SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

NEC CORPORATION
NEC STORAGE M510

SPC-1 V1.14

Submitted for Review: December 29, 2015
Submission Identifier: A00166

First Edition – December 2015

Trademarks

Table of Contents

AUDIT CERTIFICATION

Kentaro Yamamoto
NEC Corporation
1-10, Nisshin-Cho, Fuchu
Tokyo, 183-8501, Japan

December 28, 2015

The SPC Benchmark 1™ Reported Data listed below for the NEC Storage M510 was produced in compliance with the SPC Benchmark 1™ v1.14 Remote Audit requirements.

SPC Benchmark 1™ v1.14 Reported Data	
Tested Storage Product (TSP) Name: NEC Storage M510	
Metric	**Reported Result**
SPC-1 IOPS™	205,004.25
SPC-1 Price-Performance	$3.02/SPC-1 IOPS™
Total ASU Capacity	85,896.611 GB
Data Protection Level	Protected 2 *(Mirroring)*
Total Price (including three-year maintenance)	$618,321.45
Currency Used	U.S. Dollars
Target Country for availability, sales and support	USA

The following SPC Benchmark 1™ Remote 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 information supplied by NEC Corporation:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of 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.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).

Storage Performance Council
643 Bair Island Road, Suite 103
Redwood City, CA 94062
AuditService@storageperformance.org
650.556.9384

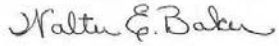
AUDIT CERTIFICATION *(CONT.)*

- 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 information supplied by NEC Corporation:
  - ✓ 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 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 NEC Corporation 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 (TSC) 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

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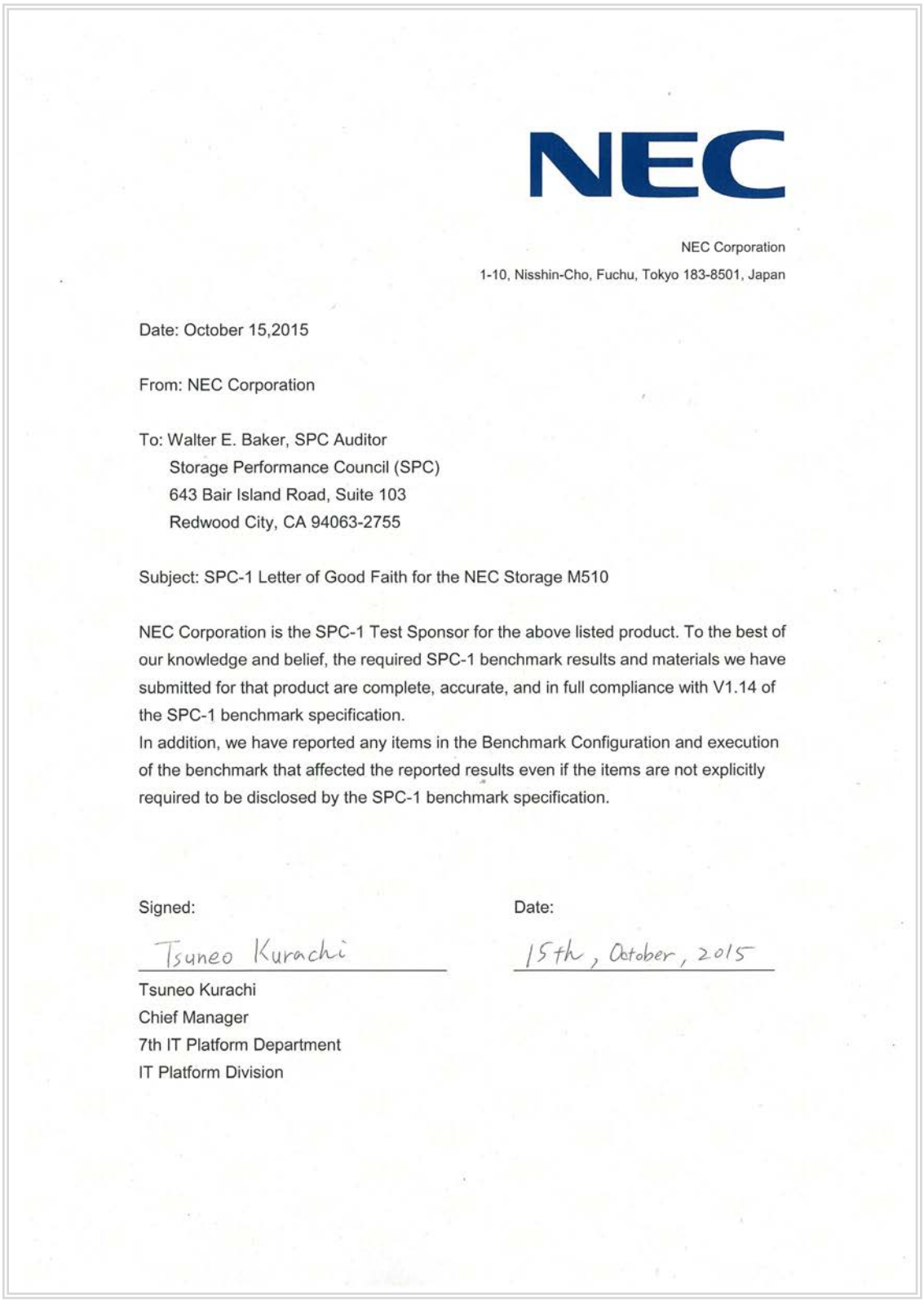
LETTER OF GOOD FAITH



NEC

NEC Corporation
1-10, Nisshin-Cho, Fuchu, Tokyo 183-8501, Japan

Date: October 15,2015

From: NEC Corporation

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

Subject: SPC-1 Letter of Good Faith for the NEC Storage M510

NEC Corporation 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 specification.

Signed: Tsuneo Kurachi

Date: 15th, October, 2015

Tsuneo Kurachi
Chief Manager
7th IT Platform Department
IT Platform Division

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	NEC Corporation – http://www.nec.com Kentaro Yamamoto – k-yamamoto@dh.jp.nec.com 1-10, Nisshin-Cho, Fuchu Tokyo, 183-8501, Japan Phone: +81 42 333 5150
Test Sponsor Alternate Contact	NEC Corporation – http://www.nec.com Yoshifumi Yamaguchi – y-yamaguchi@dc.jp.nec.com 1-10, Nisshin-Cho, Fuchu Tokyo, 183-8501, Japan Phone: +81 42 333 1710 FAX: +81 42 333 1777
Test Sponsor Alternate Contact	NEC Corporation of America – http://www.necam.com/ Chauncey Schwartz – chauncey.schwartz@necam.com 2880 Scott Blvd. Santa Clara, CA 95050 Phone: (952) 388-8466
Auditor	Storage Performance Council – http://www.storageperformance.org Walter E. Baker – AuditService@StoragePerformance.org 643 Bair Island Road, Suite 103 Redwood City, CA 94063 Phone: (650) 556-9384 FAX: (650) 556-9385

Revision Information and Key Dates

Revision Information and Key Dates	
SPC-1 Specification revision number	V1.14
SPC-1 Workload Generator revision number	V2.3.0
Date Results were first used publicly	December 29, 2015
Date the FDR was submitted to the SPC	December 29, 2015
Date the Priced Storage Configuration is available for shipment to customers	currently available
Date the TSC completed audit certification	December 28, 2015

Tested Storage Product (TSP) Description

The NEC M510 SAN disk array is intended to serve as extremely scalable, high performance primary or tiered storage in mission critical environments. Virtual environments benefit from the high levels of performance achieved through exceptional scalability, LUN locking, VMware APIs support, as well as 96GB of cache and SSD options.

The mid-range M510 disk array offers linear performance scaling from 3 to 768 drives doubling the total number of disk drives supported from the previous generation M510 storage array.

Easy to operate, reliable and efficient, the M510 storage solution simultaneously supports SSDs, NearLine SAS and traditional SAS HDD in the same enclosure, enabling flexible tiered storage architecture.

Summary of Results

SPC-1 Reported Data	
Tested Storage Product (TSP) Name: NEC Storage M510	
Metric	**Reported Result**
SPC-1 IOPS™	205,004.25
SPC-1 Price-Performance™	$3.02/SPC-1 IOPS™
Total ASU Capacity	85,896.611 GB
Data Protection Level	Protected 2 *(Mirroring)*
Total Price	$618,312.45
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.*

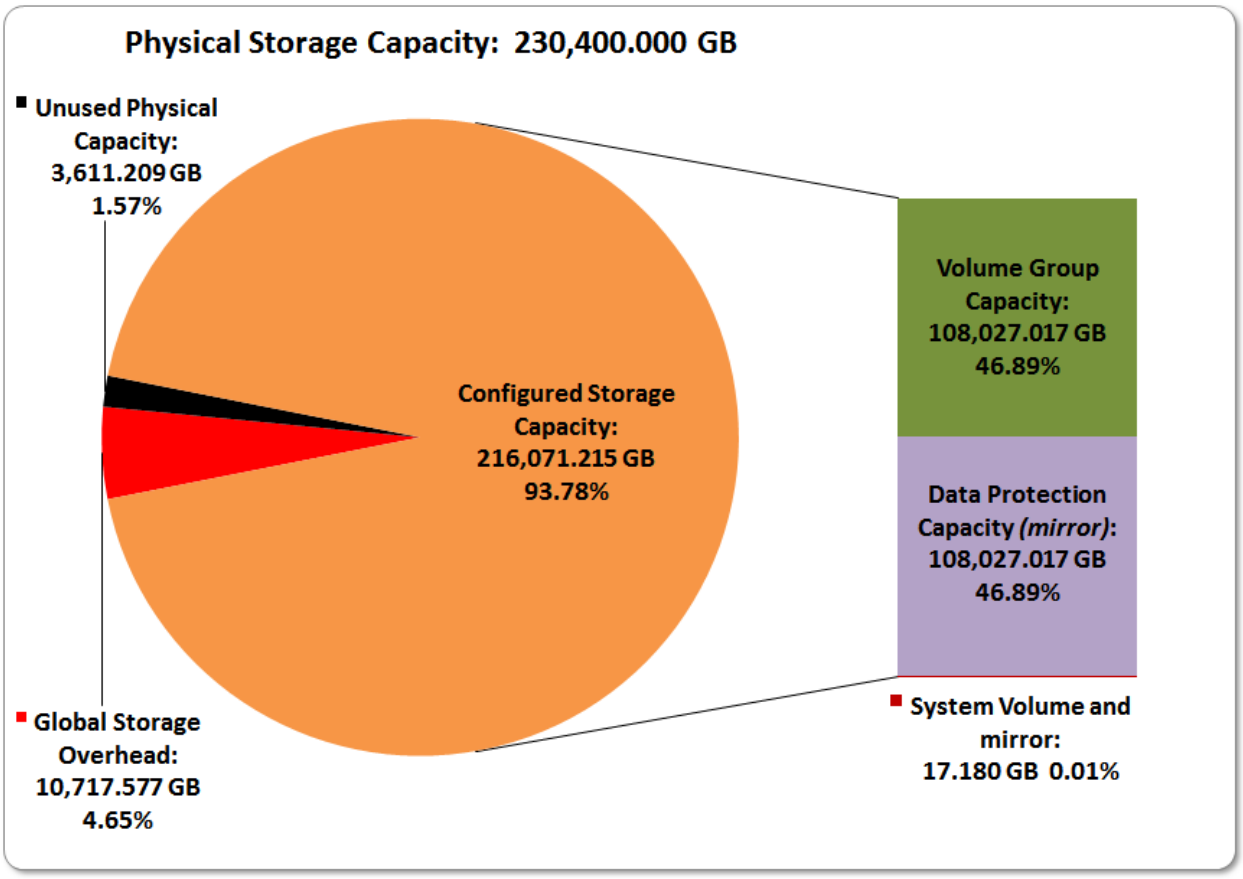
Total Price includes the cost of the Priced Storage Configuration plus three years of hardware maintenance and software support as detailed on page 17.

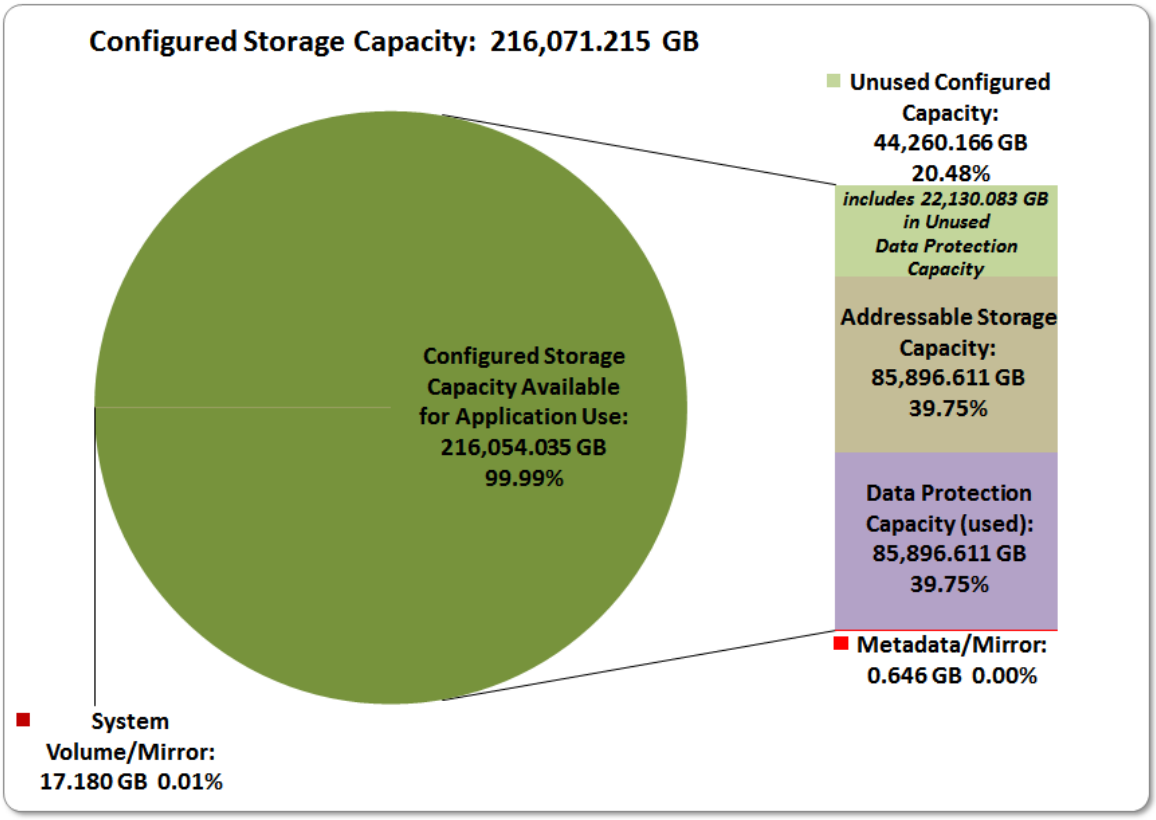
Currency Used is formal name for the currency used in calculating the **Total Price** and **SPC-1 Price-Performance™**. That currency may be the local currency of the **Target Country** or the currency of a difference country *(non-local currency)*.

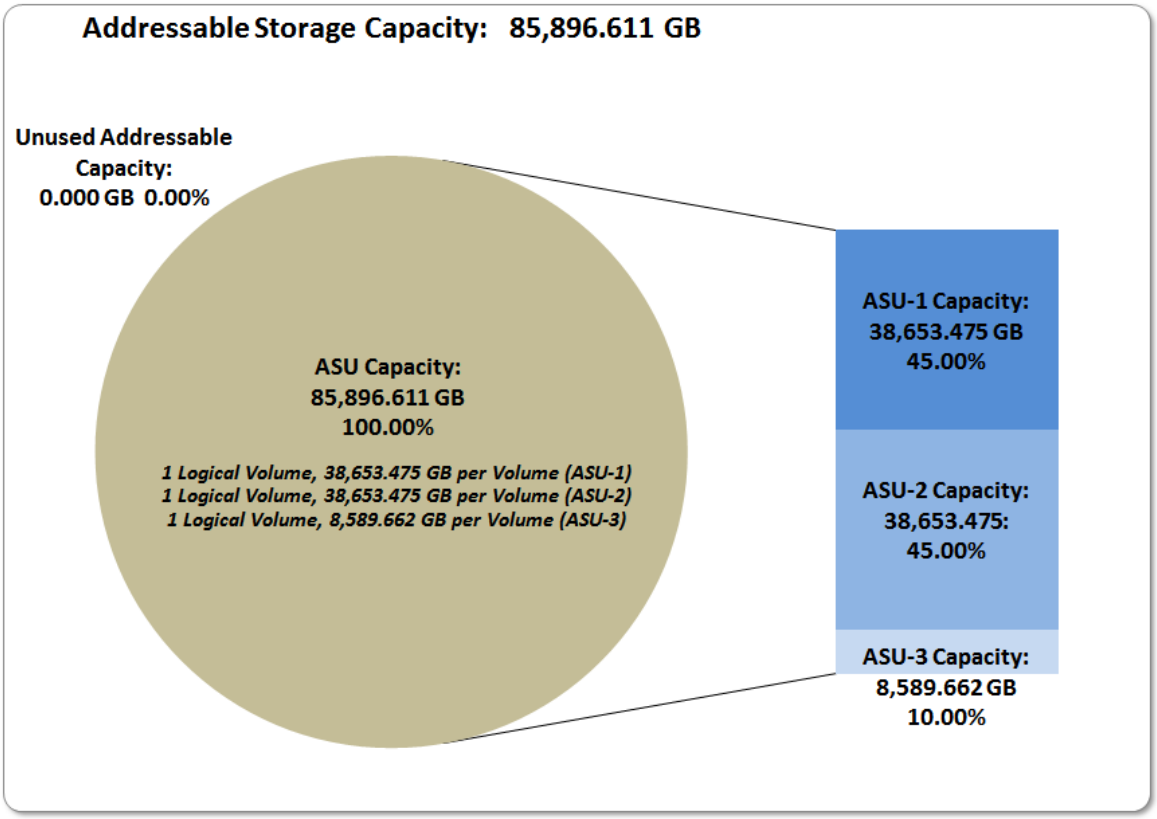
The **Target Country** is the country in which the Priced Storage Configuration is available for sale and in which the required hardware maintenance and software support is provided either directly from the Test Sponsor or indirectly via a third-party supplier.

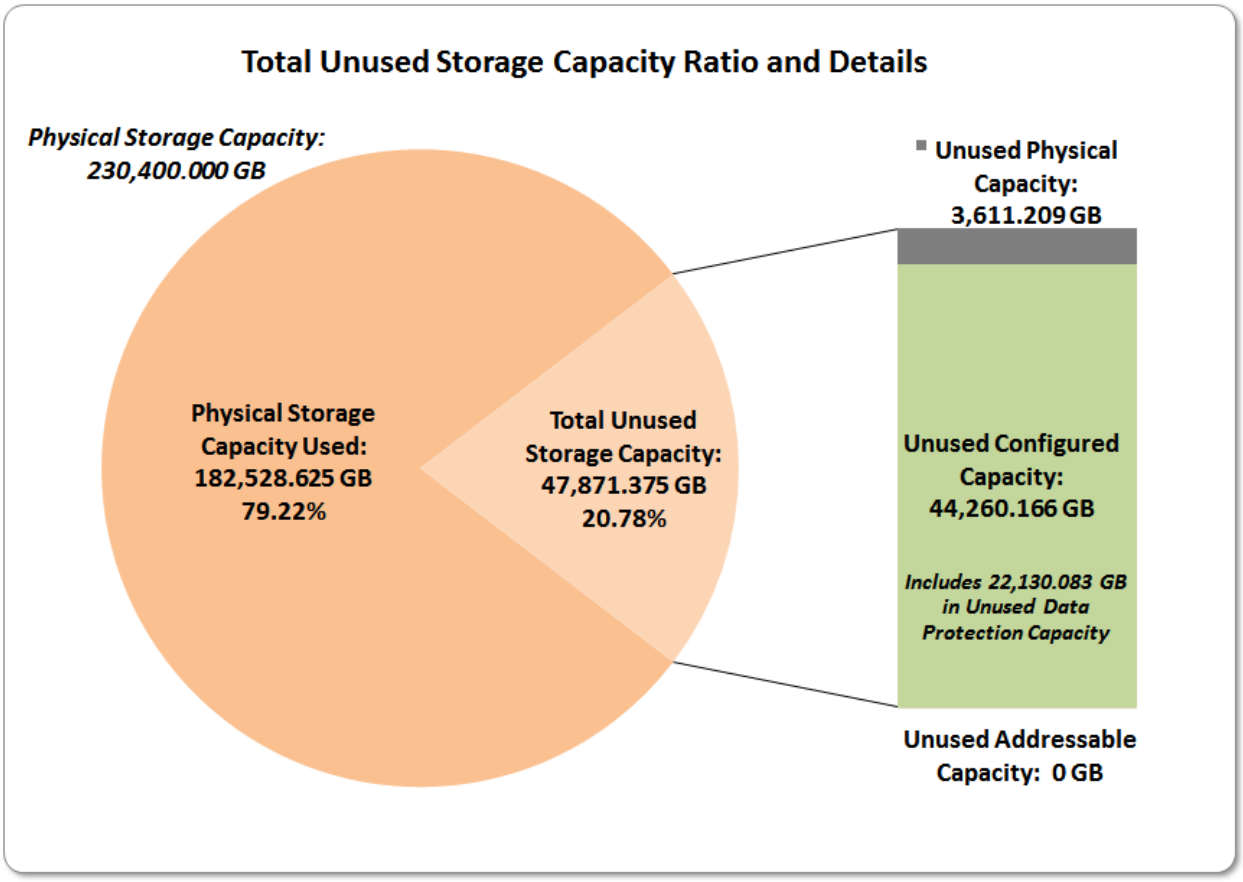
Storage Capacities, Relationships, and Utilization

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.




Configured Storage Capacity: 216,071.215 GB
Unused Configured Capacity: 44,260.166 GB 20.48%
includes 22,130.083 GB in Unused Data Protection Capacity
Addressable Storage Capacity: 85,896.611 GB 39.75%
Data Protection Capacity (used): 85,896.611 GB 39.75%
Metadata/Mirror: 0.646 GB 0.00%
Configured Storage Capacity Available for Application Use: 216,054.035 GB 99.99%
System Volume/Mirror: 17.180 GB 0.01%


Addressable Storage Capacity: 85,896.611 GB
Unused Addressable Capacity: 0.000 GB 0.00%
ASU Capacity: 85,896.611 GB 100.00%
1 Logical Volume, 38,653.475 GB per Volume (ASU-1)
1 Logical Volume, 38,653.475 GB per Volume (ASU-2)
1 Logical Volume, 8,589.662 GB per Volume (ASU-3)
ASU-1 Capacity: 38,653.475 GB 45.00%
ASU-2 Capacity: 38,653.475: 45.00%
ASU-3 Capacity: 8,589.662 GB 10.00%



SPC-1 Storage Capacity Utilization	
Application Utilization	37.28%
Protected Application Utilization	74.56%
Unused Storage Ratio	20.78%

Application Utilization: Total ASU Capacity *(85,896.611 GB)* divided by Physical Storage Capacity *(230,400.000 GB)*.

Protected Application Utilization: (Total ASU Capacity *(85,896.611 GB)* plus total Data Protection Capacity *(108,027.017 GB)* minus unused Data Protection Capacity *(22,130.083 GB)*) divided by Physical Storage Capacity *(230,400.000 GB)*.

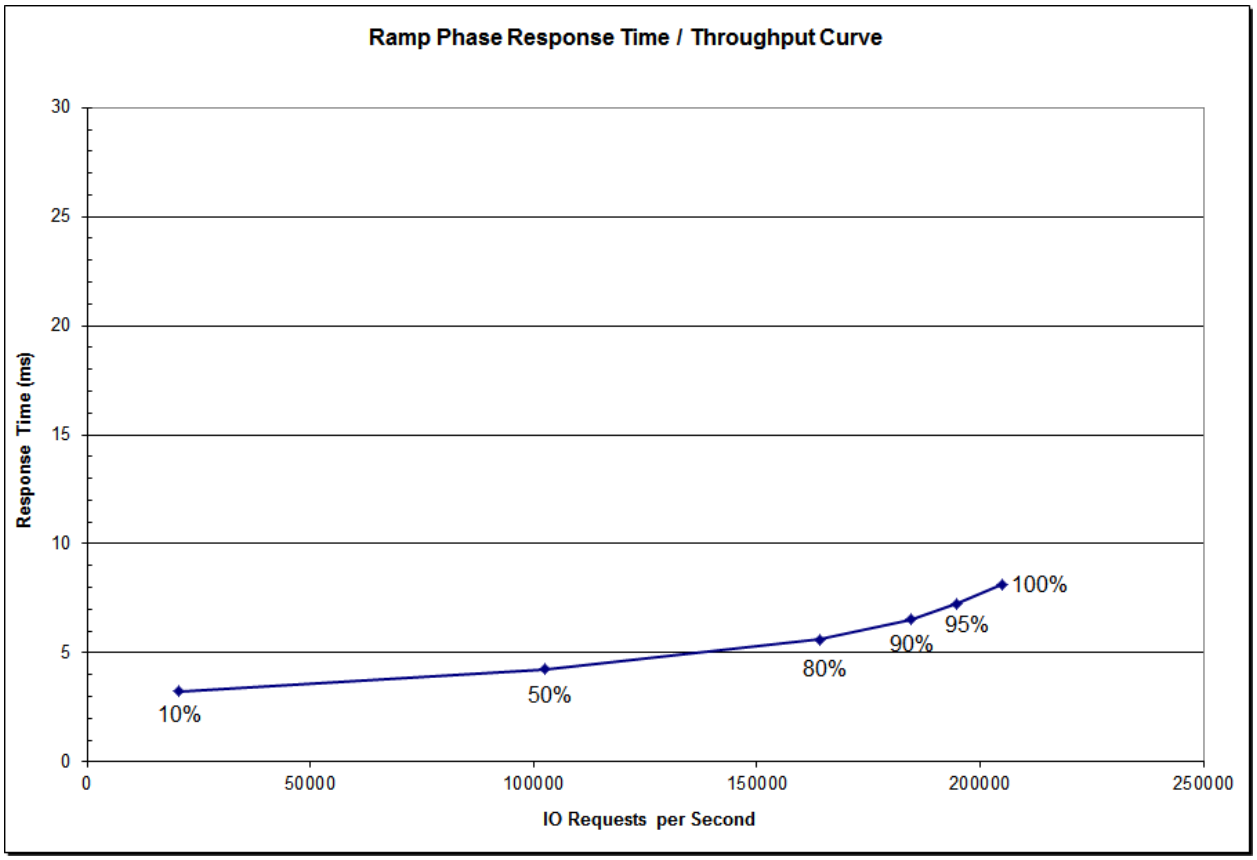
Unused Storage Ratio: Total Unused Capacity *(47,871.375 GB)* divided by Physical Storage Capacity *(230,400.000 GB)* and may not exceed 45%.

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

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
I/O Request Throughput	20,504.58	102,498.33	164,021.39	184,491.08	194,757.20	205,004.25
Average Response Time (ms):						
All ASUs	3.23	4.26	5.63	6.54	7.25	8.15
ASU-1	2.89	4.69	7.07	8.48	9.38	10.42
ASU-2	2.62	4.83	7.90	10.03	11.52	13.31
ASU-3	4.22	3.09	1.56	0.90	0.88	1.07
Reads	4.78	8.13	12.42	15.10	16.79	18.69
Writes	2.22	1.74	1.20	0.97	1.04	1.28

Priced Storage Configuration Pricing

SKU	Description	Quantity	Unit List Price	Extended List	Discount	Extended Discount
Hardware						
NF5322-SFP16E	2 - 16Gb FC SFPs	16	$367.00	$ 5,872.00	20%	$ 4,697.60
NF5352-SR00E	M510 Dual Controller Disk Array Unit w Base SW (w 2 - 4 port Disk Port Cards, w/o Host Port Card, SFP or Cache Memory)	1	$54,899.00	$ 54,899.00	20%	$ 43,919.20
Q24-HL000000072891	Localization Kit for M510/M710 Disk Array Unit	1	$ -	$ -	20%	$ -
NF5352-SF06WE	M510 2 - 4 port FC Host Port Cards (4 ports per controller) w/o SFP	4	$3,491.00	$ 13,964.00	20%	$ 11,171.20
NF5352-SD01WE	M510 2 - 4 port Disk Port Cards (4 ports per controller)	1	$2,961.00	$ 2,961.00	20%	$ 2,368.80
NF5352-SC12E	M510 Cache Memory Upgrade 24GB to 48GB per Controller (48GB to 96GB total cache)	1	$3,743.00	$ 3,743.00	20%	$ 2,994.40
NF5322-SMA75E	SAS Disk Drive (2.5" 15krpm/300GB)	768	$489.00	$375,552.00	20%	$ 300,441.60
NF5322-SE81E	Disk Enclosure 2.5 inch for Mx10	32	$5,427.00	$173,664.00	20%	$ 138,931.20
Q24-HL000000072706	Localization Kit for Mx10 Disk Enclosure	32	$ -	$ -	20%	$ -
NF9100-SF26E	Front Bezel (4U Black, w/ NEC Logo) for Mx10	1	$ 123.00	$ 123.00	20%	$ 98.40
NF9100-SF22E	Front Bezel (2U Black, w/ NEC Logo) for Mx10	32	$ 90.00	$ 2,880.00	20%	$ 2,304.00
N8190-158	NEC N8190-158 dual-port 16G FC HBAs (w/ SFP)	16	$1,570.00	$ 25,120.00	20%	$ 20,096.00
Software						
Q24-HL000000074243	M510 60 Day Trial License Bundle	1	$ -	$ -	20%	$ -
Q24-HL000000072866	M510 Base Software	1	$ -	$ -	20%	$ -
Maintenance						
Q24-DN000000072495	3 Years Upgrade to Platinum M510 Dual Controller w/Base SW	1	$9,471.00	$ 9,471.00	15%	$ 8,050.35
Q24-DN000000072679	3 Years Upgrade to Platinum M510 2 - 4 port FC Host Port Cards (4 ports per Controller)	4	$1,222.00	$ 4,888.00	15%	$ 4,154.80
Q24-DN000000072686	3 Years Upgrade to Platinum M510 2 - 4 port Disk Port Cards (4 ports per Controller)	1	$1,037.00	$ 1,037.00	15%	$ 881.45
Q24-DN000000072544	3 Years Upgrade to Platinum M510 Cache Upgrade 24GB->48GB per Controller (48GB->96GB Total)	1	$1,311.00	$ 1,311.00	15%	$ 1,114.35
Q24-DN000000072609	3 Years Upgrade to Platinum Disk Enclosure 2.5 inch for Mx10	32	$1,900.00	$ 60,800.00	15%	$ 51,680.00
Q24-DN000000072927	1 Year Platinum SW Maintenance M510 Base Software	3	$ 5,620.00	$ 16,860.00	15%	$ 14,331.00
Cables and Racks						
Power Strips	Power Strips (8 outlets)	10	$ 78.00	$ 780.00	10%	$ 702.00
RACK	Rack 42U	3	$ 1,799.00	$ 5,397.00	10%	$ 4,857.30
NF9120-SJ93	2 - 3M Mini SAS HD Cables	12	$439.00	$ 5,268.00	10%	$ 4,741.20
FC CABLE	CRU FC CABLE 5M x2 (M#LCLC-5MQ) 5M	16	$54.00	$ 864.00	10%	$ 777.60
	Totals			**$765,454.00**		**$618,312.45**

- *Power codes for M510 and Disk Enclosures are included in Localization Kits (Q24-HL000000072891 and Q24-HL000000072706)*
- *Price of M510 Disk Array Unit includes price of M510 Base Software (Q24-HL000000072866)*
- *PathManager for Windows/Linux/VMware is included in M510 Base Software (Q24-HL000000072866)*

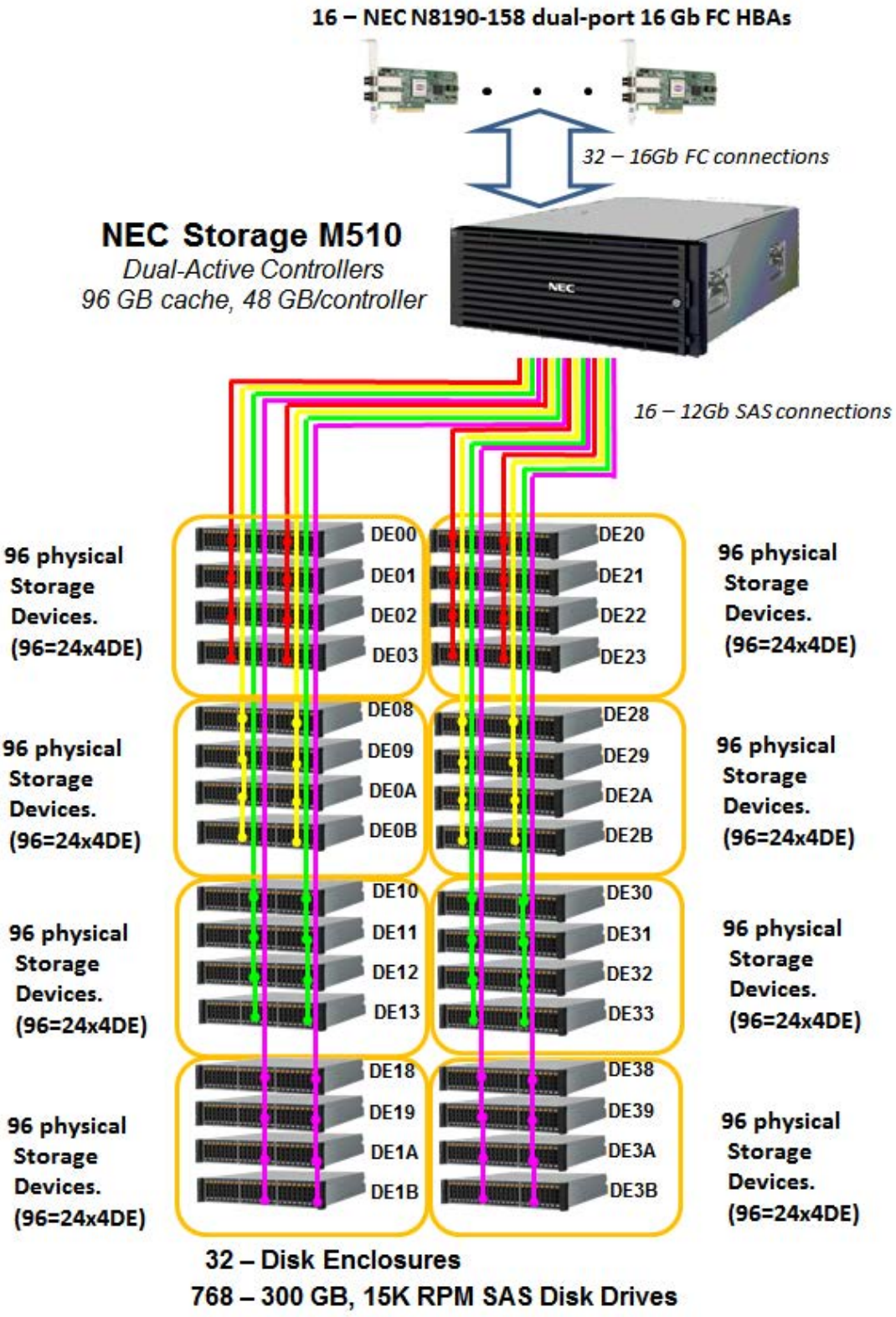
The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- Acknowledgement of new and existing problems within 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 Price 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 Tested Storage Configuration and the Priced Storage Configuration.

Priced Storage Configuration Diagram



Priced Storage Configuration Components

Priced Storage Configuration
16 – NEC N8190-158 dual-port 16Gb FC HBAs
NEC Storage M510 Dual-Active Controllers, each with 48 GB memory *(96 GB total)* 1 – 4-port Disk Port Card *(2 cards total, 8 ports total and used)*
8 – 4-port FC Host Port Cards *(4 cards and 16 ports per controller, 32 ports total and used)*
2 – 4-port Disk Port Cards *(1 card and 4 ports per controller; 8 ports total and used)*
32 – Disk Enclosures, 2.5”
768 – 300 GB, 15K RPM SAS disk drives (HDDs)
3 – 42U Racks with 10 power strips *(8 outlets per strip)*

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

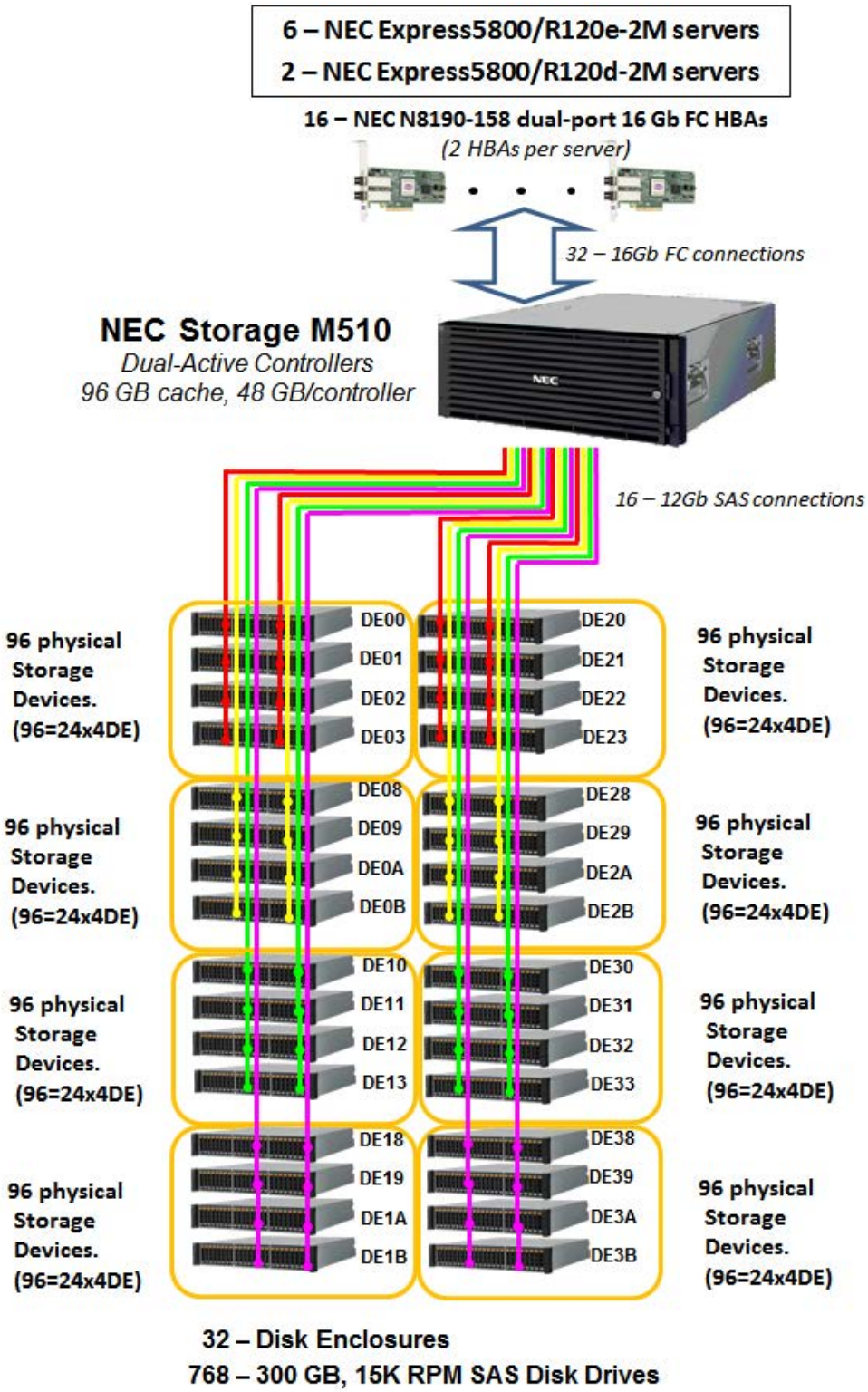
Host System(s) and Tested Storage Configuration (TSC) Table of Components

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 23 *(Host System and Tested Storage Configuration Components)*.

Benchmark Configuration/Tested Storage Configuration Diagram



Host System and Tested Storage Configuration Components

Host Systems
6 – NEC Express5800/R120e-2M servers, each with: 2 – Intel® Xeon® 2.6 GHz E5-2630 v2 processors 6 cores per processor and 15 MB Intel® Smart Cache 16 GB main memory Windows Server 2008 R2 Standard with SP1 PCIe
2 – NEC Express5800/R120d-2M servers, each with: 2 – Intel® Xeon® 2.5 GHz E5-2640 v2 processors 6 cores per processor and 15 MB Intel® Smart Cache 16 GB main memory Windows Server 2008 R2 Standard with SP1 PCIe
Tested Storage Configuration (TSC) Components
16 – NEC N8190-158 dual-port 16Gb FC HBAs
NEC Storage M510 Dual-Active Controllers, each with 48 GB memory *(96 GB total)* 1 – 4-port Disk Port Card *(2 cards total, 8 ports total and used)*
8 – 4-port FC Host Port Cards *(4 cards and 16 ports per controller, 32 ports total and used)*
2 – 4-port Disk Port Cards *(1 card and 4 ports per controller; 8 ports total and used)*
32 – Disk Enclosures, 2.5”
768 – 300 GB, 15K RPM SAS disk drives (HDDs)
3 – 42U Racks with 10 power strips *(8 outlets per strip)*

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 67 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 68 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 72.

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 72.

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 63 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 230,400.000 GB distributed over 768 disk drives (HDDs) each with a formatted capacity of 300.000 GB. There was 3,611.209 GB (1.57%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 10,717.577 GB (4.65%) of the Physical Storage Capacity. There was 44,260.166 GB (20.48%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 100% of the Addressable Storage Capacity resulting in 0.00 GB (0.00%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(Mirroring)* capacity was 108,027.017 GB of which 85,896.934 GB was utilized. The total Unused Storage capacity was 47,871.375 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.

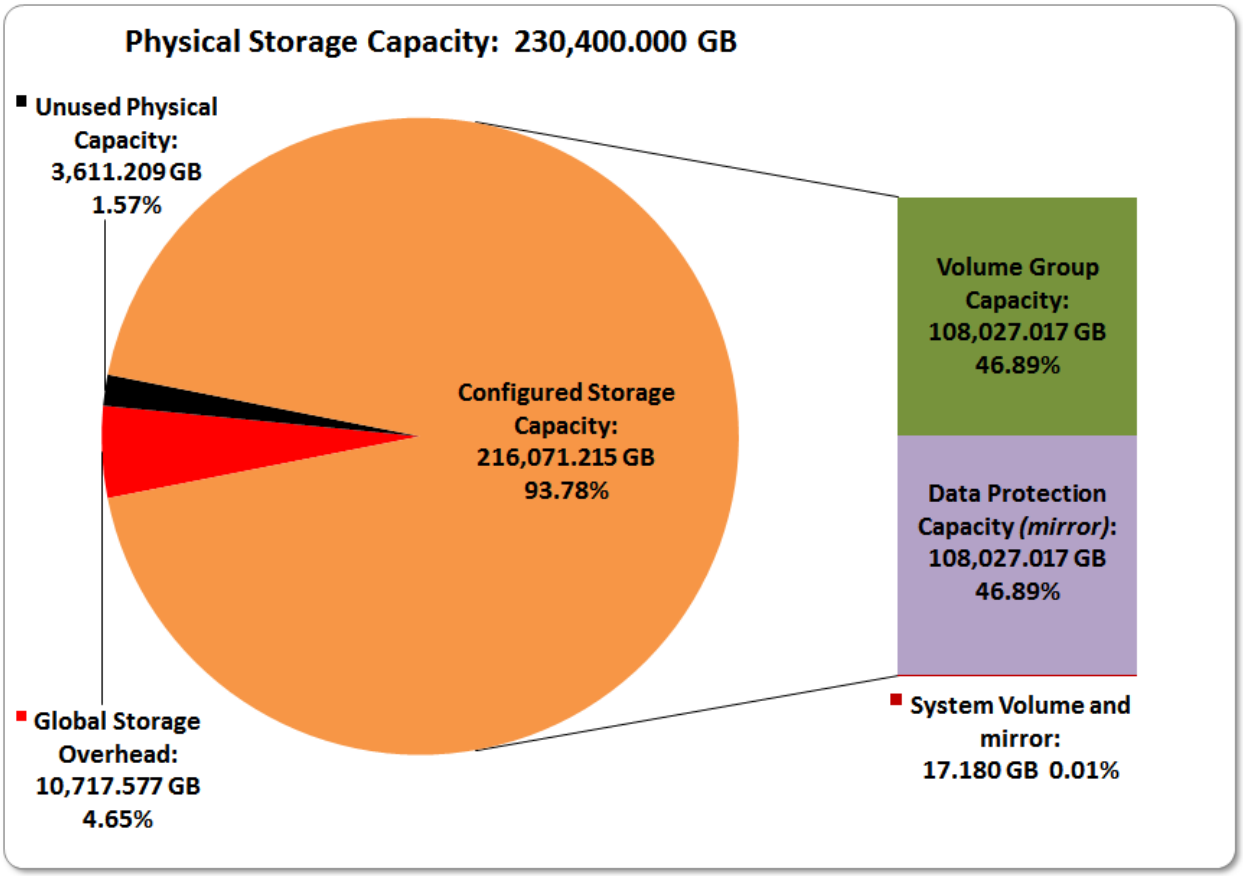
SPC-1 Storage Capacities

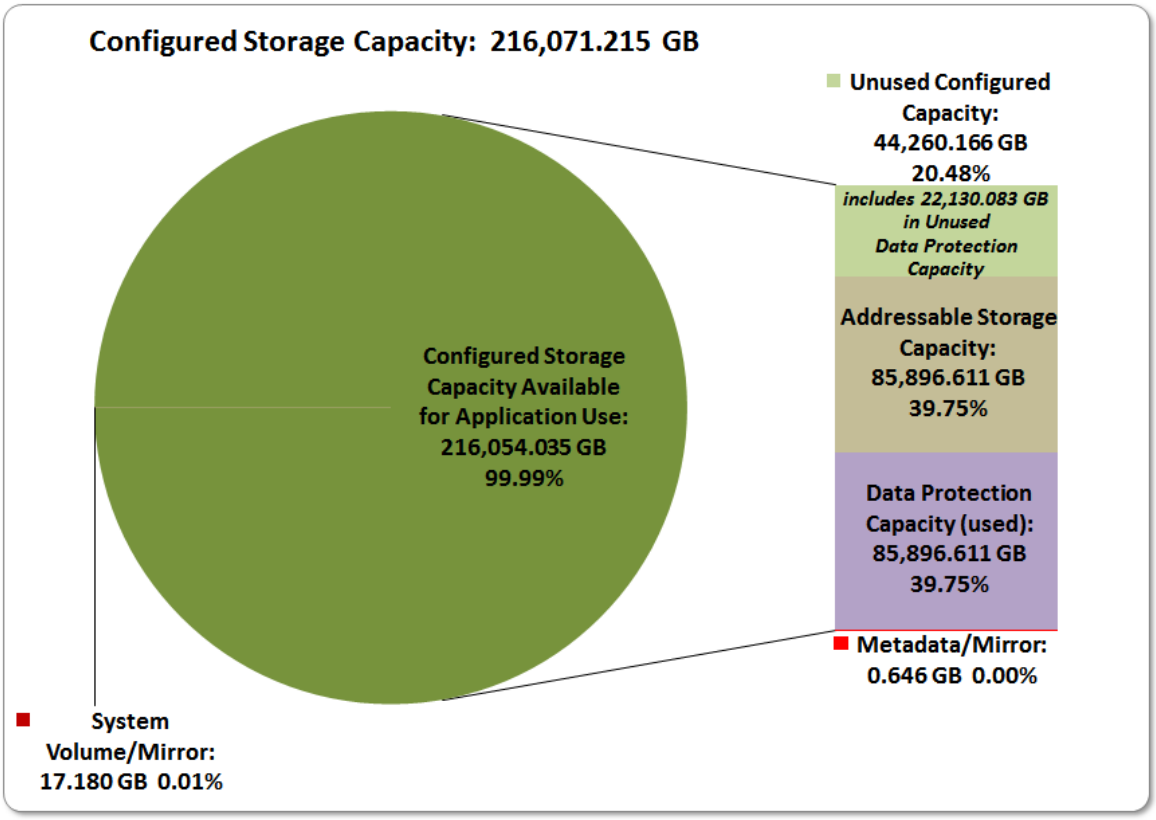
Storage Hierarchy Component	Units	Capacity
Total ASU Capacity	Gigabytes (GB)	85,896.611
Addressable Storage Capacity	Gigabytes (GB)	85,896.611
Configured Storage Capacity	Gigabytes (GB)	216,071.215
Physical Storage Capacity	Gigabytes (GB)	230,400.000
Data Protection *(Mirroring)*	Gigabytes (GB)	108,027.017
Required Storage *(system overhead/metadata)*	Gigabytes (GB)	17.826
Global Storage Overhead	Gigabytes (GB)	10,717.577
Total Unused Storage	Gigabytes (GB)	47,871.375

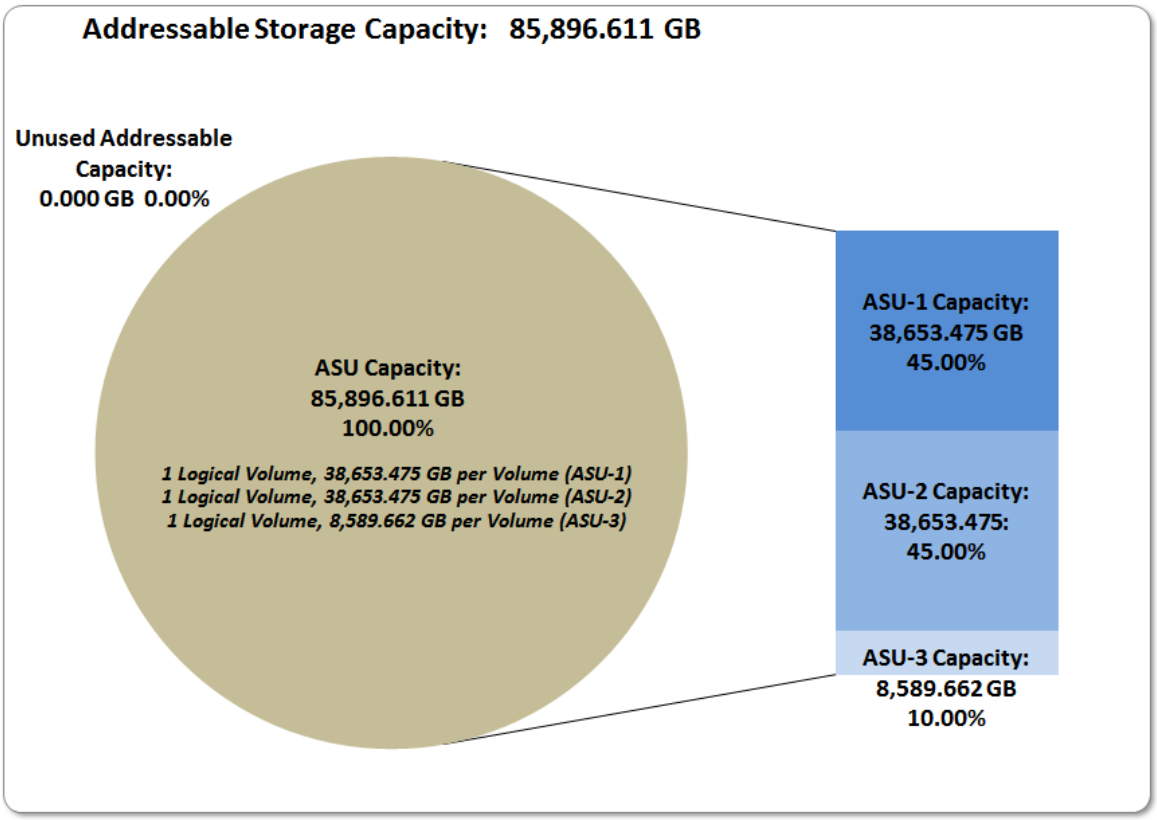
SPC-1 Storage Hierarchy Ratios

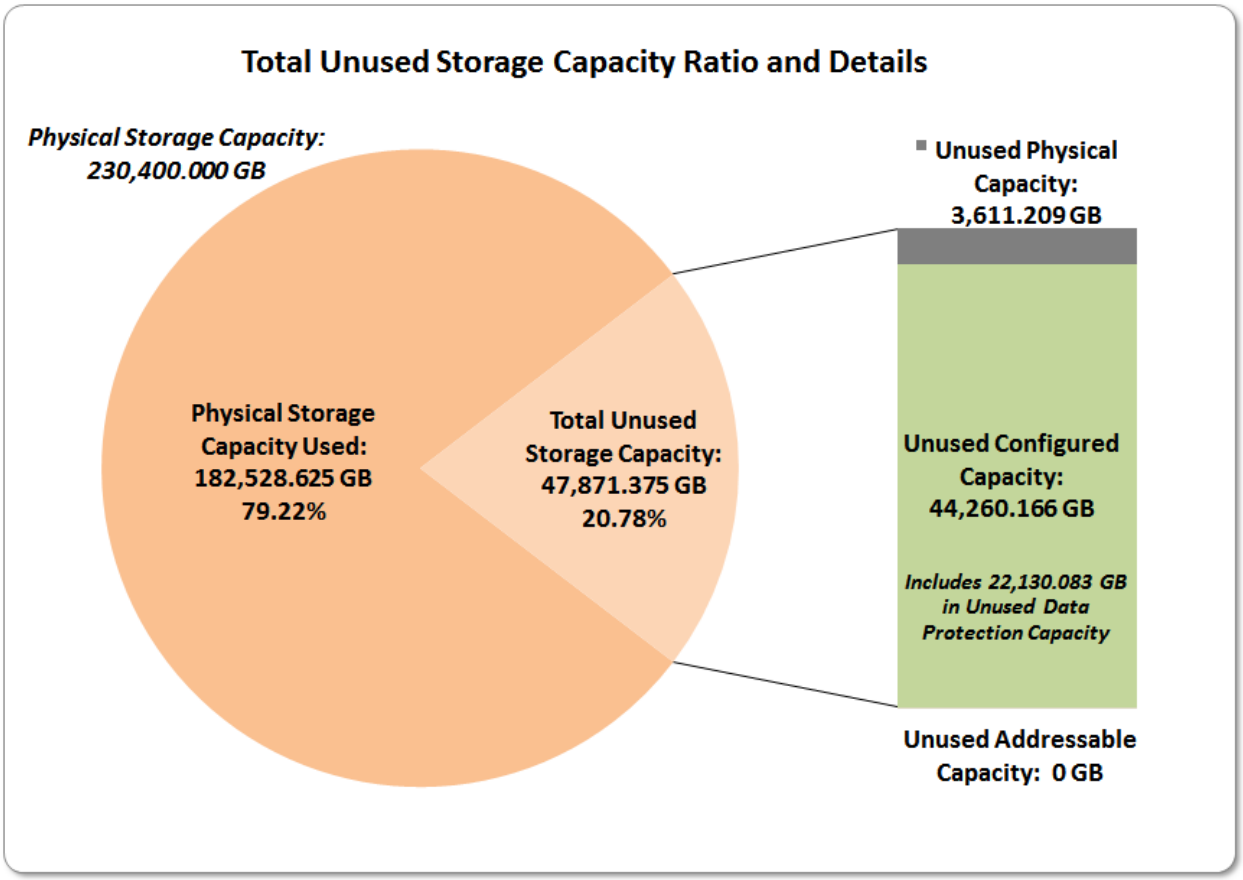
	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	100.00%	39.75%	37.28%
Required for Data Protection *(Mirroring)*		50.00%	46.89%
Addressable Storage Capacity		39.75%	37.28%
Required Storage *(system overhead/metadata)*		0.01%	0.01%
Configured Storage Capacity			93.78%
Global Storage Overhead			4.65%
Unused Storage:			
Addressable	0.00%		
Configured		20.48%	
Physical			1.57%

SPC-1 Storage Capacity Charts




Configured Storage Capacity: 216,071.215 GB
Unused Configured Capacity: 44,260.166 GB 20.48%
includes 22,130.083 GB in Unused Data Protection Capacity
Addressable Storage Capacity: 85,896.611 GB 39.75%
Data Protection Capacity (used): 85,896.611 GB 39.75%
Metadata/Mirror: 0.646 GB 0.00%
Configured Storage Capacity Available for Application Use: 216,054.035 GB 99.99%
System Volume/Mirror: 17.180 GB 0.01%


Addressable Storage Capacity: 85,896.611 GB
Unused Addressable Capacity: 0.000 GB 0.00%
ASU Capacity: 85,896.611 GB 100.00%
1 Logical Volume, 38,653.475 GB per Volume (ASU-1)
1 Logical Volume, 38,653.475 GB per Volume (ASU-2)
1 Logical Volume, 8,589.662 GB per Volume (ASU-3)
ASU-1 Capacity: 38,653.475 GB 45.00%
ASU-2 Capacity: 38,653.475: 45.00%
ASU-3 Capacity: 8,589.662 GB 10.00%



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	37.28%
Protected Application Utilization	74.56%
Unused Storage Ratio	20.78%

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 (38,653.475 GB)
1 Logical Volume 38,653.475 GB per Logical Volume (38,653.475 GB used per Logical Volume)
ASU-2 (38,653.475 GB)
1 Logical Volume 38,653.475 GB per Logical Volume (38,653.475 GB used per Logical Volume
ASU-3 (8,589.662 GB)
1 Logical Volume 8,589.662 GB per Logical Volume (8,589.662 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was **Protected 2** using ***Mirroring*** as described on page 12. 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 63 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.

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 74.

Sustainability Test Results File

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

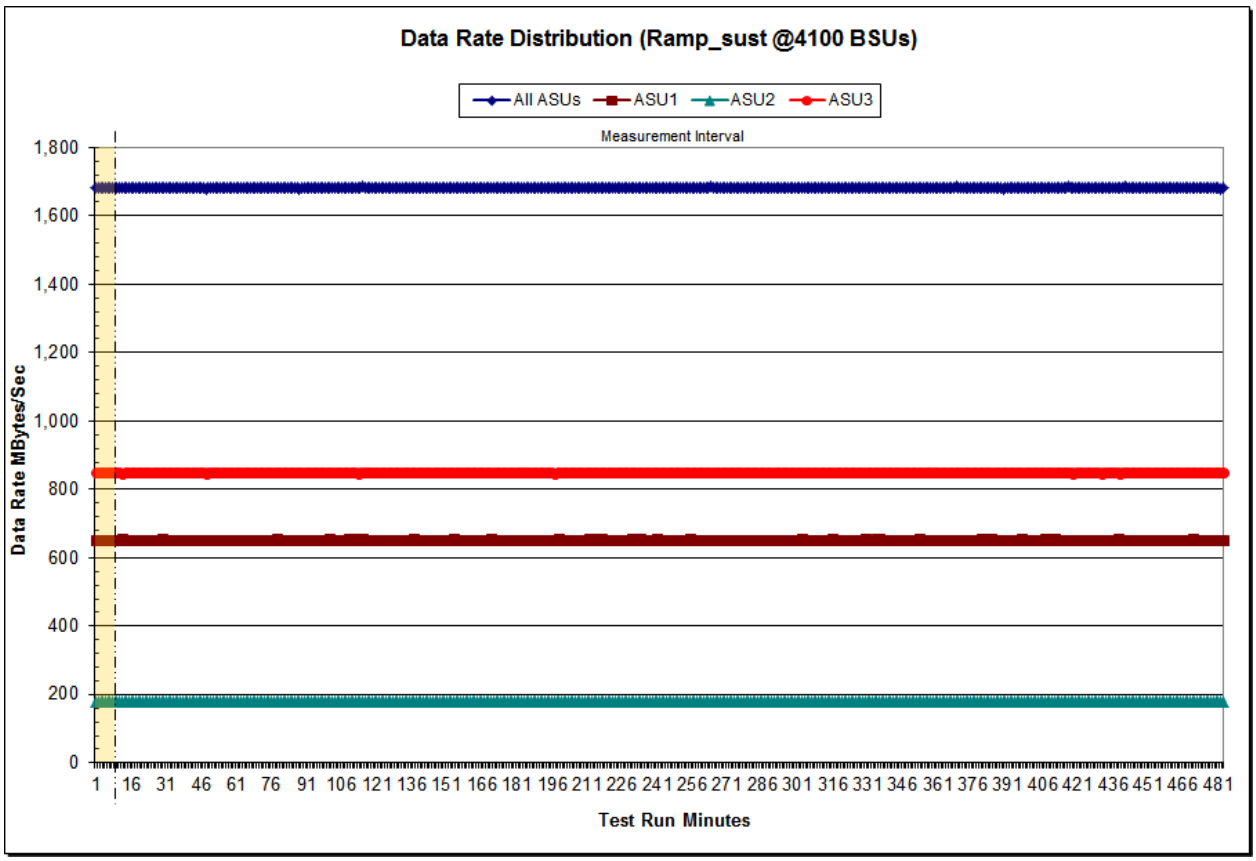
Sustainability Test Results File

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

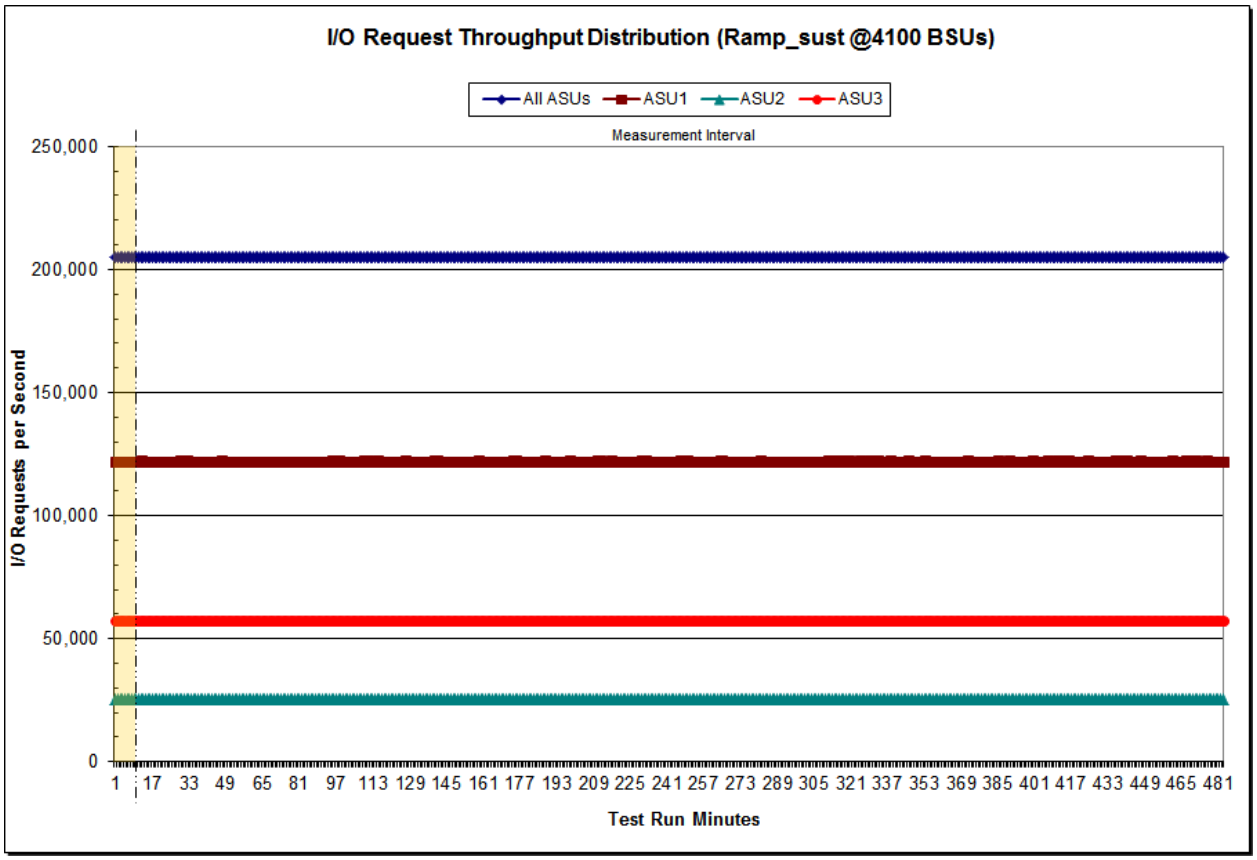


Sustainability – I/O Request Throughput Distribution Data

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

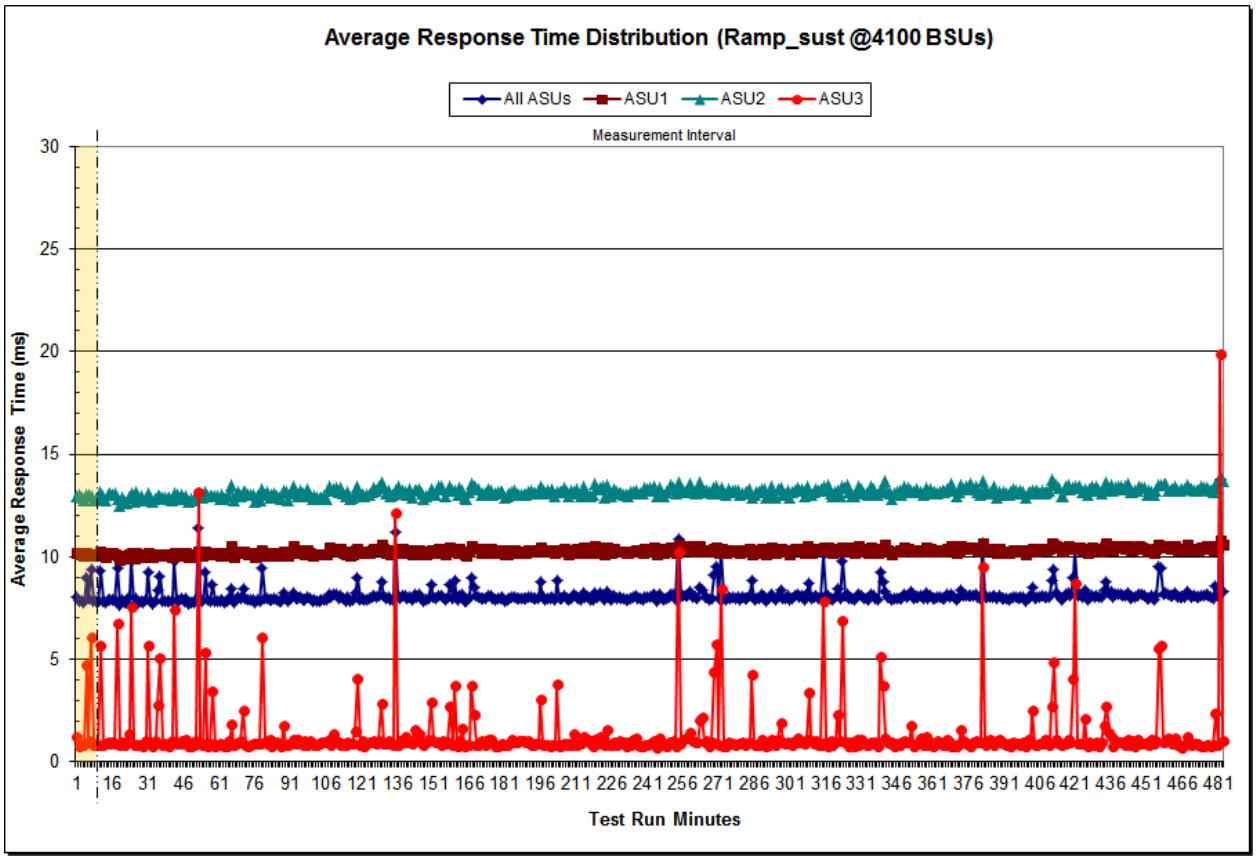


Sustainability – Average Response Time (ms) Distribution Data

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

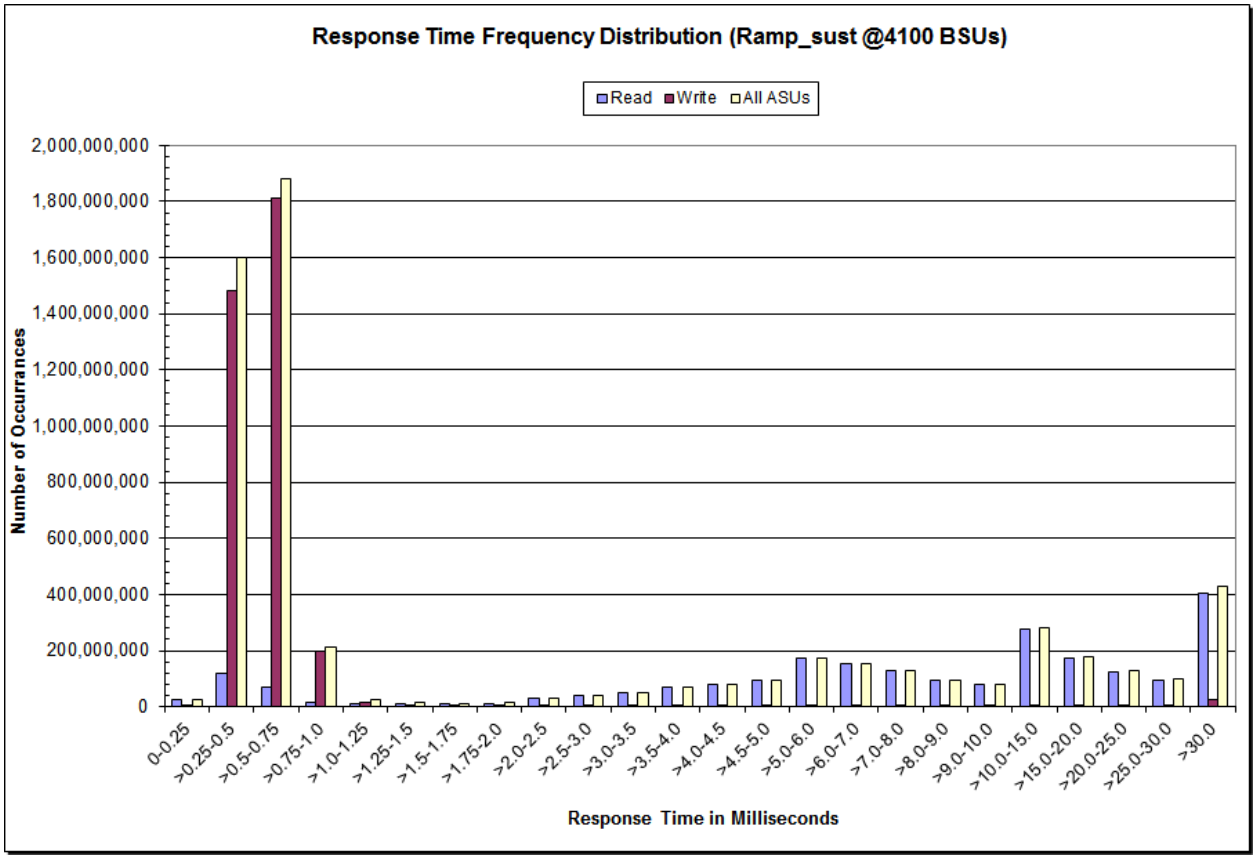
Sustainability – Average Response Time (ms) Distribution Graph



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	24,850,807	118,761,901	69,566,415	15,325,161	8,565,022	10,504,600	11,363,860	12,687,948
Write	58,942	1,483,903,340	1,811,590,246	199,046,992	14,692,749	3,404,973	1,515,190	901,674
All ASUs	24,909,749	1,602,665,241	1,881,156,661	214,372,153	23,257,771	13,909,573	12,879,050	13,589,622
ASU1	23,268,953	782,369,747	796,108,288	81,667,584	11,739,408	10,150,633	11,159,278	12,447,617
ASU2	1,622,927	192,250,498	192,411,421	20,229,421	3,127,396	2,035,461	1,075,025	817,148
ASU3	17,869	628,044,996	892,636,952	112,475,148	8,390,967	1,723,479	644,747	324,857
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	30,994,278	41,160,545	51,071,955	68,433,945	80,664,936	92,007,547	173,019,425	152,522,365
Write	1,008,400	858,614	685,932	868,428	780,967	1,031,879	2,007,202	1,995,166
All ASUs	32,002,678	42,019,159	51,757,887	69,302,373	81,445,903	93,039,426	175,026,627	154,517,531
ASU1	29,838,535	38,951,339	46,991,710	62,919,399	73,777,479	83,118,344	153,500,161	133,439,656
ASU2	1,856,005	2,862,521	4,603,197	6,178,766	7,474,359	9,668,919	21,019,607	20,580,020
ASU3	308,138	205,299	162,980	204,208	194,065	252,163	506,859	497,855
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	126,485,047	93,464,564	79,636,555	274,951,111	171,155,112	123,103,572	94,116,309	404,140,886
Write	1,915,445	1,769,176	1,637,040	6,733,581	5,155,867	4,142,565	3,398,410	26,312,040
All ASUs	128,400,492	95,233,740	81,273,595	281,684,692	176,310,979	127,246,137	97,514,719	430,452,926
ASU1	110,577,211	80,961,572	69,887,537	240,730,245	149,568,562	106,848,957	80,845,588	327,937,626
ASU2	17,401,695	13,937,592	11,108,168	39,938,042	26,020,104	19,810,671	16,169,932	93,995,227
ASU3	421,586	334,576	277,890	1,016,405	722,313	586,509	499,199	8,520,073

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	0.002	0.000	0.001	0.001	0.002	0.001	0.002	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 74.

IOPS Test Results File

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

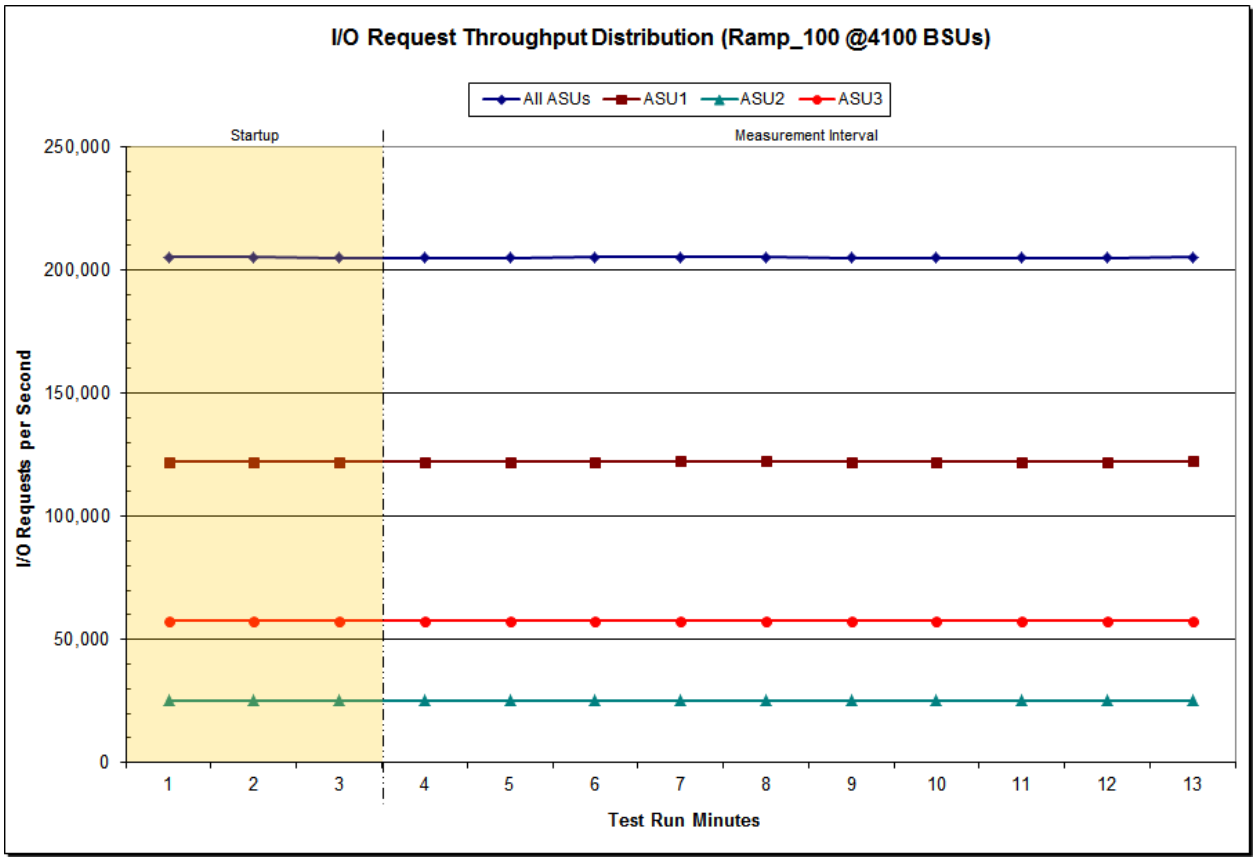
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

4,100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:35:50	17:38:51	0-2	0:03:01
Measurement Interval	17:38:51	17:48:51	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	205,014.15	122,203.48	25,209.28	57,601.38
1	205,080.10	122,220.93	25,187.75	57,671.42
2	204,999.28	122,218.78	25,225.27	57,555.23
3	204,964.98	122,157.95	25,232.92	57,574.12
4	204,986.93	122,179.45	25,222.52	57,584.97
5	205,108.05	122,228.03	25,232.77	57,647.25
6	205,095.80	122,245.02	25,221.58	57,629.20
7	205,058.03	122,245.38	25,217.22	57,595.43
8	204,874.37	122,098.60	25,218.42	57,557.35
9	204,919.85	122,114.75	25,200.27	57,604.83
10	204,982.63	122,169.92	25,203.02	57,609.70
11	205,005.63	122,223.22	25,193.05	57,589.37
12	205,046.20	122,235.17	25,213.12	57,597.92
Average	***205,004.25***	***122,189.75***	***25,215.49***	***57,599.01***

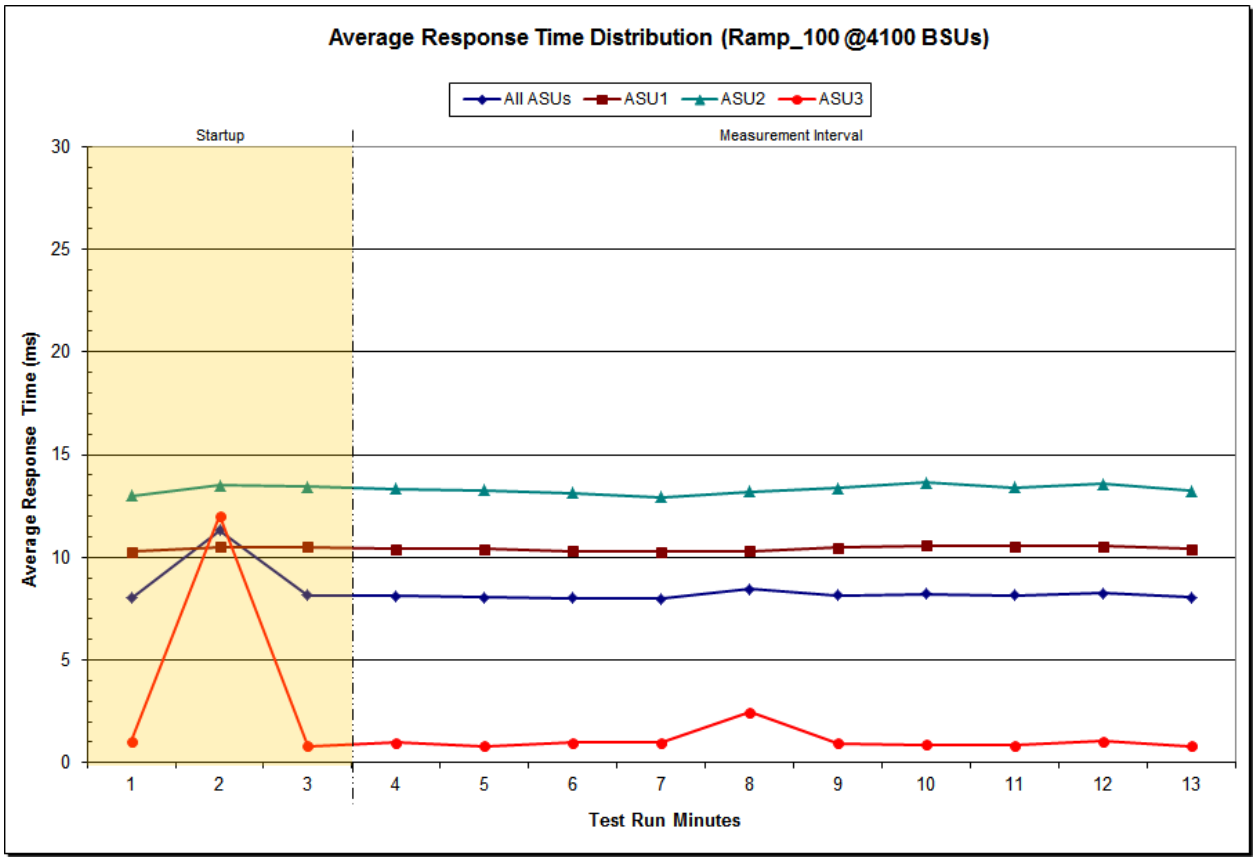
IOPS Test Run – I/O Request Throughput Distribution Graph



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

4,100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:35:50	17:38:51	0-2	0:03:01
Measurement Interval	17:38:51	17:48:51	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	8.01	10.26	13.01	1.04
1	11.30	10.51	13.52	12.02
2	8.15	10.50	13.44	0.82
3	8.11	10.40	13.33	0.99
4	8.05	10.39	13.27	0.81
5	8.02	10.30	13.12	0.97
6	8.00	10.29	12.94	0.98
7	8.46	10.31	13.20	2.46
8	8.15	10.47	13.38	0.94
9	8.23	10.58	13.64	0.88
10	8.16	10.53	13.42	0.84
11	8.25	10.56	13.58	1.04
12	8.05	10.39	13.22	0.81
Average	***8.15***	***10.42***	***13.31***	***1.07***

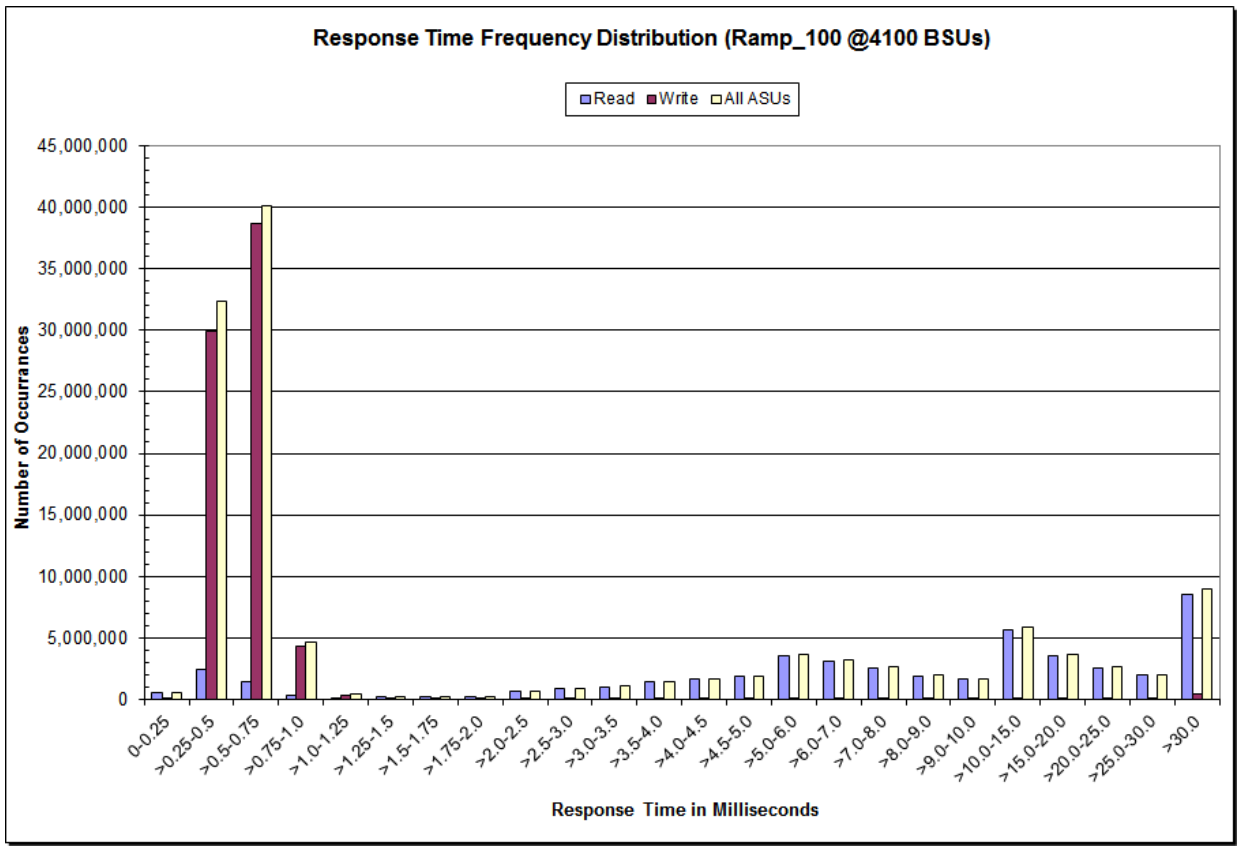
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	557,678	2,483,406	1,431,729	315,638	175,799	218,695	233,668	262,446
Write	800	29,920,823	38,679,455	4,312,621	296,823	62,076	26,492	16,193
All ASUs	558,478	32,404,229	40,111,184	4,628,259	472,622	280,771	260,160	278,639
ASU1	524,183	15,842,725	17,008,793	1,756,295	235,307	205,913	226,902	256,312
ASU2	34,036	3,896,295	4,101,983	434,090	63,336	41,393	21,650	16,313
ASU3	259	12,665,209	19,000,408	2,437,874	173,979	33,465	11,608	6,014
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	645,879	851,268	1,061,881	1,414,246	1,677,032	1,899,836	3,585,801	3,160,773
Write	18,481	16,600	13,054	17,311	15,231	20,933	40,465	40,573
All ASUs	664,360	867,868	1,074,935	1,431,557	1,692,263	1,920,769	3,626,266	3,201,346
ASU1	620,071	804,525	976,145	1,299,580	1,532,991	1,715,353	3,179,905	2,765,677
ASU2	38,599	59,445	95,692	128,011	155,533	200,439	436,496	425,598
ASU3	5,690	3,898	3,098	3,966	3,739	4,977	9,865	10,071
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	2,619,874	1,937,822	1,651,903	5,713,716	3,559,071	2,567,631	1,962,208	8,522,913
Write	38,654	35,690	33,330	137,146	104,673	83,413	68,821	489,856
All ASUs	2,658,528	1,973,512	1,685,233	5,850,862	3,663,744	2,651,044	2,031,029	9,012,769
ASU1	2,290,344	1,678,431	1,447,955	4,998,606	3,109,917	2,227,062	1,685,699	6,923,684
ASU2	359,883	288,666	231,639	832,475	540,656	413,465	336,511	1,976,716
ASU3	8,301	6,415	5,639	19,781	13,171	10,517	8,819	112,369

IOPS Test Run –Response Time Frequency Distribution Graph



IOPS Test Run – I/O Request Information

I/O Requests Completed in the Measurement Interval
123,000,427
I/O Requests Completed with Response Time = or < 30 ms
113,987,648
I/O Requests Completed with Response Time > 30 ms
9,012,769

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
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	0.001	0.002	0.001	0.002	0.000

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 16.

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 74.

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.

100% Load Level: 4,100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:35:50	17:38:51	0-3	0:03:01
Measurement Interval	17:38:51	17:48:51	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	205,014.15	122,203.48	25,209.28	57,601.38
1	205,080.10	122,220.93	25,187.75	57,671.42
2	204,999.28	122,218.78	25,225.27	57,555.23
3	204,964.98	122,157.95	25,232.92	57,574.12
4	204,986.93	122,179.45	25,222.52	57,584.97
5	205,108.05	122,228.03	25,232.77	57,647.25
6	205,095.80	122,245.02	25,221.58	57,629.20
7	205,058.03	122,245.38	25,217.22	57,595.43
8	204,874.37	122,098.60	25,218.42	57,557.35
9	204,919.85	122,114.75	25,200.27	57,604.83
10	204,982.63	122,169.92	25,203.02	57,609.70
11	205,005.63	122,223.22	25,193.05	57,589.37
12	205,046.20	122,235.17	25,213.12	57,597.92
Average	***205,004.25***	***122,189.75***	***25,215.49***	***57,599.01***

95% Load Level: 3,895 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:51:30	17:54:31	0-3	0:03:01
Measurement Interval	17:54:31	18:04:31	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	194,758.17	116,065.12	23,971.58	54,721.47
1	194,787.47	116,095.72	23,953.98	54,737.77
2	194,764.08	116,098.57	23,935.08	54,730.43
3	194,747.03	116,029.07	23,995.27	54,722.70
4	194,861.20	116,152.92	23,959.48	54,748.80
5	194,734.20	116,066.88	23,969.55	54,697.77
6	194,727.98	116,034.72	23,962.57	54,730.70
7	194,767.92	116,070.00	23,947.90	54,750.02
8	194,710.17	116,036.67	23,944.87	54,728.63
9	194,734.68	116,051.83	23,971.63	54,711.22
10	194,690.85	116,071.40	23,925.37	54,694.08
11	194,813.15	116,103.12	23,952.93	54,757.10
12	194,784.85	116,054.22	23,981.15	54,749.48
Average	***194,757.20***	***116,067.08***	***23,961.07***	***54,729.05***

90% Load Level: 3,690 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:07:14	18:10:15	0-3	0:03:01
Measurement Interval	18:10:15	18:20:15	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	184,467.45	109,890.42	22,722.08	51,854.95
1	184,536.57	110,003.17	22,721.53	51,811.87
2	184,529.63	109,989.27	22,681.68	51,858.68
3	184,495.87	109,962.48	22,662.18	51,871.20
4	184,477.38	109,927.95	22,726.02	51,823.42
5	184,519.22	110,001.38	22,711.85	51,805.98
6	184,511.43	109,928.10	22,693.45	51,889.88
7	184,486.87	109,924.30	22,708.33	51,854.23
8	184,483.20	109,945.38	22,702.25	51,835.57
9	184,475.72	109,919.03	22,708.55	51,848.13
10	184,498.18	109,931.15	22,707.73	51,859.30
11	184,409.78	109,853.20	22,726.52	51,830.07
12	184,553.17	110,013.97	22,679.27	51,859.93
Average	***184,491.08***	***109,940.70***	***22,702.62***	***51,847.77***

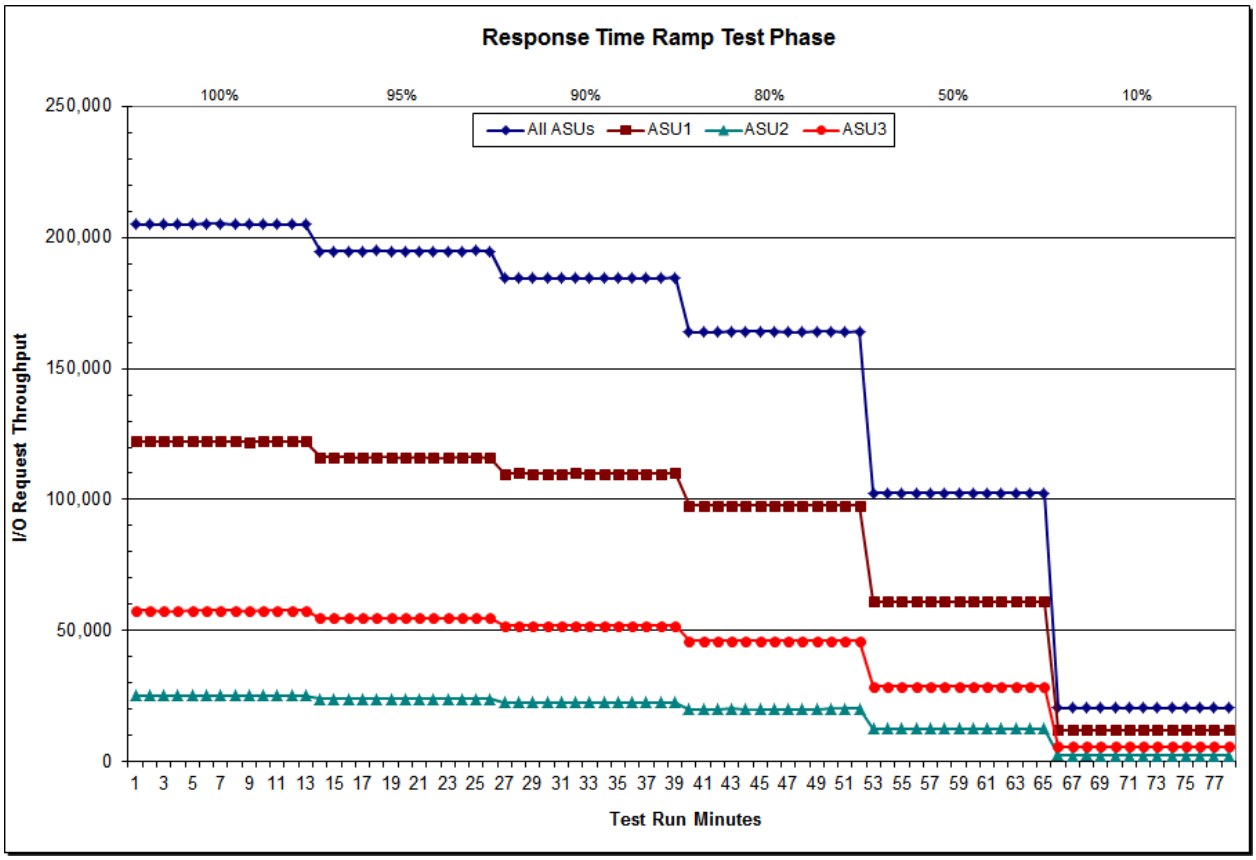
80% Load Level: 3,280 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:22:54	18:25:55	0-3	0:03:01
Measurement Interval	18:25:55	18:35:55	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	163,927.02	97,712.18	20,158.38	46,056.45
1	163,994.02	97,722.83	20,157.72	46,113.47
2	163,942.20	97,737.67	20,149.23	46,055.30
3	164,018.80	97,776.18	20,178.83	46,063.78
4	164,027.38	97,770.52	20,176.37	46,080.50
5	164,049.62	97,819.55	20,146.05	46,084.02
6	164,017.48	97,803.50	20,164.55	46,049.43
7	163,994.20	97,771.97	20,143.43	46,078.80
8	163,939.72	97,709.27	20,143.07	46,087.38
9	164,045.17	97,788.83	20,157.77	46,098.57
10	164,088.25	97,806.25	20,185.27	46,096.73
11	163,984.23	97,726.17	20,184.85	46,073.22
12	164,049.02	97,769.53	20,194.97	46,084.52
Average	***164,021.39***	***97,774.18***	***20,167.52***	***46,079.70***

Response Time Ramp Distribution (IOPS) Data *(continued)*

50% Load Level: 2,050 BSUs	Start	Stop	Interval	Duration	10% Load Level: 410 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:38:30	18:41:31	0-3	0:03:01	Start-Up/Ramp-Up	18:54:05	18:57:06	0-3	0:03:01
Measurement Interval	18:41:31	18:51:31	3-12	0:10:00	Measurement Interval	18:57:06	19:07:06	3-12	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3	*(60 second intervals)*	All ASUs	ASU-1	ASU-2	ASU-3
0	102,478.62	61,068.63	12,614.37	28,795.62	0	20,549.15	12,250.13	2,531.80	5,767.22
1	102,434.65	61,061.72	12,586.13	28,786.80	1	20,531.65	12,237.50	2,518.53	5,775.62
2	102,476.93	61,072.22	12,606.88	28,797.83	2	20,544.40	12,231.78	2,533.40	5,779.22
3	102,537.62	61,111.82	12,613.23	28,812.57	3	20,500.52	12,212.45	2,526.93	5,761.13
4	102,476.40	61,077.18	12,605.98	28,793.23	4	20,479.72	12,232.83	2,505.82	5,741.07
5	102,603.62	61,143.28	12,603.77	28,856.57	5	20,506.58	12,223.77	2,521.07	5,761.75
6	102,505.08	61,117.62	12,615.68	28,771.78	6	20,522.00	12,241.18	2,523.10	5,757.72
7	102,482.73	61,122.98	12,607.12	28,752.63	7	20,512.38	12,214.18	2,529.77	5,768.43
8	102,521.68	61,116.80	12,614.33	28,790.55	8	20,515.32	12,238.43	2,521.38	5,755.50
9	102,423.78	61,064.47	12,585.98	28,773.33	9	20,481.67	12,215.55	2,520.85	5,745.27
10	102,523.03	61,086.40	12,629.58	28,807.05	10	20,495.95	12,226.35	2,527.13	5,742.47
11	102,433.43	61,054.27	12,598.52	28,780.65	11	20,504.95	12,213.88	2,523.10	5,767.97
12	102,475.92	61,089.67	12,603.32	28,782.93	12	20,526.75	12,223.55	2,527.00	5,776.20
Average	***102,498.33***	***61,098.45***	***12,607.75***	***28,792.13***	*Average*	***20,504.58***	***12,224.22***	***2,522.62***	***5,757.75***

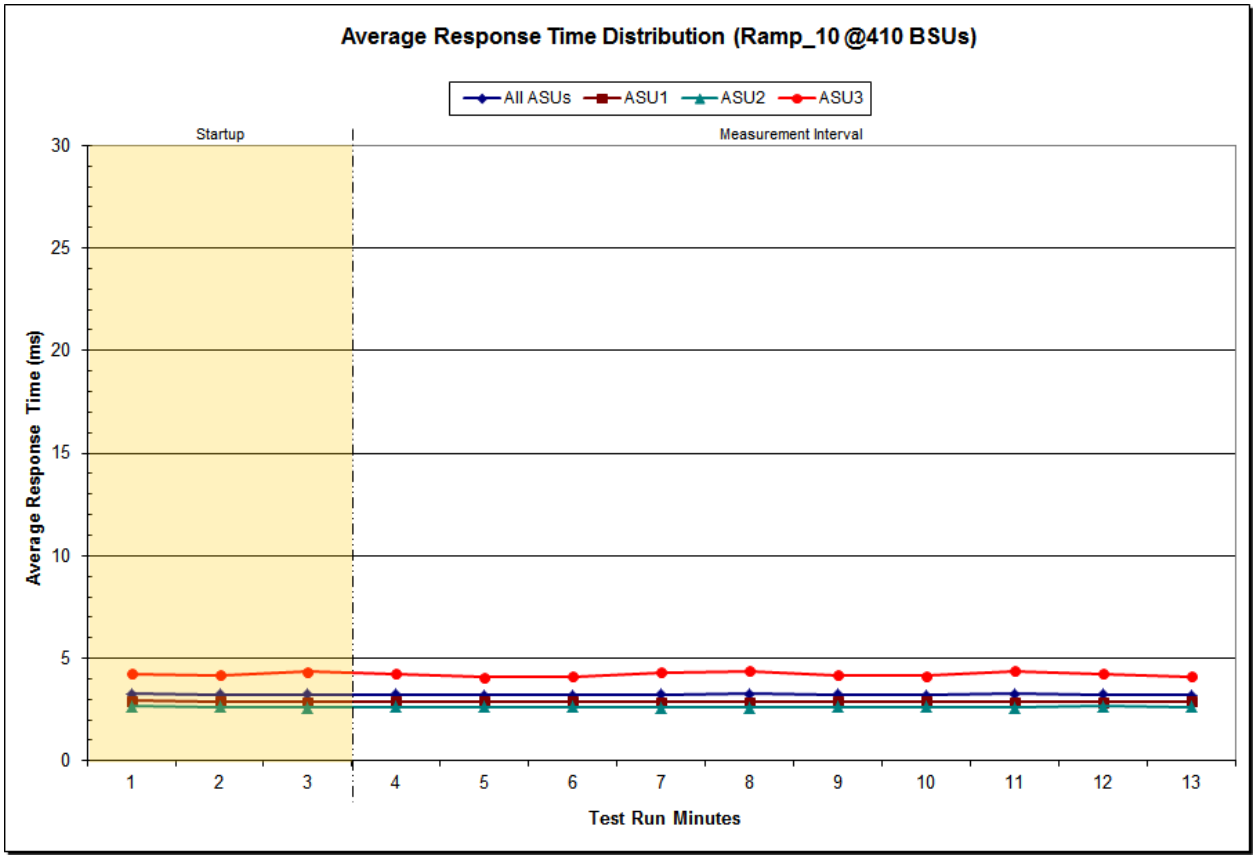
Response Time Ramp Distribution (IOPS) Graph



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

410 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:54:05	18:57:06	0-2	0:03:01
Measurement Interval	18:57:06	19:07:06	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	3.27	2.94	2.68	4.24
1	3.22	2.89	2.64	4.19
2	3.25	2.87	2.59	4.33
3	3.25	2.90	2.63	4.25
4	3.21	2.91	2.63	4.09
5	3.21	2.90	2.64	4.11
6	3.23	2.86	2.59	4.31
7	3.26	2.87	2.59	4.38
8	3.23	2.90	2.65	4.19
9	3.22	2.90	2.64	4.14
10	3.26	2.87	2.60	4.38
11	3.24	2.88	2.65	4.24
12	3.20	2.90	2.63	4.10
Average	***3.23***	***2.89***	***2.62***	***4.22***

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	0.2812	0.0700	0.2100	0.0180	0.0700	0.0350	0.2808
COV	0.003	0.002	0.004	0.002	0.0-07	0.004	0.005	0.002

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 74.

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™
Primary Metrics	***205,004.25***
Repeatability Test Phase 1	204,979.80
Repeatability Test Phase 2	204,997.58

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 greater than 95% of the reported SPC-1 IOPS™ Primary Metric.

	SPC-1 LRT™
Primary Metrics	***3.23***
Repeatability Test Phase 1	3.28
Repeatability Test Phase 2	3.25

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 plus one (1) millisecond (ms).

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

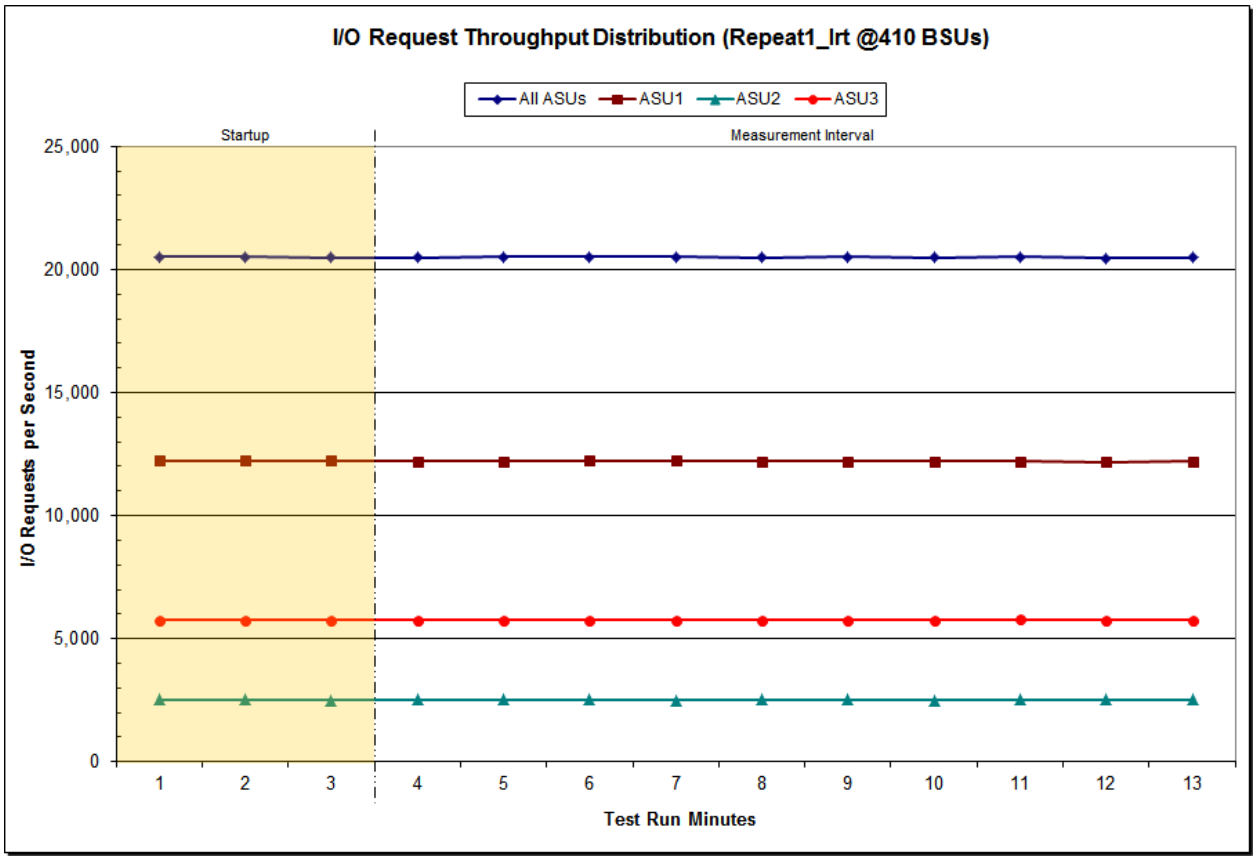
Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

410 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:09:53	19:12:53	0-2	0:03:00
Measurement Interval	19:12:53	19:22:53	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	20,509.60	12,234.17	2,526.10	5,749.33
1	20,525.02	12,249.15	2,524.42	5,751.45
2	20,498.15	12,226.83	2,514.30	5,757.02
3	20,498.85	12,205.22	2,526.52	5,767.12
4	20,504.87	12,212.15	2,525.78	5,766.93
5	20,509.48	12,236.55	2,515.37	5,757.57
6	20,509.35	12,233.23	2,514.02	5,762.10
7	20,480.18	12,202.78	2,520.00	5,757.40
8	20,509.45	12,209.20	2,532.08	5,768.17
9	20,480.73	12,202.23	2,514.15	5,764.35
10	20,517.08	12,221.42	2,522.67	5,773.00
11	20,461.45	12,193.15	2,518.32	5,749.98
12	20,489.03	12,210.13	2,528.55	5,750.35
Average	***20,496.05***	***12,212.61***	***2,521.75***	***5,761.70***

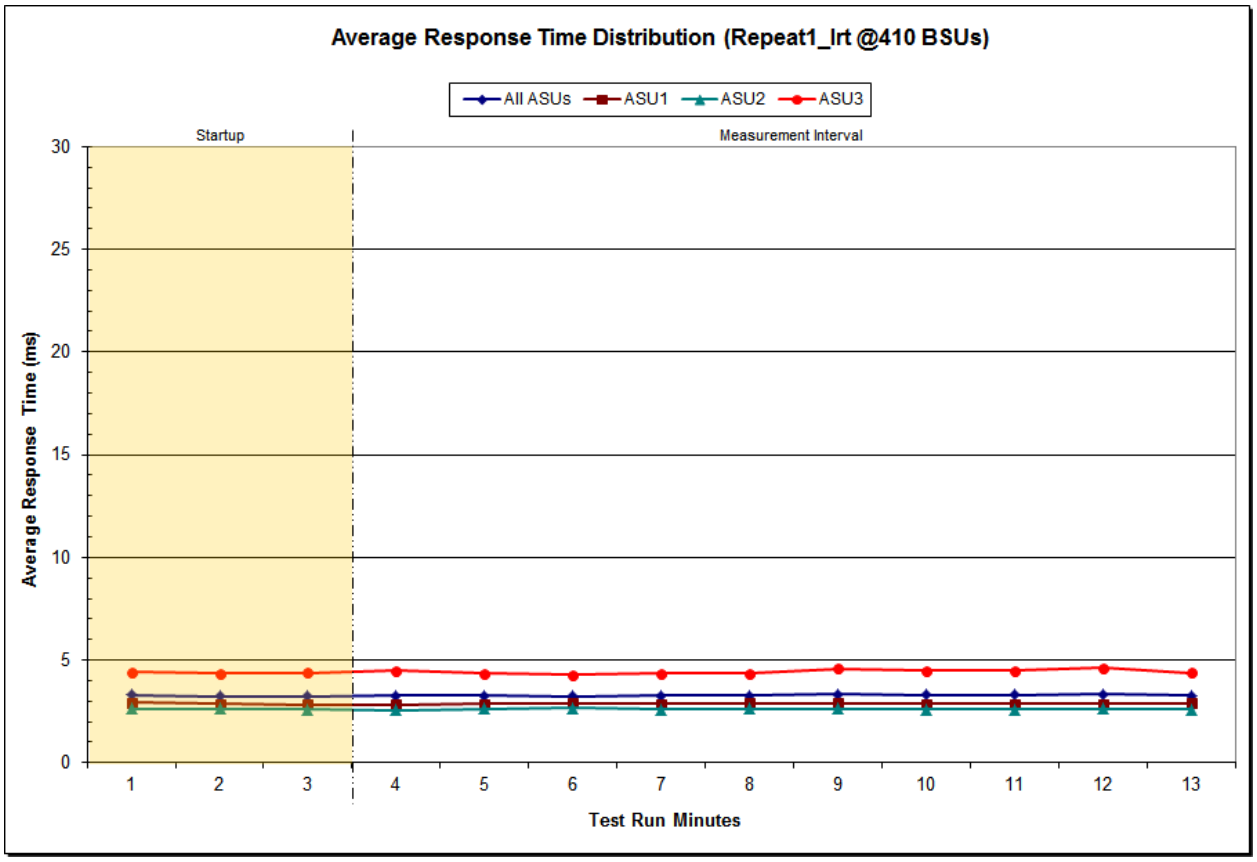
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

410 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:09:53	19:12:53	0-2	0:03:00
Measurement Interval	19:12:53	19:22:53	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	3.30	2.92	2.64	4.41
1	3.25	2.86	2.64	4.33
2	3.24	2.84	2.59	4.39
3	3.26	2.84	2.56	4.47
4	3.26	2.88	2.64	4.35
5	3.25	2.89	2.66	4.27
6	3.26	2.88	2.60	4.36
7	3.26	2.89	2.64	4.34
8	3.35	2.91	2.64	4.58
9	3.29	2.87	2.61	4.48
10	3.29	2.87	2.59	4.48
11	3.33	2.88	2.62	4.61
12	3.27	2.89	2.60	4.38
Average	***3.28***	***2.88***	***2.62***	***4.43***

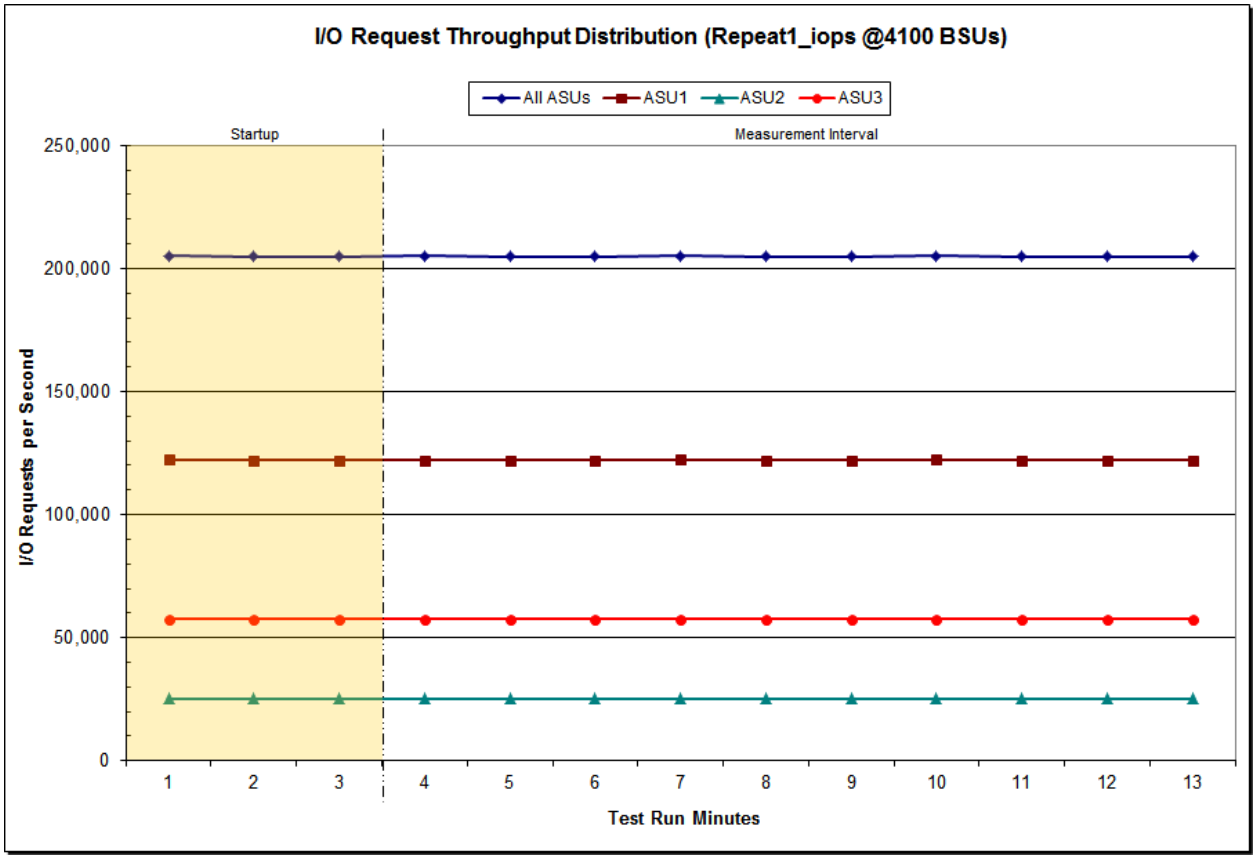
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

4,100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:25:29	19:28:30	0-2	0:03:01
Measurement Interval	19:28:30	19:38:30	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	205,103.35	122,266.17	25,209.75	57,627.43
1	204,969.73	122,151.08	25,193.32	57,625.33
2	204,868.00	122,040.40	25,213.07	57,614.53
3	205,012.05	122,175.13	25,244.22	57,592.70
4	204,884.52	122,085.05	25,225.83	57,573.63
5	204,954.68	122,139.20	25,202.08	57,613.40
6	205,139.33	122,274.23	25,234.12	57,630.98
7	204,994.88	122,185.47	25,181.28	57,628.13
8	204,900.23	122,121.05	25,203.17	57,576.02
9	205,051.13	122,263.50	25,216.15	57,571.48
10	204,967.08	122,121.40	25,234.10	57,611.58
11	204,998.77	122,190.68	25,230.73	57,577.35
12	204,895.27	122,102.67	25,217.02	57,575.58
Average	***204,979.80***	***122,165.84***	***25,218.87***	***57,595.09***

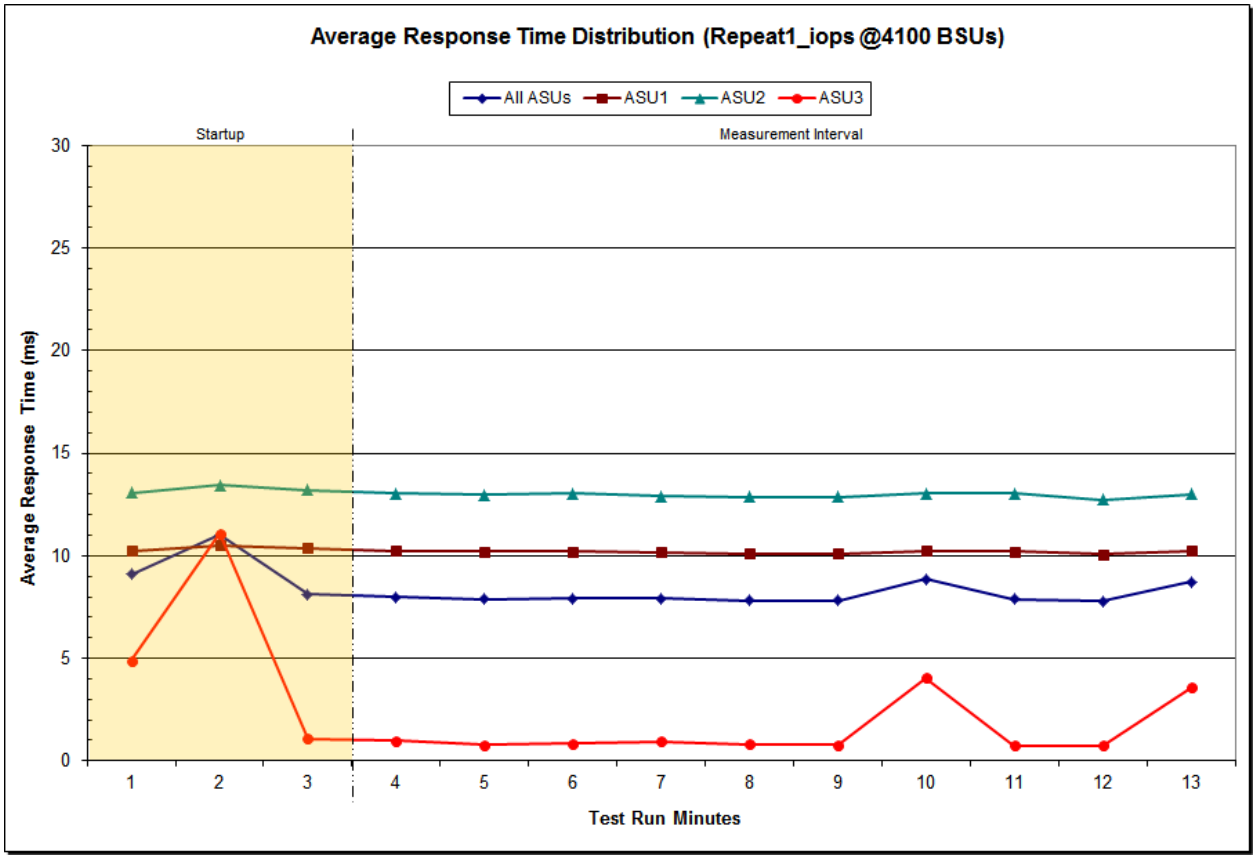
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

4,100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:25:29	19:28:30	0-2	0:03:01
Measurement Interval	19:28:30	19:38:30	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	9.09	10.25	13.06	4.89
1	11.02	10.51	13.43	11.07
2	8.11	10.38	13.22	1.08
3	7.98	10.24	13.02	0.99
4	7.89	10.19	12.97	0.79
5	7.93	10.21	13.02	0.86
6	7.91	10.17	12.91	0.94
7	7.83	10.11	12.87	0.80
8	7.83	10.11	12.87	0.78
9	8.85	10.25	13.03	4.05
10	7.90	10.20	13.04	0.75
11	7.77	10.06	12.72	0.74
12	8.71	10.24	13.00	3.59
Average	***8.06***	***10.18***	***12.94***	***1.43***

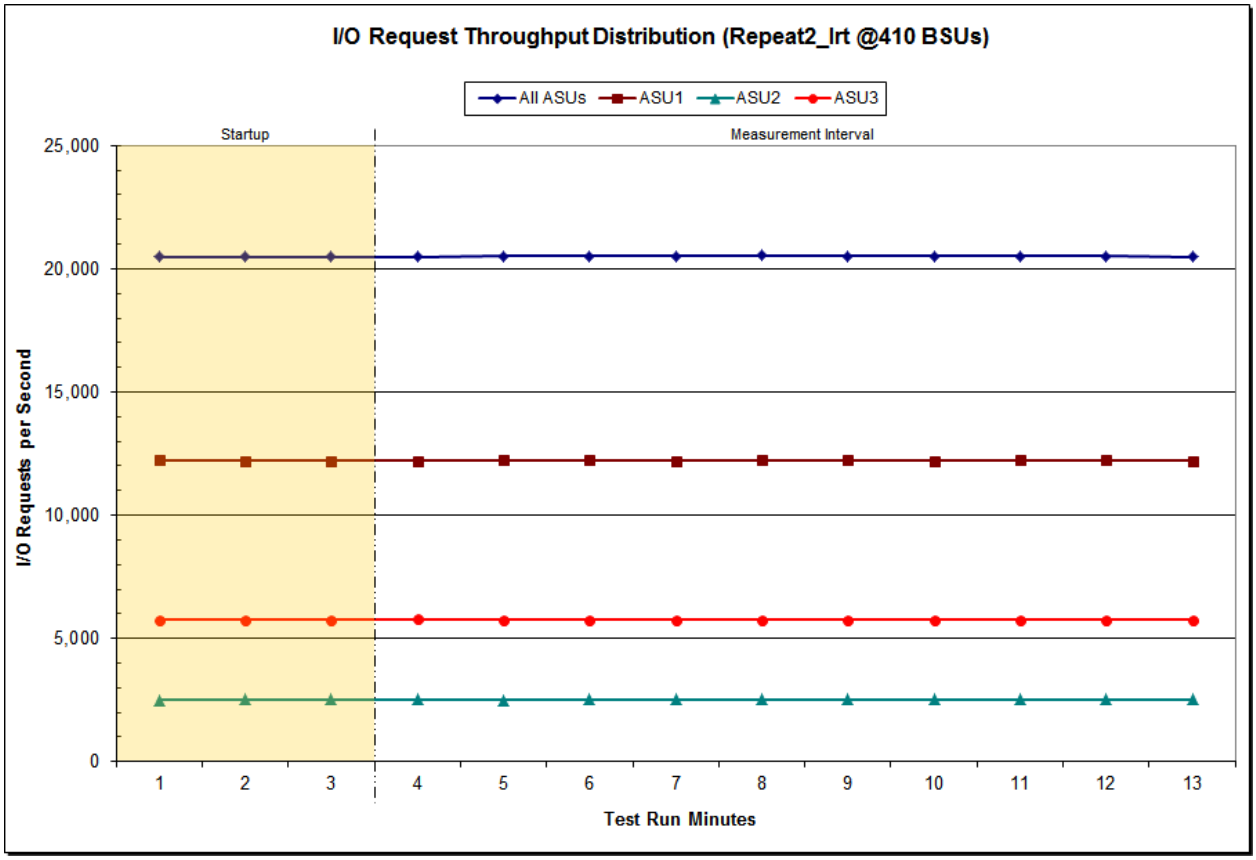
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

410 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:41:17	19:44:17	0-2	0:03:00
Measurement Interval	19:44:17	19:54:17	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	20,495.72	12,228.63	2,508.25	5,758.83
1	20,497.93	12,222.93	2,522.87	5,752.13
2	20,498.85	12,218.18	2,519.60	5,761.07
3	20,498.13	12,206.72	2,514.78	5,776.63
4	20,508.58	12,225.32	2,514.33	5,768.93
5	20,515.47	12,235.50	2,524.28	5,755.68
6	20,503.42	12,206.27	2,529.73	5,767.42
7	20,536.98	12,247.67	2,521.10	5,768.22
8	20,501.33	12,228.12	2,527.18	5,746.03
9	20,507.98	12,220.40	2,519.95	5,767.63
10	20,515.00	12,236.77	2,518.13	5,760.10
11	20,510.80	12,224.88	2,518.22	5,767.70
12	20,489.92	12,208.17	2,521.70	5,760.05
Average	***20,508.76***	***12,223.98***	***2,520.94***	***5,763.84***

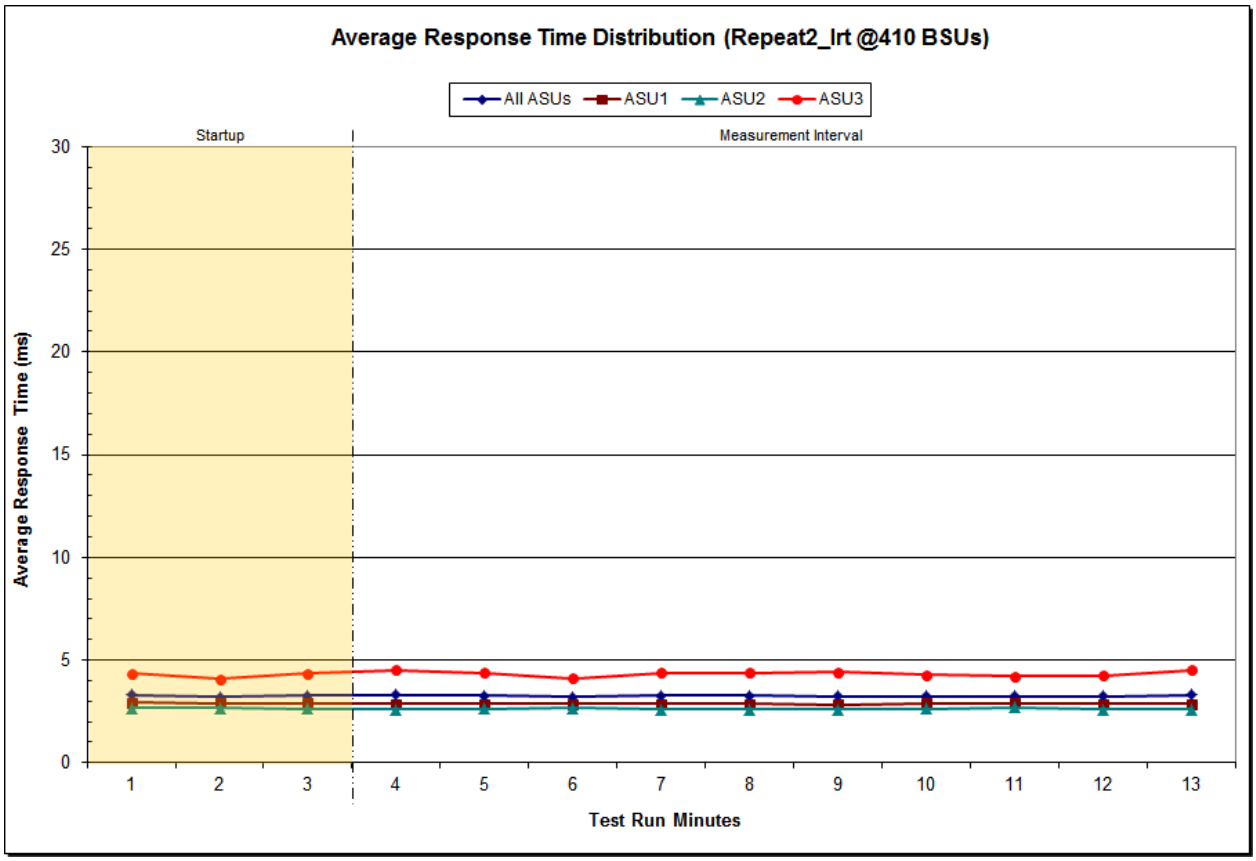
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

410 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:41:17	19:44:17	0-2	0:03:00
Measurement Interval	19:44:17	19:54:17	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	3.29	2.93	2.66	4.33
1	3.20	2.89	2.65	4.09
2	3.28	2.90	2.64	4.35
3	3.30	2.86	2.60	4.53
4	3.26	2.87	2.63	4.37
5	3.19	2.88	2.65	4.10
6	3.25	2.86	2.59	4.38
7	3.26	2.87	2.61	4.39
8	3.25	2.85	2.60	4.40
9	3.25	2.89	2.63	4.27
10	3.23	2.88	2.68	4.20
11	3.22	2.86	2.61	4.25
12	3.30	2.87	2.61	4.50
Average	***3.25***	***2.87***	***2.62***	***4.34***

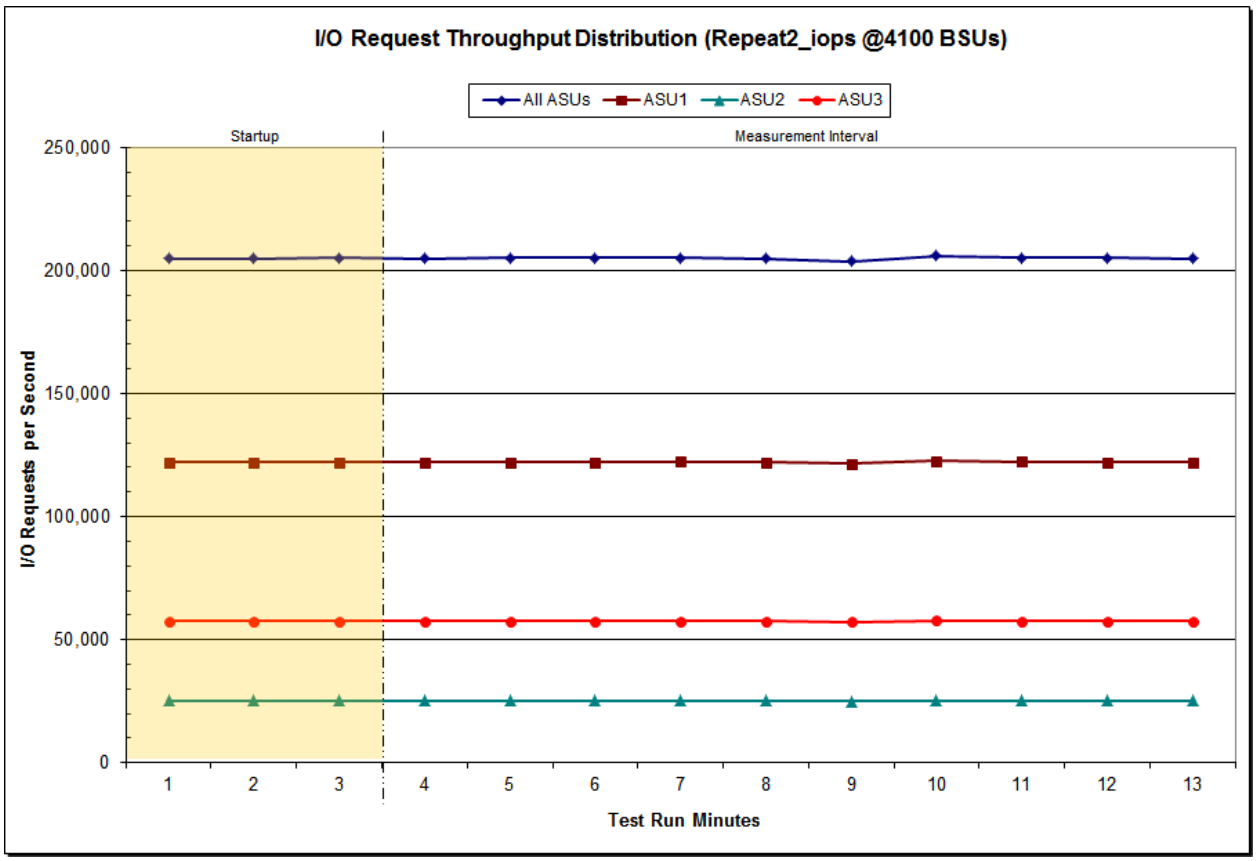
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

4,100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:56:51	19:59:52	0-2	0:03:01
Measurement Interval	19:59:52	20:09:52	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	205,010.80	122,161.90	25,208.35	57,640.55
1	204,894.17	122,133.58	25,180.13	57,580.45
2	205,033.82	122,203.18	25,191.93	57,638.70
3	204,947.45	122,152.22	25,211.10	57,584.13
4	205,067.83	122,230.23	25,199.47	57,638.13
5	205,015.30	122,202.78	25,225.28	57,587.23
6	205,030.93	122,245.30	25,246.80	57,538.83
7	204,989.57	122,128.83	25,210.90	57,649.83
8	203,823.67	121,466.58	25,089.25	57,267.83
9	206,074.52	122,761.73	25,358.03	57,954.75
10	205,056.07	122,255.28	25,211.15	57,589.63
11	205,036.82	122,155.12	25,222.83	57,658.87
12	204,933.67	122,129.93	25,201.25	57,602.48
Average	***204,997.58***	***122,172.80***	***25,217.61***	***57,607.17***

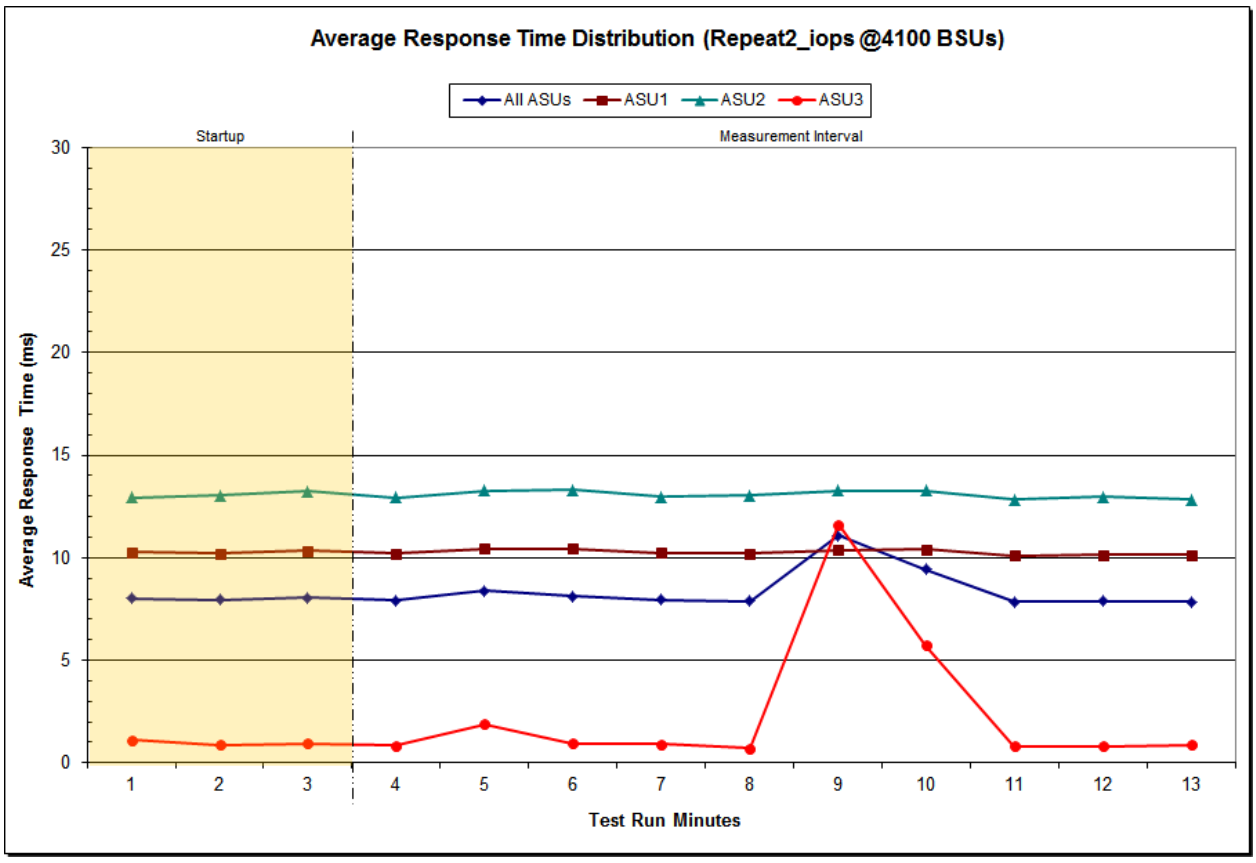
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

4,100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:56:51	19:59:52	0-2	0:03:01
Measurement Interval	19:59:52	20:09:52	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	8.02	10.26	12.93	1.12
1	7.94	10.22	13.02	0.87
2	8.07	10.35	13.23	0.96
3	7.92	10.21	12.93	0.86
4	8.38	10.44	13.27	1.89
5	8.12	10.43	13.32	0.95
6	7.95	10.24	12.97	0.90
7	7.88	10.20	13.04	0.72
8	11.08	10.37	13.26	11.63
9	9.44	10.40	13.28	5.72
10	7.84	10.12	12.84	0.82
11	7.87	10.15	12.97	0.82
12	7.87	10.13	12.85	0.88
Average	***8.44***	***10.27***	***13.07***	***2.52***

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.*

Clauses5.1.10 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	0.2807	0.0700	0.2102	0.0180	0.0701	0.0350	0.2811
COV	0.004	0.002	0.002	0.002	0.004	0.003	0.005	0.001

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
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2099	0.0180	0.0700	0.0350	0.2810
COV	0.002	0.001	0.002	0.001	0.002	0.001	0.002	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
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2811	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.003	0.001	0.003	0.001	0.006	0.004	0.004	0.002

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
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	0.001	0.001	0.001	0.002	0.001	0.001	0.001

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 74.

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

Data Persistence Test Results	
Data Persistence Test Run Number: 1	
Total Number of Logical Blocks Written	165,616,288
Total Number of Logical Blocks Verified	65,166,736
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks	10 minutes
Size in bytes of each Logical Block	512
Number of Failed I/O Requests in the process of the Test	0

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 NEC Storage M510 as documented in this Full Disclosure Report is currently available 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 17.

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 17.

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 Remote Audit of the NEC Storage M510.

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 gigibyte (GiB) is equal to 1,073,741,824 (2^{30}) bytes.

A tebibyte (TiB) is equal to 1,099,511,627,776 (2^{40}) bytes.

A pebibyte (PiB) is equal to 1,125,899,906,842,624 (2^{50}) bytes.

An exbibyte (EiB) is equal to 1,152,921,504,606,846,967 (2^{60}) bytes.

SPC-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.

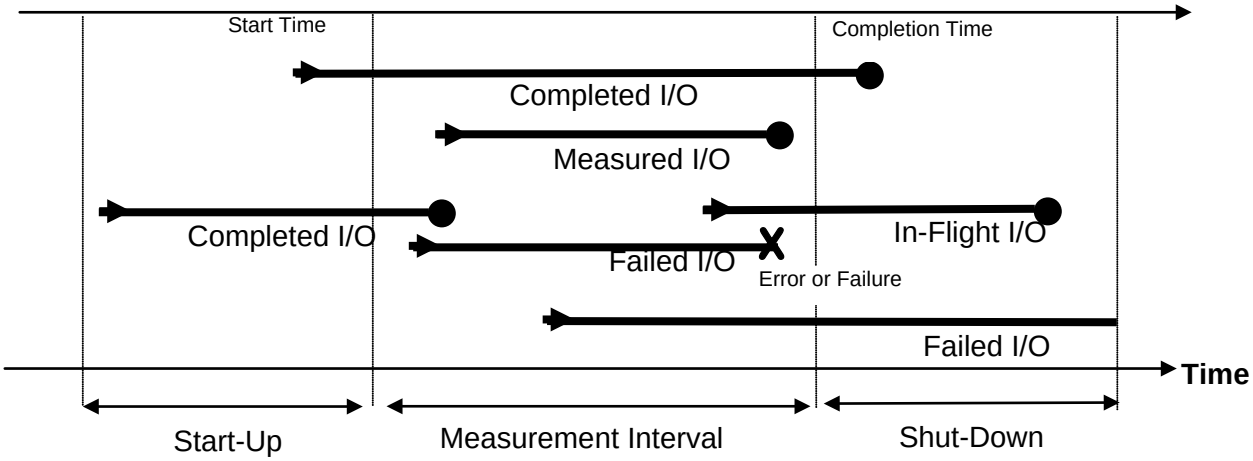
Steady State: The consistent and sustainable throughput of the TSC. During this period the load presented to the TSC by the Workload Generator is constant.

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

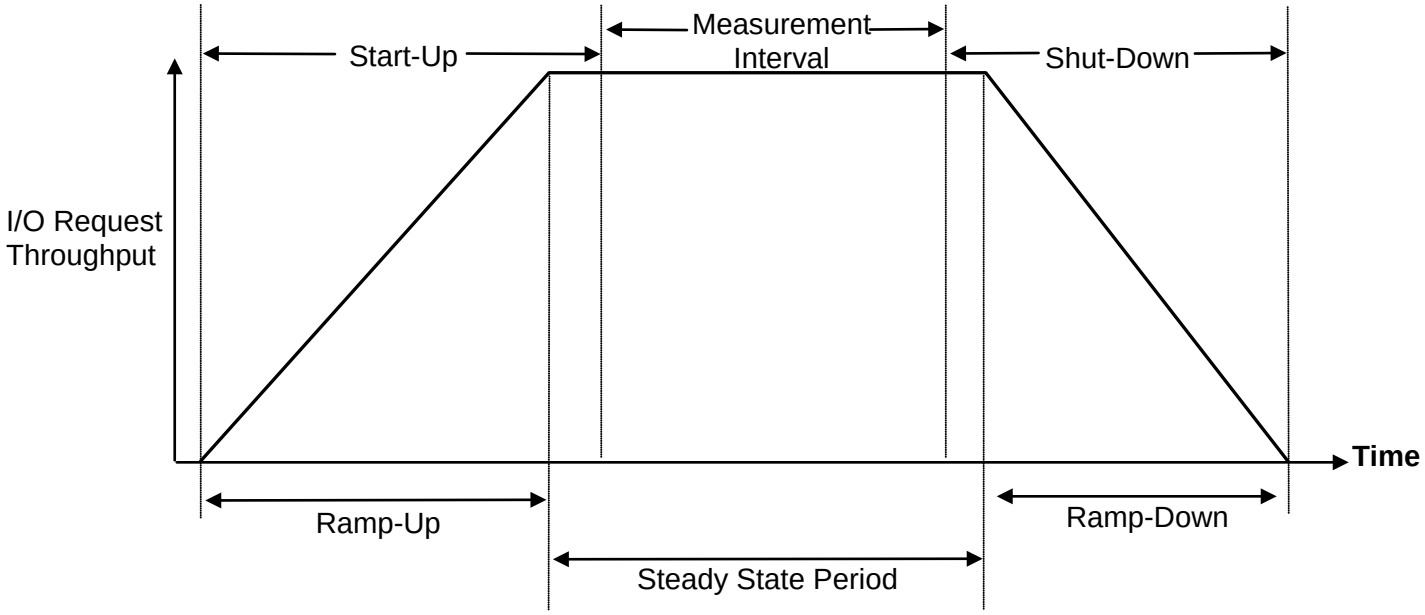
Test Run: The execution of SPC-1 for the purpose of producing or supporting an SPC-1 test result. SPC-1 Test Runs may have a finite and measured Ramp-Up period, Start-Up period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have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

There were no customer tunable parameters or options changed from their default values for the benchmark measurements.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

A CLI session is started with the NEC Storage M510, via one of the Host Systems, using telnet to enter the commands described below.

Telnet Login and Enter Maintenance Mode

Start a telnet client on one of the Host System and specify the IP address of the NEC Storage M510 *(10.1.0.11 is the default value).*

Enter ***sysadmin*** as the username at the first prompt and ***sys123*** *(default value)* at the second prompt to logon to the NEC Storage M510.

The following command will place the NEC Storage M510 into maintenance mode:

```
iSMcfg setseize -mode on
```

Create Volume Group (Pools)

The following commands will create 24 RAID-1 volume groups (pools), using 32 disk drives for each volume group:

```
iSMcfg poolbind -type dynamic -poolnumber 0000h -poolname Pool0000 -raid 1 -
pdg 00h -pdn 0000h-0007h,0800h-0807h,1000h-1007h,1800h-1807h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0001h -poolname Pool0001 -raid 1 -
pdg 00h -pdn 0008h-000fh,0808h-080fh,1008h-100fh,1808h-180fh -time 0

iSMcfg poolbind -type dynamic -poolnumber 0002h -poolname Pool0002 -raid 1 -
pdg 00h -pdn 0010h-0017h,0810h-0817h,1010h-1017h,1810h-1817h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0003h -poolname Pool0003 -raid 1 -
pdg 00h -pdn 0100h-0107h,0900h-0907h,1100h-1107h,1900h-1907h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0004h -poolname Pool0004 -raid 1 -
pdg 00h -pdn 0108h-010fh,0908h-090fh,1108h-110fh,1908h-190fh -time 0

iSMcfg poolbind -type dynamic -poolnumber 0005h -poolname Pool0005 -raid 1 -
pdg 00h -pdn 0110h-0117h,0910h-0917h,1110h-1117h,1910h-1917h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0006h -poolname Pool0006 -raid 1 -
pdg 00h -pdn 0200h-0207h,0a00h-0a07h,1200h-1207h,1a00h-1a07h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0007h -poolname Pool0007 -raid 1 -
pdg 00h -pdn 0208h-020fh,0a08h-0a0fh,1208h-120fh,1a08h-1a0fh -time 0

iSMcfg poolbind -type dynamic -poolnumber 0008h -poolname Pool0008 -raid 1 -
pdg 00h -pdn 0210h-0217h,0a10h-0a17h,1210h-1217h,1a10h-1a17h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0009h -poolname Pool0009 -raid 1 -
pdg 00h -pdn 0300h-0307h,0b00h-0b07h,1300h-1307h,1b00h-1b07h -time 0

iSMcfg poolbind -type dynamic -poolnumber 000ah -poolname Pool000a -raid 1 -
pdg 00h -pdn 0308h-030fh,0b08h-0b0fh,1308h-130fh,1b08h-1b0fh -time 0

iSMcfg poolbind -type dynamic -poolnumber 000bh -poolname Pool000b -raid 1 -
pdg 00h -pdn 0310h-0317h,0b10h-0b17h,1310h-1317h,1b10h-1b17h -time 0

iSMcfg poolbind -type dynamic -poolnumber 000ch -poolname Pool000c -raid 1 -
pdg 00h -pdn 2000h-2007h,2800h-2807h,3000h-3007h,3800h-3807h -time 0
```

```
iSMcfg poolbind -type dynamic -poolnumber 000dh -poolname Pool000d -raid 1 -
pdg 00h -pdn 2008h-200fh,2808h-280fh,3008h-300fh,3808h-380fh -time 0

iSMcfg poolbind -type dynamic -poolnumber 000eh -poolname Pool000e -raid 1 -
pdg 00h -pdn 2010h-2017h,2810h-2817h,3010h-3017h,3810h-3817h -time 0

iSMcfg poolbind -type dynamic -poolnumber 000fh -poolname Pool000f -raid 1 -
pdg 00h -pdn 2100h-2107h,2900h-2907h,3100h-3107h,3900h-3907h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0010h -poolname Pool0010 -raid 1 -
pdg 00h -pdn 2108h-210fh,2908h-290fh,3108h-310fh,3908h-390fh -time 0

iSMcfg poolbind -type dynamic -poolnumber 0011h -poolname Pool0011 -raid 1 -
pdg 00h -pdn 2110h-2117h,2910h-2917h,3110h-3117h,3910h-3917h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0012h -poolname Pool0012 -raid 1 -
pdg 00h -pdn 2200h-2207h,2a00h-2a07h,3200h-3207h,3a00h-3a07h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0013h -poolname Pool0013 -raid 1 -
pdg 00h -pdn 2208h-220fh,2a08h-2a0fh,3208h-320fh,3a08h-3a0fh -time 0

iSMcfg poolbind -type dynamic -poolnumber 0014h -poolname Pool0014 -raid 1 -
pdg 00h -pdn 2210h-2217h,2a10h-2a17h,3210h-3217h,3a10h-3a17h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0015h -poolname Pool0015 -raid 1 -
pdg 00h -pdn 2300h-2307h,2b00h-2b07h,3300h-3307h,3b00h-3b07h -time 0

iSMcfg poolbind -type dynamic -poolnumber 0016h -poolname Pool0016 -raid 1 -
pdg 00h -pdn 2308h-230fh,2b08h-2b0fh,3308h-330fh,3b08h-3b0fh -time 0

iSMcfg poolbind -type dynamic -poolnumber 0017h -poolname Pool0017 -raid 1 -
pdg 00h -pdn 2310h-2317h,2b10h-2b17h,3310h-3317h,3b10h-3b17h -time 0
```

Create Logical Disks

The following commands will create 24 logical disks, one per volume group:

```
iSMcfg ldbind -poolnumber 0000h -ldn 0000h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0001h -ldn 0001h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0002h -ldn 0002h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0003h -ldn 0003h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0004h -ldn 0004h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0005h -ldn 0005h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0006h -ldn 0006h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0007h -ldn 0007h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0008h -ldn 0008h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0009h -ldn 0009h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 000ah -ldn 000ah  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 000bh -ldn 000bh  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 000ch -ldn 000ch  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 000dh -ldn 000dh  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 000eh -ldn 000eh  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 000fh -ldn 000fh  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0010h -ldn 0010h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0011h -ldn 0011h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0012h -ldn 0012h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0013h -ldn 0013h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0014h -ldn 0014h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0015h -ldn 0015h  -capacity 4000 -unit gb -time 0
iSMcfg ldbind -poolnumber 0016h -ldn 0016h  -capacity 4000 -unit gb -time 0
```

```
iSMcfg ldbind -poolnumber 0017h -ldn 0017h  -capacity 4000 -unit gb -time 0
```

Exit Maintenance Mode and Telnet Logoff

The following command will exit maintenance mode:

```
iSMcfg setseize -mode off -force
```

The telnet session is terminated with the ***exit*** command.

SPC-1 Logical Volume Creation

The table, listed below, describes the relationship between the logical disks, created in the previous step, and the Windows "Disks" used to create the SPC-1 Logical Volumes.

Windows "Disk"	Logical Disk Number (ldn)	SPC-1 Logical Volume
DISK1	0000	ASU3
DISK2	0001	ASU1/2
DISK3	0002	ASU1/2
DISK4	0003	ASU1/2
DISK5	0004	ASU1/2
DISK6	0005	ASU1/2
DISK7	0006	ASU1/2
DISK8	0007	ASU1/2
DISK9	0008	ASU1/2
DISK10	0009	ASU1/2
DISK11	000a	ASU1/2
DISK12	000b	ASU1/2
DISK13	000c	ASU1/2
DISK14	000d	ASU3
DISK15	000e	ASU1/2
DISK16	000f	ASU1/2
DISK17	0010	ASU1/2
DISK18	0011	ASU1/2
DISK19	0012	ASU1/2
DISK20	0013	ASU1/2
DISK21	0014	ASU1/2
DISK22	0015	ASU1/2
DISK23	0016	ASU1/2
DISK24	0017	ASU1/2

The following steps are executed on a single Host System, using the Windows Disk Management utility, to create the SPC-1 Logical Volumes.

a) Start the Windows Disk Management utility and confirm that the 24 logical disks are presented as 24 Windows "Disks".

b) Convert all 24 Windows "Disks" to GPT Disks.

c) Convert all 24 Windows "Disks" to Dynamic Disks.

d) Create a Windows striped (RAID-0) volume for ASU-3 as follows:
   i. Select Windows "Disk 1" and "Disk14".
   ii. Set the capacity of each stripe to 4,095,870 MB
   iii. Assign drive letter "G" to the volume.
   iv. Do not format the volume.

e) Create a Windows striped (RAID-0) volume for ASU-1 as follows:
   i. Select the remaining 22 Windows "Disks" *("Disk2"-"Disk13", "Disk15"-"Disk24")*.
   ii. Set the capacity of each stripe to 1,675,590 MB
   iii. Assign drive letter "E" to the volume.
   iv. Do not format the volume.

f) Create a Windows striped (RAID-0) volume for ASU-2 as follows:
   i. Select the same 22 Windows "Disks" used to create ASU-1 *("Disk2"-"Disk13", "Disk15"-"Disk24")*.
   ii. Set the capacity of each stripe to 1,675,590 MB
   iii. Assign drive letter "F" to the volume.
   iv. Do not format the volume.

g) Reboot all of the Host Systems.

h) After the reboot completes, start the Windows Disk Management utility on each of the Host Systems.

i) On each Host System, select either the import foreign disk or reactivate Windows stripe sets option, as necessary, then assign drive letters to the stripe sets as were defined in steps **'d' – 'f'** above.

Note: The values listed above as MB represent 1,048,576 bytes (MiB) per unit rather than 1,000,000 bytes.

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=default,threads=8

sd=sd1,lun=\\.\e:,size=38653474635776
sd=sd2,lun=\\.\f:,size=38653474635776
sd=sd3,lun=\\.\g:,size=8589661962240

wd=default,rdpct=0,seek=-1,xfersize=1048576
wd=wd1,sd=sd1
wd=wd2,sd=sd2
wd=wd3,sd=sd3
rd=PREPSSD,wd=wd*,iorate=max,elapsed=999990,interval=10
```

Primary Metrics and Repeatability Tests

The content of SPC-1 Workload Generator command and parameter file used in this benchmark to execute the Primary Metrics *(Sustainability Test Phase, IOPS Test Phase, and Response Time Ramp Test Phase)* and Repeatability *(Repeatability Test Phase 1 and Repeatability Test Phase 2)* Tests is listed below.

```
* spc1_metrics.cfg

host=master
# 5slv x 7sv + 6slv x 1sv (ns59/60/61/62/63/64/65/66)
slaves=(ns59_1,ns59_2,ns59_3,ns59_4,ns59_5,ns60_1,ns60_2,ns60_3,ns60_4,ns60_5,ns61_1
,ns61_2,ns61_3,ns61_4,ns61_5,ns62_1,ns62_2,ns62_3,ns62_4,ns62_5,ns63_1,ns63_2,ns63_3
,ns63_4,ns63_5,ns64_1,ns64_2,ns64_3,ns64_4,ns64_5,ns65_1,ns65_2,ns65_3,ns65_4,ns65_5
,ns66_1,ns66_2,ns66_3,ns66_4,ns66_5,ns66_6)

sd=asu1_1,lun=\\.\e:,size=38653474635776
sd=asu2_1,lun=\\.\f:,size=38653474635776
sd=asu3_1,lun=\\.\g:,size=8589661962240
```

SPC-1 Persistence

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

```
* spc1_persist.cfg

sd=asu1_1,lun=\\.\e:,size=38653474635776
sd=asu2_1,lun=\\.\f:,size=38653474635776
sd=asu3_1,lun=\\.\g:,size=8589661962240
```

Slave JVMs

The Slave JVM command and parameter files are documented in the Slave JVMs section of *Appendix E: SPC-1 Workload Generator Input Parameters*.

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

There were 41 Slave JVMs used in the Primary Metrics and Repeatability Tests. Those Slave JVMs were started as the first step in the execution sequence. The Slave JVMs section below documents that step.

The following script, **master_script_1_M510.bat**, was executed to invoke the following in an uninterrupted execution sequence:

- A script, **profile.bat**, to capture the first detailed TSC system profile listing required for a SPC-1 Remote Audit.
- The ASU pre-fill script, **prepssd.bat**.
- The commands to execute the 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)*, and SPC-1 Persistence Test Run 1 *(write phase)*.
- A script, **shutdown.bat**, to power off the TSC.

The following script, **master_script_2_M510.bat**, was executed after the required TSC power off/power on cycle to invoke the following:

- The command to execute the SPC-1 Persistence Test Run 2 *(read phase)*.
- A script, **profile.bat**, to capture the second detailed TSC system profile listing required for a SPC-1 Remote Audit.

Slave JVMs

There were 51 Slave JVMs used in the Primary Metrics and Repeatability Tests. The script, **start_slave_5.bat**, listed below, illustrates the commands to start the five Slave JVMs (**ns59_s1 – ns59_s5**) that executed on the first Host System (**ns59**).

start_slave_5.bat

```
start java -Xmx1024m -Xms1024m spc1 -fns59_s1.parm -ons59_s1
start java -Xmx1024m -Xms1024m spc1 -fns59_s2.parm -ons59_s2
start java -Xmx1024m -Xms1024m spc1 -fns59_s3.parm -ons59_s3
start java -Xmx1024m -Xms1024m spc1 -fns59_s4.parm -ons59_s4
start java -Xmx1024m -Xms1024m spc1 -fns59_s5.parm -ons59_s5
```

The following scripts were used to start the remaining 36 Slave JVMs on the remaining seven Host Systems (**ns60 – ns66**):

- **ns60: start_slave_5.bat**
- **ns61: start_slave_5.bat**
- **ns62: start_slave_5.bat**
- **ns63: start_slave_5.bat**
- **ns64: start_slave_5.bat**
- **ns65: start_slave_5.bat**
- **ns66: start_slave_6.bat**

The file, listed below, is the configuration file for the first Slave JVM (**ns59_s1**).

ns59_s1.parm

```
host=ns59_1
master=192.168.10.161

sd=asu1_1,lun=\\.\e:
sd=asu2_1,lun=\\.\f:
sd=asu3_1,lun=\\.\g:
```

The following sets of configuration files were used for the remaining 36 Slave JVMs. The only difference in the remaining 40 configuration file is the host= parameter value, which specifies the appropriate Slave JVM (**ns59_s2**…**ns66_s6**).

- **ns59_s2.parm** – **ns59_s5.parm**
- **ns60_s1.parm** – **ns60_s5.parm**
- **ns61_s1.parm** – **ns61_s5.parm**
- **ns62_s1.parm** – **ns62_s5.parm**
- **ns63_s1.parm** – **ns63_s5.parm**
- **ns64_s1.parm** – **ns64_s5.parm**
- **ns65_s1.parm** – **ns65_s5.parm**
- **ns66_s1.parm** – **ns66_s6.parm**

master_script_M510.bat

```
call profile.bat
call prepssd.bat

copy /y spc1_metrics.cfg spc1.cfg
java metrics -b 4100 -t 28800
java repeat1 -b 4100
java repeat2 -b 4100

copy /y spc1_persist.cfg spc1.cfg
java persist1 -b 4100

call shutdown.bat
```

Detailed TSC System Profile

The following script and command file were used to capture the detailed TSC profile listings required for a Remote Audit.

profile.bat

```
c:\spc\teraterm\ttermpro.exe /M=C:\spc\teraterm\M510_profile.ttl
```

M510_profile.ttl

```
;; connection user/password
HOSTADDR = '192.168.70.240'
USERNAME = 'sysadmin'
PASSWORD = 'sys123'
;================================================
;; config
COMMAND = HOSTADDR
strconcat COMMAND ':23 /nossh /T=1'
;; connect
connect COMMAND
;; login
wait 'login: '
sendln USERNAME
wait 'Password: '
sendln PASSWORD

;; command1
wait 'sysadmin@M510-0# '
sendln 'iSMenv gettime'

;; command2
wait 'sysadmin@M510-0# '
sendln 'iSMview -all'

;; command3
wait 'sysadmin@M510-0# '
sendln 'iSMenv gettime'

;; finish
sendln 'exit'

end
```

ASU Pre-Fill

The following script was invoked to execute the required ASU pre-fill using the command and parameter file documented in *Appendix D: SPC-1 Workload Generator Storage Commands and Parameters* on page 72.

prepssd.bat

```
c:\spc\vdbench503rc11\vdbenchJRE32 -f c:\spc\prepssd.txt -o c:\spc\ssdprep
```

TSC Power Off

The following script and command file were used to execute the required TSC power off after completion of SPC-1 Persistence Test Run 1.

shutdown.bat

```
c:\spc\teraterm\ttermpro.exe /M=c:\spc\teraterm\M510_shutdown.ttl
```

M510_shutdown.ttl

```
;; connection user/password
HOSTADDR = '192.168.70.240'
USERNAME = 'sysadmin'
PASSWORD = 'sys123'
;================================================
;; config
COMMAND = HOSTADDR
strconcat COMMAND ':23 /nossh /T=1'
;; connect
connect COMMAND
;; login
wait 'login: '
sendln USERNAME
wait 'Password: '
sendln PASSWORD

;; command1
wait 'sysadmin@M510-0# '
sendln 'iSMenv gettime'

;; command2
wait 'sysadmin@M510-0# '
sendln 'iSMview -all'

;; command3
wait 'sysadmin@M510-0# '
sendln 'iSMcfg shutdown -time 5'

;; finish
sendln 'exit'

end
```

SPC-1 Persistence Test Run 2 *(read phase)*

The following script, was executed after the required TSC power off/power on cycle to invoke the following:

- The command to execute the SPC-1 Persistence Test Run 2 *(read phase)*.
- A script, **profile.bat**, to capture the second detailed TSC system profile listing required for a SPC-1 Remote Audit.

master_script_2_M510.bat

```
java persist2

call profile.bat
```