



**SPC BENCHMARK 2™  
FULL DISCLOSURE REPORT**

**EMC CORPORATION  
EMC VMAX 400K**

**SPC-2™ V1.5**

**Submitted for Review: July 30, 2015  
Submission Identifier: B00073**

## **First Edition – July 2015**

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# AUDIT CERTIFICATION



Joseph Perry  
EMC Corporation  
176 South Street  
Hopkinton, MA 01748

July 28, 2015

The SPC Benchmark 2™ Reported Data listed below for the **EMC VMAX 400K** were produced in compliance with the SPC Benchmark 2™ V1.5 Onsite Audit requirements.

SPC Benchmark 2™ 1.5 Reported Data	
Tested Storage Product (TSP) Name: EMC VMAX 400K	
Metric	Reported Result
SPC-2 MBPS™	55,643.78
SPC-2 Price-Performance	\$33.58/SPC-2 MBPS™
ASU Capacity	20,132.659 GB
Data Protection Level	Protected 2 (Mirroring)
Total Price (including three-year maintenance)	\$1,868,567.85
Currency Used	U.S. Dollars
Target Country for availability, sales and support	USA

The following SPC Benchmark 2™ Onsite Audit requirements were reviewed and found compliant with V1.5 of the SPC Benchmark 2™ 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 EMC 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 total Application Storage Unit (ASU) Capacity was filled with random data prior to the execution of the SPC-2 Tests.

Storage Performance Council  
643 Bair Island Road, Suite 103  
Redwood City, CA 94062  
[AuditService@storageperformance.org](mailto:AuditService@storageperformance.org)  
650.556.9384



## AUDIT CERTIFICATION (CONT.)

EMC VMAX 400K  
SPC-1 Audit Certification

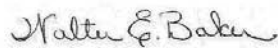
Page 2

- 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.
- Documentation that no customer tunable parameter or option was changed from its default value.
- The following Host System items were verified by physical inspection and documentation supplied by EMC 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 EMC 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 EMC 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™ Specification:
  - ✓ Data Persistence Test
  - ✓ Large File Processing Test
  - ✓ Large Database Query Test
  - ✓ Video on Demand Delivery Test
- 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™ Specification.
- The Full Disclosure Report (FDR) met all of the requirements in Clause 10 of the SPC Benchmark 2™ Specification.
- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

**Audit Notes:**

There were no audit notes or exceptions.

Respectfully,



Walter E. Baker  
SPC Auditor

Storage Performance Council  
643 Bair Island Road, Suite 103  
Redwood City, CA 94062  
[AuditService@storageperformance.org](mailto:AuditService@storageperformance.org)  
650.556.9384

# LETTER OF GOOD FAITH

## Letter of Good Faith



Date: June 1, 2015

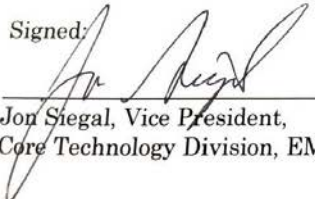
From: Jon Siegal, Vice President, Core Technology Division, EMC Corporation

To: Walter E. Baker, SPC Auditor  
Storage Performance Council (SPC)  
643 Bair Island Road, Suite 103  
Redwood City, CA 94063-2755

Subject: SPC-2 Letter of Good Faith for the EMC VMAX 400K Array

EMC is the SPC-2 Test Sponsor for the above listed storage product. To the best of our knowledge and belief, the required SPC-2 benchmark results and material we have submitted for that storage array are complete, accurate, and in full compliance with V1.5 of the SPC-2 benchmark specification.

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

Signed:   
\_\_\_\_\_  
Jon Siegal, Vice President,  
Core Technology Division, EMC Corporation

Date: 6/1/15  
Date of Signature

## EXECUTIVE SUMMARY

### Test Sponsor and Contact Information

Test Sponsor and Contact Information	
<b>Test Sponsor Primary Contact</b>	EMC Corporation – <a href="http://www.emc.com">http://www.emc.com</a> Joseph Perry – <a href="mailto:joseph.perry@emc.com">joseph.perry@emc.com</a> 176 South Street Hopkinton, MA 01748 Phone: (508) 293-7637 FAX: (508) 249-3064
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<b>Auditor</b>	Storage Performance Council – <a href="http://www.storageperformance.org">http://www.storageperformance.org</a> Walter E. Baker – <a href="mailto:AuditService@StoragePerformance.org">AuditService@StoragePerformance.org</a> 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	
<b>SPC-2 Specification revision number</b>	V1.5
<b>SPC-2 Workload Generator revision number</b>	V1.2
<b>Date Results were first used publicly</b>	July 30, 2015
<b>Date FDR was submitted to the SPC</b>	July 30, 2015
<b>Date the TSC will be available for shipment to customers</b>	currently available
<b>Date the TSC completed audit certification</b>	July 27, 2015

### Tested Storage Product (TSP) Description

The EMC VMAX 400K storage array is a highly scalable enterprise data services platform fundamentally changing what has been possible with enterprise storage by delivering new levels of automation, modernization and consolidation to customers. VMAX3 is a radically new approach to enterprise storage architecture, separating software-based data services from the underlying hardware, allowing the hallmark VMAX® capabilities – local replication, remote replication, and storage tiering – to extend to other platforms from EMC and third-party vendors. VMAX 400K also dramatically simplifies management at scale through service level objectives (SLOs), improving overall staff productivity and allowing customers to focus on the needs of the business, rather than the management of technology.

Built on the powerful Virtual Matrix Architecture with up to 384 multi-core processors, 16TB of low latency high bandwidth cache memory, and 4PB of usable capacity, VMAX 400K delivers extreme levels of performance, scale, and hyper consolidation for today's mission-critical hybrid cloud environments.

## 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
  - Currency Used
  - Target Country
- Reported Data for each SPC Test: Large File Processing (LFP), Large Database Query (LDQ), and Video on Demand Delivery (VOD) Test.

**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).

**SPC-2 Price-Performance™** is the ratio of **Total Price** to **SPC-2 MBPS™**.

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

**Total Price** includes the cost of the Priced Storage Configuration plus three years of hardware maintenance and software support as detailed on page 17.

**Data Protection Level of Protected 2** using **Mirroring**, which configures two or more identical copies of user data.

***Protected 2:** The single point of failure of any **component** in the configuration will not result in permanent loss of access to or integrity of the SPC-2 Data Repository.*

**Currency Used** is formal name for the currency used in calculating the **Total Price** and **SPC-2 Price-Performance™**. That currency may be the local currency of the **Target Country** or the currency of a difference country (*non-local currency*).

The **Target Country** is the country in which the Priced Storage Configuration is available for sale and in which the required hardware maintenance and software support is provided either directly from the Test Sponsor or indirectly via a third-party supplier.

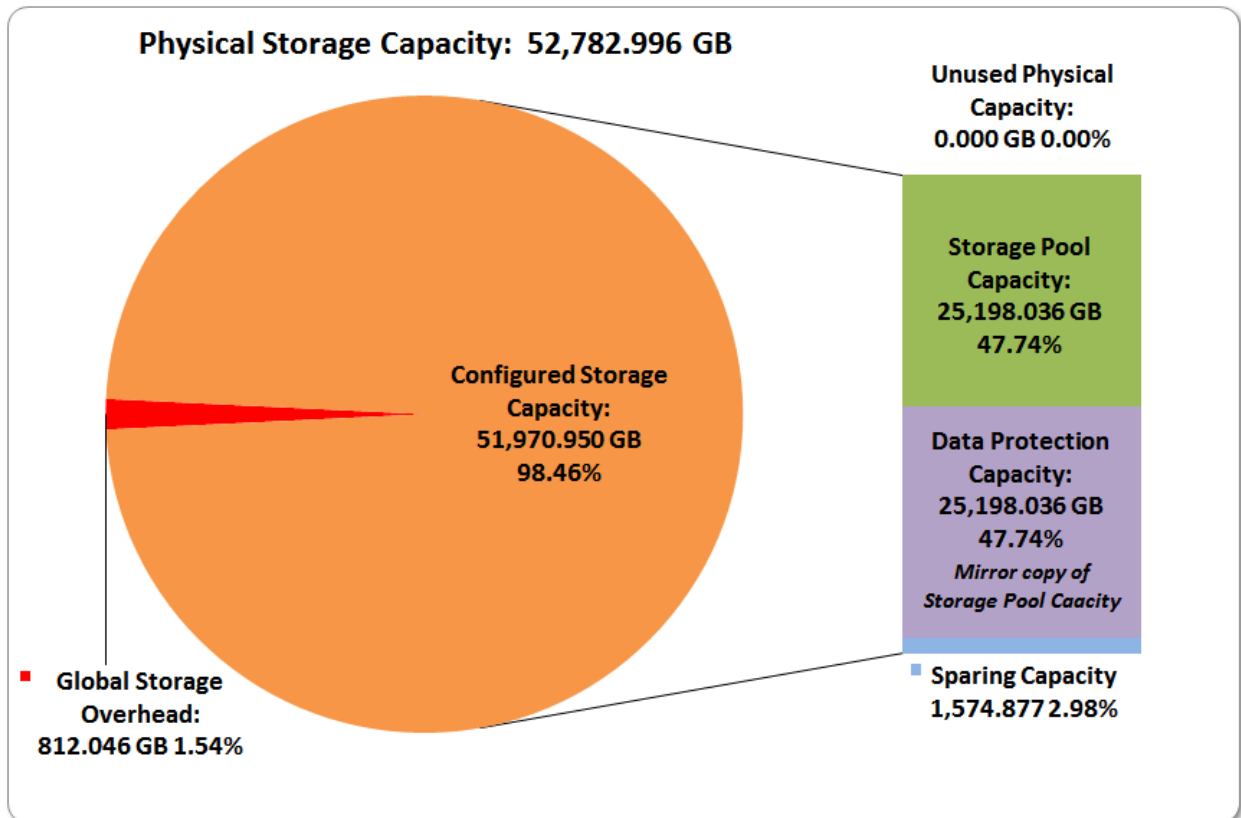
## SPC-2 Reported Data (continued)

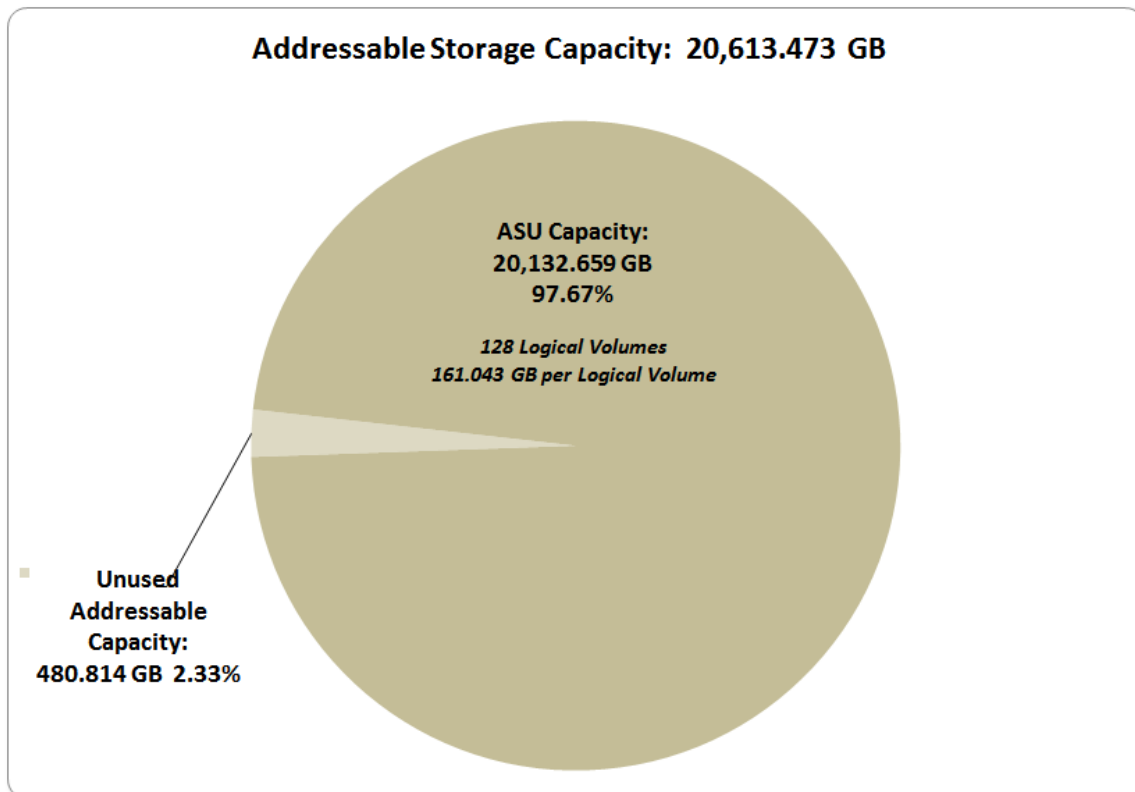
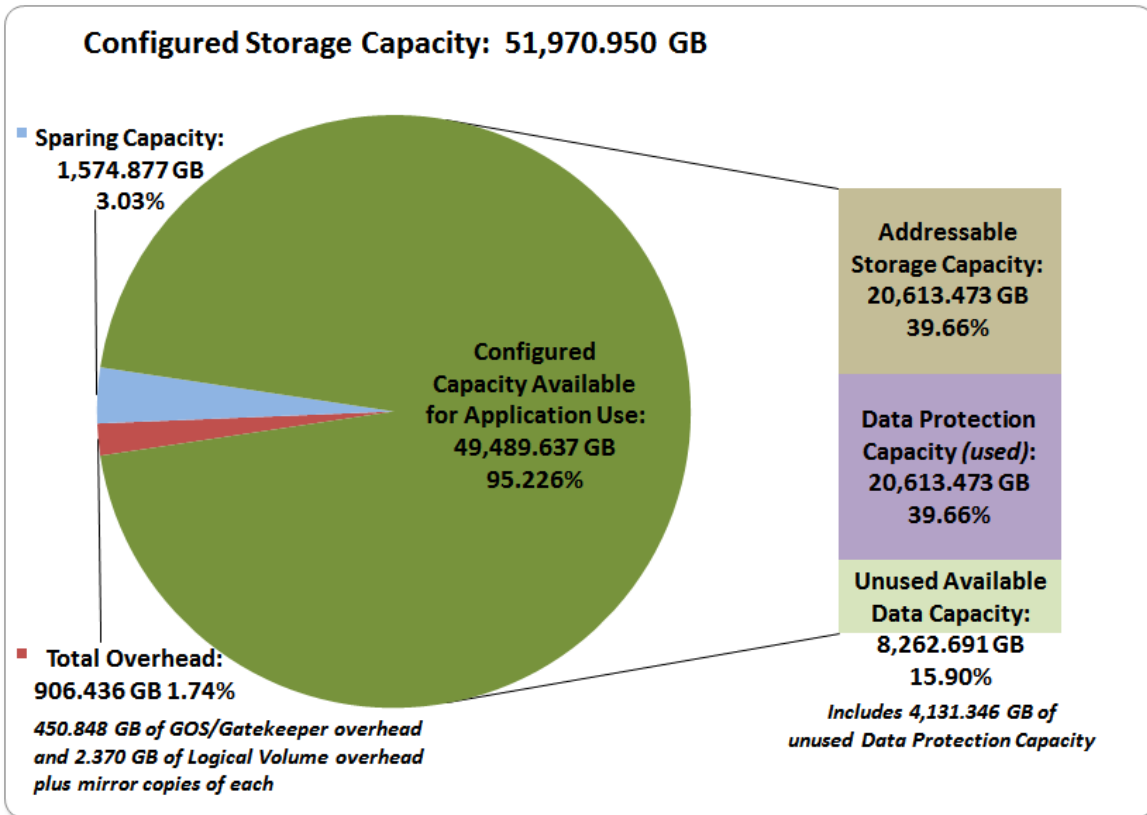
SPC-2 Reported Data				
EMC VMAX 400K				
SPC-2 MBPS™	SPC-2 Price-Performance	ASU Capacity (GB)	Total Price	Data Protection Level
55,643.78	\$33.58	20,132.659	\$1,868,567.85	Protected 2 (mirroring)
<i>The above SPC-2 MBPS™ value represents the aggregate data rate of all three SPC-2 workloads: Large File Processing (LFP), Large Database Query (LDQ), and Video On Demand (VOD)</i>				
<b>Currency Used:</b>		<b>"Target Country":</b>		
U.S. dollars		USA		
SPC-2 Large File Processing (LFP) Reported Data				
	Data Rate (MB/second)	Number of Streams	Data Rate per Stream	Price-Performance
LFP Composite	53,093.09			\$35.19
Write Only:				
1024 KiB Transfer	38,105.72	1,600	23.82	
256 KiB Transfer	39,604.05	1,600	24.75	
Read-Write:				
1024 KiB Transfer	47,324.69	1,600	29.58	
256 KiB Transfer	50,631.77	1,600	31.64	
Read Only:				
1024 KiB Transfer	71,277.05	1,600	44.55	
256 KiB Transfer	71,615.24	1,600	44.76	
<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	66,652.61			\$28.03
1024 KiB Transfer Size				
4 I/Os Outstanding	55,871.95	1,600	34.92	
1 I/O Outstanding	70,807.38	1,600	44.25	
64 KiB Transfer Size				
4 I/Os Outstanding	69,816.93	1,600	43.64	
1 I/O Outstanding	70,114.20	1,600	43.82	
<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
	47,185.63	60,000	0.79	\$39.60

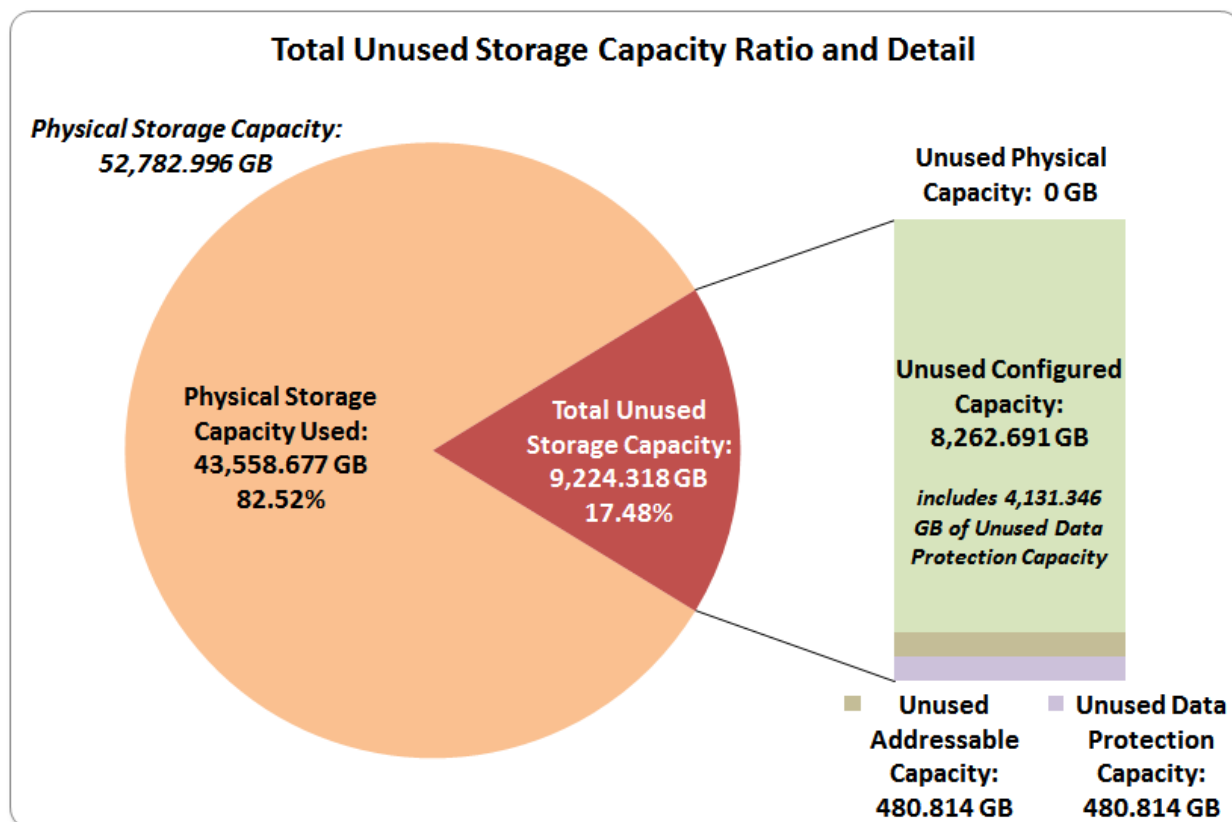
### Storage Capacities, Relationships and Utilization

The following four charts 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.

The capacity values in each of the following four charts are listed as integer values, for readability, rather than the decimal values listed elsewhere in this document.







SPC-2 Storage Capacity Utilization	
Application Utilization	38.14%
Protected Application Utilization	77.14%
Unused Storage Ratio	17.48%

**Application Utilization:** Total ASU Capacity (20,132.659 GB) divided by Physical Storage Capacity (52,782.996 GB).

**Protected Application Utilization:** Total ASU Capacity (20,132.659 GB) plus total Data Protection Capacity (25,198.036 GB) minus unused Data Protection Capacity (4,612.159 GB) divided by Physical Storage Capacity (52,782.996 GB).

**Unused Storage Ratio:** Total Unused Capacity (GB) divided by Physical Storage Capacity (52,782.996 GB) and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 26-27 in the Full Disclosure Report.



## Priced Storage Configuration Pricing

Product Description	Quantity	Unit List Price	Product List Price
VMAX 400K SYSTEM BAY 1 (3-Phase Power)	1	\$33,360.00	\$33,360.00
VMAX VG 120 SLT Drive Enclosure	16	\$25,300.00	\$404,800.00
VMAX 400K BASE Engine (512GB Cache)	1	\$437,830.00	\$437,830.00
VMAX 400K ADD Engine (512GB Cache)	7	\$394,045.00	\$2,758,315.00
VMAX400K 200GB FLASH SPARE Drives	8	\$3,905.00	\$31,240.00
VMAX400K 200GB FLASH R1 256 Drives	256	\$3,210.00	\$821,760.00
VMAX VG 5 METER CONTIGIB ETH CABLE	2	\$1,250.00	\$2,500.00
VMAX VG 3 METER CONTIGIB ETH CABLE	4	\$1,250.00	\$5,000.00
ADPTR AC 3PH 50A W3-4IN CONDUIT ADPTR	8	\$400.00	\$3,200.00
PWR Cable HBL-RSTOL 3-Phase	4	\$1,155.00	\$4,620.00
VMAX VG DIRECT 3-METER DAE Cable	16	\$1,285.00	\$20,560.00
VMAX VG 2 METER CONTIGIB ETH CABLE	1	\$1,250.00	\$1,250.00
VMAX 400K FABRIC Interconnect, consists of two SX6018 18-port Infiniband switches	1	\$46,560.00	\$46,560.00
VMAX VG SB1 Dual-Engine Hex Door Pair	1	\$3,000.00	\$3,000.00
VMAX VG SB2-8 Dual-Engine Hex Door Pair	3	\$3,000.00	\$9,000.00
VMAX VG SIDE PANELS	1	\$645.00	\$645.00
VMAX VG 8Gb FC I/O Module Pairs, 8 ports per pair	16	\$2,070.00	\$33,120.00
VMAX VG FLASH Vault Modules 700	8	\$17,860.00	\$142,880.00
VMAX VG ADD SYSTEM BAY (3-Phase Power)	3	\$13,890.00	\$41,670.00
<b>Hardware Components (with 3-year Premium Support)</b>			<b>\$4,801,310.00</b>
HYPERMAX OS 0-50TB	25	\$1,425.00	\$35,625.00
HYPERMAX OS BASE NEW 400K	1	\$28,570.00	\$28,570.00
<b>Software Components (with 3-year Premium Support)</b>			<b>\$64,195.00</b>
VMAX Installation	1		\$4,440.00
VMAX Installation Add-On	3		\$1,740.00
<b>Installation</b>			<b>\$6,180.00</b>
EMULEX LP12002-E dual port 8Gb FC HBA	64	\$505.00	\$32,320.00
5M FC Cables	128	\$23.99	\$3,070.72
<b>3rd Party Components</b>			<b>\$35,390.72</b>

**Priced Storage Configuration Pricing (continued)**

<b>Product Category</b>	<b>Product List Price</b>	<b>Discount</b>	<b>Discounted Price</b>
<b>Hardware Sub-total</b>	<b>\$4,801,310.00</b>	<b>62%</b>	<b>\$1,802,891.91</b>
<b>Software Sub-total</b>	<b>\$64,195.00</b>	<b>62%</b>	<b>\$24,105.22</b>
<b>Services Sub-total</b>	<b>\$6,180.00</b>	<b>0%</b>	<b>\$6,180.00</b>
<b>3rd Party Sub-total</b>	<b>\$35,390.72</b>	<b>0%</b>	<b>\$35,390.72</b>
<b>Grand Total</b>	<b>\$4,907,075.72</b>		<b>\$1,868,567.85</b>

The above 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

### 64 – Emulex LPe12002-E Dual Port 8Gb FC HBAs



128 – 8 Gbps FC connections  
 (2 connections per HBA)  
 (8 connections per server)  
 (16 connections per VMAX 400 Engine)



- 8 – VMAX 400K Engines (base plus 7), each with 512 GB cache (4,096 GB total)**
- 4 – 2x4 lane 6Gb SAS I/O Modules (8 2x4 lane connections)**  
 (32 modules total, 64x4 lane connections total and used)
- 16 – 8-port 8Gb FC I/O Module pairs w/SPFs**  
 (4 modules and 32 ports per VMAX 400K Engine)  
 (32 modules total, 128 ports total and used)
- 1 – VMAX 400K FABRIC Interconnect (2 – 18-port InfiniBand switches)**
- 8 – VMAX VG FLASH Vault Modules**
- 16 – VMAX VG 120 SLT Drive Enclosures**  
 (8 Drive Enclosures with 17 Flash Drives, including 1 spare)  
 (8 Drive Enclosures with 16 Flash Drives)
- 264 – VMAX 400K 200 GB Flash Drives**
- 4 – VMAX 400K System Bays and PDUs (2 VMAX 400K Engines per bay)**

## EMC VMAX 400K

## Priced Storage Configuration Components

<b>Priced Storage Configuration</b>
64 – Emulex LightPulse LPe12002-E Dual Port 8Gb FC HBAs
<b>EMC VMAX 400K</b>
8 – VMAX 400K Engines ( <i>base plus 7</i> ), each with 512 GB cache ( <i>4,096 GB total</i> )
4 – 2x4 lane 6Gb SAS I/O Modules ( <i>8 2x4 lane connections</i> ) ( <i>32 modules total, 64x4 lane connections total and used</i> )
16 – 8 port 8Gb FC I/O Module pairs ( <i>SFPs included</i> ) ( <i>4 modules and 32 ports per VMAX 400K Engine,</i> <i>32 modules total, 128 ports total and used</i> )
1 – VMAX 400K FABRIC Interconnect ( <i>consists of 2 SX6018 18-port Infiniband switches</i> )
8 – VMAX VG FLASH Vault Modules 700
16 – VMAX VG 120 SLT Drive Enclosures ( <i>8 Drive Enclosures with 17 Flash Drives, including 1 spare,</i> <i>8 Drive Enclosures with 16 Flash Drives</i> )
8 – VMAX 400K 200 GB FLASH SPARE Drives
256 – VMAX 400K 200 GB FLASH R1 Drives
4 – VMAX 400K System Bays and PDUs ( <i>3-phase power</i> )

## **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 \(Benchmark Configuration \(BC\)/Tested Storage Configuration \(TSC\) Diagram\)](#).

### **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 Tested Storage Configuration (TSC) was configured with direct-attached storage.

### **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 [23 \(Host System and Tested Storage Configuration Components\)](#).

## Benchmark Configuration/Tested Storage Configuration Diagram



## EMC VMAX 400K

## Host System and Tested Storage Configuration Components

<b>Host System</b>
<b>32 – Cisco UCS C240-M3 rack servers, with:</b> 2 – Intel® Xeon® 2.1 GHz E5-2620v2 Ivy Bridge processors 6 cores per processor and 15 MB Intel® Smart Cache 32 GB main memory Oracle Solaris 10 x86 1/13 s10x_u11wos_24 PCIe Gen3
<b>Tested Storage Configuration (TSC) Components</b>
64 – Emulex LightPulse LPe12002-E Dual Port 8Gb FC HBAs
<b>EMC VMAX 400K</b> 8 – VMAX 400K Engines ( <i>base plus 7</i> ), each with 512 GB cache ( <i>4,096 GB total</i> ) 4 – 2x4 lane 6Gb SAS I/O Modules ( <i>8 2x4 lane connections</i> ) ( <i>32 modules total, 64x4 lane connections total and used</i> )
16 – 8 port 8Gb FC I/O Module pairs ( <i>SFPs included</i> ) ( <i>4 modules and 32 ports per VMAX 400K Engine,</i> <i>32 modules total, 128 ports total and used</i> )
1 – VMAX 400K FABRIC Interconnect ( <i>consists of 2 SX6018 18-port Infiniband switches</i> )
8 – VMAX VG FLASH Vault Modules 700
16 – VMAX VG 120 SLT Drive Enclosures ( <i>8 Drive Enclosures with 17 Flash Drives, including 1 spare,</i> <i>8 Drive Enclosures with 16 Flash Drives</i> )
8 – VMAX 400K 200 GB FLASH SPARE Drives
256 – VMAX 400K 200 GB FLASH R1 Drives
4 – VMAX 400K System Bays and PDUs ( <i>3-phase power</i> )

## Customer Tunable Parameters and Options

### Clause 10.6.7.1

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

## Tested Storage Configuration (TSC) Creation and Configuration

### Clause 10.6.7.2

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 69 contains the detailed information that describes how to create and configure the logical TSC.

## SPC-2 Workload Generator Storage Configuration

### Clause 10.6.7.3

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 Parameter Files](#) on page 78.



## ASU Pre-Fill

### Clause 6.3.3

*The SPC-2 ASU is required to be completely filled with specified content prior to the execution of audited SPC-2 Tests. The content is required to consist of random data pattern such as that produced by an SPC recommended tool.*

...

### Clause 6.3.3.3

*The required ASU pre-fill must be executed as the first step in the uninterrupted benchmark execution sequence described in Clause 6.4.2. That uninterrupted sequence will consist of: ASU Pre-Fill, Large File Processing, Large Database Query, Video on Demand Delivery and Persistence Test Run 1. The only exception to this requirement is described in Clause 6.3.3.4.*

### Clause 6.3.3.4

*If approved by the Auditor, the Test Sponsor may complete the required ASU pre-fill prior to the execution of the audited SPC-2 Tests and not as part of the SPC-2 Test execution sequence.*

*The Auditor will verify the required random data pattern content in the ASU prior to the execution of the audited SPC-2 Tests. If that verification fails, the Test Sponsor is required to reload the specified content to the ASU.*

The configuration file used to complete the required ASU pre-fill appears in [Appendix D: SPC-2 Workload Generator Storage Commands and Parameter Files](#) on page [78](#).

## **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 [63](#) 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**

#### *Clause 10.6.8.1*

*Two tables and four charts documenting the storage capacities and relationships of the SPC-2 Storage Hierarchy (Clause 2.1) shall be included in the FDR. ... The capacity value in each chart may be listed as an integer value, for readability, rather than the decimal value listed in the table below.*

#### **SPC-2 Storage Capacities**

The Physical Storage Capacity consisted of 52,782.996 GB distributed over 264 solid state devices (SSDs) each with a formatted capacity of 199.936 GB. There was 0.000 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 812.046 GB (1.54%) of the Physical Storage Capacity. There was 8,262.691 GB (15.90%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 97.67% of the Addressable Storage Capacity resulting in 480.814 GB (2.33%) of Unused Storage within the Addressable Storage Capacity. The Data Protection (*Mirroring*) capacity was 25,198.036 GB of which 20,585.877 GB was utilized. The total Unused Storage was 9,224.318 GB.

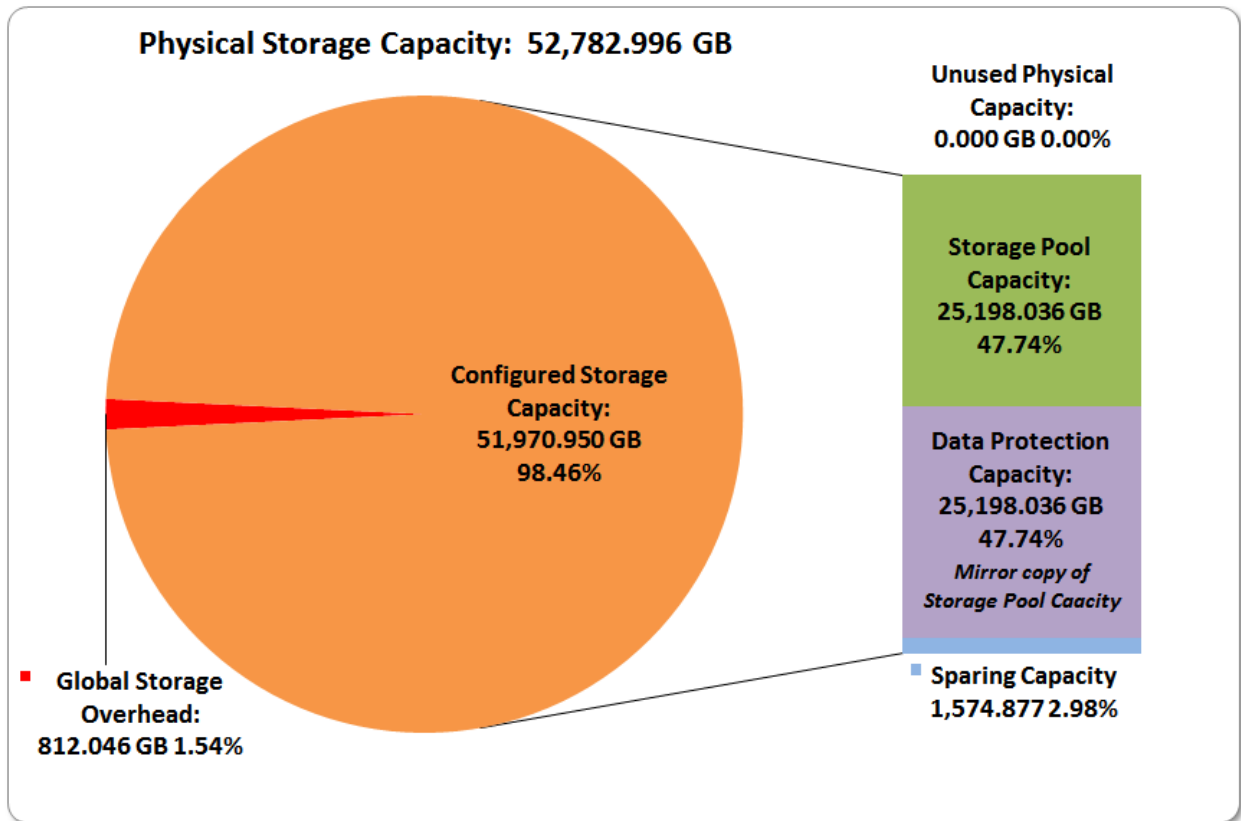
*Note: The configured Storage Devices may include additional storage capacity reserved for system overhead, which is not accessible for application use. That storage capacity may not be included in the value presented for Physical Storage Capacity.*

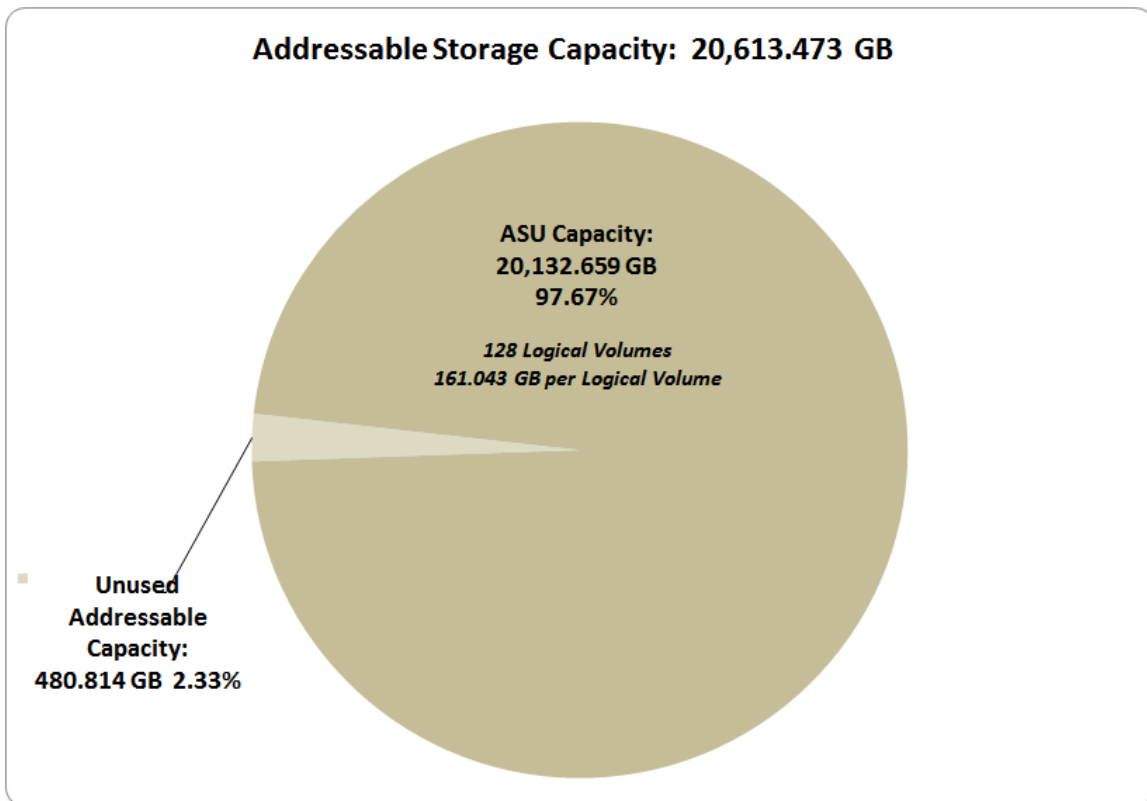
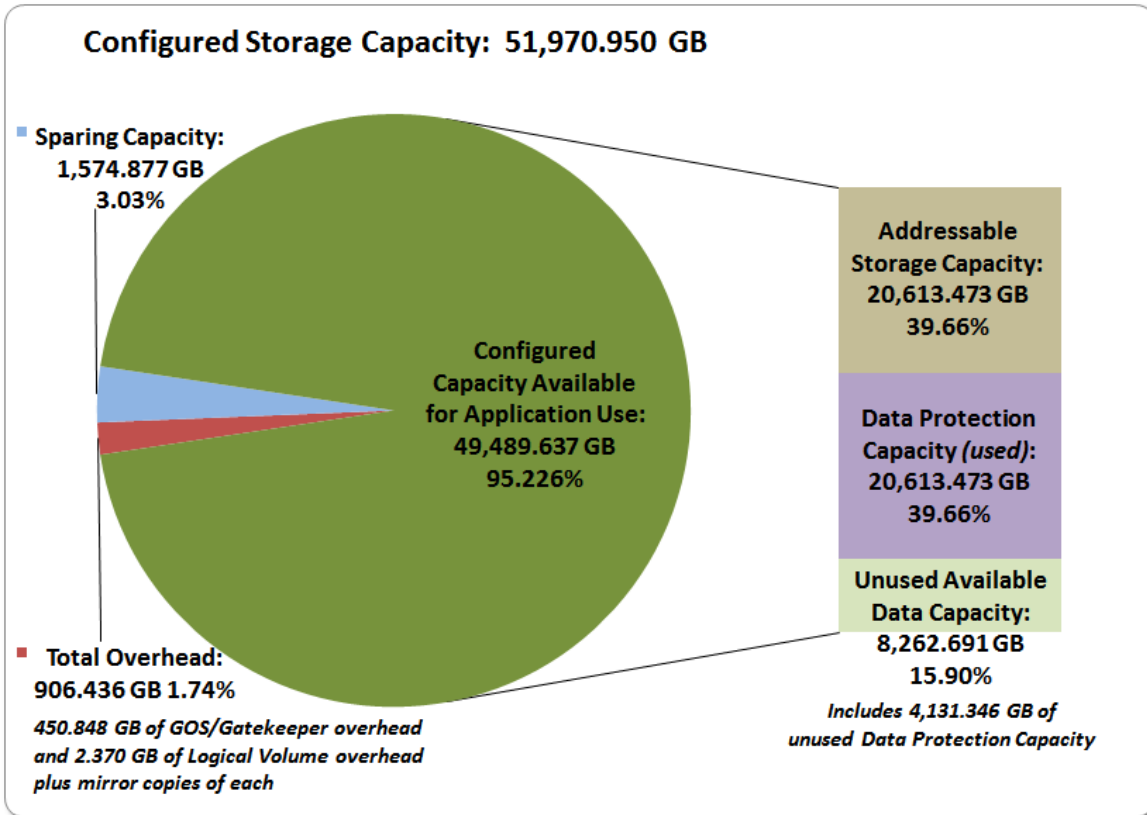
<b>SPC-2 Storage Capacities</b>		
<b>Storage Hierarchy Component</b>	<b>Units</b>	<b>Capacity</b>
Total ASU Capacity	Gigabytes (GB)	20,132.659
Addressable Storage Capacity	Gigabytes (GB)	20,613.473
Configured Storage Capacity	Gigabytes (GB)	51,970.950
Physical Storage Capacity	Gigabytes (GB)	52,782.996
Data Protection ( <i>Mirroring</i> )	Gigabytes (GB)	25,198.036
Required Storage ( <i>overhead/sparing</i> )	Gigabytes (GB)	2,481.313
Global Storage Overhead	Gigabytes (GB)	812.046
Total Unused Storage	Gigabytes (GB)	9,224.318

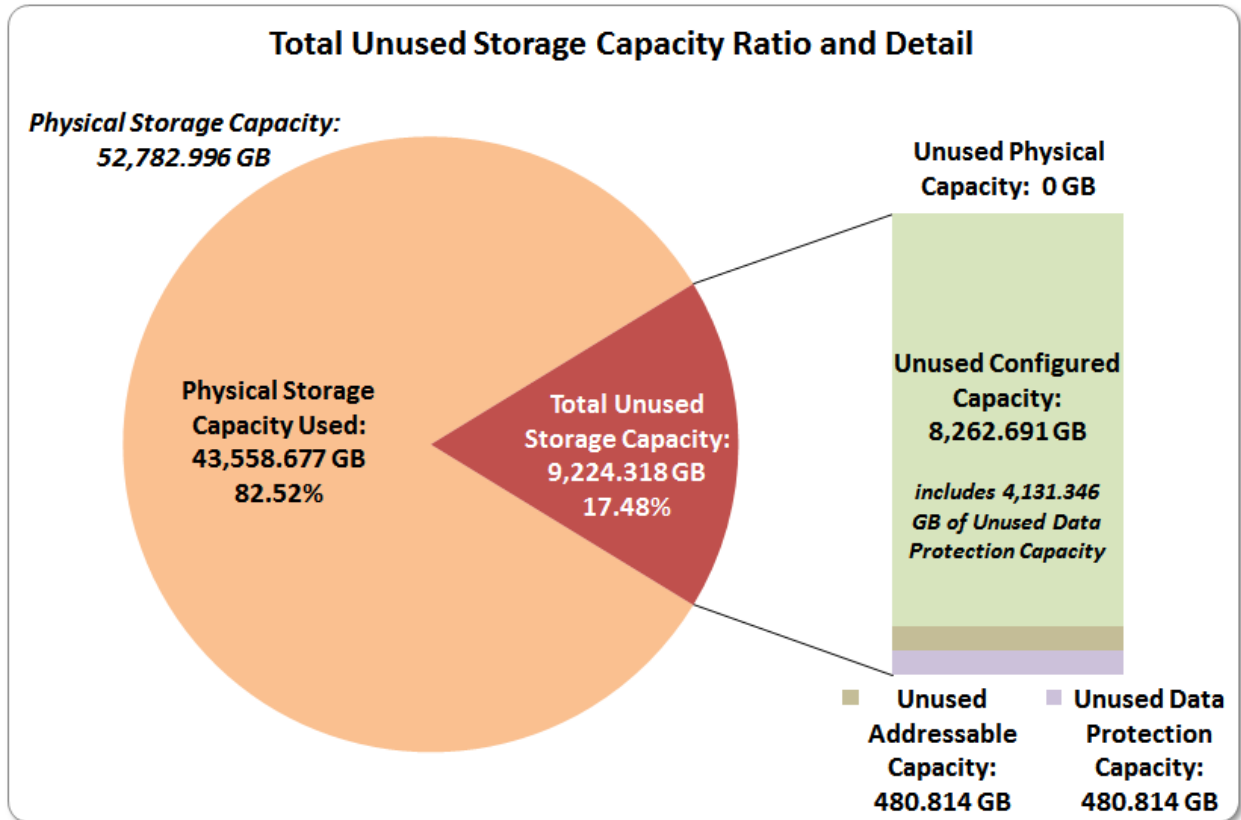
**SPC-2 Storage Hierarchy Ratios**

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
<b>Total ASU Capacity</b>	97.67%	38.74%	38.14%
<b>Data Protection (<i>mirroring</i>)</b>		48.48%	47.74%
<b>Addressable Storage Capacity</b>		39.66%	39.05%
<b>Required Storage (<i>overhead/sparing</i>)</b>		4.77%	4.70%
<b>Configured Storage Capacity</b>			98.46%
<b>Global Storage Overhead</b>			1.54%
<b>Unused Storage:</b>			
<b>Addressable</b>	2.33%		
<b>Configured</b>		15.90%	
<b>Physical</b>			0.00%

**SPC-1 Storage Capacity Charts**







### 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-2 Storage Capacity Utilization	
Application Utilization	38.14%
Protected Application Utilization	77.14%
Unused Storage Ratio	17.48%

## Logical Volume Capacity and ASU Mapping

### Clause 10.6.8.3

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.

<b>Logical Volume (LV) Capacity and Mapping</b>			
<b>ASU (20,132.659 GB)</b>			
	<b>Total Capacity (GB)</b>	<b>Capacity Used (GB)</b>	<b>Capacity Unused (GB)</b>
128 Logical Volumes	161.043 per LV	157.286 per LV	3.76 per LV

See the Storage Definition (sd) entries in [Appendix D: SPC-2 Workload Generator Storage Commands and Parameter](#) Files on page [78](#) for more detailed configuration information.

## **SPC-2 BENCHMARK EXECUTION RESULTS**

This portion of the Full Disclosure Report documents the results of the various SPC-2 Tests, Test Phases, Test Run Sequences, and Test Runs. An [SPC-2 glossary](#) on page [63](#) 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
  - 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 6.4.3.1

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

### Clause 6.4.3.2

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

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

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

### Clause 10.6.9.1

*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. *The following three tables:*
  - *Average Data Rate: The average Data Rate, in MB per second for the Measurement Interval of each Test Run in the Large File Processing Test.*
  - *Average Data Rate per Stream: The average Data Rate per Stream, in MB per second, for the Measurement Interval of each Test Run in the Large File Processing Test.*
  - *Average Response Time: The average response time, in milliseconds (ms), for the Measurement Interval of each Test Run in the Large File Processing Test.*
4. *Average Data Rate, Average Data Rate per Stream and Average Response Time graphs as defined in Clauses 10.1.1, 10.1.2 and 10.1.3.*

## SPC-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 [120](#).

### 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.

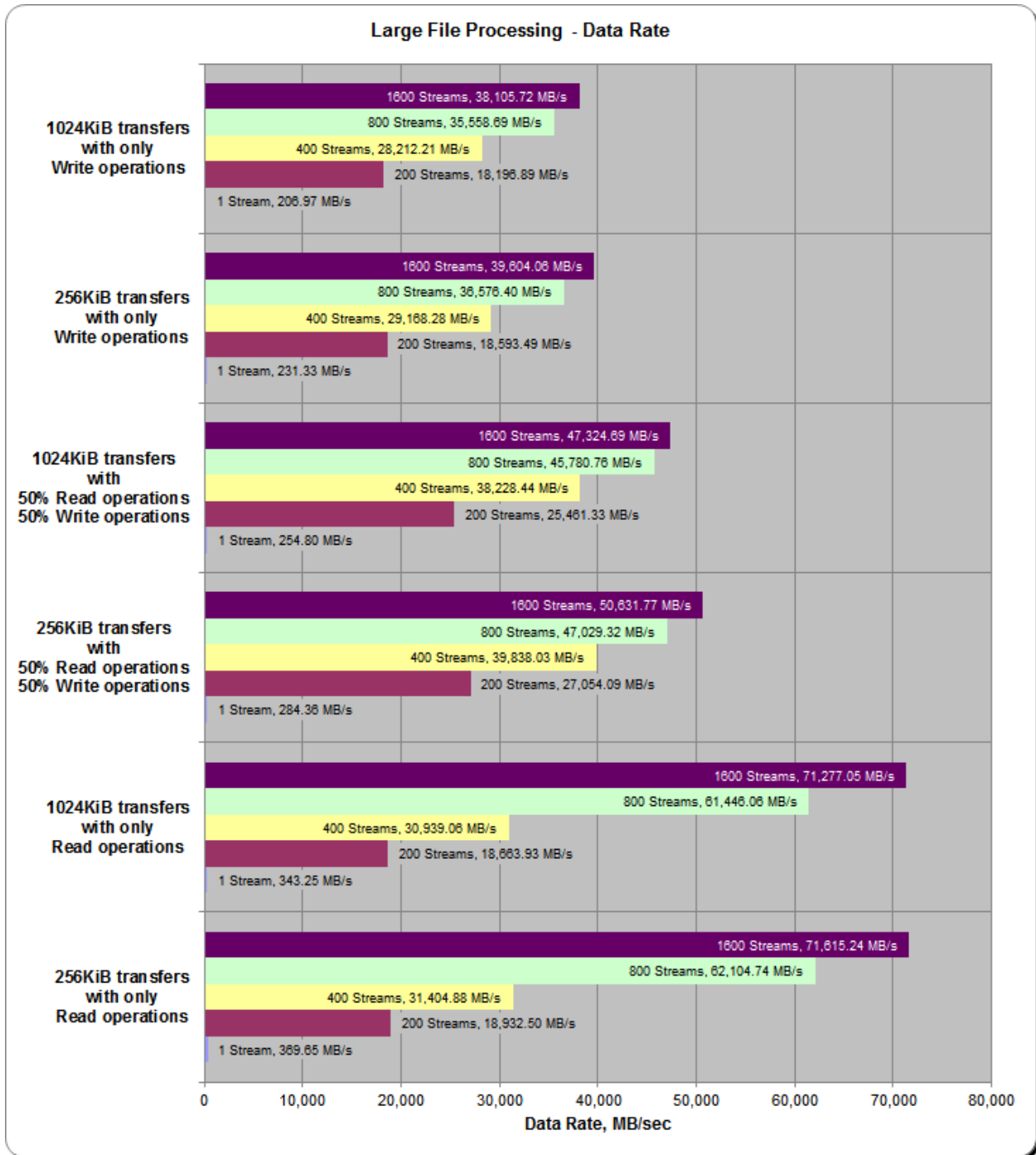
[SPC-2 Large File Processing Test Results File](#)

### 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	200 Streams	400 Streams	800 Streams	1600 Streams
Write 1024KiB	206.97	18,196.89	28,212.21	35,558.69	38,105.72
Write 256KiB	231.33	18,593.49	29,168.28	36,576.40	39,604.06
Read/Write 1024KiB	254.80	25,461.33	38,228.44	45,780.76	47,324.69
Read/Write 256KiB	284.36	27,054.09	39,838.03	47,029.32	50,631.77
Read 1024KiB	343.25	18,663.93	30,939.06	61,446.06	71,277.05
Read 256KiB	369.65	18,932.50	31,404.88	62,104.74	71,615.24

SPC-2 Large File Processing Average Data Rates Graph

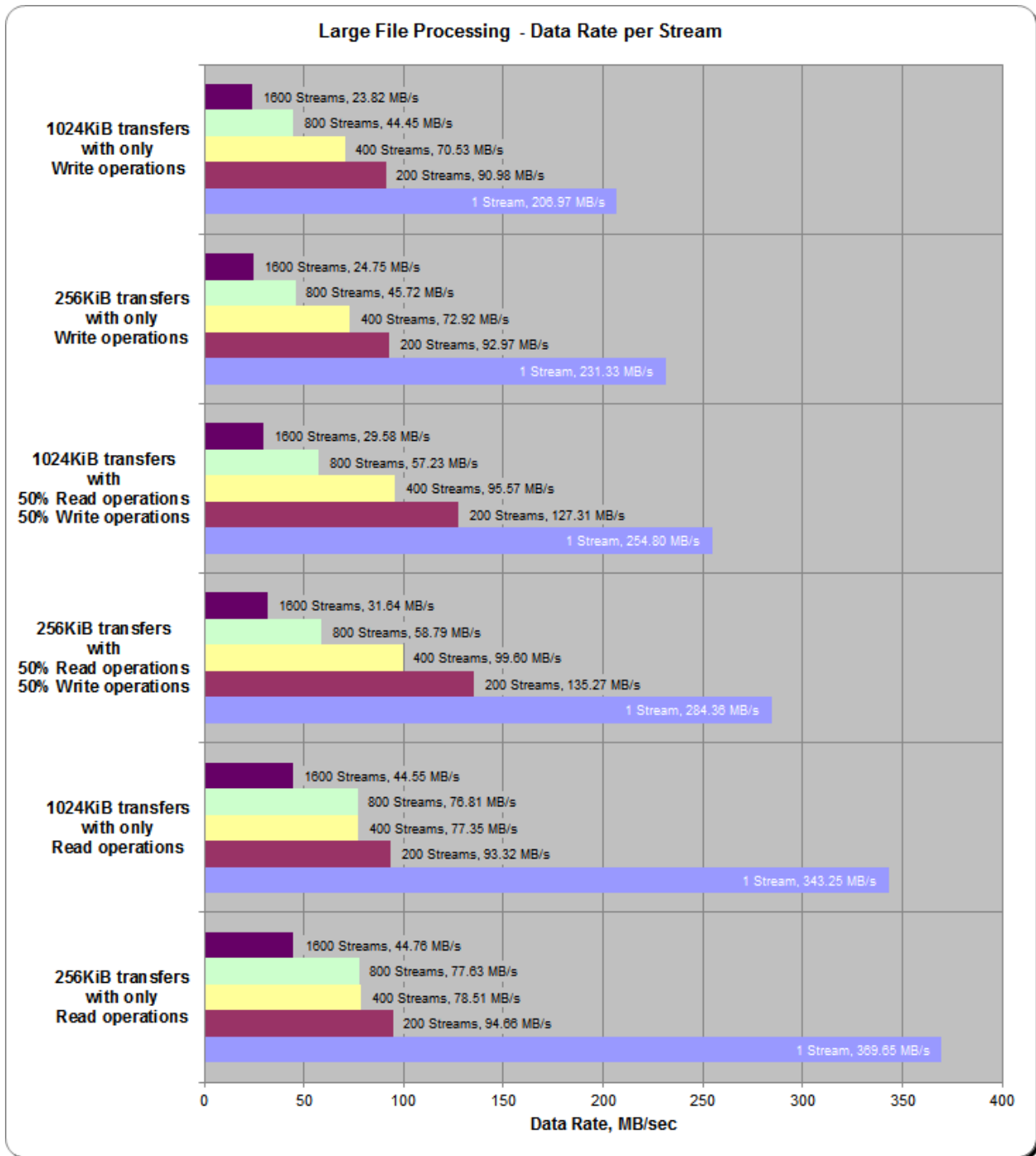


### SPC-2 Large File Processing Average Data Rate per Stream

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	200 Streams	400 Streams	800 Streams	1600 Streams
Write 1024KiB	206.97	90.98	70.53	44.45	23.82
Write 256KiB	231.33	92.97	72.92	45.72	24.75
Read/Write 1024KiB	254.80	127.31	95.57	57.23	29.58
Read/Write 256KiB	284.36	135.27	99.60	58.79	31.64
Read 1024KiB	343.25	93.32	77.35	76.81	44.55
Read 256KiB	369.65	94.66	78.51	77.63	44.76

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

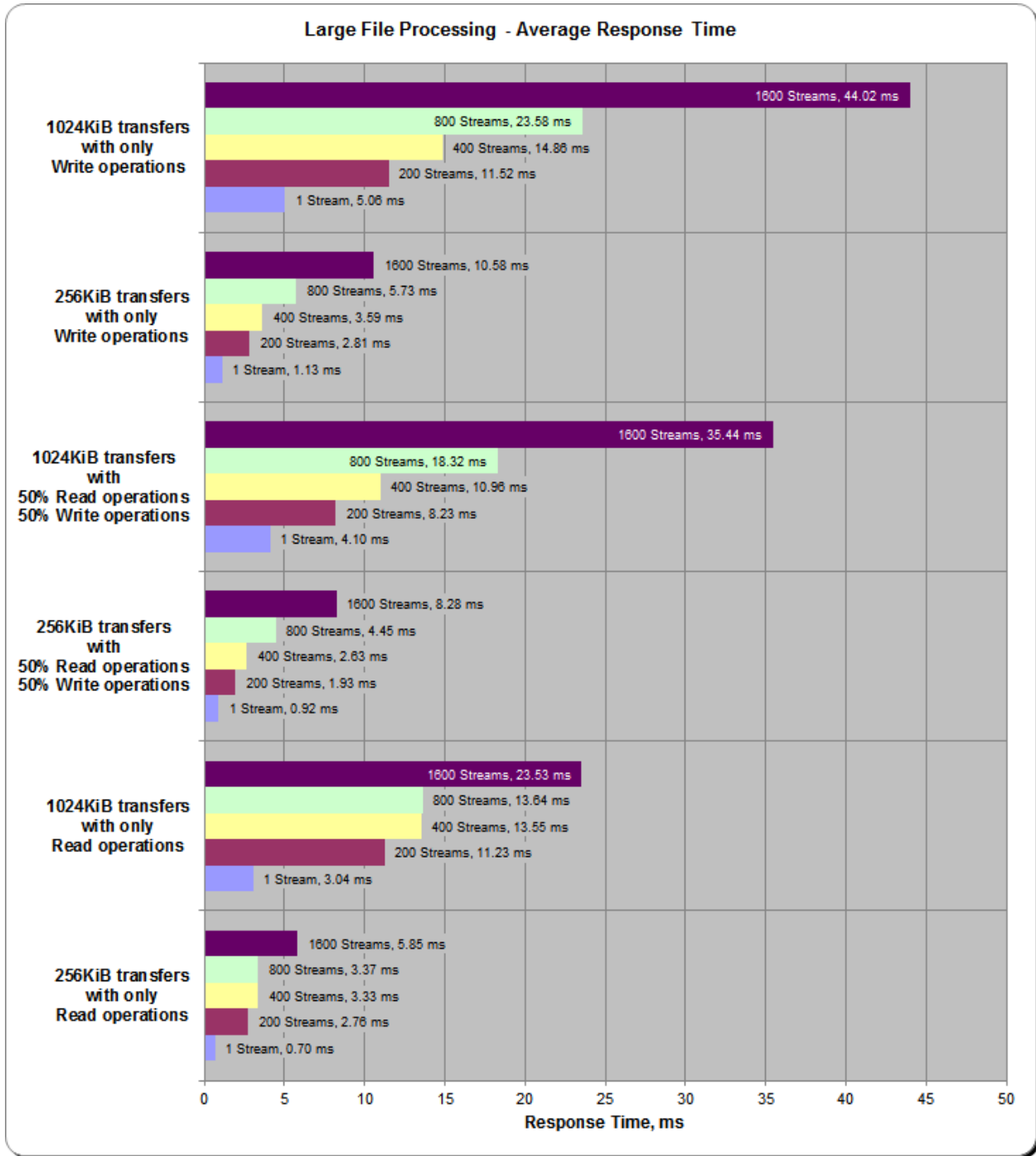


**SPC-2 Large File Processing Average Response Time**

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.

<b>Test Run Sequence</b>	<b>1 Stream</b>	<b>200 Streams</b>	<b>400 Streams</b>	<b>800 Streams</b>	<b>1600 Streams</b>
Write 1024KiB	5.06	11.52	14.86	23.58	44.02
Write 256KiB	1.13	2.81	3.59	5.73	10.58
Read/Write 1024KiB	4.10	8.23	10.96	18.32	35.44
Read/Write 256KiB	0.92	1.93	2.63	4.45	8.28
Read 1024KiB	3.04	11.23	13.55	13.64	23.53
Read 256KiB	0.70	2.76	3.33	3.37	5.85

**SPC-2 Large File Processing Average Response Time Graph**



## Large File Processing Test – WRITE ONLY Test Phase

### Clause 10.6.9.1.1

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 by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by 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 by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by Intervals graphs for the "WRITE ONLY, 256 KiB Transfer Size" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*

*A hyperlink for each of the above tables and graphs may appear in the FDR to provide access to the table or graph.*

A hyperlink to a table with the SPC-2 "Large File Processing/WRITE ONLY/1024 KiB Transfer Size" Test Run data appears on the next page. That entry is followed by hyperlinks to graphs illustrating the average Data Rate, average Data Rate per Stream, and average Response Time produced by the same Test Runs. The table and graphs present the data at five-second intervals.

Immediately following the above SPC-2 "Large File Processing/WRITE ONLY/1024 KiB Transfer Size" entries will be hyperlinks for SPC-2 "Large File Processing/WRITE ONLY/256 KiB Transfer Size" table and graphs. The table contains the Test Run data and the graphs illustrate the average Data Rate, average Data Rate per Stream, and average Response Time produced by the Test Runs.



**SPC-2 “Large File Processing/WRITE ONLY/1024 KiB Transfer Size” Test Run Data**

[SPC-2 “Large File Processing/WRITE ONLY/1024 KiB Transfer Size” Test Run Data Tables: Ramp-Up, Measurement Interval, Run-Out, and Ramp-Down Periods](#)  
(3 pages)

**SPC-2 “Large File Processing/WRITE ONLY/1024 KiB Transfer Size” Graphs**

**Average Data Rate – Complete Test Run**

**Average Data Rate – Measurement Interval (MI) Only**

**Average Data Rate per Stream**

**Average Response Time**

[SPC-2 “Large File Processing/WRITE ONLY/1024 KiB Transfer Size” graphs](#)  
(four pages, 1 graph per page)

**SPC-2 “Large File Processing/WRITE ONLY/256 KiB Transfer Size” Test Run Data**

[SPC-2 “Large File Processing/WRITE ONLY/256 KiB Transfer Size” Test Run Data Tables: Ramp-Up, Measurement Interval, Run-Out, and Ramp-Down Periods](#)  
(3 pages)

**SPC-2 “Large File Processing/WRITE ONLY/256 KiB Transfer Size” Graphs**

**Average Data Rate – Complete Test Run**

**Average Data Rate – Measurement Interval (MI) Only**

**Average Data Rate per Stream**

**Average Response Time**

[SPC-2 “Large File Processing/WRITE ONLY/256 KiB Transfer Size” graphs](#)  
(four pages, 1 graph per page)

## Large File Processing Test – READ-WRITE Test Phase

### Clause 10.6.9.1.2

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 by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by 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 by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by Intervals graphs for the "READ-WRITE, 256 KiB Transfer Size" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*

*A hyperlink for each of the above tables and graphs may appear in the FDR to provide access to the table or graph.*

A hyperlink to a table with the SPC-2 "Large File Processing/READ-WRITE/1024 KiB Transfer Size" Test Run data appears on the next page. That entry is followed by hyperlinks to graphs illustrating the average Data Rate, average Data Rate per Stream, and average Response Time produced by the same Test Runs. The table and graphs present the data at five-second intervals.

Immediately following the above SPC-2 "Large File Processing/READ-WRITE/1024 KiB Transfer Size" entries will be hyperlinks for SPC-2 "Large File Processing/READ-WRITE/256 KiB Transfer Size" table and graphs. The table contains the Test Run data and the graphs illustrate the average Data Rate, average Data Rate per Stream, and average Response Time produced by the Test Runs.

**SPC-2 “Large File Processing/READ-WRITE/1024 KiB Transfer Size” Test Run Data**

[SPC-2 “Large File Processing/READ-WRITE/1024 KiB Transfer Size” Test Run Data Tables: Ramp-Up, Measurement Interval, Run-Out, and Ramp-Down Periods](#)  
(3 pages)

**SPC-2 “Large File Processing/READ-WRITE/1024 KiB Transfer Size” Graphs**

**Average Data Rate – Complete Test Run**

**Average Data Rate – Measurement Interval (MI) Only**

**Average Data Rate per Stream**

**Average Response Time**

[SPC-2 “Large File Processing/READ-WRITE/1024 KiB Transfer Size” graphs](#)  
(four pages, 1 graph per page)

**SPC-2 “Large File Processing/READ-WRITE/256 KiB Transfer Size” Test Run Data**

[SPC-2 “Large File Processing/READ-WRITE/256 KiB Transfer Size” Test Run Data Tables: Ramp-Up, Measurement Interval, Run-Out, and Ramp-Down Periods](#)  
(3 pages)

**SPC-2 “Large File Processing/READ-WRITE/256 KiB Transfer Size” Graphs**

**Average Data Rate – Complete Test Run**

**Average Data Rate – Measurement Interval (MI) Only**

**Average Data Rate per Stream**

**Average Response Time**

[SPC-2 “Large File Processing/READ-WRITE/256 KiB Transfer Size” graphs](#)  
(four pages, 1 graph per page)

## Large File Processing Test – READ ONLY Test Phase

### Clause 10.6.9.1.3

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 by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by 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 by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by Intervals graphs for the "READ ONLY, 256 KiB Transfer Size" Test Runs as specified in Clauses 10.1.4 – 10.1.6.*

*A hyperlink for each of the above tables and graphs may appear in the FDR to provide access to the table or graph.*

A hyperlink to a table with the SPC-2 "Large File Processing/READ ONLY/1024 KiB Transfer Size" Test Run data appears on the next page. That entry is followed by hyperlinks to graphs illustrating the average Data Rate, average Data Rate per Stream, and average Response Time produced by the same Test Runs. The table and graphs present the data at five-second intervals.

Immediately following the above SPC-2 "Large File Processing/READ ONLY/1024 KiB Transfer Size" entries will be hyperlinks for SPC-2 "Large File Processing/READ ONLY/256 KiB Transfer Size" table and graphs. The table contains the Test Run data and the graphs illustrate the average Data Rate, average Data Rate per Stream, and average Response Time produced by the Test Runs.

**SPC-2 “Large File Processing/READ ONLY/1024 KiB Transfer Size” Test Run Data**

[SPC-2 “Large File Processing/READ ONLY/1024 KiB Transfer Size” Test Run Data Tables: Ramp-Up, Measurement Interval, Run-Out, and Ramp-Down Periods](#)  
(3 pages)

**SPC-2 “Large File Processing/READ ONLY/1024 KiB Transfer Size” Graphs**

**Average Data Rate – Complete Test Run**

**Average Data Rate – Measurement Interval (MI) Only**

**Average Data Rate per Stream**

**Average Response Time**

[SPC-2 “Large File Processing/READ ONLY/1024 KiB Transfer Size” graphs](#)  
(four pages, 1 graph per page)

**SPC-2 “Large File Processing/READ ONLY/256 KiB Transfer Size” Test Run Data**

[SPC-2 “Large File Processing/READ ONLY/256 KiB Transfer Size” Test Run Data Tables: Ramp-Up, Measurement Interval, Run-Out, and Ramp-Down Periods](#)  
(3 pages)

**SPC-2 “Large File Processing/READ ONLY/256 KiB Transfer Size” Graphs**

**Average Data Rate – Complete Test Run**

**Average Data Rate – Measurement Interval (MI) Only**

**Average Data Rate per Stream**

**Average Response Time**

[SPC-2 “Large File Processing/READ ONLY/256 KiB Transfer Size” graphs](#)  
(four pages, 1 graph per page)

## Large Database Query Test

### Clause 6.4.4.1

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

### Clause 6.4.4.2

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

- 1. 1024 KiB TRANSFER SIZE*
- 2. 64 KiB TRANSFER SIZE*

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

### Clause 10.6.9.2

*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:*
  - Average Data Rate: The average Data Rate, in MB per second for the Measurement Interval of each Test Run in the Large Database Query Test.*
  - Average Data Rate per Stream: The average Data Rate per Stream, in MB per second, for the Measurement Interval of each Test Run in the Large Database Query Test.*
  - Average Response Time: The average response time, in milliseconds (ms), for the Measurement Interval of each Test Run in the Large Database Query Test.*
- 4. Average Data Rate, Average Data Rate per Stream and Average Response time graphs as defined in Clauses 10.1.1, 10.1.2 and 10.1.3.*

## SPC-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 [120](#).

## 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.

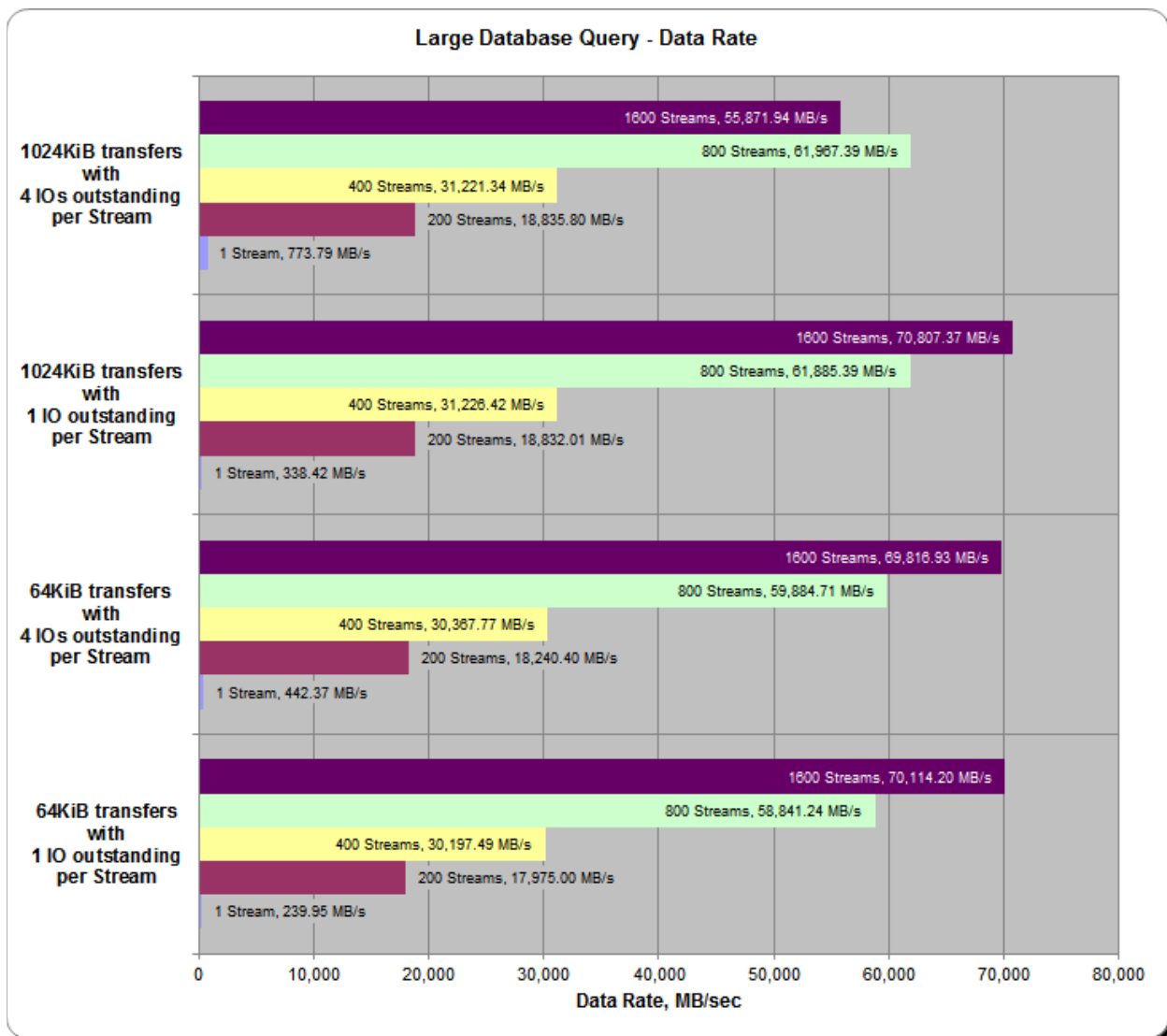
[SPC-2 Large Database Query Test Results File](#)

### 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	200 Streams	400 Streams	800 Streams	1600 Streams
1024KiB w/ 4 IOs/Stream	773.79	18,835.80	31,221.34	61,967.39	55,871.94
1024KiB w/ 1 IO/Stream	338.42	18,832.01	31,226.42	61,885.39	70,807.37
64KiB w/ 4 IOs/Stream	442.37	18,240.40	30,367.77	59,884.71	69,816.93
64KiB w/ 1 IO/Stream	239.95	17,975.00	30,197.49	58,841.24	70,114.20

### SPC-2 Large Database Query Average Data Rates Graph

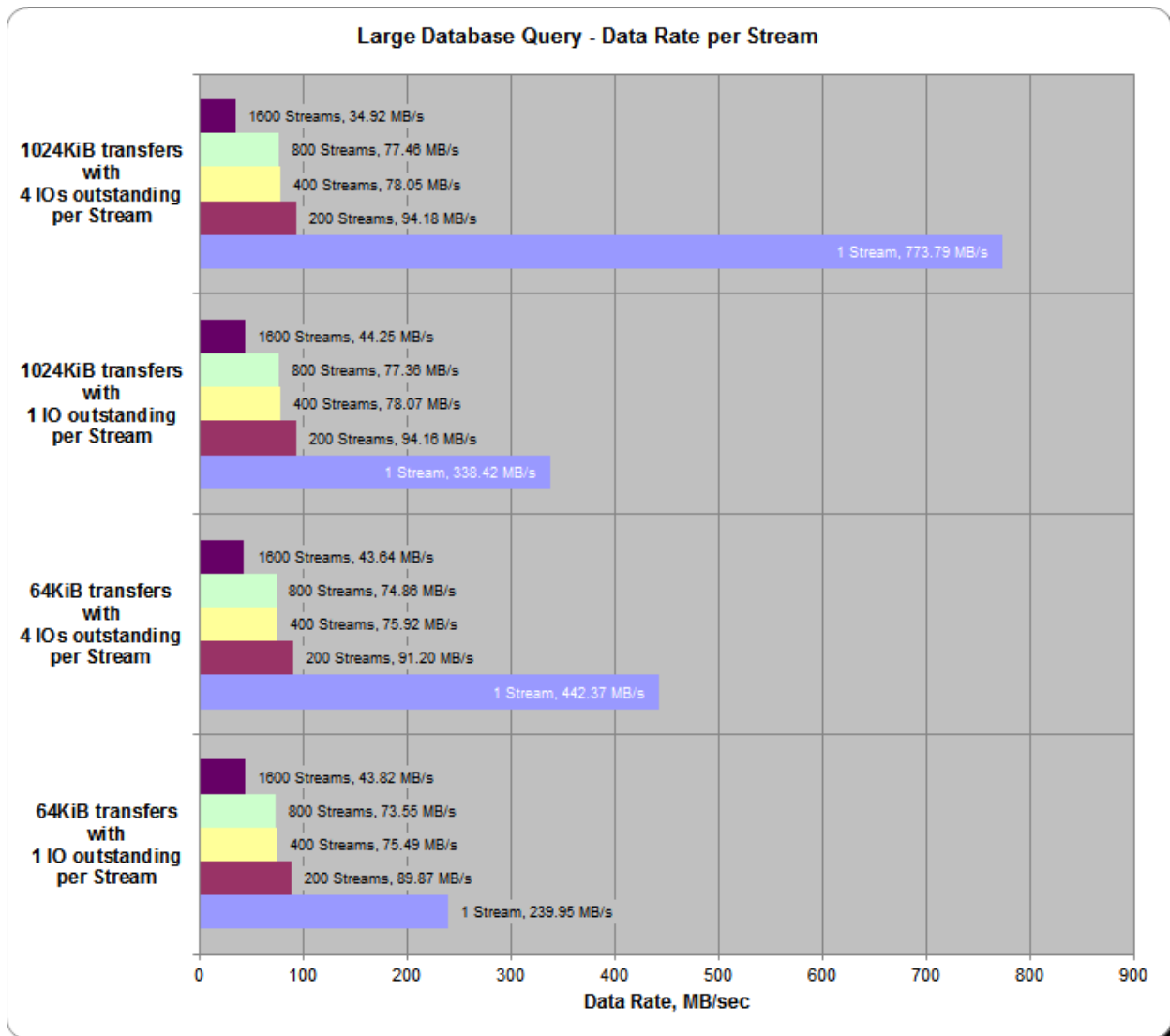


### SPC-2 Large Database Query Average Data Rate per Stream

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	200 Streams	400 Streams	800 Streams	1600 Streams
1024KiB w/ 4 IOs/Stream	773.79	94.18	78.05	77.46	34.92
1024KiB w/ 1 IO/Stream	338.42	94.16	78.07	77.36	44.25
64KiB w/ 4 IOs/Stream	442.37	91.20	75.92	74.86	43.64
64KiB w/ 1 IO/Stream	239.95	89.87	75.49	73.55	43.82

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



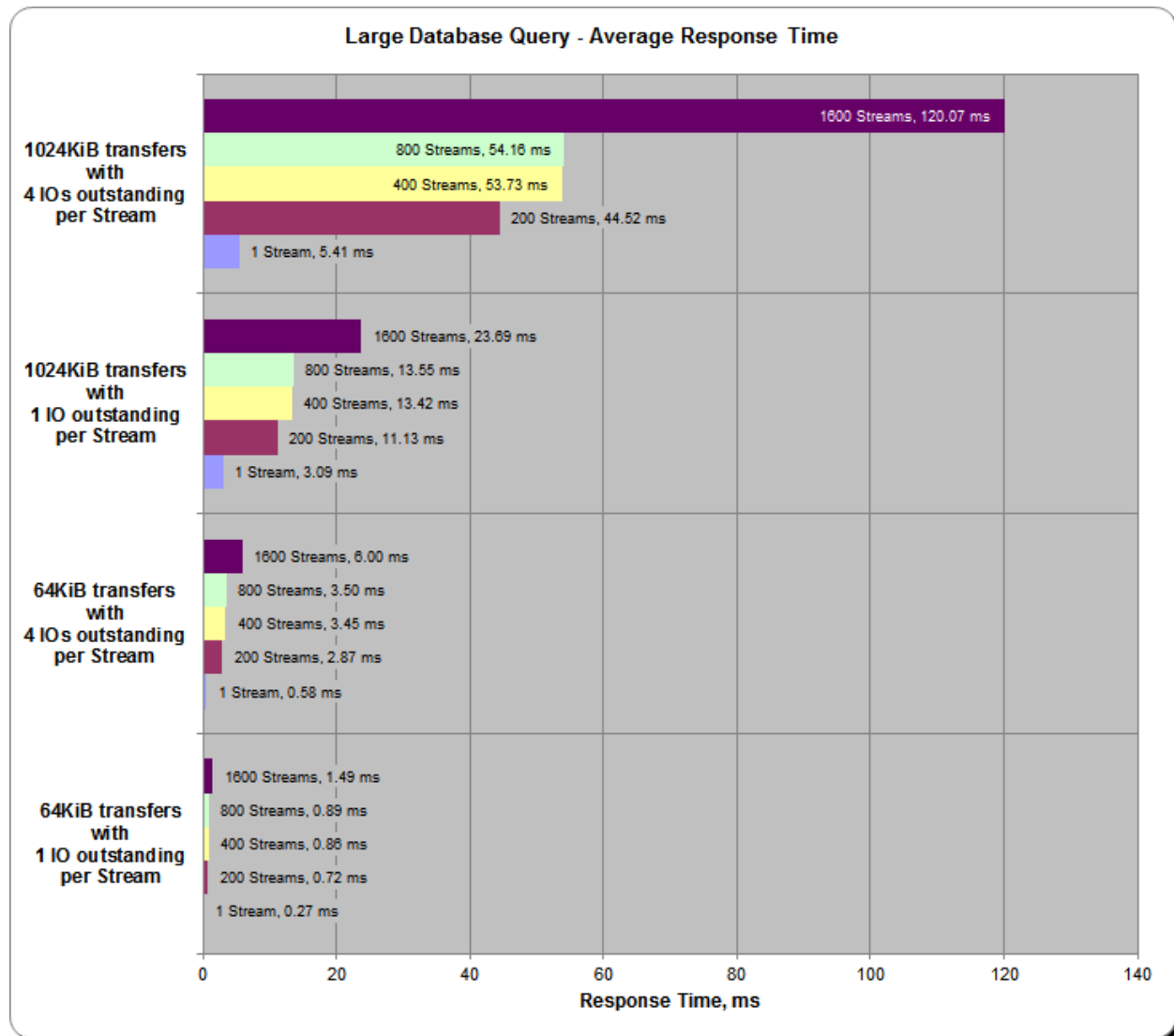


### SPC-2 Large Database Query Average Response Time

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	200 Streams	400 Streams	800 Streams	1600 Streams
1024KiB w/ 4 IOs/Stream	5.41	44.52	53.73	54.16	120.07
1024KiB w/ 1 IO/Stream	3.09	11.13	13.42	13.55	23.69
64KiB w/ 4 IOs/Stream	0.58	2.87	3.45	3.50	6.00
64KiB w/ 1 IO/Stream	0.27	0.72	0.86	0.89	1.49

### SPC-2 Large Database Query Average Response Time Graph



## Large Database Query Test – 1024 KiB TRANSFER SIZE Test Phase

### Clause 10.6.9.2.1

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

*A hyperlink for each of the above tables and graphs may appear in the FDR to provide access to the table or graph.*

A hyperlink to a table with the SPC-2 "Large Database Query/1024 KIB TRANSFER SIZE/4 Outstanding I/Os" Test Run data appears on the next page. That entry is followed by hyperlinks to graphs illustrating the average Data Rate, average Data Rate per Stream, and average Response Time produced by the same Test Runs. The table and graphs present the data at five-second intervals.

Immediately following the above SPC-2 "Large Database Query/1024 KIB TRANSFER SIZE/4 Outstanding I/Os" entries will be hyperlinks for SPC-2 "Large Database Query/1024 KIB TRANSFER SIZE/1 Outstanding I/O" table and graphs. The table contains the Test Run data and the graphs illustrate the average Data Rate, average Data Rate per Stream, and average Response Time produced by the Test Runs.

**SPC-2 “Large Database Query/1024 KIB TRANSFER SIZE/4 Outstanding I/Os” Test Run Data**

[SPC-2 “Large Database Query/1024 KIB TRANSFER SIZE/4 Outstanding I/Os” Test Run Data Tables: Ramp-Up, Measurement Interval, Run-Out, and Ramp-Down Periods](#)

*(3 pages)*

**SPC-2 “Large Database Query/1024 KIB TRANSFER SIZE/4 Outstanding I/Os” Graphs**

**Average Data Rate – Complete Test Run**

**Average Data Rate – Measurement Interval (MI) Only**

**Average Data Rate per Stream**

**Average Response Time**

[SPC-2 “Large Database Query/1024 KIB TRANSFER SIZE/4 Outstanding I/Os” graphs](#)

*(four pages, 1 graph per page)*

**SPC-2 “Large Database Query/1024 KIB TRANSFER SIZE/1 Outstanding I/O” Test Run Data**

[SPC-2 “Large Database Query/1024 KIB TRANSFER SIZE/1 Outstanding I/O” Test Run Data Tables: Ramp-Up, Measurement Interval, Run-Out, and Ramp-Down Periods](#)

*(3 pages)*

**SPC-2 “Large Database Query/1024 KIB TRANSFER SIZE/1 Outstanding I/O” Graphs**

**Average Data Rate – Complete Test Run**

**Average Data Rate – Measurement Interval (MI) Only**

**Average Data Rate per Stream**

**Average Response Time**

[SPC-2 “Large Database Query/1024 KIB TRANSFER SIZE/1 Outstanding I/O” graphs](#)

*(four pages, 1 graph per page)*

## Large Database Query Test – 64 KiB TRANSFER SIZE Test Phase

### Clause 10.6.9.2.2

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

A hyperlink for each of the above tables and graphs may appear in the FDR to provide access to the table or graph.

A hyperlink to a table with the SPC-2 "Large Database Query/64 KiB TRANSFER SIZE/4 Outstanding I/Os" Test Run data appears on the next page. That entry is followed by hyperlinks to graphs illustrating the average Data Rate, average Data Rate per Stream, and average Response Time produced by the same Test Runs. The table and graphs present the data at five-second intervals.

Immediately following the above SPC-2 "Large Database Query/64 KiB TRANSFER SIZE/4 Outstanding I/Os" entries will be hyperlinks for SPC-2 "Large Database Query/64 KiB TRANSFER SIZE/1 Outstanding I/O" table and graphs. The table contains the Test Run data and the graphs illustrate the average Data Rate, average Data Rate per Stream, and average Response Time produced by the Test Runs.

**SPC-2 “Large Database Query/64 KiB TRANSFER SIZE/4 Outstanding I/Os” Test Run Data**

[SPC-2 “Large Database Query/64 KiB TRANSFER SIZE/4 Outstanding I/Os” Test Run Data Tables: Ramp-Up, Measurement Interval, Run-Out, and Ramp-Down Periods](#)

*(3 pages)*

**SPC-2 “Large Database Query/64 KiB TRANSFER SIZE/4 Outstanding I/Os” Graphs**

**Average Data Rate – Complete Test Run**

**Average Data Rate – Measurement Interval (MI) Only**

**Average Data Rate per Stream**

**Average Response Time**

[SPC-2 “Large Database Query/64 KiB TRANSFER SIZE/4 Outstanding I/Os” graphs](#)

*(four pages, 1 graph per page)*

**SPC-2 “Large Database Query/64 KiB TRANSFER SIZE/1 Outstanding I/O” Test Run Data**

[SPC-2 “Large Database Query/64 KiB TRANSFER SIZE/1 Outstanding I/O” Test Run Data Tables: Ramp-Up, Measurement Interval, Run-Out, and Ramp-Down Periods](#)

*(3 pages)*

**SPC-2 “Large Database Query/64 KiB TRANSFER SIZE/1 Outstanding I/O” Graphs**

**Average Data Rate – Complete Test Run**

**Average Data Rate – Measurement Interval (MI) Only**

**Average Data Rate per Stream**

**Average Response Time**

[SPC-2 “Large Database Query/64 KiB TRANSFER SIZE/1 Outstanding I/O” graphs](#)

*(four pages, 1 graph per page)*

## Video on Demand Delivery Test

### Clause 6.4.5.1

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

### Clause 6.4.5.2

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

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

### Clause 10.6.9.3

*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 by Intervals, Average Data Rate per Stream by Intervals, and Average Response Time by Intervals graphs for the single Video on Demand Delivery Test Run as specified in Clause 10.1.8.*
- 6. A Maximum Response Time (intervals) graph as specified in Clause 10.1.8.*

## 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 [120](#)..

### 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	60,000
Ramp-up Time, sec	4,500
Measurement Interval, sec	7,200
Average Data Rate, MB/sec	47,185.63
Per Stream Data Rate, MB/sec	0.79
Average Response Time, ms	1.57
Average Max Response Time, ms	149.31

### Video on Demand Delivery Test – TEST RUN DATA BY INTERVAL

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

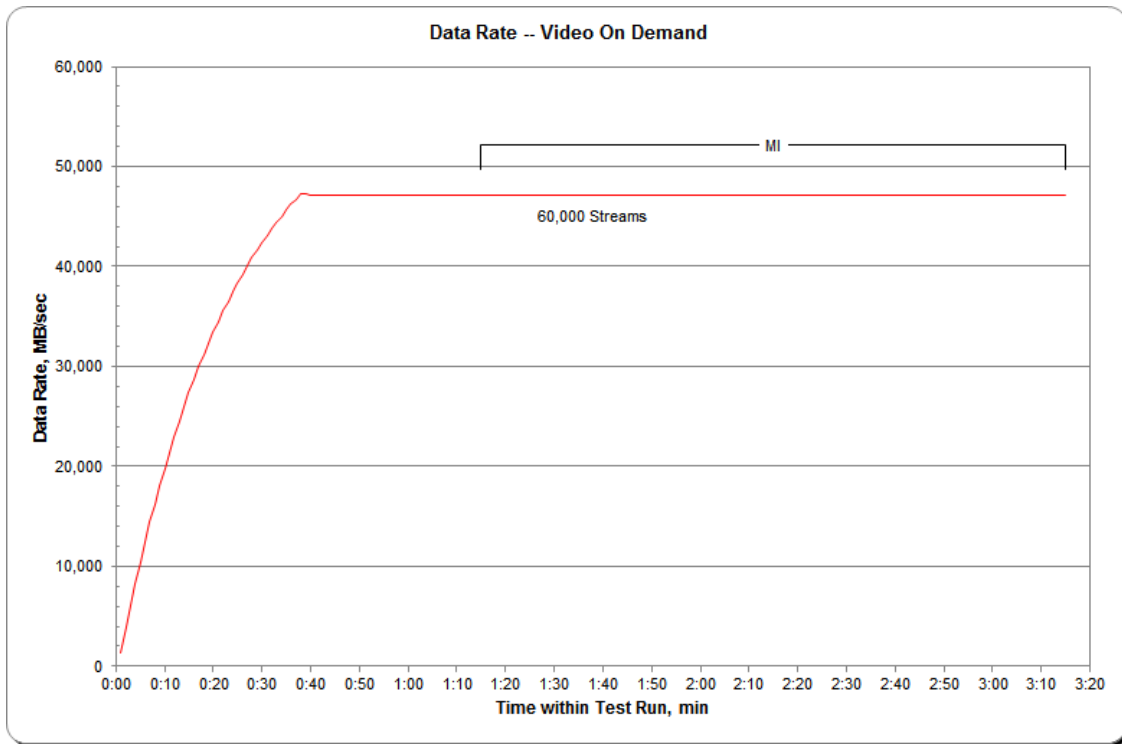
TR1					TR1					TR1				
60,000 Streams					60,000 Streams					60,000 Streams				
Test Run Sequence Time	Data Rate, MB/sec	/Stream, MB/sec	Response Time, ms	Maximum Response Time, ms	Test Run Sequence Time	Data Rate, MB/sec	/Stream, MB/sec	Response Time, ms	Maximum Response Time, ms	Test Run Sequence Time	Data Rate, MB/sec	/Stream, MB/sec	Response Time, ms	Maximum Response Time, ms
0:01:00	1,282.20	0.67	1.13	55.05	0:34:00	45,024.88	0.79	1.49	174.00	1:07:00	47,185.02	0.79	1.54	152.72
0:02:00	3,885.98	0.76	1.01	70.85	0:35:00	45,626.30	0.79	1.52	146.65	1:08:00	47,185.51	0.79	1.58	155.46
0:03:00	6,123.62	0.77	0.99	72.89	0:36:00	46,187.28	0.79	1.52	132.75	1:09:00	47,185.36	0.79	1.57	154.59
0:04:00	8,328.44	0.78	0.96	70.79	0:37:00	46,720.23	0.79	1.55	147.27	1:10:00	47,186.78	0.79	1.59	137.85
0:05:00	10,419.56	0.78	0.95	66.02	0:38:00	47,210.51	0.79	1.56	146.38	1:11:00	47,185.58	0.79	1.58	146.01
0:06:00	12,449.20	0.78	0.93	67.98	0:39:00	47,218.13	0.79	1.53	135.64	1:12:00	47,187.32	0.79	1.61	148.57
0:07:00	14,393.40	0.78	0.93	71.35	0:40:00	47,185.07	0.79	1.55	140.41	1:13:00	47,185.68	0.79	1.60	133.63
0:08:00	16,229.82	0.78	0.93	73.46	0:41:00	47,187.91	0.79	1.55	126.32	1:14:00	47,188.14	0.79	1.60	130.78
0:09:00	18,051.46	0.78	0.95	76.71	0:42:00	47,185.79	0.79	1.58	122.92	1:15:00	47,184.87	0.79	1.62	135.27
0:10:00	19,784.82	0.78	0.97	75.57	0:43:00	47,187.71	0.79	1.55	135.77	1:16:00	47,185.67	0.79	1.62	136.05
0:11:00	21,387.43	0.78	0.99	81.09	0:44:00	47,185.60	0.79	1.56	145.62	1:17:00	47,185.48	0.79	1.60	137.22
0:12:00	22,977.91	0.78	1.00	80.92	0:45:00	47,186.88	0.79	1.55	135.36	1:18:00	47,187.91	0.79	1.58	127.92
0:13:00	24,501.97	0.78	1.03	82.56	0:46:00	47,185.48	0.79	1.54	128.24	1:19:00	47,183.99	0.79	1.59	124.13
0:14:00	25,935.31	0.78	1.04	88.14	0:47:00	47,186.17	0.79	1.54	139.96	1:20:00	47,185.61	0.79	1.61	144.91
0:15:00	27,341.65	0.78	1.07	98.98	0:48:00	47,183.94	0.79	1.53	132.03	1:21:00	47,185.47	0.79	1.61	129.20
0:16:00	28,667.88	0.78	1.08	92.88	0:49:00	47,186.05	0.79	1.52	132.94	1:22:00	47,188.95	0.79	1.59	137.29
0:17:00	29,944.30	0.78	1.10	97.34	0:50:00	47,185.80	0.79	1.53	131.21	1:23:00	47,187.00	0.79	1.61	134.07
0:18:00	31,154.81	0.79	1.11	97.24	0:51:00	47,186.81	0.79	1.54	136.40	1:24:00	47,187.96	0.79	1.57	156.01
0:19:00	32,353.90	0.79	1.16	124.54	0:52:00	47,186.57	0.79	1.53	148.83	1:25:00	47,189.10	0.79	1.59	155.32
0:20:00	33,464.14	0.79	1.18	123.51	0:53:00	47,185.35	0.79	1.55	159.64	1:26:00	47,187.40	0.79	1.58	158.32
0:21:00	34,512.47	0.79	1.20	119.44	0:54:00	47,186.10	0.79	1.53	154.23	1:27:00	47,186.00	0.79	1.60	159.30
0:22:00	35,556.45	0.79	1.22	130.05	0:55:00	47,185.14	0.79	1.54	147.14	1:28:00	47,184.33	0.79	1.59	156.86
0:23:00	36,533.69	0.79	1.23	113.55	0:56:00	47,185.12	0.79	1.52	139.06	1:29:00	47,187.89	0.79	1.56	149.90
0:24:00	37,461.69	0.79	1.25	122.57	0:57:00	47,185.00	0.79	1.55	169.47	1:30:00	47,184.87	0.79	1.58	148.56
0:25:00	38,341.01	0.79	1.27	121.70	0:58:00	47,185.88	0.79	1.57	134.36	1:31:00	47,186.71	0.79	1.56	149.39
0:26:00	39,224.42	0.79	1.31	118.96	0:59:00	47,185.64	0.79	1.54	145.98	1:32:00	47,185.32	0.79	1.56	157.99
0:27:00	40,078.19	0.79	1.34	142.62	1:00:00	47,184.29	0.79	1.55	148.40	1:33:00	47,185.81	0.79	1.56	150.63
0:28:00	40,887.40	0.79	1.36	139.93	1:01:00	47,185.20	0.79	1.55	141.04	1:34:00	47,183.86	0.79	1.56	140.56
0:29:00	41,679.00	0.79	1.38	135.82	1:02:00	47,185.79	0.79	1.56	145.11	1:35:00	47,185.85	0.79	1.57	152.60
0:30:00	42,415.03	0.79	1.40	132.90	1:03:00	47,185.79	0.79	1.54	161.07	1:36:00	47,186.15	0.79	1.56	146.39
0:31:00	43,137.03	0.79	1.43	136.58	1:04:00	47,187.45	0.79	1.55	154.45	1:37:00	47,184.70	0.79	1.57	157.03
0:32:00	43,799.50	0.79	1.45	146.54	1:05:00	47,187.37	0.79	1.55	144.31	1:38:00	47,184.72	0.79	1.58	165.46
0:33:00	44,415.56	0.79	1.45	149.08	1:06:00	47,185.65	0.79	1.55	142.83	1:39:00	47,183.26	0.79	1.57	149.95



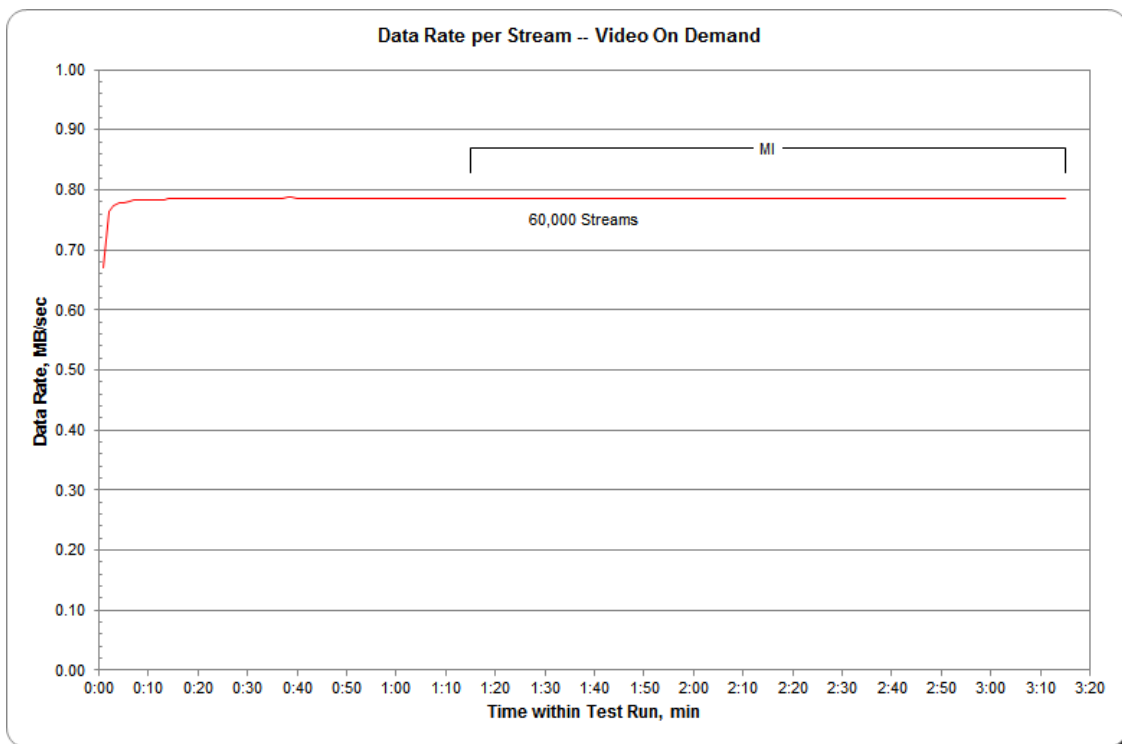
**Video on Demand Delivery Test – Test Run Data by Interval (continued)**

TR1	60,000 Streams				TR1	60,000 Streams				TR1	60,000 Streams			
Test Run Sequence Time	Data Rate, MB/sec	Data Rate / Stream, MB/sec	Response Time, ms	Maximum Response Time, ms	Test Run Sequence Time	Data Rate, MB/sec	Data Rate / Stream, MB/sec	Response Time, ms	Maximum Response Time, ms	Test Run Sequence Time	Data Rate, MB/sec	Data Rate / Stream, MB/sec	Response Time, ms	Maximum Response Time, ms
1:40:00	47,186.30	0.79	1.58	144.72	2:12:00	47,188.03	0.79	1.56	153.67	2:44:00	47,186.12	0.79	1.56	153.81
1:41:00	47,185.58	0.79	1.56	145.85	2:13:00	47,185.52	0.79	1.55	155.84	2:45:00	47,185.93	0.79	1.56	151.53
1:42:00	47,185.17	0.79	1.60	150.64	2:14:00	47,186.03	0.79	1.59	167.67	2:46:00	47,186.08	0.79	1.57	143.87
1:43:00	47,186.55	0.79	1.58	151.03	2:15:00	47,186.07	0.79	1.57	160.78	2:47:00	47,185.51	0.79	1.58	155.64
1:44:00	47,185.15	0.79	1.57	142.96	2:16:00	47,186.02	0.79	1.58	199.76	2:48:00	47,185.83	0.79	1.58	151.42
1:45:00	47,185.96	0.79	1.55	156.55	2:17:00	47,184.69	0.79	1.58	167.67	2:49:00	47,184.34	0.79	1.59	154.00
1:46:00	47,187.25	0.79	1.57	131.44	2:18:00	47,186.38	0.79	1.58	176.65	2:50:00	47,187.02	0.79	1.58	165.21
1:47:00	47,185.82	0.79	1.59	132.82	2:19:00	47,185.01	0.79	1.58	156.87	2:51:00	47,187.27	0.79	1.58	151.84
1:48:00	47,184.25	0.79	1.59	136.96	2:20:00	47,184.18	0.79	1.57	147.91	2:52:00	47,185.91	0.79	1.60	141.51
1:49:00	47,186.69	0.79	1.57	130.24	2:21:00	47,186.06	0.79	1.56	155.71	2:53:00	47,183.63	0.79	1.58	129.29
1:50:00	47,185.16	0.79	1.59	131.70	2:22:00	47,186.52	0.79	1.55	145.72	2:54:00	47,185.31	0.79	1.59	137.68
1:51:00	47,186.79	0.79	1.58	132.89	2:23:00	47,185.70	0.79	1.56	134.43	2:55:00	47,183.77	0.79	1.58	125.79
1:52:00	47,186.15	0.79	1.57	132.65	2:24:00	47,186.17	0.79	1.54	140.40	2:56:00	47,185.56	0.79	1.57	129.63
1:53:00	47,185.81	0.79	1.57	139.85	2:25:00	47,185.62	0.79	1.53	138.69	2:57:00	47,184.25	0.79	1.58	128.44
1:54:00	47,184.43	0.79	1.57	139.07	2:26:00	47,187.08	0.79	1.52	132.28	2:58:00	47,185.06	0.79	1.56	124.98
1:55:00	47,185.32	0.79	1.58	138.91	2:27:00	47,186.78	0.79	1.53	135.79	2:59:00	47,186.86	0.79	1.57	139.40
1:56:00	47,184.61	0.79	1.56	138.63	2:28:00	47,186.43	0.79	1.54	158.04	3:00:00	47,183.73	0.79	1.58	139.54
1:57:00	47,185.43	0.79	1.60	155.42	2:29:00	47,185.25	0.79	1.57	153.57	3:01:00	47,186.36	0.79	1.63	154.72
1:58:00	47,185.80	0.79	1.59	147.00	2:30:00	47,185.43	0.79	1.56	157.79	3:02:00	47,186.95	0.79	1.57	147.35
1:59:00	47,185.96	0.79	1.58	154.53	2:31:00	47,184.44	0.79	1.55	157.73	3:03:00	47,183.00	0.79	1.58	149.23
2:00:00	47,185.24	0.79	1.58	146.71	2:32:00	47,185.98	0.79	1.54	155.63	3:04:00	47,183.61	0.79	1.57	151.93
2:01:00	47,186.23	0.79	1.58	149.27	2:33:00	47,186.04	0.79	1.55	146.25	3:05:00	47,184.48	0.79	1.56	149.38
2:02:00	47,184.36	0.79	1.58	169.20	2:34:00	47,185.34	0.79	1.55	166.75	3:06:00	47,186.00	0.79	1.53	146.31
2:03:00	47,185.51	0.79	1.58	151.99	2:35:00	47,186.81	0.79	1.54	161.30	3:07:00	47,184.68	0.79	1.57	152.77
2:04:00	47,184.07	0.79	1.59	157.17	2:36:00	47,183.79	0.79	1.56	158.13	3:08:00	47,186.09	0.79	1.55	139.37
2:05:00	47,186.35	0.79	1.60	166.11	2:37:00	47,183.95	0.79	1.57	154.72	3:09:00	47,184.93	0.79	1.57	146.73
2:06:00	47,185.81	0.79	1.57	151.50	2:38:00	47,185.36	0.79	1.56	154.41	3:10:00	47,185.50	0.79	1.58	162.03
2:07:00	47,185.69	0.79	1.59	141.90	2:39:00	47,186.80	0.79	1.54	153.96	3:11:00	47,185.41	0.79	1.57	146.42
2:08:00	47,185.75	0.79	1.58	155.41	2:40:00	47,186.92	0.79	1.56	147.59	3:12:00	47,186.55	0.79	1.58	158.69
2:09:00	47,185.70	0.79	1.58	164.12	2:41:00	47,185.23	0.79	1.56	162.56	3:13:00	47,186.76	0.79	1.55	157.12
2:10:00	47,186.50	0.79	1.59	158.54	2:42:00	47,185.56	0.79	1.56	140.34	3:14:00	47,186.07	0.79	1.57	140.38
2:11:00	47,187.18	0.79	1.56	164.89	2:43:00	47,185.58	0.79	1.55	139.95	3:15:00	47,185.97	0.79	1.56	156.00

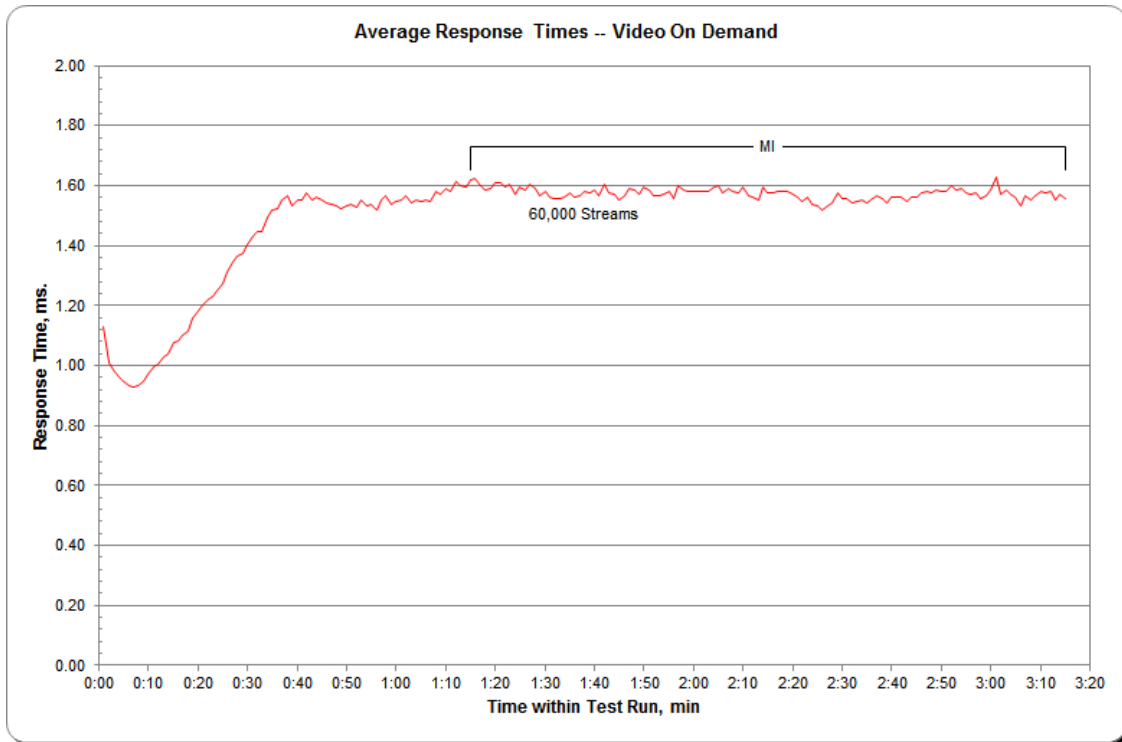
### SPC-2 Video on Demand Delivery Average Data Rate Graph



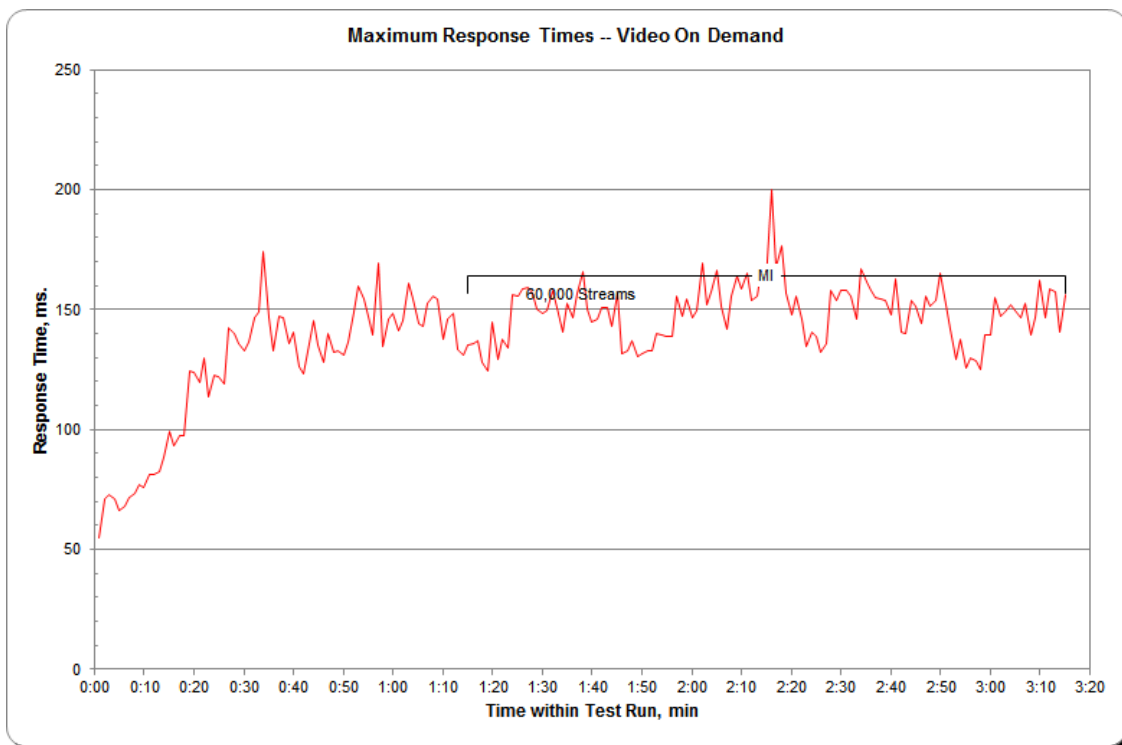
### SPC-2 Video on Demand Delivery Average Data Rate per Stream Graph



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



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



## Data Persistence Test

### Clause 7

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

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

*The SPC-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 10.6.9.4

*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 [120](#).

## 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 \(write phase\) Results File](#)

[Persistence 2 Test Run \(read phase\) Results File](#)

### Data Persistence Test Results

<b>Data Persistence Test Results</b>	
Data Persistence Test Number: 1	
Total Number of Logical Blocks Written	2,526,500
Total Number of Logical Blocks Re-referenced	160,360
Total Number of Logical Blocks Verified	2,366,140
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 Availability Data shall be stated in either a combination of specific alphanumeric month, numeric day and numeric year or as "Currently Available".*

The EMC VMAX 400K, as documented in this SPC-2 Full Disclosure Report, is currently available for customer purchase and shipment.

## **ANOMALIES OR IRREGULARITIES**

### **Clause 10.6.12**

*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 EMC VMAX 400K.

## **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

**Protected 1:** The single point of failure of any *storage device* in the configuration will not result in permanent loss of access to or integrity of the SPC-2 Data Repository.

**Protected 2:** The single point of failure of any *component* in the configuration will not result in permanent loss of access to or integrity of the SPC-2 Data Repository.

## 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:

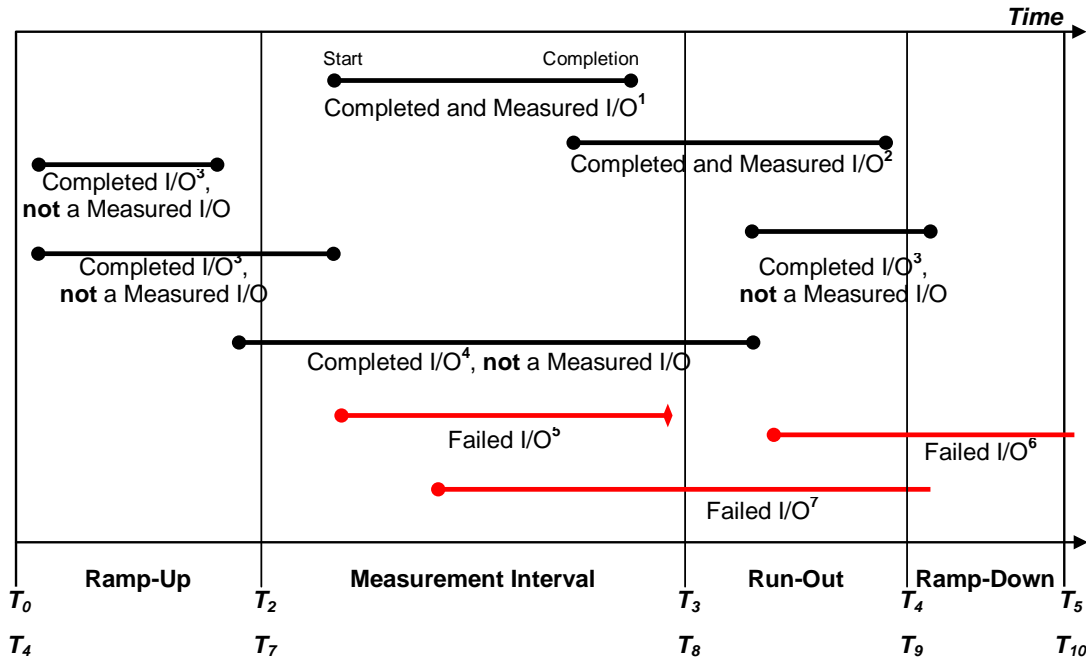
- Test Run 1: Maximum number of Streams, which is selected by the Test Sponsor
- Test Run 2: 50% of the maximum number of Streams used in Test Run 1.
- Test Run 3: 25% of the maximum number of Streams used in Test Run 1.
- Test Run 4: 12.5% of the maximum number of Streams used in Test Run 1.
- Test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

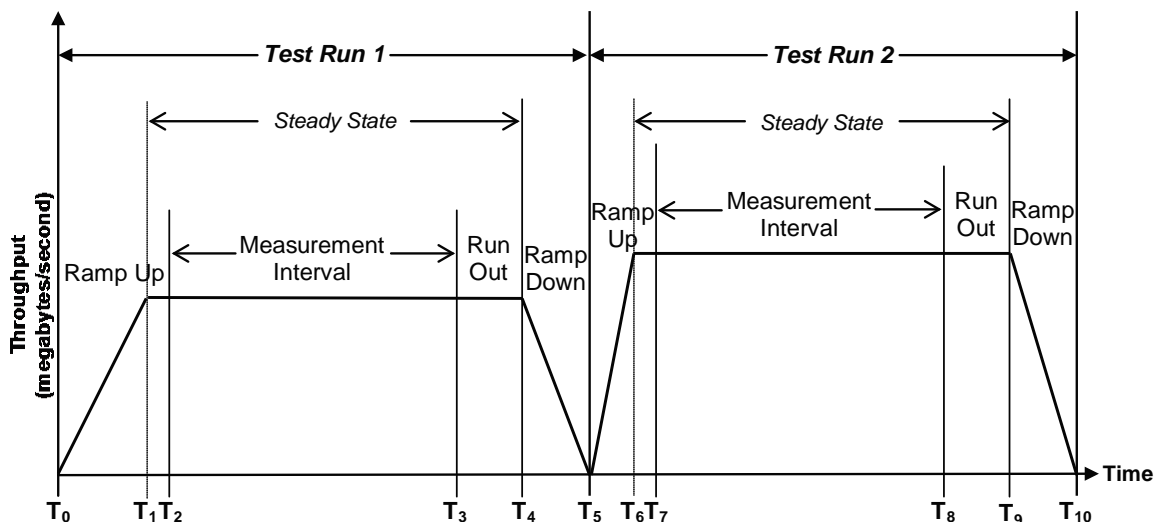
**Transfer Size:** The Transfer Size parameter specifies the number of bytes in KiB to transfer. (*Clause 3.4.7 of the SPC-2 Benchmark Specification*)

### I/O Completion Types



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

### SPC-2 Test Run Components



## **APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS**

### **Solaris System Parameters**

The following Solaris system parameter entries were changed in the **/etc/system** file for each Host System:

**set sd:sd\_max\_throttle=20**  
*maximum number of queued tag commands*

**set hz=2000**  
*sets the clock interrupt to every 500us*

**set scsi\_options=0x7f8**  
*enable wide scsi*

**set dosyncodr=0**  
*prevents the kernel from syncing time of day*

## **APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION**

Two tools are used to configured the system, **EMC SymmWin** and **EMC Solutions Enabler**.

**EMC SymmWin** is resides on the service processor of the VMAX 400K and is intended for EMC CE use in managing the system. The tool is installed as part of the system imaging process prior to customer delivery.

**EMC Solutions Enabler** is a VMAX 400K command line management tool provided by EMC and installed on a network connected server by the customer.

### **Internal Disks and Data Protection**

Internal disks and protection would typically be an EMC-CE operation, which is conducted with **EMC SymmWin** as follows:

- The CE will log in using the service processor console of the VMAX 400K and start **SymmWin** by clicking on the **SymmWin** icon on the desktop.
- The initial, factory configuration is displayed by selecting **File -> Impl From System** from the menu bar.
- The initial, factory configuration is modified by selecting **Configuration -> Disk Map** from the menu bar, which will display the following screen with the **Disks** tab.
- In the **Disks** tab, add the disks, type and data protection by right clicking on an empty slot and selecting **Add**:

Init Features DirMap SlicMap DirEdit Hosts GuestOS DAE <b>Disks</b> SRP VolReq VolMap VolEdit																
<input type="checkbox"/> Drive Legend <input checked="" type="checkbox"/> Disk Groups <input type="checkbox"/> Disks Layout <b>SPINDLE 0</b>																
ID	DA 1		DA 3		DA 5		DA 7		DA 9		DA 11		DA 13		DA 15	
	DA 2		DA 4		DA 6		DA 8		DA 10		DA 12		DA 14		DA 16	
	C0	C1	C0	C1	C0	C1	C0	C1	C0	C1	C0	C1	C0	C1	C0	C1
0																
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
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26																
27																
28																

- In the next screen, the following are specified: drive type, protection and total number of disks, including spares, that are physically present in the system.

The screenshot shows a configuration window with the following fields and values:

- Drive Type: EFD-0200GB-0
- Protection: 2-MIR
- Use: All Engines
- Total number of disks:
  - DAE-120V: 264
- How to use disks:
  - FBA: 256
  - CKD: 0
  - Spares: 8
- Spare Policy: Optimize Performance
- Group: 2
- Group Name: GRP\_2\_200\_EFD\_R1
- SRP: SRP\_1

Below the configuration fields is an "Add" button and a summary line: "Number of volumes: 2048, volume size: 6258C, total capacity: 23,834.18GIB".

ID	Disk	DAE-120V	Protection	FBA	Spares	Group	SRP	Group Name	Engines	Volumes	Type	Speed
A	EFD-0200GB-0	264	2-MIR	256	8	1	SRP_1	GRP_1_200_EFD_R1		FF7F0-FFFFE	flash	0

## Storage Pool and Data Volumes

Once the disks are added to the system, they are placed into a default storage resource pool and 2,048 data volumes are automatically created.

## Gatekeepers and GuestOS

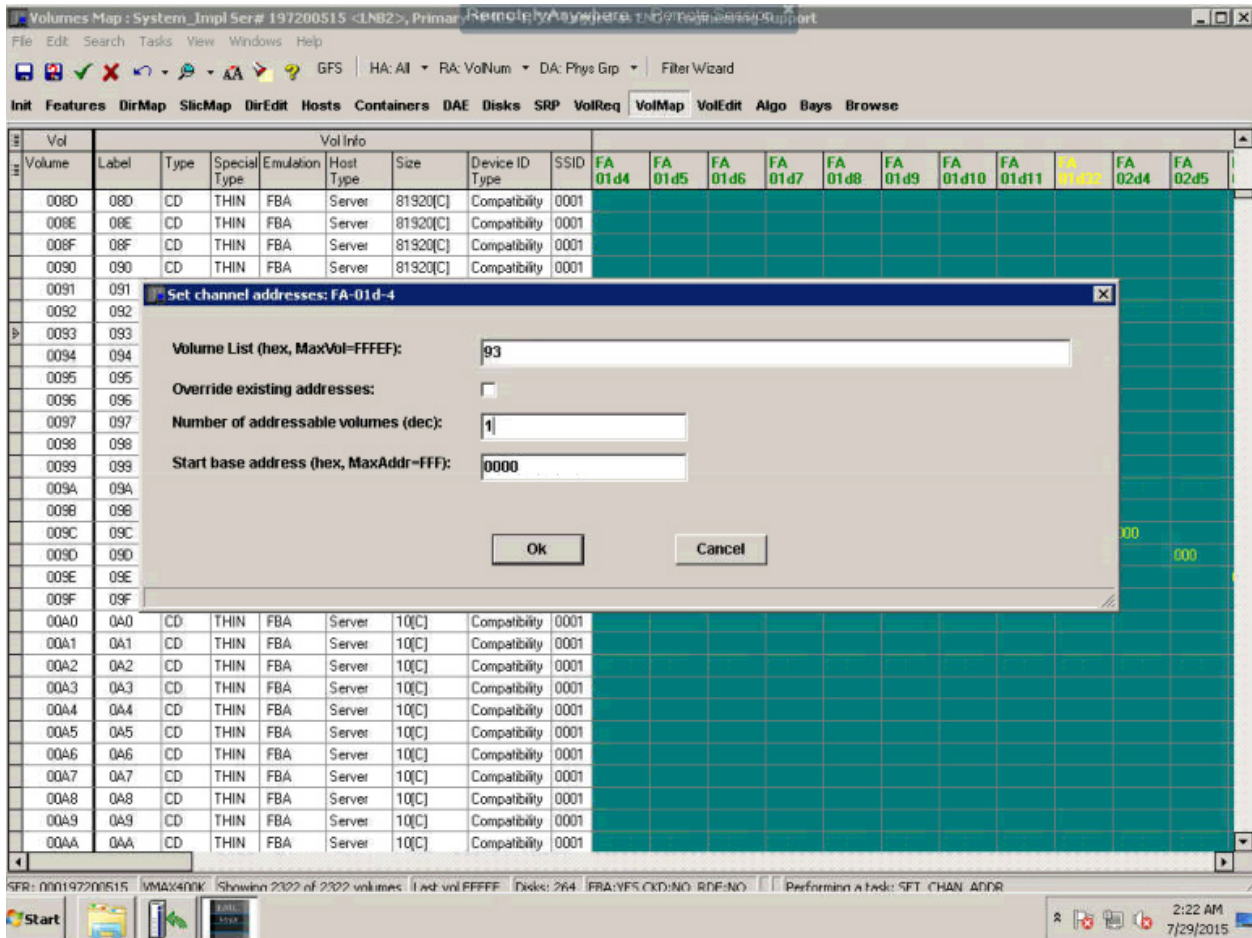
An initial set of Gatekeepers, for use with the **EMC Solutions Enabler**, must be created and mapped to front-end ports.

- Using **SymmWin**, the CE will click on **Configuration -> Volume Requests** on the menu bar. That will display the **Configuration** dialog with the **VolReq** tab open
- An initial configuration is displayed that includes the GuestOS allocations need for internal VMAX support in Volume ID 001-012. Volumes FF7F0-FFFEF contain the data devices from the previously added disks.
- **Add** 128 CDEV devices with a size of 10 cylinders, which are assigned Volume IDs of 093-112.

Req	Dist	Emul	Host Type	Size	Count	Mirror Type	Device Type	Special Type	Volumes	OldMD	Grou
0	N	FBA	Server	3[C]	1	CDEV	THIN	THIN_ACLX	001_001		
1	N	FBA	Server	6452[C]	2	CDEV	THIN	THIN_GOS_INTERNAL	002_003		
2	N	FBA	Server	40329[C]	2	CDEV	THIN	THIN_GOS_INTERNAL	004_005		
3	N	FBA	Server	134432[C]	1	CDEV	THIN	THIN_GOS_INTERNAL	006_006		
4	N	FBA	Server	3[C]	12	CDEV	THIN	THIN_GOS_INTERNAL	007_012		
5	N				128				013_092		
6	N	FBA	Server	10[C]	128	CDEV	THIN	None	093_112		
7	N				1046237				113_FF7EF		
8	N	FBA	Server	6258[C]	2048	2-MIR	TDAT	None	FF7F0_FFEF		1



- To map the volumes on the Configuration dialog, click on **VolMap**. For each Gatekeeper volume (*volumes 93-112*), map the volume by clicking on the volume under the FA port in the matrix and typing **CTL-A**. In the dialog that appears, set the **Start base address** to 0000 and the **Number of addressable volumes** to 1. The Volume list text box should equal the Volume ID. Repeat the above steps for all 128 volumes.



## Create and Map Logical Devices

The remaining steps will use the **EMC Solutions Enabler** command line utility to create and map the logical devices.

1. First, update the **Solutions Enabler** database from any of the Host Systems, using the following command:

```
symcfg discover
```

2. Create 128 logical devices, each with a capacity of 153,600 MiB, using the following command:

```
symconfigure -sid 515 commit -cmd "create dev count=128,  
size=153600MB,emulation=FBA,config=TDEV;"
```

3. While the logical devices can be mapped concurrently during the above create operation, for clarity the mapping information is included below as a separate step.

The mapping information is derived on how the Host Systems are directly connected to the VMAX 400K. For the 16 Host Systems, 8 groups of 16 volumes each were created. The matrix below describes the Host System/volume connectivity.

The second row, at the top, lists the VMAX volume in hex. The first column lists the Host Systems. The matrix describes how the Host Systems are mapped to the volumes. For example volumes **0x13 – 0x22** are mapped via port **1D4** for Host System **py01**. The same volumes are mapped to Host System **py02** via port **1D5**.

The following symconfigure commands, to map the volumes, are based on this matrix.

	VMAX Volumes								
	13-22	23-32	33-42	43-52	53-62	63-72	73-82	83-92	
py01	1D4	2D4	3D4	4D4	5D4	6D4	7D4	8D4	CLIENTS
py02	1D5	2D5	3D5	4D5	5D5	6D5	7D5	8D5	
py03	1D6	2D6	3D6	4D6	5D6	6D6	7D6	8D6	
py04	1D7	2D7	3D7	4D7	5D7	6D7	7D7	8D7	
py05	1D8	2D8	3D8	4D8	5D8	6D8	7D8	8D8	
py06	1D9	2D9	3D9	4D9	5D9	6D9	7D9	8D9	
py07	1D10	2D10	3D10	4D10	5D10	6D10	7D10	8D10	
py08	1D11	2D11	3D11	4D11	5D11	6D11	7D11	8D11	
py09	9D11	10D11	11D11	12D11	13D11	14D11	15D11	16D11	
py10	9D10	10D10	11D10	12D10	13D10	14D10	15D10	16D10	
py11	9D9	10D9	11D9	12D9	13D9	14D9	15D9	16D9	
py12	9D8	10D8	11D8	12D8	13D8	14D8	15D8	16D8	
py13	9D7	10D7	11D7	12D7	13D7	14D7	15D7	16D7	
py17	9D6	10D6	11D6	12D6	13D6	14D6	15D6	16D6	
py18	9D5	10D5	11D5	12D5	13D5	14D5	15D5	16D5	
py19	9D4	10D4	11D4	12D4	13D4	14D4	15D4	16D4	





```
symconfigure commit -cmd "map dev 83:92 to dir 16D:8 starting lun=1;"  
symconfigure commit -cmd "map dev 83:92 to dir 16D:9 starting lun=1;"  
symconfigure commit -cmd "map dev 83:92 to dir 16D:10 starting lun=1;"  
symconfigure commit -cmd "map dev 83:92 to dir 16D:11 starting lun=1;"
```

## APPENDIX D: SPC-2 WORKLOAD GENERATOR STORAGE COMMANDS AND PARAMETER FILES

### ASU Pre-Fill

```
compratio=1
hd=default,vdbench=/opt/vdbench,shell=rsh,user=root
host=py01,system=192.168.0.101
host=py02,system=192.168.0.102
host=py03,system=192.168.0.103
host=py04,system=192.168.0.104
host=py05,system=192.168.0.105
host=py06,system=192.168.0.106
host=py07,system=192.168.0.107
host=py08,system=192.168.0.108
host=py09,system=192.168.0.109
host=py10,system=192.168.0.110
host=py11,system=192.168.0.111
host=py12,system=192.168.0.112
host=py13,system=192.168.0.113
host=py17,system=192.168.0.117
host=py18,system=192.168.0.118
host=py19,system=192.168.0.119
sd=sd1,host=py01,lun=/dev/rdisk/c3t5000097378080C04d1s2
sd=sd2,host=py01,lun=/dev/rdisk/c3t5000097378080C04d2s2
sd=sd3,host=py01,lun=/dev/rdisk/c3t5000097378080C04d3s2
sd=sd4,host=py01,lun=/dev/rdisk/c3t5000097378080C04d4s2
sd=sd5,host=py01,lun=/dev/rdisk/c3t5000097378080C04d5s2
sd=sd6,host=py01,lun=/dev/rdisk/c3t5000097378080C04d6s2
sd=sd7,host=py01,lun=/dev/rdisk/c3t5000097378080C04d7s2
sd=sd8,host=py01,lun=/dev/rdisk/c3t5000097378080C04d8s2
sd=sd9,host=py02,lun=/dev/rdisk/c3t5000097378080C05d9s2
sd=sd10,host=py02,lun=/dev/rdisk/c3t5000097378080C05d10s2
sd=sd11,host=py02,lun=/dev/rdisk/c3t5000097378080C05d11s2
sd=sd12,host=py02,lun=/dev/rdisk/c3t5000097378080C05d12s2
sd=sd13,host=py02,lun=/dev/rdisk/c3t5000097378080C05d13s2
sd=sd14,host=py02,lun=/dev/rdisk/c3t5000097378080C05d14s2
sd=sd15,host=py02,lun=/dev/rdisk/c3t5000097378080C05d15s2
sd=sd16,host=py02,lun=/dev/rdisk/c3t5000097378080C05d16s2
sd=sd17,host=py03,lun=/dev/rdisk/c4t5000097378080C46d1s2
sd=sd18,host=py03,lun=/dev/rdisk/c4t5000097378080C46d2s2
sd=sd19,host=py03,lun=/dev/rdisk/c4t5000097378080C46d3s2
sd=sd20,host=py03,lun=/dev/rdisk/c4t5000097378080C46d4s2
sd=sd21,host=py03,lun=/dev/rdisk/c4t5000097378080C46d5s2
sd=sd22,host=py03,lun=/dev/rdisk/c4t5000097378080C46d6s2
sd=sd23,host=py03,lun=/dev/rdisk/c4t5000097378080C46d7s2
sd=sd24,host=py03,lun=/dev/rdisk/c4t5000097378080C46d8s2
sd=sd25,host=py04,lun=/dev/rdisk/c4t5000097378080C47d9s2
sd=sd26,host=py04,lun=/dev/rdisk/c4t5000097378080C47d10s2
sd=sd27,host=py04,lun=/dev/rdisk/c4t5000097378080C47d11s2
sd=sd28,host=py04,lun=/dev/rdisk/c4t5000097378080C47d12s2
sd=sd29,host=py04,lun=/dev/rdisk/c4t5000097378080C47d13s2
sd=sd30,host=py04,lun=/dev/rdisk/c4t5000097378080C47d14s2
sd=sd31,host=py04,lun=/dev/rdisk/c4t5000097378080C47d15s2
sd=sd32,host=py04,lun=/dev/rdisk/c4t5000097378080C47d16s2
sd=sd33,host=py05,lun=/dev/rdisk/c7t5000097378080C88d1s2
sd=sd34,host=py05,lun=/dev/rdisk/c7t5000097378080C88d2s2
sd=sd35,host=py05,lun=/dev/rdisk/c7t5000097378080C88d3s2
sd=sd36,host=py05,lun=/dev/rdisk/c7t5000097378080C88d4s2
sd=sd37,host=py05,lun=/dev/rdisk/c7t5000097378080C88d5s2
```

sd=sd38,host=py05,lun=/dev/rdisk/c7t5000097378080C88d6s2  
sd=sd39,host=py05,lun=/dev/rdisk/c7t5000097378080C88d7s2  
sd=sd40,host=py05,lun=/dev/rdisk/c7t5000097378080C88d8s2  
sd=sd41,host=py06,lun=/dev/rdisk/c6t5000097378080C89d9s2  
sd=sd42,host=py06,lun=/dev/rdisk/c6t5000097378080C89d10s2  
sd=sd43,host=py06,lun=/dev/rdisk/c6t5000097378080C89d11s2  
sd=sd44,host=py06,lun=/dev/rdisk/c6t5000097378080C89d12s2  
sd=sd45,host=py06,lun=/dev/rdisk/c6t5000097378080C89d13s2  
sd=sd46,host=py06,lun=/dev/rdisk/c6t5000097378080C89d14s2  
sd=sd47,host=py06,lun=/dev/rdisk/c6t5000097378080C89d15s2  
sd=sd48,host=py06,lun=/dev/rdisk/c6t5000097378080C89d16s2  
sd=sd49,host=py07,lun=/dev/rdisk/c8t5000097378080CCAd1s2  
sd=sd50,host=py07,lun=/dev/rdisk/c8t5000097378080CCAd2s2  
sd=sd51,host=py07,lun=/dev/rdisk/c8t5000097378080CCAd3s2  
sd=sd52,host=py07,lun=/dev/rdisk/c8t5000097378080CCAd4s2  
sd=sd53,host=py07,lun=/dev/rdisk/c8t5000097378080CCAd5s2  
sd=sd54,host=py07,lun=/dev/rdisk/c8t5000097378080CCAd6s2  
sd=sd55,host=py07,lun=/dev/rdisk/c8t5000097378080CCAd7s2  
sd=sd56,host=py07,lun=/dev/rdisk/c8t5000097378080CCAd8s2  
sd=sd57,host=py08,lun=/dev/rdisk/c8t5000097378080CCBd9s2  
sd=sd58,host=py08,lun=/dev/rdisk/c8t5000097378080CCBd10s2  
sd=sd59,host=py08,lun=/dev/rdisk/c8t5000097378080CCBd11s2  
sd=sd60,host=py08,lun=/dev/rdisk/c8t5000097378080CCBd12s2  
sd=sd61,host=py08,lun=/dev/rdisk/c8t5000097378080CCBd13s2  
sd=sd62,host=py08,lun=/dev/rdisk/c8t5000097378080CCBd14s2  
sd=sd63,host=py08,lun=/dev/rdisk/c8t5000097378080CCBd15s2  
sd=sd64,host=py08,lun=/dev/rdisk/c8t5000097378080CCBd16s2  
sd=sd65,host=py09,lun=/dev/rdisk/c5t5000097378080F0Bd1s2  
sd=sd66,host=py09,lun=/dev/rdisk/c5t5000097378080F0Bd2s2  
sd=sd67,host=py09,lun=/dev/rdisk/c5t5000097378080F0Bd3s2  
sd=sd68,host=py09,lun=/dev/rdisk/c5t5000097378080F0Bd4s2  
sd=sd69,host=py09,lun=/dev/rdisk/c5t5000097378080F0Bd5s2  
sd=sd70,host=py09,lun=/dev/rdisk/c5t5000097378080F0Bd6s2  
sd=sd71,host=py09,lun=/dev/rdisk/c5t5000097378080F0Bd7s2  
sd=sd72,host=py09,lun=/dev/rdisk/c5t5000097378080F0Bd8s2  
sd=sd73,host=py10,lun=/dev/rdisk/c5t5000097378080F0Ad9s2  
sd=sd74,host=py10,lun=/dev/rdisk/c5t5000097378080F0Ad10s2  
sd=sd75,host=py10,lun=/dev/rdisk/c5t5000097378080F0Ad11s2  
sd=sd76,host=py10,lun=/dev/rdisk/c5t5000097378080F0Ad12s2  
sd=sd77,host=py10,lun=/dev/rdisk/c5t5000097378080F0Ad13s2  
sd=sd78,host=py10,lun=/dev/rdisk/c5t5000097378080F0Ad14s2  
sd=sd79,host=py10,lun=/dev/rdisk/c5t5000097378080F0Ad15s2  
sd=sd80,host=py10,lun=/dev/rdisk/c5t5000097378080F0Ad16s2  
sd=sd81,host=py11,lun=/dev/rdisk/c6t5000097378080F49d1s2  
sd=sd82,host=py11,lun=/dev/rdisk/c6t5000097378080F49d2s2  
sd=sd83,host=py11,lun=/dev/rdisk/c6t5000097378080F49d3s2  
sd=sd84,host=py11,lun=/dev/rdisk/c6t5000097378080F49d4s2  
sd=sd85,host=py11,lun=/dev/rdisk/c6t5000097378080F49d5s2  
sd=sd86,host=py11,lun=/dev/rdisk/c6t5000097378080F49d6s2  
sd=sd87,host=py11,lun=/dev/rdisk/c6t5000097378080F49d7s2  
sd=sd88,host=py11,lun=/dev/rdisk/c6t5000097378080F49d8s2  
sd=sd89,host=py12,lun=/dev/rdisk/c6t5000097378080F48d9s2  
sd=sd90,host=py12,lun=/dev/rdisk/c6t5000097378080F48d10s2  
sd=sd91,host=py12,lun=/dev/rdisk/c6t5000097378080F48d11s2  
sd=sd92,host=py12,lun=/dev/rdisk/c6t5000097378080F48d12s2  
sd=sd93,host=py12,lun=/dev/rdisk/c6t5000097378080F48d13s2  
sd=sd94,host=py12,lun=/dev/rdisk/c6t5000097378080F48d14s2  
sd=sd95,host=py12,lun=/dev/rdisk/c6t5000097378080F48d15s2  
sd=sd96,host=py12,lun=/dev/rdisk/c6t5000097378080F48d16s2  
sd=sd97,host=py13,lun=/dev/rdisk/c9t5000097378080F87d1s2  
sd=sd98,host=py13,lun=/dev/rdisk/c9t5000097378080F87d2s2  
sd=sd99,host=py13,lun=/dev/rdisk/c9t5000097378080F87d3s2  
sd=sd100,host=py13,lun=/dev/rdisk/c9t5000097378080F87d4s2

```
sd=sd101,host=py13,lun=/dev/rdisk/c9t5000097378080F87d5s2
sd=sd102,host=py13,lun=/dev/rdisk/c9t5000097378080F87d6s2
sd=sd103,host=py13,lun=/dev/rdisk/c9t5000097378080F87d7s2
sd=sd104,host=py13,lun=/dev/rdisk/c9t5000097378080F87d8s2
sd=sd105,host=py17,lun=/dev/rdisk/c2t5000097378080F86d9s2
sd=sd106,host=py17,lun=/dev/rdisk/c2t5000097378080F86d10s2
sd=sd107,host=py17,lun=/dev/rdisk/c2t5000097378080F86d11s2
sd=sd108,host=py17,lun=/dev/rdisk/c2t5000097378080F86d12s2
sd=sd109,host=py17,lun=/dev/rdisk/c2t5000097378080F86d13s2
sd=sd110,host=py17,lun=/dev/rdisk/c2t5000097378080F86d14s2
sd=sd111,host=py17,lun=/dev/rdisk/c2t5000097378080F86d15s2
sd=sd112,host=py17,lun=/dev/rdisk/c2t5000097378080F86d16s2
sd=sd113,host=py18,lun=/dev/rdisk/c2t5000097378080FC4d1s2
sd=sd114,host=py18,lun=/dev/rdisk/c2t5000097378080FC4d2s2
sd=sd115,host=py18,lun=/dev/rdisk/c2t5000097378080FC4d3s2
sd=sd116,host=py18,lun=/dev/rdisk/c2t5000097378080FC4d4s2
sd=sd117,host=py18,lun=/dev/rdisk/c2t5000097378080FC4d5s2
sd=sd118,host=py18,lun=/dev/rdisk/c2t5000097378080FC4d6s2
sd=sd119,host=py18,lun=/dev/rdisk/c2t5000097378080FC4d7s2
sd=sd120,host=py18,lun=/dev/rdisk/c2t5000097378080FC4d8s2
sd=sd121,host=py19,lun=/dev/rdisk/c16t5000097378080FC5d9s2
sd=sd122,host=py19,lun=/dev/rdisk/c16t5000097378080FC5d10s2
sd=sd123,host=py19,lun=/dev/rdisk/c16t5000097378080FC5d11s2
sd=sd124,host=py19,lun=/dev/rdisk/c16t5000097378080FC5d12s2
sd=sd125,host=py19,lun=/dev/rdisk/c16t5000097378080FC5d13s2
sd=sd126,host=py19,lun=/dev/rdisk/c16t5000097378080FC5d14s2
sd=sd127,host=py19,lun=/dev/rdisk/c16t5000097378080FC5d15s2
sd=sd128,host=py19,lun=/dev/rdisk/c16t5000097378080FC5d16s2
wd=wd_raw1,host=py01,sd=(sd1-sd8),seekpct=eof
wd=wd_raw9,host=py02,sd=(sd9-sd16),seekpct=eof
wd=wd_raw17,host=py03,sd=(sd17-sd24),seekpct=eof
wd=wd_raw25,host=py04,sd=(sd25-sd32),seekpct=eof
wd=wd_raw33,host=py05,sd=(sd33-sd40),seekpct=eof
wd=wd_raw41,host=py06,sd=(sd41-sd48),seekpct=eof
wd=wd_raw49,host=py07,sd=(sd49-sd56),seekpct=eof
wd=wd_raw57,host=py08,sd=(sd57-sd64),seekpct=eof
wd=wd_raw65,host=py09,sd=(sd65-sd72),seekpct=eof
wd=wd_raw73,host=py10,sd=(sd73-sd80),seekpct=eof
wd=wd_raw81,host=py11,sd=(sd81-sd88),seekpct=eof
wd=wd_raw89,host=py12,sd=(sd89-sd96),seekpct=eof
wd=wd_raw97,host=py13,sd=(sd97-sd104),seekpct=eof
wd=wd_raw105,host=py17,sd=(sd105-sd112),seekpct=eof
wd=wd_raw113,host=py18,sd=(sd113-sd120),seekpct=eof
wd=wd_raw121,host=py19,sd=(sd121-sd128),seekpct=eof
rd=rd_1,wd=wd_raw*,elapsed=24h,interval=10,forxfersize=128k,forrdpct=(0),forthreads=
(1),iorate=max
```



## Common Commands/Parameters – LFP, LDQ and VOD Tests

The following command/parameter lines appear in each of the command and parameter files for the Large File Processing (LFP), Large Database Query (LDQ) and Video on Demand (VOD) Tests. The command lines are only listed below to eliminate redundancy.

```
host=localhost,  
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),  
spc2="/usr/local/spc/spc2",  
shell=spc2,  
jvms=10,  
maxstreams=400  
host=(192.168.0.102,py02),  
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),  
spc2="/usr/local/spc/spc2",  
shell=spc2,  
jvms=10,  
maxstreams=400  
host=(192.168.0.103,py03),  
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),  
spc2="/usr/local/spc/spc2",  
shell=spc2,  
jvms=10,  
maxstreams=400  
host=(192.168.0.104,py04),  
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),  
spc2="/usr/local/spc/spc2",  
shell=spc2,  
jvms=10,  
maxstreams=400  
host=(192.168.0.105,py05),  
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),  
spc2="/usr/local/spc/spc2",  
shell=spc2,  
jvms=10,  
maxstreams=400  
host=(192.168.0.106,py06),  
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),  
spc2="/usr/local/spc/spc2",  
shell=spc2,  
jvms=10,  
maxstreams=400  
host=(192.168.0.107,py07),  
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),  
spc2="/usr/local/spc/spc2",  
shell=spc2,  
jvms=10,  
maxstreams=400  
host=(192.168.0.108,py08),  
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),  
spc2="/usr/local/spc/spc2",  
shell=spc2,  
jvms=10,  
maxstreams=400  
host=(192.168.0.109,py09),  
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),  
spc2="/usr/local/spc/spc2",  
shell=spc2,  
jvms=10,  
maxstreams=400
```

```
host=(192.168.0.110,py10),
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),
spc2="/usr/local/spc/spc2",
shell=spc2,
jvms=10,
maxstreams=400
host=(192.168.0.111,py11),
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),
spc2="/usr/local/spc/spc2",
shell=spc2,
jvms=10,
maxstreams=400
host=(192.168.0.112,py12),
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),
spc2="/usr/local/spc/spc2",
shell=spc2,
jvms=10,
maxstreams=400
host=(192.168.0.113,py13),
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),
spc2="/usr/local/spc/spc2",
shell=spc2,
jvms=10,
maxstreams=400
host=(192.168.0.117,py17),
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),
spc2="/usr/local/spc/spc2",
shell=spc2,
jvms=10,
maxstreams=400
host=(192.168.0.118,py18),
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),
spc2="/usr/local/spc/spc2",
shell=spc2,
jvms=10,
maxstreams=400
host=(192.168.0.119,py19),
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),
spc2="/usr/local/spc/spc2",
shell=spc2,
jvms=10,
maxstreams=400
sd=default,host=localhost,size=150000m
sd=sd1,lun=/dev/rdisk/c3t5000097378080C04d1s2
sd=sd2,lun=/dev/rdisk/c3t5000097378080C04d2s2
sd=sd3,lun=/dev/rdisk/c3t5000097378080C04d3s2
sd=sd4,lun=/dev/rdisk/c3t5000097378080C04d4s2
sd=sd5,lun=/dev/rdisk/c3t5000097378080C04d5s2
sd=sd6,lun=/dev/rdisk/c3t5000097378080C04d6s2
sd=sd7,lun=/dev/rdisk/c3t5000097378080C04d7s2
sd=sd8,lun=/dev/rdisk/c3t5000097378080C04d8s2
sd=sd9,lun=/dev/rdisk/c3t5000097378080C04d9s2
sd=sd10,lun=/dev/rdisk/c3t5000097378080C04d10s2
sd=sd11,lun=/dev/rdisk/c3t5000097378080C04d11s2
sd=sd12,lun=/dev/rdisk/c3t5000097378080C04d12s2
sd=sd13,lun=/dev/rdisk/c3t5000097378080C04d13s2
sd=sd14,lun=/dev/rdisk/c3t5000097378080C04d14s2
sd=sd15,lun=/dev/rdisk/c3t5000097378080C04d15s2
sd=sd16,lun=/dev/rdisk/c3t5000097378080C04d16s2
sd=sd17,lun=/dev/rdisk/c8t5000097378080C44d1s2
sd=sd18,lun=/dev/rdisk/c8t5000097378080C44d2s2
sd=sd19,lun=/dev/rdisk/c8t5000097378080C44d3s2
sd=sd20,lun=/dev/rdisk/c8t5000097378080C44d4s2
```

sd=sd21,lun=/dev/rdisk/c8t5000097378080C44d5s2  
sd=sd22,lun=/dev/rdisk/c8t5000097378080C44d6s2  
sd=sd23,lun=/dev/rdisk/c8t5000097378080C44d7s2  
sd=sd24,lun=/dev/rdisk/c8t5000097378080C44d8s2  
sd=sd25,lun=/dev/rdisk/c8t5000097378080C44d9s2  
sd=sd26,lun=/dev/rdisk/c8t5000097378080C44d10s2  
sd=sd27,lun=/dev/rdisk/c8t5000097378080C44d11s2  
sd=sd28,lun=/dev/rdisk/c8t5000097378080C44d12s2  
sd=sd29,lun=/dev/rdisk/c8t5000097378080C44d13s2  
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sd=sd31,lun=/dev/rdisk/c8t5000097378080C44d15s2  
sd=sd32,lun=/dev/rdisk/c8t5000097378080C44d16s2  
sd=sd33,lun=/dev/rdisk/c7t5000097378080C84d1s2  
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sd=sd35,lun=/dev/rdisk/c7t5000097378080C84d3s2  
sd=sd36,lun=/dev/rdisk/c7t5000097378080C84d4s2  
sd=sd37,lun=/dev/rdisk/c7t5000097378080C84d5s2  
sd=sd38,lun=/dev/rdisk/c7t5000097378080C84d6s2  
sd=sd39,lun=/dev/rdisk/c7t5000097378080C84d7s2  
sd=sd40,lun=/dev/rdisk/c7t5000097378080C84d8s2  
sd=sd41,lun=/dev/rdisk/c7t5000097378080C84d9s2  
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sd=sd54,lun=/dev/rdisk/c4t5000097378080CC4d6s2  
sd=sd55,lun=/dev/rdisk/c4t5000097378080CC4d7s2  
sd=sd56,lun=/dev/rdisk/c4t5000097378080CC4d8s2  
sd=sd57,lun=/dev/rdisk/c4t5000097378080CC4d9s2  
sd=sd58,lun=/dev/rdisk/c4t5000097378080CC4d10s2  
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sd=sd69,lun=/dev/rdisk/c9t5000097378080D04d5s2  
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sd=sd77,lun=/dev/rdisk/c9t5000097378080D04d13s2  
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sd=sd82,lun=/dev/rdisk/c6t5000097378080D44d2s2  
sd=sd83,lun=/dev/rdisk/c6t5000097378080D44d3s2

```
sd=sd84,lun=/dev/rdisk/c6t5000097378080D44d4s2
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sd=sd86,lun=/dev/rdisk/c6t5000097378080D44d6s2
sd=sd87,lun=/dev/rdisk/c6t5000097378080D44d7s2
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sd=sd89,lun=/dev/rdisk/c6t5000097378080D44d9s2
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sd=sd94,lun=/dev/rdisk/c6t5000097378080D44d14s2
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sd=sd105,lun=/dev/rdisk/c5t5000097378080D84d9s2
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sd=sd126,lun=/dev/rdisk/c10t5000097378080DC4d14s2
sd=sd127,lun=/dev/rdisk/c10t5000097378080DC4d15s2
sd=sd128,lun=/dev/rdisk/c10t5000097378080DC4d16s2
sd=default,host=py02,size=150000m
sd=sd1,lun=/dev/rdisk/c3t5000097378080C05d1s2
sd=sd2,lun=/dev/rdisk/c3t5000097378080C05d2s2
sd=sd3,lun=/dev/rdisk/c3t5000097378080C05d3s2
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sd=sd7,lun=/dev/rdisk/c3t5000097378080C05d7s2
sd=sd8,lun=/dev/rdisk/c3t5000097378080C05d8s2
sd=sd9,lun=/dev/rdisk/c3t5000097378080C05d9s2
sd=sd10,lun=/dev/rdisk/c3t5000097378080C05d10s2
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sd=sd12,lun=/dev/rdisk/c3t5000097378080C05d12s2
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sd=sd14,lun=/dev/rdisk/c3t5000097378080C05d14s2
sd=sd15,lun=/dev/rdisk/c3t5000097378080C05d15s2
sd=sd16,lun=/dev/rdisk/c3t5000097378080C05d16s2
sd=sd17,lun=/dev/rdisk/c4t5000097378080C45d1s2
```

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sd=sd19,lun=/dev/rdisk/c4t5000097378080C45d3s2  
sd=sd20,lun=/dev/rdisk/c4t5000097378080C45d4s2  
sd=sd21,lun=/dev/rdisk/c4t5000097378080C45d5s2  
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sd=sd71,lun=/dev/rdisk/c5t5000097378080D05d7s2  
sd=sd72,lun=/dev/rdisk/c5t5000097378080D05d8s2  
sd=sd73,lun=/dev/rdisk/c5t5000097378080D05d9s2  
sd=sd74,lun=/dev/rdisk/c5t5000097378080D05d10s2  
sd=sd75,lun=/dev/rdisk/c5t5000097378080D05d11s2  
sd=sd76,lun=/dev/rdisk/c5t5000097378080D05d12s2  
sd=sd77,lun=/dev/rdisk/c5t5000097378080D05d13s2  
sd=sd78,lun=/dev/rdisk/c5t5000097378080D05d14s2  
sd=sd79,lun=/dev/rdisk/c5t5000097378080D05d15s2  
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sd=sd47,lun=/dev/rdisk/c3t5000097378080E84d15s2  
sd=sd48,lun=/dev/rdisk/c3t5000097378080E84d16s2  
sd=sd49,lun=/dev/rdisk/c9t5000097378080EC4d1s2  
sd=sd50,lun=/dev/rdisk/c9t5000097378080EC4d2s2  
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sd=sd52,lun=/dev/rdisk/c9t5000097378080EC4d4s2  
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sd=sd58,lun=/dev/rdisk/c9t5000097378080EC4d10s2  
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sd=sd74,lun=/dev/rdisk/c8t5000097378080F04d10s2  
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sd=sd99,lun=/dev/rdisk/c1t5000097378080F84d3s2  
sd=sd100,lun=/dev/rdisk/c1t5000097378080F84d4s2  
sd=sd101,lun=/dev/rdisk/c1t5000097378080F84d5s2  
sd=sd102,lun=/dev/rdisk/c1t5000097378080F84d6s2  
sd=sd103,lun=/dev/rdisk/c1t5000097378080F84d7s2  
sd=sd104,lun=/dev/rdisk/c1t5000097378080F84d8s2



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sd=sd107, lun=/dev/rdisk/c1t5000097378080F84d11s2  
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sd=sd109, lun=/dev/rdisk/c1t5000097378080F84d13s2  
sd=sd110, lun=/dev/rdisk/c1t5000097378080F84d14s2  
sd=sd111, lun=/dev/rdisk/c1t5000097378080F84d15s2  
sd=sd112, lun=/dev/rdisk/c1t5000097378080F84d16s2  
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sd=sd119, lun=/dev/rdisk/c2t5000097378080FC4d7s2  
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sd=sd125, lun=/dev/rdisk/c2t5000097378080FC4d13s2  
sd=sd126, lun=/dev/rdisk/c2t5000097378080FC4d14s2  
sd=sd127, lun=/dev/rdisk/c2t5000097378080FC4d15s2  
sd=sd128, lun=/dev/rdisk/c2t5000097378080FC4d16s2  
sd=default, host=pyl9, size=150000m  
sd=sd1, lun=/dev/rdisk/c14t5000097378080E05d1s2  
sd=sd2, lun=/dev/rdisk/c14t5000097378080E05d2s2  
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sd=sd8, lun=/dev/rdisk/c14t5000097378080E05d8s2  
sd=sd9, lun=/dev/rdisk/c14t5000097378080E05d9s2  
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sd=sd28, lun=/dev/rdisk/c12t5000097378080E45d12s2  
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sd=sd35, lun=/dev/rdisk/c13t5000097378080E85d3s2  
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sd=sd47,lun=/dev/rdisk/c13t5000097378080E85d15s2  
sd=sd48,lun=/dev/rdisk/c13t5000097378080E85d16s2  
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sd=sd54,lun=/dev/rdisk/c11t5000097378080EC5d6s2  
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sd=sd63,lun=/dev/rdisk/c11t5000097378080EC5d15s2  
sd=sd64,lun=/dev/rdisk/c11t5000097378080EC5d16s2  
sd=sd65,lun=/dev/rdisk/c10t5000097378080F05d1s2  
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sd=sd69,lun=/dev/rdisk/c10t5000097378080F05d5s2  
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sd=sd76,lun=/dev/rdisk/c10t5000097378080F05d12s2  
sd=sd77,lun=/dev/rdisk/c10t5000097378080F05d13s2  
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sd=sd81,lun=/dev/rdisk/c15t5000097378080F45d1s2  
sd=sd82,lun=/dev/rdisk/c15t5000097378080F45d2s2  
sd=sd83,lun=/dev/rdisk/c15t5000097378080F45d3s2  
sd=sd84,lun=/dev/rdisk/c15t5000097378080F45d4s2  
sd=sd85,lun=/dev/rdisk/c15t5000097378080F45d5s2  
sd=sd86,lun=/dev/rdisk/c15t5000097378080F45d6s2  
sd=sd87,lun=/dev/rdisk/c15t5000097378080F45d7s2  
sd=sd88,lun=/dev/rdisk/c15t5000097378080F45d8s2  
sd=sd89,lun=/dev/rdisk/c15t5000097378080F45d9s2  
sd=sd90,lun=/dev/rdisk/c15t5000097378080F45d10s2  
sd=sd91,lun=/dev/rdisk/c15t5000097378080F45d11s2  
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sd=sd93,lun=/dev/rdisk/c15t5000097378080F45d13s2  
sd=sd94,lun=/dev/rdisk/c15t5000097378080F45d14s2  
sd=sd95,lun=/dev/rdisk/c15t5000097378080F45d15s2  
sd=sd96,lun=/dev/rdisk/c15t5000097378080F45d16s2  
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sd=sd99,lun=/dev/rdisk/c17t5000097378080F85d3s2  
sd=sd100,lun=/dev/rdisk/c17t5000097378080F85d4s2  
sd=sd101,lun=/dev/rdisk/c17t5000097378080F85d5s2

```
sd=sd102,lun=/dev/rdisk/c17t5000097378080F85d6s2
sd=sd103,lun=/dev/rdisk/c17t5000097378080F85d7s2
sd=sd104,lun=/dev/rdisk/c17t5000097378080F85d8s2
sd=sd105,lun=/dev/rdisk/c17t5000097378080F85d9s2
sd=sd106,lun=/dev/rdisk/c17t5000097378080F85d10s2
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sd=sd108,lun=/dev/rdisk/c17t5000097378080F85d12s2
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sd=sd111,lun=/dev/rdisk/c17t5000097378080F85d15s2
sd=sd112,lun=/dev/rdisk/c17t5000097378080F85d16s2
sd=sd113,lun=/dev/rdisk/c16t5000097378080FC5d1s2
sd=sd114,lun=/dev/rdisk/c16t5000097378080FC5d2s2
sd=sd115,lun=/dev/rdisk/c16t5000097378080FC5d3s2
sd=sd116,lun=/dev/rdisk/c16t5000097378080FC5d4s2
sd=sd117,lun=/dev/rdisk/c16t5000097378080FC5d5s2
sd=sd118,lun=/dev/rdisk/c16t5000097378080FC5d6s2
sd=sd119,lun=/dev/rdisk/c16t5000097378080FC5d7s2
sd=sd120,lun=/dev/rdisk/c16t5000097378080FC5d8s2
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sd=sd122,lun=/dev/rdisk/c16t5000097378080FC5d10s2
sd=sd123,lun=/dev/rdisk/c16t5000097378080FC5d11s2
sd=sd124,lun=/dev/rdisk/c16t5000097378080FC5d12s2
sd=sd125,lun=/dev/rdisk/c16t5000097378080FC5d13s2
sd=sd126,lun=/dev/rdisk/c16t5000097378080FC5d14s2
sd=sd127,lun=/dev/rdisk/c16t5000097378080FC5d15s2
sd=sd128,lun=/dev/rdisk/c16t5000097378080FC5d16s2
```

## Large File Processing Test (LFP)

### Common Commands/Parameters – LFP, LDQ and VOD Tests

```
*** Large File Processing Tests
maxlatestart=0
reportinginterval=5
segmentlength=512m
rd=default,measurement=180,runout=45,rampdown=15,buffers=1
** LFP, "write" Test Phase
rd=default,rdpct=0,xfersize=1024k
rd=TR1_SPC-2-FP2.0,rampup=180,periods=90,streams=1600
rd=default,rampup=180,periods=90
rd=TR2_SPC-2-FP2.0,streams=800
rd=TR3_SPC-2-FP2.0,streams=400
rd=TR4_SPC-2-FP2.0,streams=200
rd=TR5_SPC-2-FP2.0,streams=1
rd=default,xfersize=256k
rd=TR6_SPC-2-FP2.0,rampup=180,periods=90,streams=1600
rd=default,rampup=180,periods=90
rd=TR7_SPC-2-FP2.0,streams=800
rd=TR8_SPC-2-FP2.0,streams=400
rd=TR9_SPC-2-FP2.0,streams=200
rd=TR10_SPC-2-FP2.0,streams=1
** LFP, "read-write" Test Phase
rd=default,rdpct=50,xfersize=1024k
rd=TR11_SPC-2-FP2.0,rampup=180,periods=90,streams=1600
rd=default,rampup=180,periods=90
rd=TR12_SPC-2-FP2.0,streams=800
rd=TR13_SPC-2-FP2.0,streams=400
rd=TR14_SPC-2-FP2.0,streams=200
rd=TR15_SPC-2-FP2.0,streams=1
rd=default,xfersize=256k
rd=TR16_SPC-2-FP2.0,rampup=180,periods=90,streams=1600
```

```
rd=default,rampup=180,periods=90
rd=TR17_SPC-2-FP2.0,streams=800
rd=TR18_SPC-2-FP2.0,streams=400
rd=TR19_SPC-2-FP2.0,streams=200
rd=TR20_SPC-2-FP2.0,streams=1
** LFP, "read" Test Phase
rd=default,rdpct=100,xfersize=1024k
rd=TR21_SPC-2-FP2.0,rampup=180,periods=90,streams=1600
rd=default,rampup=180,periods=90
rd=TR22_SPC-2-FP2.0,streams=800
rd=TR23_SPC-2-FP2.0,streams=400
rd=TR24_SPC-2-FP2.0,streams=200
rd=TR25_SPC-2-FP2.0,streams=1
rd=default,xfersize=256k
rd=TR26_SPC-2-FP2.0,rampup=180,periods=90,streams=1600
rd=default,rampup=180,periods=90
rd=TR27_SPC-2-FP2.0,streams=800
rd=TR28_SPC-2-FP2.0,streams=400
rd=TR29_SPC-2-FP2.0,streams=200
rd=TR30_SPC-2-FP2.0,streams=1
```

## Large Database Query Test (LDQ)

### Common Commands/Parameters – LFP, LDQ and VOD Tests

```
* Large database Processing:
*
maxlatestart=0
reportinginterval=5
segmentlength=512m
* Fixed parameters
rd=default,rdpct=99,rampup=180,measurement=180,runout=45,rampdown=15,periods=90
rd=default,xfersize=1024k,buffers=4,streams=1600
rd=TR1_SPC-2-DQ2.0,streams=1600
rd=TR2_SPC-2-DQ2.0,streams=800
rd=TR3_SPC-2-DQ2.0,streams=400
rd=TR4_SPC-2-DQ2.0,streams=200
rd=TR5_SPC-2-DQ2.0,streams=1
rd=default,xfersize=1024k,buffers=1,streams=1600
rd=TR6_SPC-2-DQ2.0,streams=1600
rd=TR7_SPC-2-DQ2.0,streams=800
rd=TR8_SPC-2-DQ2.0,streams=400
rd=TR9_SPC-2-DQ2.0,streams=200
rd=TR10_SPC-2-DQ2.0,streams=1
rd=default,xfersize=64k,buffers=4,streams=1600
rd=TR11_SPC-2-DQ2.0,streams=1600
rd=TR12_SPC-2-DQ2.0,streams=800
rd=TR13_SPC-2-DQ2.0,streams=400
rd=TR14_SPC-2-DQ2.0,streams=200
rd=TR15_SPC-2-DQ2.0,streams=1
rd=default,xfersize=64k,buffers=1,streams=1600
rd=TR16_SPC-2-DQ2.0,streams=1600
rd=TR17_SPC-2-DQ2.0,streams=800
rd=TR18_SPC-2-DQ2.0,streams=400
rd=TR19_SPC-2-DQ2.0,streams=200
rd=TR20_SPC-2-DQ2.0,streams=1
```

## Logical Volume Initialization and Video on Demand Delivery (VOD)

### Common Commands/Parameters – LFP, LDQ and VOD Tests

```
maxlatestart=0
videosegmentduration=1200
maxlatevod=0
reportinginterval=5
rd=default,rampup=4500,periods=2250,measurement=7200,runout=45,rampdown=15,buffers=8
rd=TR1_SPC-2-VOD11.0,streams=60000
```

## Common Commands/Parameters – SPC-2 Persistence Test

The following command/parameter lines appear in each of the command and parameter files for the two SPC-2 Persistence Test Runs. The command lines are only listed below to eliminate redundancy.

```
host=localhost,
java=(/bench/jdk1.7.0_75/bin/amd64/java,"-Xms1024m -Xmx1024m -Xincgc"),
spc2="/usr/local/spc/spc2",
shell=spc2,
jvms=10,
maxstreams=400
sd=default,host=localhost,size=150000m
sd=sd1,lun=/dev/rdisk/c3t5000097378080C04d1s2
sd=sd2,lun=/dev/rdisk/c3t5000097378080C04d2s2
sd=sd3,lun=/dev/rdisk/c3t5000097378080C04d3s2
sd=sd4,lun=/dev/rdisk/c3t5000097378080C04d4s2
sd=sd5,lun=/dev/rdisk/c3t5000097378080C04d5s2
sd=sd6,lun=/dev/rdisk/c3t5000097378080C04d6s2
sd=sd7,lun=/dev/rdisk/c3t5000097378080C04d7s2
sd=sd8,lun=/dev/rdisk/c3t5000097378080C04d8s2
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sd=sd10,lun=/dev/rdisk/c3t5000097378080C04d10s2
sd=sd11,lun=/dev/rdisk/c3t5000097378080C04d11s2
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sd=sd21,lun=/dev/rdisk/c8t5000097378080C44d5s2
sd=sd22,lun=/dev/rdisk/c8t5000097378080C44d6s2
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sd=sd25,lun=/dev/rdisk/c8t5000097378080C44d9s2
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sd=sd28,lun=/dev/rdisk/c8t5000097378080C44d12s2
sd=sd29,lun=/dev/rdisk/c8t5000097378080C44d13s2
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sd=sd31,lun=/dev/rdisk/c8t5000097378080C44d15s2
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sd=sd33,lun=/dev/rdisk/c7t5000097378080C84d1s2
sd=sd34,lun=/dev/rdisk/c7t5000097378080C84d2s2
sd=sd35,lun=/dev/rdisk/c7t5000097378080C84d3s2
sd=sd36,lun=/dev/rdisk/c7t5000097378080C84d4s2
sd=sd37,lun=/dev/rdisk/c7t5000097378080C84d5s2
sd=sd38,lun=/dev/rdisk/c7t5000097378080C84d6s2
sd=sd39,lun=/dev/rdisk/c7t5000097378080C84d7s2
```

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sd=sd41,lun=/dev/rdisk/c7t5000097378080C84d9s2  
sd=sd42,lun=/dev/rdisk/c7t5000097378080C84d10s2  
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sd=sd45,lun=/dev/rdisk/c7t5000097378080C84d13s2  
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sd=sd75,lun=/dev/rdisk/c9t5000097378080D04d11s2  
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sd=sd80,lun=/dev/rdisk/c9t5000097378080D04d16s2  
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sd=sd102,lun=/dev/rdisk/c5t5000097378080D84d6s2

```
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sd=sd118,lun=/dev/rdisk/c10t5000097378080DC4d6s2
sd=sd119,lun=/dev/rdisk/c10t5000097378080DC4d7s2
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sd=sd122,lun=/dev/rdisk/c10t5000097378080DC4d10s2
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sd=sd126,lun=/dev/rdisk/c10t5000097378080DC4d14s2
sd=sd127,lun=/dev/rdisk/c10t5000097378080DC4d15s2
sd=sd128,lun=/dev/rdisk/c10t5000097378080DC4d16s2
```

## SPC-2 Persistence Test Run 1 (*write phase*)

### Common Commands/Parameters – SPC-2 Persistence Test

```
* Persistence Write Test
maxlatestart=0
reportinginterval=5
segmentlength=512m

* Fixed Parameters
rd=default,rampup=180,periods=90,measurement=300,runout=0,rampdown=0,buffers=1
rd=default,rdpct=0,xfersize=1024k
rd=TR1_SPC-2-persist-w,streams=1600
```

## SPC-2 Persistence Test Run 2 (*read phase*)

### Common Commands/Parameters – SPC-2 Persistence Test

```
* Persistence Read Test
maxlatestart=0
reportinginterval=5
segmentlength=512m

* Fixed Parameters
rd=default,rampup=0,periods=0,measurement=300,runout=0,rampdown=0,buffers=1
rd=default,rdpct=100,xfersize=1024k
rd=TR1_SPC-2-persist-r,streams=0
```

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

### **ASU Pre-Fill, Large File Processing Test, Large Database Query Test, Video on Demand Delivery Test, and SPC-2 Persistence Test Run 1 (*write phase*)**

The following script, [run\\_first.sh](#), was executed to invoke the following in an uninterrupted execution sequence:

- Commands to delete any output directories from previous SPC-2 measurements.
- The command to execute the required ASU prefill
- Invoke the [remotestart.sh](#) script to start the Slave JVMs for the following audited SPC-2 measurements.
- The commands to execute the Large File Processing Test (LFP), Large Data Query Test (LDQ), Video on Demand Delivery (VOD) Test and SPC-2 Persistence Test Run 1 (*write phase*).
- Command to organize the various output directories for audit submission.

The SPC-2 SPC-2 Persistence Test Run 2 was executed, after the required TSC power off/power on cycle, via the [command line](#).

Also listed below are two utility scripts, [spc2\\_source](#) and [do\\_all](#), used in the benchmark execution.

#### **run\_first.sh**

```
#!/bin/bash
#
# Run prefill, initialization, lfp, ldq,vod and persist-write in an uninterrupted
way
source spc2_source
cd /bench/spc2

do_all rm -rf /bench/spc2/1.results_prefill
do_all rm -rf /bench/spc2/2.results_init
do_all rm -rf /bench/spc2/3.results_lfp
do_all rm -rf /bench/spc2/4.results_ldq
do_all rm -rf /bench/spc2/5.results_vod
do_all rm -rf /bench/spc2/6.results_persist_write
do_all rm -rf /bench/spc2/7.remotestart.out
do_all rm -rf /bench/spc2/8.results_persist_read
do_all rm -rf /bench/spc2/9.remotestart.out

echo "start prefill"
/opt/vdbench/vdbench -f prefill.txt -o 1.results_prefill
# Start RemoteStart on each of the clients if not already started
sleep 10
m=`do_all ps -ef | grep -i remotestart | grep -v grep | wc -l`
if ((m==0))
then
    /bench/spc2/do_all /bench/spc2/remotestart.sh
fi
echo "$m clients started"
```



```
echo "start init"
java vdbench -w SPC2 -f vod.txt -o 2.results_init -init
echo "start lfp"
spc2 -f lfp.txt -o 3.results_lfp
echo "start ldq"
spc2 -f ldq.txt -o 4.results_ldq
echo "start vod"
spc2 -f vod.txt -o 5.results_vod
echo "persistence prewrite"
spc2 -f persist_write.txt -o 6.results_persist_write
mkdir 7.remotestart.out
do_all but_me rcp -r /bench/spc2/3.results_lfp/ py01:/bench/spc2/3.results_lfp/
do_all but_me rcp -r /bench/spc2/4.results_lfp/ py01:/bench/spc2/4.results_ldq/
do_all but_me rcp -r /bench/spc2/5.results_vod/ py01:/bench/spc2/5.results_vod/

echo "Power off Array for Read test"
```

### remotestart.sh

```
#!/bin/bash
# Script to start clients
cd /bench/spc2
source spc2_source
nohup java RemoteStart < /dev/null > `hostname`.remotestart.out
2>`hostname`.remotestart.err &
```

### spc2\_source

A utility script to set various environments variables.

```
#!/bin/bash
export
PATH=/opt/emc/SYMCLI/bin:/usr/local/spc/spc2:/bench/jdk1.7.0_75/bin/amd64:/bench/spc
2:$PATH
export CLASSPATH=/usr/local/spc/spc2:$CLASSPATH
export LD_LIBRARY_PATH=/usr/local/spc/spc2:$LD_LIBRARY_PATH
export HOSTS_LIST="py01 py02 py03 py04 py05 py06 py07 py08 py09 py10 py11 py12 py13
py17 py18 py19"
export HOST_TYPE="Solaris"
export JVMS=10
export JAVA_OPTS="-Xms1024m -Xmx1024m -Xincgc"
export TERM=vt100
```

### do\_all

A utility' script to perform operations on the various Host Systems.

```
#!/bin/ksh
if [ 0 = `echo ${HOSTS_LIST:-0}|wc -w` -o 0 = ${HOST_TYPE:-0} ]
then
    echo Environment HOSTS_LIST and HOST_TYPE are required to $0 $*
    exit
fi
#
# set defaults
#
but_me=: # impossible nodename for any host
background=0
#
# parse arguments for options
#
if [ "K$1" = "K-bg" ]
```

```

    then
        background=1
        shift
fi
if [ "K$1" = "Kbut_me" ]
then
    #
    # set $but_me to my local unix nodename, to skip
    #
    but_me=`uname -n`
    shift
else
    if [ "K$1" = "Kbut" ]
    then
        shift
        if [ "K$1" = "Kme" ]
        then
            but_me=`uname -n`
            shift
        else
            # second argument was not "me"
            # so put the "but" back
            #
            set but $*
        fi
    fi
fi
fi
if [ "K$1" = "K-bg" ]
then
    background=1
    shift
fi
#
#
#
if [ "HP-UX" = $HOST_TYPE -o "UNIX_SV" = $HOST_TYPE ]
then
    remote_shell=remsh
else
    remote_shell=rsh
fi
#
# set array varriable from environment
#
hostsleft=": $HOSTS_LIST"
n=0
hostsdone=""
while [ "K:" != "K$hostsleft" ]
do
    #
    # do last host first
    #
    thishost=${hostsleft##* }
    #
    # report host
    #
    if [ 1 != $background ]
    then
        echo $thishost ''
    fi
    #
    #
    #

```

```

if [ "$thishost" = "$but_me" ]
then
  echo skipped "(myself)"
else
  if [ remsh = $remote_shell ]
  then
    if [ 1 = $background ]
    then
      remsh $thishost "$*" | sed -e "s/^/$thishost /" &
    else
      remsh $thishost "$*"
    fi
  else
    if [ `uname -n` != "$thishost" ]
    then
      if [ 1 = $background ]
      then
        rsh $thishost "$*" 2>&1 | sed -e "s/^/$thishost
/" &
      else
        rsh $thishost "$*"
      fi
    else
      if [ 1 = $background ]
      then
        ( cd ; $* ) 2>&1 | sed -e "s/^/$thishost /" &
      else
        ( cd ; $* )
      fi
    fi
  fi
  n=$((n + 1))
fi
#
# discard thishost
#
# echo ''
# echo                $hostsleft --- $hostsdone
hostsleft=${hostsleft% *}
# echo                $hostsleft - $thishost - $hostsdone
hostsdone="$hostsdone $thishost"
# echo                $hostsleft --- $hostsdone
# echo ''

done
if [ 1 = $background ]
then
  wait
fi
#
# report completion
#
echo Done on $n hosts: "$hostsdone"

exit 0

```

### **SPC-2 Persistence Test Run 2 (*read phase*)**

SPC-2 Persistence Test Run 2 was executed from the command line using the following commands:

```
bash
cd /bench/spc2
source spc2_source
do_all/bench/spc2/remotestart.sh
spc2 -f persist_read.txt -o 10.results_persist_read
```

## APPENDIX F: THIRD-PARTY QUOTES

### Emulex LightPulse LPE12002-E HBAs

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QTY	Part Number	Description	Price	Subtotal
Delete 64	LPE12002-E	EMULEX - LIGHTPULSE 3GB DUAL CHANNEL PCI-EXPRESS 3.3 LOW PROFILE FIBRE CHANNEL HOST BUS ADAPTER WITH STANDARD BRACKET CARD ONLY (LPE12002-E) IN STOCK	\$505.00	\$32,320.00
Merchandise Subtotal:				\$32,320.00

**Shipping - Billing Info**

**Ship To**  **Bill To**  Copy Ship To

Ship To Company: EMC  
Attention: \_\_\_\_\_  
Street Address: 176 South St  
Suite/Unit/Apt: \_\_\_\_\_  
City: Hopkinton State: MA Zipcode: 01748

Bill To Company: EMC  
Attention: \_\_\_\_\_  
Street Address: 176 South St  
Suite/Unit/Apt: \_\_\_\_\_  
City: Hopkinton State: MA Zip: 01748

Purchase Order: TBD Optional  
Contact Phone: 608 435 1000 \* Contact Fax: \_\_\_\_\_  
Your Email: joseph.peny@emc.com \*  
Create Password: ..... \* Must be Alphanumeric and minimum 7 characters  
Confirm Password: ..... \*

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**Payment Options**

Credit / Debit Card  PayPal 1% Discount  Wire Transfer  Other  Explain: \_\_\_\_\_  
Select Credit Card Type:

Name on Card: \_\_\_\_\_ Card Number: \_\_\_\_\_

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