



**SPC BENCHMARK 1™  
FULL DISCLOSURE REPORT**

**HEWLETT PACKARD COMPANY  
HP 3PAR STORESERV 7400 STORAGE SYSTEM  
(WITH SSDs)**

**SPC-1 V1.14**

**Submitted for Review: May 23, 2013  
Submission Identifier: A00134**

**First Edition – May 2013**

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## AUDIT CERTIFICATION



Bill McCormack  
Hewlett Packard Company  
4209 Technology Drive  
Fremont, CA 94538

May 21, 2013

The SPC Benchmark 1™ Reported Data listed below for the HP 3PAR StoreServ 7400 Storage System (*with SSDs*) was produced in compliance with the SPC Benchmark 1™ v1.14 Onsite Audit requirements.

SPC Benchmark 1™ v1.14 Reported Data	
Tested Storage Product (TSP) Name:	
HP 3PAR StoreServ 7400 Storage System ( <i>with SSDs</i> )	
Metric	Reported Result
SPC-1 IOPS™	258,078.23
SPC-1 Price-Performance	\$0.58/SPC-1 IOPS™
Total ASU Capacity	1,145.324 GB
Data Protection Level	Protected 2 ( <i>Mirroring</i> )
Total Price (including three-year maintenance)	\$148,737.80
Currency Used	U.S. Dollars
Target Country for availability, sales and support	USA

The following SPC Benchmark 1™ Onsite Audit requirements were reviewed and found compliant with 1.14 of the SPC Benchmark 1™ specification:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified by physical inspection and information supplied by Hewlett Packard Company:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of each Application Storage Unit (ASU) and requirements.
- The total Application Storage Unit (ASU) Capacity was filled with random data, using an auditor approved tool, prior to execution of the SPC-1 Tests.

Storage Performance Council  
643 Bair Island Road, Suite 103  
Redwood City, CA 94062  
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650.556.9384



## AUDIT CERTIFICATION (CONT.)

HP 3PAR StoreServ 7400 Storage System (with SSDs)  
SPC-1 Audit Certification

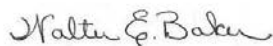
Page 2

- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Physical verification of the components to match the above diagram.
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters that were changed from default values.
- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.
- The following Host System requirements were verified by physical inspection and information supplied by Hewlett Packard Company:
  - ✓ The type of Host Systems including the number of processors and main memory.
  - ✓ The presence and version number of the SPC-1 Workload Generator on each Host System.
  - ✓ The TSC boundary within each Host System.
- The execution of each Test, Test Phase, and Test Run was observed and found compliant with all of the requirements and constraints of Clauses 4, 5, and 11 of the SPC-1 Benchmark Specification.
- The Test Results Files and resultant Summary Results Files received from Hewlett Packard Company for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability 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 8 of the SPC-1 Benchmark Specification.
- The Full Disclosure Report (FDR) met all of the requirements in Clause 9 of the SPC-1 Benchmark 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  
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# LETTER OF GOOD FAITH



Hewlett-Packard Company  
4209 Technology Drive  
Fremont, CA 94538  
USA

Date: May 13, 2013

From: Peter Slocum  
Vice President of Engineering  
Hewlett Packard Company  
4209 Technology Drive  
Fremont, CA 94538

TO: Walter E. Baker  
SPC Administrator and Auditor  
Gradiant Systems, Inc.  
643 Blair Island Road, Suite 103  
Redwood City, CA 94063

Subject: SPC-1 Letter of Good Faith for the HP 3PAR StoreServ 7400 Storage System

Hewlett Packard Company is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC – 1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with v1.14 of the SPC-1 benchmark specification.

In addition, we have reported any items in the Benchmark Configuration and execution of the benchmark that affected the reported results even if the items are not explicitly required to be disclosed by the SPC-1 benchmark specifications.

Signed:

Date:

  
Peter Slocum  
Vice President of Engineering  
Hewlett Packard Company

*May-13-2013*  
Date of Signature

## EXECUTIVE SUMMARY

### Test Sponsor and Contact Information

Test Sponsor and Contact Information	
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### Revision Information and Key Dates

Revision Information and Key Dates	
<b>SPC-1 Specification revision number</b>	V1.14
<b>SPC-1 Workload Generator revision number</b>	V2.3.0
<b>Date Results were first used publicly</b>	May 23, 2013
<b>Date the FDR was submitted to the SPC</b>	May 23, 2013
<b>Date the Priced Storage Configuration is available for shipment to customers</b>	April 1, 2012
<b>Date the TSC completed audit certification</b>	May 21, 2013

### Tested Storage Product (TSP) Description

The HP 3PAR StoreServ 7400 extends the innovative HP 3PAR StoreServ architecture to the midrange delivering effortless, efficient, bulletproof, and future proof storage to the entire midrange. Tier 1 storage data services and performance are now available to midrange customers. Spend less time managing storage, get more features for less money, and do it all without sacrificing performance or future scalability. The HP 3PAR StoreServ 7400 offers quad controller resiliency, multi-tenant design and mixed workload support. With hardware assisted thin technologies and advanced tiering the HP 3PAR StoreServ 7400 can help significantly reduce capacity. The HP 3PAR StoreServ 7400 is designed to reduce management complexities with built-in autonomic management, allowing effortless and instant response to new workload demands.

HP 3PAR StoreServ is also the first product family with a common architecture that offers midrange affordability and spans to the largest global enterprise, giving midrange

customers access to the same features as the world's largest service providers. You can start small and grow without painful upgrades down the road

## Summary of Results

SPC-1 Reported Data	
Tested Storage Product (TSP) Name: HP 3PAR StoreServ 7400 Storage System (with SSDs)	
Metric	Reported Result
SPC-1 IOPS™	258,078.23
SPC-1 Price-Performance™	\$0.58/SPC-1 IOPS™
Total ASU Capacity	1,145.324 GB
Data Protection Level	Protected 2 (Mirroring)
Total Price	\$148,737.80
Currency Used	U.S. Dollars
Target Country for availability, sales and support	USA

SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

SPC-1 Price-Performance™ is the ratio of **Total Price** to SPC-1 IOPS™.

**Total ASU** (Application Storage Unit) **Capacity** represents the total storage capacity available to be read and written in the course of executing the SPC-1 benchmark.

A **Data Protection Level** of **Protected 2** using **Mirroring** 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-1 Data Repository.*

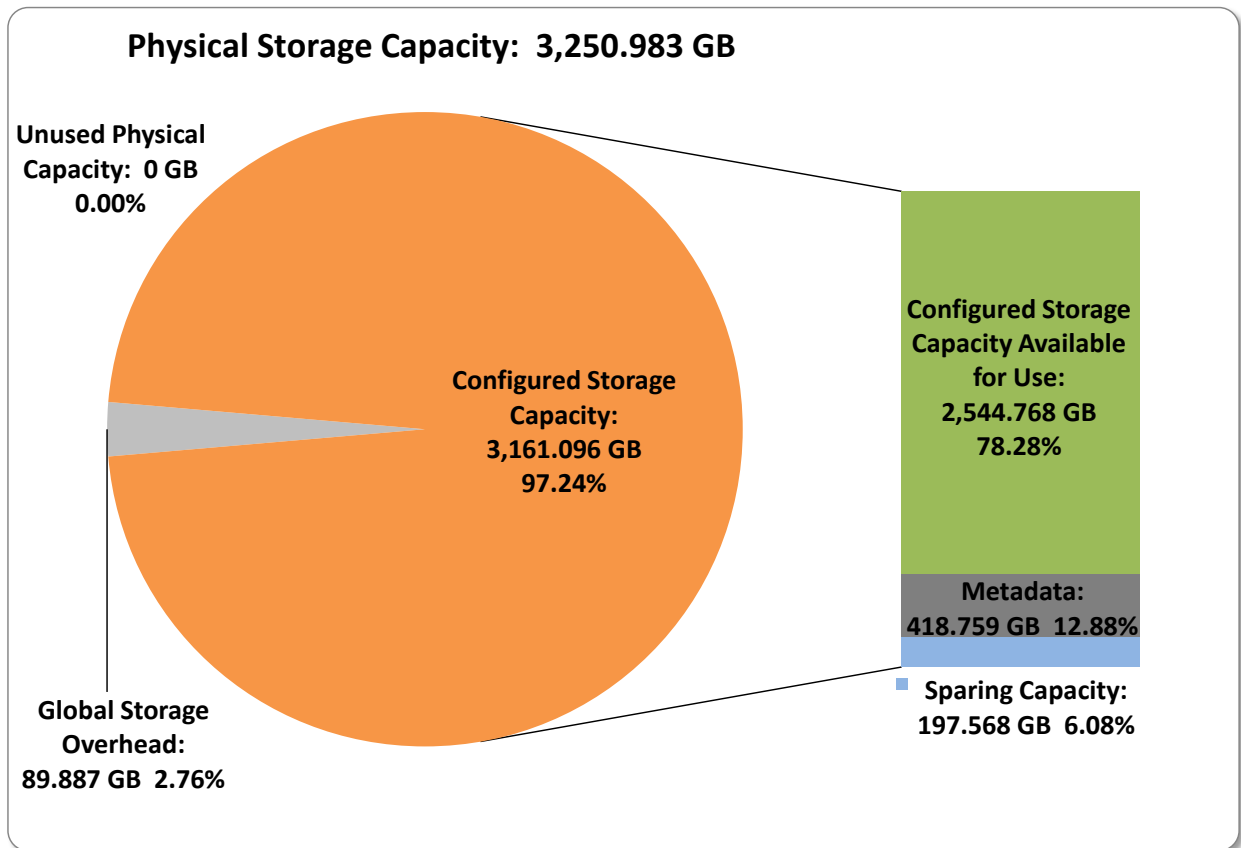
**Total Price** includes the cost of the Priced Storage Configuration plus three years of hardware maintenance and software support as detailed on page 18.

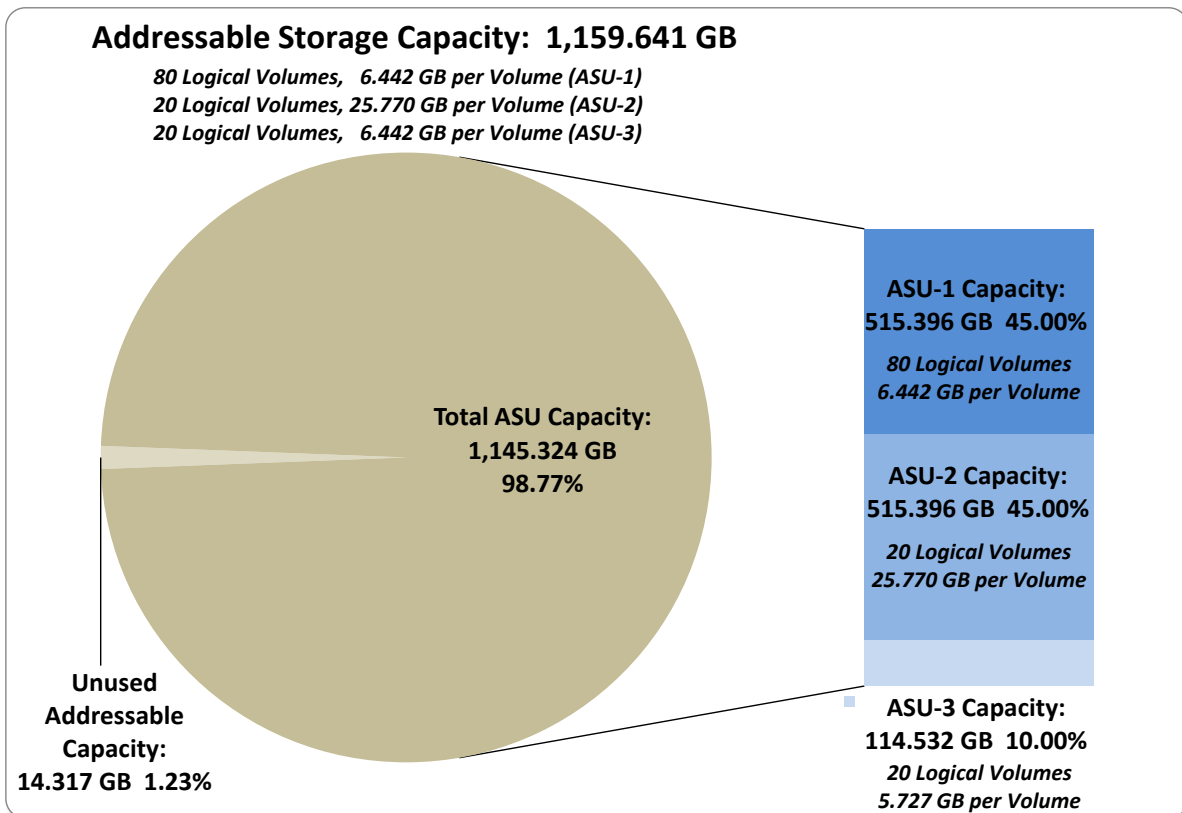
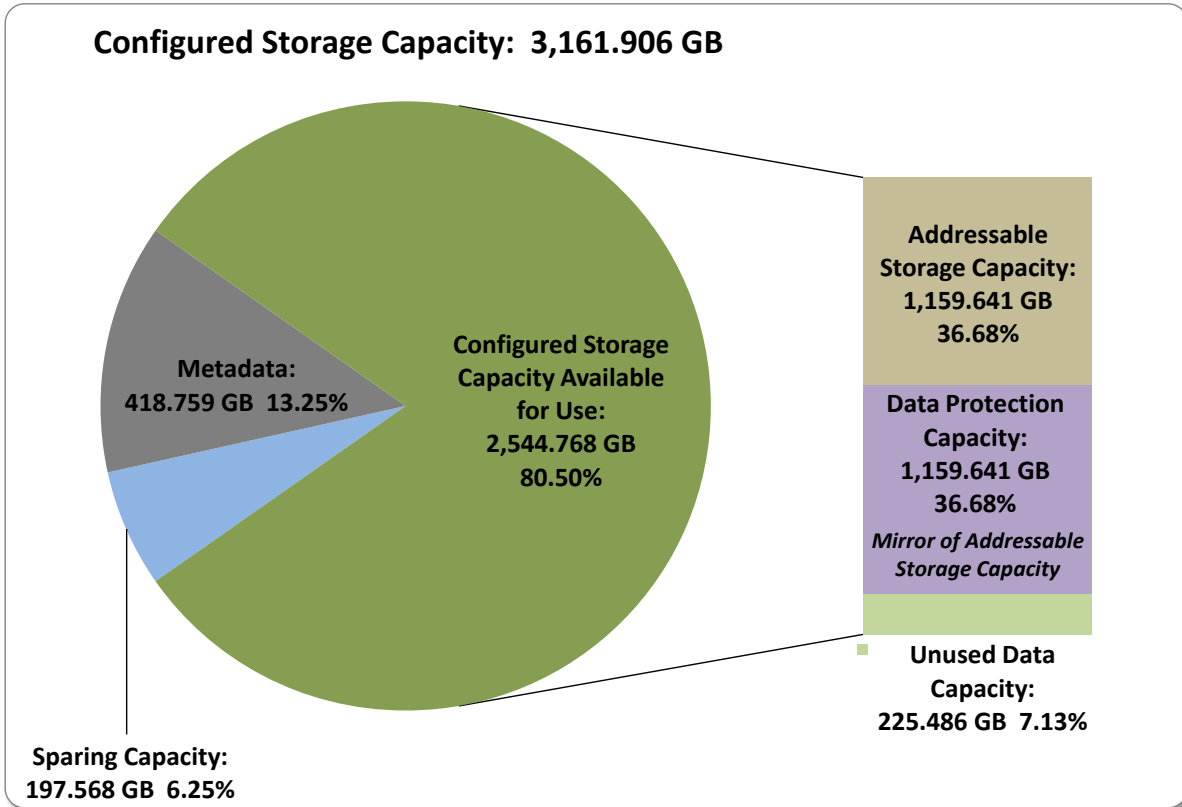
**Currency Used** is formal name for the currency used in calculating the **Total Price** and **SPC-1 Price-Performance™**. That currency may be the local currency of the **Target Country** or the currency of a difference country (*non-local currency*).

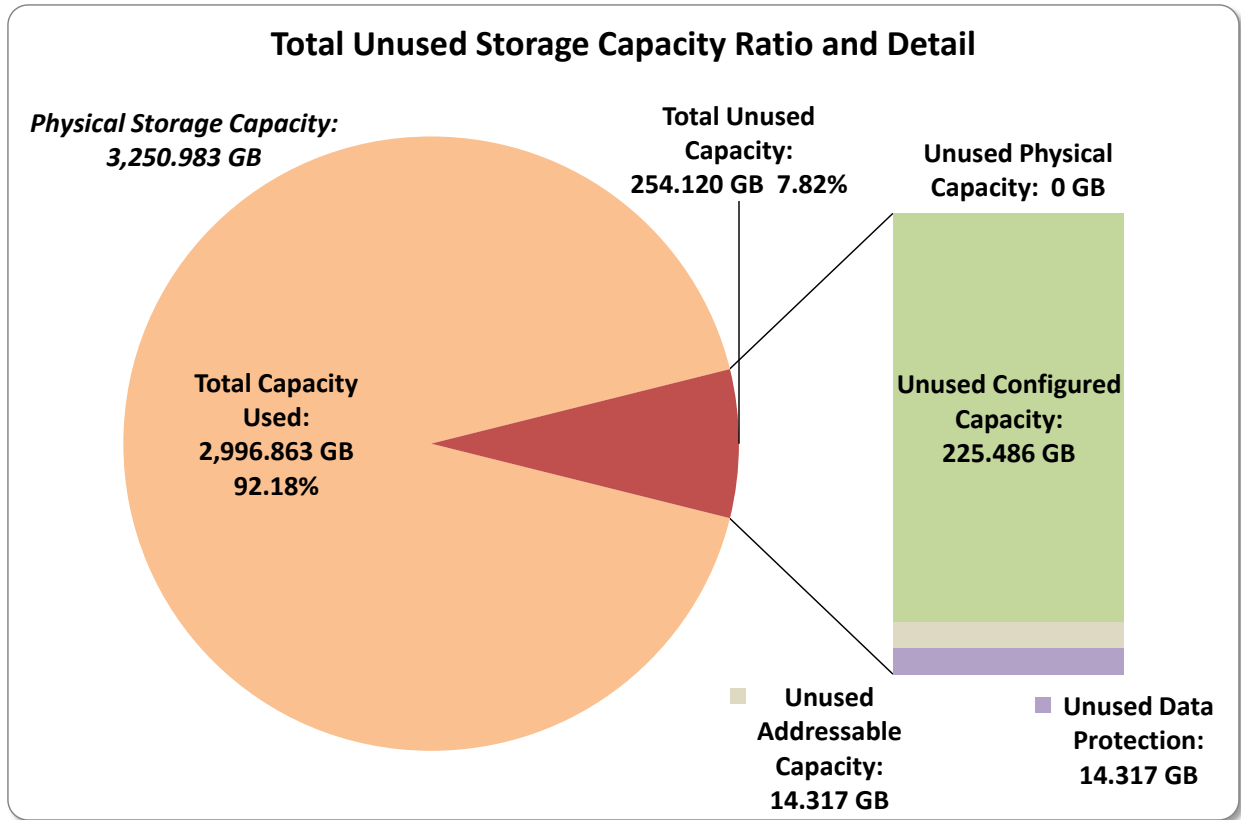
The **Target Country** is the country in which the Priced Storage Configuration is available for sale and in which the required hardware maintenance and software support is provided either directly from the Test Sponsor or indirectly via a third-party supplier.

### 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.







SPC-1 Storage Capacity Utilization	
Application Utilization	35.23%
Protected Application Utilization	70.46%
Unused Storage Ratio	7.82%

**Application Utilization:** Total ASU Capacity (1,145.324 GB) divided by Physical Storage Capacity (3,250,893 GB).

**Protected Application Utilization:** Total ASU Capacity (1,145.324 GB) plus total Data Protection Capacity (1,159.641 GB) minus unused Data Protection Capacity (14.317 GB) divided by Physical Storage Capacity (3,250,893 GB).

**Unused Storage Ratio:** Total Unused Capacity (254.120 GB) divided by Physical Storage Capacity (3,250,893 GB) and may not exceed 45%.

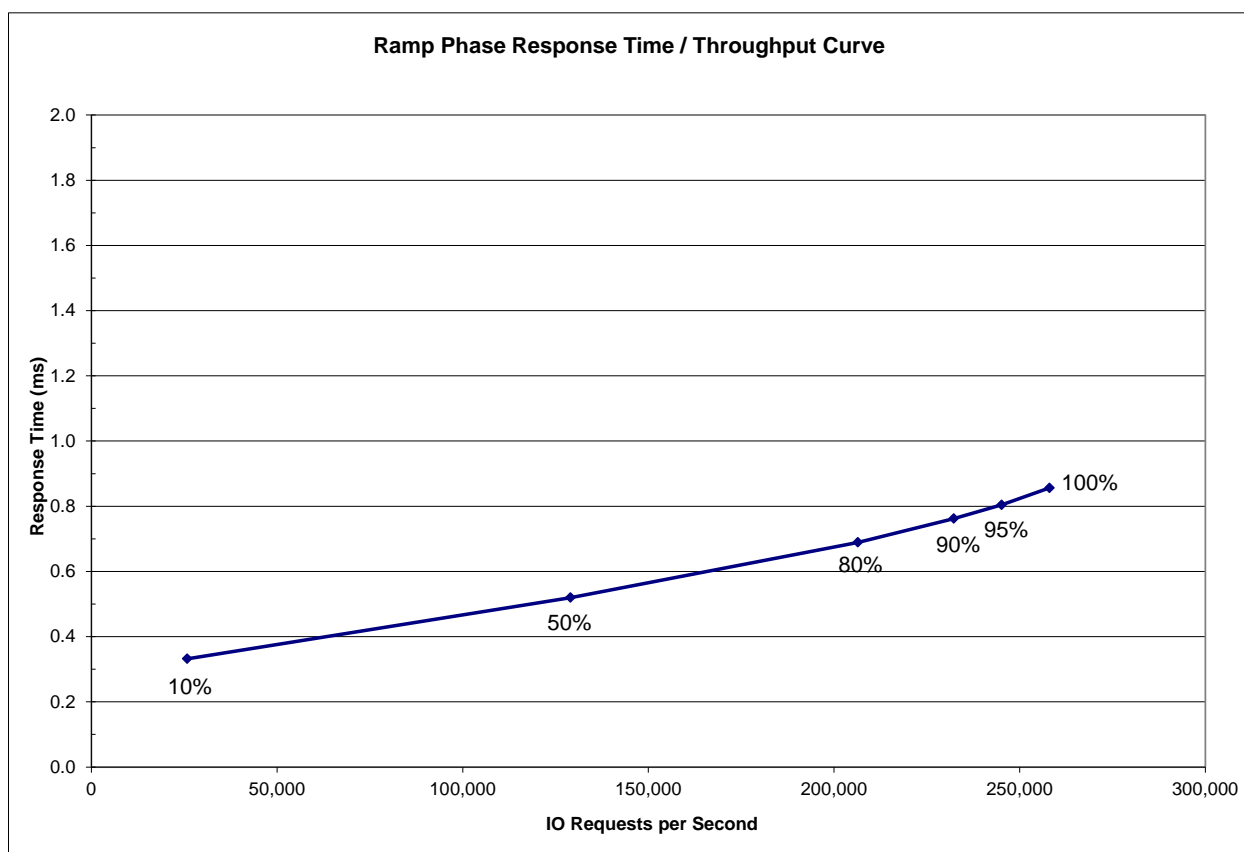
Detailed information for the various storage capacities and utilizations is available on pages 25-26.



### Response Time – Throughput Curve

The Response Time-Throughput Curve illustrates the Average Response Time (milliseconds) and I/O Request Throughput at 100%, 95%, 90%, 80%, 50%, and 10% of the workload level used to generate the SPC-1 IOPS™ metric.

The Average Response Time measured at any of the above load points cannot exceed 30 milliseconds or the benchmark measurement is invalid.



### Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
<b>I/O Request Throughput</b>	25,808.53	129,050.58	206,449.89	232,250.08	245,182.22	258,078.23
<b>Average Response Time (ms):</b>						
<b>All ASUs</b>	0.33	0.52	0.69	0.76	0.80	0.86
<b>ASU-1</b>	0.33	0.55	0.75	0.84	0.88	0.93
<b>ASU-2</b>	0.38	0.56	0.73	0.80	0.84	0.89
<b>ASU-3</b>	0.32	0.43	0.54	0.59	0.63	0.68
<b>Reads</b>	0.40	0.73	1.03	1.16	1.23	1.31
<b>Writes</b>	0.29	0.38	0.47	0.50	0.53	0.56

## Priced Storage Configuration Pricing

QNT	PART NUMBER	DESCRIPTION	UNIT PRICE	EXTENDED PRICE	DISCOUNT	DISCOUNTED PRICE
1	QR485A	HP 3PAR StoreServ 7400 4-N Storage Base	44,387.00	44,387.00	45%	24,412.85
1	QR485A 0D1	Factory integrated	-	-	45%	-
4	QR486A	HP 3PAR 7000 4-pt 8Gb/s FC Adapter	3,273.00	13,092.00	45%	7,200.60
4	QR486A 0D1	Factory integrated	-	-	45%	-
16	QR502A	HP M6710 100GB 6G SAS 2.5in SLC SSD	4,114.00	65,824.00	45%	36,203.20
16	QR502A 0D1	Factory integrated	-	-	45%	-
1	BC773A	HP 3PAR 7400 OS Suite Base LTU	2,035.00	2,035.00	45%	1,119.25
1	BC773A 0D1	Factory integrated	-	-	45%	-
32	BC774A	HP 3PAR 7400 OS Suite Drive LTU	407.00	13,024.00	45%	7,163.20
32	BC774A 0D1	Factory integrated	-	-	45%	-
16	QR502A	HP M6710 100GB 6G SAS 2.5in SLC SSD	4,114.00	65,824.00	45%	36,203.20
16	QR502A 0D1	Factory integrated	-	-	45%	-
1	HA110A3	HP 3y Support Plus 24 SVC	-	-	45%	-
1	HA110A3 RDD	HP 3PAR 7400 OS Suite Base LTU Supp	6,229.00	6,229.00	45%	3,425.95
32	HA110A3 S7D	HP 3PAR 7400 OS Suite Drive LTU Supp	108.00	3,456.00	45%	1,900.80
32	HA110A3 WUV	HP 3PAR 7000 100GB SSD Support	453.00	14,496.00	45%	7,972.80
4	HA110A3 WUX	HP 3PAR 7000 Adapter Support	355.00	1,420.00	45%	781.00
1	HA110A3 WUY	HP 3PAR 7400 4-node Storage Base Support	4,879.00	4,879.00	45%	2,683.45
1	QR516B	HP 3PAR 7000 Service Processor	3,490.00	3,490.00	45%	1,919.50
1	HA110A3	HP 3PAR 7000 Service Processor Support	382.00	382.00	45%	210.10
20	QK735A	HP Premier Flex LC/LC Multi-mode OM4 2 fiber 15m Cable	162.00	3,240.00	45%	1,782.00
5	third-party	Emulex LPe12004-M8 HBA	2,879.46	14,397.30	0%	14,397.30
20	third-party	Avago - AFBR-57D7APZ-HP9 SFPs	68.13	1,362.60	0%	1,362.60
<b>TOTAL PRICE</b>						<b>\$148,737.80</b>

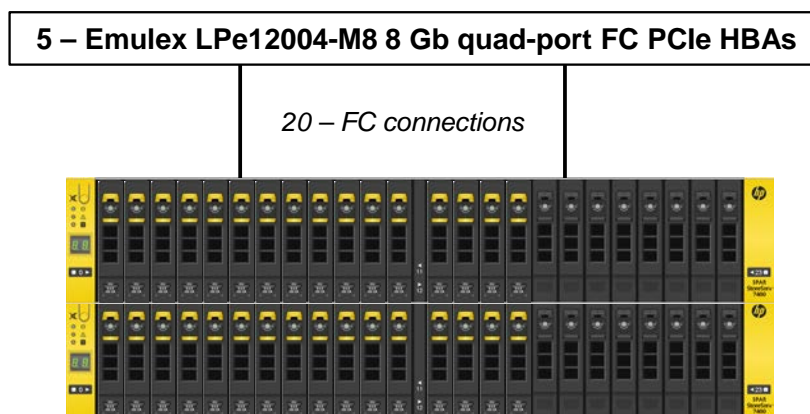
The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- Acknowledgement of new and existing problems with four (4) hours.
- Onsite presence of a qualified maintenance engineer or provision of a customer replaceable part within four (4) hours of the above acknowledgement for any hardware failure that results in an inoperative Priced Storage Configuration that can be remedied by the repair or replacement of a 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



### HP 3PAR StoreServ 7400 Storage System

- 4 Controller Nodes, each with:
  - 16 GB of cache (64 GB total)
  - 1 built-in dual-port 8 Gb FC front-end adapter
  - 1 quad-port 8 Gb FC front-end adapter
  - 1 dual-port SAS adapter
- 1 built-in enclosure per node pair  
(maximum of 24 SFF devices per enclosure)
- 32 – 100 GB Solid State Devices (SSDs)  
(16 SSDs per node pair enclosure)

### Priced Storage Configuration Components

Priced Storage Configuration:
5 – Emulex LPe12004-M8 8Gb quad-port FC PCIe HBAs
<b>HP 3PAR StoreServ 7400 Storage System</b> 4 Controller Nodes, each with: 16 GB of cache (64 GB total) 1 built-in dual-port 8 Gb FC front-end adapter (8 ports total, 8 ports used) 1 quad-port 8 Gb FC front-end adapter (16 ports total, 12 ports used, 3 ports per adapter) 1 built-in dual-port SAS adapter (8 ports total, 4 ports used, 1 port per adapter) 1 built-in enclosure per node pair (maximum of 24 SFF devices)
32 – 100 GB Solid State Devices (SSDs) (16 SSDs per node pair enclosure)

In each of the following sections of this document, the appropriate Full Disclosure Report requirement, from the SPC-1 benchmark specification, is stated in italics followed by the information to fulfill the stated requirement.

## **CONFIGURATION INFORMATION**

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

#### *Clause 9.4.3.4.1*

*A one page Benchmark Configuration (BC)/Tested Storage Configuration (TSC) diagram shall be included in the FDR...*

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page [21 \(Benchmark Configuration/Tested Storage Configuration Diagram\)](#).

### **Storage Network Configuration**

#### *Clause 9.4.3.4.1*

...

- 5. If the TSC contains network storage, the diagram will include the network configuration. If a single diagram is not sufficient to illustrate both the Benchmark Configuration and network configuration in sufficient detail, the Benchmark Configuration diagram will include a high-level network illustration as shown in Figure 9-8. In that case, a separate, detailed network configuration diagram will also be included as described in Clause 9.4.3.4.2.*

#### *Clause 9.4.3.4.2*

*If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.4.3.4.1 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 9-9.*

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

### **Host System(s) and Tested Storage Configuration (TSC) Table of Components**

#### *Clause 9.4.3.4.3*

*The FDR will contain a table that lists the major components of each Host System and the Tested Storage Configuration (TSC).*

The Host System(s) and TSC table of components may be found on page [22 \(Host Systems and Tested Storage Configuration Components\)](#).

## Benchmark Configuration/Tested Storage Configuration Diagram

5 – HP ProLiant DL360 G7 servers



5 – Emulex LPe12004-M8 8 Gb quad-port FC  
PCIe HBAs (1 HBA per server)

20 – FC connections



### HP 3PAR StoreServ 7400 Storage System

4 Controller Nodes, each with:

16 GB of cache (64 GB total)

1 built-in dual-port 8 Gb FC front-end adapter

1 quad-port 8 Gb FC front-end adapter

1 dual-port SAS adapter

1 built-in enclosure per node pair

(maximum of 24 SFF devices per enclosure)

32 – 100 GB Solid State Devices (SSDs)

(16 SSDs per node pair enclosure)

**Host Systems and Tested Storage Configuration Components**

<b>Host Systems:</b>	<b>Tested Storage Configuration (TSC):</b>
<p><b>5 – HP ProLiant DL360 G7 servers</b> each with:</p> <ul style="list-style-type: none"> <li>2 – Intel® Xeon® L5630 4 core processor, 2.13 GHz, 12 MB Intel® Smart Cache</li> <li>12 GB main memory</li> <li>Red Hat Enterprise Linux 6.2 (2.6.32.220 el6 x86_64)</li> <li>PCIe</li> </ul>	<p>5 – Emulex LPe12004-M8 8Gb quad-port FC PCIe HBAs (1 HBA per server)</p> <hr/> <p><b>HP 3PAR StoreServ 7400 Storage System</b></p> <p>4 Controller Nodes, each with:</p> <ul style="list-style-type: none"> <li>16 GB of cache (64 GB total)</li> <li>1 built-in dual-port 8 Gb FC front-end adapter (8 ports total, 8 ports used)</li> <li>1 quad-port 8 Gb FC front-end adapter (16 ports total, 12 ports used, 3 ports per adapter)</li> <li>1 built-in dual-port SAS adapter (8 ports total, 4 ports used, 1 port per adapter)</li> <li>1 built-in enclosure per node pair (maximum of 24 SFF devices)</li> </ul> <hr/> <p>32 – 100 GB Solid State Devices (SSDs) (16 SSDs per node pair enclosure)</p>

## Customer Tunable Parameters and Options

### Clause 9.4.3.5.1

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

## Tested Storage Configuration (TSC) Description

### Clause 9.4.3.5.2

The FDR must include sufficient information to recreate the logical representation of the TSC. In addition to customer tunable parameters and options (Clause 4.2.4.5.3), 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 9.2.4.4.1 and/or the Storage Network Configuration Diagram in Clause 9.2.4.4.2.
  - The logical representation of the TSC, configured from the above components that will be presented to the 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 78 contains the detailed information that describes how to create and configure the logical TSC.

## SPC-1 Workload Generator Storage Configuration

### Clause 9.4.3.5.3

The FDR must include all SPC-1 Workload Generator storage configuration commands and parameters.

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in [Appendix D: SPC-1 Workload Generator Storage Commands and Parameters](#) on page 82.

## ASU Pre-Fill

### Clause 5.3.3

*Each of the three SPC-1 ASUs (ASU-1, ASU-2 and ASU-3) is required to be completely filled with specified content prior to the execution of audited SPC-1 Tests. The content is required to consist of random data pattern such as that produced by an SPC recommended tool.*

The configuration file used to complete the required ASU pre-fill appears in [Appendix D: SPC-1 Workload Generator Storage Commands and Parameters](#) on page [82](#).



## SPC-1 DATA REPOSITORY

This portion of the Full Disclosure Report presents the detailed information that fully documents the various SPC-1 storage capacities and mappings used in the Tested Storage Configuration. [SPC-1 Data Repository Definitions](#) on page [73](#) contains definitions of terms specific to the SPC-1 Data Repository.

### Storage Capacities and Relationships

#### Clause 9.4.3.6.1

*Two tables and four charts documenting the storage capacities and relationships of the SPC-1 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-1 Storage Capacities

The Physical Storage Capacity consisted of 3,250.983 GB distributed over 32 solid state devices (SSDs), each with a formatted capacity of 101.593 GB. There was 0.000 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 89.887 GB (2.76%) of the Physical Storage Capacity. There was 225.486 GB (7.13%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 98.77% of the Addressable Storage Capacity resulting in 14.317 GB (1.23%) of Unused Storage within the Addressable Storage Capacity. The Data Protection (*Mirroring*) capacity was 1,159.641 GB of which 1,145.324 GB was utilized. The total Unused Storage capacity was 254.120 GB.

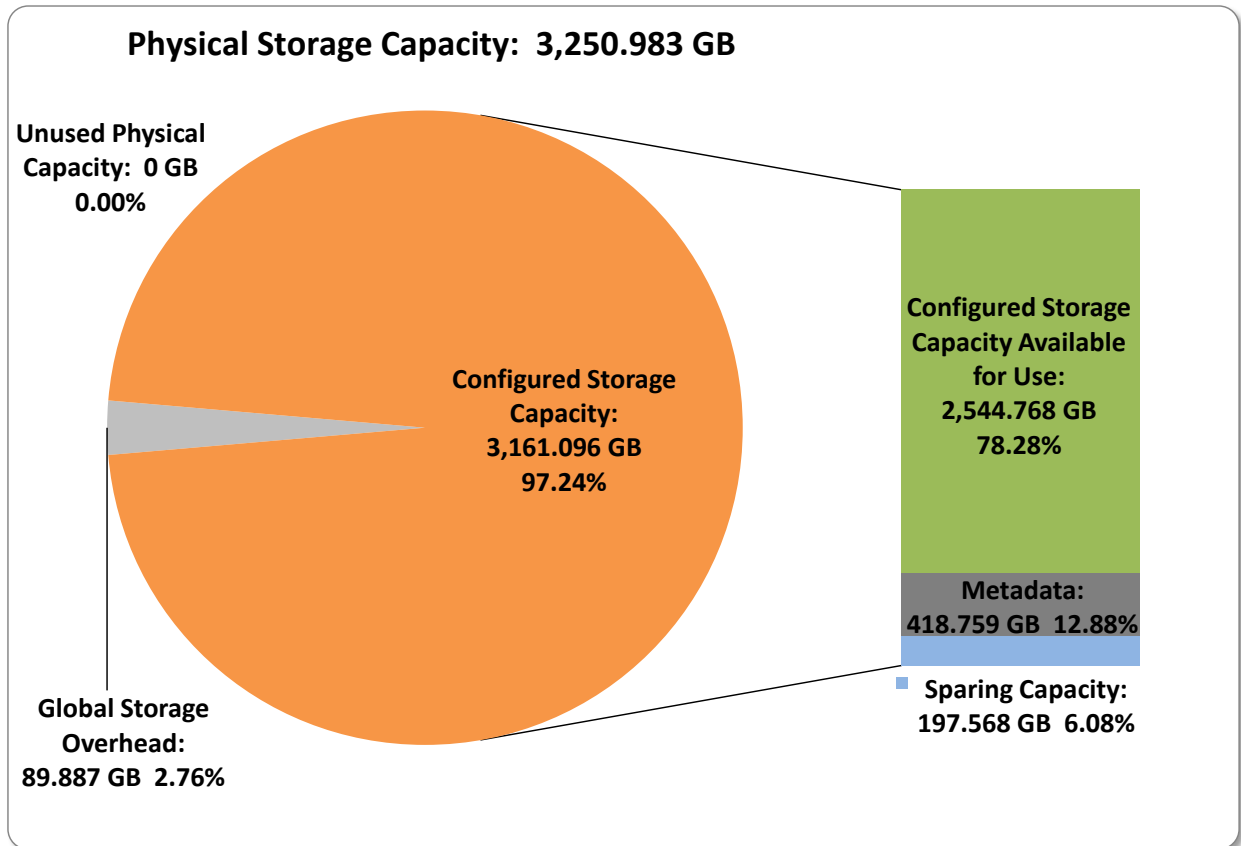
*Note: The configured Storage Devices may include additional storage capacity reserved for system overhead, which is not accessible for application use. That storage capacity may not be included in the value presented for Physical Storage Capacity.*

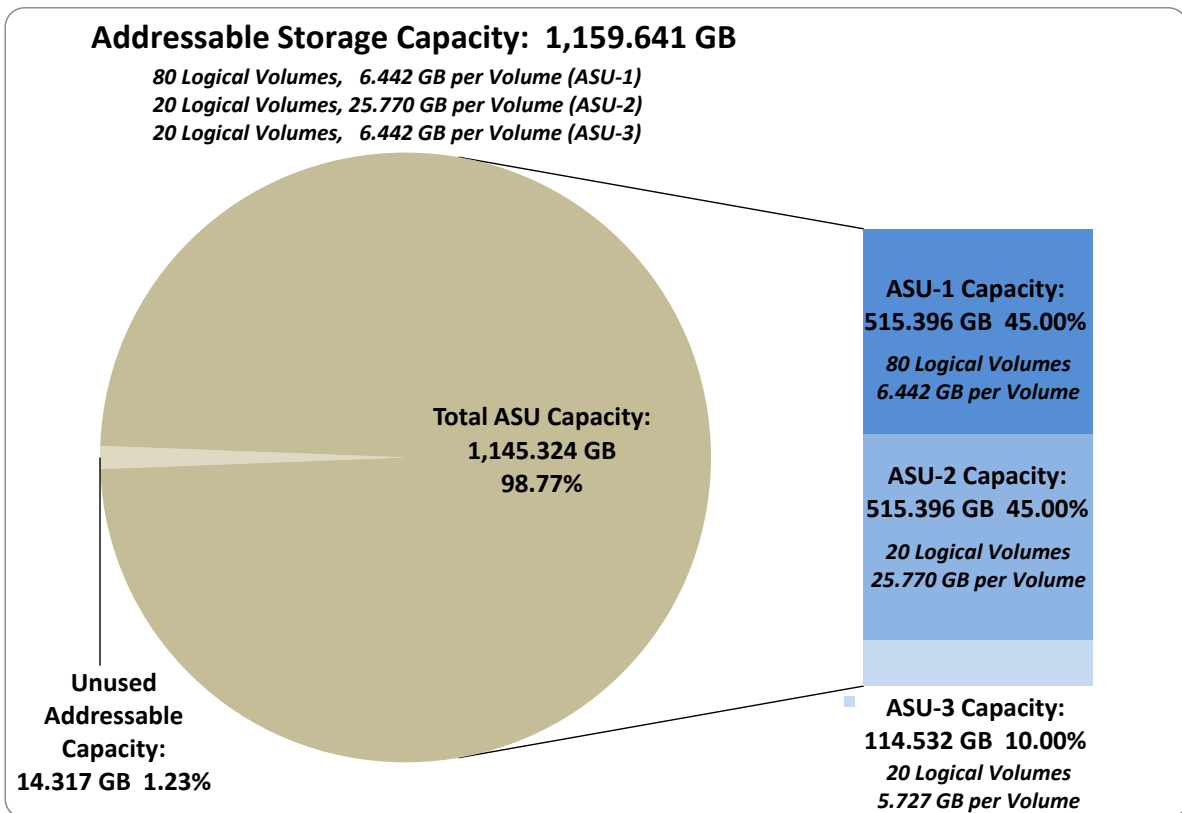
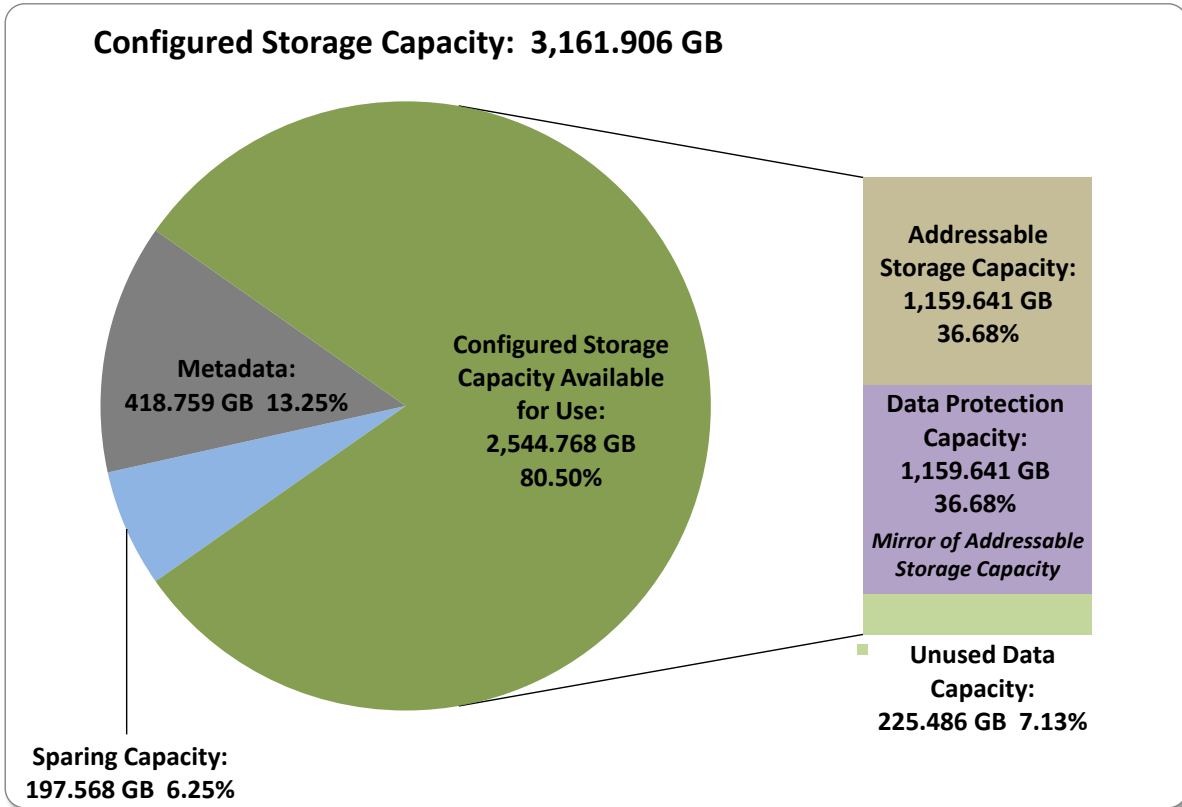
SPC-1 Storage Capacities		
Storage Hierarchy Component	Units	Capacity
Total ASU Capacity	Gigabytes (GB)	1,145.324
Addressable Storage Capacity	Gigabytes (GB)	1,159.641
Configured Storage Capacity	Gigabytes (GB)	3,161.096
Physical Storage Capacity	Gigabytes (GB)	3,250.983
Data Protection ( <i>Mirroring</i> )	Gigabytes (GB)	1,159.641
Required Storage ( <i>sparing, metadata</i> )	Gigabytes (GB)	616.328
Global Storage Overhead	Gigabytes (GB)	89.887
Total Unused Storage	Gigabytes (GB)	254.120

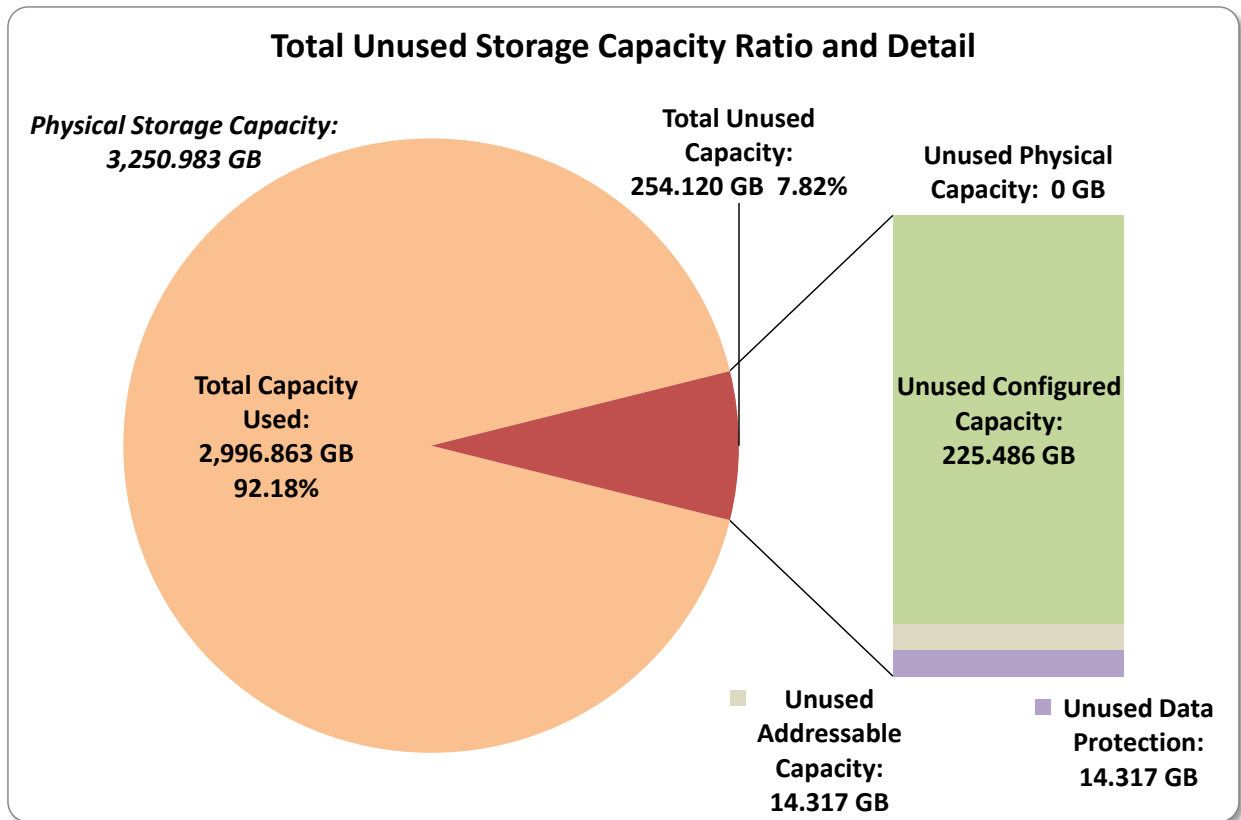
**SPC-1 Storage Hierarchy Ratios**

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
<b>Total ASU Capacity</b>	98.77%	36.23%	35.23%
<b>Required for Data Protection (<i>Mirroring</i>)</b>		36.68%	35.67%
<b>Addressable Storage Capacity</b>		36.68%	35.67%
<b>Required Storage (<i>sparing, metadata</i>)</b>		19.50%	18.96%
<b>Configured Storage Capacity</b>			97.24%
<b>Global Storage Overhead</b>			2.76%
<b>Unused Storage:</b>			
<b>Addressable</b>	1.23%		
<b>Configured</b>		7.13%	
<b>Physical</b>			0.00%

**SPC-1 Storage Capacity Charts**







## Storage Capacity Utilization

### Clause 9.4.3.6.2

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

### Clause 2.8.1

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

### Clause 2.8.2

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

### Clause 2.8.3

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

SPC-1 Storage Capacity Utilization	
Application Utilization	35.23%
Protected Application Utilization	70.46%

Unused Storage Ratio	7.82%
----------------------	-------

### Logical Volume Capacity and ASU Mapping

*Clause 9.4.3.6.3*

A table illustrating the capacity of each ASU and the mapping of Logical Volumes to ASUs shall be provided in the FDR. ... Logical Volumes shall be sequenced in the table from top to bottom per its position in the contiguous address space of each ASU. The capacity of each Logical Volume shall be stated. ... In conjunction with this table, the Test Sponsor shall provide a complete description of the type of data protection (see Clause 2.4.5) used on each Logical Volume.

Logical Volume Capacity and Mapping		
ASU-1 (GB)	ASU-2 (GB)	ASU-3 (GB)
80 Logical Volumes 6.442 GB per Logical Volume (6.442 GB used per Logical Volume)	20 Logical Volumes 25.770 GB per Logical Volume (25.770 GB used per Logical Volume)	20 Logical Volumes 6.442 GB per Logical Volume (5.727 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was [Protected 2](#) using *Mirroring* as described on page [13](#). See “ASU Configuration” in the [IOPS Test Results File](#) for more detailed configuration information.

## **SPC-1 BENCHMARK EXECUTION RESULTS**

This portion of the Full Disclosure Report documents the results of the various SPC-1 Tests, Test Phases, and Test Runs. An [SPC-1 glossary](#) on page 73 contains definitions of terms specific to the SPC-1 Tests, Test Phases, and Test Runs.

### *Clause 5.4.3*

*The Tests must be executed in the following sequence: Primary Metrics, Repeatability, and Data Persistence. That required sequence must be uninterrupted from the start of Primary Metrics to the completion of Persistence Test Run 1. Uninterrupted means the Benchmark Configuration shall not be power cycled, restarted, disturbed, altered, or adjusted during the above measurement sequence. If the required sequence is interrupted other than for the Host System/TSC power cycle between the two Persistence Test Runs, the measurement is invalid.*

## **SPC-1 Tests, Test Phases, and Test Runs**

The SPC-1 benchmark consists of the following Tests, Test Phases, and Test Runs:

- **Primary Metrics Test**
  - Sustainability Test Phase and Test Run
  - IOPS Test Phase and Test Run
  - Response Time Ramp Test Phase
    - 95% of IOPS Test Run
    - 90% of IOPS Test Run
    - 80% of IOPS Test Run
    - 50% of IOPS Test Run
    - 10% of IOPS Test Run (LRT)
- **Repeatability Test**
  - Repeatability Test Phase 1
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run
  - Repeatability Test Phase 2
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run
- **Data Persistence Test**
  - Data Persistence Test Run 1
  - Data Persistence Test Run 2

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

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

## “Ramp-Up” Test Runs

### Clause 5.3.13

*In order to warm-up caches or perform the initial ASU data migration in a multi-tier configuration, a Test Sponsor may perform a series of “Ramp-Up” Test Runs as a substitute for an initial, gradual Ramp-Up.*

### Clause 5.3.13.3

*The “Ramp-Up” Test Runs will immediately precede the Primary Metrics Test as part of the uninterrupted SPC-1 measurement sequence.*

### Clause 9.4.3.7.1

*If a series of “Ramp-Up” Test Runs were included in the SPC-1 measurement sequence, the FDR shall report the duration (ramp-up and measurement interval), BSU level, SPC-1 IOPS and average response time for each “Ramp-Up” Test Run in an appropriate table.*

There were no “Ramp-Up” Test Runs executed in this set of benchmark measurements.

## Primary Metrics Test – Sustainability Test Phase

### Clause 5.4.4.1.1

*The Sustainability Test Phase has exactly one Test Run and shall demonstrate the maximum sustainable I/O Request Throughput within at least a continuous eight (8) hour Measurement Interval. This Test Phase also serves to insure that the TSC has reached Steady State prior to reporting the final maximum I/O Request Throughput result (SPC-1 IOPS™).*

### Clause 5.4.4.1.2

*The computed I/O Request Throughput of the Sustainability Test must be within 5% of the reported SPC-1 IOPS™ result.*

### Clause 5.4.4.1.4

*The Average Response Time, as defined in Clause 5.1.1, will be computed and reported for the Sustainability Test Run and cannot exceed 30 milliseconds. If the Average Response time exceeds that 30-milliseconds constraint, the measurement is invalid.*

### Clause 9.4.3.7.2

*For the Sustainability Test Phase the FDR shall contain:*

- 1. A Data Rate Distribution graph and data table.*
- 2. I/O Request Throughput Distribution graph and data table.*
- 3. A Response Time Frequency Distribution graph and table.*
- 4. An Average Response Time Distribution graph and table.*
- 5. The human readable Test Run Results File produced by the Workload Generator (may be included in an appendix).*
- 6. A listing or screen image of all input parameters supplied to the Workload Generator (may be included in an appendix).*
- 7. The Measured Intensity Multiplier for each I/O stream.*
- 8. The variability of the Measured Intensity Multiplier, as defined in Clause 5.3.13.3.*



### SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in [Appendix E: SPC-1 Workload Generator Input Parameters](#) on Page 95.

### Sustainability Test Results File

A link to the test results file generated from the Sustainability Test Run is listed below.

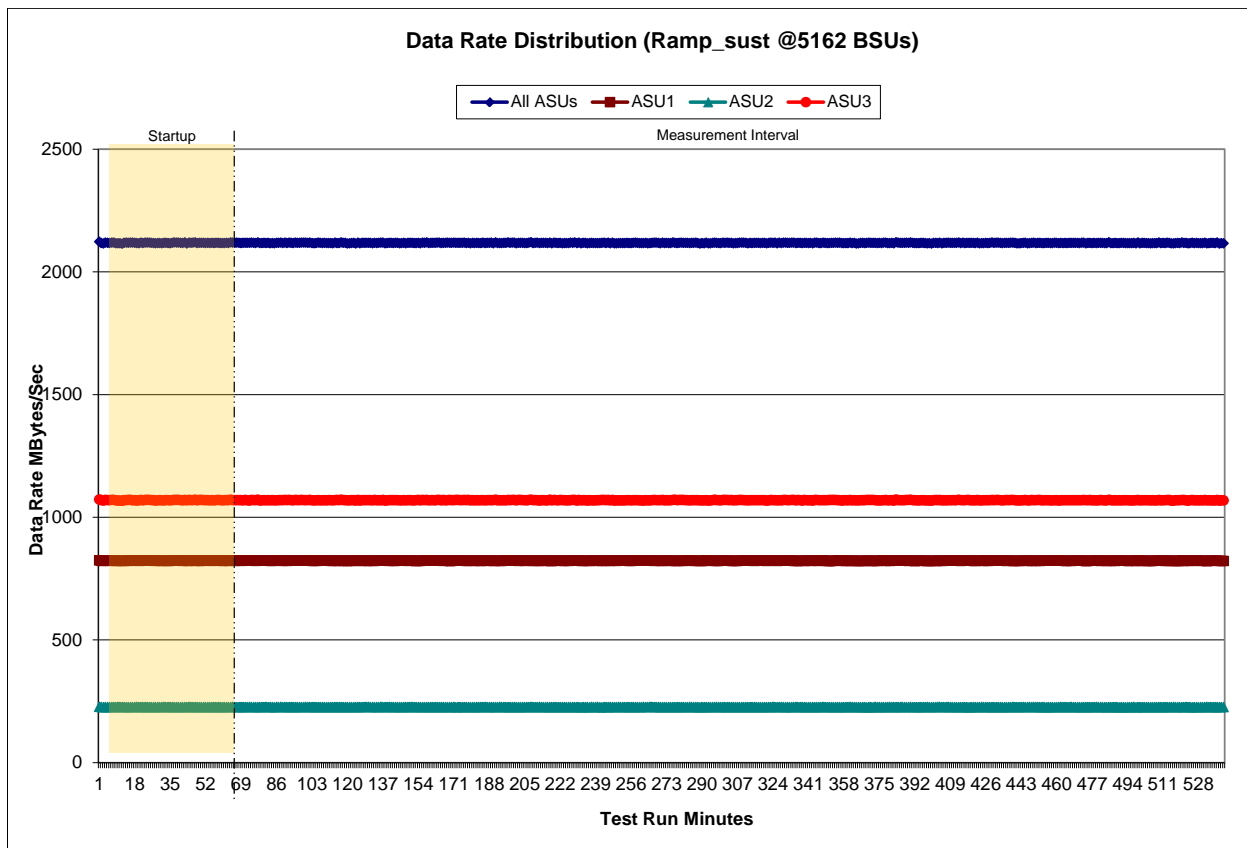
[Sustainability Test Results File](#)

### Sustainability – Data Rate Distribution Data (MB/second)

The Sustainability Data Rate table of data is not embedded in this document due to its size. The table is available via the following URL:

[Sustainability Data Rate Table](#)

### Sustainability – Data Rate Distribution Graph

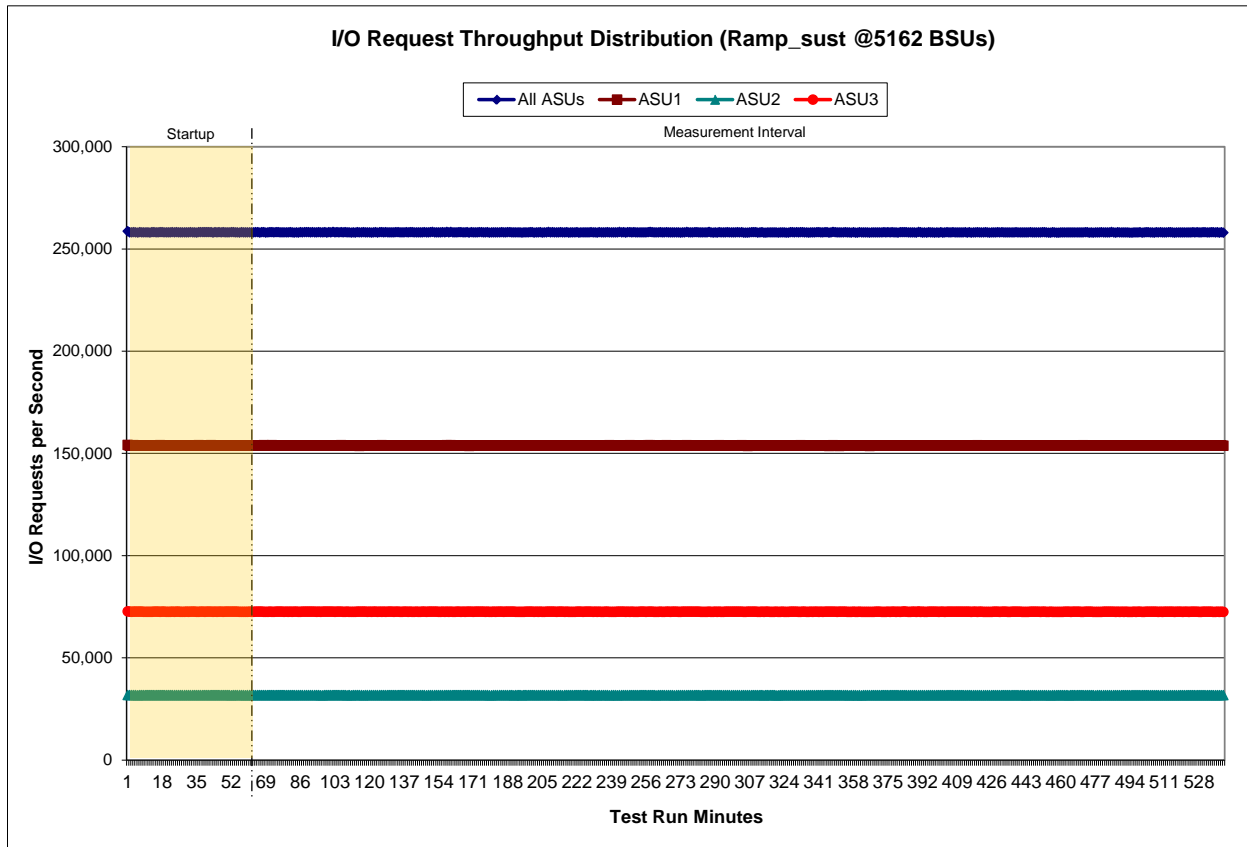


### Sustainability – I/O Request Throughput Distribution Data

The Sustainability I/O Request Throughput table of data is not embedded in this document due to its size. The table is available via the following URL:

[Sustainability I/O Request Throughput Table](#)

### Sustainability – I/O Request Throughput Distribution Graph

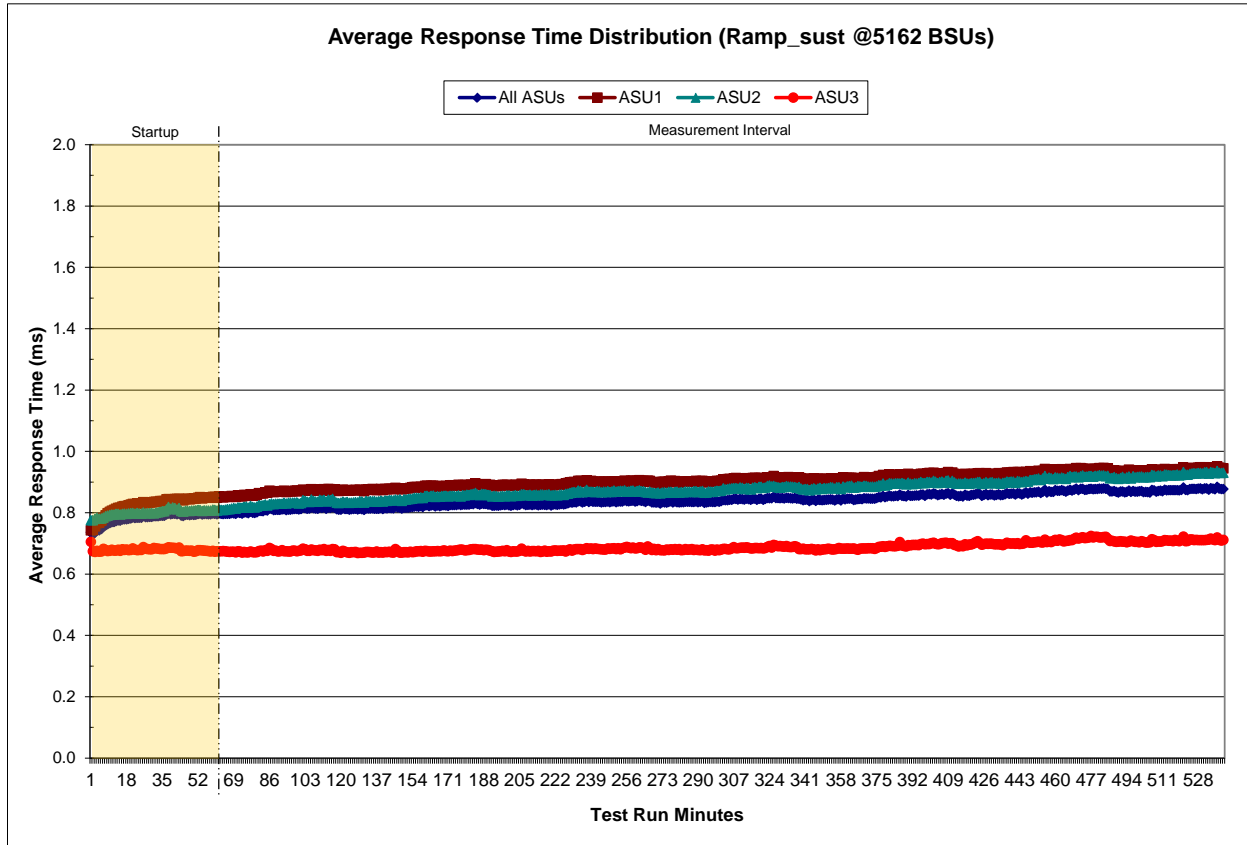


### Sustainability – Average Response Time (ms) Distribution Data

The Sustainability Average Response Time table of data is not embedded in this document due to its size. The table is available via the following URL:

[Sustainability Average Response Time Table](#)

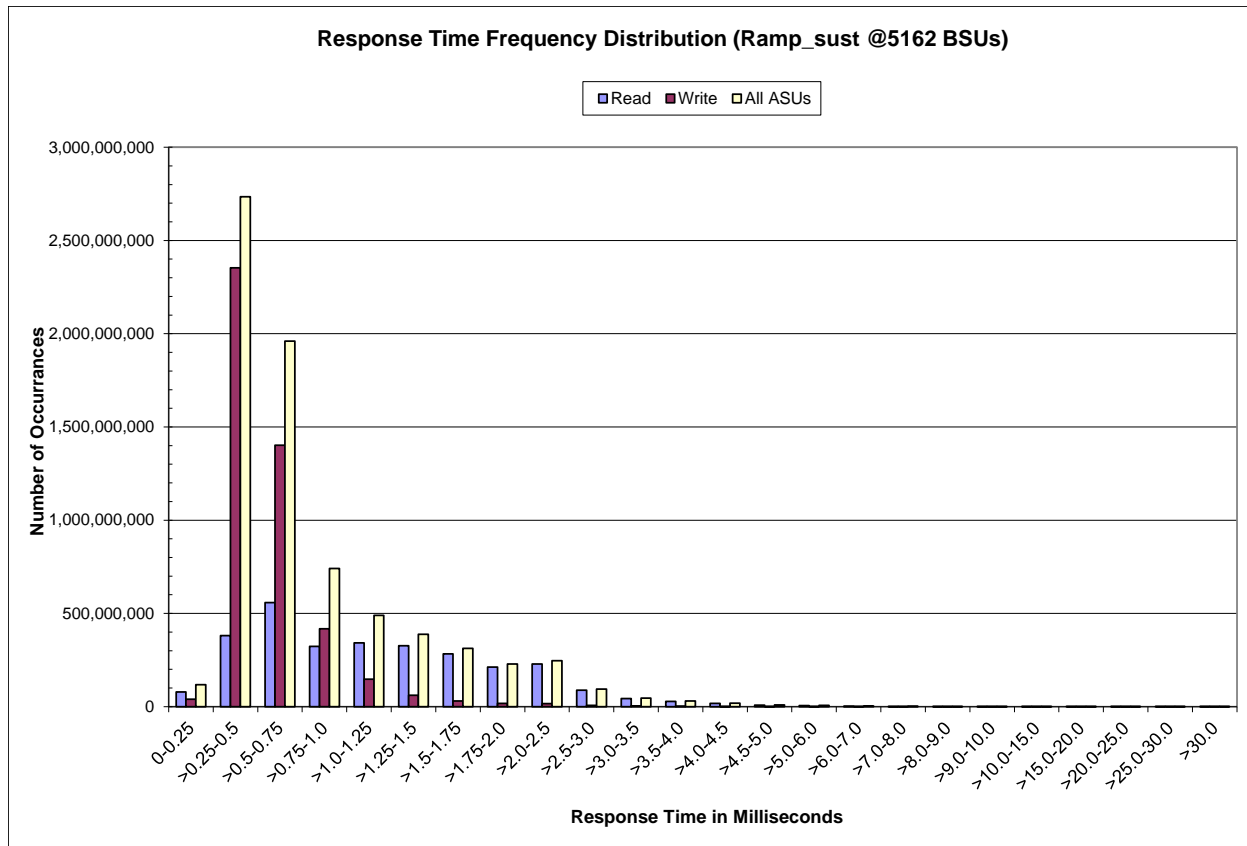
### Sustainability – Average Response Time (ms) Distribution Graph



**Sustainability – Response Time Frequency Distribution Data**

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	78,249,505	381,567,478	558,572,870	322,740,932	342,380,780	327,270,317	282,675,461	211,685,780
Write	39,505,611	2,352,876,034	1,401,635,135	418,167,086	147,533,409	60,908,401	30,436,414	17,514,893
All ASUs	117,755,116	2,734,443,512	1,960,208,005	740,908,018	489,914,189	388,178,718	313,111,875	229,200,673
ASU1	103,046,111	1,664,974,439	955,116,585	341,631,532	301,783,423	280,690,773	241,297,694	180,528,477
ASU2	10,067,237	366,897,391	210,247,469	69,978,664	57,672,460	51,958,844	44,208,726	33,316,376
ASU3	4,641,768	702,571,682	794,843,951	329,297,822	130,458,306	55,529,101	27,605,455	15,355,820
Response Time (ms)	>2.0-2.5	>2.5-3.0	>3.0-3.5	>3.5-4.0	>4.0-4.5	>4.5-5.0	>5.0-6.0	>6.0-7.0
Read	229,259,954	87,896,749	42,930,143	28,442,858	17,138,708	8,261,271	5,483,112	2,110,037
Write	16,656,750	6,353,653	2,873,894	1,585,409	1,275,376	1,180,625	1,213,684	921,283
All ASUs	245,916,704	94,250,402	45,804,037	30,028,267	18,414,084	9,441,896	6,696,796	3,031,320
ASU1	194,614,798	74,037,007	36,101,011	23,957,398	14,475,539	7,035,357	4,771,204	1,884,762
ASU2	37,002,798	14,680,160	7,157,602	4,710,828	2,860,132	1,398,433	950,794	369,545
ASU3	14,299,108	5,533,235	2,545,424	1,360,041	1,078,413	1,008,106	974,798	777,013
Response Time (ms)	>7.0-8.0	>8.0-9.0	>9.0-10.0	>10.0-15.0	>15.0-20.0	>20.0-25.0	>25.0-30.0	>30.0
Read	1,053,738	574,524	339,658	1,261,612	919,400	479,964	194,249	86,911
Write	545,775	211,027	78,578	135,769	37,066	13,608	4,613	2,545
All ASUs	1,599,513	785,551	418,236	1,397,381	956,466	493,572	198,862	89,456
ASU1	928,992	499,570	293,819	1,077,442	780,502	405,995	163,973	73,011
ASU2	180,490	97,061	56,859	205,896	148,409	78,192	31,739	14,525
ASU3	490,031	188,920	67,558	114,043	27,555	9,385	3,150	1,920

**Sustainability – Response Time Frequency Distribution Graph**



## Sustainability – Measured Intensity Multiplier and Coefficient of Variation

### Clause 3.4.3

**IM – Intensity Multiplier:** The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.

### Clauses 5.1.10 and 5.3.15.2

**MIM – Measured Intensity Multiplier:** The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.

### Clause 5.3.15.3

**COV – Coefficient of Variation:** This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.001	0.000	0.001	0.000	0.002	0.001	0.001	0.000

## Primary Metrics Test – IOPS Test Phase

### Clause 5.4.4.2

*The IOPS Test Phase consists of one Test Run at the 100% load point with a Measurement Interval of ten (10) minutes. The IOPS Test Phase immediately follows the Sustainability Test Phase without any interruption or manual intervention.*

*The IOPS Test Run generates the SPC-1 IOPS™ primary metric, which is computed as the I/O Request Throughput for the Measurement Interval of the IOPS Test Run.*

*The Average Response Time is computed for the IOPS Test Run and cannot exceed 30 milliseconds. If the Average Response Time exceeds the 30 millisecond constraint, the measurement is invalid.*

### Clause 9.4.3.7.3

*For the IOPS Test Phase the FDR shall contain:*

- 1. I/O Request Throughput Distribution (data and graph).*
- 2. A Response Time Frequency Distribution.*
- 3. An Average Response Time Distribution.*
- 4. The human readable Test Run Results File produced by the Workload Generator.*
- 5. A listing or screen image of all input parameters supplied to the Workload Generator.*
- 6. The total number of I/O Requests completed in the Measurement Interval as well as the number of I/O Requests with a Response Time less than or equal to 30 milliseconds and the number of I/O Requests with a Response Time greater than 30 milliseconds.*

## SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in [Appendix E: SPC-1 Workload Generator Input Parameters](#) on Page [95](#).

## IOPS Test Results File

A link to the test results file generated from the IOPS Test Run is listed below.

[IOPS Test Results File](#)

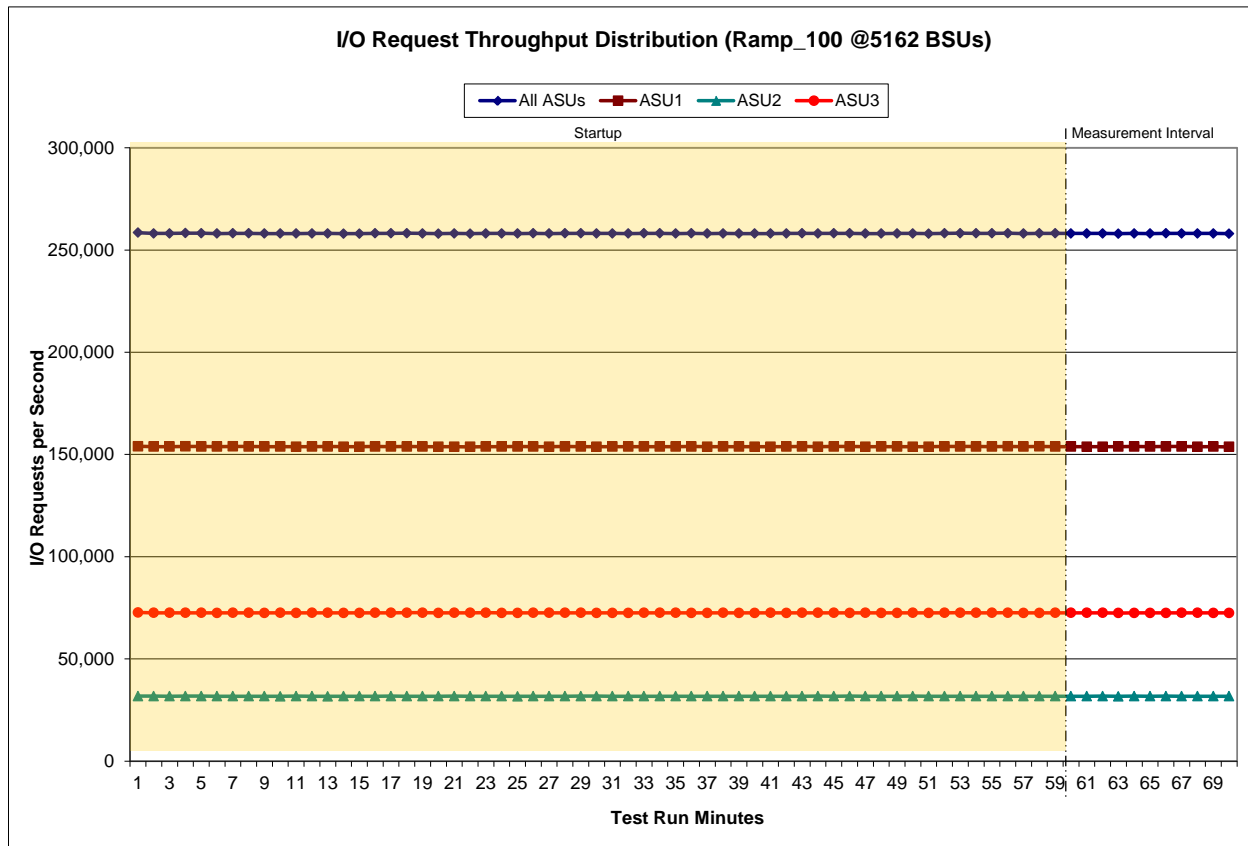
**IOPS Test Run – I/O Request Throughput Distribution Data (Ramp-Up)**

5,162 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	5:35:58	6:35:59	0-59	1:00:01
<i>Measurement Interval</i>	6:35:59	6:45:59	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	258,489.90	154,004.28	31,789.63	72,695.98
1	258,130.78	153,817.88	31,774.52	72,538.38
2	258,127.92	153,851.20	31,716.10	72,560.62
3	258,248.70	153,918.78	31,766.63	72,563.28
4	258,221.57	153,897.57	31,785.47	72,538.53
5	258,046.05	153,809.12	31,742.05	72,494.88
6	258,160.82	153,918.67	31,723.67	72,518.48
7	258,168.43	153,877.87	31,731.67	72,558.90
8	258,060.28	153,817.17	31,741.72	72,501.40
9	258,060.03	153,811.62	31,701.55	72,546.87
10	258,047.58	153,800.72	31,774.72	72,472.15
11	258,099.25	153,826.60	31,743.70	72,528.95
12	258,103.90	153,873.80	31,700.77	72,529.33
13	257,988.78	153,759.35	31,727.82	72,501.62
14	258,006.05	153,799.13	31,720.67	72,486.25
15	258,137.83	153,873.60	31,738.62	72,525.62
16	258,148.12	153,828.72	31,782.18	72,537.22
17	258,202.60	153,858.57	31,763.30	72,580.73
18	258,115.53	153,805.87	31,738.67	72,571.00
19	258,023.55	153,794.85	31,752.42	72,476.28
20	258,078.22	153,768.03	31,765.50	72,544.68
21	258,019.38	153,722.87	31,754.47	72,542.05
22	258,123.68	153,815.03	31,729.12	72,579.53
23	258,077.97	153,856.07	31,740.17	72,481.73
24	258,077.53	153,871.33	31,708.78	72,497.42
25	258,144.92	153,836.88	31,742.42	72,565.62
26	258,045.37	153,784.85	31,738.33	72,522.18
27	258,134.58	153,866.37	31,730.65	72,537.57
28	258,150.13	153,853.38	31,773.48	72,523.27
29	258,083.63	153,772.70	31,797.12	72,513.82
30	258,081.08	153,843.42	31,734.02	72,503.65
31	258,041.90	153,832.40	31,731.65	72,477.85
32	258,146.10	153,844.28	31,739.82	72,562.00
33	258,138.58	153,849.50	31,728.98	72,560.10
34	258,069.68	153,823.32	31,719.62	72,526.75
35	258,133.42	153,890.22	31,748.13	72,495.07
36	258,038.87	153,774.05	31,756.03	72,508.78
37	258,121.47	153,812.62	31,754.62	72,554.23
38	258,076.78	153,823.97	31,744.65	72,508.17
39	258,036.27	153,780.15	31,757.38	72,498.73
40	258,038.05	153,754.72	31,740.07	72,543.27
41	258,081.17	153,809.15	31,758.25	72,513.77
42	258,145.35	153,871.58	31,751.28	72,522.48
43	258,116.62	153,790.57	31,773.90	72,552.15
44	258,148.00	153,879.67	31,736.55	72,531.78
45	258,138.05	153,858.83	31,790.08	72,489.13
46	258,043.63	153,775.83	31,747.53	72,520.27
47	258,030.18	153,810.12	31,719.82	72,500.25
48	258,107.70	153,848.65	31,759.50	72,499.55
49	258,124.15	153,775.30	31,779.40	72,569.45
50	258,010.45	153,767.08	31,734.25	72,509.12
51	258,146.60	153,877.67	31,732.72	72,536.22
52	258,233.05	153,904.60	31,750.12	72,578.33
53	258,170.85	153,889.77	31,730.73	72,550.35
54	258,133.18	153,804.50	31,762.85	72,565.83
55	258,234.37	153,913.72	31,745.98	72,574.67
56	258,075.80	153,838.23	31,728.18	72,509.38
57	258,157.52	153,930.28	31,742.62	72,484.62
58	258,139.70	153,841.62	31,731.02	72,567.07
59	258,130.63	153,834.40	31,739.35	72,556.88

**IOPS Test Run – I/O Request Throughput Distribution Data  
 (Measurement Interval)**

5,162 BSUs	Start	Stop	Interval	Duration
<b>Start-Up/Ramp-Up</b>	5:35:58	6:35:59	0-59	1:00:01
<b>Measurement Interval</b>	6:35:59	6:45:59	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	258,110.45	153,796.27	31,765.02	72,549.17
61	258,089.58	153,765.22	31,770.88	72,553.48
62	257,986.92	153,823.12	31,708.12	72,455.68
63	258,129.88	153,879.52	31,785.15	72,465.22
64	258,041.67	153,814.15	31,756.72	72,470.80
65	258,146.37	153,875.67	31,787.53	72,483.17
66	258,125.80	153,864.50	31,724.60	72,536.70
67	258,082.22	153,779.25	31,739.75	72,563.22
68	258,079.27	153,849.03	31,741.43	72,488.80
69	257,990.17	153,749.87	31,764.73	72,475.57
<b>Average</b>	<b>258,078.23</b>	<b>153,819.66</b>	<b>31,754.39</b>	<b>72,504.18</b>

**IOPS Test Run – I/O Request Throughput Distribution Graph**





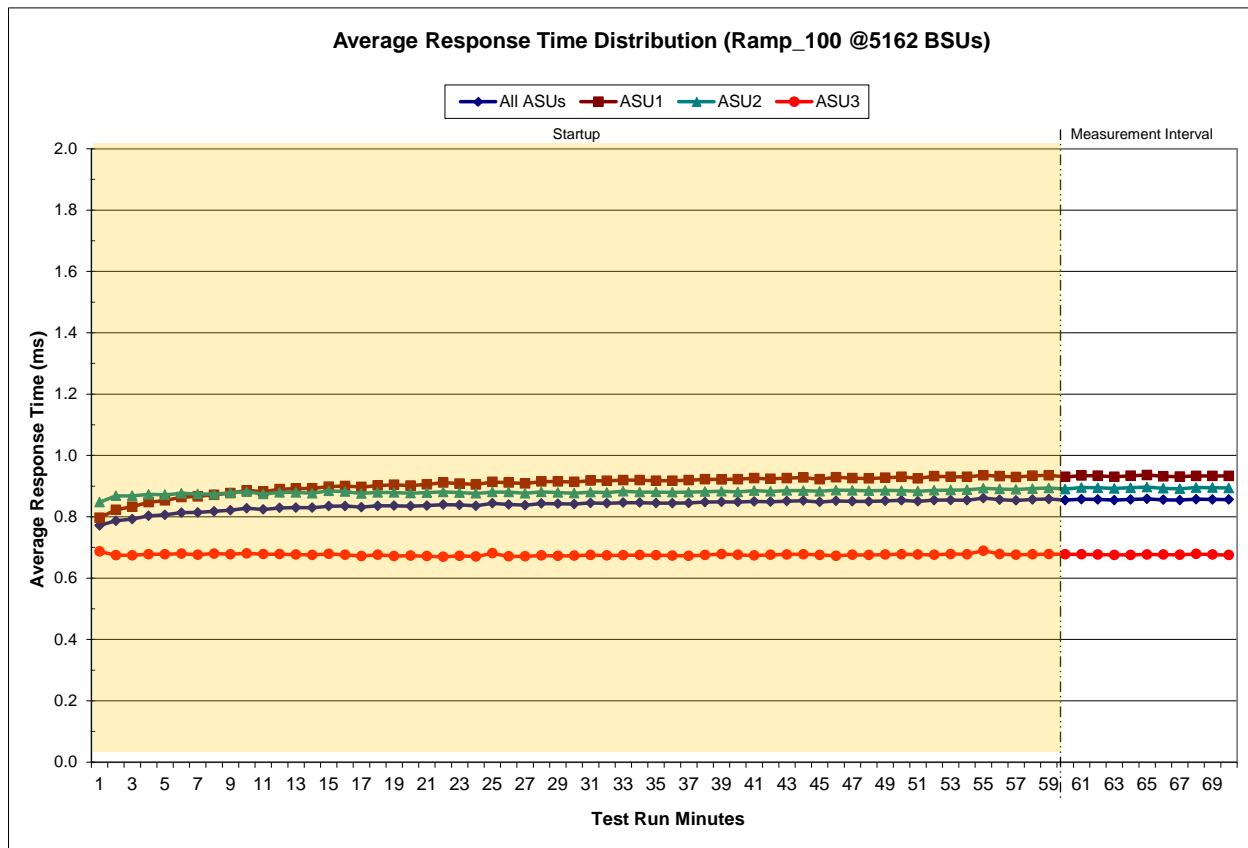
**IOPS Test Run – Average Response Time (ms) Distribution Data (Ramp-Up)**

5,162 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	5:35:58	6:35:59	0-59	1:00:01
<i>Measurement Interval</i>	6:35:59	6:45:59	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	0.77	0.80	0.85	0.69
1	0.79	0.82	0.87	0.67
2	0.79	0.83	0.87	0.67
3	0.80	0.85	0.87	0.68
4	0.81	0.85	0.87	0.68
5	0.81	0.86	0.88	0.68
6	0.81	0.87	0.87	0.68
7	0.82	0.87	0.87	0.68
8	0.82	0.88	0.88	0.68
9	0.83	0.89	0.88	0.68
10	0.82	0.88	0.87	0.68
11	0.83	0.89	0.88	0.68
12	0.83	0.89	0.88	0.68
13	0.83	0.89	0.88	0.68
14	0.83	0.90	0.88	0.68
15	0.84	0.90	0.88	0.68
16	0.83	0.90	0.88	0.67
17	0.84	0.90	0.88	0.68
18	0.84	0.90	0.88	0.67
19	0.83	0.90	0.88	0.67
20	0.84	0.91	0.88	0.67
21	0.84	0.91	0.88	0.67
22	0.84	0.91	0.88	0.67
23	0.84	0.91	0.88	0.67
24	0.84	0.91	0.88	0.68
25	0.84	0.91	0.88	0.67
26	0.84	0.91	0.88	0.67
27	0.84	0.92	0.88	0.67
28	0.84	0.91	0.88	0.67
29	0.84	0.91	0.88	0.67
30	0.85	0.92	0.88	0.68
31	0.84	0.92	0.88	0.67
32	0.85	0.92	0.88	0.67
33	0.85	0.92	0.88	0.68
34	0.84	0.92	0.88	0.67
35	0.84	0.92	0.88	0.67
36	0.85	0.92	0.88	0.67
37	0.85	0.92	0.88	0.68
38	0.85	0.92	0.88	0.68
39	0.85	0.92	0.88	0.68
40	0.85	0.93	0.89	0.67
41	0.85	0.92	0.88	0.68
42	0.85	0.93	0.89	0.68
43	0.85	0.93	0.89	0.68
44	0.85	0.92	0.88	0.68
45	0.85	0.93	0.89	0.67
46	0.85	0.93	0.89	0.68
47	0.85	0.93	0.88	0.68
48	0.85	0.93	0.89	0.68
49	0.85	0.93	0.89	0.68
50	0.85	0.93	0.88	0.68
51	0.85	0.93	0.89	0.68
52	0.85	0.93	0.89	0.68
53	0.85	0.93	0.89	0.68
54	0.86	0.94	0.89	0.69
55	0.86	0.93	0.89	0.68
56	0.85	0.93	0.89	0.68
57	0.86	0.93	0.89	0.68
58	0.86	0.94	0.89	0.68
59	0.85	0.93	0.89	0.68

**IOPS Test Run – Average Response Time (ms) Distribution Data  
 (Measurement Interval)**

5,162 BSUs	Start	Stop	Interval	Duration
<b>Start-Up/Ramp-Up</b>	5:35:58	6:35:59	0-59	1:00:01
<b>Measurement Interval</b>	6:35:59	6:45:59	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	0.86	0.93	0.90	0.68
61	0.86	0.93	0.89	0.68
62	0.85	0.93	0.89	0.68
63	0.86	0.93	0.89	0.68
64	0.86	0.94	0.90	0.68
65	0.86	0.93	0.89	0.68
66	0.85	0.93	0.89	0.68
67	0.86	0.93	0.90	0.68
68	0.86	0.93	0.89	0.68
69	0.86	0.93	0.89	0.68
<b>Average</b>	<b>0.86</b>	<b>0.93</b>	<b>0.89</b>	<b>0.68</b>

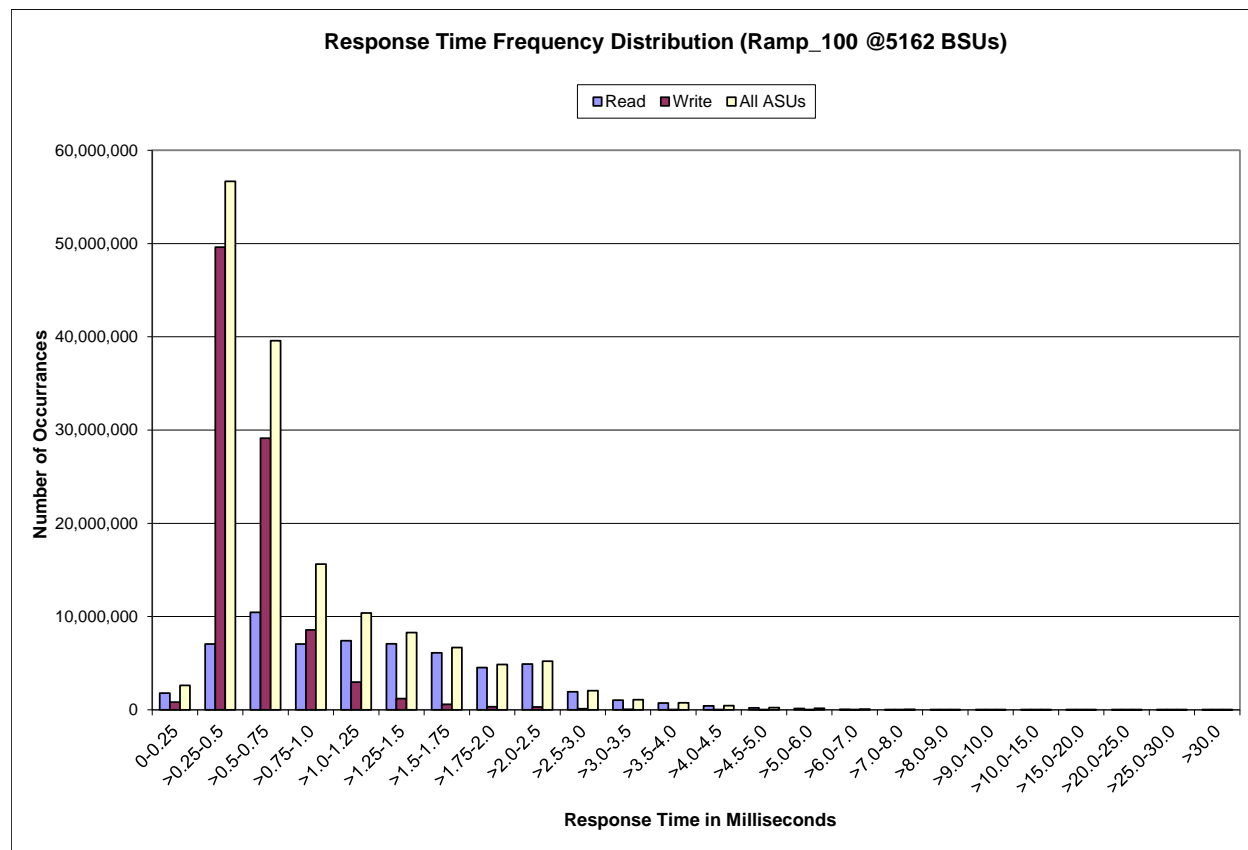
**IOPS Test Run – Average Response Time (ms) Distribution Graph**



**IOPS Test Run –Response Time Frequency Distribution Data**

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	1,799,027	7,064,299	10,461,856	7,063,283	7,417,312	7,085,504	6,107,370	4,537,632
Write	825,285	49,607,035	29,117,089	8,568,733	2,972,309	1,191,635	577,508	324,803
All ASUs	2,624,312	56,671,334	39,578,945	15,632,016	10,389,621	8,277,139	6,684,878	4,862,435
ASU1	2,282,820	34,207,311	18,744,579	7,319,552	6,499,253	6,066,421	5,213,181	3,874,364
ASU2	246,463	7,715,545	4,072,922	1,454,239	1,242,439	1,122,959	949,803	706,724
ASU3	95,029	14,748,478	16,761,444	6,858,225	2,647,929	1,087,759	521,894	281,347
Response Time (ms)	>2.0-2.5	>2.5-3.0	>3.0-3.5	>3.5-4.0	>4.0-4.5	>4.5-5.0	>5.0-6.0	>6.0-7.0
Read	4,906,564	1,932,746	1,033,546	723,233	431,295	204,403	132,985	48,943
Write	301,085	113,429	49,560	27,813	23,401	21,966	21,698	15,984
All ASUs	5,207,649	2,046,175	1,083,106	751,046	454,696	226,369	154,683	64,927
ASU1	4,176,917	1,630,462	868,950	608,567	363,178	173,842	114,940	42,787
ASU2	777,543	318,527	170,466	118,908	71,606	33,783	22,241	8,437
ASU3	253,189	97,186	43,690	23,571	19,912	18,744	17,502	13,703
Response Time (ms)	>7.0-8.0	>8.0-9.0	>9.0-10.0	>10.0-15.0	>15.0-20.0	>20.0-25.0	>25.0-30.0	>30.0
Read	24,140	13,020	7,467	26,696	24,637	16,578	7,439	3,400
Write	8,610	2,735	884	1,435	237	70	33	18
All ASUs	32,750	15,755	8,351	28,131	24,874	16,648	7,472	3,418
ASU1	20,747	11,080	6,287	22,620	20,749	13,998	6,257	2,804
ASU2	4,094	2,136	1,263	4,213	3,914	2,591	1,192	598
ASU3	7,909	2,539	801	1,298	211	59	23	16

**IOPS Test Run –Response Time Frequency Distribution Graph**



### IOPS Test Run – I/O Request Information

I/O Requests Completed in the Measurement Interval	I/O Requests Completed with Response Time = or < 30 ms	I/O Requests Completed with Response Time > 30 ms
154,846,730	154,843,312	3,418

### IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

**IM – Intensity Multiplier:** The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.

Clauses 5.1.10 and 5.3.15.2

**MIM – Measured Intensity Multiplier:** The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.

Clause 5.3.15.3

**COV – Coefficient of Variation:** This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
<b>IM</b>	<b>0.0350</b>	<b>0.2810</b>	<b>0.0700</b>	<b>0.2100</b>	<b>0.0180</b>	<b>0.0700</b>	<b>0.0350</b>	<b>0.2810</b>
MIM	0.0350	0.2811	0.0700	0.2100	0.0180	0.0700	0.0350	0.2809
COV	0.002	0.000	0.001	0.000	0.002	0.001	0.002	0.001

## Primary Metrics Test – Response Time Ramp Test Phase

### Clause 5.4.4.3

*The Response Time Ramp Test Phase consists of five Test Runs, one each at 95%, 90%, 80%, 50%, and 10% of the load point (100%) used to generate the SPC-1 IOPS™ primary metric. Each of the five Test Runs has a Measurement Interval of ten (10) minutes. The Response Time Ramp Test Phase immediately follows the IOPS Test Phase without any interruption or manual intervention.*

*The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 17.*

*In addition, the Average Response Time measured during the 10% Test Run is the value for the SPC-1 LRT™ metric. That value represents the Average Response Time of a lightly loaded TSC.*

### Clause 9.4.3.7.4

*The following content shall appear in the FDR for the Response Time Ramp Phase:*

- 1. A Response Time Ramp Distribution.*
- 2. The human readable Test Run Results File produced by the Workload Generator for each Test Run within the Response Time Ramp Test Phase.*
- 3. For the 10% Load Level Test Run (SPC-1 LRT™ metric) an Average Response Time Distribution.*
- 4. A listing or screen image of all input parameters supplied to the Workload Generator.*

## SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in [Appendix E: SPC-1 Workload Generator Input Parameters](#) on Page [95](#).

## Response Time Ramp Test Results File

A link to each test result file generated from each Response Time Ramp Test Run list listed below.

[95% Load Level](#)

[90% Load Level](#)

[80% Load Level](#)

[50% Load Level](#)

[10% Load Level](#)

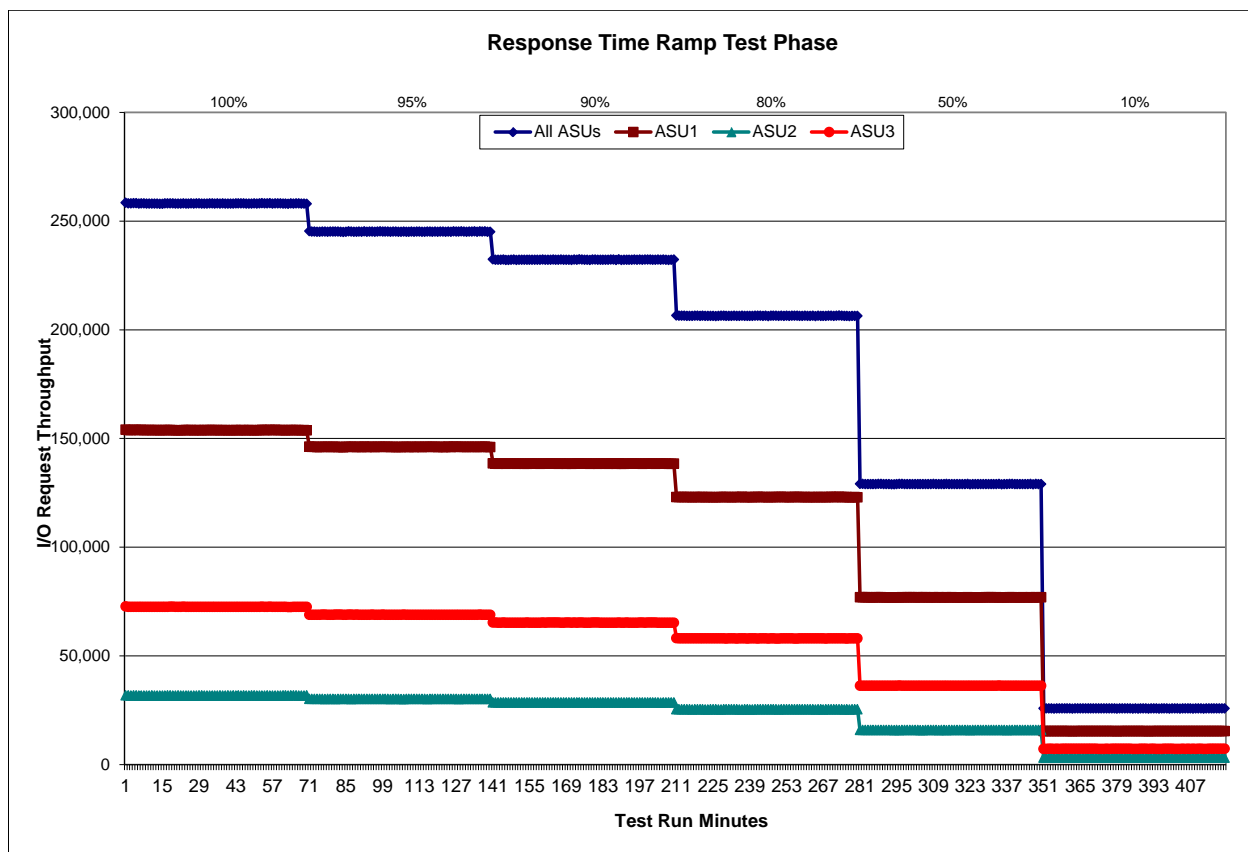
### Response Time Ramp Distribution (IOPS) Data

The five Test Runs that comprise the Response Time Ramp Phase are executed at 95%, 90%, 80%, 50%, and 10% of the Business Scaling Unit (BSU) load level used to produce the SPC-1 IOPS™ primary metric. The 100% BSU load level is included in the following Response Time Ramp data table and graph for completeness.

The Response Time Ramp data table is not embedded in this document due to its size. The table is available via the following URL:

[Response Time Ramp Data Table](#)

### Response Time Ramp Distribution (IOPS) Graph



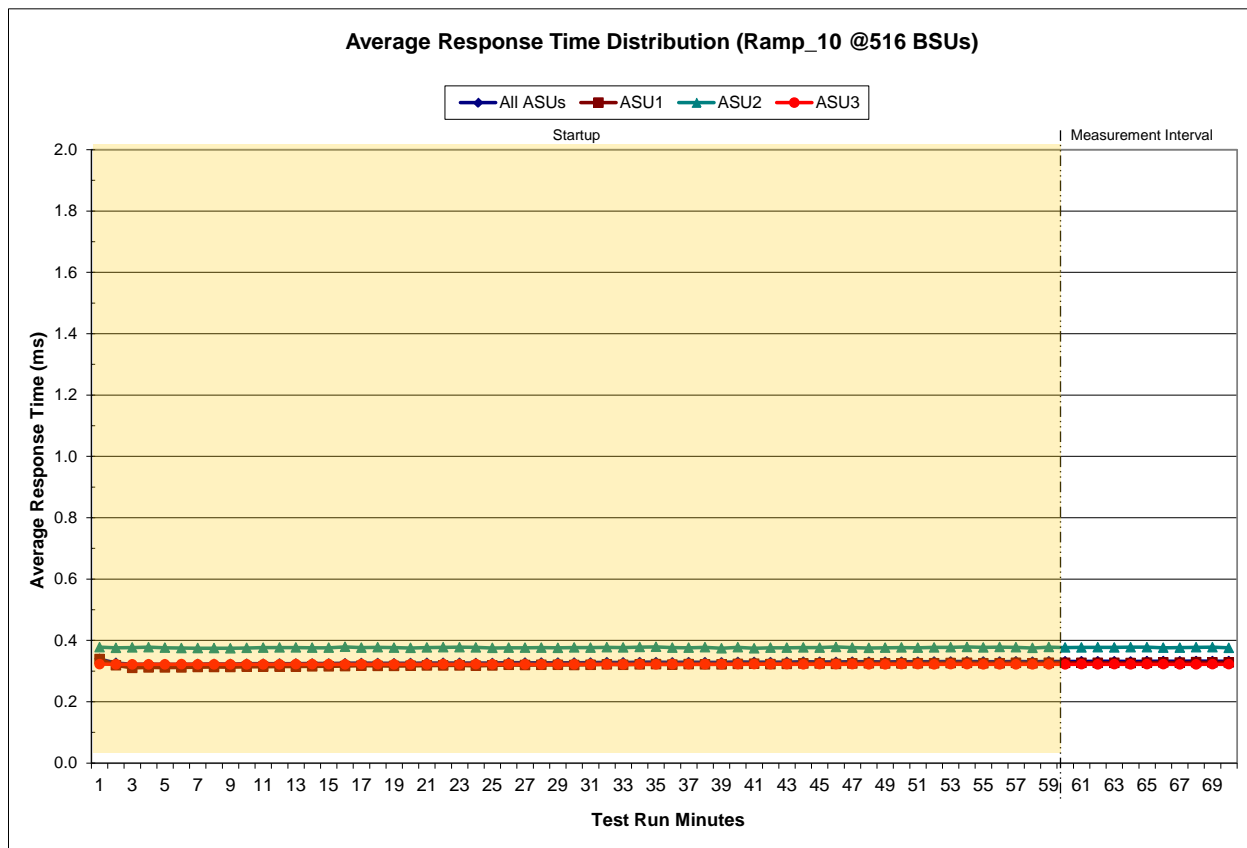
**SPC-1 LRT™ Average Response Time (ms) Distribution Data (Ramp-Up)**

516 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	11:28:25	12:28:26	0-59	1:00:01
<i>Measurement Interval</i>	12:28:26	12:38:26	59-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	0.34	0.34	0.38	0.32
1	0.33	0.32	0.38	0.32
2	0.32	0.31	0.38	0.32
3	0.32	0.31	0.38	0.32
4	0.32	0.31	0.38	0.32
5	0.32	0.31	0.37	0.32
6	0.32	0.31	0.37	0.32
7	0.32	0.31	0.37	0.32
8	0.32	0.31	0.37	0.32
9	0.32	0.31	0.38	0.32
10	0.32	0.31	0.38	0.32
11	0.32	0.31	0.38	0.32
12	0.32	0.31	0.38	0.32
13	0.32	0.32	0.38	0.32
14	0.32	0.32	0.38	0.32
15	0.33	0.32	0.38	0.32
16	0.33	0.32	0.38	0.32
17	0.33	0.32	0.38	0.32
18	0.33	0.32	0.38	0.32
19	0.33	0.32	0.38	0.32
20	0.33	0.32	0.38	0.32
21	0.33	0.32	0.38	0.32
22	0.33	0.32	0.38	0.32
23	0.33	0.32	0.38	0.32
24	0.33	0.32	0.38	0.32
25	0.33	0.32	0.38	0.32
26	0.33	0.32	0.38	0.32
27	0.33	0.32	0.38	0.32
28	0.33	0.32	0.38	0.32
29	0.33	0.32	0.38	0.32
30	0.33	0.32	0.38	0.32
31	0.33	0.32	0.38	0.32
32	0.33	0.32	0.38	0.32
33	0.33	0.32	0.38	0.32
34	0.33	0.32	0.38	0.32
35	0.33	0.32	0.38	0.32
36	0.33	0.32	0.38	0.32
37	0.33	0.32	0.38	0.32
38	0.33	0.32	0.37	0.32
39	0.33	0.32	0.38	0.32
40	0.33	0.32	0.37	0.32
41	0.33	0.32	0.38	0.32
42	0.33	0.32	0.38	0.32
43	0.33	0.32	0.38	0.32
44	0.33	0.32	0.38	0.32
45	0.33	0.32	0.38	0.32
46	0.33	0.32	0.38	0.32
47	0.33	0.33	0.38	0.32
48	0.33	0.32	0.38	0.32
49	0.33	0.32	0.38	0.32
50	0.33	0.33	0.38	0.32
51	0.33	0.33	0.38	0.32
52	0.33	0.33	0.38	0.32
53	0.33	0.33	0.38	0.32
54	0.33	0.33	0.38	0.32
55	0.33	0.33	0.38	0.32
56	0.33	0.33	0.38	0.32
57	0.33	0.33	0.38	0.32
58	0.33	0.33	0.38	0.32
59	0.33	0.33	0.38	0.32

**SPC-1 LRT™ Average Response Time (ms) Distribution Data  
 (Measurement Interval)**

516 BSUs	Start	Stop	Interval	Duration
<b>Start-Up/Ramp-Up</b>	11:28:25	12:28:26	0-59	1:00:01
<b>Measurement Interval</b>	12:28:26	12:38:26	59-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	0.33	0.33	0.38	0.32
61	0.33	0.33	0.38	0.32
62	0.33	0.33	0.38	0.32
63	0.33	0.33	0.38	0.32
64	0.33	0.33	0.38	0.32
65	0.33	0.33	0.38	0.32
66	0.33	0.33	0.38	0.32
67	0.33	0.33	0.38	0.32
68	0.33	0.33	0.38	0.32
69	0.33	0.33	0.38	0.32
<b>Average</b>	<b>0.33</b>	<b>0.33</b>	<b>0.38</b>	<b>0.32</b>

**SPC-1 LRT™ Average Response Time (ms) Distribution Graph**





**SPC-1 LRT™ (10%) – Measured Intensity Multiplier and Coefficient of Variation**

Clause 3.4.3

**IM – Intensity Multiplier:** The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.

Clauses 5.1.10 and 5.3.15.2

**MIM – Measured Intensity Multiplier:** The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.

Clause 5.3.15.3

**COV – Coefficient of Variation:** This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
MIM	0.0350	0.2810	0.0700	0.2101	0.0180	0.0700	0.0350	0.2809
COV	0.005	0.001	0.003	0.001	0.005	0.003	0.004	0.001

## Repeatability Test

### Clause 5.4.5

*The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ primary metric and the SPC-1 LRT™ metric generated in earlier Test Runs.*

*There are two identical Repeatability Test Phases. Each Test Phase contains two Test Runs. Each of the Test Runs will have a Measurement Interval of no less than ten (10) minutes. The two Test Runs in each Test Phase will be executed without interruption or any type of manual intervention.*

*The first Test Run in each Test Phase is executed at the 10% load point. The Average Response Time from each of the Test Runs is compared to the SPC-1 LRT™ metric. Each Average Response Time value must be less than the SPC-1 LRT™ metric plus 5% or less than the SPC-1 LRT™ metric plus one (1) millisecond (ms).*

*The second Test Run in each Test Phase is executed at the 100% load point. The I/O Request Throughput from the Test Runs is compared to the SPC-1 IOPS™ primary metric. Each I/O Request Throughput value must be greater than the SPC-1 IOPS™ primary metric minus 5%. In addition, the Average Response Time for each Test Run cannot exceed 30 milliseconds.*

*If any of the above constraints are not met, the benchmark measurement is invalid.*

### Clause 9.4.3.7.5

*The following content shall appear in the FDR for each Test Run in the two Repeatability Test Phases:*

- 1. A table containing the results of the Repeatability Test.*
- 2. An I/O Request Throughput Distribution graph and table.*
- 3. An Average Response Time Distribution graph and table.*
- 4. The human readable Test Run Results File produced by the Workload Generator.*
- 5. A listing or screen image of all input parameters supplied to the Workload Generator.*

## SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in [Appendix E: SPC-1 Workload Generator Input Parameters](#) on Page 95.

**Repeatability Test Results File**

The values for the SPC-1 IOPS™, SPC-1 LRT™, and the Repeatability Test measurements are listed in the tables below.

	SPC-1 IOPS™
<b>Primary Metrics</b>	<b>258,078.23</b>
<b>Repeatability Test Phase 1</b>	258,088.06
<b>Repeatability Test Phase 2</b>	258,117.03

The SPC-1 IOPS™ values in the above table were generated using 100% of the specified Business Scaling Unit (BSU) load level. Each of the Repeatability Test Phase values for SPC-1 IOPS™ must be greater than 95% of the reported SPC-1 IOPS™ Primary Metric.

	SPC-1 LRT™
<b>Primary Metrics</b>	<b>0.33 ms</b>
<b>Repeatability Test Phase 1</b>	0.33 ms
<b>Repeatability Test Phase 2</b>	0.33 ms

The average response time values in the SPC-1 LRT™ column were generated using 10% of the specified Business Scaling Unit (BSU) load level. Each of the Repeatability Test Phase values for SPC-1 LRT™ must be less than 105% of the reported SPC-1 LRT™ Primary Metric or less than the reported SPC-1 LRT™ Primary Metric minus one (1) millisecond (ms).

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

- Repeatability Test Phase 1, Test Run 1 (LRT)**
- Repeatability Test Phase 1, Test Run 2 (IOPS)**
- Repeatability Test Phase 2, Test Run 1 (LRT)**
- Repeatability Test Phase 2, Test Run 2 (IOPS)**

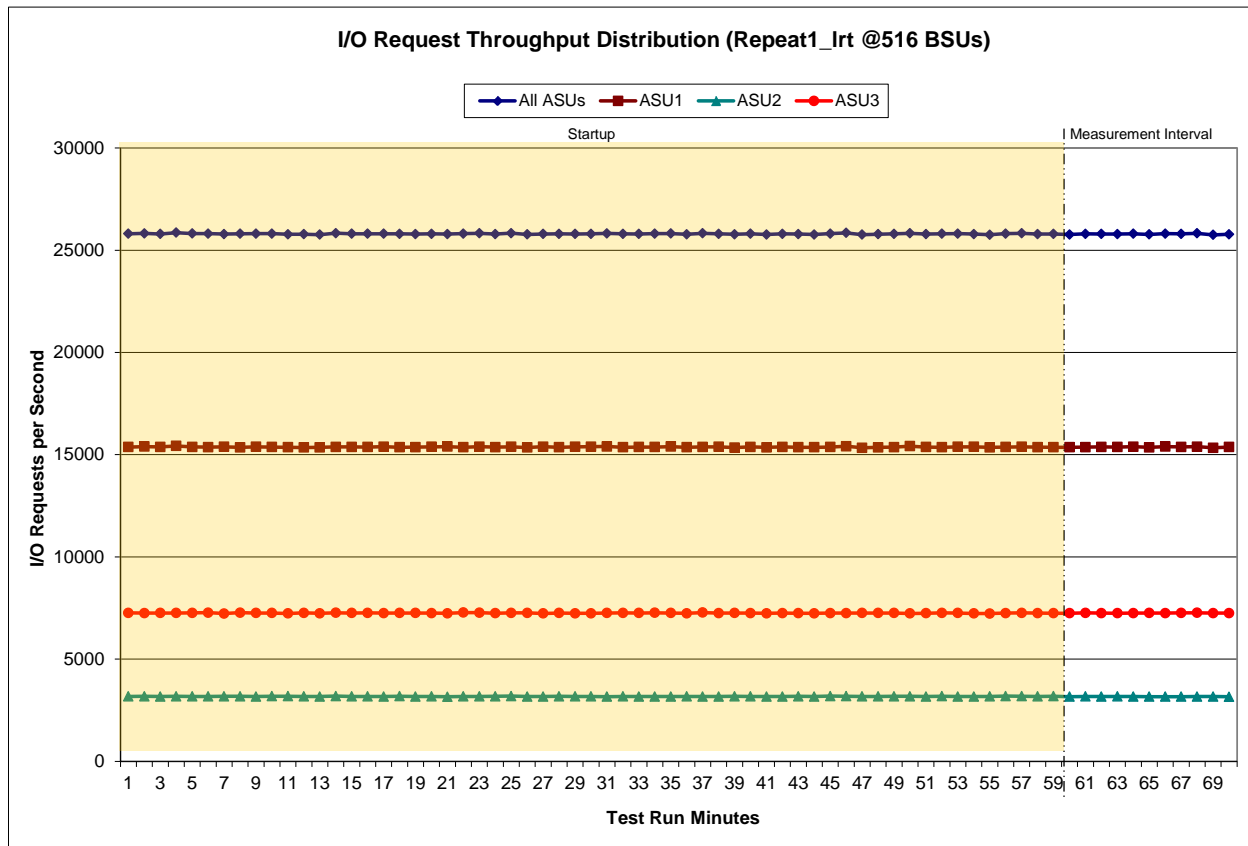
**Repeatability 1 LRT – I/O Request Throughput Distribution Data (Ramp-Up)**

516 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:38:44	13:38:44	0-2	1:00:00
Measurement Interval	13:38:44	13:48:44	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	25,806.62	15,374.27	3,175.27	7,257.08
1	25,823.42	15,395.42	3,178.82	7,249.18
2	25,795.72	15,377.58	3,166.03	7,252.10
3	25,859.17	15,425.02	3,180.92	7,253.23
4	25,815.43	15,379.98	3,173.38	7,262.07
5	25,811.27	15,364.35	3,174.18	7,272.73
6	25,788.28	15,382.08	3,176.73	7,229.47
7	25,805.40	15,357.97	3,176.57	7,270.87
8	25,809.27	15,382.90	3,170.52	7,255.85
9	25,809.17	15,373.42	3,182.02	7,253.73
10	25,778.07	15,360.08	3,185.57	7,232.42
11	25,783.53	15,352.15	3,172.42	7,258.97
12	25,762.62	15,354.80	3,168.27	7,239.55
13	25,833.53	15,379.93	3,188.87	7,264.73
14	25,805.43	15,377.95	3,174.05	7,253.43
15	25,804.27	15,370.20	3,173.67	7,260.40
16	25,802.93	15,387.57	3,167.87	7,247.50
17	25,800.65	15,361.05	3,184.60	7,255.00
18	25,786.55	15,365.07	3,168.12	7,253.37
19	25,800.87	15,380.68	3,171.57	7,248.62
20	25,787.52	15,392.42	3,159.02	7,236.08
21	25,811.98	15,363.53	3,173.78	7,274.67
22	25,827.80	15,387.88	3,171.98	7,267.93
23	25,789.75	15,369.02	3,179.65	7,241.08
24	25,832.15	15,382.93	3,189.15	7,260.07
25	25,774.53	15,348.47	3,167.92	7,258.15
26	25,793.10	15,388.35	3,169.82	7,234.93
27	25,799.48	15,362.15	3,181.13	7,256.20
28	25,792.27	15,382.10	3,172.47	7,237.70
29	25,801.90	15,387.40	3,175.48	7,239.02
30	25,819.55	15,397.77	3,165.22	7,256.57
31	25,798.32	15,364.02	3,173.20	7,261.10
32	25,796.17	15,371.83	3,170.47	7,253.87
33	25,808.65	15,371.33	3,171.02	7,266.30
34	25,817.02	15,393.27	3,166.75	7,257.00
35	25,777.00	15,362.25	3,173.93	7,240.82
36	25,826.77	15,378.68	3,170.02	7,278.07
37	25,801.00	15,382.35	3,169.42	7,249.23
38	25,780.32	15,347.82	3,179.25	7,253.25
39	25,802.83	15,379.33	3,172.13	7,251.37
40	25,764.90	15,357.95	3,166.07	7,240.88
41	25,797.25	15,379.33	3,167.15	7,250.77
42	25,788.53	15,364.00	3,181.90	7,242.63
43	25,768.92	15,361.52	3,168.53	7,238.87
44	25,810.92	15,369.65	3,191.18	7,250.08
45	25,845.88	15,412.03	3,185.62	7,248.23
46	25,763.13	15,335.97	3,171.37	7,255.80
47	25,785.23	15,357.92	3,173.20	7,254.12
48	25,797.75	15,365.18	3,179.75	7,252.82
49	25,825.87	15,414.48	3,176.98	7,234.40
50	25,788.27	15,373.73	3,170.20	7,244.33
51	25,807.00	15,363.70	3,181.93	7,261.37
52	25,808.35	15,384.62	3,166.70	7,257.03
53	25,788.38	15,385.18	3,168.80	7,234.40
54	25,757.95	15,358.30	3,174.77	7,224.88
55	25,811.27	15,371.13	3,190.65	7,249.48
56	25,826.17	15,384.47	3,183.50	7,258.20
57	25,788.97	15,366.08	3,172.10	7,250.78
58	25,792.73	15,362.78	3,185.55	7,244.40
59	25,769.08	15,362.60	3,163.98	7,242.50

**Repeatability 1 LRT – I/O Request Throughput Distribution Data  
 (Measurement Interval)**

516 BSUs	Start	Stop	Interval	Duration
<b>Start-Up/Ramp-Up</b>	12:38:44	13:38:44	0-2	1:00:00
<b>Measurement Interval</b>	13:38:44	13:48:44	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	25,799.87	15,364.52	3,174.63	7,260.72
61	25,795.65	15,377.20	3,170.33	7,248.12
62	25,788.02	15,371.07	3,171.30	7,245.65
63	25,807.65	15,389.78	3,167.22	7,250.65
64	25,775.33	15,357.30	3,162.08	7,255.95
65	25,809.72	15,393.93	3,165.42	7,250.37
66	25,800.27	15,375.85	3,162.90	7,261.52
67	25,825.08	15,388.42	3,170.28	7,266.38
68	25,751.27	15,335.10	3,168.83	7,247.33
69	25,779.65	15,371.22	3,159.92	7,248.52
<b>Average</b>	<b>25,793.25</b>	<b>15,372.44</b>	<b>3,167.29</b>	<b>7,253.52</b>

**Repeatability 1 LRT – I/O Request Throughput Distribution Graph**



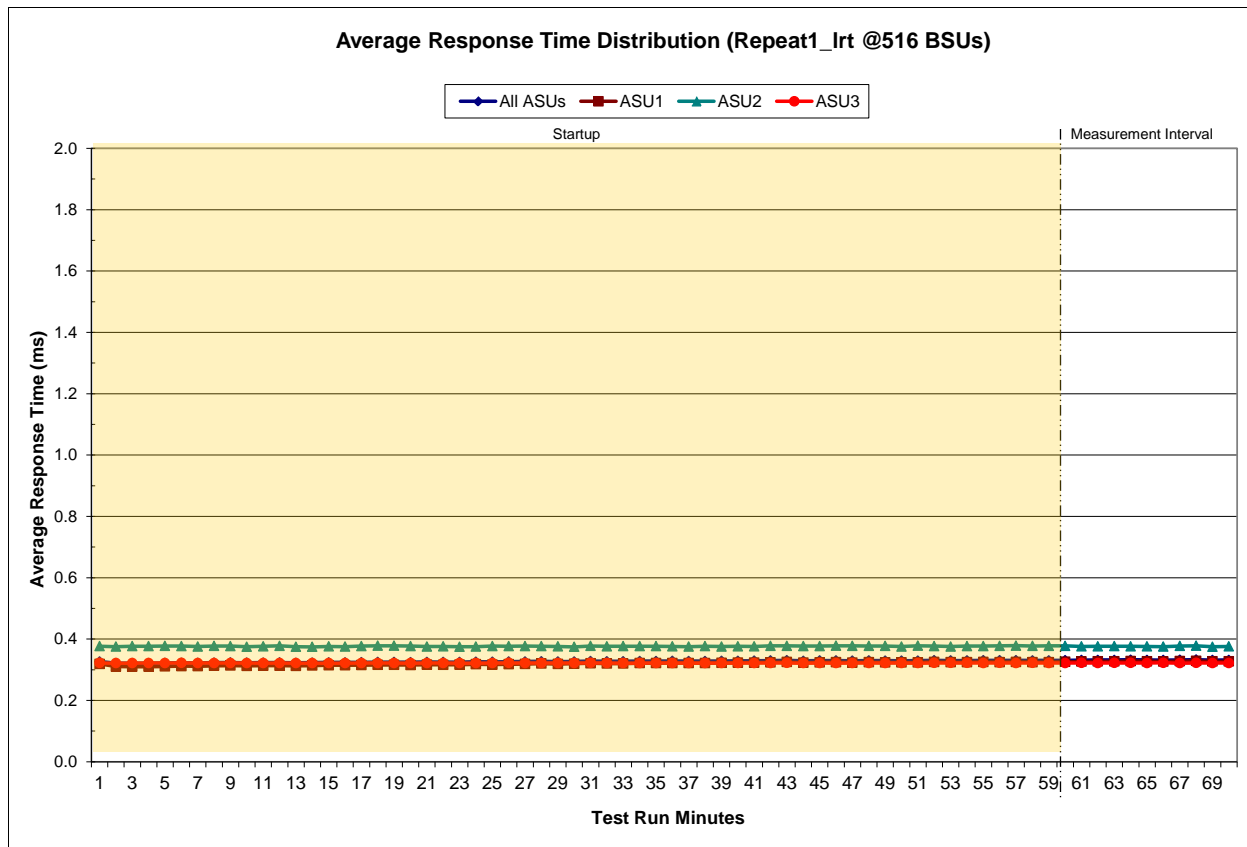
**Repeatability 1 LRT –Average Response Time (ms) Distribution Data (Ramp-Up)**

516 BSUs Start-Up/Ramp-Up Measurement Interval	Start 12:38:44 13:38:44	Stop 13:38:44 13:48:44	Interval 0-59 59-69	Duration 1:00:00 0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	0.33	0.32	0.38	0.32
1	0.32	0.31	0.38	0.32
2	0.32	0.31	0.38	0.32
3	0.32	0.31	0.38	0.32
4	0.32	0.31	0.38	0.32
5	0.32	0.31	0.38	0.32
6	0.32	0.31	0.38	0.32
7	0.32	0.31	0.38	0.32
8	0.32	0.31	0.38	0.32
9	0.32	0.31	0.37	0.32
10	0.32	0.31	0.38	0.32
11	0.32	0.31	0.38	0.32
12	0.32	0.31	0.37	0.32
13	0.32	0.31	0.37	0.32
14	0.32	0.31	0.38	0.32
15	0.32	0.31	0.38	0.32
16	0.32	0.31	0.38	0.32
17	0.33	0.32	0.38	0.32
18	0.33	0.32	0.38	0.32
19	0.32	0.32	0.38	0.32
20	0.33	0.32	0.38	0.32
21	0.33	0.32	0.38	0.32
22	0.33	0.32	0.37	0.32
23	0.33	0.32	0.38	0.32
24	0.33	0.32	0.38	0.32
25	0.33	0.32	0.38	0.32
26	0.33	0.32	0.38	0.32
27	0.33	0.32	0.38	0.32
28	0.33	0.32	0.38	0.32
29	0.33	0.32	0.37	0.32
30	0.33	0.32	0.38	0.32
31	0.33	0.32	0.38	0.32
32	0.33	0.32	0.38	0.32
33	0.33	0.32	0.38	0.32
34	0.33	0.32	0.38	0.32
35	0.33	0.32	0.38	0.32
36	0.33	0.32	0.38	0.32
37	0.33	0.32	0.38	0.32
38	0.33	0.32	0.38	0.32
39	0.33	0.32	0.38	0.32
40	0.33	0.32	0.38	0.32
41	0.33	0.32	0.38	0.32
42	0.33	0.33	0.38	0.32
43	0.33	0.32	0.38	0.32
44	0.33	0.32	0.38	0.32
45	0.33	0.32	0.38	0.32
46	0.33	0.32	0.38	0.32
47	0.33	0.32	0.38	0.32
48	0.33	0.32	0.38	0.32
49	0.33	0.32	0.38	0.32
50	0.33	0.32	0.38	0.32
51	0.33	0.33	0.38	0.32
52	0.33	0.32	0.38	0.32
53	0.33	0.32	0.38	0.32
54	0.33	0.33	0.38	0.32
55	0.33	0.32	0.38	0.32
56	0.33	0.33	0.38	0.32
57	0.33	0.32	0.38	0.32
58	0.33	0.32	0.38	0.32
59	0.33	0.33	0.38	0.32

**Repeatability 1 LRT –Average Response Time (ms) Distribution Data  
 (Measurement Interval)**

516 BSUs	Start	Stop	Interval	Duration
<b>Start-Up/Ramp-Up</b>	12:38:44	13:38:44	0-59	1:00:00
<b>Measurement Interval</b>	13:38:44	13:48:44	59-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	0.33	0.33	0.38	0.32
61	0.33	0.33	0.38	0.32
62	0.33	0.33	0.38	0.32
63	0.33	0.33	0.38	0.32
64	0.33	0.33	0.38	0.32
65	0.33	0.33	0.38	0.32
66	0.33	0.33	0.38	0.32
67	0.33	0.33	0.38	0.32
68	0.33	0.33	0.38	0.32
69	0.33	0.33	0.38	0.32
<b>Average</b>	<b>0.33</b>	<b>0.33</b>	<b>0.38</b>	<b>0.32</b>

**Repeatability 1 LRT –Average Response Time (ms) Distribution Graph**



**Repeatability 1 IOPS – I/O Request Throughput Distribution Data (Ramp-Up)**

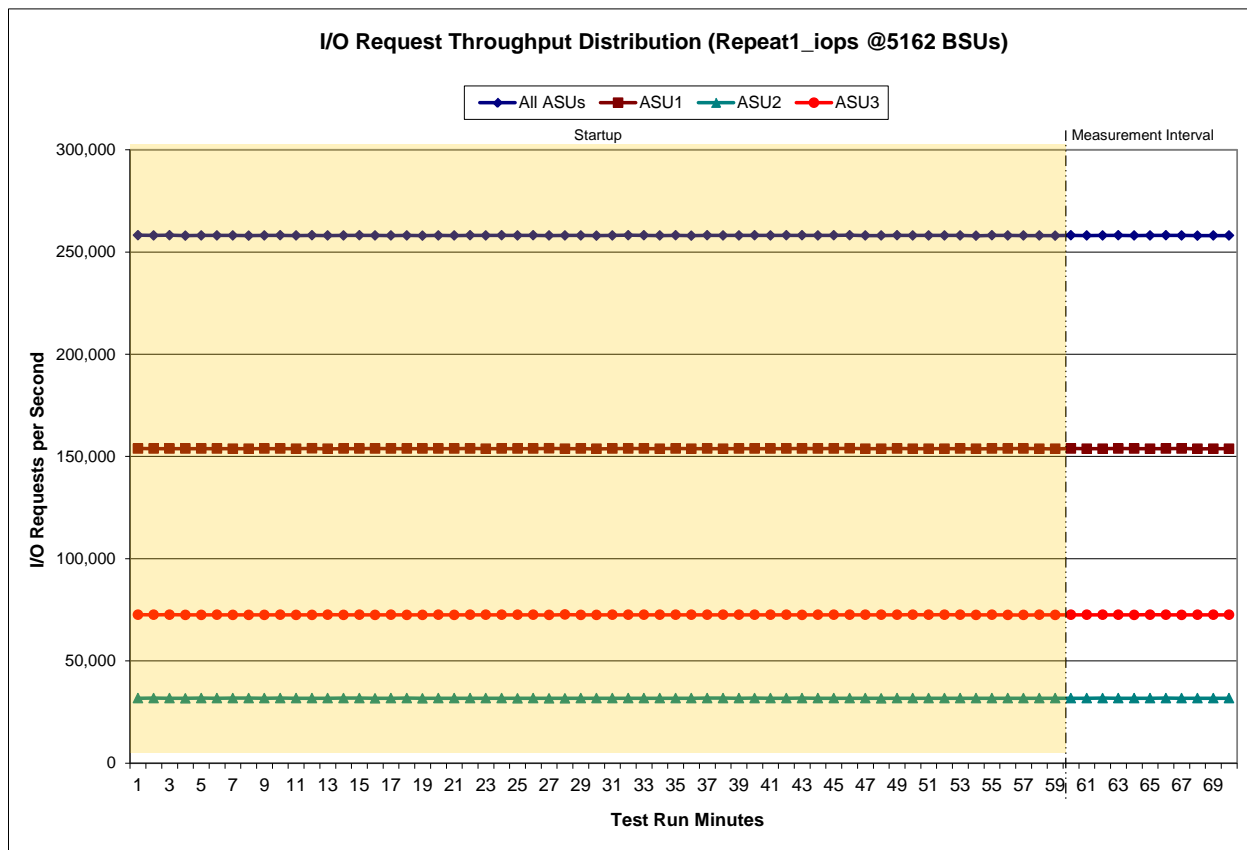
5,162 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:49:22	14:49:23	0-2	1:00:01
Measurement Interval	14:49:23	14:59:23	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	258,222.33	153,863.20	31,740.88	72,618.25
1	258,093.80	153,809.33	31,767.05	72,517.42
2	258,185.42	153,808.57	31,759.18	72,617.67
3	258,003.45	153,821.05	31,680.30	72,502.10
4	258,078.80	153,812.02	31,766.80	72,499.98
5	258,108.73	153,804.88	31,750.90	72,552.95
6	258,106.38	153,785.02	31,811.97	72,509.40
7	258,004.50	153,753.15	31,776.57	72,474.78
8	258,087.45	153,849.52	31,743.00	72,494.93
9	258,158.32	153,833.88	31,775.00	72,549.43
10	258,036.35	153,801.70	31,718.85	72,515.80
11	258,148.03	153,920.20	31,735.97	72,491.87
12	258,060.57	153,743.93	31,730.70	72,585.93
13	258,102.83	153,818.88	31,782.00	72,501.95
14	258,168.12	153,836.73	31,810.60	72,520.78
15	258,088.88	153,869.48	31,710.77	72,508.63
16	258,075.25	153,805.65	31,713.13	72,556.47
17	258,100.10	153,824.93	31,768.45	72,506.72
18	258,006.15	153,808.00	31,687.90	72,510.25
19	258,097.40	153,805.28	31,735.23	72,556.88
20	258,060.35	153,849.83	31,726.22	72,484.30
21	258,156.35	153,866.22	31,730.27	72,559.87
22	258,084.97	153,777.62	31,750.75	72,556.60
23	258,132.90	153,833.87	31,736.13	72,562.90
24	258,109.60	153,842.65	31,705.85	72,561.10
25	258,158.33	153,847.15	31,758.23	72,552.95
26	258,070.18	153,920.95	31,709.12	72,440.12
27	258,118.03	153,780.53	31,694.20	72,643.30
28	258,117.32	153,845.32	31,759.83	72,512.17
29	257,973.00	153,713.70	31,765.27	72,494.03
30	258,124.47	153,804.67	31,760.58	72,559.22
31	258,205.67	153,898.13	31,739.28	72,568.25
32	258,143.08	153,852.07	31,756.18	72,534.83
33	258,045.48	153,782.05	31,737.40	72,526.03
34	258,143.25	153,862.53	31,740.28	72,540.43
35	258,021.53	153,759.63	31,737.98	72,523.92
36	258,143.65	153,817.23	31,777.92	72,548.50
37	258,116.18	153,785.52	31,790.47	72,540.20
38	258,122.78	153,813.83	31,752.05	72,556.90
39	258,167.77	153,849.93	31,795.97	72,521.87
40	258,130.38	153,838.02	31,755.30	72,537.07
41	258,142.65	153,833.55	31,759.35	72,549.75
42	258,146.20	153,866.70	31,768.13	72,511.37
43	258,081.37	153,823.90	31,728.68	72,528.78
44	258,160.57	153,883.85	31,754.80	72,521.92
45	258,216.28	153,938.93	31,732.92	72,544.43
46	258,065.55	153,785.38	31,717.28	72,562.88
47	258,032.65	153,772.28	31,707.02	72,553.35
48	258,142.87	153,880.10	31,729.05	72,533.72
49	258,100.02	153,794.53	31,723.02	72,582.47
50	258,090.20	153,786.15	31,750.52	72,553.53
51	258,083.38	153,761.02	31,749.35	72,573.02
52	258,102.43	153,850.82	31,720.72	72,530.90
53	257,966.27	153,744.78	31,756.22	72,465.27
54	258,134.95	153,829.20	31,740.65	72,565.10
55	258,086.38	153,833.13	31,742.87	72,510.38
56	258,071.92	153,884.65	31,744.98	72,442.28
57	258,064.95	153,764.95	31,750.73	72,549.27
58	258,012.10	153,745.28	31,757.47	72,509.35
59	258,156.35	153,870.15	31,735.68	72,550.52



**Repeatability 1 IOPS – I/O Request Throughput Distribution Data  
 (Measurement Interval)**

5,162 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	13:49:22	14:49:23	0-2	1:00:01
<i>Measurement Interval</i>	14:49:23	14:59:23	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	258,050.90	153,767.07	31,724.10	72,559.73
61	258,106.52	153,802.65	31,772.20	72,531.67
62	258,165.05	153,892.37	31,730.13	72,542.55
63	258,076.18	153,844.05	31,724.50	72,507.63
64	258,111.85	153,780.60	31,756.62	72,574.63
65	258,134.53	153,832.65	31,780.82	72,521.07
66	258,113.43	153,860.55	31,744.33	72,508.55
67	258,008.18	153,721.02	31,750.40	72,536.77
68	258,053.63	153,758.20	31,726.62	72,568.82
69	258,060.28	153,778.00	31,742.02	72,540.27
<b>Average</b>	<b>258,088.06</b>	<b>153,803.72</b>	<b>31,745.17</b>	<b>72,539.17</b>

**Repeatability 1 IOPS – I/O Request Throughput Distribution Graph**



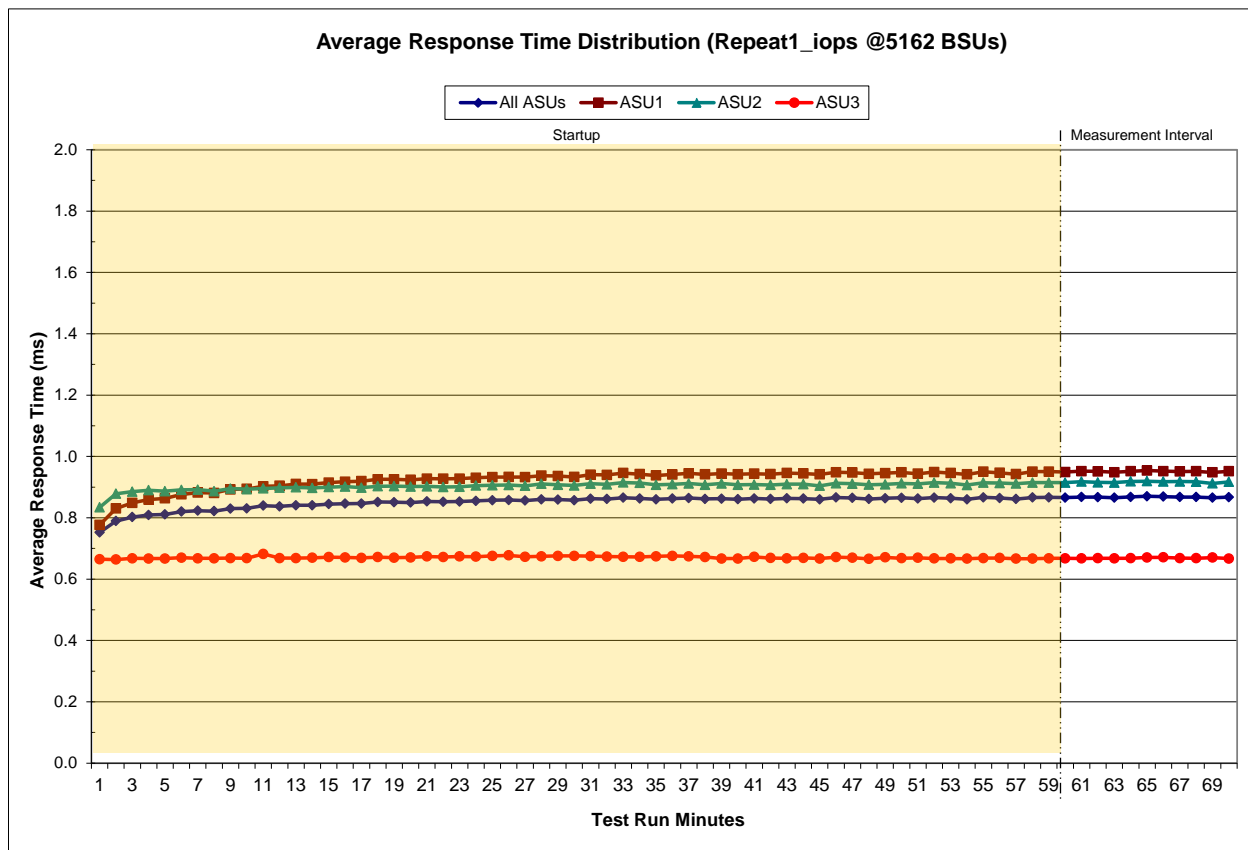
**Repeatability 1 IOPS –Average Response Time (ms) Distribution Data (Ramp-Up)**

5,162 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	13:49:22	14:49:23	0-59	1:00:01
<i>Measurement Interval</i>	14:49:23	14:59:23	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	0.75	0.78	0.83	0.66
1	0.79	0.83	0.88	0.66
2	0.80	0.85	0.89	0.67
3	0.81	0.86	0.89	0.67
4	0.81	0.86	0.89	0.67
5	0.82	0.88	0.89	0.67
6	0.82	0.88	0.89	0.67
7	0.82	0.88	0.89	0.67
8	0.83	0.89	0.90	0.67
9	0.83	0.89	0.89	0.67
10	0.84	0.90	0.90	0.68
11	0.84	0.90	0.90	0.67
12	0.84	0.91	0.90	0.67
13	0.84	0.91	0.90	0.67
14	0.84	0.91	0.90	0.67
15	0.85	0.92	0.90	0.67
16	0.85	0.92	0.90	0.67
17	0.85	0.93	0.90	0.67
18	0.85	0.93	0.90	0.67
19	0.85	0.92	0.90	0.67
20	0.85	0.93	0.90	0.67
21	0.85	0.93	0.90	0.67
22	0.85	0.93	0.90	0.67
23	0.86	0.93	0.91	0.67
24	0.86	0.93	0.91	0.68
25	0.86	0.93	0.91	0.68
26	0.86	0.93	0.90	0.67
27	0.86	0.94	0.91	0.67
28	0.86	0.94	0.91	0.68
29	0.86	0.93	0.91	0.68
30	0.86	0.94	0.91	0.67
31	0.86	0.94	0.91	0.67
32	0.87	0.95	0.92	0.67
33	0.86	0.94	0.91	0.67
34	0.86	0.94	0.91	0.67
35	0.86	0.94	0.91	0.68
36	0.86	0.94	0.91	0.67
37	0.86	0.94	0.91	0.67
38	0.86	0.94	0.91	0.67
39	0.86	0.94	0.91	0.67
40	0.86	0.94	0.91	0.67
41	0.86	0.94	0.91	0.67
42	0.86	0.95	0.91	0.67
43	0.86	0.94	0.91	0.67
44	0.86	0.94	0.90	0.67
45	0.87	0.95	0.91	0.67
46	0.86	0.95	0.91	0.67
47	0.86	0.94	0.91	0.67
48	0.86	0.95	0.91	0.67
49	0.86	0.95	0.91	0.67
50	0.86	0.94	0.91	0.67
51	0.87	0.95	0.91	0.67
52	0.86	0.95	0.91	0.67
53	0.86	0.94	0.91	0.67
54	0.87	0.95	0.91	0.67
55	0.86	0.95	0.91	0.67
56	0.86	0.94	0.91	0.67
57	0.87	0.95	0.91	0.67
58	0.87	0.95	0.91	0.67
59	0.87	0.95	0.91	0.67

**Repeatability 1 IOPS –Average Response Time (ms) Distribution Data  
 (Measurement Interval)**

5,162 BSUs	Start	Stop	Interval	Duration
<b>Start-Up/Ramp-Up</b>	13:49:22	14:49:23	0-59	1:00:01
<b>Measurement Interval</b>	14:49:23	14:59:23	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	0.87	0.95	0.92	0.67
61	0.87	0.95	0.92	0.67
62	0.87	0.95	0.91	0.67
63	0.87	0.95	0.92	0.67
64	0.87	0.95	0.92	0.67
65	0.87	0.95	0.92	0.67
66	0.87	0.95	0.92	0.67
67	0.87	0.95	0.92	0.67
68	0.87	0.95	0.91	0.67
69	0.87	0.95	0.92	0.67
<b>Average</b>	<b>0.87</b>	<b>0.95</b>	<b>0.92</b>	<b>0.67</b>

**Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph**



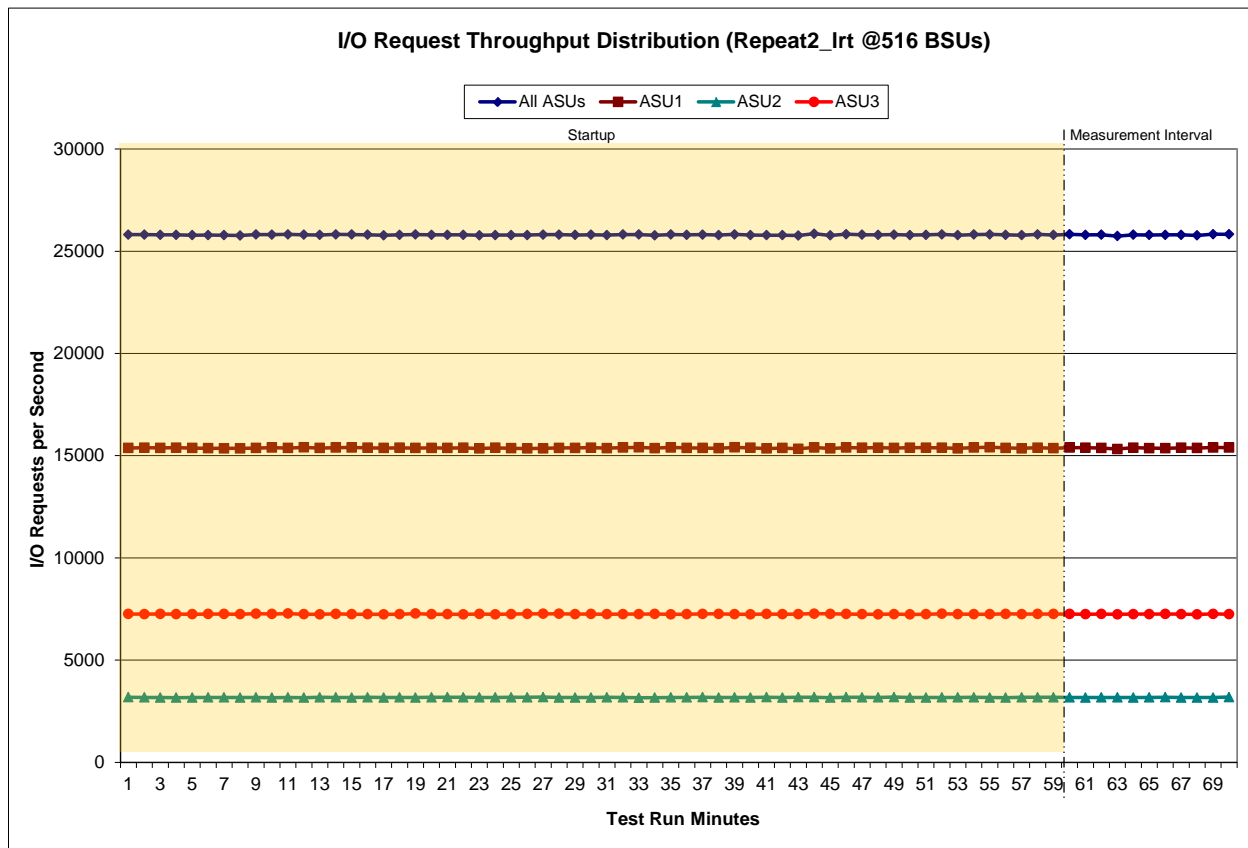
**Repeatability 2 LRT – I/O Request Throughput Distribution Data (Ramp-Up)**

516 BSUs Start-Up/Ramp-Up Measurement Interval	Start 14:59:40 15:59:40	Stop 15:59:40 16:09:40	Interval 0-59 60-69	Duration 1:00:00 0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	25,812.13	15,374.68	3,185.17	7,252.28
1	25,812.30	15,387.43	3,174.50	7,250.37
2	25,798.12	15,378.68	3,167.47	7,251.97
3	25,802.00	15,391.08	3,164.47	7,246.45
4	25,785.30	15,370.42	3,169.72	7,245.17
5	25,789.60	15,361.50	3,175.83	7,252.27
6	25,784.02	15,355.90	3,176.20	7,251.92
7	25,769.78	15,357.68	3,167.97	7,244.13
8	25,813.58	15,369.73	3,174.15	7,269.70
9	25,811.72	15,391.53	3,165.37	7,254.82
10	25,818.77	15,370.43	3,173.15	7,275.18
11	25,805.97	15,403.42	3,161.52	7,241.03
12	25,793.00	15,374.83	3,178.90	7,239.27
13	25,822.72	15,392.65	3,171.83	7,258.23
14	25,817.00	15,401.42	3,171.02	7,244.57
15	25,805.17	15,382.30	3,176.65	7,246.22
16	25,778.50	15,371.60	3,166.87	7,240.03
17	25,799.83	15,381.93	3,172.82	7,245.08
18	25,813.33	15,371.25	3,167.88	7,274.20
19	25,801.47	15,377.02	3,180.98	7,243.47
20	25,798.67	15,372.15	3,184.88	7,241.63
21	25,799.05	15,382.80	3,180.67	7,235.58
22	25,779.73	15,349.50	3,173.72	7,256.52
23	25,790.58	15,381.03	3,172.73	7,236.82
24	25,788.95	15,360.60	3,177.82	7,250.53
25	25,788.15	15,351.13	3,179.18	7,257.83
26	25,811.50	15,354.53	3,189.58	7,267.38
27	25,807.92	15,378.10	3,165.90	7,263.92
28	25,793.50	15,377.08	3,167.17	7,249.25
29	25,807.53	15,386.45	3,168.28	7,252.80
30	25,789.55	15,367.77	3,176.63	7,245.15
31	25,817.30	15,394.33	3,174.55	7,248.42
32	25,816.60	15,406.02	3,159.23	7,251.35
33	25,779.23	15,364.90	3,160.63	7,253.70
34	25,813.97	15,400.38	3,173.22	7,240.37
35	25,799.10	15,378.73	3,174.82	7,245.55
36	25,812.98	15,369.63	3,185.03	7,258.32
37	25,787.78	15,361.87	3,167.63	7,258.28
38	25,819.60	15,403.92	3,172.67	7,243.02
39	25,787.30	15,381.82	3,167.38	7,238.10
40	25,785.98	15,348.48	3,185.70	7,251.80
41	25,783.00	15,373.33	3,168.12	7,241.55
42	25,768.63	15,332.82	3,184.18	7,251.63
43	25,853.15	15,398.55	3,184.03	7,270.57
44	25,772.15	15,349.22	3,165.22	7,257.72
45	25,830.07	15,393.20	3,183.85	7,253.02
46	25,804.27	15,381.32	3,179.58	7,243.37
47	25,799.75	15,385.95	3,173.30	7,240.50
48	25,810.32	15,372.28	3,189.75	7,248.28
49	25,790.93	15,390.03	3,168.40	7,232.50
50	25,797.18	15,386.57	3,166.73	7,243.88
51	25,819.70	15,382.60	3,171.60	7,265.50
52	25,782.80	15,357.67	3,175.75	7,249.38
53	25,815.87	15,392.12	3,177.68	7,246.07
54	25,821.07	15,407.52	3,167.43	7,246.12
55	25,802.33	15,376.77	3,164.60	7,260.97
56	25,782.20	15,356.18	3,176.85	7,249.17
57	25,823.80	15,388.53	3,181.25	7,254.02
58	25,794.85	15,361.28	3,178.53	7,255.03
59	25,826.33	15,395.25	3,175.23	7,255.85

**Repeatability 2 LRT – I/O Request Throughput Distribution Data  
 (Measurement Interval)**

516 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	14:59:40	15:59:40	0-59	1:00:00
<i>Measurement Interval</i>	15:59:40	16:09:40	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	25,802.13	15,388.20	3,170.52	7,243.42
61	25,804.12	15,373.65	3,176.23	7,254.23
62	25,738.17	15,325.48	3,172.43	7,240.25
63	25,805.77	15,387.05	3,169.63	7,249.08
64	25,794.38	15,367.82	3,176.32	7,250.25
65	25,799.30	15,363.72	3,182.85	7,252.73
66	25,801.40	15,382.98	3,168.18	7,250.23
67	25,773.15	15,374.42	3,166.92	7,231.82
68	25,831.27	15,400.22	3,170.88	7,260.17
69	25,827.00	15,391.80	3,189.22	7,245.98
<b>Average</b>	<b>25,797.67</b>	<b>15,375.53</b>	<b>3,174.32</b>	<b>7,247.82</b>

**Repeatability 2 LRT – I/O Request Throughput Distribution Graph**



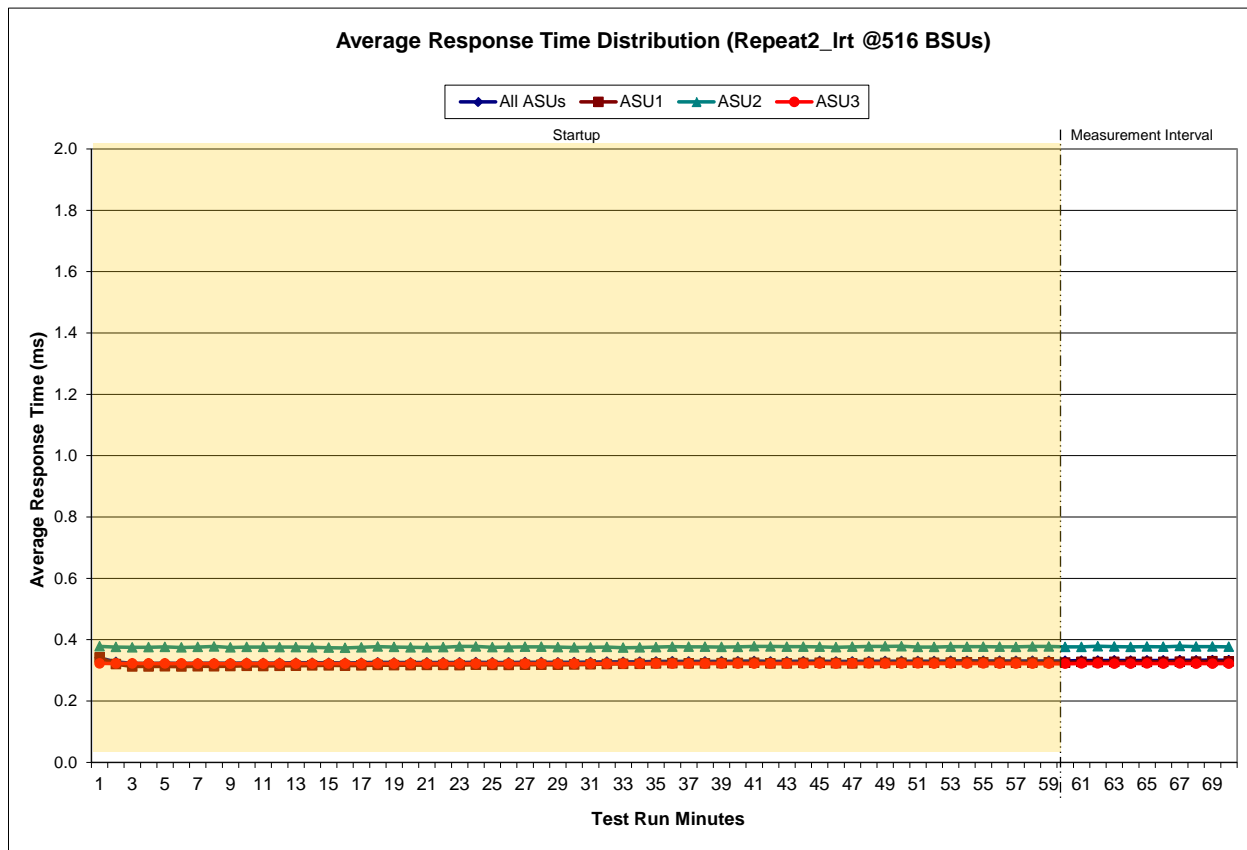
**Repeatability 2 LRT –Average Response Time (ms) Distribution Data (Ramp-Up)**

516 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	14:59:40	15:59:40	0-59	1:00:00
<i>Measurement Interval</i>	15:59:40	16:09:40	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	0.34	0.34	0.38	0.32
1	0.33	0.32	0.38	0.32
2	0.32	0.31	0.37	0.32
3	0.32	0.31	0.38	0.32
4	0.32	0.31	0.38	0.32
5	0.32	0.31	0.37	0.32
6	0.32	0.31	0.38	0.32
7	0.32	0.31	0.38	0.32
8	0.32	0.31	0.37	0.32
9	0.32	0.31	0.38	0.32
10	0.32	0.31	0.38	0.32
11	0.32	0.31	0.38	0.32
12	0.32	0.32	0.38	0.32
13	0.32	0.32	0.38	0.32
14	0.32	0.32	0.37	0.32
15	0.32	0.32	0.37	0.32
16	0.32	0.32	0.37	0.32
17	0.33	0.32	0.38	0.32
18	0.33	0.32	0.38	0.32
19	0.33	0.32	0.37	0.32
20	0.33	0.32	0.37	0.32
21	0.33	0.32	0.38	0.32
22	0.33	0.32	0.38	0.32
23	0.33	0.32	0.38	0.32
24	0.33	0.32	0.38	0.32
25	0.33	0.32	0.38	0.32
26	0.33	0.32	0.38	0.32
27	0.33	0.32	0.38	0.32
28	0.33	0.32	0.38	0.32
29	0.33	0.32	0.37	0.32
30	0.33	0.32	0.37	0.32
31	0.33	0.32	0.38	0.32
32	0.33	0.32	0.37	0.32
33	0.33	0.32	0.37	0.32
34	0.33	0.32	0.38	0.32
35	0.33	0.32	0.38	0.32
36	0.33	0.32	0.38	0.32
37	0.33	0.32	0.38	0.32
38	0.33	0.32	0.38	0.32
39	0.33	0.32	0.38	0.32
40	0.33	0.32	0.38	0.32
41	0.33	0.32	0.38	0.32
42	0.33	0.32	0.38	0.32
43	0.33	0.32	0.38	0.32
44	0.33	0.32	0.38	0.32
45	0.33	0.32	0.38	0.32
46	0.33	0.32	0.38	0.32
47	0.33	0.32	0.38	0.32
48	0.33	0.32	0.38	0.32
49	0.33	0.32	0.38	0.32
50	0.33	0.32	0.38	0.32
51	0.33	0.32	0.38	0.32
52	0.33	0.32	0.38	0.32
53	0.33	0.33	0.38	0.32
54	0.33	0.33	0.38	0.32
55	0.33	0.33	0.38	0.32
56	0.33	0.33	0.38	0.32
57	0.33	0.33	0.38	0.32
58	0.33	0.33	0.38	0.32
59	0.33	0.33	0.38	0.32

**Repeatability 2 LRT –Average Response Time (ms) Distribution Data  
 (Measurement Interval)**

516 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	14:59:40	15:59:40	0-59	1:00:00
<i>Measurement Interval</i>	15:59:40	16:09:40	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	0.33	0.33	0.38	0.32
61	0.33	0.33	0.38	0.32
62	0.33	0.33	0.38	0.32
63	0.33	0.33	0.38	0.32
64	0.33	0.33	0.38	0.32
65	0.33	0.33	0.38	0.32
66	0.33	0.33	0.38	0.32
67	0.33	0.33	0.38	0.32
68	0.33	0.33	0.38	0.32
69	0.33	0.33	0.38	0.32
<b>Average</b>	<b>0.33</b>	<b>0.33</b>	<b>0.38</b>	<b>0.32</b>

**Repeatability 2 LRT –Average Response Time (ms) Distribution Graph**



**Repeatability 2 IOPS – I/O Request Throughput Distribution Data (Ramp-Up)**

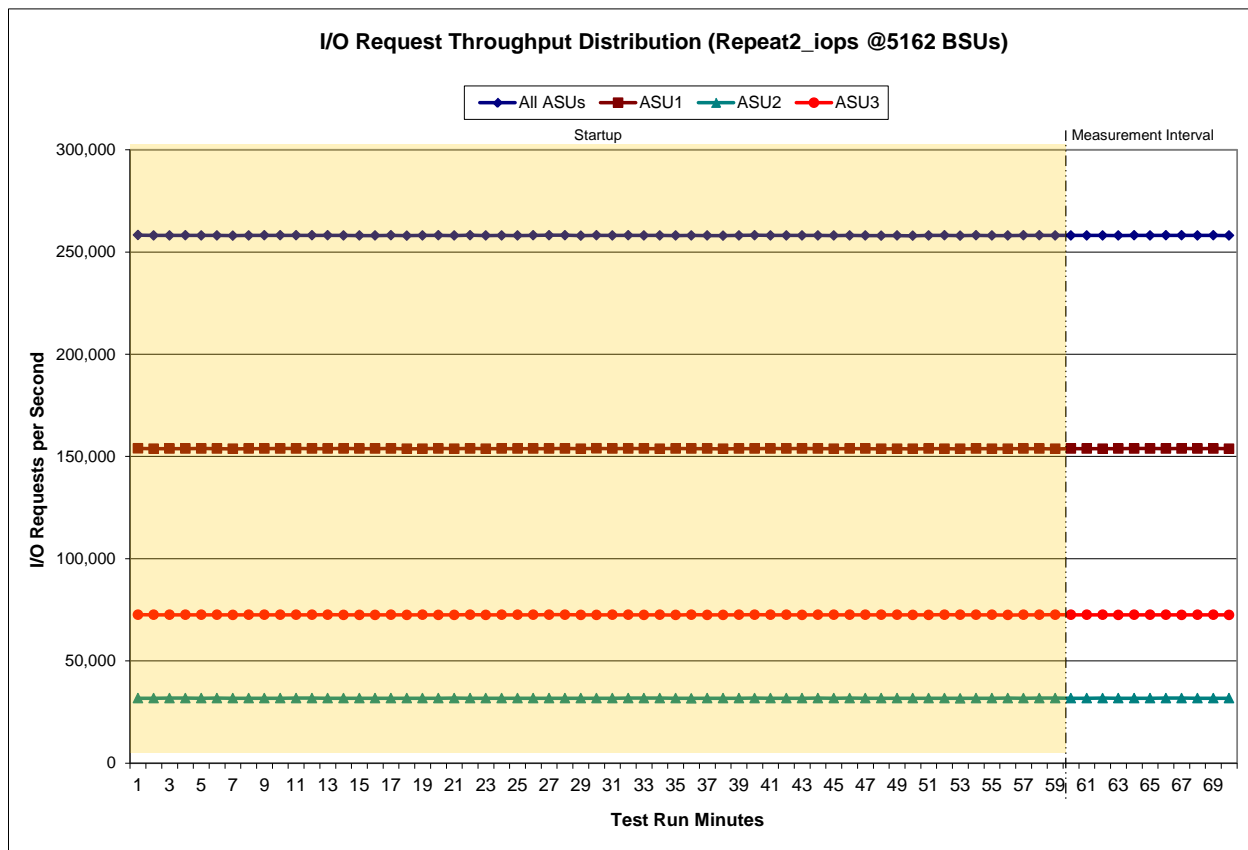
5,162 BSUs Start-Up/Ramp-Up Measurement Interval	Start	Stop	Interval	Duration
	16:10:17	17:10:18	0-59	1:00:01
	17:10:18	17:20:18	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	258,284.00	153,936.95	31,762.12	72,584.93
1	258,105.50	153,792.42	31,756.73	72,556.35
2	258,112.23	153,807.70	31,773.43	72,531.10
3	258,152.12	153,841.28	31,792.55	72,518.28
4	258,121.13	153,858.12	31,732.02	72,531.00
5	258,099.78	153,813.25	31,767.65	72,518.88
6	257,997.27	153,736.95	31,750.22	72,510.10
7	258,109.32	153,836.35	31,730.20	72,542.77
8	258,147.55	153,849.27	31,741.95	72,556.33
9	258,141.75	153,884.68	31,732.50	72,524.57
10	258,174.73	153,865.70	31,772.62	72,536.42
11	258,147.32	153,839.98	31,766.63	72,540.70
12	258,155.63	153,826.32	31,745.08	72,584.23
13	258,119.35	153,862.25	31,750.55	72,506.55
14	258,050.13	153,806.72	31,739.68	72,503.73
15	258,040.77	153,815.63	31,736.00	72,489.13
16	258,139.53	153,857.83	31,759.42	72,522.28
17	258,003.45	153,746.87	31,754.02	72,502.57
18	258,084.48	153,800.97	31,748.80	72,534.72
19	258,152.30	153,891.92	31,751.77	72,508.62
20	258,028.10	153,791.85	31,770.48	72,465.77
21	258,199.50	153,887.23	31,737.37	72,574.90
22	258,039.20	153,803.77	31,744.73	72,490.70
23	258,079.98	153,817.08	31,737.63	72,525.27
24	258,071.02	153,816.48	31,734.45	72,520.08
25	258,161.20	153,846.33	31,761.87	72,553.00
26	258,208.37	153,850.37	31,759.63	72,598.37
27	258,194.55	153,872.37	31,746.23	72,575.95
28	258,009.90	153,761.20	31,741.82	72,506.88
29	258,182.23	153,922.42	31,748.53	72,511.28
30	258,119.77	153,839.67	31,757.87	72,522.23
31	258,179.35	153,862.10	31,781.42	72,535.83
32	258,110.23	153,824.35	31,799.90	72,485.98
33	258,095.68	153,787.98	31,768.02	72,539.68
34	258,045.72	153,875.57	31,728.35	72,441.80
35	258,116.33	153,841.12	31,693.73	72,581.48
36	258,077.35	153,837.60	31,736.22	72,503.53
37	258,014.78	153,741.77	31,764.65	72,508.37
38	258,115.55	153,822.63	31,748.78	72,544.13
39	258,203.90	153,842.12	31,766.82	72,594.97
40	258,126.60	153,867.08	31,723.28	72,536.23
41	258,114.67	153,845.27	31,749.58	72,519.82
42	258,093.88	153,862.13	31,724.03	72,507.72
43	258,117.98	153,828.32	31,766.23	72,523.43
44	258,049.78	153,764.78	31,741.58	72,543.42
45	258,128.77	153,838.98	31,768.75	72,521.03
46	258,064.78	153,816.25	31,716.30	72,532.23
47	258,012.67	153,720.00	31,737.20	72,555.47
48	258,049.70	153,761.60	31,748.95	72,539.15
49	257,958.68	153,726.50	31,748.13	72,484.05
50	258,086.98	153,855.77	31,727.45	72,503.77
51	258,155.53	153,786.27	31,753.22	72,616.05
52	257,981.22	153,741.38	31,704.00	72,535.83
53	258,161.77	153,848.63	31,763.47	72,549.67
54	258,041.65	153,778.75	31,726.65	72,536.25
55	258,044.62	153,800.45	31,798.17	72,446.00
56	258,136.22	153,855.67	31,739.77	72,540.78
57	258,136.13	153,822.90	31,767.18	72,546.05
58	258,080.38	153,721.47	31,775.48	72,583.43
59	258,116.40	153,819.58	31,764.33	72,532.48



**Repeatability 2 IOPS – I/O Request Throughput Distribution Data  
 (Measurement Interval)**

5,162 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	16:10:17	17:10:18	0-59	1:00:01
<i>Measurement Interval</i>	17:10:18	17:20:18	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	258,099.87	153,844.93	31,712.23	72,542.70
61	258,110.92	153,793.37	31,770.35	72,547.20
62	258,074.97	153,804.45	31,763.87	72,506.65
63	258,164.30	153,872.53	31,747.50	72,544.27
64	258,125.93	153,867.87	31,734.42	72,523.65
65	258,142.43	153,819.35	31,772.43	72,550.65
66	258,177.93	153,880.43	31,796.77	72,500.73
67	258,106.03	153,835.55	31,747.65	72,522.83
68	258,134.38	153,857.83	31,742.15	72,534.40
69	258,033.53	153,794.85	31,754.60	72,484.08
<b>Average</b>	<b>258,117.03</b>	<b>153,837.12</b>	<b>31,754.20</b>	<b>72,525.72</b>

**Repeatability 2 IOPS – I/O Request Throughput Distribution Graph**



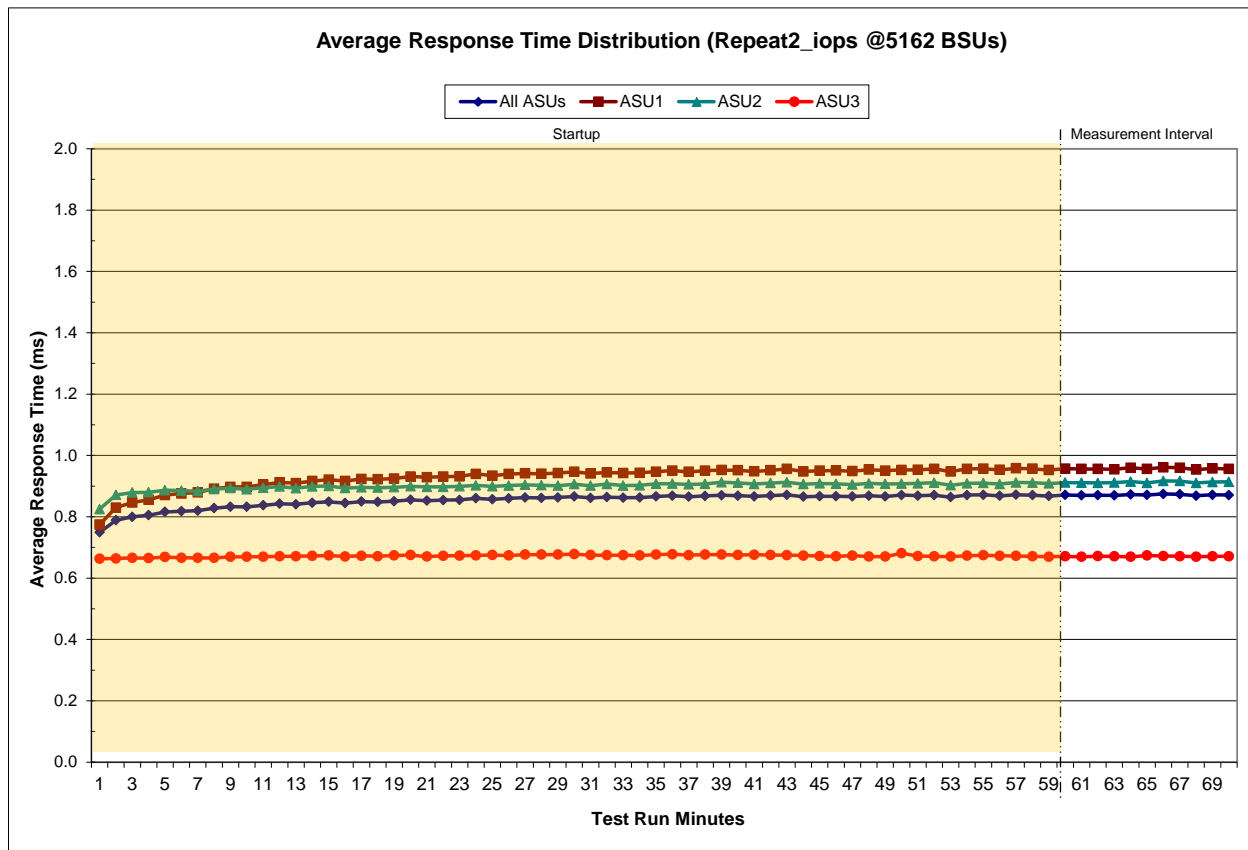
**Repeatability 2 IOPS –Average Response Time (ms) Distribution Data (Ramp-Up)**

5,162 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	16:10:17	17:10:18	0-59	1:00:01
<i>Measurement Interval</i>	17:10:18	17:20:18	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	0.75	0.77	0.83	0.66
1	0.79	0.83	0.87	0.66
2	0.80	0.85	0.88	0.67
3	0.81	0.86	0.88	0.67
4	0.82	0.87	0.89	0.67
5	0.82	0.88	0.89	0.67
6	0.82	0.88	0.88	0.67
7	0.83	0.89	0.89	0.67
8	0.83	0.90	0.89	0.67
9	0.83	0.90	0.89	0.67
10	0.84	0.90	0.89	0.67
11	0.84	0.91	0.90	0.67
12	0.84	0.91	0.89	0.67
13	0.85	0.92	0.90	0.67
14	0.85	0.92	0.90	0.67
15	0.84	0.92	0.89	0.67
16	0.85	0.92	0.90	0.67
17	0.85	0.92	0.89	0.67
18	0.85	0.92	0.90	0.67
19	0.86	0.93	0.90	0.68
20	0.85	0.93	0.90	0.67
21	0.85	0.93	0.90	0.67
22	0.86	0.93	0.90	0.67
23	0.86	0.94	0.90	0.67
24	0.86	0.93	0.90	0.68
25	0.86	0.94	0.90	0.67
26	0.86	0.94	0.90	0.68
27	0.86	0.94	0.90	0.68
28	0.86	0.94	0.90	0.68
29	0.87	0.95	0.91	0.68
30	0.86	0.94	0.90	0.68
31	0.86	0.94	0.91	0.67
32	0.86	0.94	0.90	0.67
33	0.86	0.94	0.90	0.67
34	0.87	0.95	0.91	0.68
35	0.87	0.95	0.91	0.68
36	0.87	0.95	0.91	0.67
37	0.87	0.95	0.91	0.68
38	0.87	0.95	0.91	0.68
39	0.87	0.95	0.91	0.68
40	0.87	0.95	0.91	0.68
41	0.87	0.95	0.91	0.68
42	0.87	0.96	0.91	0.67
43	0.87	0.95	0.91	0.67
44	0.87	0.95	0.91	0.67
45	0.87	0.95	0.91	0.67
46	0.87	0.95	0.91	0.67
47	0.87	0.95	0.91	0.67
48	0.87	0.95	0.91	0.67
49	0.87	0.95	0.91	0.68
50	0.87	0.95	0.91	0.67
51	0.87	0.96	0.91	0.67
52	0.86	0.95	0.90	0.67
53	0.87	0.96	0.91	0.67
54	0.87	0.96	0.91	0.67
55	0.87	0.95	0.91	0.67
56	0.87	0.96	0.91	0.67
57	0.87	0.96	0.91	0.67
58	0.87	0.95	0.91	0.67
59	0.87	0.96	0.91	0.67

**Repeatability 2 IOPS –Average Response Time (ms) Distribution Data  
 (Measurement Interval)**

5,162 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	16:10:17	17:10:18	0-59	1:00:01
<i>Measurement Interval</i>	17:10:18	17:20:18	60-69	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
60	0.87	0.96	0.91	0.67
61	0.87	0.96	0.91	0.67
62	0.87	0.95	0.91	0.67
63	0.87	0.96	0.91	0.67
64	0.87	0.96	0.91	0.67
65	0.87	0.96	0.92	0.67
66	0.87	0.96	0.92	0.67
67	0.87	0.95	0.91	0.67
68	0.87	0.96	0.91	0.67
69	0.87	0.96	0.91	0.67
<i>Average</i>	<i>0.87</i>	<i>0.96</i>	<i>0.91</i>	<i>0.67</i>

**Repeatability 2 IOPS –Average Response Time (ms) Distribution Graph**



**Repeatability 1 (LRT)**  
**Measured Intensity Multiplier and Coefficient of Variation**

*Clause 3.4.3*

**IM – Intensity Multiplier:** The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.

*Clauses 5.1.10 and 5.3.15.2*

**MIM – Measured Intensity Multiplier:** The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.

*Clause 5.3.15.3*

**COV – Coefficient of Variation:** This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
<b>IM</b>	<b>0.0350</b>	<b>0.2810</b>	<b>0.0700</b>	<b>0.2100</b>	<b>0.0180</b>	<b>0.0700</b>	<b>0.0350</b>	<b>0.2810</b>
MIM	0.0349	0.2810	0.0700	0.2101	0.0180	0.0699	0.0349	0.2812
COV	0.005	0.001	0.003	0.001	0.009	0.002	0.003	0.00`

**Repeatability 1 (IOPS)**  
**Measured Intensity Multiplier and Coefficient of Variation**

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
<b>IM</b>	<b>0.0350</b>	<b>0.2810</b>	<b>0.0700</b>	<b>0.2100</b>	<b>0.0180</b>	<b>0.0700</b>	<b>0.0350</b>	<b>0.2810</b>
MIM	0.0350	0.2810	0.0700	0.2099	0.0180	0.0700	0.0350	0.2811
COV	0.001	0.000	0.001	0.000	0.002	0.001	0.001	0.000

**Repeatability 2 (LRT)**  
**Measured Intensity Multiplier and Coefficient of Variation**

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
<b>IM</b>	<b>0.0350</b>	<b>0.2810</b>	<b>0.0700</b>	<b>0.2100</b>	<b>0.0180</b>	<b>0.0700</b>	<b>0.0350</b>	<b>0.2810</b>
MIM	0.0350	0.2807	0.701	0.2102	0.0180	0.0700	0.0350	0.2809
COV	0.003	0.001	0.002	0.001	0.006	0.003	0.004	0.001

**Repeatability 2 (IOPS)**  
**Measured Intensity Multiplier and Coefficient of Variation**

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
<b>IM</b>	<b>0.0350</b>	<b>0.2810</b>	<b>0.0700</b>	<b>0.2100</b>	<b>0.0180</b>	<b>0.0700</b>	<b>0.0350</b>	<b>0.2810</b>
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.001	0.000	0.001	0.000	0.002	0.001	0.001	0.000

## Data Persistence Test

### Clause 6

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

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

*The SPC-1 Workload Generator will write 16 block I/O requests at random over the total Addressable Storage Capacity of the TSC for ten (10) minutes at a minimum of 25% of the load used to generate the SPC-1 IOPS™ primary metric. The bit pattern selected to be written to each block as well as the address of the block will be retained in a log file.*

*The Tested Storage Configuration (TSC) 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.*

*The SPC-1 Workload Generator will then use the above log file to verify each block written contains the correct bit pattern.*

### Clause 9.4.3.8

*The following content shall appear in this section of the FDR:*

1. *A listing or screen image of all input parameters supplied to the Workload Generator.*
2. *For the successful Data Persistence Test Run, a table illustrating key results. The content, appearance, and format of this table are specified in Table 9-12. Information displayed in this table shall be obtained from the Test Run Results File referenced below in #3.*
3. *For the successful Data Persistence Test Run, the human readable Test Run Results file produced by the Workload Generator (may be contained in an appendix).*

## SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in [Appendix E: SPC-1 Workload Generator Input Parameters](#) on Page [95](#).

## Data Persistence Test Results File

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

[Persistence 1 Test Results File](#)

[Persistence 2 Test Results File](#)

**Data Persistence Test Results**

<b>Data Persistence Test Results</b>	
Data Persistence Test Run Number: 1	
Total Number of Logical Blocks Written	1,097,819
Total Number of Logical Blocks Verified	690,281
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks	5 minutes
Size in bytes of each Logical Block	1,024
Number of Failed I/O Requests in the process of the Test	0

If approved by the SPC Auditor, the SPC-2 Persistence Test may be used to meet the SPC-1 persistence requirements. Both the SPC-1 and SPC-2 Persistence Tests provide the same level of functionality and verification of data integrity. The SPC-2 Persistence Test may be easily configured to address an SPC-1 storage configuration. The SPC-2 Persistence Test extends the size of storage configurations that may be tested and significantly reduces the test duration of such configurations.

The SPC-2 Persistence Test was approved for use in this set of audited measurements.

In some cases the same address was the target of multiple writes, which resulted in more Logical Blocks Written than Logical Blocks Verified. In the case of multiple writes to the same address, the pattern written and verified must be associated with the last write to that address.

## **PRICED STORAGE CONFIGURATION AVAILABILITY DATE**

### **Clause 9.4.3.9**

*The committed delivery data 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 for the Priced Storage Configuration must be the date at which all components are committed to be available.*

The HP 3PAR StoreServ 7400 Storage System as documented in this Full Disclosure Report will become available on April 1, 2012 for customer purchase and shipment.

## **PRICING INFORMATION**

### **Clause 9.4.3.3.6**

*The Executive Summary shall contain a pricing spreadsheet as documented in Clause 8.3.1.*

Pricing information may be found in the Priced Storage Configuration Pricing section on page 18.

## **TESTED STORAGE CONFIGURATION (TSC) AND PRICED STORAGE CONFIGURATION DIFFERENCES**

### **Clause 9.4.3.3.8**

*The Executive Summary shall contain a list of all differences between the Tested Storage Configuration (TSC) and the Priced Storage Configuration.*

A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration may be found in the Executive Summary portion of this document on page 18.

## **ANOMALIES OR IRREGULARITIES**

### **Clause 9.4.3.10**

*The FDR shall include a clear and complete description of any anomalies or irregularities encountered in the course of executing the SPC-1 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-1 Onsite Audit of the HP 3PAR StoreServ 7400 Storage System.



## **APPENDIX A: SPC-1 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-1 Data Repository Definitions**

**Total ASU Capacity:** The total storage capacity read and written in the course of executing the SPC-1 benchmark.

**Application Storage Unit (ASU):** The logical interface between the storage and SPC-1 Workload Generator. The three ASUs (Data, User, and Log) are typically 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-1 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-1 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 three ASUs.

**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 amount of storage capacity available for use by application programs but not included in the Total ASU Capacity.

## SPC-1 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-1 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-1 Data Repository.

## SPC-1 Test Execution Definitions

**Average Response Time:** The sum of the Response Times for all Measured I/O Requests divided by the total number of Measured I/O Requests.

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

**Completion Time:** The time recorded by the Workload Generator when an I/O Request is satisfied by the TSC as signaled by System Software.

**Data Rate:** The data transferred in all Measured I/O Requests in an SPC-1 Test Run divided by the length of the Test Run in seconds.

**Expected I/O Count:** For any given I/O Stream and Test Phase, the product of 50 times the BSU level, the duration of the Test Phase in seconds, and the Intensity Multiplier for that I/O Stream.

**Failed I/O Request:** Any I/O Request issued by the Workload Generator that could not be completed or was signaled as failed by System Software. A Failed I/O Request has no Completion Time (see “I/O Completion Types” below).

**I/O Request Throughput:** The total number of Measured I/O requests in an SPC-1 Test Run divided by the duration of the Measurement Interval in seconds.

**In-Flight I/O Request:** An I/O Request issued by the I/O Command Generator to the TSC that has a recorded Start Time, but does not complete within the Measurement Interval (see “I/O Completion Types” below).

**Measured I/O Request:** A Completed I/O Request with a Completion Time occurring within the Measurement Interval (see “I/O Completion Types” below).

**Measured Intensity Multiplier:** The percentage of all Measured I/O Requests that were issued by a given I/O Stream.

**Measurement Interval:** The finite and contiguous time period, after the TSC has reached Steady State, when data is collected by a Test Sponsor to generate an SPC-1 test result or support an SPC-1 test result.

**Ramp-Up:** The 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.

**Ramp-Down:** The time required for the BC to complete all I/O Requests issued by the Workload Generator. The Ramp-Down period begins when the Workload Generator ceases to issue new I/O Requests to the TSC.

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

**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 Tested Storage Configuration (TSC).

**Start-Up:** The period that begins after the Workload Generator starts to submit I/O requests to the TSC and ends at the beginning of the Measurement Interval.

**Shut-Down:** The period between the end of the Measurement Interval and the time when all I/O Requests issued by the Workload Generator have completed or failed.

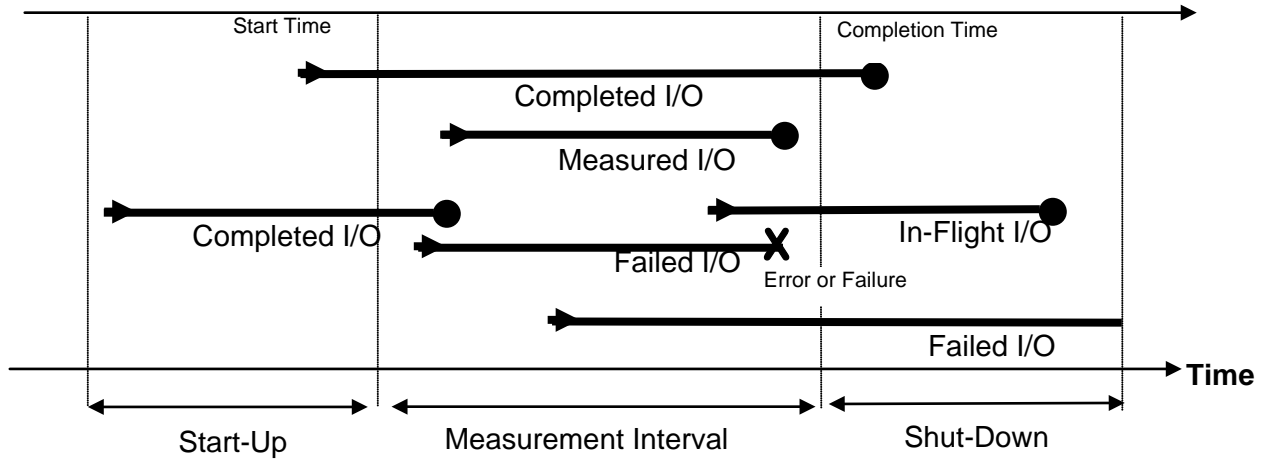
**Steady State:** The consistent and sustainable throughput of the TSC. During this period the load presented to the TSC by the Workload Generator is constant.

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

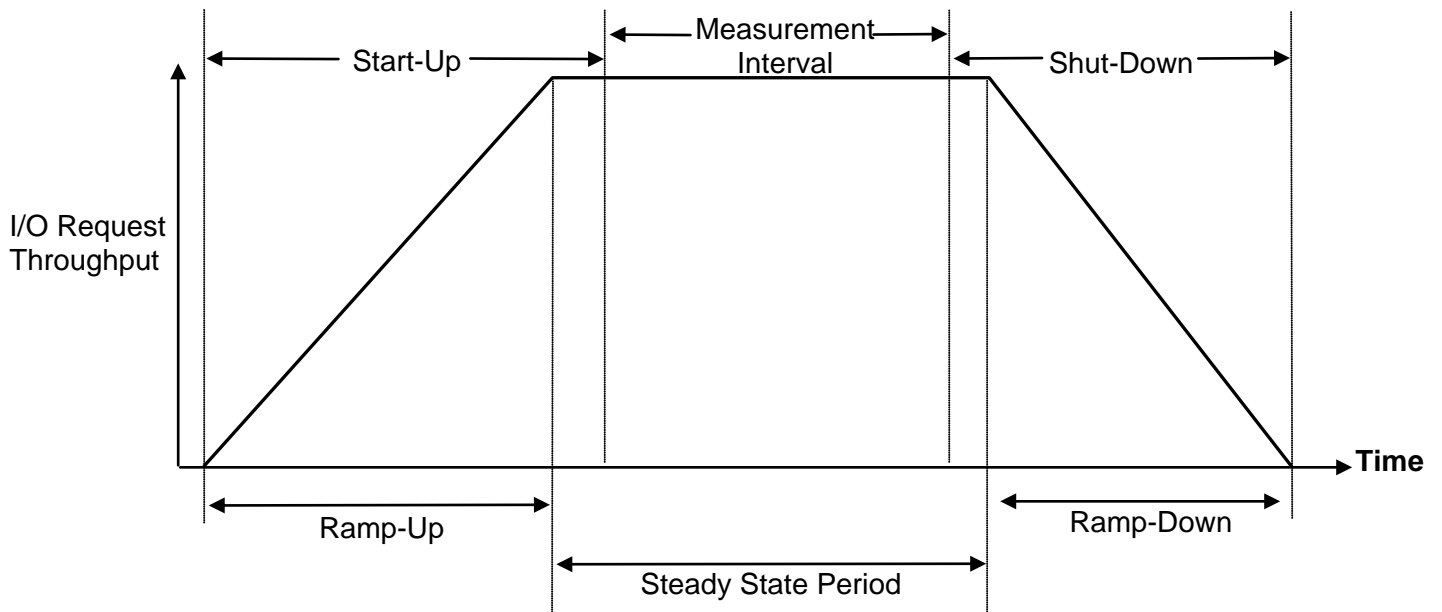
**Test Run:** The execution of SPC-1 for the purpose of producing or supporting an SPC-1 test result. SPC-1 Test Runs may have a finite and measured Ramp-Up period, Start-Up period, Shut-Down period, and Ramp-Down period as illustrated in the “SPC-1 Test Run Components” below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

**Test Phase:** A collection of one or more SPC-1 Test Runs sharing a common objective and intended to be run in a specific sequence.

### I/O Completion Types



### SPC-1 Test Run Components



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

The following customer tunable parameters and options were changed from their default values on each of the Host Systems for this benchmark. The [Host System Configuration](#) section of [Appendix C: Tested Storage Configuration \(TSC\) Creation](#) documents how those parameters and options were changed.

- Emulex HBA queue depth was set to 128 per device
- The default **cfq** scheduler was changed to **noop** scheduler.
- The RHEL ramdisk image was rebuilt and each Host System rebooted so that the above changes would be in effect.

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

### **Customer-Ready Configuration**

As part of the customer installation process, an HP Field Engineer will execute a series of default commands that will result in the storage system self-configuring and self-provisioning the appropriate available, spare and metadata capacities based upon the number and capacity of storage devices in the HP 3PAR StoreServ 7400 Storage System configuration.

The HP Field Engineer will then execute an HP-supported script to right-size the space required for system metadata on HP 3PAR StoreServ 7000 SSD-only configurations. This script is specifically designed and optimized for the HP 3PAR StoreServ 7200 and 7400 Storage Systems with SSD-only configurations, running on 3PAR Operating System version 3.1.2 MU1 (*the current shipping version as of this date*).

Future releases of 3PAR Operating System will automatically right-size the space required for system metadata on SSD-only configurations without the need for execution of this script.

The scripts, referenced in the next two sections, appear in the [TSC Creation/Configuration Scripts](#) section.

### **Front-End Port Configuration – Create Hosts**

The [spc\\_hosts](#) script, executed from a command window on the StoreServ 7400, created the paths (hosts) for all ports of each Host System used (20 ports, 4 per Host System).

### **Create the SPC-1 Logical Volumes**

The [spc\\_r1\\_setup](#) script, executed from a command window on the StoreServ 7400, does the following

- Creates 120 SPC-1 Logical Volumes  
(80 for ASU-1, 20 for ASU-2 and 20 for ASU-3)
- Exports the volumes to the Host System ports.

The volumes are visible to the Host Systems after a reboot of each Host System.

### **Host System Configuration**

The following customer tunable parameters were changed on each Host System:

- Edit and save **/etc/modprobe.d/lpfc.conf**, as follows, to change the Emulex HBA default queue length.  
**-> cd /etc/modprobe.d**  
**-> vi lpfc.conf**  
**options lpfc lpfc\_lun\_queue\_depth=128**

- Edit and save **/etc/grub.conf**, as follows, to change the default Linux scheduler.  
-> **vi /etc/grub.conf**  
**elevator = noop** (added at the end of the kernel line)
- Rebuild the RHEL ramdisk image and reboot each Host System, as follows, so that the above changes will be in effect:  
-> **uname -a**  
-> **dracut -v -f /boot/initramfs-2.6.32-220.el6.x86\_64.img 2.6.32-220.el6.x86\_64**  
-> **reboot**

## TSC Creation/Configuration Scripts

### spc\_hosts

```
createhost d211_0 10000000C9D889B8
createhost d211_1 10000000C9D889B9
createhost d211_2 10000000C9D889BA
createhost d211_3 10000000C9D889BB
createhost d212_0 10000000C9D889C0
createhost d212_1 10000000C9D889C1
createhost d212_2 10000000C9D889C2
createhost d212_3 10000000C9D889C3
createhost d213_0 10000000C9D8E8DC
createhost d213_1 10000000C9D8E8DD
createhost d213_2 10000000C9D8E8DE
createhost d213_3 10000000C9D8E8DF
createhost d214_0 10000000C9D889FC
createhost d214_1 10000000C9D889FD
createhost d214_2 10000000C9D889FE
createhost d214_3 10000000C9D889FF
createhost d220_0 10000000C9D8846F
createhost d220_1 10000000C9D8846C
createhost d220_2 10000000C9D8846D
createhost d220_3 10000000C9D8846E
```

### spc\_r1\_setup

```
createcpg -t r1 -ha mag -p -devtype SSD -nd 0 cpgssd0
createcpg -t r1 -ha mag -p -devtype SSD -nd 1 cpgssd1
createcpg -t r1 -ha mag -p -devtype SSD -nd 2 cpgssd2
createcpg -t r1 -ha mag -p -devtype SSD -nd 3 cpgssd3

j=10;
nd=0
for i in `seq 1 80`; do
    createvv -i $j cpgssd${nd} asu1.${i} 6144;
    j=$((j+1))
    nd=$((nd+1))
    if (($nd>3))
    then
        nd=0
    fi
done
```

```
createvvset asula asul.1 asul.5 asul.9 asul.13 asul.17 asul.21 asul.25 asul.29
asul.33 asul.37 asul.41 asul.45 asul.49 asul.53 asul.57 asul.61 asul.65 asul.69
asul.73 asul.77
createvvset asulb asul.2 asul.6 asul.10 asul.14 asul.18 asul.22 asul.26 asul.30
asul.34 asul.38 asul.42 asul.46 asul.50 asul.54 asul.58 asul.62 asul.66 asul.70
asul.74 asul.78
createvvset asulc asul.3 asul.7 asul.11 asul.15 asul.19 asul.23 asul.27 asul.31
asul.35 asul.39 asul.43 asul.47 asul.51 asul.55 asul.59 asul.63 asul.67 asul.71
asul.75 asul.79
createvvset asuld asul.4 asul.8 asul.12 asul.16 asul.20 asul.24 asul.28 asul.32
asul.36 asul.40 asul.44 asul.48 asul.52 asul.56 asul.60 asul.64 asul.68 asul.72
asul.76 asul.80
```

```
j=101;
nd=0
for i in `seq 1 20`; do
    createvv -i $j cpgssd${nd} asu2.${i} 24576;
    j=$((j+1))
    nd=$((nd+1))
    if (($nd>3))
    then
        nd=0
    fi
done
```

```
createvvset asu2a asu2.1 asu2.5 asu2.9 asu2.13 asu2.17
createvvset asu2b asu2.2 asu2.6 asu2.10 asu2.14 asu2.18
createvvset asu2c asu2.3 asu2.7 asu2.11 asu2.15 asu2.19
createvvset asu2d asu2.4 asu2.8 asu2.12 asu2.16 asu2.20
```

nd=0

```
for i in `seq 1 20`; do
    createvv -i $j cpgssd${nd} asu3.${i} 6144;
    j=$((j+1))
    nd=$((nd+1))
    if (($nd>3))
    then
        nd=0
    fi
done
```

```
createvvset asu3a asu3.1 asu3.5 asu3.9 asu3.13 asu3.17
createvvset asu3b asu3.2 asu3.6 asu3.10 asu3.14 asu3.18
createvvset asu3c asu3.3 asu3.7 asu3.11 asu3.15 asu3.19
createvvset asu3d asu3.4 asu3.8 asu3.12 asu3.16 asu3.20
```

```
createhostset hosta d211_0 d212_0 d213_0 d214_0 d220_0
createhostset hostb d211_1 d212_1 d213_1 d214_1 d220_1
createhostset hostc d211_2 d212_2 d213_2 d214_2 d220_2
createhostset hostd d211_3 d212_3 d213_3 d214_3 d220_3
```

```
createvlun -f set:asula auto set:hosta
createvlun -f set:asulb auto set:hostb
createvlun -f set:asulc auto set:hostc
createvlun -f set:asuld auto set:hostd
createvlun -f set:asu2a auto set:hosta
```



```
createvln -f set:asu2b auto set:hostb  
createvln -f set:asu2c auto set:hostc  
createvln -f set:asu2d auto set:hostd  
createvln -f set:asu3a auto set:hosta  
createvln -f set:asu3b auto set:hostb  
createvln -f set:asu3c auto set:hostc  
createvln -f set:asu3d auto set:hostd
```

## APPENDIX D: SPC-1 WORKLOAD GENERATOR STORAGE COMMANDS AND PARAMETERS

### ASU Pre-Fill

The content of command and parameter file, used in this benchmark to execute the required ASU pre-fill, is listed below.

```
compratio=1
sd=asul_1,lun=/dev/mapper/360002ac0000000000000000a0001859d,size=6442447500,threads=
1,openflags=o_direct
sd=asul_2,lun=/dev/mapper/360002ac0000000000000000b0001859d,size=6442447500,threads=
1,openflags=o_direct
sd=asul_3,lun=/dev/mapper/360002ac0000000000000000c0001859d,size=6442447500,threads=
1,openflags=o_direct
sd=asul_4,lun=/dev/mapper/360002ac0000000000000000d0001859d,size=6442447500,threads=
1,openflags=o_direct
sd=asul_5,lun=/dev/mapper/360002ac0000000000000000e0001859d,size=6442447500,threads=
1,openflags=o_direct
sd=asul_6,lun=/dev/mapper/360002ac0000000000000000f0001859d,size=6442447500,threads=
1,openflags=o_direct
sd=asul_7,lun=/dev/mapper/360002ac000000000000000100001859d,size=6442447500,threads=
1,openflags=o_direct
sd=asul_8,lun=/dev/mapper/360002ac000000000000000110001859d,size=6442447500,threads=
1,openflags=o_direct
sd=asul_9,lun=/dev/mapper/360002ac000000000000000120001859d,size=6442447500,threads=
1,openflags=o_direct
sd=asul_10,lun=/dev/mapper/360002ac000000000000000130001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_11,lun=/dev/mapper/360002ac000000000000000140001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_12,lun=/dev/mapper/360002ac000000000000000150001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_13,lun=/dev/mapper/360002ac000000000000000160001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_14,lun=/dev/mapper/360002ac000000000000000170001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_15,lun=/dev/mapper/360002ac000000000000000180001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_16,lun=/dev/mapper/360002ac000000000000000190001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_17,lun=/dev/mapper/360002ac0000000000000001a0001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_18,lun=/dev/mapper/360002ac0000000000000001b0001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_19,lun=/dev/mapper/360002ac0000000000000001c0001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_20,lun=/dev/mapper/360002ac0000000000000001d0001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_21,lun=/dev/mapper/360002ac0000000000000001e0001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_22,lun=/dev/mapper/360002ac0000000000000001f0001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_23,lun=/dev/mapper/360002ac000000000000000200001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_24,lun=/dev/mapper/360002ac000000000000000210001859d,size=6442447500,threads
=1,openflags=o_direct
sd=asul_25,lun=/dev/mapper/360002ac000000000000000220001859d,size=6442447500,threads
=1,openflags=o_direct
```

sd=asul\_26,lun=/dev/mapper/360002ac000000000000000230001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_27,lun=/dev/mapper/360002ac000000000000000240001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_28,lun=/dev/mapper/360002ac000000000000000250001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_29,lun=/dev/mapper/360002ac000000000000000260001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_30,lun=/dev/mapper/360002ac000000000000000270001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_31,lun=/dev/mapper/360002ac000000000000000280001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_32,lun=/dev/mapper/360002ac000000000000000290001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_33,lun=/dev/mapper/360002ac0000000000000002a0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_34,lun=/dev/mapper/360002ac0000000000000002b0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_35,lun=/dev/mapper/360002ac0000000000000002c0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_36,lun=/dev/mapper/360002ac0000000000000002d0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_37,lun=/dev/mapper/360002ac0000000000000002e0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_38,lun=/dev/mapper/360002ac0000000000000002f0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_39,lun=/dev/mapper/360002ac000000000000000300001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_40,lun=/dev/mapper/360002ac000000000000000310001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_41,lun=/dev/mapper/360002ac000000000000000320001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_42,lun=/dev/mapper/360002ac000000000000000330001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_43,lun=/dev/mapper/360002ac000000000000000340001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_44,lun=/dev/mapper/360002ac000000000000000350001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_45,lun=/dev/mapper/360002ac000000000000000360001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_46,lun=/dev/mapper/360002ac000000000000000370001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_47,lun=/dev/mapper/360002ac000000000000000380001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_48,lun=/dev/mapper/360002ac000000000000000390001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_49,lun=/dev/mapper/360002ac0000000000000003a0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_50,lun=/dev/mapper/360002ac0000000000000003b0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_51,lun=/dev/mapper/360002ac0000000000000003c0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_52,lun=/dev/mapper/360002ac0000000000000003d0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_53,lun=/dev/mapper/360002ac0000000000000003e0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_54,lun=/dev/mapper/360002ac0000000000000003f0001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_55,lun=/dev/mapper/360002ac000000000000000400001859d,size=6442447500,threads  
=1,openflags=o\_direct  
sd=asul\_56,lun=/dev/mapper/360002ac000000000000000410001859d,size=6442447500,threads  
=1,openflags=o\_direct

sd=asul\_57,lun=/dev/mapper/360002ac000000000000000430001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_58,lun=/dev/mapper/360002ac000000000000000420001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_59,lun=/dev/mapper/360002ac000000000000000450001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_60,lun=/dev/mapper/360002ac000000000000000440001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_61,lun=/dev/mapper/360002ac000000000000000460001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_62,lun=/dev/mapper/360002ac000000000000000470001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_63,lun=/dev/mapper/360002ac000000000000000480001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_64,lun=/dev/mapper/360002ac000000000000000490001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_65,lun=/dev/mapper/360002ac0000000000000004a0001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_66,lun=/dev/mapper/360002ac0000000000000004b0001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_67,lun=/dev/mapper/360002ac0000000000000004c0001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_68,lun=/dev/mapper/360002ac0000000000000004d0001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_69,lun=/dev/mapper/360002ac0000000000000004e0001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_70,lun=/dev/mapper/360002ac0000000000000004f0001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_71,lun=/dev/mapper/360002ac000000000000000500001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_72,lun=/dev/mapper/360002ac000000000000000510001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_73,lun=/dev/mapper/360002ac000000000000000520001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_74,lun=/dev/mapper/360002ac000000000000000530001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_75,lun=/dev/mapper/360002ac000000000000000540001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_76,lun=/dev/mapper/360002ac000000000000000550001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_77,lun=/dev/mapper/360002ac000000000000000560001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_78,lun=/dev/mapper/360002ac000000000000000570001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_79,lun=/dev/mapper/360002ac000000000000000580001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asul\_80,lun=/dev/mapper/360002ac000000000000000590001859d,size=6442447500,threads=1,openflags=o\_direct  
sd=asu2\_1,lun=/dev/mapper/360002ac000000000000000650001859d,size=25769790000,threads=1,openflags=o\_direct  
sd=asu2\_2,lun=/dev/mapper/360002ac000000000000000660001859d,size=25769790000,threads=1,openflags=o\_direct  
sd=asu2\_3,lun=/dev/mapper/360002ac000000000000000670001859d,size=25769790000,threads=1,openflags=o\_direct  
sd=asu2\_4,lun=/dev/mapper/360002ac000000000000000680001859d,size=25769790000,threads=1,openflags=o\_direct  
sd=asu2\_5,lun=/dev/mapper/360002ac000000000000000690001859d,size=25769790000,threads=1,openflags=o\_direct  
sd=asu2\_6,lun=/dev/mapper/360002ac0000000000000006a0001859d,size=25769790000,threads=1,openflags=o\_direct  
sd=asu2\_7,lun=/dev/mapper/360002ac0000000000000006b0001859d,size=25769790000,threads=1,openflags=o\_direct

```
sd=asu2_8,lun=/dev/mapper/360002ac0000000000000006c0001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_9,lun=/dev/mapper/360002ac0000000000000006d0001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_10,lun=/dev/mapper/360002ac00000000000000070001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_11,lun=/dev/mapper/360002ac0000000000000006f0001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_12,lun=/dev/mapper/360002ac0000000000000006e0001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_13,lun=/dev/mapper/360002ac000000000000000710001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_14,lun=/dev/mapper/360002ac000000000000000720001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_15,lun=/dev/mapper/360002ac000000000000000730001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_16,lun=/dev/mapper/360002ac000000000000000740001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_17,lun=/dev/mapper/360002ac000000000000000750001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_18,lun=/dev/mapper/360002ac000000000000000760001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_19,lun=/dev/mapper/360002ac000000000000000770001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu2_20,lun=/dev/mapper/360002ac000000000000000780001859d,size=25769790000,threads=1,openflags=o_direct
sd=asu3_1,lun=/dev/mapper/360002ac000000000000000790001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_2,lun=/dev/mapper/360002ac0000000000000007a0001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_3,lun=/dev/mapper/360002ac0000000000000007b0001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_4,lun=/dev/mapper/360002ac0000000000000007c0001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_5,lun=/dev/mapper/360002ac0000000000000007d0001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_6,lun=/dev/mapper/360002ac0000000000000007e0001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_7,lun=/dev/mapper/360002ac0000000000000007f0001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_8,lun=/dev/mapper/360002ac000000000000000800001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_9,lun=/dev/mapper/360002ac000000000000000810001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_10,lun=/dev/mapper/360002ac000000000000000820001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_11,lun=/dev/mapper/360002ac000000000000000830001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_12,lun=/dev/mapper/360002ac000000000000000840001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_13,lun=/dev/mapper/360002ac000000000000000850001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_14,lun=/dev/mapper/360002ac000000000000000860001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_15,lun=/dev/mapper/360002ac000000000000000870001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_16,lun=/dev/mapper/360002ac000000000000000880001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_17,lun=/dev/mapper/360002ac000000000000000890001859d,size=5726620000,threads=1,openflags=o_direct
sd=asu3_18,lun=/dev/mapper/360002ac0000000000000008a0001859d,size=5726620000,threads=1,openflags=o_direct
```

## SPC-1 WORKLOAD GENERATOR STORAGE COMMANDS AND PARAMETERS

```
sd=asu3_19,lun=/dev/mapper/360002ac0000000000000008b0001859d,size=5726620000,threads
=1,openflags=o_direct
sd=asu3_20,lun=/dev/mapper/360002ac0000000000000008c0001859d,size=5726620000,threads
=1,openflags=o_direct

wd=wd1,sd=asu*,rdpct=0,seek=-1,xfersize=1m
rd=prepspc,wd=wd*,iorate=max,elapsed=12000,interval=10
```

**SPC-1 Common Commands Lines**

The following command lines appear at the beginning of each command and parameter file for the Primary Metrics Test, Repeatability Test and SPC-1 Persistence Test Run 1. The command lines are only listed below to eliminate redundancy.

```
sd=asul_1,lun=/dev/mapper/360002ac0000000000000000a0001859d,size=6442447500
sd=asul_2,lun=/dev/mapper/360002ac0000000000000000b0001859d,size=6442447500
sd=asul_3,lun=/dev/mapper/360002ac0000000000000000c0001859d,size=6442447500
sd=asul_4,lun=/dev/mapper/360002ac0000000000000000d0001859d,size=6442447500
sd=asul_5,lun=/dev/mapper/360002ac0000000000000000e0001859d,size=6442447500
sd=asul_6,lun=/dev/mapper/360002ac0000000000000000f0001859d,size=6442447500
sd=asul_7,lun=/dev/mapper/360002ac000000000000000010001859d,size=6442447500
sd=asul_8,lun=/dev/mapper/360002ac0000000000000000110001859d,size=6442447500
sd=asul_9,lun=/dev/mapper/360002ac0000000000000000120001859d,size=6442447500
sd=asul_10,lun=/dev/mapper/360002ac0000000000000000130001859d,size=6442447500
sd=asul_11,lun=/dev/mapper/360002ac0000000000000000140001859d,size=6442447500
sd=asul_12,lun=/dev/mapper/360002ac0000000000000000150001859d,size=6442447500
sd=asul_13,lun=/dev/mapper/360002ac0000000000000000160001859d,size=6442447500
sd=asul_14,lun=/dev/mapper/360002ac0000000000000000170001859d,size=6442447500
sd=asul_15,lun=/dev/mapper/360002ac0000000000000000180001859d,size=6442447500
sd=asul_16,lun=/dev/mapper/360002ac0000000000000000190001859d,size=6442447500
sd=asul_17,lun=/dev/mapper/360002ac00000000000000001a0001859d,size=6442447500
sd=asul_18,lun=/dev/mapper/360002ac00000000000000001b0001859d,size=6442447500
sd=asul_19,lun=/dev/mapper/360002ac00000000000000001c0001859d,size=6442447500
sd=asul_20,lun=/dev/mapper/360002ac00000000000000001d0001859d,size=6442447500
sd=asul_21,lun=/dev/mapper/360002ac00000000000000001e0001859d,size=6442447500
sd=asul_22,lun=/dev/mapper/360002ac00000000000000001f0001859d,size=6442447500
sd=asul_23,lun=/dev/mapper/360002ac0000000000000000200001859d,size=6442447500
sd=asul_24,lun=/dev/mapper/360002ac0000000000000000210001859d,size=6442447500
sd=asul_25,lun=/dev/mapper/360002ac0000000000000000220001859d,size=6442447500
sd=asul_26,lun=/dev/mapper/360002ac0000000000000000230001859d,size=6442447500
sd=asul_27,lun=/dev/mapper/360002ac0000000000000000240001859d,size=6442447500
sd=asul_28,lun=/dev/mapper/360002ac0000000000000000250001859d,size=6442447500
sd=asul_29,lun=/dev/mapper/360002ac0000000000000000260001859d,size=6442447500
sd=asul_30,lun=/dev/mapper/360002ac0000000000000000270001859d,size=6442447500
sd=asul_31,lun=/dev/mapper/360002ac0000000000000000280001859d,size=6442447500
sd=asul_32,lun=/dev/mapper/360002ac0000000000000000290001859d,size=6442447500
sd=asul_33,lun=/dev/mapper/360002ac00000000000000002a0001859d,size=6442447500
sd=asul_34,lun=/dev/mapper/360002ac00000000000000002b0001859d,size=6442447500
sd=asul_35,lun=/dev/mapper/360002ac00000000000000002c0001859d,size=6442447500
sd=asul_36,lun=/dev/mapper/360002ac00000000000000002d0001859d,size=6442447500
sd=asul_37,lun=/dev/mapper/360002ac00000000000000002e0001859d,size=6442447500
sd=asul_38,lun=/dev/mapper/360002ac00000000000000002f0001859d,size=6442447500
sd=asul_39,lun=/dev/mapper/360002ac0000000000000000300001859d,size=6442447500
sd=asul_40,lun=/dev/mapper/360002ac0000000000000000310001859d,size=6442447500
sd=asul_41,lun=/dev/mapper/360002ac0000000000000000320001859d,size=6442447500
sd=asul_42,lun=/dev/mapper/360002ac0000000000000000330001859d,size=6442447500
sd=asul_43,lun=/dev/mapper/360002ac0000000000000000340001859d,size=6442447500
sd=asul_44,lun=/dev/mapper/360002ac0000000000000000350001859d,size=6442447500
sd=asul_45,lun=/dev/mapper/360002ac0000000000000000360001859d,size=6442447500
sd=asul_46,lun=/dev/mapper/360002ac0000000000000000370001859d,size=6442447500
sd=asul_47,lun=/dev/mapper/360002ac0000000000000000380001859d,size=6442447500
sd=asul_48,lun=/dev/mapper/360002ac0000000000000000390001859d,size=6442447500
```

sd=asu1\_49, lun=/dev/mapper/360002ac00000000000000003a0001859d, size=6442447500  
sd=asu1\_50, lun=/dev/mapper/360002ac00000000000000003b0001859d, size=6442447500  
sd=asu1\_51, lun=/dev/mapper/360002ac00000000000000003c0001859d, size=6442447500  
sd=asu1\_52, lun=/dev/mapper/360002ac00000000000000003d0001859d, size=6442447500  
sd=asu1\_53, lun=/dev/mapper/360002ac00000000000000003e0001859d, size=6442447500  
sd=asu1\_54, lun=/dev/mapper/360002ac00000000000000003f0001859d, size=6442447500  
sd=asu1\_55, lun=/dev/mapper/360002ac0000000000000000400001859d, size=6442447500  
sd=asu1\_56, lun=/dev/mapper/360002ac0000000000000000410001859d, size=6442447500  
sd=asu1\_57, lun=/dev/mapper/360002ac0000000000000000430001859d, size=6442447500  
sd=asu1\_58, lun=/dev/mapper/360002ac0000000000000000420001859d, size=6442447500  
sd=asu1\_59, lun=/dev/mapper/360002ac0000000000000000450001859d, size=6442447500  
sd=asu1\_60, lun=/dev/mapper/360002ac0000000000000000440001859d, size=6442447500  
sd=asu1\_61, lun=/dev/mapper/360002ac0000000000000000460001859d, size=6442447500  
sd=asu1\_62, lun=/dev/mapper/360002ac0000000000000000470001859d, size=6442447500  
sd=asu1\_63, lun=/dev/mapper/360002ac0000000000000000480001859d, size=6442447500  
sd=asu1\_64, lun=/dev/mapper/360002ac0000000000000000490001859d, size=6442447500  
sd=asu1\_65, lun=/dev/mapper/360002ac00000000000000004a0001859d, size=6442447500  
sd=asu1\_66, lun=/dev/mapper/360002ac00000000000000004b0001859d, size=6442447500  
sd=asu1\_67, lun=/dev/mapper/360002ac00000000000000004c0001859d, size=6442447500  
sd=asu1\_68, lun=/dev/mapper/360002ac00000000000000004d0001859d, size=6442447500  
sd=asu1\_69, lun=/dev/mapper/360002ac00000000000000004e0001859d, size=6442447500  
sd=asu1\_70, lun=/dev/mapper/360002ac00000000000000004f0001859d, size=6442447500  
sd=asu1\_71, lun=/dev/mapper/360002ac0000000000000000500001859d, size=6442447500  
sd=asu1\_72, lun=/dev/mapper/360002ac0000000000000000510001859d, size=6442447500  
sd=asu1\_73, lun=/dev/mapper/360002ac0000000000000000520001859d, size=6442447500  
sd=asu1\_74, lun=/dev/mapper/360002ac0000000000000000530001859d, size=6442447500  
sd=asu1\_75, lun=/dev/mapper/360002ac0000000000000000540001859d, size=6442447500  
sd=asu1\_76, lun=/dev/mapper/360002ac0000000000000000550001859d, size=6442447500  
sd=asu1\_77, lun=/dev/mapper/360002ac0000000000000000560001859d, size=6442447500  
sd=asu1\_78, lun=/dev/mapper/360002ac0000000000000000570001859d, size=6442447500  
sd=asu1\_79, lun=/dev/mapper/360002ac0000000000000000580001859d, size=6442447500  
sd=asu1\_80, lun=/dev/mapper/360002ac0000000000000000590001859d, size=6442447500  
sd=asu2\_1, lun=/dev/mapper/360002ac0000000000000000650001859d, size=25769790000  
sd=asu2\_2, lun=/dev/mapper/360002ac0000000000000000660001859d, size=25769790000  
sd=asu2\_3, lun=/dev/mapper/360002ac0000000000000000670001859d, size=25769790000  
sd=asu2\_4, lun=/dev/mapper/360002ac0000000000000000680001859d, size=25769790000  
sd=asu2\_5, lun=/dev/mapper/360002ac0000000000000000690001859d, size=25769790000  
sd=asu2\_6, lun=/dev/mapper/360002ac00000000000000006a0001859d, size=25769790000  
sd=asu2\_7, lun=/dev/mapper/360002ac00000000000000006b0001859d, size=25769790000  
sd=asu2\_8, lun=/dev/mapper/360002ac00000000000000006c0001859d, size=25769790000  
sd=asu2\_9, lun=/dev/mapper/360002ac00000000000000006d0001859d, size=25769790000  
sd=asu2\_10, lun=/dev/mapper/360002ac0000000000000000700001859d, size=25769790000  
sd=asu2\_11, lun=/dev/mapper/360002ac00000000000000006f0001859d, size=25769790000  
sd=asu2\_12, lun=/dev/mapper/360002ac00000000000000006e0001859d, size=25769790000  
sd=asu2\_13, lun=/dev/mapper/360002ac0000000000000000710001859d, size=25769790000  
sd=asu2\_14, lun=/dev/mapper/360002ac0000000000000000720001859d, size=25769790000  
sd=asu2\_15, lun=/dev/mapper/360002ac0000000000000000730001859d, size=25769790000  
sd=asu2\_16, lun=/dev/mapper/360002ac0000000000000000740001859d, size=25769790000  
sd=asu2\_17, lun=/dev/mapper/360002ac0000000000000000750001859d, size=25769790000  
sd=asu2\_18, lun=/dev/mapper/360002ac0000000000000000760001859d, size=25769790000  
sd=asu2\_19, lun=/dev/mapper/360002ac0000000000000000770001859d, size=25769790000  
sd=asu2\_20, lun=/dev/mapper/360002ac0000000000000000780001859d, size=25769790000  
sd=asu3\_1, lun=/dev/mapper/360002ac0000000000000000790001859d, size=5726620000  
sd=asu3\_2, lun=/dev/mapper/360002ac00000000000000007a0001859d, size=5726620000  
sd=asu3\_3, lun=/dev/mapper/360002ac00000000000000007b0001859d, size=5726620000  
sd=asu3\_4, lun=/dev/mapper/360002ac00000000000000007c0001859d, size=5726620000  
sd=asu3\_5, lun=/dev/mapper/360002ac00000000000000007d0001859d, size=5726620000  
sd=asu3\_6, lun=/dev/mapper/360002ac00000000000000007e0001859d, size=5726620000  
sd=asu3\_7, lun=/dev/mapper/360002ac00000000000000007f0001859d, size=5726620000  
sd=asu3\_8, lun=/dev/mapper/360002ac0000000000000000800001859d, size=5726620000  
sd=asu3\_9, lun=/dev/mapper/360002ac0000000000000000810001859d, size=5726620000  
sd=asu3\_10, lun=/dev/mapper/360002ac0000000000000000820001859d, size=5726620000

```
sd=asu3_11,lun=/dev/mapper/360002ac000000000000000830001859d,size=5726620000
sd=asu3_12,lun=/dev/mapper/360002ac000000000000000840001859d,size=5726620000
sd=asu3_13,lun=/dev/mapper/360002ac000000000000000850001859d,size=5726620000
sd=asu3_14,lun=/dev/mapper/360002ac000000000000000860001859d,size=5726620000
sd=asu3_15,lun=/dev/mapper/360002ac000000000000000870001859d,size=5726620000
sd=asu3_16,lun=/dev/mapper/360002ac000000000000000880001859d,size=5726620000
sd=asu3_17,lun=/dev/mapper/360002ac000000000000000890001859d,size=5726620000
sd=asu3_18,lun=/dev/mapper/360002ac0000000000000008a0001859d,size=5726620000
sd=asu3_19,lun=/dev/mapper/360002ac0000000000000008b0001859d,size=5726620000
sd=asu3_20,lun=/dev/mapper/360002ac0000000000000008c0001859d,size=5726620000
```

## Primary Metrics Test, and Repeatability Tests

The content of SPC-1 Workload Generator command and parameter file, used in this benchmark to execute the Primary Metrics and Repeatability Tests, is listed below.

```
javaparms="-Xms1024m -Xmx1024m -Xss128k"
host=master
```

```
slaves=(slave211a,slave211b,slave211c,slave211d,slave211e,slave211f,slave211g,slave211h,slave211i,slave211j,slave211k,slave211l,slave211m,slave211n,slave212a,slave212b,slave212c,slave212d,slave212e,slave212f,slave212g,slave212h,slave212i,slave212j,slave212k,slave212l,slave212m,slave212n,slave213a,slave213b,slave213c,slave213d,slave213e,slave213f,slave213g,slave213h,slave213i,slave213j,slave213k,slave213l,slave213m,slave213n,slave214a,slave214b,slave214c,slave214d,slave214e,slave214f,slave214g,slave214h,slave214i,slave214j,slave214k,slave214l,slave214m,slave214n)
```

[SPC-1 common command lines](#)

## SPC-1 Persistence Test Run 1

The content of SPC-1 Workload Generator command and parameter file, used in this benchmark to execute a reduced level SPC-1 Persistence Test Run 1, is listed below.

```
javaparms="-Xms2048m -Xmx2048m -Xss512k"
```

[SPC-1 common command lines](#)



## SPC-2 Persistence Test

The content of SPC-2 Workload Generator command and parameter files, used in this benchmark to execute the SPC-2 Persistence Test, are listed below.

### SPC-2 Common Commands Lines

The following command lines appear at the beginning of each SPC-2 Workload Generator command and parameter file. The command lines are only listed below to eliminate redundancy.

\* Persistence Test Command Entries

\* Master Host Definition Parameter

```
host=localhost,  
  spc2="/home/spc/spc2",  
  jvms=1,  
  maxstreams=400
```

```
*****  
* Storage Definition Parameters *  
*****
```

```
sd=sd1,lun=/dev/mapper/360002ac000000000000000a0001859d,size=6442447500  
sd=sd2,lun=/dev/mapper/360002ac000000000000000b0001859d,size=6442447500  
sd=sd3,lun=/dev/mapper/360002ac000000000000000c0001859d,size=6442447500  
sd=sd4,lun=/dev/mapper/360002ac000000000000000d0001859d,size=6442447500  
sd=sd5,lun=/dev/mapper/360002ac000000000000000e0001859d,size=6442447500  
sd=sd6,lun=/dev/mapper/360002ac000000000000000f0001859d,size=6442447500  
sd=sd7,lun=/dev/mapper/360002ac00000000000000100001859d,size=6442447500  
sd=sd8,lun=/dev/mapper/360002ac00000000000000110001859d,size=6442447500  
sd=sd9,lun=/dev/mapper/360002ac00000000000000120001859d,size=6442447500  
sd=sd10,lun=/dev/mapper/360002ac00000000000000130001859d,size=6442447500  
sd=sd11,lun=/dev/mapper/360002ac00000000000000140001859d,size=6442447500  
sd=sd12,lun=/dev/mapper/360002ac00000000000000150001859d,size=6442447500  
sd=sd13,lun=/dev/mapper/360002ac00000000000000160001859d,size=6442447500  
sd=sd14,lun=/dev/mapper/360002ac00000000000000170001859d,size=6442447500  
sd=sd15,lun=/dev/mapper/360002ac00000000000000180001859d,size=6442447500  
sd=sd16,lun=/dev/mapper/360002ac00000000000000190001859d,size=6442447500  
sd=sd17,lun=/dev/mapper/360002ac000000000000001a0001859d,size=6442447500  
sd=sd18,lun=/dev/mapper/360002ac000000000000001b0001859d,size=6442447500  
sd=sd19,lun=/dev/mapper/360002ac000000000000001c0001859d,size=6442447500  
sd=sd20,lun=/dev/mapper/360002ac000000000000001d0001859d,size=6442447500  
sd=sd21,lun=/dev/mapper/360002ac000000000000001e0001859d,size=6442447500  
sd=sd22,lun=/dev/mapper/360002ac000000000000001f0001859d,size=6442447500  
sd=sd23,lun=/dev/mapper/360002ac00000000000000200001859d,size=6442447500  
sd=sd24,lun=/dev/mapper/360002ac00000000000000210001859d,size=6442447500  
sd=sd25,lun=/dev/mapper/360002ac00000000000000220001859d,size=6442447500  
sd=sd26,lun=/dev/mapper/360002ac00000000000000230001859d,size=6442447500  
sd=sd27,lun=/dev/mapper/360002ac00000000000000240001859d,size=6442447500  
sd=sd28,lun=/dev/mapper/360002ac00000000000000250001859d,size=6442447500  
sd=sd29,lun=/dev/mapper/360002ac00000000000000260001859d,size=6442447500  
sd=sd30,lun=/dev/mapper/360002ac00000000000000270001859d,size=6442447500  
sd=sd31,lun=/dev/mapper/360002ac00000000000000280001859d,size=6442447500
```

sd=sd32, lun=/dev/mapper/360002ac00000000000000290001859d, size=6442447500  
sd=sd33, lun=/dev/mapper/360002ac000000000000002a0001859d, size=6442447500  
sd=sd34, lun=/dev/mapper/360002ac000000000000002b0001859d, size=6442447500  
sd=sd35, lun=/dev/mapper/360002ac000000000000002c0001859d, size=6442447500  
sd=sd36, lun=/dev/mapper/360002ac000000000000002d0001859d, size=6442447500  
sd=sd37, lun=/dev/mapper/360002ac000000000000002e0001859d, size=6442447500  
sd=sd38, lun=/dev/mapper/360002ac000000000000002f0001859d, size=6442447500  
sd=sd39, lun=/dev/mapper/360002ac00000000000000300001859d, size=6442447500  
sd=sd40, lun=/dev/mapper/360002ac00000000000000310001859d, size=6442447500  
sd=sd41, lun=/dev/mapper/360002ac00000000000000320001859d, size=6442447500  
sd=sd42, lun=/dev/mapper/360002ac00000000000000330001859d, size=6442447500  
sd=sd43, lun=/dev/mapper/360002ac00000000000000340001859d, size=6442447500  
sd=sd44, lun=/dev/mapper/360002ac00000000000000350001859d, size=6442447500  
sd=sd45, lun=/dev/mapper/360002ac00000000000000360001859d, size=6442447500  
sd=sd46, lun=/dev/mapper/360002ac00000000000000370001859d, size=6442447500  
sd=sd47, lun=/dev/mapper/360002ac00000000000000380001859d, size=6442447500  
sd=sd48, lun=/dev/mapper/360002ac00000000000000390001859d, size=6442447500  
sd=sd49, lun=/dev/mapper/360002ac000000000000003a0001859d, size=6442447500  
sd=sd50, lun=/dev/mapper/360002ac000000000000003b0001859d, size=6442447500  
sd=sd51, lun=/dev/mapper/360002ac000000000000003c0001859d, size=6442447500  
sd=sd52, lun=/dev/mapper/360002ac000000000000003d0001859d, size=6442447500  
sd=sd53, lun=/dev/mapper/360002ac000000000000003e0001859d, size=6442447500  
sd=sd54, lun=/dev/mapper/360002ac000000000000003f0001859d, size=6442447500  
sd=sd55, lun=/dev/mapper/360002ac00000000000000400001859d, size=6442447500  
sd=sd56, lun=/dev/mapper/360002ac00000000000000410001859d, size=6442447500  
sd=sd57, lun=/dev/mapper/360002ac00000000000000430001859d, size=6442447500  
sd=sd58, lun=/dev/mapper/360002ac00000000000000420001859d, size=6442447500  
sd=sd59, lun=/dev/mapper/360002ac00000000000000450001859d, size=6442447500  
sd=sd60, lun=/dev/mapper/360002ac00000000000000440001859d, size=6442447500  
sd=sd61, lun=/dev/mapper/360002ac00000000000000460001859d, size=6442447500  
sd=sd62, lun=/dev/mapper/360002ac00000000000000470001859d, size=6442447500  
sd=sd63, lun=/dev/mapper/360002ac00000000000000480001859d, size=6442447500  
sd=sd64, lun=/dev/mapper/360002ac00000000000000490001859d, size=6442447500  
sd=sd65, lun=/dev/mapper/360002ac000000000000004a0001859d, size=6442447500  
sd=sd66, lun=/dev/mapper/360002ac000000000000004b0001859d, size=6442447500  
sd=sd67, lun=/dev/mapper/360002ac000000000000004c0001859d, size=6442447500  
sd=sd68, lun=/dev/mapper/360002ac000000000000004d0001859d, size=6442447500  
sd=sd69, lun=/dev/mapper/360002ac000000000000004e0001859d, size=6442447500  
sd=sd70, lun=/dev/mapper/360002ac000000000000004f0001859d, size=6442447500  
sd=sd71, lun=/dev/mapper/360002ac00000000000000500001859d, size=6442447500  
sd=sd72, lun=/dev/mapper/360002ac00000000000000510001859d, size=6442447500  
sd=sd73, lun=/dev/mapper/360002ac00000000000000520001859d, size=6442447500  
sd=sd74, lun=/dev/mapper/360002ac00000000000000530001859d, size=6442447500  
sd=sd75, lun=/dev/mapper/360002ac00000000000000540001859d, size=6442447500  
sd=sd76, lun=/dev/mapper/360002ac00000000000000550001859d, size=6442447500  
sd=sd77, lun=/dev/mapper/360002ac00000000000000560001859d, size=6442447500  
sd=sd78, lun=/dev/mapper/360002ac00000000000000570001859d, size=6442447500  
sd=sd79, lun=/dev/mapper/360002ac00000000000000580001859d, size=6442447500  
sd=sd80, lun=/dev/mapper/360002ac00000000000000590001859d, size=6442447500  
sd=sd81, lun=/dev/mapper/360002ac00000000000000650001859d, size=25769790000  
sd=sd82, lun=/dev/mapper/360002ac00000000000000660001859d, size=25769790000  
sd=sd83, lun=/dev/mapper/360002ac00000000000000670001859d, size=25769790000  
sd=sd84, lun=/dev/mapper/360002ac00000000000000680001859d, size=25769790000  
sd=sd85, lun=/dev/mapper/360002ac00000000000000690001859d, size=25769790000  
sd=sd86, lun=/dev/mapper/360002ac000000000000006a0001859d, size=25769790000  
sd=sd87, lun=/dev/mapper/360002ac000000000000006b0001859d, size=25769790000  
sd=sd88, lun=/dev/mapper/360002ac000000000000006c0001859d, size=25769790000  
sd=sd89, lun=/dev/mapper/360002ac000000000000006d0001859d, size=25769790000  
sd=sd90, lun=/dev/mapper/360002ac00000000000000700001859d, size=25769790000  
sd=sd91, lun=/dev/mapper/360002ac000000000000006f0001859d, size=25769790000  
sd=sd92, lun=/dev/mapper/360002ac000000000000006e0001859d, size=25769790000  
sd=sd93, lun=/dev/mapper/360002ac00000000000000710001859d, size=25769790000

```
sd=sd94,lun=/dev/mapper/360002ac000000000000000720001859d,size=25769790000
sd=sd95,lun=/dev/mapper/360002ac000000000000000730001859d,size=25769790000
sd=sd96,lun=/dev/mapper/360002ac000000000000000740001859d,size=25769790000
sd=sd97,lun=/dev/mapper/360002ac000000000000000750001859d,size=25769790000
sd=sd98,lun=/dev/mapper/360002ac000000000000000760001859d,size=25769790000
sd=sd99,lun=/dev/mapper/360002ac000000000000000770001859d,size=25769790000
sd=sd100,lun=/dev/mapper/360002ac000000000000000780001859d,size=25769790000
sd=sd101,lun=/dev/mapper/360002ac000000000000000790001859d,size=5726620000
sd=sd102,lun=/dev/mapper/360002ac0000000000000007a0001859d,size=5726620000
sd=sd103,lun=/dev/mapper/360002ac0000000000000007b0001859d,size=5726620000
sd=sd104,lun=/dev/mapper/360002ac0000000000000007c0001859d,size=5726620000
sd=sd105,lun=/dev/mapper/360002ac0000000000000007d0001859d,size=5726620000
sd=sd106,lun=/dev/mapper/360002ac0000000000000007e0001859d,size=5726620000
sd=sd107,lun=/dev/mapper/360002ac0000000000000007f0001859d,size=5726620000
sd=sd108,lun=/dev/mapper/360002ac000000000000000800001859d,size=5726620000
sd=sd109,lun=/dev/mapper/360002ac000000000000000810001859d,size=5726620000
sd=sd110,lun=/dev/mapper/360002ac000000000000000820001859d,size=5726620000
sd=sd111,lun=/dev/mapper/360002ac000000000000000830001859d,size=5726620000
sd=sd112,lun=/dev/mapper/360002ac000000000000000840001859d,size=5726620000
sd=sd113,lun=/dev/mapper/360002ac000000000000000850001859d,size=5726620000
sd=sd114,lun=/dev/mapper/360002ac000000000000000860001859d,size=5726620000
sd=sd115,lun=/dev/mapper/360002ac000000000000000870001859d,size=5726620000
sd=sd116,lun=/dev/mapper/360002ac000000000000000880001859d,size=5726620000
sd=sd117,lun=/dev/mapper/360002ac000000000000000890001859d,size=5726620000
sd=sd118,lun=/dev/mapper/360002ac0000000000000008a0001859d,size=5726620000
sd=sd119,lun=/dev/mapper/360002ac0000000000000008b0001859d,size=5726620000
sd=sd120,lun=/dev/mapper/360002ac0000000000000008c0001859d,size=5726620000
```

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

### [SPC-2 common commands](#)

\* PERSISTENCE WRITE TEST

```
maxlatestart=1
reportinginterval=5
segmentlength=512m
rd=default,rampup=360,periods=90,measurement=300,runout=0,rampdown=0,buffers=1

rd=default,rdpct=0,xfersize=1024k
rd=TR1_SPC-2-PERSIST-w,streams=173
```

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

### [SPC-2 common commands](#)

\* PERSISTENCE READ TEST

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

maxpersistenceerrors=10

rd=default,buffers=1,rdpct=100,xfersize=1024k
rd=TR1_SPC-2-PERSIST-R
```

## Slave JVMs

Each Slave JVM was invoked with a command and parameter file similar to the example listed below. The only difference in each file was “host” parameter value, which was unique to each Slave JVM, e.g. **slave211a...slave211n,slave212a...slave213a...slave214a...**

```
javaparms="-Xms1024m -Xmx1024m -Xss128k"  
master=dl360g7-220  
host=slave211a  
  
sd=asul_1,lun=/dev/mapper/360002ac0000000000000000a0001859d,size=6442447500  
sd=asul_2,lun=/dev/mapper/360002ac0000000000000000b0001859d,size=6442447500  
sd=asul_3,lun=/dev/mapper/360002ac0000000000000000c0001859d,size=6442447500  
sd=asul_4,lun=/dev/mapper/360002ac0000000000000000d0001859d,size=6442447500  
sd=asul_5,lun=/dev/mapper/360002ac0000000000000000e0001859d,size=6442447500  
sd=asul_6,lun=/dev/mapper/360002ac0000000000000000f0001859d,size=6442447500  
sd=asul_7,lun=/dev/mapper/360002ac000000000000000010001859d,size=6442447500  
sd=asul_8,lun=/dev/mapper/360002ac0000000000000000110001859d,size=6442447500  
sd=asul_9,lun=/dev/mapper/360002ac0000000000000000120001859d,size=6442447500  
sd=asul_10,lun=/dev/mapper/360002ac0000000000000000130001859d,size=6442447500  
sd=asul_11,lun=/dev/mapper/360002ac0000000000000000140001859d,size=6442447500  
sd=asul_12,lun=/dev/mapper/360002ac0000000000000000150001859d,size=6442447500  
sd=asul_13,lun=/dev/mapper/360002ac0000000000000000160001859d,size=6442447500  
sd=asul_14,lun=/dev/mapper/360002ac0000000000000000170001859d,size=6442447500  
sd=asul_15,lun=/dev/mapper/360002ac0000000000000000180001859d,size=6442447500  
sd=asul_16,lun=/dev/mapper/360002ac0000000000000000190001859d,size=6442447500  
sd=asul_17,lun=/dev/mapper/360002ac00000000000000001a0001859d,size=6442447500  
sd=asul_18,lun=/dev/mapper/360002ac00000000000000001b0001859d,size=6442447500  
sd=asul_19,lun=/dev/mapper/360002ac00000000000000001c0001859d,size=6442447500  
sd=asul_20,lun=/dev/mapper/360002ac00000000000000001d0001859d,size=6442447500  
sd=asul_21,lun=/dev/mapper/360002ac00000000000000001e0001859d,size=6442447500  
sd=asul_22,lun=/dev/mapper/360002ac00000000000000001f0001859d,size=6442447500  
sd=asul_23,lun=/dev/mapper/360002ac0000000000000000200001859d,size=6442447500  
sd=asul_24,lun=/dev/mapper/360002ac0000000000000000210001859d,size=6442447500  
sd=asul_25,lun=/dev/mapper/360002ac0000000000000000220001859d,size=6442447500  
sd=asul_26,lun=/dev/mapper/360002ac0000000000000000230001859d,size=6442447500  
sd=asul_27,lun=/dev/mapper/360002ac0000000000000000240001859d,size=6442447500  
sd=asul_28,lun=/dev/mapper/360002ac0000000000000000250001859d,size=6442447500  
sd=asul_29,lun=/dev/mapper/360002ac0000000000000000260001859d,size=6442447500  
sd=asul_30,lun=/dev/mapper/360002ac0000000000000000270001859d,size=6442447500  
sd=asul_31,lun=/dev/mapper/360002ac0000000000000000280001859d,size=6442447500  
sd=asul_32,lun=/dev/mapper/360002ac0000000000000000290001859d,size=6442447500  
sd=asul_33,lun=/dev/mapper/360002ac00000000000000002a0001859d,size=6442447500  
sd=asul_34,lun=/dev/mapper/360002ac00000000000000002b0001859d,size=6442447500  
sd=asul_35,lun=/dev/mapper/360002ac00000000000000002c0001859d,size=6442447500  
sd=asul_36,lun=/dev/mapper/360002ac00000000000000002d0001859d,size=6442447500  
sd=asul_37,lun=/dev/mapper/360002ac00000000000000002e0001859d,size=6442447500  
sd=asul_38,lun=/dev/mapper/360002ac00000000000000002f0001859d,size=6442447500  
sd=asul_39,lun=/dev/mapper/360002ac0000000000000000300001859d,size=6442447500  
sd=asul_40,lun=/dev/mapper/360002ac0000000000000000310001859d,size=6442447500  
sd=asul_41,lun=/dev/mapper/360002ac0000000000000000320001859d,size=6442447500  
sd=asul_42,lun=/dev/mapper/360002ac0000000000000000330001859d,size=6442447500  
sd=asul_43,lun=/dev/mapper/360002ac0000000000000000340001859d,size=6442447500  
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sd=asul_45,lun=/dev/mapper/360002ac0000000000000000360001859d,size=6442447500  
sd=asul_46,lun=/dev/mapper/360002ac0000000000000000370001859d,size=6442447500  
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sd=asul_48,lun=/dev/mapper/360002ac0000000000000000390001859d,size=6442447500  
sd=asul_49,lun=/dev/mapper/360002ac00000000000000003a0001859d,size=6442447500  
sd=asul_50,lun=/dev/mapper/360002ac00000000000000003b0001859d,size=6442447500
```

## SPC-1 WORKLOAD GENERATOR STORAGE COMMANDS AND PARAMETERS

sd=asul\_51, lun=/dev/mapper/360002ac00000000000000003c0001859d, size=6442447500  
sd=asul\_52, lun=/dev/mapper/360002ac00000000000000003d0001859d, size=6442447500  
sd=asul\_53, lun=/dev/mapper/360002ac00000000000000003e0001859d, size=6442447500  
sd=asul\_54, lun=/dev/mapper/360002ac00000000000000003f0001859d, size=6442447500  
sd=asul\_55, lun=/dev/mapper/360002ac0000000000000000400001859d, size=6442447500  
sd=asul\_56, lun=/dev/mapper/360002ac0000000000000000410001859d, size=6442447500  
sd=asul\_57, lun=/dev/mapper/360002ac0000000000000000430001859d, size=6442447500  
sd=asul\_58, lun=/dev/mapper/360002ac0000000000000000420001859d, size=6442447500  
sd=asul\_59, lun=/dev/mapper/360002ac0000000000000000450001859d, size=6442447500  
sd=asul\_60, lun=/dev/mapper/360002ac0000000000000000440001859d, size=6442447500  
sd=asul\_61, lun=/dev/mapper/360002ac0000000000000000460001859d, size=6442447500  
sd=asul\_62, lun=/dev/mapper/360002ac0000000000000000470001859d, size=6442447500  
sd=asul\_63, lun=/dev/mapper/360002ac0000000000000000480001859d, size=6442447500  
sd=asul\_64, lun=/dev/mapper/360002ac0000000000000000490001859d, size=6442447500  
sd=asul\_65, lun=/dev/mapper/360002ac00000000000000004a0001859d, size=6442447500  
sd=asul\_66, lun=/dev/mapper/360002ac00000000000000004b0001859d, size=6442447500  
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sd=asul\_68, lun=/dev/mapper/360002ac00000000000000004d0001859d, size=6442447500  
sd=asul\_69, lun=/dev/mapper/360002ac00000000000000004e0001859d, size=6442447500  
sd=asul\_70, lun=/dev/mapper/360002ac00000000000000004f0001859d, size=6442447500  
sd=asul\_71, lun=/dev/mapper/360002ac0000000000000000500001859d, size=6442447500  
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sd=asul\_79, lun=/dev/mapper/360002ac0000000000000000580001859d, size=6442447500  
sd=asul\_80, lun=/dev/mapper/360002ac0000000000000000590001859d, size=6442447500  
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sd=asu2\_2, lun=/dev/mapper/360002ac0000000000000000660001859d, size=25769790000  
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sd=asu2\_7, lun=/dev/mapper/360002ac00000000000000006b0001859d, size=25769790000  
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sd=asu2\_15, lun=/dev/mapper/360002ac0000000000000000730001859d, size=25769790000  
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sd=asu3\_3, lun=/dev/mapper/360002ac00000000000000007b0001859d, size=5726620000  
sd=asu3\_4, lun=/dev/mapper/360002ac00000000000000007c0001859d, size=5726620000  
sd=asu3\_5, lun=/dev/mapper/360002ac00000000000000007d0001859d, size=5726620000  
sd=asu3\_6, lun=/dev/mapper/360002ac00000000000000007e0001859d, size=5726620000  
sd=asu3\_7, lun=/dev/mapper/360002ac00000000000000007f0001859d, size=5726620000  
sd=asu3\_8, lun=/dev/mapper/360002ac0000000000000000800001859d, size=5726620000  
sd=asu3\_9, lun=/dev/mapper/360002ac0000000000000000810001859d, size=5726620000  
sd=asu3\_10, lun=/dev/mapper/360002ac0000000000000000820001859d, size=5726620000  
sd=asu3\_11, lun=/dev/mapper/360002ac0000000000000000830001859d, size=5726620000  
sd=asu3\_12, lun=/dev/mapper/360002ac0000000000000000840001859d, size=5726620000

```
sd=asu3_13,lun=/dev/mapper/360002ac0000000000000000850001859d,size=5726620000
sd=asu3_14,lun=/dev/mapper/360002ac0000000000000000860001859d,size=5726620000
sd=asu3_15,lun=/dev/mapper/360002ac0000000000000000870001859d,size=5726620000
sd=asu3_16,lun=/dev/mapper/360002ac0000000000000000880001859d,size=5726620000
sd=asu3_17,lun=/dev/mapper/360002ac0000000000000000890001859d,size=5726620000
sd=asu3_18,lun=/dev/mapper/360002ac00000000000000008a0001859d,size=5726620000
sd=asu3_19,lun=/dev/mapper/360002ac00000000000000008b0001859d,size=5726620000
sd=asu3_20,lun=/dev/mapper/360002ac00000000000000008c0001859d,size=5726620000
```

## **APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS**

### **ASU Pre-Fill, Primary Metrics Test, Repeatability Test and Persistence Test Run 1**

The following script was used to execute the required ASU pre-fill, Primary Metrics Test (*Sustainability Test Phase, IOPS Test Phase, and Response Time Ramp Test Phase*), Repeatability Test (*Repeatability Test Phase 1 and Repeatability Test Phase 2*), a reduced level SPC-1 Persistence Test Run 1 and Persistence SPC-2 Persistence Test Run 1 in an uninterrupted sequence.

```
runid="spcresubmit7000"
bsu=5162
date
# do prefill - set for 12000 seconds but will end as soon as each VV is full
/home/vdbench/vdbench -f /home/vdbench/spc1_prefill
mv output output_prefill.$runid

# prepare for metrics and run it

cp /home/spc/spc1/metrics.spc1.cfg spc1.cfg

ssh dl360g7-211 "/home/spc/spc1/startmyslaves " > /dev/null &
ssh dl360g7-212 "/home/spc/spc1/startmyslaves " > /dev/null &
ssh dl360g7-213 "/home/spc/spc1/startmyslaves " > /dev/null &
ssh dl360g7-214 "/home/spc/spc1/startmyslaves " > /dev/null &

sleep 10

java -Xms1536m -Xmx1536m -Xss512k metrics -b $bsu -t 28800 -s 3600

java -Xms1536m -Xmx1536m -Xss512k repeat1 -b $bsu -s 3600

java -Xms1536m -Xmx1536m -Xss512k repeat2 -b $bsu -s 3600

sleep 10

# kill off slaves on other hosts - not needed for persistence

ssh dl360g7-211 "/home/spc/spc1/killmyslaves " &
ssh dl360g7-212 "/home/spc/spc1/killmyslaves " &
ssh dl360g7-213 "/home/spc/spc1/killmyslaves " &
ssh dl360g7-214 "/home/spc/spc1/killmyslaves " &

# save off all files thru metrics and repeatability

mv metrics metrics.$runid
mv repeatability1 repeatability1.$runid
mv repeatability2 repeatability2.$runid

# prepare for persistence 1 at half rate

cp persist1.spc1.cfg spc1.cfg
```

```
# set bsu to half value used above
bsu=2581
java -Xms2048m -Xmx2048m -Xss512k persist1 -b $bsu

# more saving
mv persistencel persistencel.$runid
mv SPCOut SPCOut.$runid

# prepare for spc2 persistence test - 1 stream per 30 bsus

# prepare for write persistence phase after init

cd /home/spc/spc2

LD_LIBRARY_PATH=/home/spc/spc2
CLASSPATH=/home/spc/spc2

java -Xmx1536m -Xms1536m vdbench -wSPC2 -f spc2persistw -o persinit.output -init

sleep 5

java -Xmx1536m -Xms1536m vdbench -wSPC2 -f spc2persistw -o perswrite.output
```

### startmyslaves

The configured Slave JVMs executed on four of the five Host Systems. The following script was used start the Slave JVMs on the first of those four Host Systems (*dl360g7-211*). A similar script was used to start the Slave JVMs on the remaining three Host Systems.

```
java spc1 -f /home/spc/spc1/spc1sl_a.cfg -o /home/spc/spc1/211_a.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_b.cfg -o /home/spc/spc1/211_b.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_c.cfg -o /home/spc/spc1/211_c.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_d.cfg -o /home/spc/spc1/211_d.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_e.cfg -o /home/spc/spc1/211_e.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_f.cfg -o /home/spc/spc1/211_f.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_g.cfg -o /home/spc/spc1/211_g.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_h.cfg -o /home/spc/spc1/211_h.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_i.cfg -o /home/spc/spc1/211_i.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_j.cfg -o /home/spc/spc1/211_j.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_k.cfg -o /home/spc/spc1/211_k.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_l.cfg -o /home/spc/spc1/211_l.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_m.cfg -o /home/spc/spc1/211_m.output &
sleep 2
java spc1 -f /home/spc/spc1/spc1sl_n.cfg -o /home/spc/spc1/211_n.output &
sleep 2
```



## **killmyslaves**

The following script was executed on each of the four Host Systems where Slave JVMs executed to terminate those Slave JVMs prior the SPC-1 Persistence Test Run 1.

```
pkill java
```

## **Persistence Test Run 2**

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

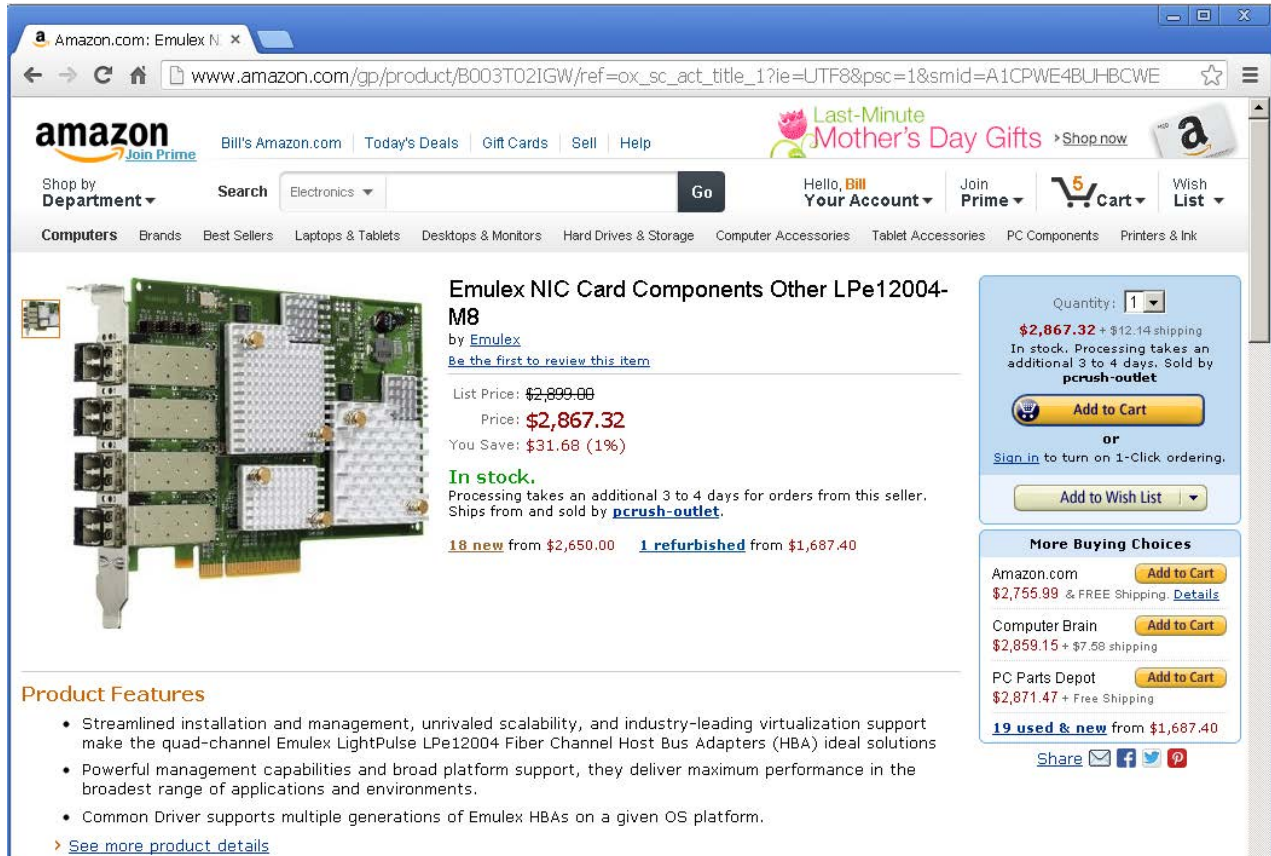
```
cd /home/spc/spc2

LD_LIBRARY_PATH=/home/spc/spc2
CLASSPATH=/home/spc/spc2

java -Xmx1536m -Xms1536m vdbench -wSPC2 -f spc2persistr -o persread.output
```

## APPENDIX F: THIRD-PARTY QUOTATIONS

### Emulex LPe12004-M8 HBAs



Amazon.com: Emulex N

www.amazon.com/gp/product/B003T021GW/ref=ox\_sc\_act\_title\_1?ie=UTF8&psc=1&smid=A1CPWE4BU-HCWE

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Computers Brands Best Sellers Laptops & Tablets Desktops & Monitors Hard Drives & Storage Computer Accessories Tablet Accessories PC Components Printers & Ink

**Emulex NIC Card Components Other LPe12004-M8**  
by Emulex  
[Be the first to review this item](#)

List Price: ~~\$2,899.00~~  
Price: **\$2,867.32**  
You Save: **\$31.68 (1%)**

**In stock.**  
Processing takes an additional 3 to 4 days for orders from this seller.  
Ships from and sold by **pcrush-outlet**.

**18 new** from \$2,650.00 **1 refurbished** from \$1,687.40

Quantity: 1

**\$2,867.32** + \$12.14 shipping  
In stock. Processing takes an additional 3 to 4 days. Sold by **pcrush-outlet**

**Add to Cart**

or  
[Sign in](#) to turn on 1-Click ordering.

**Add to Wish List**

**More Buying Choices**

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<b>\$2,755.99</b> & FREE Shipping. <a href="#">Details</a>	
Computer Brain	<b>Add to Cart</b>
<b>\$2,859.15</b> + \$7.88 shipping	
PC Parts Depot	<b>Add to Cart</b>
<b>\$2,871.47</b> + Free Shipping	
<b>19 used &amp; new</b> from <b>\$1,687.40</b>	

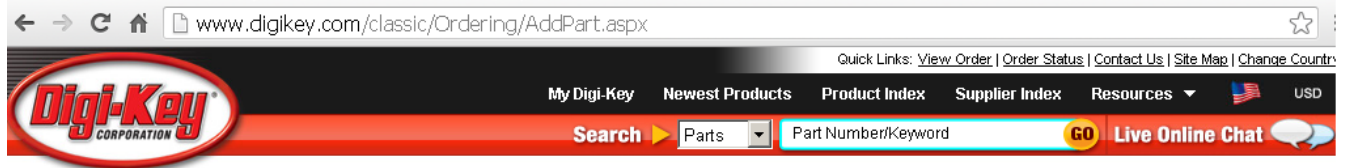
[Share](#) [Email](#) [Facebook](#) [Twitter](#) [Pinterest](#)

**Product Features**

- Streamlined installation and management, unrivaled scalability, and industry-leading virtualization support make the quad-channel Emulex LightPulse LPe12004 Fiber Channel Host Bus Adapters (HBA) ideal solutions
- Powerful management capabilities and broad platform support, they deliver maximum performance in the broadest range of applications and environments.
- Common Driver supports multiple generations of Emulex HBAs on a given OS platform.

[See more product details](#)

## 8 Gbps SFPs



[Web ID](#) 46739822 [Access ID](#) 63170 **Salesorder Number** Uncommitted [Login](#)

**Pricing is valid for this Web ID until 6/12/2013 if you place your order online**

If you need to find a part number, use the search box in the upper right of the page or click the icon here.

If you know exactly what you want, fill in the quantity, part number, and optional customer reference number below and select **Add to Order**.

**Quantities are not reserved until the order has been submitted.** You will be reminded of backorder quantities at submit time. Available quantities may have changed due to real time inventory. To check current availability, click the "Update Stock Status" button below.

Quantity	Part Number	Customer Reference	
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="button" value="Add to Order"/>

Click on the **Part Number** to **MODIFY** or **DELETE** an item from your order.

All prices are in US dollars.

Index	Quantity	Part Number	Description	Customer Reference	Available Quantity	Backorder Quantity	Unit Price	Extended Price
1	20	<a href="#">AFBR-37D7APZ</a>	TXRX OPT SFP 850NM 8GBE SR GEN 2		20 Immediate	0	67.50000	\$1,350.00
							<b>Subtotal</b>	<b>\$1,350.00</b>
							<b>Shipping</b>	<b>Estimate</b>
							<b>Sales Tax</b>	<b>unknown</b>
							<b>Total</b>	<b>unknown</b>

Approximate shipping charges based on Zip/Postal Code: **94538**

Description	8 oz.	1 lb.	5 lbs.	10 lbs.
UPS Ground (order by 3:00 PM CT)	\$7.63	\$7.63	\$10.22	\$12.54