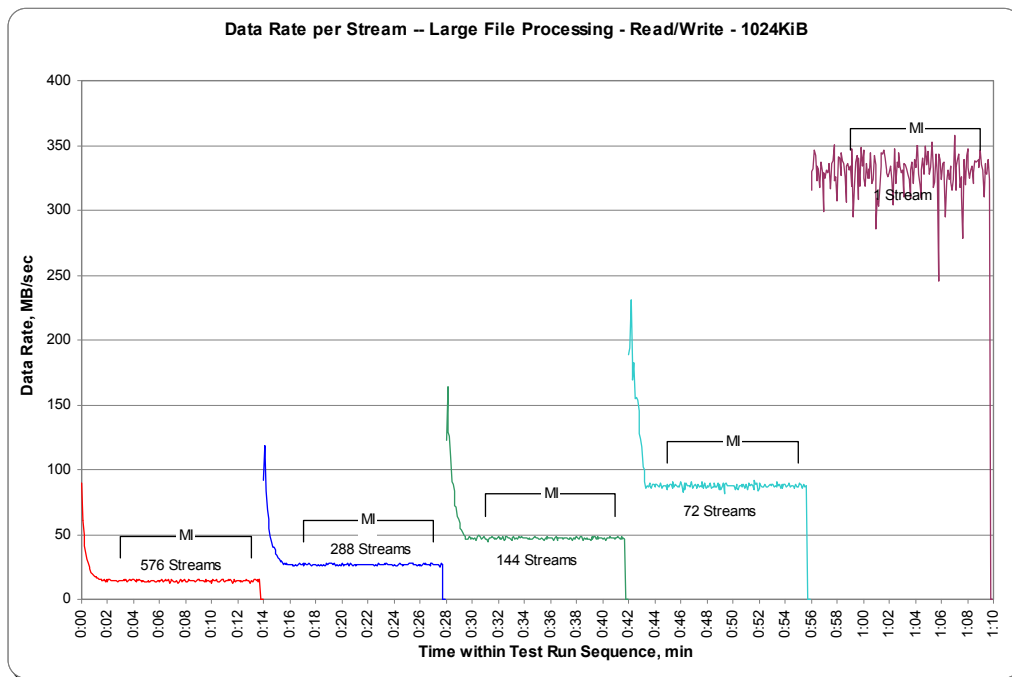
SPC-2 “Large File Processing/ READ-WRITE/1024 KiB Transfer Size” Average Data Rate Graph – Complete Test Run



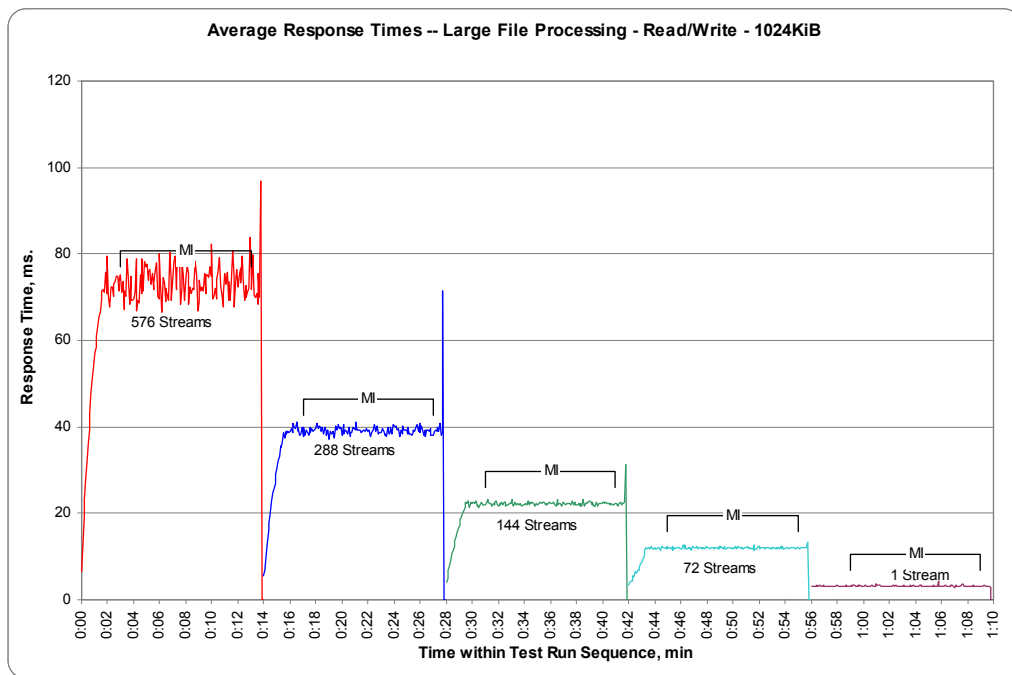
SPC-2 “Large File Processing/ READ-WRITE/1024 KiB Transfer Size” Average Data Rate Graph – Measurement Interval (MI) Only



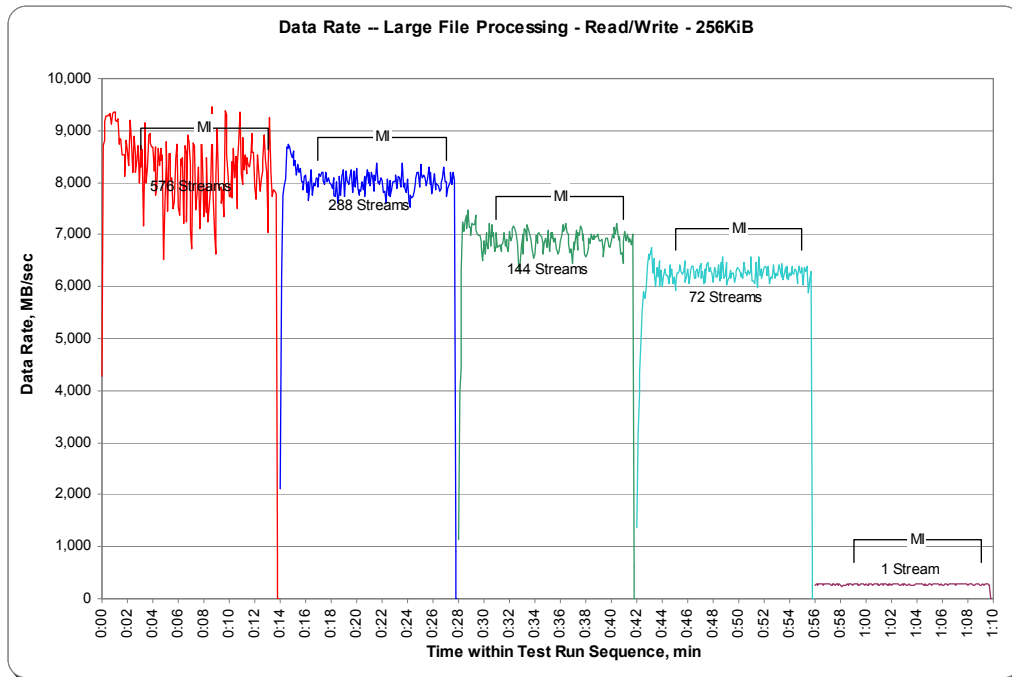
SPC-2 “Large File Processing/READ-WRITE/1024 KiB Transfer Size” Average Data Rate per Stream Graph



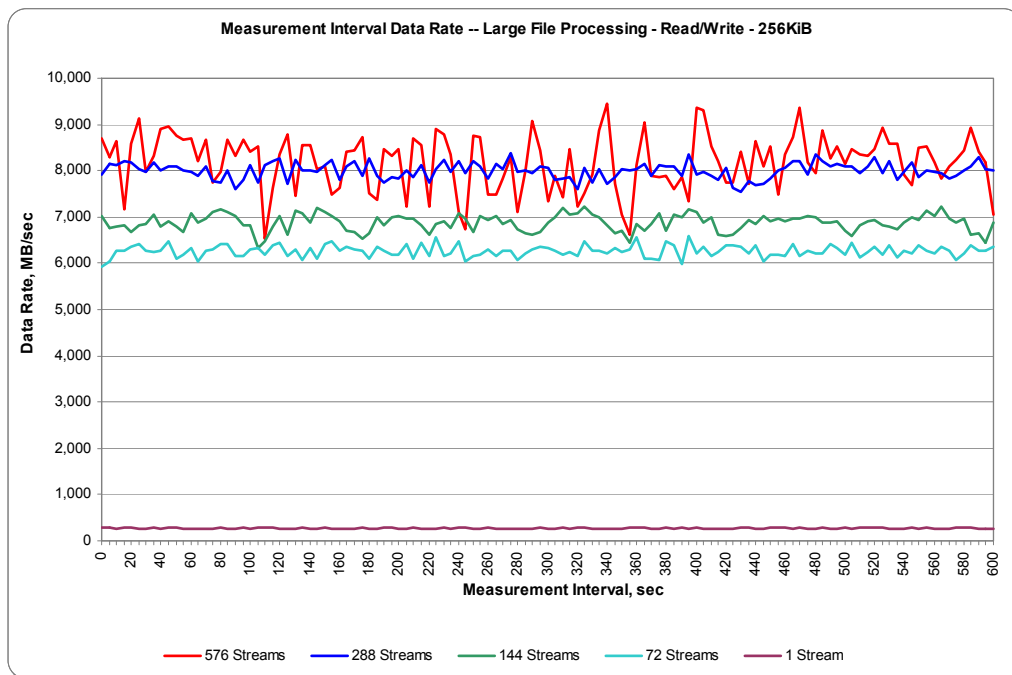
SPC-2 “Large File Processing/READ-WRITE/1024 KiB Transfer Size” Average Response Time Graph



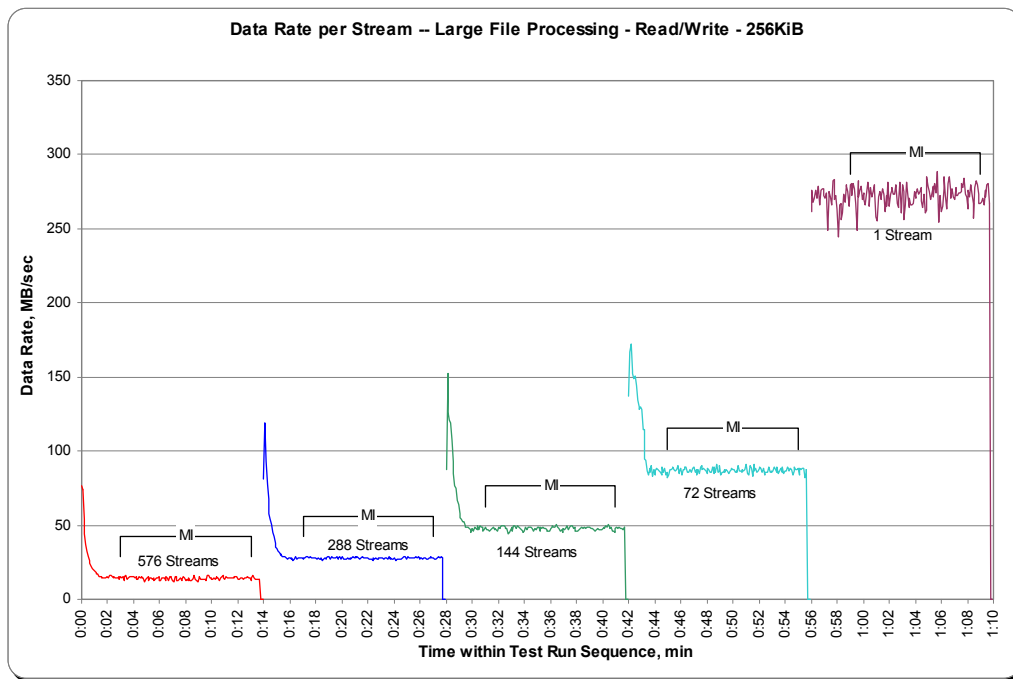
SPC-2 “Large File Processing/READ-WRITE/256 KiB Transfer Size” Average Data Rate Graph – Complete Test Run



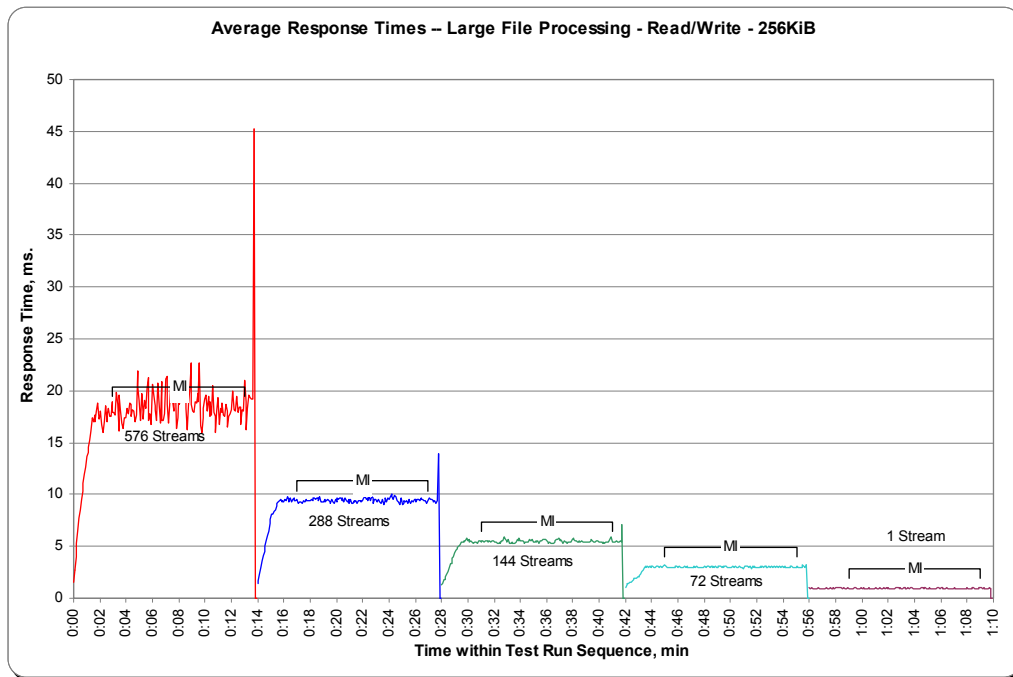
SPC-2 “Large File Processing/READ-WRITE/256 KiB Transfer Size” Average Data Rate Graph – Measurement Interval (MI) Only



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 10.6.8.1.3

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.*

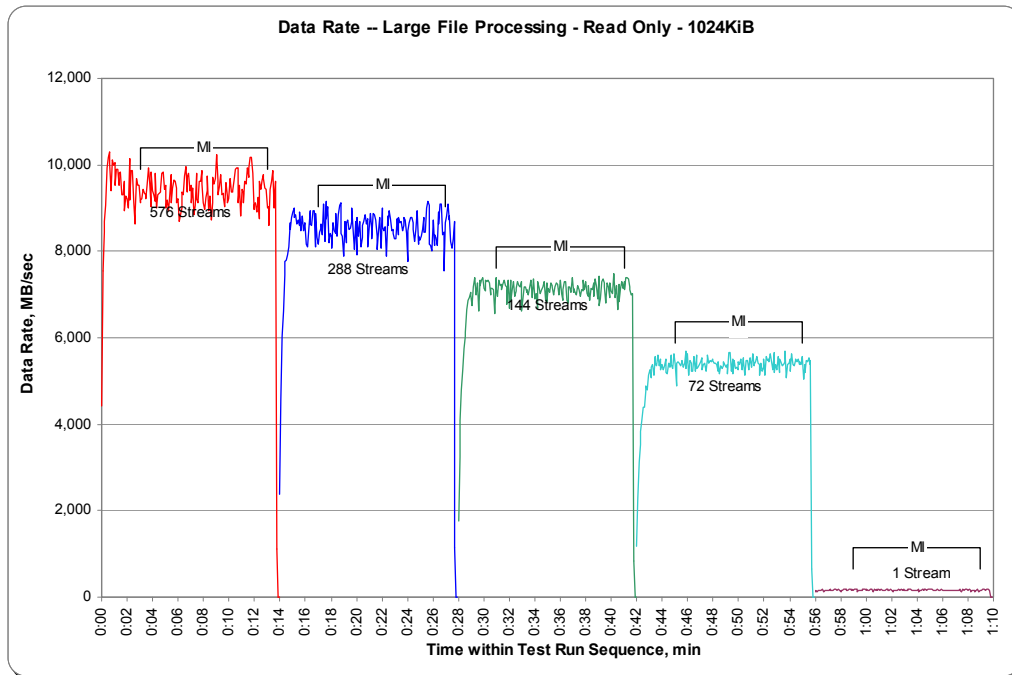
The SPC-2 "Large File Processing/READ ONLY/1024 KiB Transfer Size" and "Large File Processing/ READ ONLY /256 KiB Transfer Size" data tables are not embedded in this document due to size. The tables are available via the URLs listed below:

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

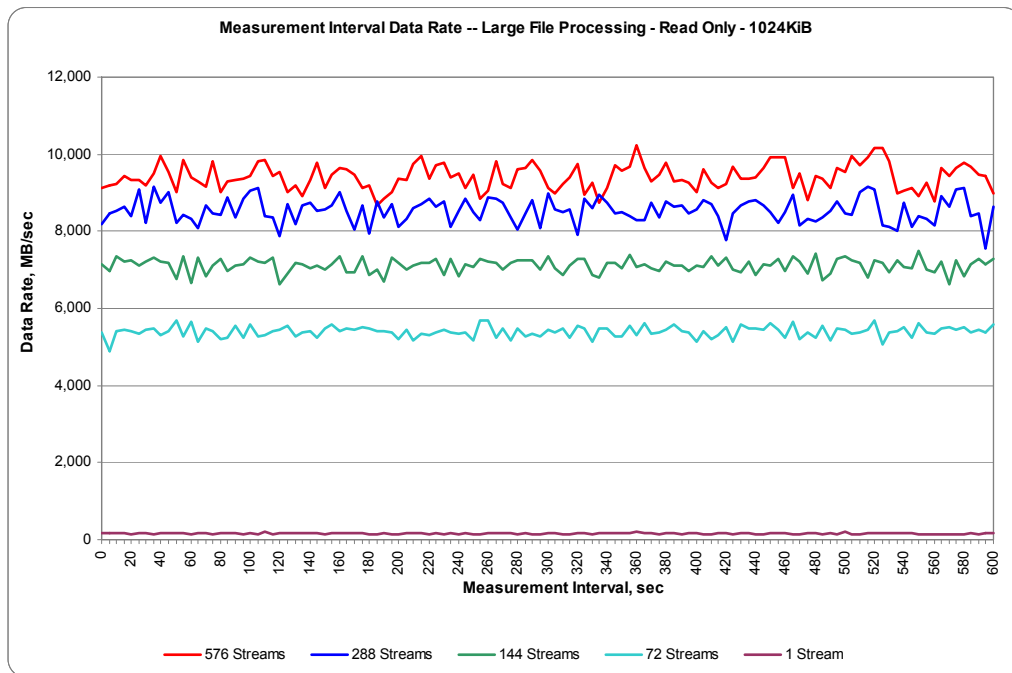
SPC-2 "Large File Processing/ Read Only /256 KiB Transfer Size" Test Run Data

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.

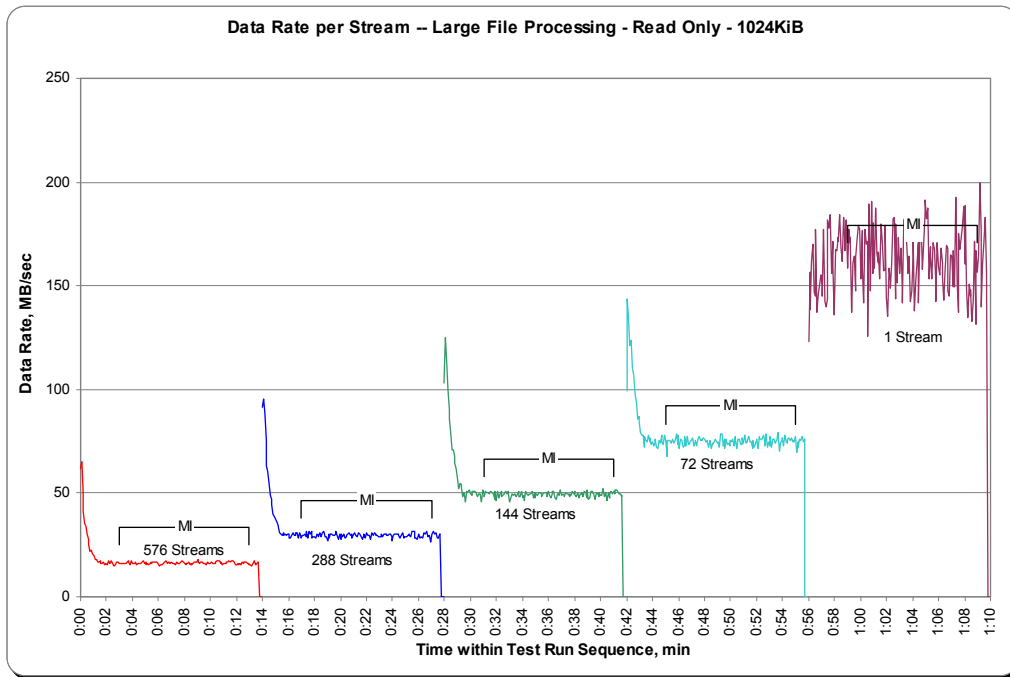
SPC-2 “Large File Processing/READ ONLY/1024 KiB Transfer Size” Average Data Rate Graph – Complete Test Run



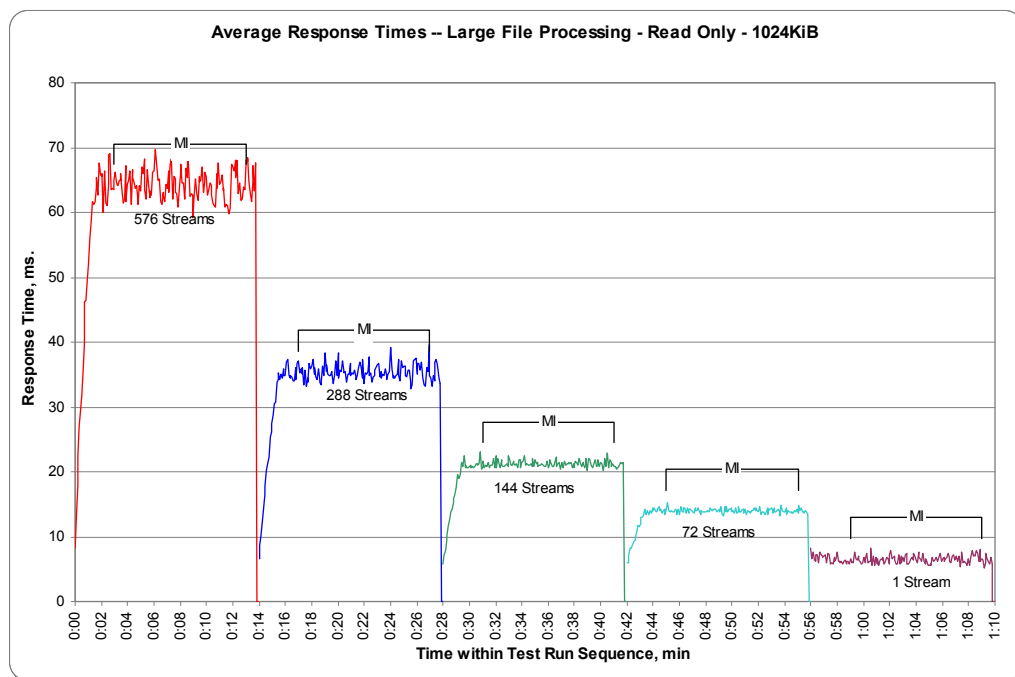
SPC-2 “Large File Processing/READ ONLY/1024 KiB Transfer Size” Average Data Rate Graph – Measurement Interval (MI) Only



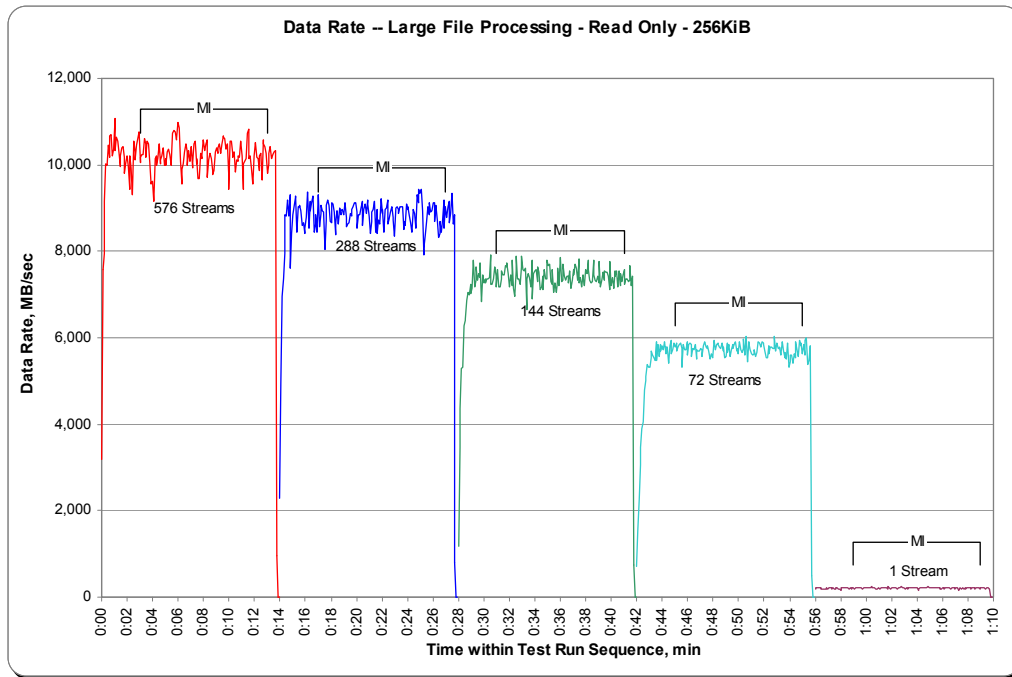
SPC-2 “Large File Processing/READ ONLY/1024 KiB Transfer Size” Average Data Rate per Stream Graph



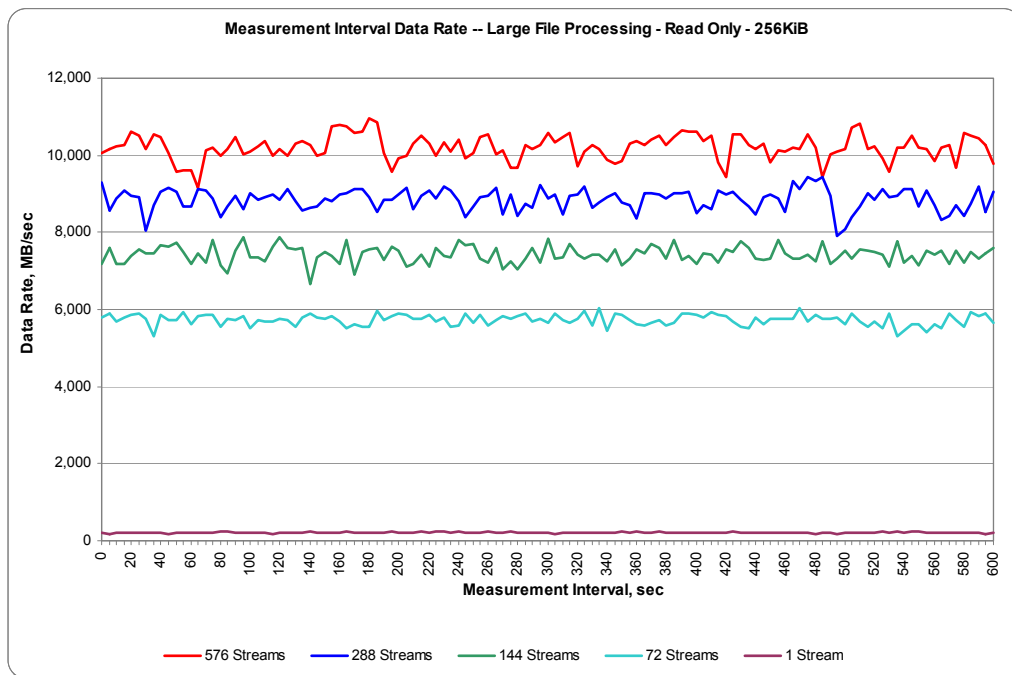
SPC-2 “Large File Processing/READ ONLY/1024 KiB Transfer Size” Average Response Time Graph



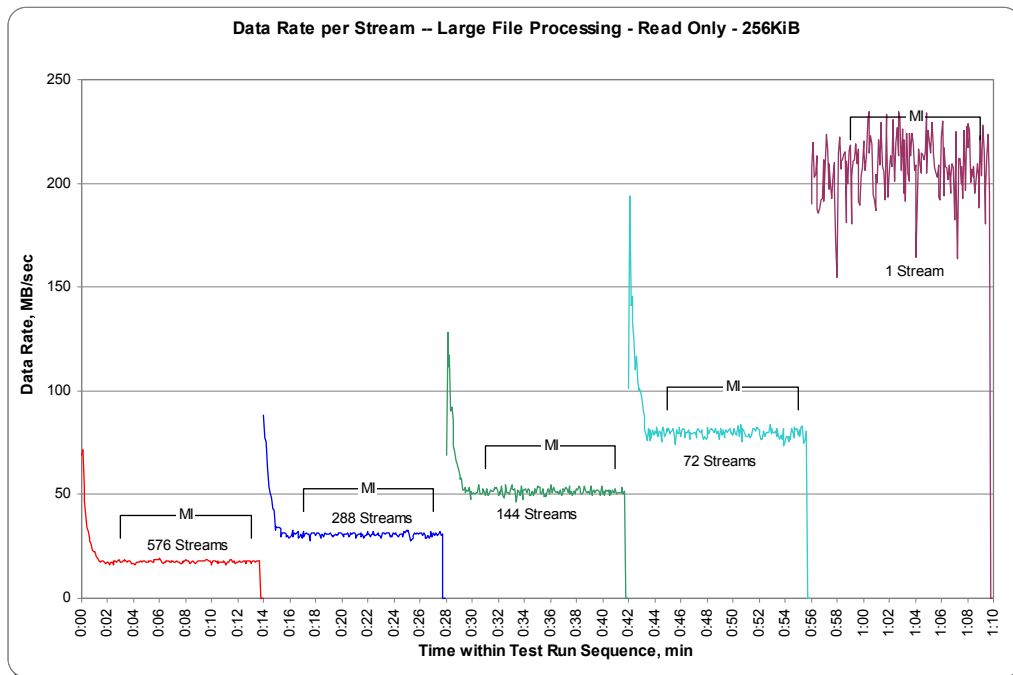
SPC-2 “Large File Processing/READ ONLY/256 KiB Transfer Size” Average Data Rate Graph – Complete Test Run



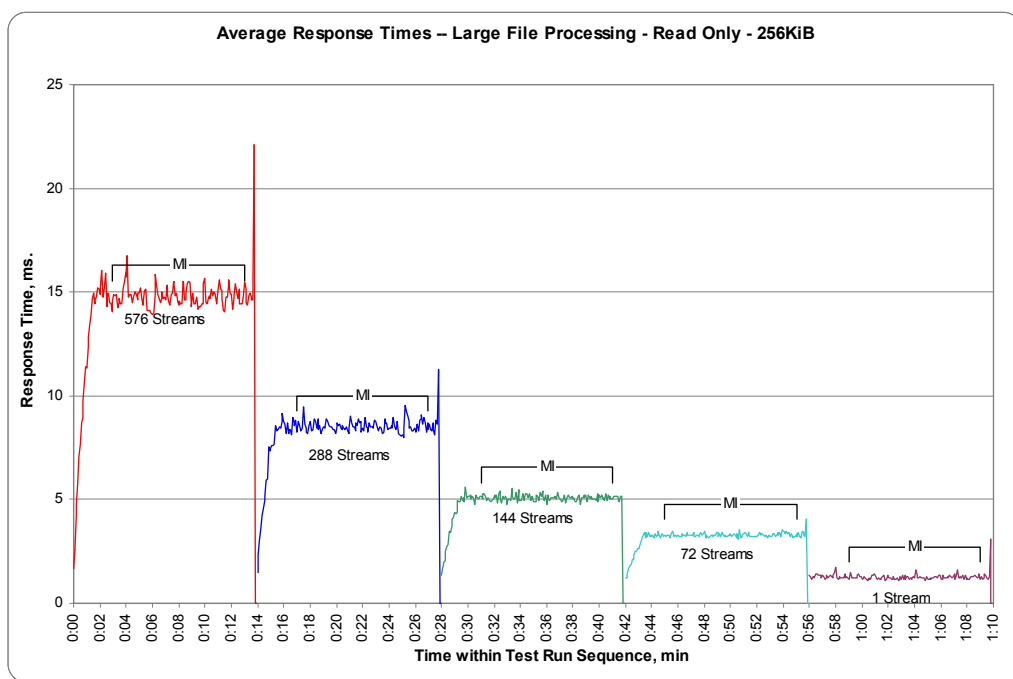
SPC-2 “Large File Processing/READ ONLY/256 KiB Transfer Size” Average Data Rate Graph – Measurement Interval (MI) Only



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 6.4.3.1

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 6.4.3.2

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 10.6.8.2

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

- 1. A listing of the SPC-2 Workload Generator commands and parameters used to execute each of the Test Runs in the Large Database Query Test.*
- 2. The human readable SPC-2 Test Results File for each of the Test Runs in the Large Database Query Test.*
- 3. A table that contains the following information for each Test Run in the two Test Phases of the Large Database Query 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-2 Workload Generator Commands and Parameters

The SPC-2 Workload Generator commands and parameters for the Large Database Query Test Runs are documented in “Appendix E: SPC-2 Workload Generator Execution Commands and Parameters” on Page 105.

SPC-2 Test Results File

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

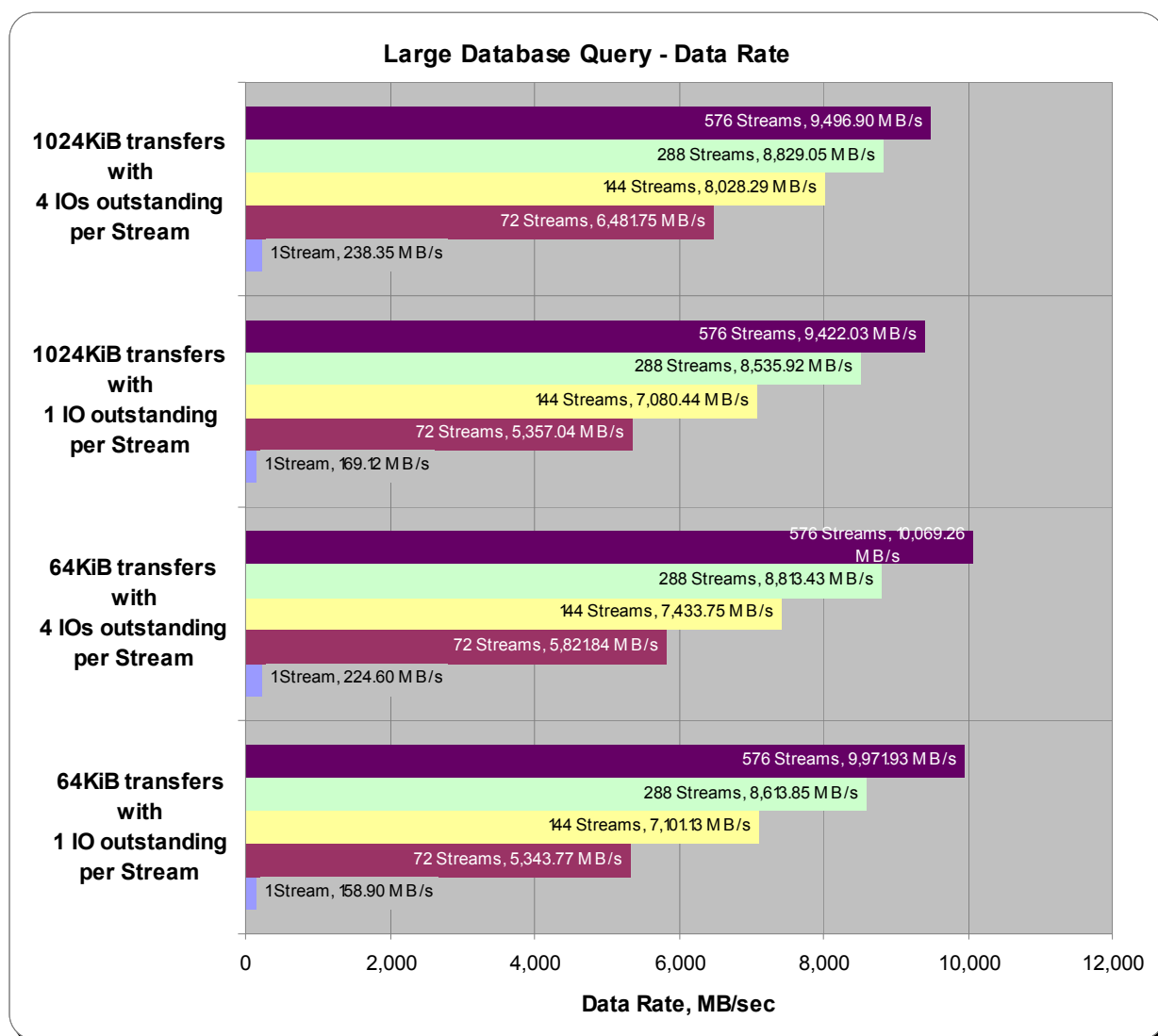
[SPC-2 Large Database Query Test Results File](#)

SPC-2 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-2 Large Database Query Test is listed in the table below as well as illustrated in the following graph.

| Test Run Sequence | 1 Stream | 72 Streams | 144 Streams | 288 Streams | 576 Streams |
|-------------------------|----------|------------|-------------|-------------|-------------|
| 1024KiB w/ 4 IOs/Stream | 238.35 | 6,481.75 | 8,028.29 | 8,829.05 | 9,496.90 |
| 1024KiB w/ 1 IO/Stream | 169.12 | 5,357.04 | 7,080.44 | 8,535.92 | 9,422.03 |
| 64KiB w/ 4 IOs/Stream | 224.60 | 5,821.84 | 7,433.75 | 8,813.43 | 10,069.26 |
| 64KiB w/ 1 IO/Stream | 158.90 | 5,343.77 | 7,101.13 | 8,613.85 | 9,971.93 |

SPC-2 Large Database Query Average Data Rates Graph

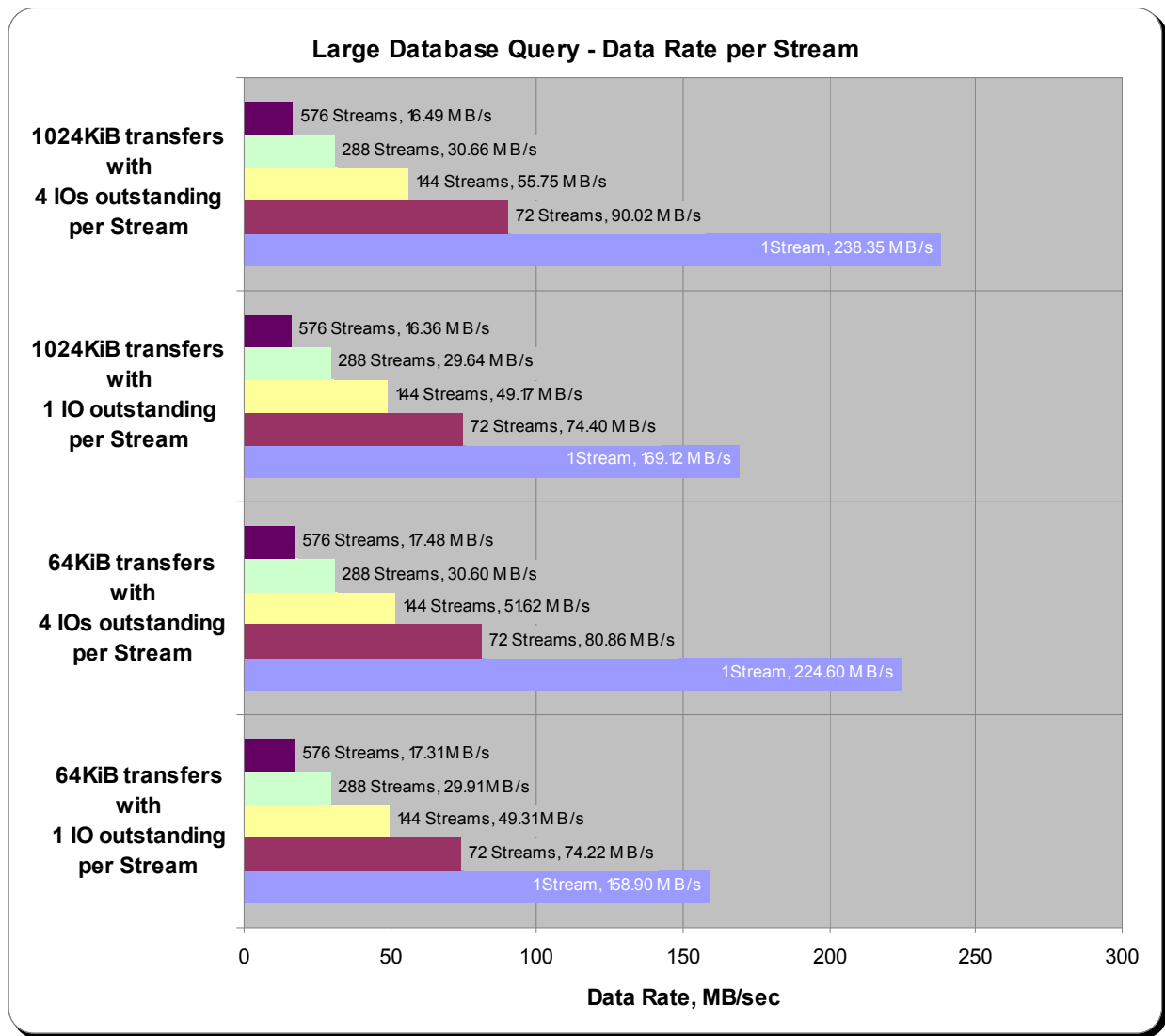


SPC-2 Large Database Query Average Data Rate per Stream

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

| Test Run Sequence | 1 Stream | 72 Streams | 144 Streams | 288 Streams | 576 Streams |
|-------------------------|----------|------------|-------------|-------------|-------------|
| 1024KiB w/ 4 IOs/Stream | 238.35 | 90.02 | 55.75 | 30.66 | 16.49 |
| 1024KiB w/ 1 IO/Stream | 169.12 | 74.40 | 49.17 | 29.64 | 16.36 |
| 64KiB w/ 4 IOs/Stream | 224.60 | 80.86 | 51.62 | 30.60 | 17.48 |
| 64KiB w/ 1 IO/Stream | 158.90 | 74.22 | 49.31 | 29.91 | 17.31 |

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

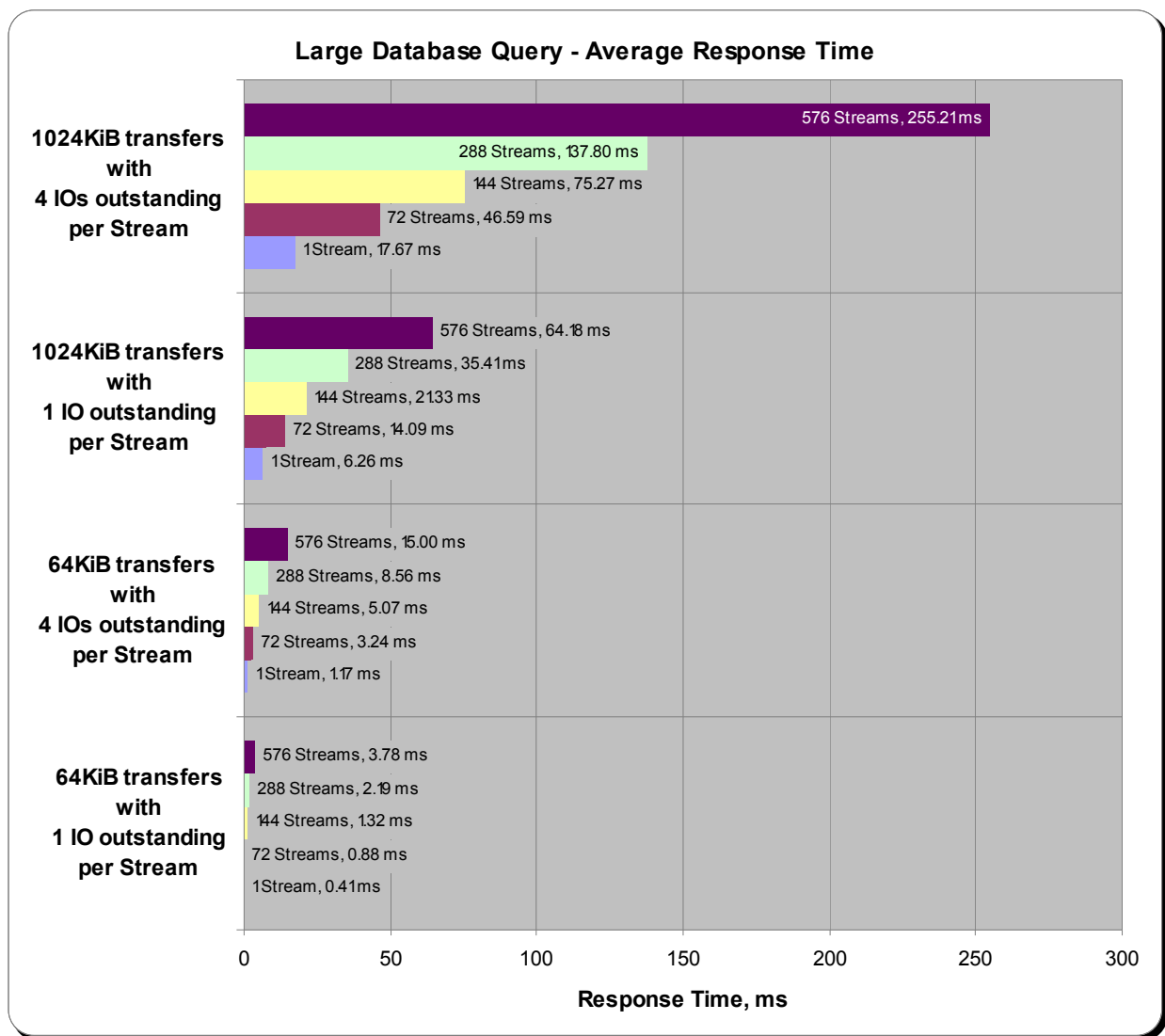


SPC-2 Large Database Query Average Response Time

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

| Test Run Sequence | 1 Stream | 72 Streams | 144 Streams | 288 Streams | 576 Streams |
|-------------------------|----------|------------|-------------|-------------|-------------|
| 1024KiB w/ 4 IOs/Stream | 17.67 | 46.59 | 75.27 | 137.80 | 255.21 |
| 1024KiB w/ 1 IO/Stream | 6.26 | 14.09 | 21.33 | 35.41 | 64.18 |
| 64KiB w/ 4 IOs/Stream | 1.17 | 3.24 | 5.07 | 8.56 | 15.00 |
| 64KiB w/ 1 IO/Stream | 0.41 | 0.88 | 1.32 | 2.19 | 3.78 |

SPC-2 Large Database Query Average Response Time Graph



Large Database Query Test – 1024 KIB TRANSFER SIZE Test Phase

Clause 10.6.8.2.1

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 (intervals), Average Data Rate per Stream (intervals), and Average Response Time (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 (intervals), Average Data Rate per Stream (intervals), and Average Response Time (intervals) graphs for the "1024 KiB Transfer Size, 1 Outstanding I/O" Test Runs as specified in Clauses 10.1.4 – 10.1.6.

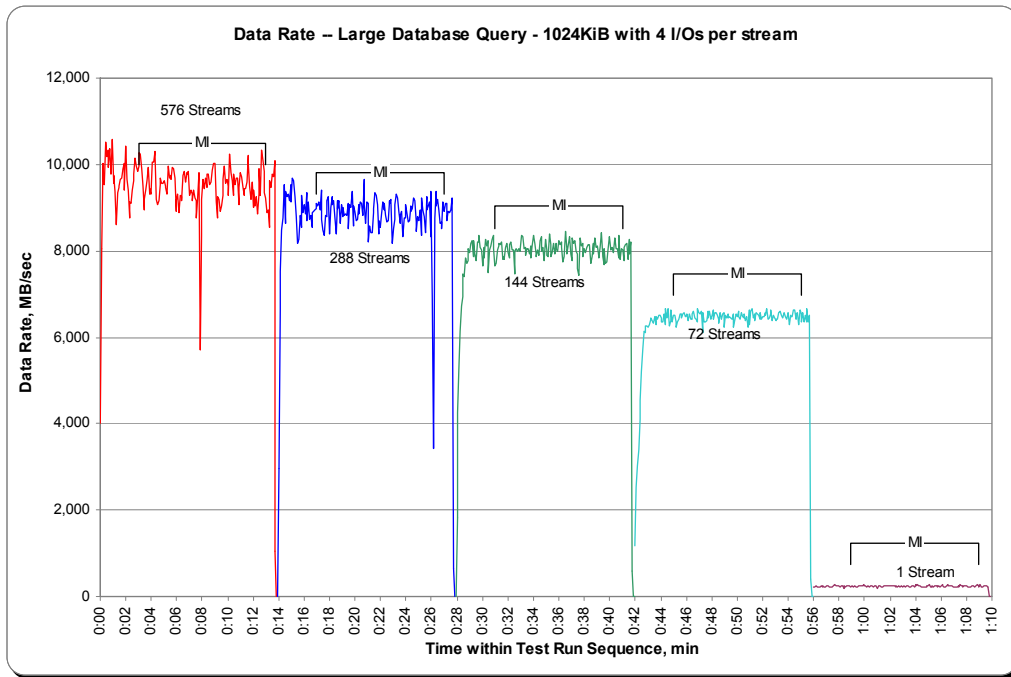
The SPC-2 "Large DatabaseQuery/1024 KIB TRANSFER SIZE/4 Outstanding I/Os" and "Large DatabaseQuery/1024 KIB TRANSFER SIZE/1 Outstanding I/O" data tables are not embedded in this document due to size. The tables are available via the URLs listed below:

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

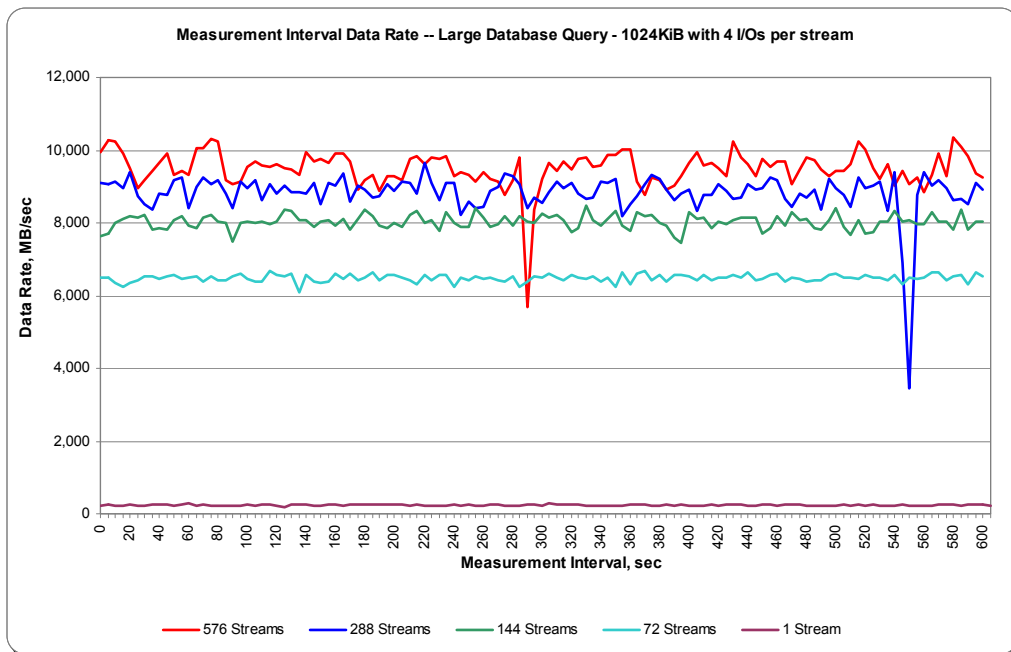
Large DatabaseQuery/1024 KIB TRANSFER SIZE/1 Outstanding I/O

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.

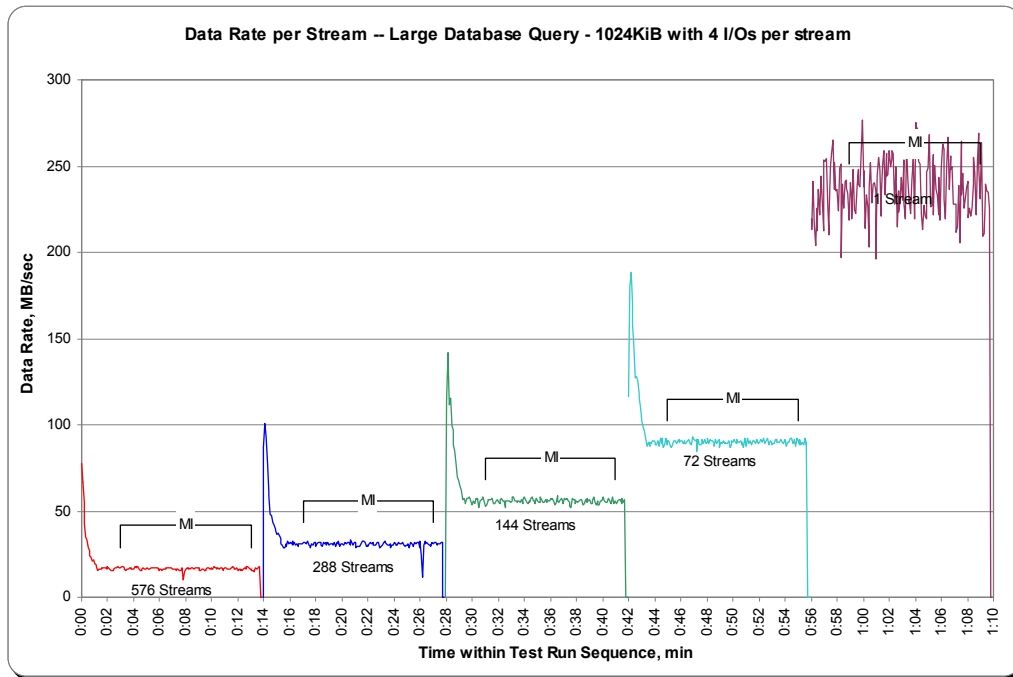
**SPC-2 “Large Database Query/1024 KiB Transfer Size/4 Outstanding I/Os”
 Average Data Rate Graph – Complete Test Run**



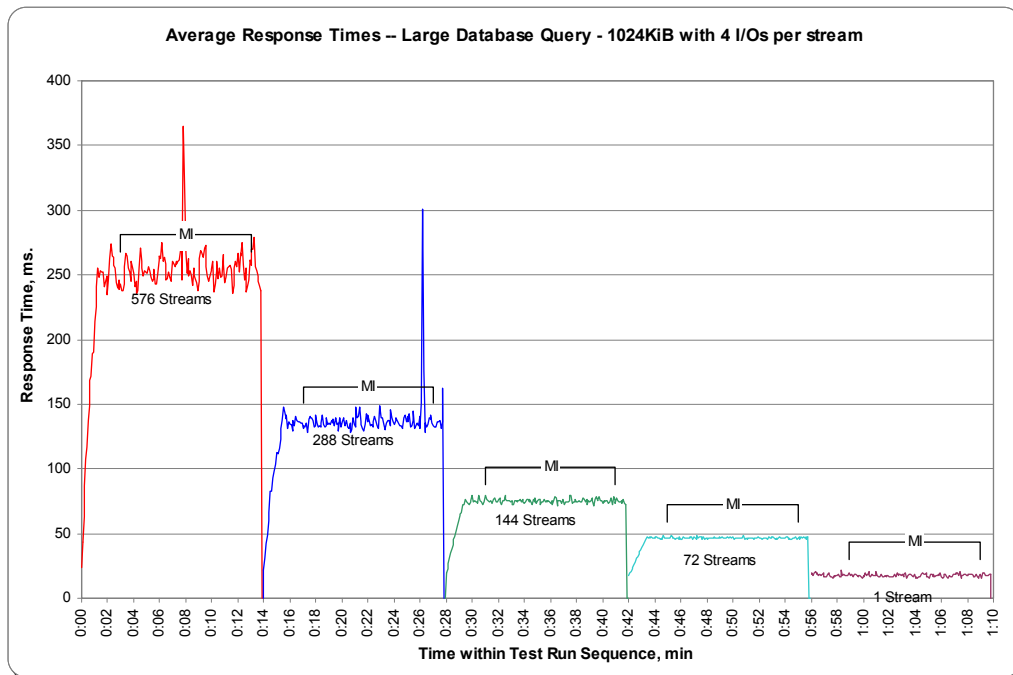
**SPC-2 “Large Database Query/1024 KiB Transfer Size/4 Outstanding I/Os”
 Average Data Rate Graph – Measurement Interval (MI) Only**



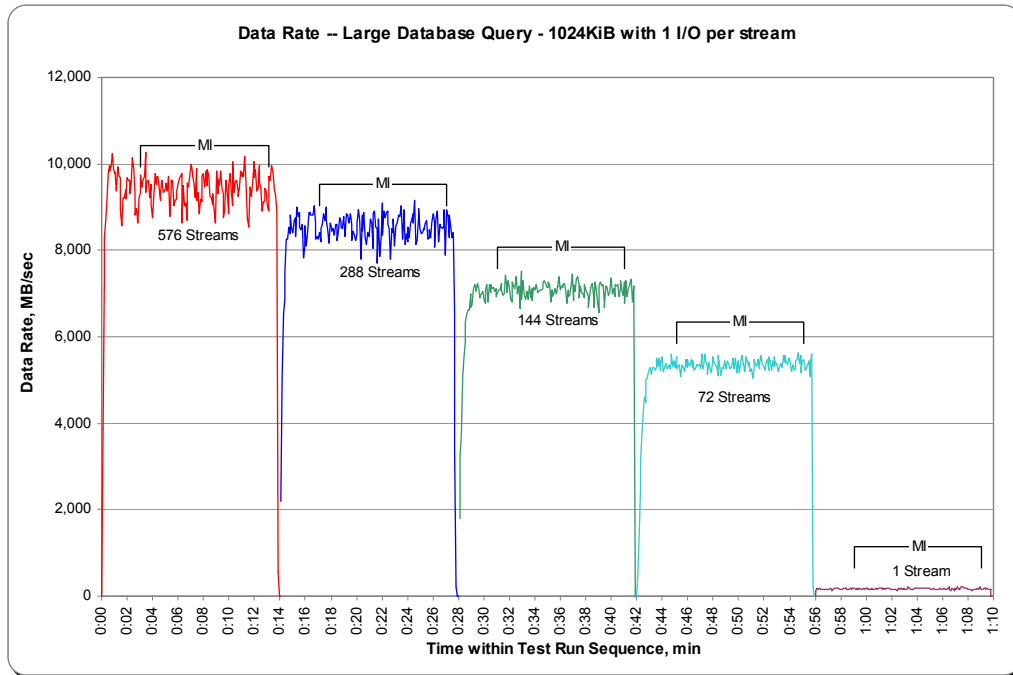
SPC-2 “Large Database Query/1024 KiB Transfer Size/4 Outstanding I/Os” Average Data Rate per Stream Graph



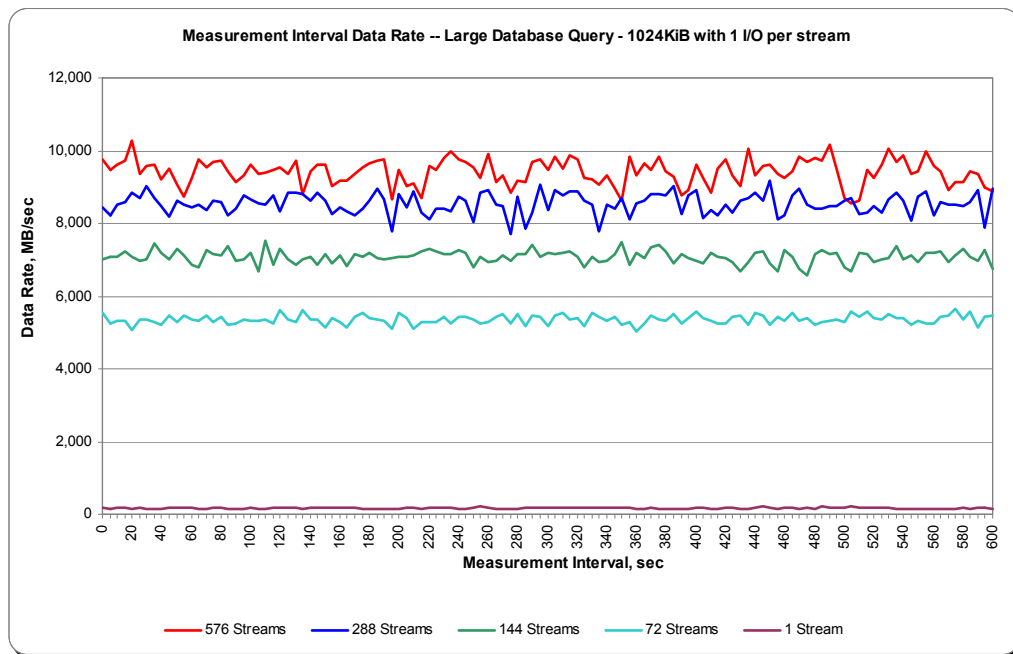
SPC-2 “Large Database Query/1024 KiB Transfer Size/4 Outstanding I/Os” Average Response Time Graph



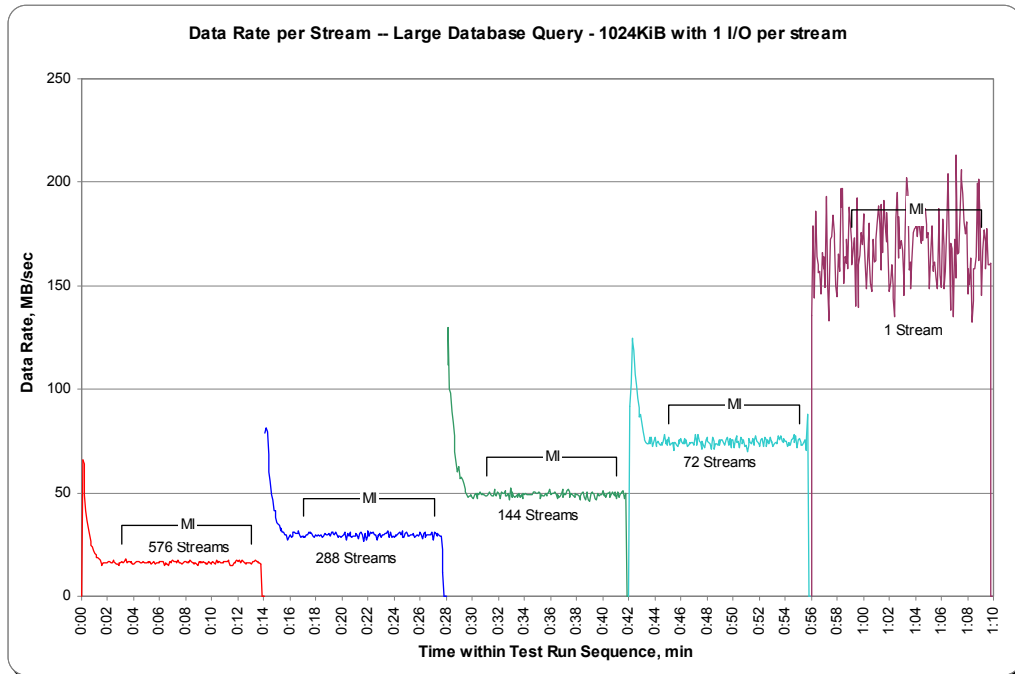
SPC-2 “Large Database Query/1024 KiB Transfer Size/1 Outstanding I/O” Average Data Rate Graph – Complete Test Run



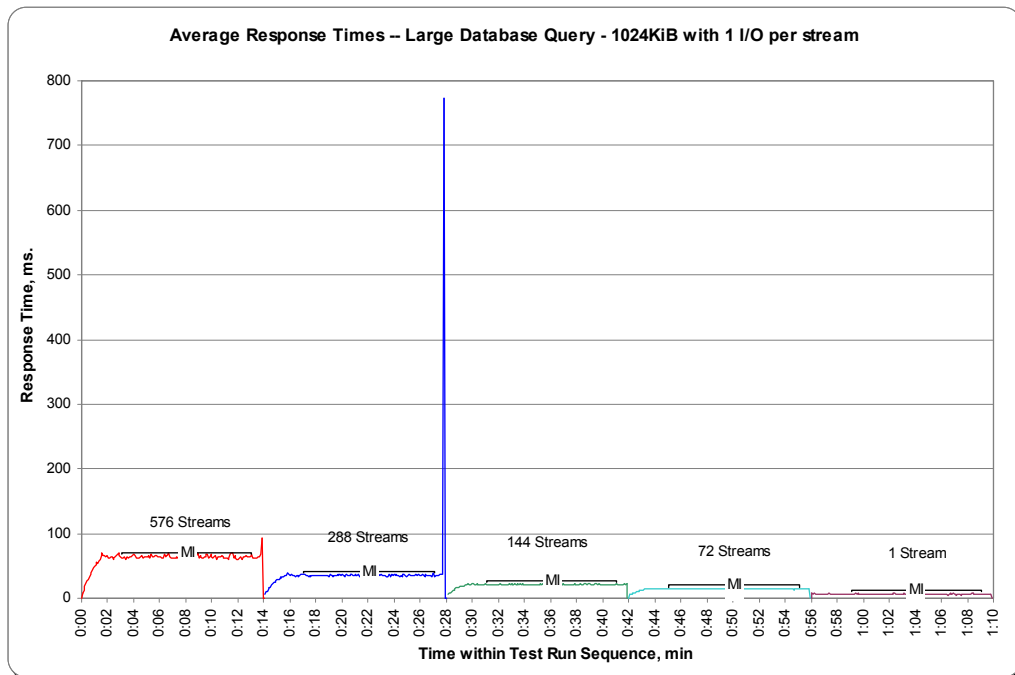
SPC-2 “Large Database Query/1024 KiB Transfer Size/1 Outstanding I/O” Average Data Rate Graph – Measurement Interval (MI) Only



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



SPC-2 “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 10.6.8.2.1

5. *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.*
6. *Average Data Rate (intervals), Average Data Rate per Stream (intervals), and Average Response Time (intervals) graphs for the "64 KiB Transfer Size, 4 Outstanding I/Os" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*
7. *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.*
8. *Average Data Rate (intervals), Average Data Rate per Stream (intervals), and Average Response Time (intervals) graphs for the "64 KiB Transfer Size, 1 Outstanding I/O" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*

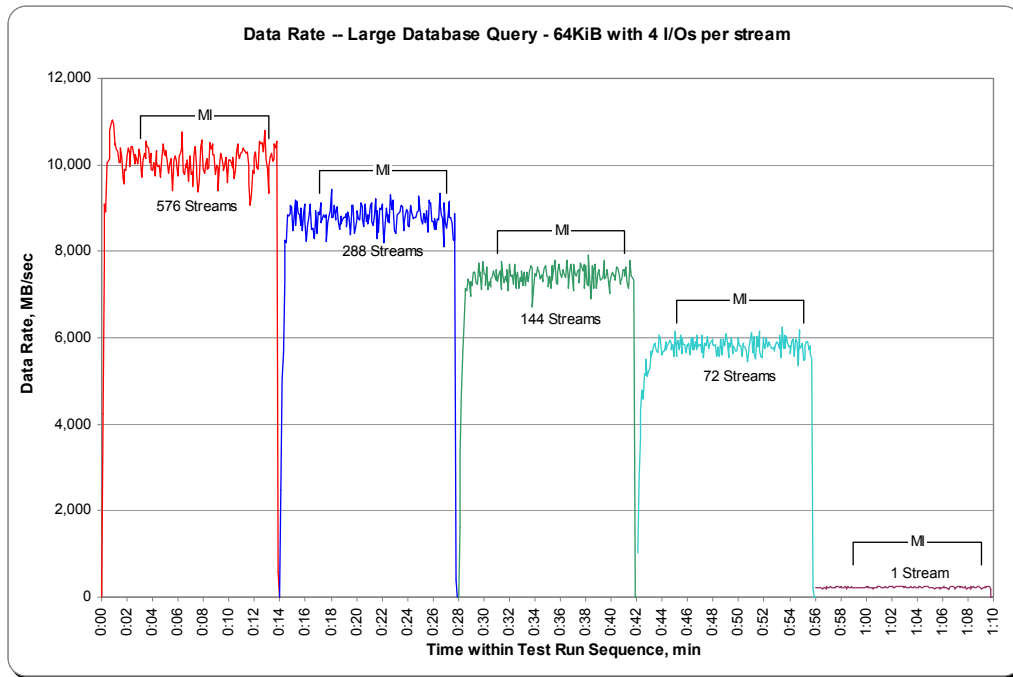
The SPC-2 "Large DatabaseQuery/64 KiB TRANSFER SIZE/4 Outstanding I/Os" and "Large DatabaseQuery/64 KiB TRANSFER SIZE/1 Outstanding I/O" data tables are not embedded in this document due to size. The tables are available via the URLs listed below:

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

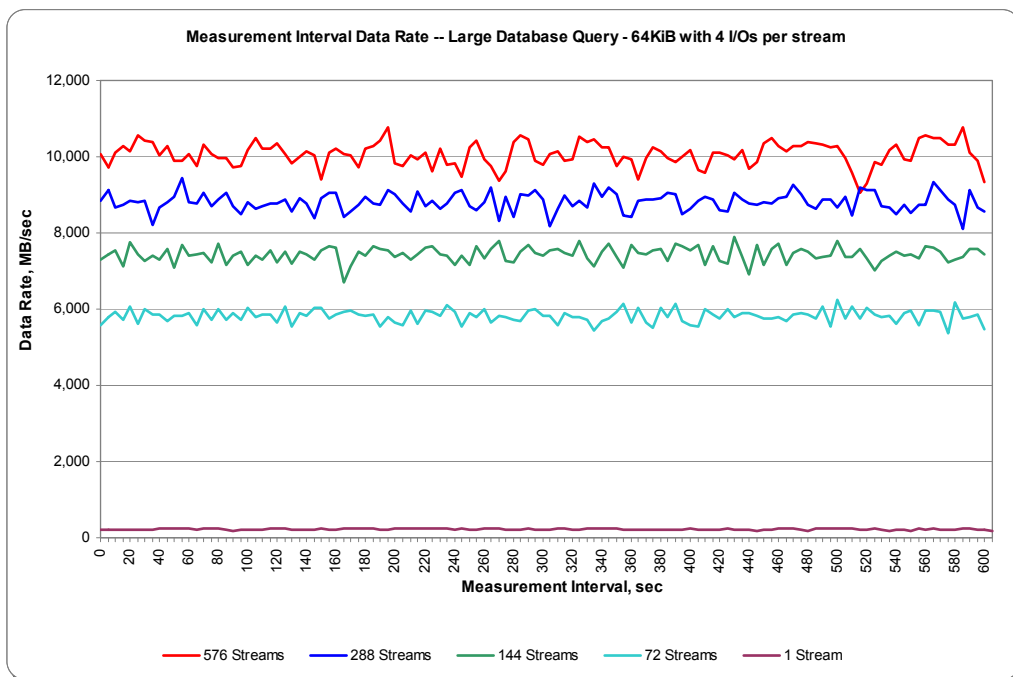
Large DatabaseQuery/64 KiB TRANSFER SIZE/1 Outstanding I/O

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.

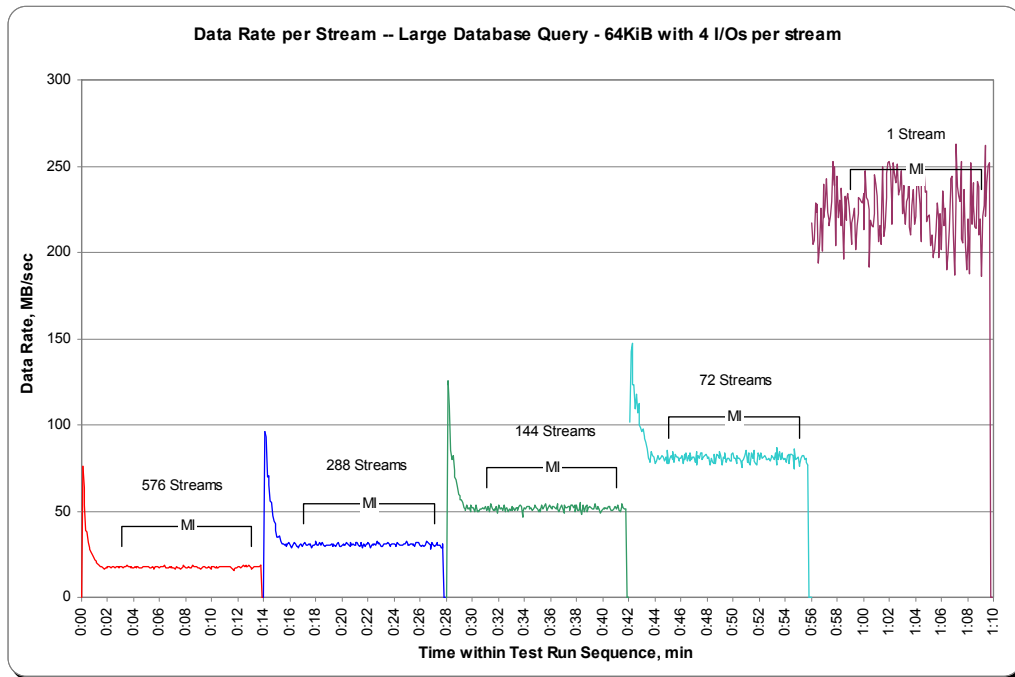
SPC-2 “Large Database Query/64 KiB Transfer Size/4 Outstanding I/Os” Average Data Rate Graph – Complete Test Run



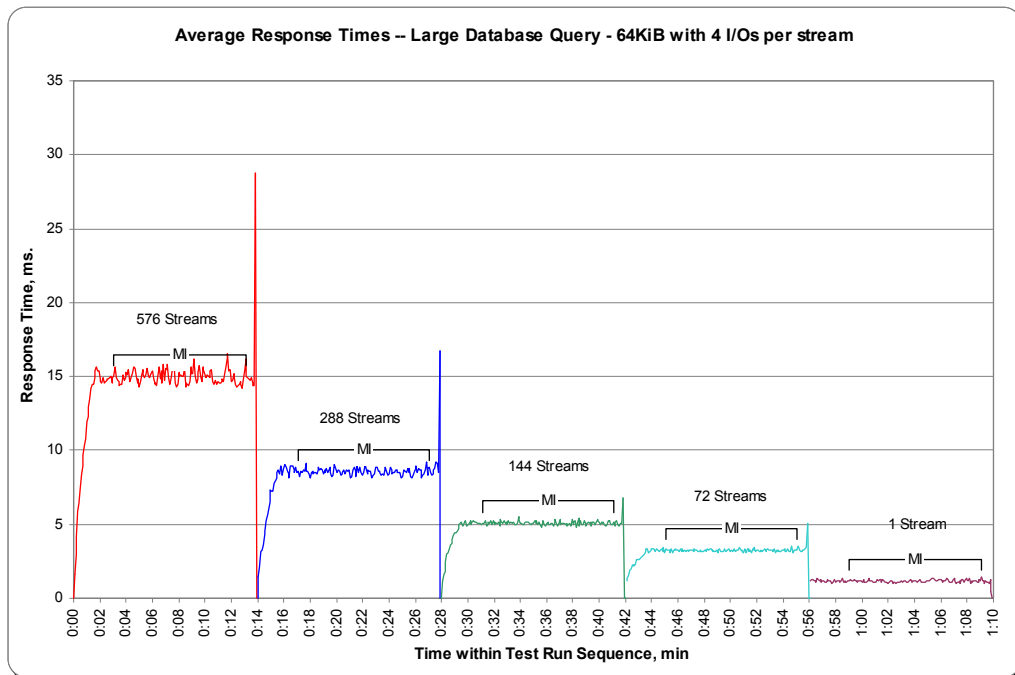
SPC-2 “Large Database Query/64 KiB Transfer Size/4 Outstanding I/Os” Average Data Rate Graph – Measurement Interval (MI) Only



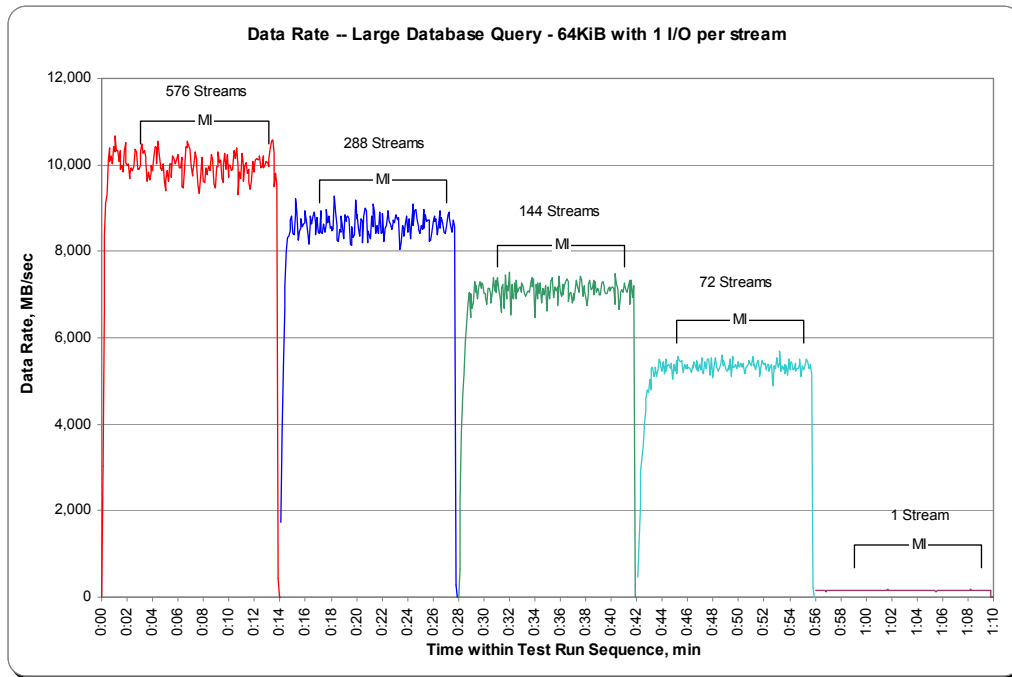
SPC-2 “Large Database Query/64 KiB Transfer Size/4 Outstanding I/Os” Average Data Rate per Stream Graph



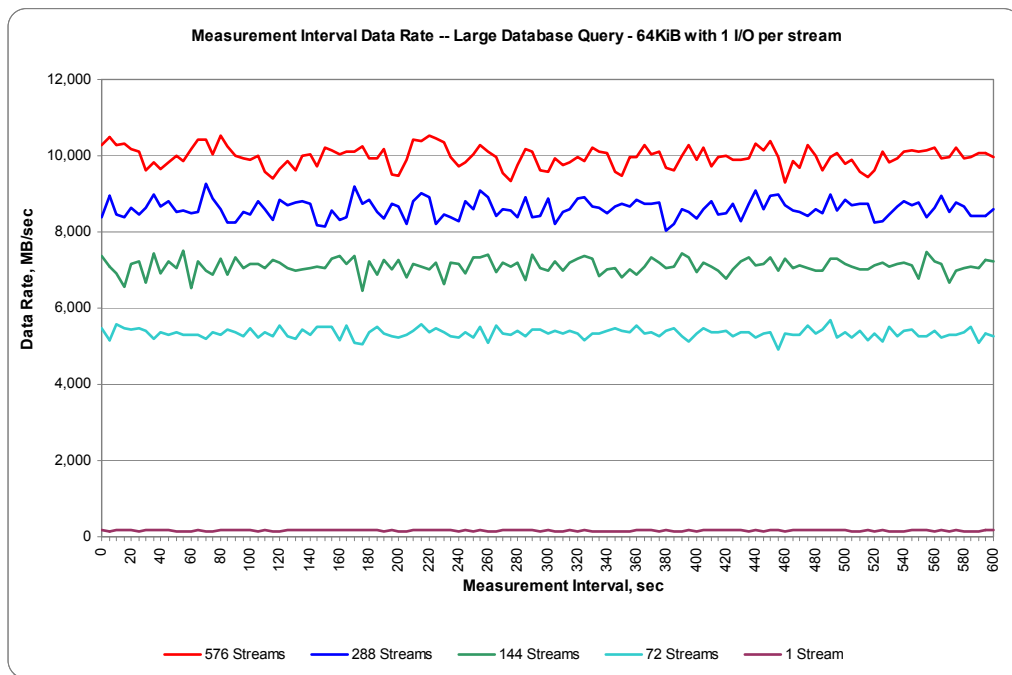
SPC-2 “Large Database Query/64 KiB Transfer Size/4 Outstanding I/Os” Average Response Time Graph



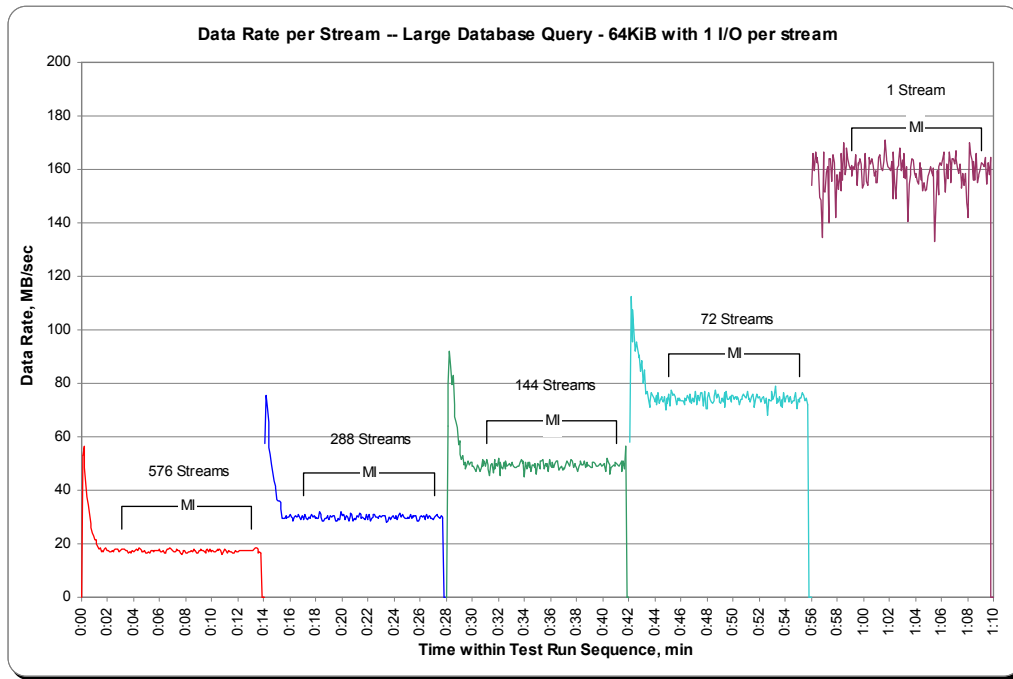
SPC-2 “Large Database Query/64 KiB Transfer Size/1 Outstanding I/O” Average Data Rate Graph – Complete Test Run



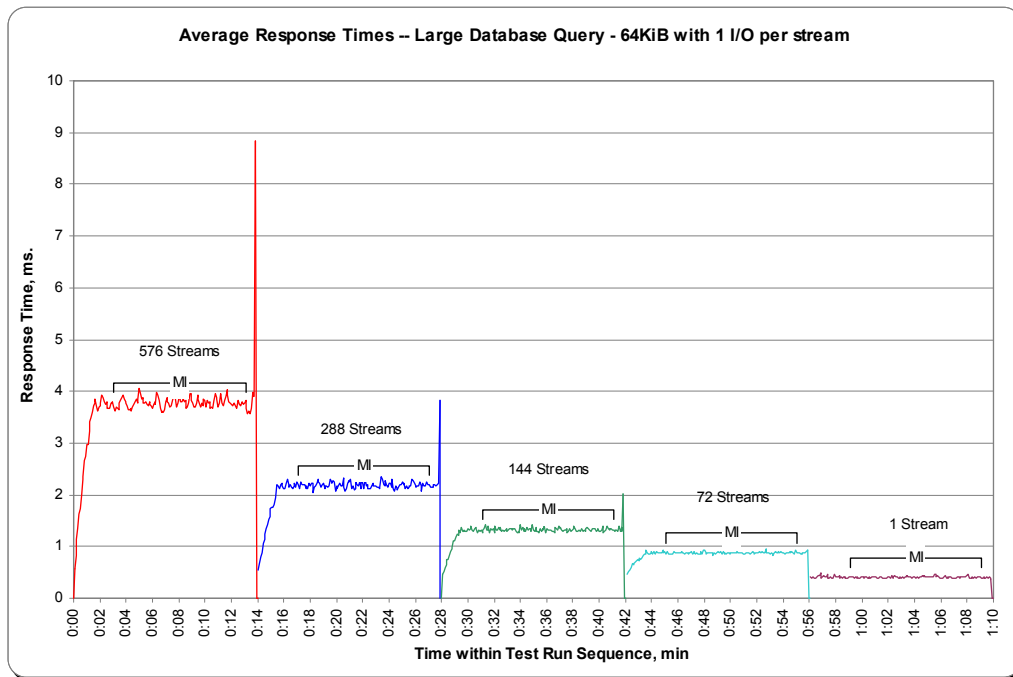
SPC-2 “Large Database Query/64 KiB Transfer Size/1 Outstanding I/O” Average Data Rate Graph – Measurement Interval (MI) Only



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



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



Video on Demand Delivery Test

Clause 6.4.4.1

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 6.4.2.2

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 10.6.8.3

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

- 1. A listing of the SPC-2 Workload Generator commands and parameters used to execute the Test Run in the Video on Demand Delivery Test.*
- 2. The human readable SPC-2 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 (intervals), Average Data Rate per Stream (intervals), and Average Response Time (intervals) 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, which will utilize the format defined in Clause 10.1.6, substituting maximum Response Time data for average Response Time data.*

SPC-2 Workload Generator Commands and Parameters

The SPC-2 Workload Generator commands and parameters for the Video on Demand Delivery Test Run are documented in “Appendix E: SPC-2 Workload Generator Execution Commands and Parameters” on Page 105.

SPC-2 Test Results File

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

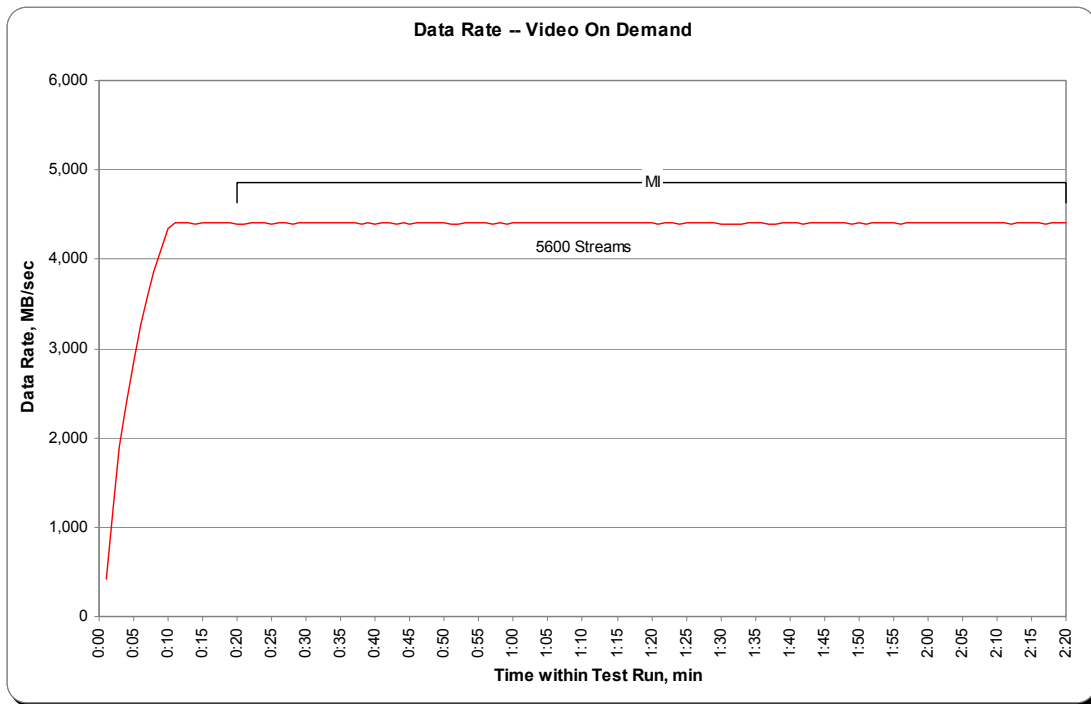
[SPC-2 Video on Demand Delivery Test Results File](#)

SPC-2 Video on Demand Delivery Test Run Data

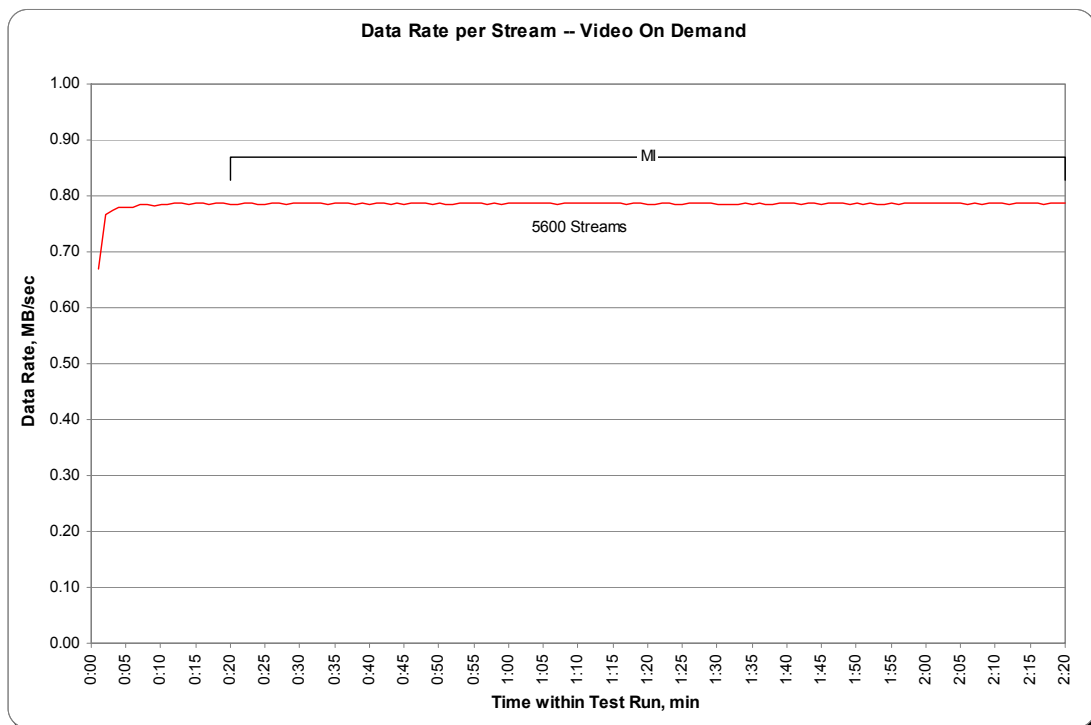
The number of Streams specified, Ramp-Up duration in seconds, Measurement Interval duration in seconds, average Data Rate for the Measurement Interval, and average Data Rate per Stream for the Measurement Interval are listed in the following table.

| SPC-2-VOD | TR1 |
|-------------------------------|----------|
| Number of Streams | 5600 |
| Ramp-up Time, sec | 1200 |
| Measurement Interval, sec | 7200 |
| Average Data Rate, MB/sec | 4,404.00 |
| Per Stream Data Rate, MB/sec | 0.79 |
| Average Response Time, ms | 2.55 |
| Average Max Response Time, ms | 417.14 |

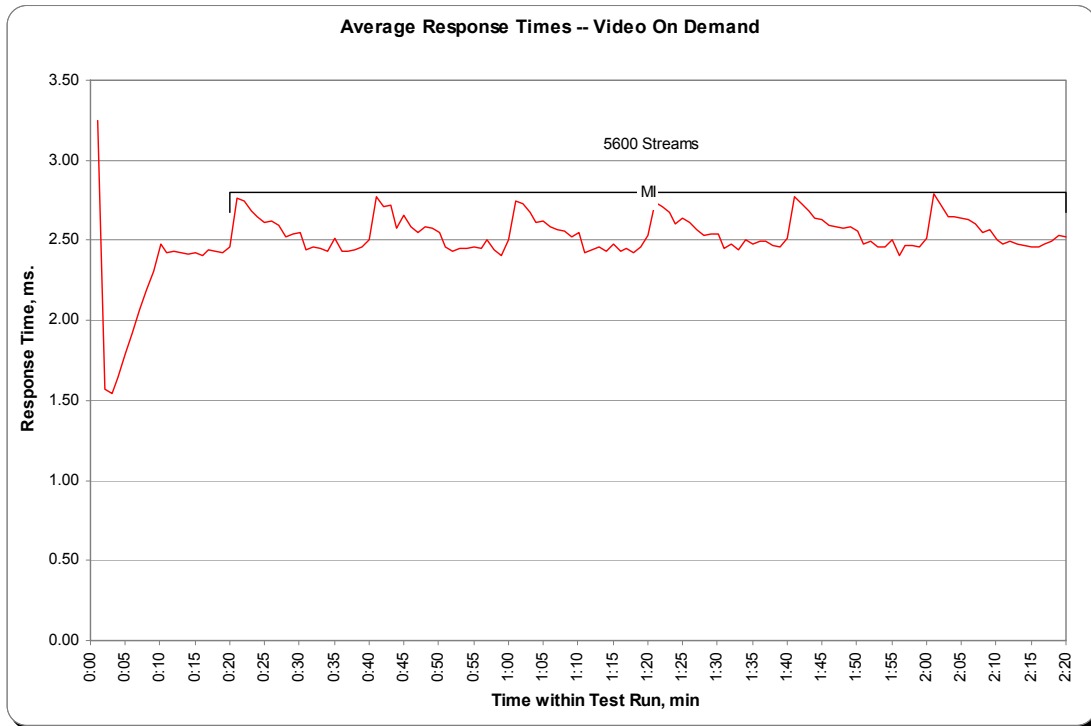
SPC-2 Video on Demand Delivery Average Data Rate Graph



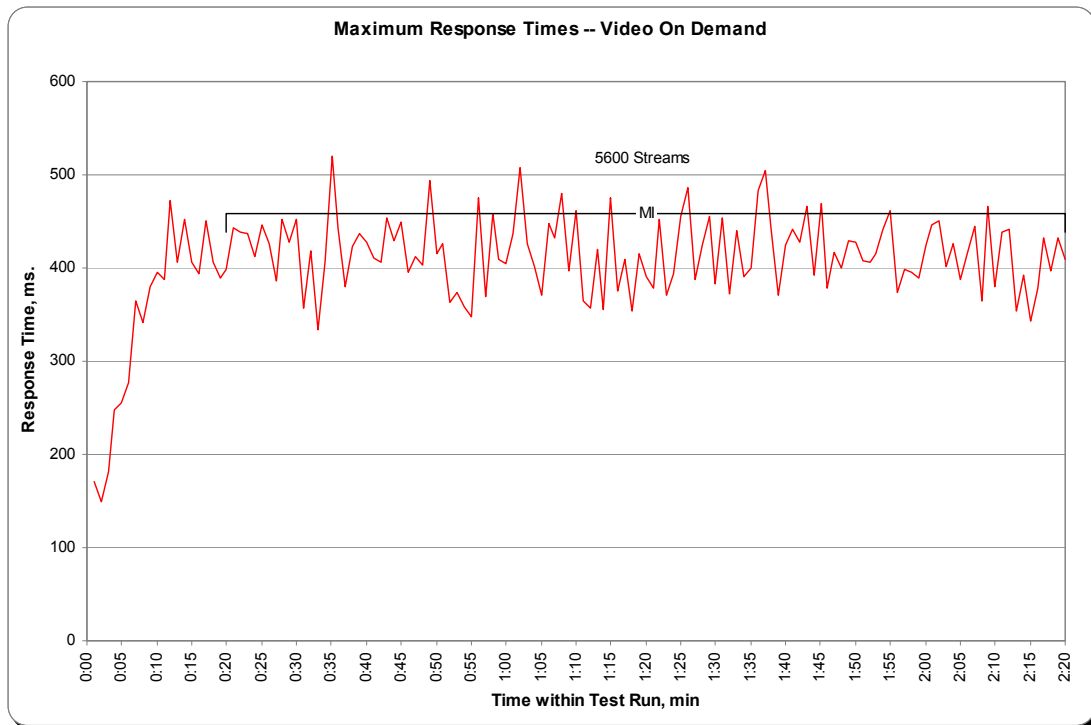
SPC-2 Video on Demand Delivery Average Data Rate per Stream Graph



SPC-2 Video on Demand Delivery Average Response Time Graph



SPC-2 Video on Demand Delivery Maximum Response Time Graph



Data Persistence Test

Clause 6

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-2 Workload Generator will write a specific pattern at randomly selected locations throughout the Total ASU Capacity (Persistence Test Run 1). The SPC-2 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-2 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 10.6.8.4

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

1. *A listing of the SPC-2 Workload Generator commands and parameters used to execute each of the Test Runs in the Persistence Test.*
2. *The human readable SPC-2 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-2 Workload Generator Commands and Parameters

The SPC-2 Workload Generator commands and parameters for the Persistence Test Runs are documented in “Appendix E: SPC-2 Workload Generator Execution Commands and Parameters” on Page 105.

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 | 2,945,331 |
| Total Number of Logical Blocks Re-referenced | 29,938 |
| Total Number of Logical Blocks Verified | 2,945,331 |
| 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 10.6.9

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 FDR shall state: “The **Priced Storage Configuration**, as documented in this Full Disclosure Report will be available for shipment to customers on MMMM DD, YYYY.” Where **Priced Storage Configuration** is the Priced Storage Configuration Name as described in Clause 10.6.5.3, #1 and MM is month, DD is the day, and YY is the year of the date that the Priced Storage Configuration, as documented, is available for shipment to customers as described above.*

The IBM XIV® Storage System Gen3, as documented in this SPC-2 Full Disclosure Report, will become available on October 31, 2011 for customer purchase and shipment.

ANOMALIES OR IRREGULARITIES

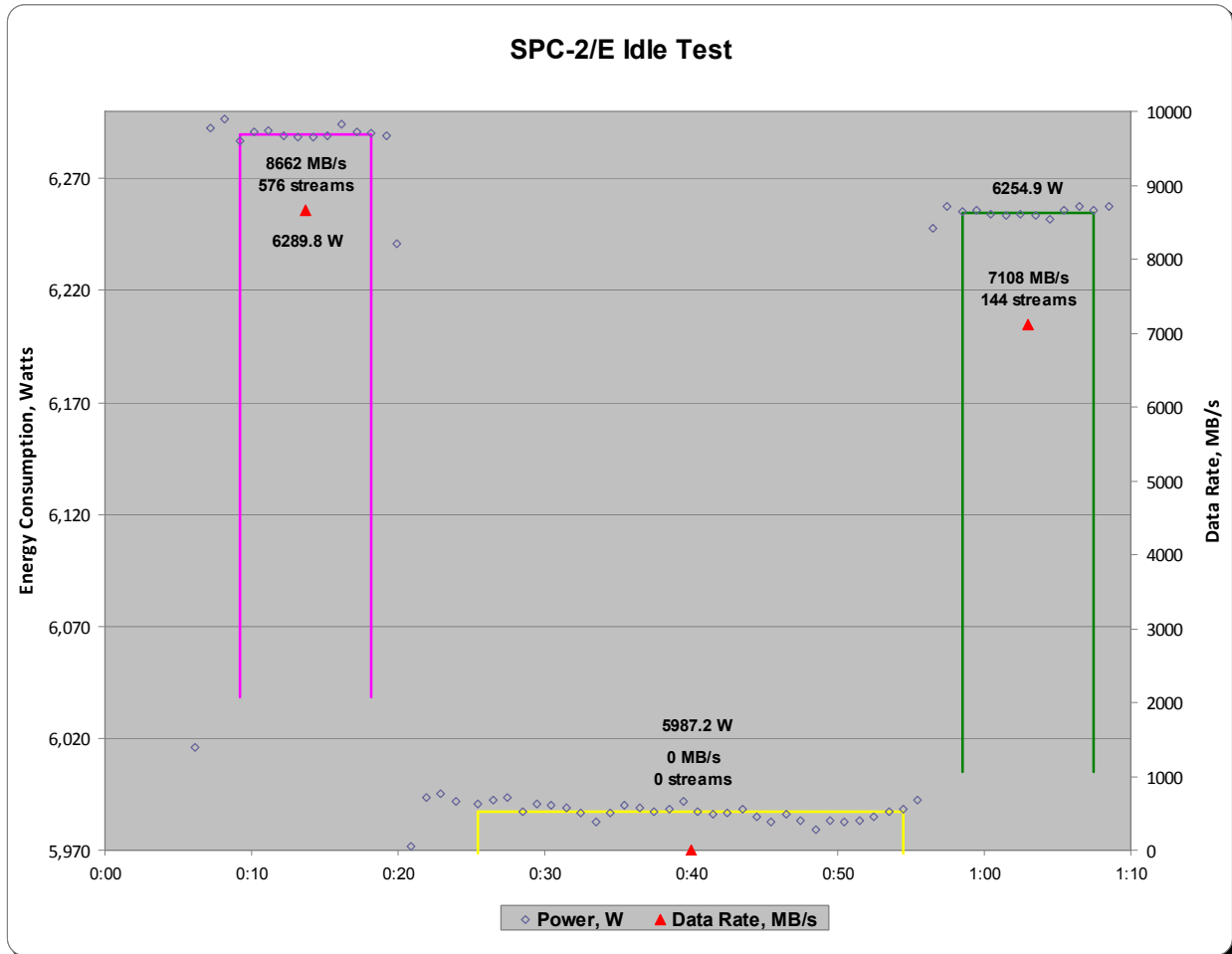
Clause 10.6.11

The FDR shall include a clear and complete description of any anomalies or irregularities encountered in the course of executing the SPC-2 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-2 Onsite Audit of the IBM XIV® Storage System Gen3.

SPC-2/E REPORTED DATA AND CHARTS

SPC-2/E Idle Test Chart and Data Table



| Test Run | Average Power (Watts) | Data Rate (MB/s) |
|-------------------------------------|-----------------------|------------------|
| Pre Idle - 576 streams, Read/Write | 6,289.8 | 8,662 |
| Idle - 0 streams, | 5,987.2 | 0 |
| Post Idle - 144 streams, Read/Write | 6,254.9 | 7,108 |

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

Power Environment

Average RMS Voltage: 209.83 Average Power Factor: 0.978

| | Usage Profile | | | Nominal | | | |
|---------------------|----------------------|----------|------|----------------|-----------------|-----------------|------------------|
| | Hours of Use per Day | | | Power watts | Traffic MBPS | Ratio MBPS/w | Heat BTU/hr |
| | Heavy | Moderate | Idle | | | | |
| Low Daily Usage: | 0 | 8 | 16 | 6068.44 | 2426.97 | 0.40 | 20,706.12 |
| Medium Daily Usage: | 4 | 14 | 6 | 6177.86 | 5690.73 | 0.92 | 21,079.46 |
| High Daily Usage: | 18 | 6 | 0 | 6266.34 | 8316.11 | 1.33 | 21,381.36 |

Composite Metrics: 6,170.88 5,477.94 0.89

Annual Energy Use, kWh: 54,056.88
 Energy Cost, \$/kWh: \$ 0.12 Annual Energy Cost, \$: \$ 6,486.83

HEAVY SPC-2 LFP Workload: 6,278.14W at a data rate of 8,661.17 MB/s.

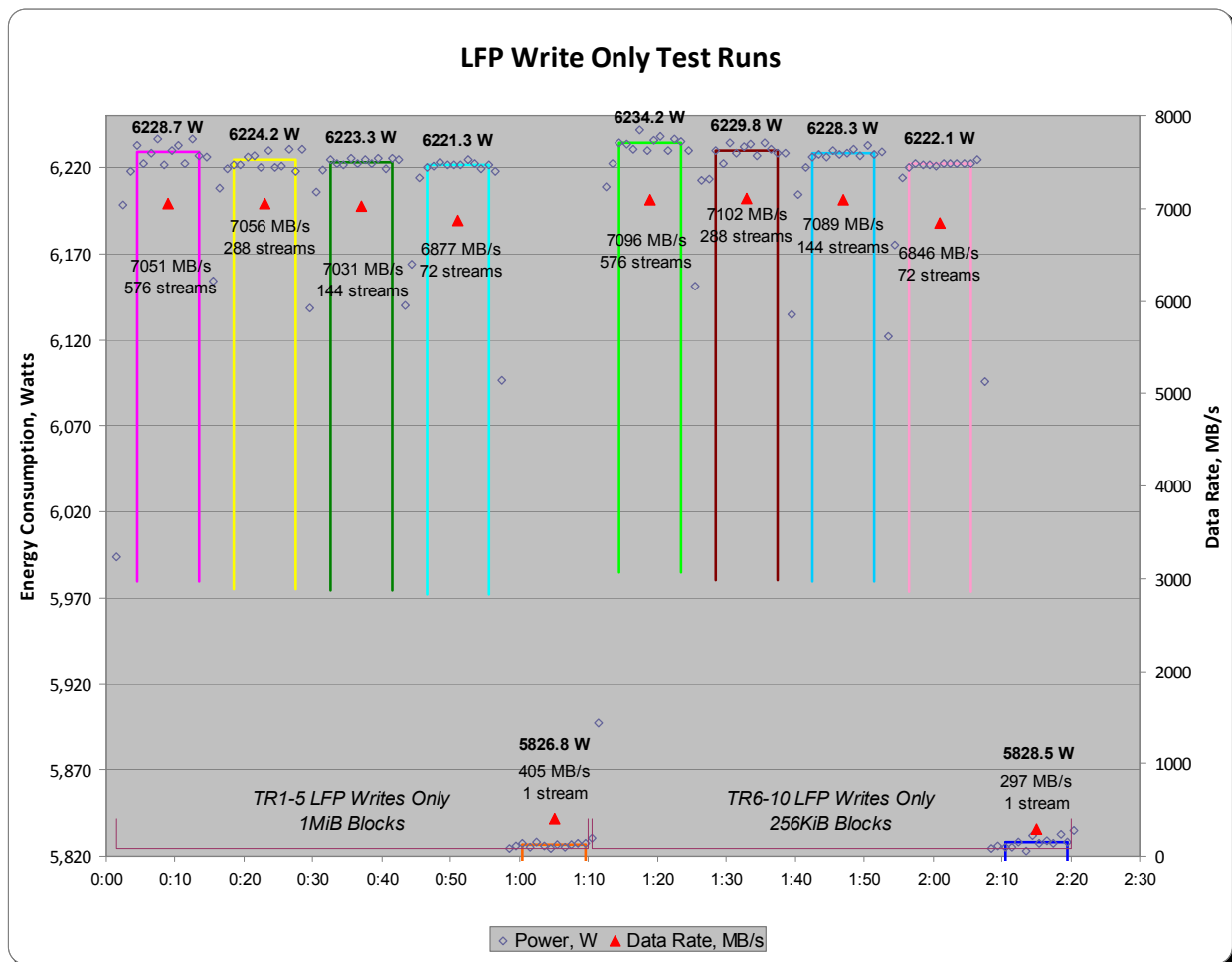
MODERATE SPC-2 LFP Workload: 6,230.91W at a data rate of 7,280.92 MB/s

IDLE SPC-2 LFP Workload: 5,987.20W 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-2 Large File Processing (LFP) workload.

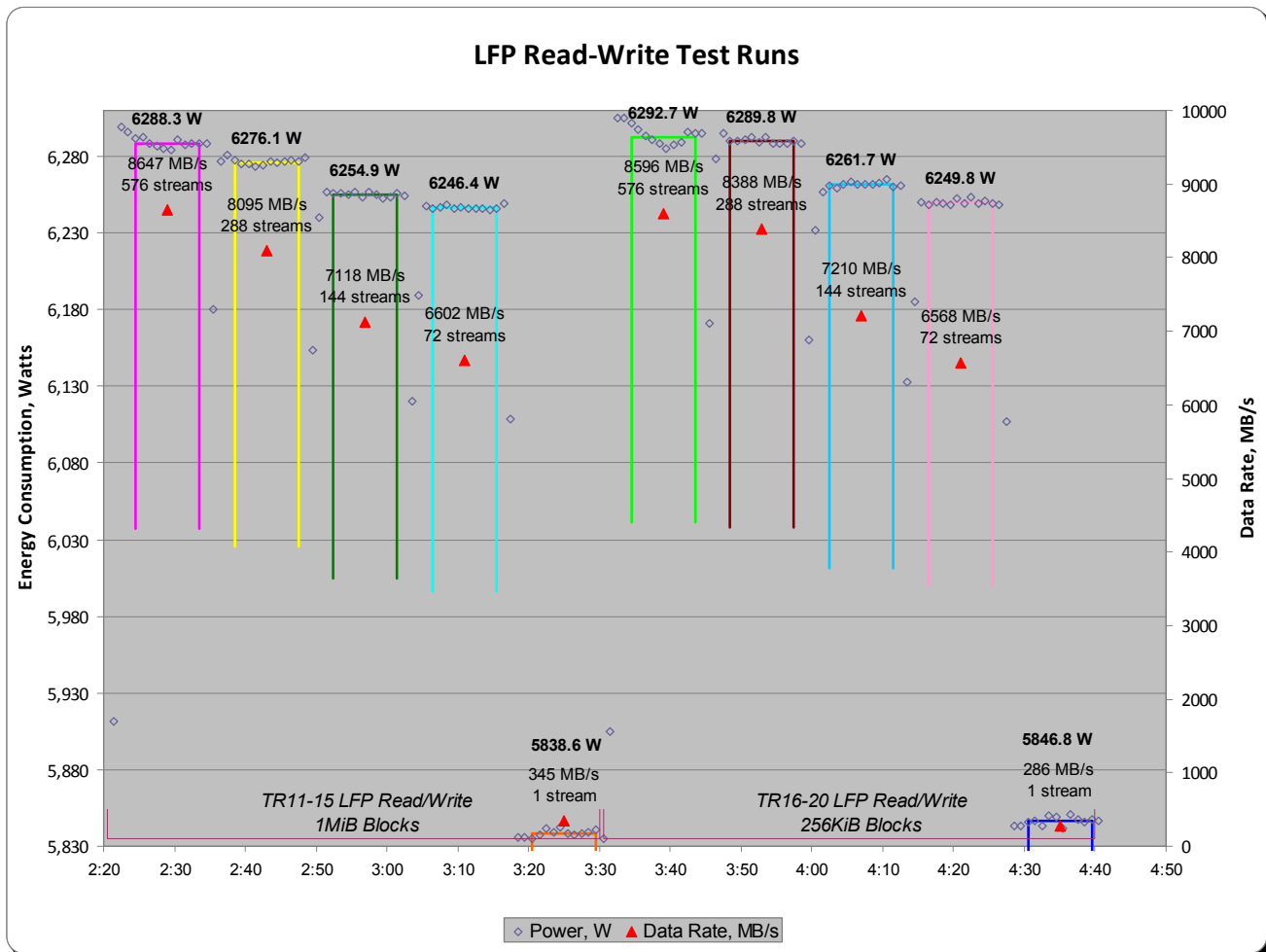
The definitions for the remaining items in the above LFP SPC-2/E Reported Data table are available on at the following location in the Executive Summary portion of this document: [reported data definitions](#).

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



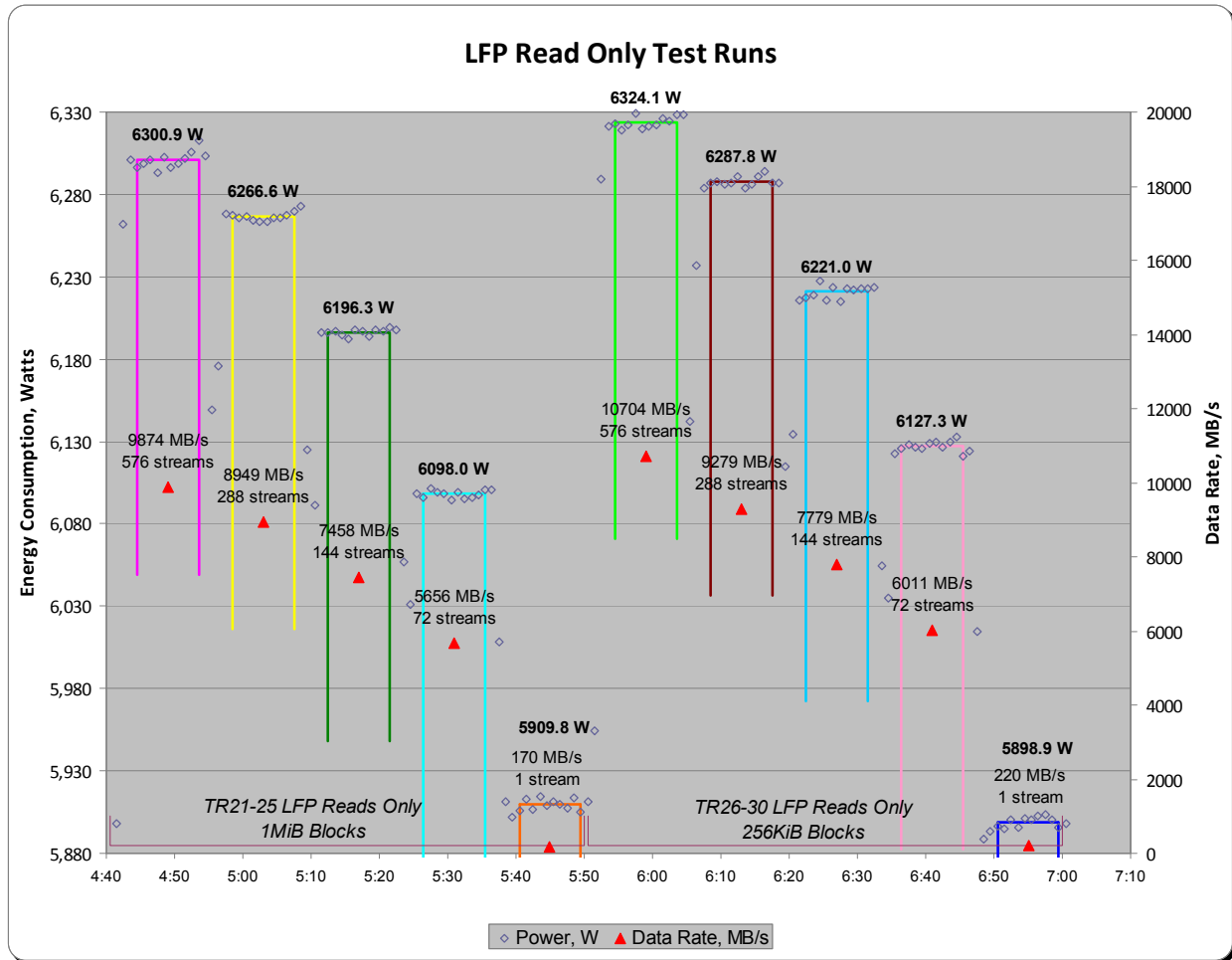
| Test Run (TR) | Average Power Watts | Data Rate MB/s |
|---------------------------------|------------------------|-------------------|
| TR1 - 576 streams, 1MB Writes | 6,228.7 | 7,051 |
| TR2 - 288 streams, 1MB Writes | 6,224.2 | 7,056 |
| TR3 - 144 streams, 1MB Writes | 6,223.3 | 7,031 |
| TR4 - 72 streams, 1MB Writes | 6,221.3 | 6,877 |
| TR5 - 1 streams, 1MB Writes | 5,826.8 | 405 |
| TR6 - 576 streams, 256KB Writes | 6,234.2 | 7,096 |
| TR7 - 288 streams, 256KB Writes | 6,229.8 | 7,102 |
| TR8 - 144 streams, 256KB Writes | 6,228.3 | 7,089 |
| TR9 - 72 streams, 256KB Writes | 6,222.1 | 6,846 |
| TR10 - 1 streams, 256KB Writes | 5,828.5 | 297 |

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



| Test Run (TR) | Average Power (Watts) | Data Rate (MB/s) |
|---------------------------------------|-----------------------|------------------|
| TR11 - 576 streams, 1MB Read/Writes | 6,288.3 | 8,647 |
| TR12 - 288 streams, 1MB Read/Writes | 6,276.1 | 8,095 |
| TR13 - 144 streams, 1MB Read/Writes | 6,254.9 | 7,118 |
| TR14 - 72 streams, 1MB Read/Writes | 6,246.4 | 6,602 |
| TR15 - 1 streams, 1 MB Read/Writes | 5,838.6 | 345 |
| TR16 - 576 streams, 256KB Read/Writes | 6,292.7 | 8,596 |
| TR17 - 288 streams, 256KB Read/Writes | 6,289.8 | 8,388 |
| TR18 - 144 streams, 256KB Read/Writes | 6,261.7 | 7,210 |
| TR19 - 72 streams, 256KB Read/Writes | 6,249.8 | 6,568 |
| TR20 - 1 streams, 256 KB Read/Writes | 5,846.8 | 286 |

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



| Test Run (TR) | Average Power (Watts) | Data Rate (MB/s) |
|---------------------------------|-----------------------|------------------|
| TR21 - 576 streams, 1MB Reads | 6,300.9 | 9,874 |
| TR22 - 288 streams, 1MB Reads | 6,266.6 | 8,949 |
| TR23 - 144 streams, 1MB Reads | 6,196.3 | 7,458 |
| TR24 - 72 streams, 1MB Reads | 6,098.0 | 5,656 |
| TR25 - 1 streams, 1MB Reads | 5,909.8 | 170 |
| TR26 - 576 streams, 256KB Reads | 6,324.1 | 10,704 |
| TR27 - 288 streams, 256KB Reads | 6,287.8 | 9,279 |
| TR28 - 144 streams, 256KB Reads | 6,221.0 | 7,779 |
| TR29 - 72 streams, 256KB Reads | 6,127.3 | 6,011 |
| TR30 - 1 streams, 256KB Reads | 5,898.9 | 220 |

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

| | Usage Profile | | | Nominal | | | Heat BTU/hr |
|---------------------------|----------------------|----------|------|-------------------------|-----------------|-----------------|--------------------|
| | Hours of Use per Day | | | Power watts | Traffic MBPS | Ratio MBPS/w | |
| | Heavy | Moderate | Idle | | | | |
| Low Daily Usage: | 0 | 8 | 16 | 6065.96 | 2590.30 | 0.43 | 20,697.66 |
| Medium Daily Usage: | 4 | 14 | 6 | 6180.23 | 6235.22 | 1.01 | 21,087.55 |
| High Daily Usage: | 18 | 6 | 0 | 6294.69 | 9602.59 | 1.53 | 21,478.10 |
| Composite Metrics: | | | | 6,180.29 | 6,142.70 | 0.99 | |
| Annual Energy Use, kWh: | 54,139.35 | | | | | | |
| Energy Cost, \$/kWh: | \$ 0.12 | | | Annual Energy Cost, \$: | | | \$ 6,496.72 |

HEAVY SPC-2 LDQ Workload: 6,318.43W at a data rate of 10,213.16 MB/s.

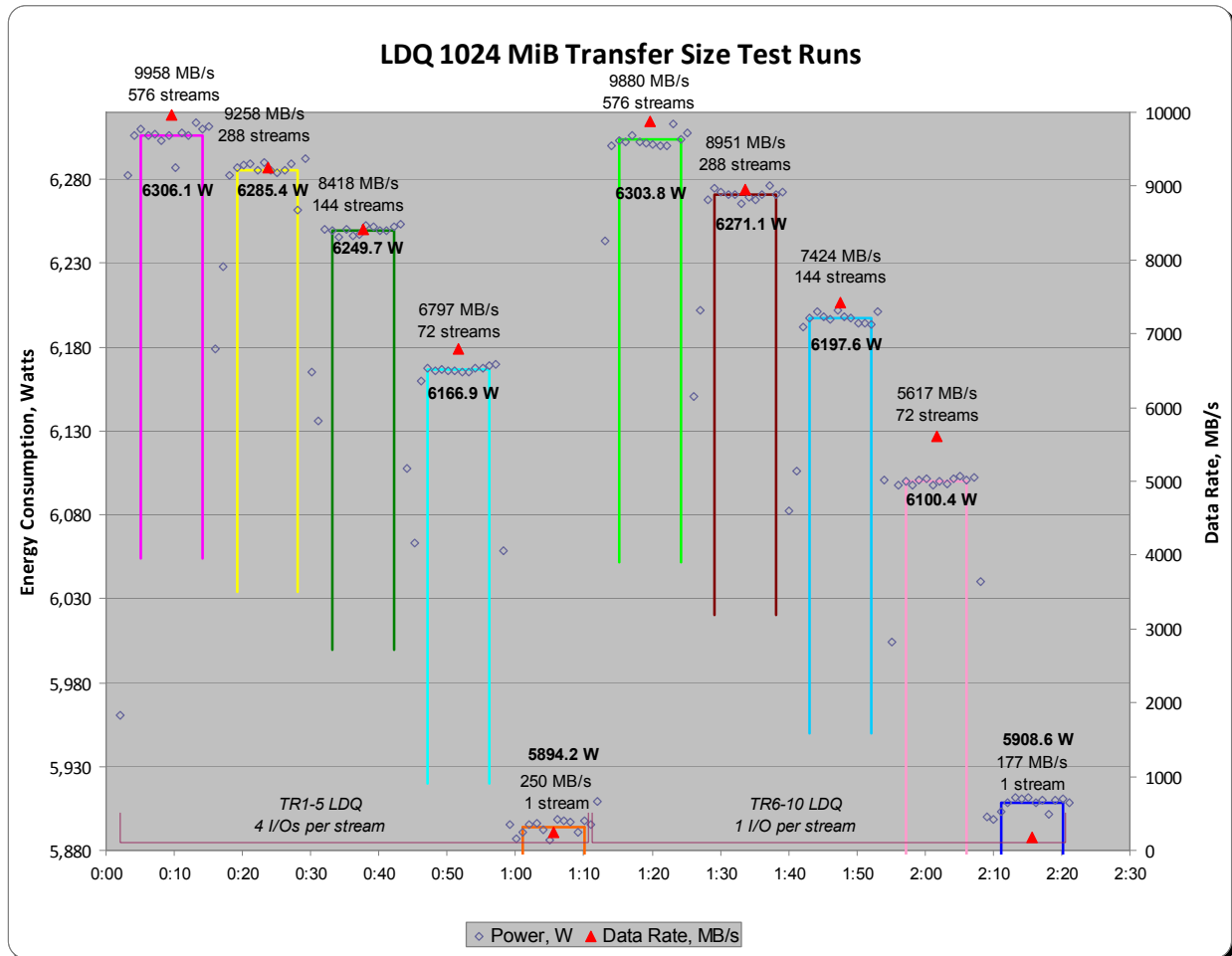
MODERATE SPC-2 LDQ Workload: 6,223.47W at a data rate of 7,770.90 MB/s

IDLE SPC-2 LDQ Workload: 5,987.20W 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-2 Large Database Query (LDQ) workload.

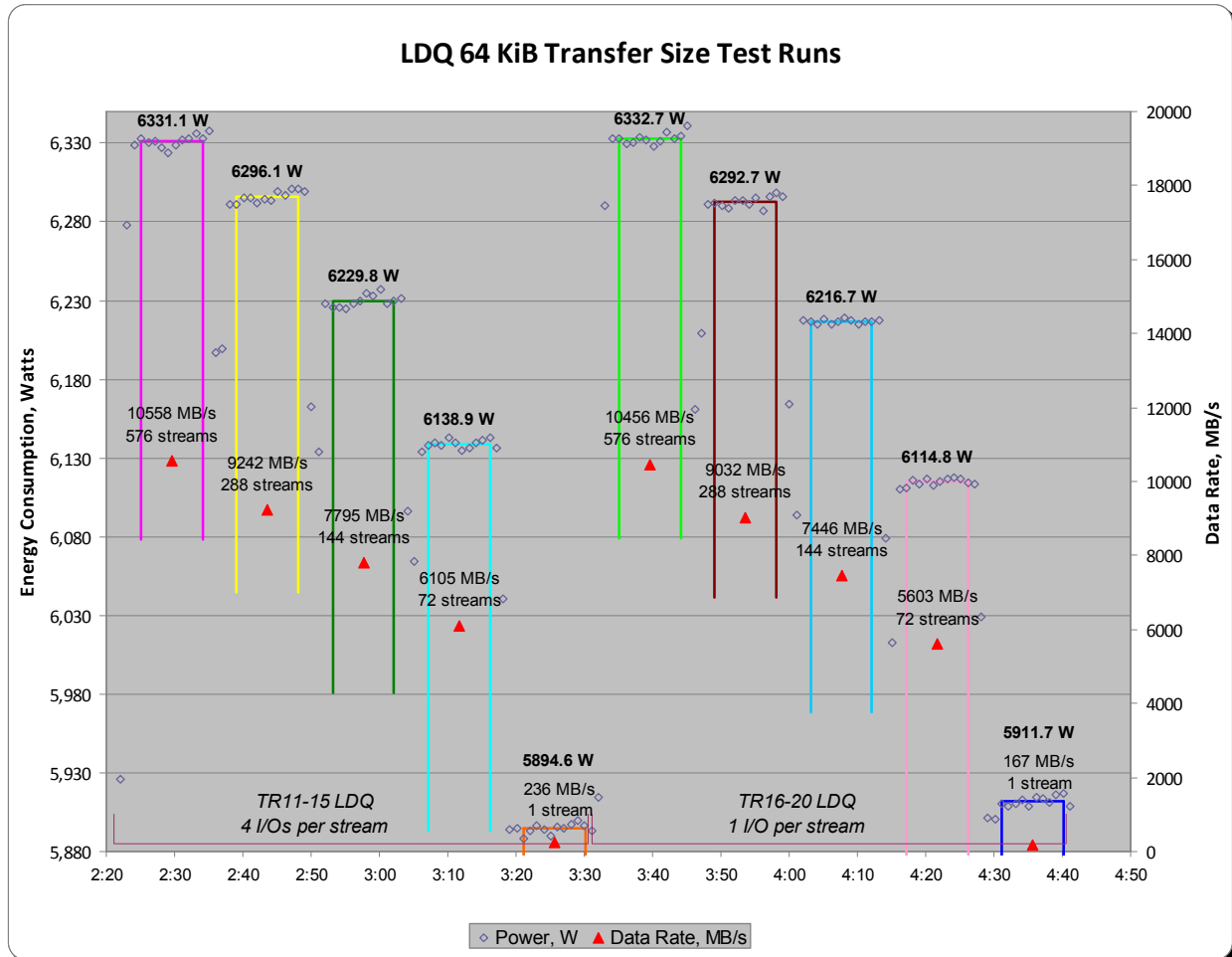
The definitions for the remaining items in the above LDQ SPC-2/E Reported Data table are available on at the following location in the Executive Summary portion of this document: [reported data definitions](#).

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



| Test Run (TR) | Average Power (Watts) | Data Rate (MB/s) |
|-------------------------------|-----------------------|------------------|
| TR1 - 576 streams, 4x1MB I/Os | 6,306.1 | 9,958 |
| TR2 - 288 streams, 4x1MB I/Os | 6,285.4 | 9,258 |
| TR3 - 144 streams, 4x1MB I/Os | 6,249.7 | 8,418 |
| TR4 - 72 streams, 4x1MB I/Os | 6,166.9 | 6,797 |
| TR5 - 1 streams, 4x1MB I/Os | 5,894.2 | 250 |
| TR6 - 576 streams, 1x1MB I/Os | 6,303.8 | 9,880 |
| TR7 - 288 streams, 1x1MB I/Os | 6,271.1 | 8,951 |
| TR8 - 144 streams, 1x1MB I/Os | 6,197.6 | 7,424 |
| TR9 - 72 streams, 1x1MB I/Os | 6,100.4 | 5,617 |
| TR10 - 1 streams, 1x1MB I/Os | 5,908.6 | 177 |

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 - 576 streams, 4x1MB I/Os | 6,331.1 | 10,558 |
| TR12 - 288 streams, 4x1MB I/Os | 6,296.1 | 9,242 |
| TR13 - 144 streams, 4x1MB I/Os | 6,229.8 | 7,795 |
| TR14 - 72 streams, 4x1MB I/Os | 6,138.9 | 6,105 |
| TR15 - 1 streams, 4x1MB I/Os | 5,894.6 | 236 |
| TR16 - 576 streams, 1x1MB I/Os | 6,332.7 | 10,456 |
| TR17 - 288 streams, 1x1MB I/Os | 6,292.7 | 9,032 |
| TR18 - 144 streams, 1x1MB I/Os | 6,216.7 | 7,446 |
| TR19 - 72 streams, 1x1MB I/Os | 6,114.8 | 5,603 |
| TR20 - 1 streams, 1x1MB I/Os | 5,911.7 | 167 |

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

| | Usage Profile | | | Nominal | | | Heat BTU/hr |
|---------------------|----------------------|----------|------|----------------|-----------------|-----------------|----------------|
| | Hours of Use per Day | | | Power watts | Traffic MBPS | Ratio MBPS/w | |
| | Heavy | Moderate | Idle | | | | |
| Low Daily Usage: | 0 | 8 | 16 | 6013.59 | 1539.31 | 0.26 | 20,518.97 |
| Medium Daily Usage: | 4 | 14 | 6 | 6046.57 | 3463.45 | 0.57 | 20,631.50 |
| High Daily Usage: | 18 | 6 | 0 | 6066.36 | 4617.93 | 0.76 | 20,699.02 |

| | | | | |
|--------------------------------|-----------|--------------------------------|--------------------|-------------|
| Composite Metrics: | | 6,042.17 | 3,206.90 | 0.53 |
| Annual Energy Use, kWh: | 52,929.42 | | | |
| Energy Cost, \$/kWh: | \$ 0.12 | Annual Energy Cost, \$: | \$ 6,351.53 | |

HEAVY SPC-2 VOD Workload: 6,066.36W at a data rate of 4,617.93 MB/s.

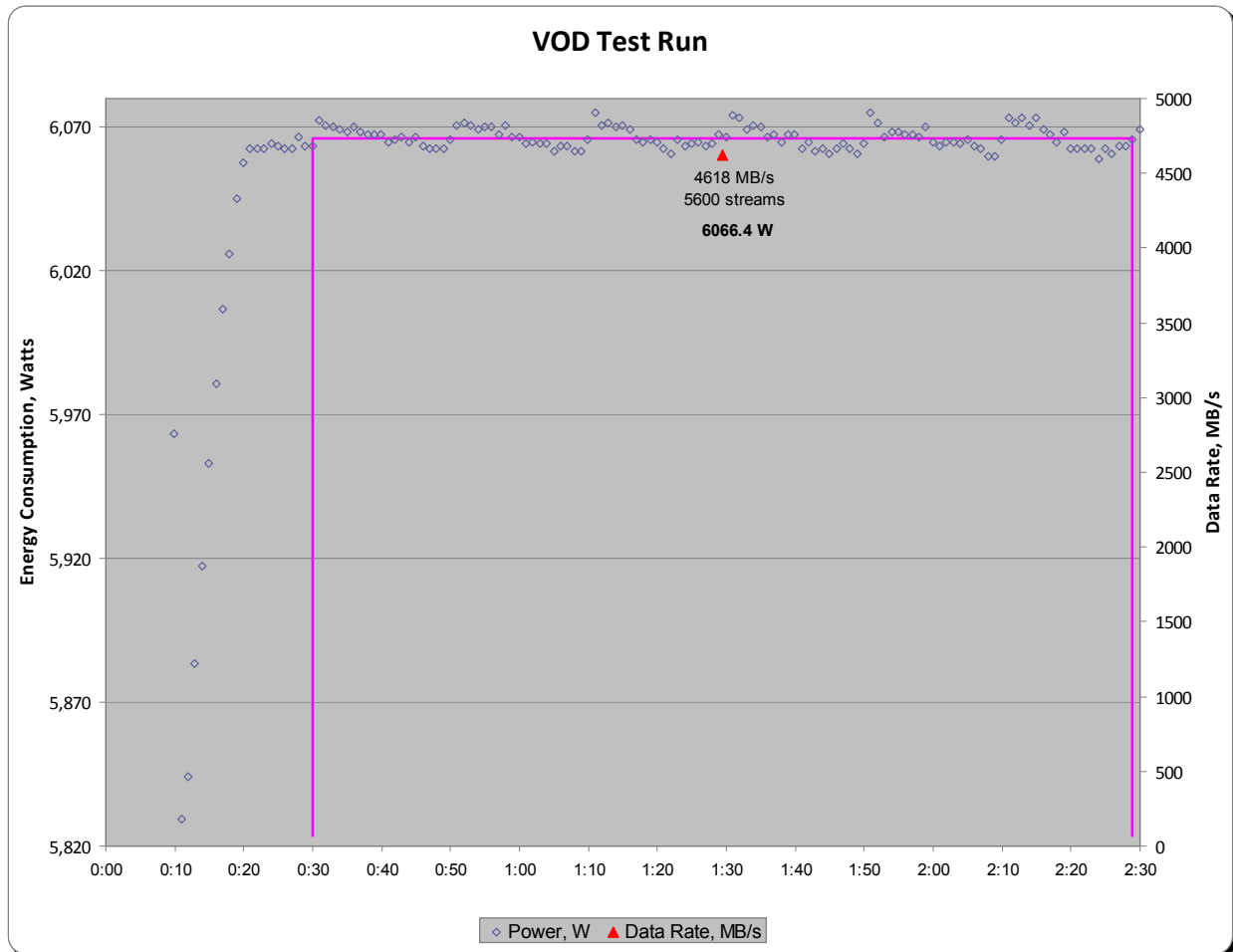
MODERATE SPC-2 VOD Workload: 6,066.36W at a data rate of 4,617.93 MB/s

IDLE SPC-2 VOD Workload: 5,987.20W 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-2 Video on Demand Delivery (VOD) workload.

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

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



| Test Run (TR) | Average Power (Watts) | Data Rate (MB/s) |
|---------------------|-----------------------|------------------|
| TR1 - 5600 streams, | 6,066.4 | 4,618 |

APPENDIX A: SPC-2 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 gibibyte (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-2 Data Repository Definitions

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

Application Storage Unit (ASU): The logical interface between the storage and SPC-2 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-2 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-2 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-2 Data Protection Levels

RAID5: User data is distributed across the disks in the array. Check data corresponding to user data is distributed across multiple disks in the form of bit-by-bit parity.

Mirroring: Two or more identical copies of user data are maintained on separate disks.

Other Protection Level: Any data protection other than **RAID5** or **Mirroring**.

Unprotected: There is no data protection provided.

SPC-2 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-2 Test Run divided by the length of the Test Run in seconds.

Failed I/O Request: Any I/O Request issued by the SPC-2 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-2 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-2 Test Run (see “SPC-2 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-2 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-2 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-2 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-2 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-2 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-2 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-2 Test Runs sharing a common objective and intended to be run in a specific sequence.

Test Run: The execution of SPC-2 that produces specific SPC-2 test results. SPC-2 Test Runs have specified, measured Ramp-Up, Measurement Interval, Run-Out and Ramp-Down periods. “SPC-2 Test Run Components” (*see below*) illustrates the Ramp-Up, Steady State, Measurement Interval, Run-Out, and Ramp-Down components contained in two uninterrupted SPC-2 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:

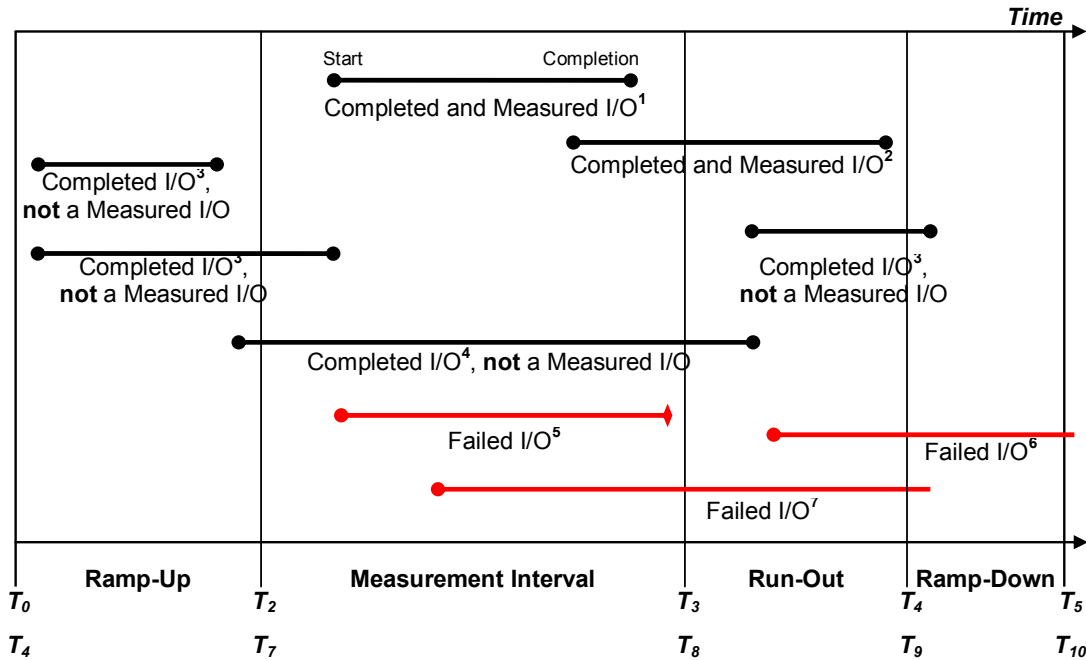
- Test Run 1: Maximum number of Streams, which is selected by the Test Sponsor
- Test Run 2: 50% of the maximum number of Streams used in Test Run 1.
- Test Run 3: 25% of the maximum number of Streams used in Test Run 1.
- Test Run 4: 12.5% of the maximum number of Streams used in Test Run 1.
- Test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

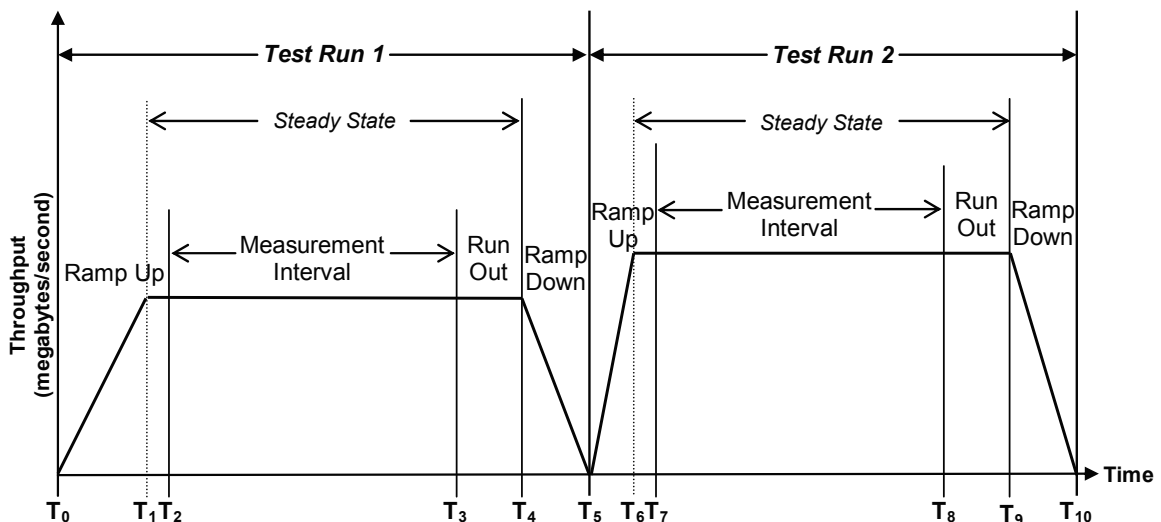
Transfer Size: The Transfer Size parameter specifies the number of bytes in KiB to transfer. (*Clause 3.4.7 of the SPC-2 Benchmark Specification*)

I/O Completion Types



Completed and Measured I/O¹: I/O started and completed within the Measurement Interval.
Completed and Measured I/O²: I/O started within the Measurement Interval and completed within Ramp Down.
Completed I/O³: I/O started before or after the Measurement Interval – not measured.
Completed I/O⁴: I/O started before and completed after the Measurement Interval – not measured.
Failed I/O⁵: Signaled as failed by System Software.
Failed I/O⁶: I/O did not complete prior to the end of Ramp-Down.
Failed I/O⁷: I/O did not complete prior to the end of Run-Out.

SPC-2 Test Run Components



APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

The queue depth of each LUN was set to 256 from a default value of 32. The maximum transfer size of LUN was explicitly set to 1 MiB, which is the default value of the parameter.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

The creation and configuration of the TSC was done with XCLI, which is a command line interface utility for XIV management. The utility must be executed on a supported host platform (AXI, Linux or Windows) that can communicate with the XIV system via TCP/IP.

The following are the specific steps and XCLI commands used:

Step 1. Create two storage pools, each with capacity 79,656 GB

```
pool_create pool=pool1 size=79656 snapshot_size=0
pool_create pool=pool2 size=79656 snapshot_size=0
```

Step 2. Create 45 volumes in each pool (*volume capacity 1,755 GB*)

```
vol_create vol=regress_01 size=1755 pool=pool1
vol_create vol=regress_02 size=1755 pool=pool1
vol_create vol=regress_03 size=1755 pool=pool1
vol_create vol=regress_04 size=1755 pool=pool1
vol_create vol=regress_05 size=1755 pool=pool1
vol_create vol=regress_06 size=1755 pool=pool1
vol_create vol=regress_07 size=1755 pool=pool1
vol_create vol=regress_08 size=1755 pool=pool1
vol_create vol=regress_09 size=1755 pool=pool1
vol_create vol=regress_10 size=1755 pool=pool1
vol_create vol=regress_11 size=1755 pool=pool1
vol_create vol=regress_12 size=1755 pool=pool1
vol_create vol=regress_13 size=1755 pool=pool1
vol_create vol=regress_14 size=1755 pool=pool1
vol_create vol=regress_15 size=1755 pool=pool1
vol_create vol=regress_16 size=1755 pool=pool1
vol_create vol=regress_17 size=1755 pool=pool1
vol_create vol=regress_18 size=1755 pool=pool1
vol_create vol=regress_19 size=1755 pool=pool1
vol_create vol=regress_20 size=1755 pool=pool1
vol_create vol=regress_21 size=1755 pool=pool1
vol_create vol=regress_22 size=1755 pool=pool1
vol_create vol=regress_23 size=1755 pool=pool1
vol_create vol=regress_24 size=1755 pool=pool1
vol_create vol=regress_25 size=1755 pool=pool1
vol_create vol=regress_26 size=1755 pool=pool1
vol_create vol=regress_27 size=1755 pool=pool1
vol_create vol=regress_28 size=1755 pool=pool1
vol_create vol=regress_29 size=1755 pool=pool1
vol_create vol=regress_30 size=1755 pool=pool1
vol_create vol=regress_31 size=1755 pool=pool1
vol_create vol=regress_32 size=1755 pool=pool1
vol_create vol=regress_33 size=1755 pool=pool1
vol_create vol=regress_34 size=1755 pool=pool1
vol_create vol=regress_35 size=1755 pool=pool1
vol_create vol=regress_36 size=1755 pool=pool1
vol_create vol=regress_37 size=1755 pool=pool1
vol_create vol=regress_38 size=1755 pool=pool1
vol_create vol=regress_39 size=1755 pool=pool1
vol_create vol=regress_40 size=1755 pool=pool1
vol_create vol=regress_41 size=1755 pool=pool1
vol_create vol=regress_42 size=1755 pool=pool1
vol_create vol=regress_43 size=1755 pool=pool1
vol_create vol=regress_44 size=1755 pool=pool1
vol_create vol=regress_45 size=1755 pool=pool1
```

```
vol_create vol=regress_46 size=1755 pool=pool2
vol_create vol=regress_47 size=1755 pool=pool2
vol_create vol=regress_48 size=1755 pool=pool2
vol_create vol=regress_49 size=1755 pool=pool2
vol_create vol=regress_50 size=1755 pool=pool2
vol_create vol=regress_51 size=1755 pool=pool2
vol_create vol=regress_52 size=1755 pool=pool2
vol_create vol=regress_53 size=1755 pool=pool2
vol_create vol=regress_54 size=1755 pool=pool2
vol_create vol=regress_55 size=1755 pool=pool2
vol_create vol=regress_56 size=1755 pool=pool2
vol_create vol=regress_57 size=1755 pool=pool2
vol_create vol=regress_58 size=1755 pool=pool2
vol_create vol=regress_59 size=1755 pool=pool2
vol_create vol=regress_60 size=1755 pool=pool2
vol_create vol=regress_61 size=1755 pool=pool2
vol_create vol=regress_62 size=1755 pool=pool2
vol_create vol=regress_63 size=1755 pool=pool2
vol_create vol=regress_64 size=1755 pool=pool2
vol_create vol=regress_65 size=1755 pool=pool2
vol_create vol=regress_66 size=1755 pool=pool2
vol_create vol=regress_67 size=1755 pool=pool2
vol_create vol=regress_68 size=1755 pool=pool2
vol_create vol=regress_69 size=1755 pool=pool2
vol_create vol=regress_70 size=1755 pool=pool2
vol_create vol=regress_71 size=1755 pool=pool2
vol_create vol=regress_72 size=1755 pool=pool2
vol_create vol=regress_73 size=1755 pool=pool2
vol_create vol=regress_74 size=1755 pool=pool2
vol_create vol=regress_75 size=1755 pool=pool2
vol_create vol=regress_76 size=1755 pool=pool2
vol_create vol=regress_77 size=1755 pool=pool2
vol_create vol=regress_78 size=1755 pool=pool2
vol_create vol=regress_79 size=1755 pool=pool2
vol_create vol=regress_80 size=1755 pool=pool2
vol_create vol=regress_81 size=1755 pool=pool2
vol_create vol=regress_82 size=1755 pool=pool2
vol_create vol=regress_83 size=1755 pool=pool2
vol_create vol=regress_84 size=1755 pool=pool2
vol_create vol=regress_85 size=1755 pool=pool2
vol_create vol=regress_86 size=1755 pool=pool2
vol_create vol=regress_87 size=1755 pool=pool2
vol_create vol=regress_88 size=1755 pool=pool2
vol_create vol=regress_89 size=1755 pool=pool2
vol_create vol=regress_90 size=1755 pool=pool2
```

Step 3. Define 3 hosts which will have access to the volumes

```
host_define host=perfsh6
host_define host=perfsh3a
host_define host=perfsh3b
```

Step 4. Define mappings such that each host has access to each volume

```
map_vol host=perfsh6 vol=regress_01 lun=1
map_vol host=perfsh6 vol=regress_02 lun=2
map_vol host=perfsh6 vol=regress_03 lun=3
map_vol host=perfsh6 vol=regress_04 lun=4
map_vol host=perfsh6 vol=regress_05 lun=5
map_vol host=perfsh6 vol=regress_06 lun=6
```

```
map_vol host=perfsh6 vol=regress_07 lun=7
map_vol host=perfsh6 vol=regress_08 lun=8
map_vol host=perfsh6 vol=regress_09 lun=9
map_vol host=perfsh6 vol=regress_10 lun=10
map_vol host=perfsh6 vol=regress_11 lun=11
map_vol host=perfsh6 vol=regress_12 lun=12
map_vol host=perfsh6 vol=regress_13 lun=13
map_vol host=perfsh6 vol=regress_14 lun=14
map_vol host=perfsh6 vol=regress_15 lun=15
map_vol host=perfsh6 vol=regress_16 lun=16
map_vol host=perfsh6 vol=regress_17 lun=17
map_vol host=perfsh6 vol=regress_18 lun=18
map_vol host=perfsh6 vol=regress_19 lun=19
map_vol host=perfsh6 vol=regress_20 lun=20
map_vol host=perfsh6 vol=regress_21 lun=21
map_vol host=perfsh6 vol=regress_22 lun=22
map_vol host=perfsh6 vol=regress_23 lun=23
map_vol host=perfsh6 vol=regress_24 lun=24
map_vol host=perfsh6 vol=regress_25 lun=25
map_vol host=perfsh6 vol=regress_26 lun=26
map_vol host=perfsh6 vol=regress_27 lun=27
map_vol host=perfsh6 vol=regress_28 lun=28
map_vol host=perfsh6 vol=regress_29 lun=29
map_vol host=perfsh6 vol=regress_30 lun=30
map_vol host=perfsh6 vol=regress_31 lun=31
map_vol host=perfsh6 vol=regress_32 lun=32
map_vol host=perfsh6 vol=regress_33 lun=33
map_vol host=perfsh6 vol=regress_34 lun=34
map_vol host=perfsh6 vol=regress_35 lun=35
map_vol host=perfsh6 vol=regress_36 lun=36
map_vol host=perfsh6 vol=regress_37 lun=37
map_vol host=perfsh6 vol=regress_38 lun=38
map_vol host=perfsh6 vol=regress_39 lun=39
map_vol host=perfsh6 vol=regress_40 lun=40
map_vol host=perfsh6 vol=regress_41 lun=41
map_vol host=perfsh6 vol=regress_42 lun=42
map_vol host=perfsh6 vol=regress_43 lun=43
map_vol host=perfsh6 vol=regress_44 lun=44
map_vol host=perfsh6 vol=regress_45 lun=45
map_vol host=perfsh6 vol=regress_46 lun=46
map_vol host=perfsh6 vol=regress_47 lun=47
map_vol host=perfsh6 vol=regress_48 lun=48
map_vol host=perfsh6 vol=regress_49 lun=49
map_vol host=perfsh6 vol=regress_50 lun=50
map_vol host=perfsh6 vol=regress_51 lun=51
map_vol host=perfsh6 vol=regress_52 lun=52
map_vol host=perfsh6 vol=regress_53 lun=53
map_vol host=perfsh6 vol=regress_54 lun=54
map_vol host=perfsh6 vol=regress_55 lun=55
map_vol host=perfsh6 vol=regress_56 lun=56
map_vol host=perfsh6 vol=regress_57 lun=57
map_vol host=perfsh6 vol=regress_58 lun=58
map_vol host=perfsh6 vol=regress_59 lun=59
map_vol host=perfsh6 vol=regress_60 lun=60
map_vol host=perfsh6 vol=regress_61 lun=61
map_vol host=perfsh6 vol=regress_62 lun=62
map_vol host=perfsh6 vol=regress_63 lun=63
map_vol host=perfsh6 vol=regress_64 lun=64
map_vol host=perfsh6 vol=regress_65 lun=65
map_vol host=perfsh6 vol=regress_66 lun=66
map_vol host=perfsh6 vol=regress_67 lun=67
map_vol host=perfsh6 vol=regress_68 lun=68
map_vol host=perfsh6 vol=regress_69 lun=69
```

```
map_vol host=perfsh6 vol=regress_70 lun=70
map_vol host=perfsh6 vol=regress_71 lun=71
map_vol host=perfsh6 vol=regress_72 lun=72
map_vol host=perfsh6 vol=regress_73 lun=73
map_vol host=perfsh6 vol=regress_74 lun=74
map_vol host=perfsh6 vol=regress_75 lun=75
map_vol host=perfsh6 vol=regress_76 lun=76
map_vol host=perfsh6 vol=regress_77 lun=77
map_vol host=perfsh6 vol=regress_78 lun=78
map_vol host=perfsh6 vol=regress_79 lun=79
map_vol host=perfsh6 vol=regress_80 lun=80
map_vol host=perfsh6 vol=regress_81 lun=81
map_vol host=perfsh6 vol=regress_82 lun=82
map_vol host=perfsh6 vol=regress_83 lun=83
map_vol host=perfsh6 vol=regress_84 lun=84
map_vol host=perfsh6 vol=regress_85 lun=85
map_vol host=perfsh6 vol=regress_86 lun=86
map_vol host=perfsh6 vol=regress_87 lun=87
map_vol host=perfsh6 vol=regress_88 lun=88
map_vol host=perfsh6 vol=regress_89 lun=89
map_vol host=perfsh6 vol=regress_90 lun=90
```

```
map_vol host=perfsh3a vol=regress_01 lun=1 -y
map_vol host=perfsh3a vol=regress_02 lun=2 -y
map_vol host=perfsh3a vol=regress_03 lun=3 -y
map_vol host=perfsh3a vol=regress_04 lun=4 -y
map_vol host=perfsh3a vol=regress_05 lun=5 -y
map_vol host=perfsh3a vol=regress_06 lun=6 -y
map_vol host=perfsh3a vol=regress_07 lun=7 -y
map_vol host=perfsh3a vol=regress_08 lun=8 -y
map_vol host=perfsh3a vol=regress_09 lun=9 -y
map_vol host=perfsh3a vol=regress_10 lun=10 -y
map_vol host=perfsh3a vol=regress_11 lun=11 -y
map_vol host=perfsh3a vol=regress_12 lun=12 -y
map_vol host=perfsh3a vol=regress_13 lun=13 -y
map_vol host=perfsh3a vol=regress_14 lun=14 -y
map_vol host=perfsh3a vol=regress_15 lun=15 -y
map_vol host=perfsh3a vol=regress_16 lun=16 -y
map_vol host=perfsh3a vol=regress_17 lun=17 -y
map_vol host=perfsh3a vol=regress_18 lun=18 -y
map_vol host=perfsh3a vol=regress_19 lun=19 -y
map_vol host=perfsh3a vol=regress_20 lun=20 -y
map_vol host=perfsh3a vol=regress_21 lun=21 -y
map_vol host=perfsh3a vol=regress_22 lun=22 -y
map_vol host=perfsh3a vol=regress_23 lun=23 -y
map_vol host=perfsh3a vol=regress_24 lun=24 -y
map_vol host=perfsh3a vol=regress_25 lun=25 -y
map_vol host=perfsh3a vol=regress_26 lun=26 -y
map_vol host=perfsh3a vol=regress_27 lun=27 -y
map_vol host=perfsh3a vol=regress_28 lun=28 -y
map_vol host=perfsh3a vol=regress_29 lun=29 -y
map_vol host=perfsh3a vol=regress_30 lun=30 -y
map_vol host=perfsh3a vol=regress_31 lun=31 -y
map_vol host=perfsh3a vol=regress_32 lun=32 -y
map_vol host=perfsh3a vol=regress_33 lun=33 -y
map_vol host=perfsh3a vol=regress_34 lun=34 -y
map_vol host=perfsh3a vol=regress_35 lun=35 -y
map_vol host=perfsh3a vol=regress_36 lun=36 -y
map_vol host=perfsh3a vol=regress_37 lun=37 -y
map_vol host=perfsh3a vol=regress_38 lun=38 -y
map_vol host=perfsh3a vol=regress_39 lun=39 -y
map_vol host=perfsh3a vol=regress_40 lun=40 -y
map_vol host=perfsh3a vol=regress_41 lun=41 -y
```

```
map_vol host=perfsh3a vol=regress_42 lun=42 -y
map_vol host=perfsh3a vol=regress_43 lun=43 -y
map_vol host=perfsh3a vol=regress_44 lun=44 -y
map_vol host=perfsh3a vol=regress_45 lun=45 -y
map_vol host=perfsh3a vol=regress_46 lun=46 -y
map_vol host=perfsh3a vol=regress_47 lun=47 -y
map_vol host=perfsh3a vol=regress_48 lun=48 -y
map_vol host=perfsh3a vol=regress_49 lun=49 -y
map_vol host=perfsh3a vol=regress_50 lun=50 -y
map_vol host=perfsh3a vol=regress_51 lun=51 -y
map_vol host=perfsh3a vol=regress_52 lun=52 -y
map_vol host=perfsh3a vol=regress_53 lun=53 -y
map_vol host=perfsh3a vol=regress_54 lun=54 -y
map_vol host=perfsh3a vol=regress_55 lun=55 -y
map_vol host=perfsh3a vol=regress_56 lun=56 -y
map_vol host=perfsh3a vol=regress_57 lun=57 -y
map_vol host=perfsh3a vol=regress_58 lun=58 -y
map_vol host=perfsh3a vol=regress_59 lun=59 -y
map_vol host=perfsh3a vol=regress_60 lun=60 -y
map_vol host=perfsh3a vol=regress_61 lun=61 -y
map_vol host=perfsh3a vol=regress_62 lun=62 -y
map_vol host=perfsh3a vol=regress_63 lun=63 -y
map_vol host=perfsh3a vol=regress_64 lun=64 -y
map_vol host=perfsh3a vol=regress_65 lun=65 -y
map_vol host=perfsh3a vol=regress_66 lun=66 -y
map_vol host=perfsh3a vol=regress_67 lun=67 -y
map_vol host=perfsh3a vol=regress_68 lun=68 -y
map_vol host=perfsh3a vol=regress_69 lun=69 -y
map_vol host=perfsh3a vol=regress_70 lun=70 -y
map_vol host=perfsh3a vol=regress_71 lun=71 -y
map_vol host=perfsh3a vol=regress_72 lun=72 -y
map_vol host=perfsh3a vol=regress_73 lun=73 -y
map_vol host=perfsh3a vol=regress_74 lun=74 -y
map_vol host=perfsh3a vol=regress_75 lun=75 -y
map_vol host=perfsh3a vol=regress_76 lun=76 -y
map_vol host=perfsh3a vol=regress_77 lun=77 -y
map_vol host=perfsh3a vol=regress_78 lun=78 -y
map_vol host=perfsh3a vol=regress_79 lun=79 -y
map_vol host=perfsh3a vol=regress_80 lun=80 -y
map_vol host=perfsh3a vol=regress_81 lun=81 -y
map_vol host=perfsh3a vol=regress_82 lun=82 -y
map_vol host=perfsh3a vol=regress_83 lun=83 -y
map_vol host=perfsh3a vol=regress_84 lun=84 -y
map_vol host=perfsh3a vol=regress_85 lun=85 -y
map_vol host=perfsh3a vol=regress_86 lun=86 -y
map_vol host=perfsh3a vol=regress_87 lun=87 -y
map_vol host=perfsh3a vol=regress_88 lun=88 -y
map_vol host=perfsh3a vol=regress_89 lun=89 -y
map_vol host=perfsh3a vol=regress_90 lun=90 -y

map_vol host=perfsh3b vol=regress_01 lun=1 -y
map_vol host=perfsh3b vol=regress_02 lun=2 -y
map_vol host=perfsh3b vol=regress_03 lun=3 -y
map_vol host=perfsh3b vol=regress_04 lun=4 -y
map_vol host=perfsh3b vol=regress_05 lun=5 -y
map_vol host=perfsh3b vol=regress_06 lun=6 -y
map_vol host=perfsh3b vol=regress_07 lun=7 -y
map_vol host=perfsh3b vol=regress_08 lun=8 -y
map_vol host=perfsh3b vol=regress_09 lun=9 -y
map_vol host=perfsh3b vol=regress_10 lun=10 -y
map_vol host=perfsh3b vol=regress_11 lun=11 -y
map_vol host=perfsh3b vol=regress_12 lun=12 -y
map_vol host=perfsh3b vol=regress_13 lun=13 -y
```

```
map_vol host=perfsh3b vol=regress_14 lun=14 -y
map_vol host=perfsh3b vol=regress_15 lun=15 -y
map_vol host=perfsh3b vol=regress_16 lun=16 -y
map_vol host=perfsh3b vol=regress_17 lun=17 -y
map_vol host=perfsh3b vol=regress_18 lun=18 -y
map_vol host=perfsh3b vol=regress_19 lun=19 -y
map_vol host=perfsh3b vol=regress_20 lun=20 -y
map_vol host=perfsh3b vol=regress_21 lun=21 -y
map_vol host=perfsh3b vol=regress_22 lun=22 -y
map_vol host=perfsh3b vol=regress_23 lun=23 -y
map_vol host=perfsh3b vol=regress_24 lun=24 -y
map_vol host=perfsh3b vol=regress_25 lun=25 -y
map_vol host=perfsh3b vol=regress_26 lun=26 -y
map_vol host=perfsh3b vol=regress_27 lun=27 -y
map_vol host=perfsh3b vol=regress_28 lun=28 -y
map_vol host=perfsh3b vol=regress_29 lun=29 -y
map_vol host=perfsh3b vol=regress_30 lun=30 -y
map_vol host=perfsh3b vol=regress_31 lun=31 -y
map_vol host=perfsh3b vol=regress_32 lun=32 -y
map_vol host=perfsh3b vol=regress_33 lun=33 -y
map_vol host=perfsh3b vol=regress_34 lun=34 -y
map_vol host=perfsh3b vol=regress_35 lun=35 -y
map_vol host=perfsh3b vol=regress_36 lun=36 -y
map_vol host=perfsh3b vol=regress_37 lun=37 -y
map_vol host=perfsh3b vol=regress_38 lun=38 -y
map_vol host=perfsh3b vol=regress_39 lun=39 -y
map_vol host=perfsh3b vol=regress_40 lun=40 -y
map_vol host=perfsh3b vol=regress_41 lun=41 -y
map_vol host=perfsh3b vol=regress_42 lun=42 -y
map_vol host=perfsh3b vol=regress_43 lun=43 -y
map_vol host=perfsh3b vol=regress_44 lun=44 -y
map_vol host=perfsh3b vol=regress_45 lun=45 -y
map_vol host=perfsh3b vol=regress_46 lun=46 -y
map_vol host=perfsh3b vol=regress_47 lun=47 -y
map_vol host=perfsh3b vol=regress_48 lun=48 -y
map_vol host=perfsh3b vol=regress_49 lun=49 -y
map_vol host=perfsh3b vol=regress_50 lun=50 -y
map_vol host=perfsh3b vol=regress_51 lun=51 -y
map_vol host=perfsh3b vol=regress_52 lun=52 -y
map_vol host=perfsh3b vol=regress_53 lun=53 -y
map_vol host=perfsh3b vol=regress_54 lun=54 -y
map_vol host=perfsh3b vol=regress_55 lun=55 -y
map_vol host=perfsh3b vol=regress_56 lun=56 -y
map_vol host=perfsh3b vol=regress_57 lun=57 -y
map_vol host=perfsh3b vol=regress_58 lun=58 -y
map_vol host=perfsh3b vol=regress_59 lun=59 -y
map_vol host=perfsh3b vol=regress_60 lun=60 -y
map_vol host=perfsh3b vol=regress_61 lun=61 -y
map_vol host=perfsh3b vol=regress_62 lun=62 -y
map_vol host=perfsh3b vol=regress_63 lun=63 -y
map_vol host=perfsh3b vol=regress_64 lun=64 -y
map_vol host=perfsh3b vol=regress_65 lun=65 -y
map_vol host=perfsh3b vol=regress_66 lun=66 -y
map_vol host=perfsh3b vol=regress_67 lun=67 -y
map_vol host=perfsh3b vol=regress_68 lun=68 -y
map_vol host=perfsh3b vol=regress_69 lun=69 -y
map_vol host=perfsh3b vol=regress_70 lun=70 -y
map_vol host=perfsh3b vol=regress_71 lun=71 -y
map_vol host=perfsh3b vol=regress_72 lun=72 -y
map_vol host=perfsh3b vol=regress_73 lun=73 -y
map_vol host=perfsh3b vol=regress_74 lun=74 -y
map_vol host=perfsh3b vol=regress_75 lun=75 -y
map_vol host=perfsh3b vol=regress_76 lun=76 -y
```

```
map_vol host=perfsh3b vol=regress_77 lun=77 -y
map_vol host=perfsh3b vol=regress_78 lun=78 -y
map_vol host=perfsh3b vol=regress_79 lun=79 -y
map_vol host=perfsh3b vol=regress_80 lun=80 -y
map_vol host=perfsh3b vol=regress_81 lun=81 -y
map_vol host=perfsh3b vol=regress_82 lun=82 -y
map_vol host=perfsh3b vol=regress_83 lun=83 -y
map_vol host=perfsh3b vol=regress_84 lun=84 -y
map_vol host=perfsh3b vol=regress_85 lun=85 -y
map_vol host=perfsh3b vol=regress_86 lun=86 -y
map_vol host=perfsh3b vol=regress_87 lun=87 -y
map_vol host=perfsh3b vol=regress_88 lun=88 -y
map_vol host=perfsh3b vol=regress_89 lun=89 -y
map_vol host=perfsh3b vol=regress_90 lun=90 -y
```

Step 5. Define WWPNs for use by each host.

```
host_add_port host=perfsh6 fcaddress=10000000C9A9F186
host_add_port host=perfsh6 fcaddress=10000000C9A928D8

host_add_port host=perfsh3a fcaddress=10000000C9B7999D
host_add_port host=perfsh3a fcaddress=10000000C9B77235
host_add_port host=perfsh3a fcaddress=10000000C9B84E23
host_add_port host=perfsh3a fcaddress=10000000C9B83FCF
host_add_port host=perfsh3a fcaddress=10000000C9B848CB
host_add_port host=perfsh3a fcaddress=10000000C9B796C7
host_add_port host=perfsh3a fcaddress=10000000C9B79B61
host_add_port host=perfsh3a fcaddress=10000000C9B79AF5

host_add_port host=perfsh3b fcaddress=10000000C9B83FBD
host_add_port host=perfsh3b fcaddress=10000000C9B841D1
host_add_port host=perfsh3b fcaddress=10000000C9A933FD
host_add_port host=perfsh3b fcaddress=10000000C9A92EEF
host_add_port host=perfsh3b fcaddress=10000000C9A474EF
host_add_port host=perfsh3b fcaddress=10000000C9B846AD
host_add_port host=perfsh3b fcaddress=10000000C9B812DB
host_add_port host=perfsh3b fcaddress=10000000C9A1E993
```

AIX Configuration

After Steps 1-5 were completed, the resulting volumes were detected by AIX by issuing the command **cfgmgr** on each of the Host Systems. The queue depth and maximum transfer size of each volume, documented in Appendix B, were set by executing the commands contained in the following script on each of the Host Systems:

```
luns=$(lsdev -Cc disk | grep XIV | awk '{ print $1 }')
for i in $luns
do
    rmdev -l hdisk$i
    chdev -l hdisk$i -a queue_depth=256
    chdev -l hdisk$i -a max_transfer=0x100000
    mkdev -l hdisk$i
    let i="i+1"
done
```


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

The following SPC-2 Workload Generator command and parameters files were used for execution of the SPC-2 Logical Volume initialization, SPC-2/E 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.

Common Entries

The following command lines appear at the beginning of each of the listed SPC-2 Workload Generator command and parameter files.

```
*local host is (perfsh6,9.11.211.126)
host=localhost,jvms=1,maxstreams=400
host=(9.11.210.91,perfsh3a),
    java=("/usr/java5/bin/java", "-Xms384m -Xmx768m -Xss128k"),
    spc2="/perform/spc2install",
    shell=spc2,
    jvms=4,
    maxstreams=400
host=(9.11.210.92,perfsh3b),
    java=("/usr/java5/bin/java", "-Xms384m -Xmx768m -Xss128k"),
    spc2="/perform/spc2install",
    shell=spc2,
    jvms=4,
    maxstreams=400
```

```
sd=default,host=localhost,size=1600g
sd=sd1,lun=/dev/rhdisk12
sd=sd2,lun=/dev/rhdisk13
sd=sd3,lun=/dev/rhdisk14
sd=sd4,lun=/dev/rhdisk15
sd=sd5,lun=/dev/rhdisk16
sd=sd6,lun=/dev/rhdisk17
sd=sd7,lun=/dev/rhdisk18
sd=sd8,lun=/dev/rhdisk19
sd=sd9,lun=/dev/rhdisk20
sd=sd10,lun=/dev/rhdisk21
sd=sd11,lun=/dev/rhdisk22
sd=sd12,lun=/dev/rhdisk23
sd=sd13,lun=/dev/rhdisk24
sd=sd14,lun=/dev/rhdisk25
sd=sd15,lun=/dev/rhdisk26
sd=sd16,lun=/dev/rhdisk27
sd=sd17,lun=/dev/rhdisk28
sd=sd18,lun=/dev/rhdisk29
sd=sd19,lun=/dev/rhdisk30
sd=sd20,lun=/dev/rhdisk31
sd=sd21,lun=/dev/rhdisk32
sd=sd22,lun=/dev/rhdisk33
sd=sd23,lun=/dev/rhdisk34
sd=sd24,lun=/dev/rhdisk35
sd=sd25,lun=/dev/rhdisk36
sd=sd26,lun=/dev/rhdisk37
sd=sd27,lun=/dev/rhdisk38
sd=sd28,lun=/dev/rhdisk39
sd=sd29,lun=/dev/rhdisk40
sd=sd30,lun=/dev/rhdisk41
sd=sd31,lun=/dev/rhdisk42
```

```
sd=sd32, lun=/dev/rhdisk43
sd=sd33, lun=/dev/rhdisk44
sd=sd34, lun=/dev/rhdisk45
sd=sd35, lun=/dev/rhdisk46
sd=sd36, lun=/dev/rhdisk47
sd=sd37, lun=/dev/rhdisk48
sd=sd38, lun=/dev/rhdisk49
sd=sd39, lun=/dev/rhdisk50
sd=sd40, lun=/dev/rhdisk51
sd=sd41, lun=/dev/rhdisk52
sd=sd42, lun=/dev/rhdisk53
sd=sd43, lun=/dev/rhdisk54
sd=sd44, lun=/dev/rhdisk55
sd=sd45, lun=/dev/rhdisk56
sd=sd46, lun=/dev/rhdisk57
sd=sd47, lun=/dev/rhdisk58
sd=sd48, lun=/dev/rhdisk59
sd=sd49, lun=/dev/rhdisk60
sd=sd50, lun=/dev/rhdisk61
sd=sd51, lun=/dev/rhdisk62
sd=sd52, lun=/dev/rhdisk63
sd=sd53, lun=/dev/rhdisk64
sd=sd54, lun=/dev/rhdisk65
sd=sd55, lun=/dev/rhdisk66
sd=sd56, lun=/dev/rhdisk67
sd=sd57, lun=/dev/rhdisk68
sd=sd58, lun=/dev/rhdisk69
sd=sd59, lun=/dev/rhdisk70
sd=sd60, lun=/dev/rhdisk71
sd=sd61, lun=/dev/rhdisk72
sd=sd62, lun=/dev/rhdisk73
sd=sd63, lun=/dev/rhdisk74
sd=sd64, lun=/dev/rhdisk75
sd=sd65, lun=/dev/rhdisk76
sd=sd66, lun=/dev/rhdisk77
sd=sd67, lun=/dev/rhdisk78
sd=sd68, lun=/dev/rhdisk79
sd=sd69, lun=/dev/rhdisk80
sd=sd70, lun=/dev/rhdisk81
sd=sd71, lun=/dev/rhdisk82
sd=sd72, lun=/dev/rhdisk83
sd=sd73, lun=/dev/rhdisk84
sd=sd74, lun=/dev/rhdisk85
sd=sd75, lun=/dev/rhdisk86
sd=sd76, lun=/dev/rhdisk87
sd=sd77, lun=/dev/rhdisk88
sd=sd78, lun=/dev/rhdisk89
sd=sd79, lun=/dev/rhdisk90
sd=sd80, lun=/dev/rhdisk91
sd=sd81, lun=/dev/rhdisk92
sd=sd82, lun=/dev/rhdisk93
sd=sd83, lun=/dev/rhdisk94
sd=sd84, lun=/dev/rhdisk95
sd=sd85, lun=/dev/rhdisk96
sd=sd86, lun=/dev/rhdisk97
sd=sd87, lun=/dev/rhdisk98
sd=sd88, lun=/dev/rhdisk99
sd=sd89, lun=/dev/rhdisk100
sd=sd90, lun=/dev/rhdisk101
```

```
sd=default, host=perfsh3a, size=1600g
sd=sd1, lun=/dev/rhdisk102
sd=sd2, lun=/dev/rhdisk103
```

sd=sd3, lun=/dev/rhdisk104
sd=sd4, lun=/dev/rhdisk105
sd=sd5, lun=/dev/rhdisk106
sd=sd6, lun=/dev/rhdisk107
sd=sd7, lun=/dev/rhdisk108
sd=sd8, lun=/dev/rhdisk109
sd=sd9, lun=/dev/rhdisk110
sd=sd10, lun=/dev/rhdisk111
sd=sd11, lun=/dev/rhdisk112
sd=sd12, lun=/dev/rhdisk113
sd=sd13, lun=/dev/rhdisk114
sd=sd14, lun=/dev/rhdisk115
sd=sd15, lun=/dev/rhdisk116
sd=sd16, lun=/dev/rhdisk117
sd=sd17, lun=/dev/rhdisk118
sd=sd18, lun=/dev/rhdisk119
sd=sd19, lun=/dev/rhdisk120
sd=sd20, lun=/dev/rhdisk121
sd=sd21, lun=/dev/rhdisk122
sd=sd22, lun=/dev/rhdisk123
sd=sd23, lun=/dev/rhdisk124
sd=sd24, lun=/dev/rhdisk125
sd=sd25, lun=/dev/rhdisk126
sd=sd26, lun=/dev/rhdisk127
sd=sd27, lun=/dev/rhdisk128
sd=sd28, lun=/dev/rhdisk129
sd=sd29, lun=/dev/rhdisk130
sd=sd30, lun=/dev/rhdisk131
sd=sd31, lun=/dev/rhdisk132
sd=sd32, lun=/dev/rhdisk133
sd=sd33, lun=/dev/rhdisk134
sd=sd34, lun=/dev/rhdisk135
sd=sd35, lun=/dev/rhdisk136
sd=sd36, lun=/dev/rhdisk137
sd=sd37, lun=/dev/rhdisk138
sd=sd38, lun=/dev/rhdisk139
sd=sd39, lun=/dev/rhdisk140
sd=sd40, lun=/dev/rhdisk141
sd=sd41, lun=/dev/rhdisk142
sd=sd42, lun=/dev/rhdisk143
sd=sd43, lun=/dev/rhdisk144
sd=sd44, lun=/dev/rhdisk145
sd=sd45, lun=/dev/rhdisk146
sd=sd46, lun=/dev/rhdisk147
sd=sd47, lun=/dev/rhdisk148
sd=sd48, lun=/dev/rhdisk149
sd=sd49, lun=/dev/rhdisk150
sd=sd50, lun=/dev/rhdisk151
sd=sd51, lun=/dev/rhdisk152
sd=sd52, lun=/dev/rhdisk153
sd=sd53, lun=/dev/rhdisk154
sd=sd54, lun=/dev/rhdisk155
sd=sd55, lun=/dev/rhdisk156
sd=sd56, lun=/dev/rhdisk157
sd=sd57, lun=/dev/rhdisk158
sd=sd58, lun=/dev/rhdisk159
sd=sd59, lun=/dev/rhdisk160
sd=sd60, lun=/dev/rhdisk161
sd=sd61, lun=/dev/rhdisk162
sd=sd62, lun=/dev/rhdisk163
sd=sd63, lun=/dev/rhdisk164
sd=sd64, lun=/dev/rhdisk165
sd=sd65, lun=/dev/rhdisk166

```
sd=sd66,lun=/dev/rhdisk167
sd=sd67,lun=/dev/rhdisk168
sd=sd68,lun=/dev/rhdisk169
sd=sd69,lun=/dev/rhdisk170
sd=sd70,lun=/dev/rhdisk171
sd=sd71,lun=/dev/rhdisk172
sd=sd72,lun=/dev/rhdisk173
sd=sd73,lun=/dev/rhdisk174
sd=sd74,lun=/dev/rhdisk175
sd=sd75,lun=/dev/rhdisk176
sd=sd76,lun=/dev/rhdisk177
sd=sd77,lun=/dev/rhdisk178
sd=sd78,lun=/dev/rhdisk179
sd=sd79,lun=/dev/rhdisk180
sd=sd80,lun=/dev/rhdisk181
sd=sd81,lun=/dev/rhdisk182
sd=sd82,lun=/dev/rhdisk183
sd=sd83,lun=/dev/rhdisk184
sd=sd84,lun=/dev/rhdisk185
sd=sd85,lun=/dev/rhdisk186
sd=sd86,lun=/dev/rhdisk187
sd=sd87,lun=/dev/rhdisk188
sd=sd88,lun=/dev/rhdisk189
sd=sd89,lun=/dev/rhdisk190
sd=sd90,lun=/dev/rhdisk191
```

```
sd=default,host=perfsh3b,size=1600g
sd=sd1,lun=/dev/rhdisk4
sd=sd2,lun=/dev/rhdisk5
sd=sd3,lun=/dev/rhdisk6
sd=sd4,lun=/dev/rhdisk7
sd=sd5,lun=/dev/rhdisk8
sd=sd6,lun=/dev/rhdisk9
sd=sd7,lun=/dev/rhdisk10
sd=sd8,lun=/dev/rhdisk11
sd=sd9,lun=/dev/rhdisk12
sd=sd10,lun=/dev/rhdisk13
sd=sd11,lun=/dev/rhdisk14
sd=sd12,lun=/dev/rhdisk15
sd=sd13,lun=/dev/rhdisk16
sd=sd14,lun=/dev/rhdisk17
sd=sd15,lun=/dev/rhdisk18
sd=sd16,lun=/dev/rhdisk19
sd=sd17,lun=/dev/rhdisk20
sd=sd18,lun=/dev/rhdisk21
sd=sd19,lun=/dev/rhdisk22
sd=sd20,lun=/dev/rhdisk23
sd=sd21,lun=/dev/rhdisk24
sd=sd22,lun=/dev/rhdisk25
sd=sd23,lun=/dev/rhdisk26
sd=sd24,lun=/dev/rhdisk27
sd=sd25,lun=/dev/rhdisk28
sd=sd26,lun=/dev/rhdisk29
sd=sd27,lun=/dev/rhdisk30
sd=sd28,lun=/dev/rhdisk31
sd=sd29,lun=/dev/rhdisk32
sd=sd30,lun=/dev/rhdisk33
sd=sd31,lun=/dev/rhdisk34
sd=sd32,lun=/dev/rhdisk35
sd=sd33,lun=/dev/rhdisk36
sd=sd34,lun=/dev/rhdisk37
sd=sd35,lun=/dev/rhdisk38
sd=sd36,lun=/dev/rhdisk39
```

sd=sd37, lun=/dev/rhdisk40
sd=sd38, lun=/dev/rhdisk41
sd=sd39, lun=/dev/rhdisk42
sd=sd40, lun=/dev/rhdisk43
sd=sd41, lun=/dev/rhdisk44
sd=sd42, lun=/dev/rhdisk45
sd=sd43, lun=/dev/rhdisk46
sd=sd44, lun=/dev/rhdisk47
sd=sd45, lun=/dev/rhdisk48
sd=sd46, lun=/dev/rhdisk49
sd=sd47, lun=/dev/rhdisk50
sd=sd48, lun=/dev/rhdisk51
sd=sd49, lun=/dev/rhdisk52
sd=sd50, lun=/dev/rhdisk53
sd=sd51, lun=/dev/rhdisk54
sd=sd52, lun=/dev/rhdisk55
sd=sd53, lun=/dev/rhdisk56
sd=sd54, lun=/dev/rhdisk57
sd=sd55, lun=/dev/rhdisk58
sd=sd56, lun=/dev/rhdisk59
sd=sd57, lun=/dev/rhdisk60
sd=sd58, lun=/dev/rhdisk61
sd=sd59, lun=/dev/rhdisk62
sd=sd60, lun=/dev/rhdisk63
sd=sd61, lun=/dev/rhdisk64
sd=sd62, lun=/dev/rhdisk65
sd=sd63, lun=/dev/rhdisk66
sd=sd64, lun=/dev/rhdisk67
sd=sd65, lun=/dev/rhdisk68
sd=sd66, lun=/dev/rhdisk69
sd=sd67, lun=/dev/rhdisk70
sd=sd68, lun=/dev/rhdisk71
sd=sd69, lun=/dev/rhdisk72
sd=sd70, lun=/dev/rhdisk73
sd=sd71, lun=/dev/rhdisk74
sd=sd72, lun=/dev/rhdisk75
sd=sd73, lun=/dev/rhdisk76
sd=sd74, lun=/dev/rhdisk77
sd=sd75, lun=/dev/rhdisk78
sd=sd76, lun=/dev/rhdisk79
sd=sd77, lun=/dev/rhdisk80
sd=sd78, lun=/dev/rhdisk81
sd=sd79, lun=/dev/rhdisk82
sd=sd80, lun=/dev/rhdisk83
sd=sd81, lun=/dev/rhdisk84
sd=sd82, lun=/dev/rhdisk85
sd=sd83, lun=/dev/rhdisk86
sd=sd84, lun=/dev/rhdisk87
sd=sd85, lun=/dev/rhdisk88
sd=sd86, lun=/dev/rhdisk89
sd=sd87, lun=/dev/rhdisk90
sd=sd88, lun=/dev/rhdisk91
sd=sd89, lun=/dev/rhdisk92
sd=sd90, lun=/dev/rhdisk93

SPC-2 Logical Volume Initialization and Pre-Idle Phase

```
maxlatestart=0
reportinginterval=5
segmentlength=512m

rd=default,rampup=180,measurement=600,runout=45,rampdown=15,buffers=1,periods=90
rd=default,rdpct=50,xfersize=1024k
rd=TR11_SPC-2-FP2.0,streams=576
```

Post-Idle Phase

```
maxlatestart=0
reportinginterval=5
segmentlength=512m

rd=default,rampup=180,measurement=600,runout=45,rampdown=15,buffers=1,periods=90
rd=default,rdpct=50,xfersize=1024k
rd=TR11_SPC-2-FP2.0,streams=144
```

Large File Processing Test (LFP)

```
maxlatestart=0
reportinginterval=5
segmentlength=512m

rd=default,rampup=180,measurement=600,runout=45,rampdown=15,buffers=1,periods=90
rd=default,rdpct=0,xfersize=1024k
rd=TR1_SPC-2-FP2.0,streams=576
rd=TR2_SPC-2-FP2.0,streams=288
rd=TR3_SPC-2-FP2.0,streams=144
rd=TR4_SPC-2-FP2.0,streams=72
rd=TR5_SPC-2-FP2.0,streams=1
rd=default,rdpct=0,xfersize=256k
rd=TR6_SPC-2-FP2.0,streams=576
rd=TR7_SPC-2-FP2.0,streams=288
rd=TR8_SPC-2-FP2.0,streams=144
rd=TR9_SPC-2-FP2.0,streams=72
rd=TR10_SPC-2-FP2.0,streams=1
rd=default,rdpct=50,xfersize=1024k
rd=TR11_SPC-2-FP2.0,streams=576
rd=TR12_SPC-2-FP2.0,streams=288
rd=TR13_SPC-2-FP2.0,streams=144
rd=TR14_SPC-2-FP2.0,streams=72
rd=TR15_SPC-2-FP2.0,streams=1
rd=default,rdpct=50,xfersize=256k
rd=TR16_SPC-2-FP2.0,streams=576
rd=TR17_SPC-2-FP2.0,streams=288
rd=TR18_SPC-2-FP2.0,streams=144
rd=TR19_SPC-2-FP2.0,streams=72
rd=TR20_SPC-2-FP2.0,streams=1
rd=default,rdpct=100,xfersize=1024k
rd=TR21_SPC-2-FP2.0,streams=576
rd=TR22_SPC-2-FP2.0,streams=288
rd=TR23_SPC-2-FP2.0,streams=144
rd=TR24_SPC-2-FP2.0,streams=72
rd=TR25_SPC-2-FP2.0,streams=1
rd=default,rdpct=100,xfersize=256k
rd=TR26_SPC-2-FP2.0,streams=576
rd=TR27_SPC-2-FP2.0,streams=288
```

```
rd=TR28_SPC-2-FP2.0,streams=144  
rd=TR29_SPC-2-FP2.0,streams=72  
rd=TR30_SPC-2-FP2.0,streams=1
```

Large Database Query Test (*LDQ*)

```
maxlatestart=0  
reportinginterval=5  
segmentlength=512m  
  
rd=default,rdpct=99,rampup=180,measurement=600,runout=45,rampdown=15,periods=90  
rd=default,xfersize=1024k,buffers=4  
rd=TR1_SPC-2-DQ2.0,streams=576  
rd=TR2_SPC-2-DQ2.0,streams=288  
rd=TR3_SPC-2-DQ2.0,streams=144  
rd=TR4_SPC-2-DQ2.0,streams=72  
rd=TR5_SPC-2-DQ2.0,streams=1  
rd=default,xfersize=1024k,buffers=1  
rd=TR6_SPC-2-DQ2.0,streams=576  
rd=TR7_SPC-2-DQ2.0,streams=288  
rd=TR8_SPC-2-DQ2.0,streams=144  
rd=TR9_SPC-2-DQ2.0,streams=72  
rd=TR10_SPC-2-DQ2.0,streams=1  
rd=default,xfersize=64k,buffers=4  
rd=TR11_SPC-2-DQ2.0,streams=576  
rd=TR12_SPC-2-DQ2.0,streams=288  
rd=TR13_SPC-2-DQ2.0,streams=144  
rd=TR14_SPC-2-DQ2.0,streams=72  
rd=TR15_SPC-2-DQ2.0,streams=1  
rd=default,xfersize=64k,buffers=1  
rd=TR16_SPC-2-DQ2.0,streams=576  
rd=TR17_SPC-2-DQ2.0,streams=288  
rd=TR18_SPC-2-DQ2.0,streams=144  
rd=TR19_SPC-2-DQ2.0,streams=72  
rd=TR20_SPC-2-DQ2.0,streams=1
```

Video on Demand Delivery Test (*VOD*)

```
maxlatestart=0  
reportinginterval=5  
videosegmentduration=1200  
maxlatevod=0  
  
rd=default,measurement=7200,rampup=1200,runout=45,rampdown=15,periods=600  
rd=TR1_SPC-2-VOD11.0,streams=2000,buffers=8
```

Persistence Test Run 1 (*write phase*)

```
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=192
```

Persistence Test Run 2 (*read phase*)

```
maxlatestart=1
reportinginterval=5
segmentlength=512m

maxpersistenceerrors=10
*corruptstreams=3

rd=default,buffers=1,rdpct=100,xfersize=1024k
rd=TR1-5s_SPC-2-persist-r
```


APPENDIX E: SPC-2 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, as well as, Persistence Test Run 1.

```
export PATH=$PATH:/usr/java5/bin
export SPC2HOME=/perform_xiv/spc2install
export CLASSPATH=$SPC2HOME
export LIBPATH=$SPC2HOME/aix
export IBM_JAVADUMP_OUTOFMEMORY=false
export IBM_HEAPDUMP_OUTOFMEMORY=false

java -Xoptionsfile=javaopts.cfg vdbench -f lfp_preidle.cfg -init -o init_output
java -Xoptionsfile=javaopts.cfg vdbench -f lfp_preidle.cfg -o preidle_output
sleep 2100
java -Xoptionsfile=javaopts.cfg vdbench -f lfp_postidle.cfg -o postidle_output

java -Xoptionsfile=javaopts.cfg vdbench -f vod.cfg -o vod_output
java -Xoptionsfile=javaopts.cfg vdbench -f lfp.cfg -o lfp_output
java -Xoptionsfile=javaopts.cfg vdbench -f ldq.cfg -o ldq_output
java -Xoptionsfile=javaopts.cfg vdbench -f persistw.cfg -o persistw_output
xcli -m perfxiv3a -u admin -p adminadmin "disk_list" > diskdat.txt
rm capdat.txt
for h in `lsdev -Cc disk | awk '/XIV/ {print $1}'`
do
echo $h `bootinfo -s $h` >> capdat.txt
done
```

Persistence Test Run 2

The following script was used to execute Persistence Test Run 2.

```
#!/usr/bin/ksh
export PATH=$PATH:/usr/java5/bin
export SPC2HOME=/perform/spc2install
export CLASSPATH=$SPC2HOME
export LIBPATH=$SPC2HOME/aix
export IBM_JAVADUMP_OUTOFMEMORY=false
export IBM_HEAPDUMP_OUTOFMEMORY=false
java -Xoptionsfile=javaopts.cfg vdbench -f persistr.cfg -o persistr_output
```