SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

TEXAS MEMORY SYSTEMS, INC.
TEXAS MEMORY SYSTEMS RAMSAN-620

SPC-1 V1.11

Submitted for Review: October 27, 2009
Submission Identifier: A00085

First Edition – October 2009

Trademarks

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AUDIT CERTIFICATION

Matt Key
Texas Memory Systems, Inc.
10777 Westheimer Road, Suite 600
Houston, TX 77042

October22, 2009

The SPC Benchmark 1™ results listed below for the Texas Memory Systems RamSan-620 were produced in compliance with the SPC Benchmark 1™ 1.11 Onsite Audit requirements.

SPC Benchmark 1™ 1.11 Results	
Tested Storage Configuration (TSC) Name: Texas Memory Systems RamSan-620	
Metric	**Reported Result**
SPC-1 IOPS™	254,994.21
SPC-1 Price-Performance	$1.13/SPC-1 IOPS™
Total ASU Capacity	4,896.143 GB
Data Protection Level	Protected *(RAID-5)*
Total TSC Price (including three-year maintenance)	$287,858

The following SPC Benchmark 1™ Onsite Audit requirements were reviewed and found compliant with 1.11 of the SPC Benchmark 1™ specification:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items, based on information supplied by Texas Memory Systems, Inc.:
  - ✓ 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.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters that were changed from default values.

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643 Bair Island Road, Suite 103
Redwood City, CA 94062
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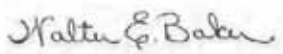
AUDIT CERTIFICATION *(CONT.)*

- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.
- The following Host System requirements, based on information supplied by Texas Memory Systems, Inc.:
  - ✓ The type of Host System 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 Test Results Files and resultant Summary Results Files received from Texas Memory Systems, Inc. for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability Test
- There were no differences between the Tested Storage Configuration and the 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

TMS
TEXAS MEMORY SYSTEMS

October 1, 2009
From: Woody Hutsell, President, Texas Memory Systems

Subject: SPC-1 Letter of Good Faith for the RamSan-620

Texas Memory Systems 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 Version 1.11 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: _____
Woody Hutsell, President

Date: 10/1/2009
10/1/2009

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Texas Memory Systems, Inc. – http://www.texmemsys.com/ Matt Key – matt.k@ramsan.com 10777 Westheimer Road, Suite 600 Houston, TX 77042 Phone (713) 278-6272 FAX: (713) 266-0332
Test Sponsor Alternate Contact	Texas Memory Systems, Inc. – http://www.texmemsys.com/ Jamon Bowen – jamon.b@ramsan.com 10777 Westheimer Road, Suite 600 Houston, TX 77042 Phone (713) 266-3200 FAX: (713) 266-0332
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	V1.11
SPC-1 Workload Generator revision number	V2.1.0
Date Results were first used publicly	October 27, 2009
Date the FDR was submitted to the SPC	October 27, 2009
Date the priced storage configuration is available for shipment to customers	currently available
Date the TSC completed audit certification	October 22, 2009

Tested Storage Product (TSP) Description

The Texas Memory Systems' RamSan-620 rack mounted SLC NAND Flash system is a 2U enterprise class designed solid state disk offering scalable performance and affordable high capacity that is space and power efficient. In addition it offers:

- 1-5TB usable SLC NAND Flash storage capacity
- ECC and RAID protection designed in at the chip level for the ultimate reliability
- Extremely low latency, delivering 250,000 IOPs and 3GB/s random throughput
- Fibre Channel or Infiniband connectivity
- Highly "green" profile at 230 watts typical power consumption

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: Texas Memory Systems RamSan-620	
Metric	**Reported Result**
SPC-1 IOPS™	254,994.21
SPC-1 Price-Performance	$1.13/SPC-1 IOPS™
Total ASU Capacity	4,896.143 GB
Data Protection Level	Protected *(RAID-5)*
Total TSC Price (including three-year maintenance)	$287,858

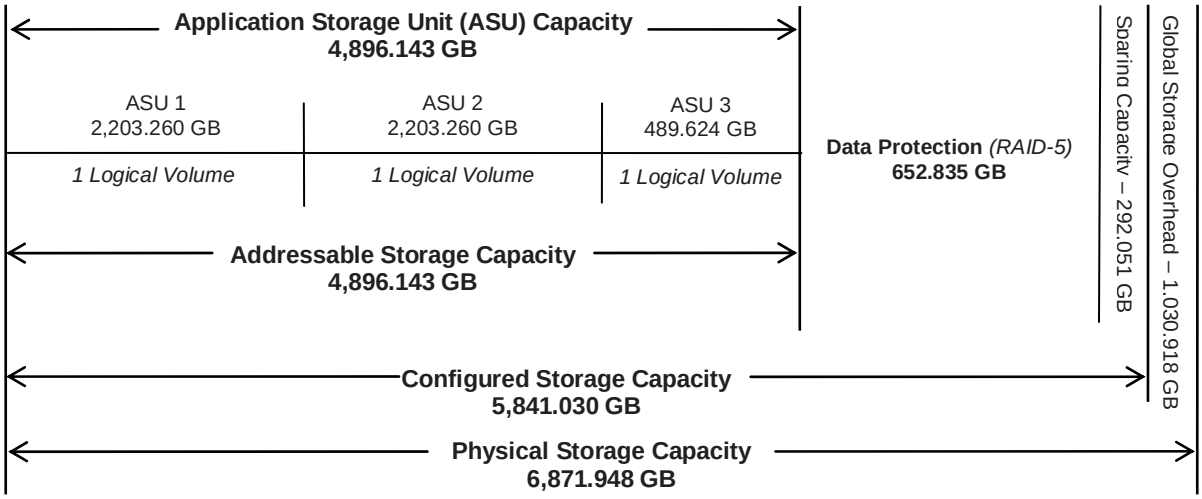
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

A **Data Protection Level** of **Protected** using ***RAID-5*** provided data protection by distributing check data corresponding to user data across multiple storage elements in each Storage Device in the form of bit-by-bit parity. In addition, ECC data protection was provided at the sector level.

Storage Capacities, Relationships, and Utilization

The following diagram and table document the various storage capacities, used in this benchmark, and their relationships, as well as the storage utilization values required to be reported.



SPC-1 Storage Capacity Utilization	
Application Utilization	71.25%
Protected Application Utilization	80.75%
Unused Storage Ratio	0.00%

Application Utilization: Total ASU Capacity *(4,896.143 GB)* divided by Physical Storage Capacity *(6,871.948 GB)*

Protected Application Utilization: (Total ASU Capacity *(4,896.143 GB)* plus total Data Protection Capacity *(652.835 GB)* minus unused Data Protection Capacity (0.000 *GB)* divided by Physical Storage Capacity *(6,871.948 GB)*

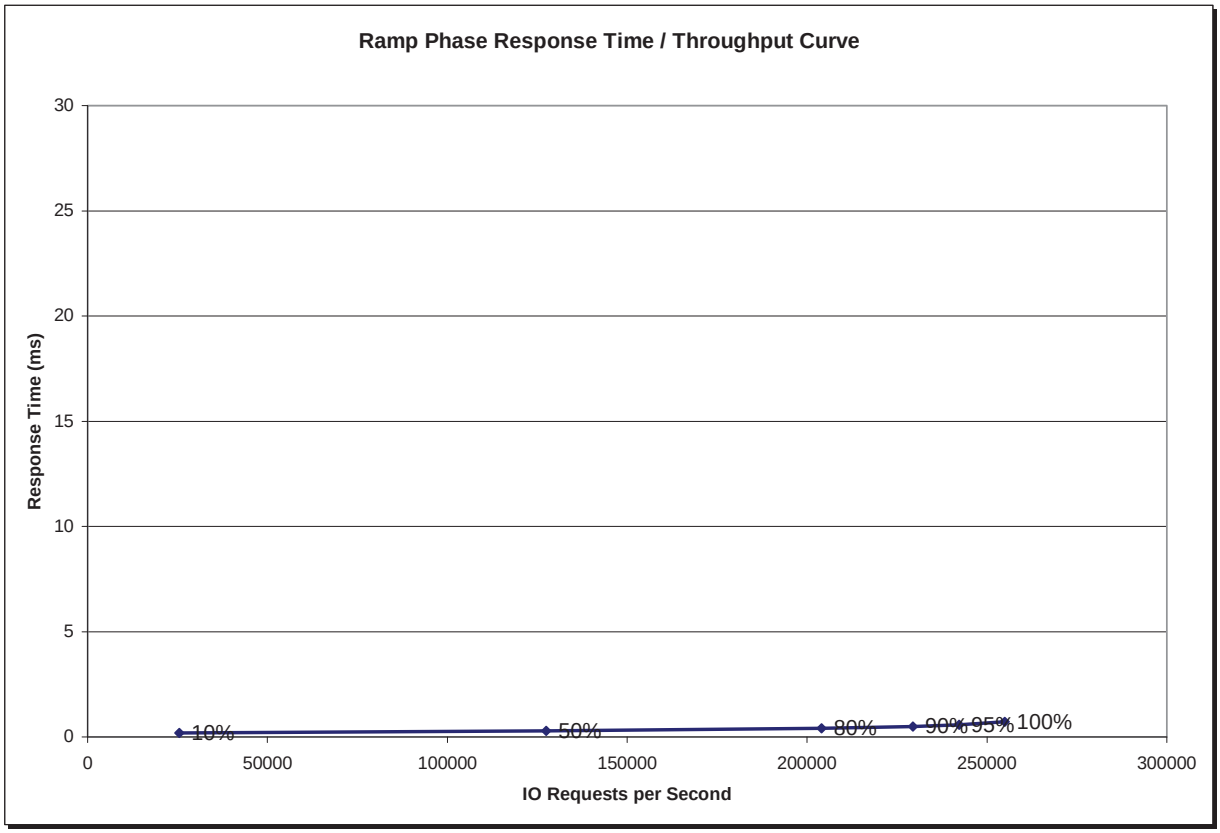
Unused Storage Ratio: Total Unused Capacity *(0.000 GB)* divided by Physical Storage Capacity *(6,871.948 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 18-19 in the Full Disclosure Report.

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	25,505.41	127,521.34	203,995.39	229,490.10	242,258.35	254,994.21
Average Response Time (ms):						
All ASUs	0.19	0.29	0.41	0.49	0.57	0.72
ASU-1	0.21	0.30	0.40	0.47	0.54	0.70
ASU-2	0.17	0.27	0.37	0.44	0.50	0.60
ASU-3	0.15	0.29	0.45	0.56	0.65	0.82
Reads	0.27	0.34	0.41	0.46	0.50	0.62
Writes	0.13	0.26	0.41	0.51	0.61	0.79

Priced Storage Configuration Pricing

Ln #	Qty	Part	Description	Unit Price	Ext. Price
HARDWARE					
1	1	U-RamSan-620/5TB	5-TB RamSan-620 Includes: 5TB Flash storage 1-FC140 (dual ported 4Gbit Fibre Channel). Redundant batteries, fans and power modules.	$ 220,000	$ 220,000
2	3	U-FC-140	Additional Dual 4-Gb Fibre Channel Link. Up to three additional links can be ordered.	$3,000	$ 9,000
3	1	U-620-ActiveSpare	Firmware feature that enables designation of one FTF card as an active spare.	$4,000	$ 4,000
Hardware List Price					$ 233,000
Hardware Discount				0%	$ -
HARDWARE SUB-TOTAL					**$ 233,000**
SUPPORT					
3	1	U-620-Critical-Year1	Advanced Parts Replacement with 7x24x4 on-site service for one year, which must run concurrent with first year of warranty. If this SKU is ordered, [24x7-Phone-Support] and [SparesKit] must be ordered per site. Customer is responsible for shipping. Price and availability may vary based on location.*	$4000/unit	$ 4,000
4	1	U-620-Critical-AddYr	Advanced Parts Replacement with 7x24x4 on-site Service for one year. [24x7-Phone-Support] must be ordered per site. Customer is responsible for shipping. Price and availability may vary based on location. Maximum of two additional years of on-site service can be ordered.*	$4000/unit + 5% of hardware list	$ 15,650
5	1	U-620-Critical-AddYr	Advanced Parts Replacement with 7x24x4 on-site Service for one year. [24x7-Phone-Support] must be ordered per site. Customer is responsible for shipping. Price and availability may vary based on location. Maximum of two additional years of on-site service can be ordered.*	$4000/unit + 5% of hardware list	$ 15,650
6	3	U-24x7-Phone-Support	One-year 24x7 technical support by phone per site.	$ 1,000	$ 3,000
7	1	U-620-SparesKit/256GBFM	Includes 1 Power Supply, 1 Fan Bank, Spare 256GB Flash Module.	$ 8,750	$ 8,750
Support List Price					$ 47,050
Support Discount				0%	$ -
SUPPORT SUB-TOTAL					**$ 47,050**
ADDITIONAL ITEMS					
8	8	U-QLE2460	Qlogic 4gb Fibre channel host bus adapters	$929	$ 7,432
9	8	U-3MLCLC	Three meter LC-LC fibre channel cable	$22	$ 176
ADDITIONAL ITEMS SUB-TOTAL					**$ 7,608**
10	1	Shipping	Overnight courier service	$200	$ 200
TOTAL PURCHASE PRICE					**$ 287,858**

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

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

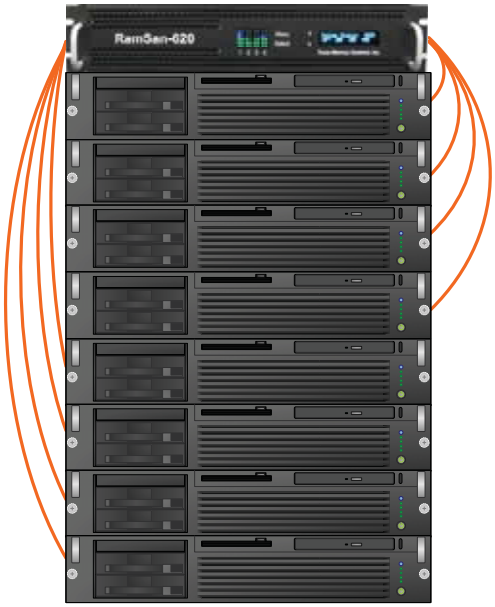
Benchmark Configuration (BC)/Tested Storage Configuration (TSC) Priced Storage Configuration Diagram

Texas Memory Systems RamSan-620

4 – dual port 4Gb FC Controllers

20 – 320 GiB Solid State Devices

8 – Qlogic QLE2462 HBAs



8 – Supermicro AMD Opteron Host Systems

Benchmark Configuration/Tested Storage Configuration Priced Storage Configuration Components

Host System:	Tested Storage Configuration (TSC)/ Priced Storage Configuration:
8 – Supermicro AMD Opteron Servers, each with:	8 – Qlogic QLE2462 4Gb dual-port PCIe HBAs
2 – AMD Opteron Model 275 dual core 2.2 GHz CPUs	**Texas Memory Systems RamSan-620** 4 – dual port 4Gb FC controllers 16 GB controller cache *(768 MiB/Solid State Device)* 8 – 4Gb Fibre Channel front-end connections 4 – proprietary bus backend connections 20 – 320 GiB Solid State Devices
2 x 1024 KB L2 cache per CPU	
4 GB main memory	
Windows Server 2003 Enterprise Edition with SP2	
TMS MPIO Driver 1.1.5	
PCI	
WG	

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 15 *(Benchmark Configuration/Tested Storage Configuration/Priced 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 TSC did not utilize network storage.

Host System 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). Table 9-10 specifies the content, format, and appearance of the table.

The Host System and TSC table of components may be found on page 15 *(Benchmark Configuration/Tested Storage Configuration / Priced Storage Configuration Components)*.

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 60 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 61 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 63.

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 56 contains definitions of terms specific to the SPC-1 Data Repository.

Storage Capacities and Relationships

Clause 9.4.3.6.1

Two tables and an illustration documenting the storage capacities and relationships of the SPC-1 Storage Hierarchy (Clause 2.1) shall be included in the FDR.

SPC-1 Storage Capacities

SPC-1 Storage Capacities		
Storage Hierarchy Component	**Units**	**Capacity**
Total ASU Capacity	Gigabytes (GB)	4,896.143
Addressable Storage Capacity	Gigabytes (GB)	4,896.143
Configured Storage Capacity	Gigabytes (GB)	5,841.030
Physical Storage Capacity	Gigabytes (GB)	6,871.948
Data Protection *(RAID-5)*	Gigabytes (GB)	652.835
Required Storage *(configured spare)*	Gigabytes (GB)	292.051
Global Storage Overhead	Gigabytes (GB)	1,030.918
Total Unused Storage	Gigabytes (GB)	0.000

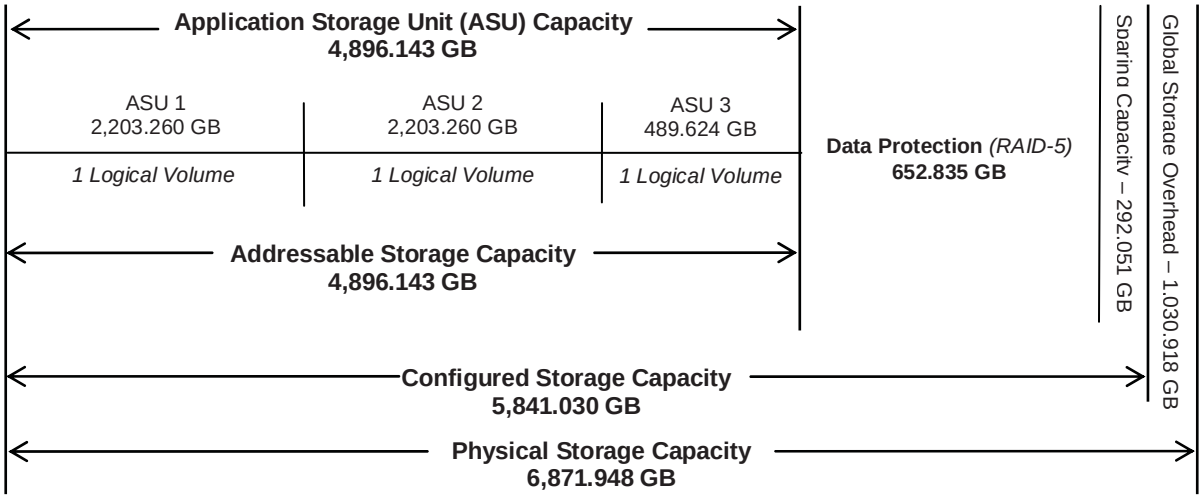
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	100.00%	83.82%	71.25%
Required for Data Protection *(RAID-5))*		11.18%	9.50%
Addressable Storage Capacity		83.82%	71.25%
Required Storage *(configured spare)*		5.00%	4.25%
Configured Storage Capacity			85.00%
Global Storage Overhead			15.00%
Unused Storage:			
Addressable	0.00%		
Configured		0.00%	
Physical			0.00%

The Physical Storage Capacity consisted of 6,871.948 GB distributed over 20 Solid State Devices *(SSDs)* each with a formatted capacity of 343.597 GB. There was 0.000 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 1,030.918 GB (15.00%) of Physical Storage Capacity. There was 0.000 GB (0.00%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 100% of the Addressable Storage Capacity resulting in 0.000 GB (0.00%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(RAID-5)* capacity was 652.835 GB of which 652.835 GB was utilized. The total Unused Storage was 0.000 GB.

SPC-1 Storage Capacities and Relationships Illustration

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



Logical Volume Capacity and ASU Mapping

Clause 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 (2,203.260 GB)	**ASU-2 (2,203.260 GB)**	**ASU-3 (489.624 GB)**
1 Logical Volumes 2,203.260 GB per Logical Volume (2,203.260 GB used per Logical Volume)	1 Logical Volumes 2,203.260 GB per Logical Volume (2,203.260 GB used per Logical Volume)	1 Logical Volumes 489.624 GB per Logical Volume (489.624 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was “RAID-5” as described on page 11. See “ASU Configuration” in the **IOPS Test Results File** for more detailed configuration information.

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	71.25%%
Protected Application Utilization	80.75%%
Unused Storage Ratio	0.00%

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. "SPC-1 Test Execution Definitions" on page 57 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.

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 three (3) 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 9.4.3.7.1

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 64.

Sustainability Test Results File

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

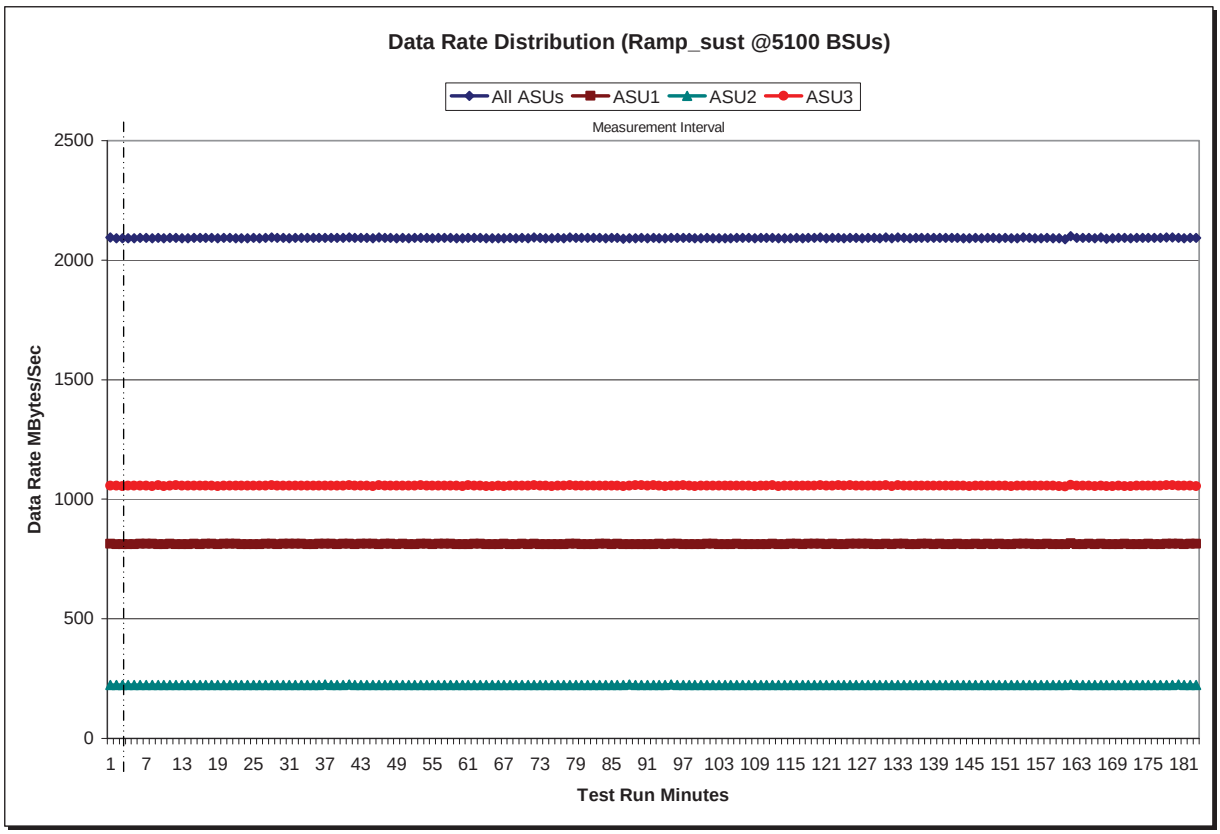
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	13:18:09	13:21:09	0-2	0:03:00
Measurement Interval	13:21:09	16:21:09	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	2,094.19	813.46	223.78	1,056.95	63	2,091.88	812.49	223.82	1,055.57	126	2,091.92	812.81	223.22	1,055.90
1	2,091.91	812.44	223.09	1,056.37	64	2,091.69	812.46	223.76	1,055.47	127	2,093.29	812.67	223.41	1,057.21
2	2,091.70	812.62	223.90	1,055.18	65	2,090.86	811.95	223.23	1,055.68	128	2,093.14	812.50	223.36	1,057.28
3	2,091.56	812.19	223.49	1,055.88	66	2,091.56	812.86	223.57	1,055.13	129	2,091.47	812.25	223.22	1,056.00
4	2,091.78	812.27	223.37	1,056.13	67	2,092.59	811.83	223.64	1,057.12	130	2,094.51	813.07	223.67	1,057.78
5	2,093.85	812.84	223.74	1,057.27	68	2,092.31	811.77	223.56	1,056.97	131	2,090.85	811.86	223.40	1,055.59
6	2,092.46	813.06	223.05	1,056.35	69	2,092.36	813.24	222.97	1,056.15	132	2,094.36	812.72	223.81	1,057.84
7	2,091.14	812.96	223.14	1,055.04	70	2,092.09	811.87	223.84	1,056.39	133	2,093.17	812.76	223.30	1,057.11
8	2,093.84	812.34	223.79	1,057.71	71	2,094.95	813.38	223.16	1,058.41	134	2,092.18	812.61	223.00	1,056.57
9	2,091.13	812.29	223.61	1,055.23	72	2,092.37	812.04	224.07	1,056.27	135	2,092.46	812.07	223.53	1,056.86
10	2,093.61	813.05	223.49	1,057.07	73	2,091.85	812.54	223.01	1,056.30	136	2,093.10	812.91	223.69	1,056.50
11	2,093.58	812.51	223.49	1,057.58	74	2,091.82	812.62	223.64	1,055.55	137	2,092.58	812.84	223.20	1,056.54
12	2,091.67	811.81	223.47	1,056.38	75	2,092.38	812.60	223.66	1,056.13	138	2,092.97	812.56	223.78	1,056.63
13	2,091.97	811.85	223.83	1,056.30	76	2,092.30	812.05	223.62	1,056.62	139	2,092.84	812.89	223.44	1,056.51
14	2,093.08	812.72	223.59	1,056.77	77	2,094.64	813.43	223.56	1,057.65	140	2,092.94	812.52	223.87	1,056.56
15	2,092.62	812.42	223.82	1,056.38	78	2,092.33	813.33	222.70	1,056.30	141	2,092.37	812.53	223.50	1,056.35
16	2,092.78	812.75	223.66	1,056.37	79	2,092.48	812.09	223.70	1,056.69	142	2,093.36	812.82	223.76	1,056.77
17	2,093.98	812.83	223.74	1,057.41	80	2,092.43	812.31	223.08	1,057.04	143	2,091.76	812.18	223.58	1,056.00
18	2,090.94	812.33	223.61	1,055.00	81	2,093.55	812.61	223.75	1,057.19	144	2,091.59	812.43	223.56	1,055.60
19	2,092.99	812.76	223.49	1,056.74	82	2,093.00	813.68	223.34	1,055.98	145	2,092.85	812.99	223.25	1,056.61
20	2,093.32	812.80	223.28	1,057.25	83	2,091.96	812.92	223.00	1,056.03	146	2,091.40	812.41	223.13	1,055.85
21	2,092.16	812.68	223.71	1,055.77	84	2,092.50	811.99	223.60	1,056.91	147	2,092.45	812.98	223.26	1,056.21
22	2,091.77	812.00	223.33	1,056.45	85	2,092.61	812.71	223.54	1,056.36	148	2,092.37	812.55	223.56	1,056.26
23	2,092.23	812.20	223.43	1,056.61	86	2,090.47	812.44	223.66	1,054.38	149	2,092.14	812.70	223.73	1,055.71
24	2,093.42	812.38	223.66	1,057.39	87	2,092.24	811.84	224.18	1,056.22	150	2,092.65	812.18	223.79	1,056.68
25	2,091.80	812.20	223.78	1,055.82	88	2,092.22	811.62	222.92	1,057.68	151	2,090.95	811.70	223.66	1,055.59
26	2,092.65	813.40	223.28	1,055.98	89	2,094.04	812.46	223.71	1,057.87	152	2,091.52	813.13	222.69	1,055.70
27	2,094.73	813.10	223.34	1,058.29	90	2,091.29	811.97	223.33	1,055.98	153	2,094.17	812.88	224.01	1,057.28
28	2,092.88	812.58	223.54	1,056.75	91	2,093.73	812.33	223.21	1,058.20	154	2,093.46	813.03	223.55	1,056.88
29	2,093.23	812.82	223.69	1,056.73	92	2,092.33	812.75	223.47	1,056.11	155	2,091.18	811.60	223.54	1,056.04
30	2,092.21	812.86	223.59	1,055.76	93	2,091.74	812.35	223.82	1,055.57	156	2,092.02	812.35	223.59	1,056.09
31	2,093.05	812.85	223.31	1,056.89	94	2,092.70	812.75	224.15	1,055.80	157	2,092.34	812.71	223.13	1,056.50
32	2,093.05	813.27	223.48	1,056.31	95	2,092.52	812.67	223.70	1,056.15	158	2,091.15	812.15	222.96	1,056.04
33	2,093.07	812.42	223.53	1,057.11	96	2,093.10	812.36	223.23	1,057.51	159	2,090.85	812.37	223.19	1,055.29
34	2,092.64	812.61	223.24	1,056.79	97	2,092.96	812.44	223.68	1,056.84	160	2,087.46	810.85	222.97	1,053.63
35	2,093.00	813.04	223.63	1,056.33	98	2,090.97	812.17	223.77	1,055.03	161	2,100.97	815.80	224.20	1,060.97
36	2,093.33	812.95	224.10	1,056.27	99	2,091.57	811.87	223.22	1,056.48	162	2,092.40	812.31	223.65	1,056.45
37	2,093.34	813.26	223.79	1,056.29	100	2,093.14	813.13	223.58	1,056.42	163	2,093.12	812.52	223.20	1,057.40
38	2,092.34	812.53	223.19	1,056.63	101	2,092.15	812.66	223.75	1,055.74	164	2,093.68	812.73	223.59	1,057.36
39	2,093.78	812.82	223.77	1,057.19	102	2,092.02	812.13	222.97	1,056.92	165	2,091.20	812.25	223.35	1,055.60
40	2,094.94	813.19	224.25	1,057.50	103	2,091.31	812.43	223.25	1,055.63	166	2,094.30	813.76	223.43	1,057.12
41	2,093.22	812.41	223.86	1,056.95	104	2,091.32	812.43	223.27	1,055.62	167	2,090.13	811.56	223.35	1,055.21
42	2,093.14	812.86	223.78	1,056.50	105	2,093.65	813.41	223.81	1,056.43	168	2,091.20	812.30	223.34	1,055.56
43	2,093.66	813.08	223.99	1,056.59	106	2,093.24	812.49	223.60	1,057.14	169	2,092.76	812.54	223.28	1,056.94
44	2,092.10	812.93	223.75	1,055.42	107	2,092.44	811.93	223.95	1,056.57	170	2,092.34	813.15	223.70	1,055.50
45	2,094.34	812.46	223.53	1,058.35	108	2,091.49	812.26	223.83	1,055.40	171	2,090.89	812.27	223.38	1,055.23
46	2,092.38	812.99	223.67	1,055.73	109	2,093.73	812.60	223.76	1,057.36	172	2,092.40	812.16	223.45	1,056.80
47	2,094.03	813.28	224.07	1,056.69	110	2,093.90	812.57	223.98	1,057.36	173	2,093.23	812.41	223.89	1,056.92
48	2,091.56	812.12	223.69	1,055.74	111	2,093.44	812.96	222.95	1,057.53	174	2,092.97	812.72	223.81	1,056.45
49	2,093.80	812.90	223.55	1,057.36	112	2,090.98	812.41	223.20	1,055.36	175	2,093.12	812.27	223.70	1,057.15
50	2,091.40	811.54	223.73	1,056.13	113	2,092.06	812.50	223.48	1,056.07	176	2,092.94	812.36	223.56	1,057.02
51	2,092.62	812.10	224.04	1,056.49	114	2,091.90	812.85	223.25	1,055.79	177	2,094.15	813.00	223.53	1,057.61
52	2,093.95	812.98	223.40	1,057.56	115	2,093.40	813.18	223.29	1,056.92	178	2,094.49	813.09	223.86	1,057.53
53	2,092.38	812.76	223.23	1,056.38	116	2,090.90	811.64	223.56	1,055.69	179	2,093.33	812.97	224.09	1,056.27
54	2,092.12	812.45	223.61	1,056.07	117	2,093.21	812.73	223.46	1,057.02	180	2,091.87	812.40	223.27	1,056.20
55	2,092.80	813.30	223.38	1,056.12	118	2,093.51	813.01	223.47	1,057.03	181	2,092.77	813.05	223.12	1,056.59
56	2,092.58	812.71	223.91	1,055.97	119	2,094.39	813.12	223.82	1,057.44	182	2,092.65	813.46	223.58	1,055.60
57	2,092.73	813.02	223.39	1,056.33	120	2,091.79	811.84	223.49	1,056.45					
58	2,091.48	811.79	223.09	1,056.59	121	2,092.51	812.90	222.84	1,056.77					
59	2,091.83	812.50	223.79	1,055.54	122	2,093.58	811.96	223.69	1,057.93					
60	2,093.32	812.59	223.24	1,057.50	123	2,092.03	812.55	223.59	1,055.89					
61	2,093.59	813.03	223.75	1,056.81	124	2,093.73	812.93	223.04	1,057.76					
62	2,092.43	812.67	223.04	1,056.71	125	2,092.46	812.71	223.20	1,056.55					

Sustainability – Data Rate Distribution Graph

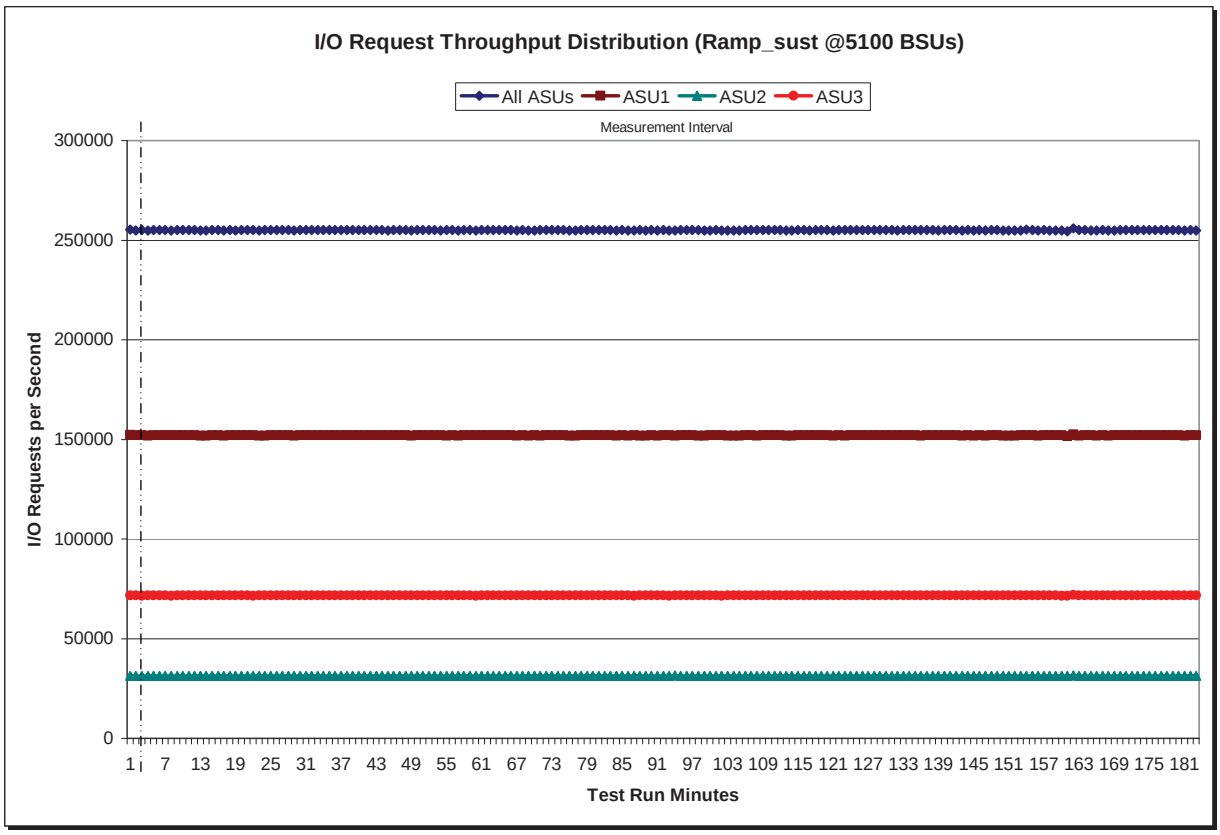


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	13:18:09	13:21:09	0-2	0:03:00
Measurement Interval	13:21:09	16:21:09	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	255,353.48	152,194.95	31,406.10	71,752.43	63	254,985.65	151,971.98	31,391.83	71,621.83	126	255,006.68	152,052.43	31,317.57	71,636.68
1	254,930.93	151,975.80	31,313.32	71,641.82	64	255,021.20	151,971.83	31,385.47	71,663.90	127	255,031.62	151,993.70	31,374.38	71,663.53
2	255,000.03	152,053.02	31,375.78	71,571.23	65	255,001.22	151,978.38	31,372.17	71,650.67	128	255,009.12	152,041.98	31,354.42	71,612.72
3	254,938.88	151,940.97	31,340.98	71,656.93	66	254,878.07	151,911.05	31,353.82	71,613.20	129	255,013.42	151,985.45	31,368.23	71,659.73
4	254,994.15	151,975.85	31,386.20	71,632.10	67	255,068.37	151,968.32	31,396.63	71,703.42	130	255,006.45	151,961.08	31,354.40	71,690.97
5	254,998.52	151,989.02	31,342.40	71,667.10	68	254,958.43	151,927.68	31,385.48	71,645.27	131	254,942.33	151,953.73	31,343.70	71,644.90
6	255,033.03	152,040.80	31,322.42	71,669.82	69	254,939.57	151,962.42	31,332.23	71,644.92	132	255,033.43	151,963.08	31,410.93	71,659.42
7	254,899.50	151,970.98	31,374.23	71,554.28	70	254,999.62	151,927.63	31,391.05	71,680.93	133	254,970.18	151,959.15	31,386.90	71,624.13
8	255,063.23	151,992.70	31,385.93	71,684.60	71	255,123.32	152,038.77	31,376.78	71,707.77	134	254,978.45	151,994.73	31,318.13	71,665.58
9	255,049.17	152,020.98	31,399.93	71,628.25	72	255,104.97	152,005.80	31,414.50	71,684.67	135	254,973.47	151,940.43	31,343.85	71,689.18
10	255,102.80	152,020.70	31,376.43	71,705.67	73	254,976.78	151,961.68	31,328.90	71,686.20	136	254,992.13	151,946.47	31,373.45	71,672.22
11	255,051.95	151,953.25	31,383.08	71,715.62	74	254,993.78	152,020.40	31,334.13	71,639.25	137	255,038.18	152,027.20	31,385.97	71,625.02
12	254,916.48	151,906.12	31,367.65	71,642.72	75	254,894.85	151,918.88	31,352.08	71,623.88	138	254,953.70	151,965.25	31,358.17	71,630.28
13	254,905.58	151,904.72	31,381.97	71,618.90	76	254,876.50	151,865.55	31,395.68	71,615.27	139	255,016.02	151,987.95	31,378.42	71,649.65
14	255,062.70	151,972.08	31,391.47	71,699.15	77	255,056.63	152,052.77	31,347.87	71,656.00	140	255,023.75	151,962.08	31,369.70	71,691.97
15	255,005.08	151,962.35	31,388.02	71,654.72	78	255,005.13	152,025.90	31,320.38	71,658.85	141	255,027.03	151,998.03	31,347.77	71,681.23
16	254,948.77	151,914.72	31,370.57	71,663.48	79	255,117.17	152,060.25	31,360.35	71,696.57	142	254,921.72	151,919.92	31,381.40	71,620.40
17	255,059.77	152,028.93	31,364.48	71,666.35	80	255,017.83	152,019.80	31,335.27	71,662.77	143	254,972.88	151,949.45	31,372.30	71,651.13
18	254,931.47	151,973.38	31,358.63	71,599.45	81	255,059.20	152,007.95	31,390.62	71,660.63	144	254,900.32	151,910.93	31,355.42	71,633.97
19	254,985.80	151,963.40	31,377.30	71,645.10	82	255,063.60	152,054.55	31,388.72	71,620.33	145	255,006.08	151,982.50	31,356.48	71,667.10
20	255,096.92	152,035.33	31,370.77	71,690.82	83	254,963.78	151,941.03	31,360.13	71,662.62	146	254,869.05	151,939.37	31,326.28	71,603.40
21	254,991.95	152,031.00	31,368.22	71,592.73	84	254,998.07	151,978.95	31,362.62	71,656.50	147	255,018.83	152,040.95	31,325.93	71,651.95
22	254,872.45	151,915.28	31,348.15	71,609.02	85	254,941.57	151,941.35	31,372.25	71,627.97	148	254,997.03	152,005.13	31,378.47	71,613.43
23	254,988.88	151,933.62	31,396.63	71,658.63	86	254,914.05	151,988.42	31,357.27	71,568.37	149	254,903.93	151,892.00	31,398.57	71,613.37
24	255,086.27	152,021.38	31,389.07	71,675.82	87	255,010.92	151,939.62	31,400.93	71,670.37	150	254,924.77	151,932.73	31,381.80	71,610.23
25	255,014.03	151,994.67	31,372.60	71,646.77	88	254,939.40	151,897.87	31,337.82	71,703.72	151	254,810.00	151,840.53	31,358.63	71,610.83
26	255,021.15	152,020.95	31,358.65	71,641.55	89	255,056.55	151,962.25	31,410.63	71,683.67	152	254,953.08	151,998.48	31,348.65	71,605.95
27	255,116.73	152,042.13	31,349.38	71,725.22	90	254,900.27	151,887.87	31,374.97	71,637.43	153	255,184.93	152,039.98	31,395.08	71,749.87
28	254,956.72	151,914.13	31,384.35	71,658.23	91	255,107.67	152,013.25	31,360.80	71,733.62	154	255,017.12	152,007.33	31,350.33	71,659.45
29	255,050.07	151,995.72	31,353.67	71,700.68	92	254,928.18	152,004.75	31,329.42	71,594.02	155	254,932.25	151,943.27	31,354.43	71,634.55
30	255,016.82	152,048.23	31,356.93	71,611.65	93	254,901.08	151,864.57	31,425.62	71,610.90	156	254,999.52	151,956.52	31,359.92	71,683.08
31	255,045.63	152,035.40	31,375.15	71,635.08	94	255,047.22	152,011.62	31,397.43	71,638.17	157	254,927.85	151,948.67	31,323.38	71,655.80
32	255,073.67	152,050.83	31,328.60	71,694.23	95	255,001.15	151,970.02	31,387.55	71,643.58	158	254,910.53	151,980.52	31,327.50	71,602.52
33	254,992.40	151,968.35	31,387.70	71,636.35	96	255,028.12	151,979.30	31,343.48	71,705.33	159	254,864.48	151,966.48	31,325.68	71,572.32
34	255,006.20	151,958.67	31,365.33	71,682.20	97	255,033.93	151,931.85	31,394.08	71,708.00	160	254,414.67	151,652.80	31,294.87	71,467.00
35	255,003.95	152,001.17	31,376.55	71,626.23	98	254,857.17	151,875.15	31,368.52	71,613.50	161	255,930.53	152,542.37	31,482.22	71,905.95
36	255,104.83	152,057.15	31,396.40	71,651.28	99	254,949.32	151,966.70	31,328.17	71,654.45	162	254,969.58	151,940.77	31,387.77	71,641.05
37	255,017.73	152,005.63	31,371.83	71,640.27	100	255,024.08	151,975.82	31,385.55	71,662.72	163	255,001.23	151,947.65	31,342.70	71,710.88
38	254,981.60	151,969.60	31,335.85	71,676.15	101	254,891.13	151,947.50	31,358.22	71,585.42	164	254,952.62	151,964.70	31,334.98	71,652.93
39	255,124.65	152,069.22	31,385.30	71,670.13	102	254,917.15	151,883.95	31,356.32	71,676.88	165	254,944.48	151,942.15	31,379.85	71,622.48
40	255,166.23	152,113.35	31,372.53	71,680.35	103	254,939.27	151,928.30	31,374.40	71,636.57	166	255,117.17	152,072.20	31,354.53	71,690.43
41	255,016.78	151,955.37	31,413.47	71,647.95	104	254,908.18	151,939.88	31,347.15	71,621.15	167	254,834.78	151,877.65	31,343.02	71,614.12
42	255,050.90	152,005.38	31,372.50	71,673.02	105	255,109.87	152,072.37	31,360.98	71,676.52	168	254,917.37	151,955.68	31,355.85	71,605.83
43	255,050.02	152,047.37	31,368.75	71,633.90	106	255,043.33	152,019.97	31,356.55	71,666.82	169	255,071.20	152,028.58	31,375.60	71,667.02
44	254,954.32	151,986.02	31,334.00	71,634.30	107	254,978.70	151,932.30	31,389.80	71,656.60	170	255,018.92	151,983.27	31,369.30	71,666.35
45	255,059.13	151,985.75	31,396.37	71,677.02	108	255,012.30	152,013.82	31,364.77	71,633.72	171	255,044.58	152,044.58	31,368.38	71,631.62
46	255,014.95	151,981.80	31,403.10	71,630.05	109	255,027.73	151,966.03	31,368.53	71,693.17	172	254,979.30	151,975.50	31,372.82	71,630.98
47	255,033.35	151,995.67	31,389.98	71,647.70	110	255,046.32	152,022.52	31,390.95	71,632.85	173	255,030.23	152,007.63	31,358.43	71,664.17
48	254,891.72	151,906.32	31,372.23	71,613.17	111	255,021.42	152,028.87	31,357.88	71,634.67	174	255,024.55	151,962.80	31,385.17	71,676.58
49	255,092.98	152,035.97	31,341.03	71,715.98	112	254,860.30	151,936.57	31,313.98	71,609.75	175	254,986.77	151,950.25	31,375.87	71,660.65
50	255,012.45	151,965.10	31,378.17	71,669.18	113	254,883.08	151,915.23	31,347.60	71,620.25	176	255,096.05	152,024.28	31,380.42	71,691.35
51	255,070.53	151,945.40	31,414.70	71,710.43	114	254,986.30	152,007.18	31,344.70	71,634.42	177	255,058.45	151,966.75	31,364.62	71,727.08
52	255,121.60	152,052.70	31,361.60	71,707.30	115	254,997.72	152,048.65	31,317.48	71,631.58	178	255,071.67	151,984.47	31,364.63	71,722.57
53	254,966.97	151,969.42	31,333.62	71,663.93	116	254,943.13	151,966.62	31,334.78	71,641.73	179	255,166.55	152,111.92	31,398.05	71,656.58
54	254,978.48	151,927.55	31,409.22	71,641.72	117	255,021.85	152,009.65	31,344.77	71,667.43	180	254,871.23	151,890.25	31,346.83	71,634.15
55	255,032.53	152,041.08	31,352.57	71,638.88	118	255,040.25	152,027.75	31,335.83	71,676.67	181	255,045.33	152,003.78	31,369.97	71,671.58
56	254,938.95	151,939.32	31,366.08	71,633.55	119	255,109.02	152,028.78	31,362.70	71,717.53	182	254,934.03	151,980.85	31,341.62	71,611.57
57	255,062.45	152,086.13	31,356.97	71,619.35	120	254,888.68	151,853.27	31,353.48	71,681.93	Average	255,001.03	151,980.59	31,365.87	71,654.57
58	255,001.30	151,976.80	31,374.52	71,649.98	121	255,098.73	152,054.05	31,344.02	71,700.67					
59	254,925.65	151,951.33	31,382.80	71,591.52	122	254,970.80	151,901.72	31,395.58	71,673.50					
60	255,089.27	152,010.92	31,358.02	71,720.33	123	255,021.88	151,984.58	31,397.45	71,639.85					
61	255,100.92	152,019.63	31,370.10	71,711.18	124	254,983.48	151,982.17	31,312.80	71,688.52					
62	255,001.50	151,999.17	31,359.65	71,642.68	125	254,987.00	151,957.95	31,356.83	71,672.22					

Sustainability – I/O Request Throughput Distribution Graph

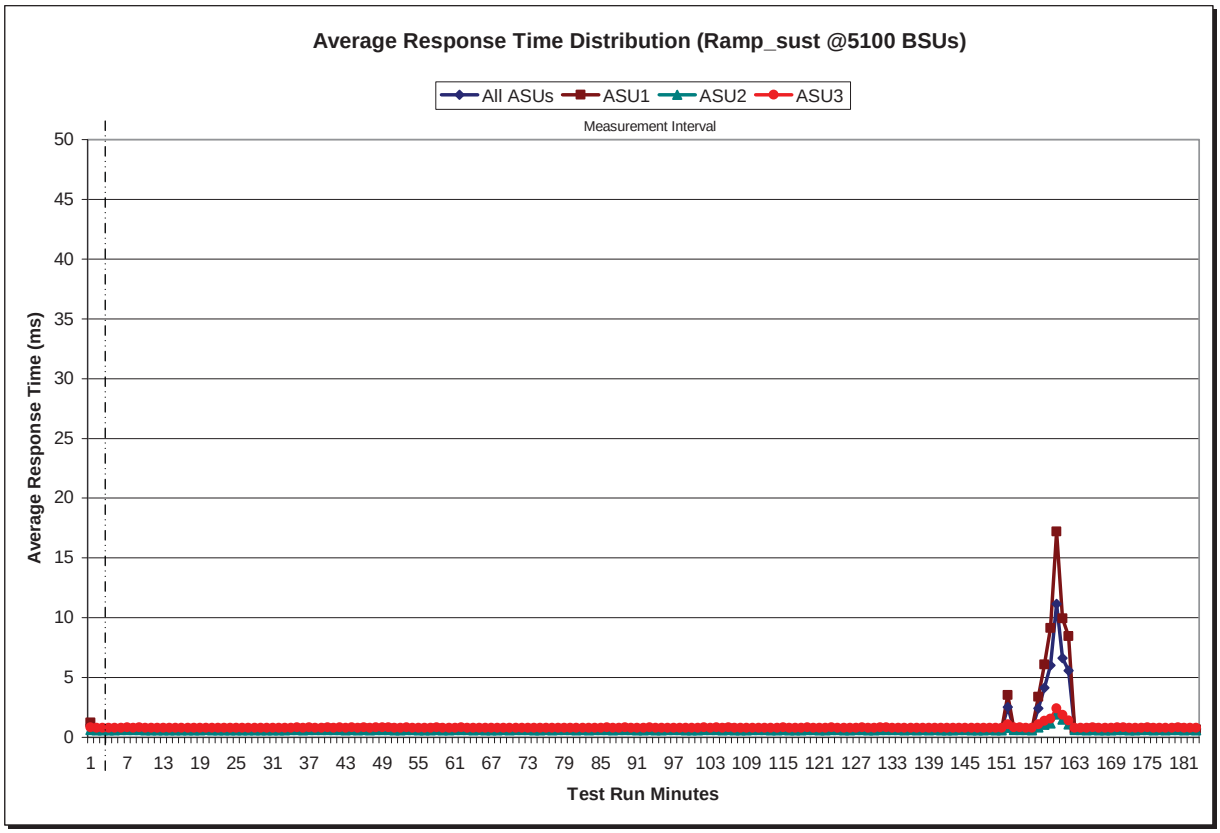


Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	13:18:09	13:21:09	0-2	0:03:00
Measurement Interval	13:21:09	16:21:09	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	1.04	1.22	0.61	0.83	63	0.70	0.68	0.59	0.80	126	0.71	0.69	0.59	0.80
1	0.70	0.68	0.59	0.80	64	0.70	0.68	0.60	0.80	127	0.72	0.69	0.60	0.82
2	0.69	0.67	0.58	0.79	65	0.69	0.67	0.59	0.79	128	0.70	0.67	0.59	0.80
3	0.70	0.67	0.59	0.80	66	0.70	0.68	0.59	0.80	129	0.69	0.66	0.58	0.78
4	0.69	0.67	0.59	0.79	67	0.69	0.66	0.58	0.79	130	0.72	0.70	0.60	0.81
5	0.71	0.68	0.59	0.81	68	0.70	0.68	0.60	0.80	131	0.72	0.70	0.60	0.81
6	0.71	0.68	0.60	0.81	69	0.70	0.68	0.59	0.80	132	0.71	0.69	0.60	0.81
7	0.70	0.68	0.59	0.80	70	0.71	0.69	0.60	0.81	133	0.71	0.69	0.59	0.80
8	0.71	0.69	0.60	0.82	71	0.71	0.68	0.60	0.81	134	0.69	0.67	0.58	0.79
9	0.68	0.66	0.58	0.78	72	0.71	0.68	0.59	0.80	135	0.71	0.69	0.60	0.81
10	0.69	0.67	0.59	0.79	73	0.70	0.68	0.59	0.80	136	0.69	0.67	0.59	0.79
11	0.70	0.68	0.59	0.80	74	0.69	0.67	0.59	0.79	137	0.71	0.69	0.60	0.81
12	0.69	0.66	0.59	0.79	75	0.71	0.68	0.60	0.81	138	0.69	0.67	0.58	0.78
13	0.70	0.67	0.59	0.80	76	0.70	0.67	0.59	0.80	139	0.71	0.68	0.60	0.81
14	0.69	0.67	0.59	0.79	77	0.70	0.68	0.59	0.80	140	0.70	0.68	0.59	0.80
15	0.70	0.67	0.59	0.80	78	0.71	0.69	0.59	0.81	141	0.70	0.68	0.59	0.80
16	0.70	0.68	0.59	0.80	79	0.70	0.68	0.60	0.80	142	0.71	0.68	0.59	0.80
17	0.70	0.67	0.59	0.80	80	0.70	0.68	0.59	0.80	143	0.71	0.69	0.60	0.81
18	0.69	0.67	0.58	0.79	81	0.71	0.68	0.60	0.80	144	0.71	0.69	0.60	0.81
19	0.71	0.68	0.60	0.81	82	0.70	0.68	0.59	0.80	145	0.70	0.67	0.59	0.80
20	0.68	0.66	0.59	0.79	83	0.71	0.69	0.60	0.81	146	0.69	0.66	0.58	0.78
21	0.69	0.67	0.58	0.79	84	0.71	0.68	0.60	0.81	147	0.70	0.67	0.59	0.79
22	0.69	0.66	0.59	0.79	85	0.72	0.70	0.60	0.81	148	0.70	0.68	0.60	0.81
23	0.70	0.67	0.59	0.80	86	0.70	0.68	0.59	0.80	149	0.69	0.66	0.58	0.78
24	0.69	0.67	0.59	0.79	87	0.72	0.70	0.60	0.81	150	0.69	0.67	0.59	0.79
25	0.70	0.68	0.59	0.80	88	0.71	0.69	0.60	0.81	151	2.50	3.52	0.81	1.08
26	0.69	0.67	0.59	0.80	89	0.70	0.68	0.60	0.81	152	0.72	0.70	0.61	0.82
27	0.69	0.67	0.59	0.79	90	0.70	0.68	0.59	0.80	153	0.72	0.69	0.60	0.81
28	0.70	0.67	0.59	0.80	91	0.70	0.68	0.59	0.80	154	0.71	0.68	0.60	0.81
29	0.70	0.68	0.59	0.80	92	0.71	0.68	0.60	0.81	155	0.70	0.67	0.59	0.79
30	0.70	0.67	0.59	0.80	93	0.70	0.68	0.59	0.80	156	2.43	3.38	0.83	1.09
31	0.68	0.66	0.58	0.79	94	0.70	0.68	0.59	0.80	157	4.14	6.09	1.05	1.37
32	0.70	0.67	0.59	0.79	95	0.71	0.69	0.60	0.81	158	6.03	9.15	1.17	1.53
33	0.70	0.68	0.59	0.81	96	0.71	0.69	0.60	0.81	159	11.17	17.19	1.89	2.43
34	0.72	0.70	0.60	0.82	97	0.70	0.68	0.60	0.81	160	6.64	9.94	1.46	1.89
35	0.70	0.68	0.59	0.80	98	0.70	0.68	0.59	0.80	161	5.57	8.46	1.08	1.41
36	0.72	0.69	0.60	0.81	99	0.70	0.68	0.59	0.80	162	0.70	0.68	0.60	0.80
37	0.71	0.68	0.60	0.81	100	0.69	0.67	0.59	0.79	163	0.71	0.69	0.60	0.81
38	0.71	0.68	0.59	0.80	101	0.71	0.69	0.60	0.81	164	0.70	0.68	0.59	0.80
39	0.72	0.70	0.60	0.81	102	0.71	0.68	0.60	0.80	165	0.73	0.71	0.61	0.82
40	0.71	0.68	0.60	0.81	103	0.71	0.69	0.60	0.81	166	0.70	0.68	0.59	0.80
41	0.72	0.70	0.60	0.82	104	0.70	0.67	0.59	0.80	167	0.70	0.68	0.59	0.80
42	0.71	0.69	0.59	0.80	105	0.72	0.70	0.61	0.82	168	0.70	0.68	0.59	0.80
43	0.72	0.69	0.60	0.82	106	0.70	0.68	0.59	0.80	169	0.72	0.70	0.60	0.82
44	0.70	0.68	0.59	0.80	107	0.70	0.67	0.59	0.80	170	0.71	0.69	0.60	0.81
45	0.74	0.72	0.61	0.83	108	0.69	0.67	0.59	0.79	171	0.69	0.67	0.59	0.79
46	0.70	0.67	0.59	0.80	109	0.71	0.69	0.60	0.81	172	0.70	0.68	0.59	0.80
47	0.71	0.69	0.60	0.81	110	0.71	0.68	0.60	0.81	173	0.71	0.68	0.59	0.80
48	0.72	0.69	0.61	0.82	111	0.71	0.69	0.60	0.80	174	0.73	0.71	0.61	0.82
49	0.73	0.71	0.61	0.82	112	0.70	0.68	0.59	0.80	175	0.71	0.69	0.59	0.80
50	0.70	0.67	0.59	0.80	113	0.70	0.67	0.59	0.80	176	0.70	0.68	0.60	0.80
51	0.69	0.67	0.58	0.79	114	0.71	0.69	0.60	0.81	177	0.71	0.68	0.59	0.80
52	0.72	0.70	0.60	0.82	115	0.70	0.68	0.59	0.80	178	0.70	0.68	0.59	0.80
53	0.70	0.68	0.60	0.80	116	0.70	0.67	0.59	0.79	179	0.73	0.70	0.61	0.82
54	0.71	0.68	0.59	0.80	117	0.71	0.68	0.59	0.80	180	0.70	0.67	0.59	0.80
55	0.70	0.68	0.59	0.80	118	0.72	0.70	0.60	0.82	181	0.71	0.69	0.60	0.81
56	0.70	0.67	0.59	0.80	119	0.70	0.68	0.59	0.80	182	0.69	0.66	0.59	0.79
57	0.73	0.71	0.61	0.82	120	0.69	0.67	0.59	0.79	Average	0.89	0.97	0.62	0.83
58	0.69	0.66	0.59	0.79	121	0.69	0.67	0.59	0.79					
59	0.70	0.68	0.59	0.80	122	0.72	0.70	0.61	0.82					
60	0.70	0.68	0.59	0.80	123	0.71	0.68	0.60	0.81					
61	0.71	0.69	0.60	0.81	124	0.70	0.67	0.59	0.80					
62	0.70	0.68	0.59	0.80	125	0.70	0.67	0.59	0.80					

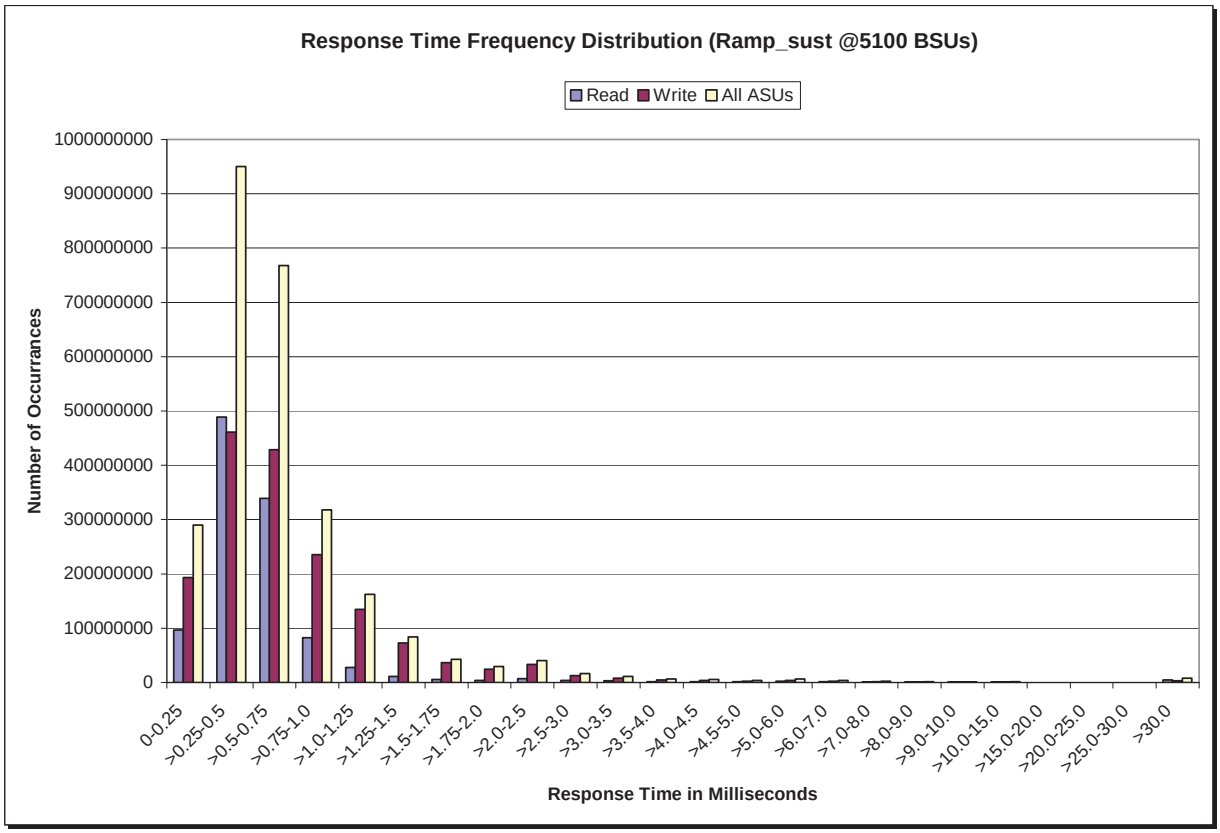
Sustainability – Average Response Time (ms) Distribution Graph



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	96,776,952	489,149,942	339,335,386	82,556,276	27,620,996	10,782,734	5,803,178	4,012,579
Write	193,546,601	460,831,281	428,604,447	235,520,624	134,666,355	73,070,541	36,677,517	24,919,320
All ASUs	290,323,553	949,981,223	767,939,833	318,076,900	162,287,351	83,853,275	42,480,695	28,931,899
ASU1	164,691,675	629,970,289	480,796,260	165,373,902	74,204,747	35,054,424	15,961,015	10,773,089
ASU2	52,397,969	123,508,629	87,264,555	34,562,899	17,529,650	9,161,007	4,523,857	3,028,869
ASU3	73,233,909	196,502,305	199,879,018	118,140,099	70,552,954	39,637,844	21,995,823	15,129,941
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	7,105,055	3,598,641	2,948,164	1,926,433	1,937,650	1,303,683	2,181,439	1,646,745
Write	33,373,529	13,066,077	8,156,093	4,408,112	3,952,166	2,579,312	3,837,890	2,681,654
All ASUs	40,478,584	16,664,718	11,104,257	6,334,545	5,889,816	3,882,995	6,019,329	4,328,399
ASU1	17,053,704	8,348,028	6,439,892	4,041,824	4,001,871	2,718,146	4,357,964	3,322,844
ASU2	3,918,593	1,194,975	604,839	279,283	227,702	133,763	187,474	110,739
ASU3	19,506,287	7,121,715	4,059,526	2,013,438	1,660,243	1,031,086	1,473,891	894,816
Response Time (ms)	**>7.0-8.0**	**>8.0-9.0**	**>9.0-10.0**	**>10.0-15.0**	**>15.0-20.0**	**>20.0-25.0**	**>25.0-30.0**	**>30.0**
Read	1,097,465	746,847	455,013	679,174	95,366	44,626	34,261	4,364,143
Write	1,625,416	1,051,938	606,685	874,431	117,866	62,456	53,038	3,524,844
All ASUs	2,722,881	1,798,785	1,061,698	1,553,605	213,232	107,082	87,299	7,888,987
ASU1	2,223,432	1,553,143	948,852	1,431,422	187,093	81,775	62,476	7,792,405
ASU2	51,264	22,964	9,644	9,480	499	74	3	22,689
ASU3	448,185	222,678	103,202	112,703	25,640	25,233	24,820	73,893

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 5.3.13.2

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 5.3.13.3

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

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

Primary Metrics Test – IOPS Test Phase

Clause 5.4.4.2

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

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

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

Clause 9.4.3.7.2

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 t 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 64.

IOPS Test Results File

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

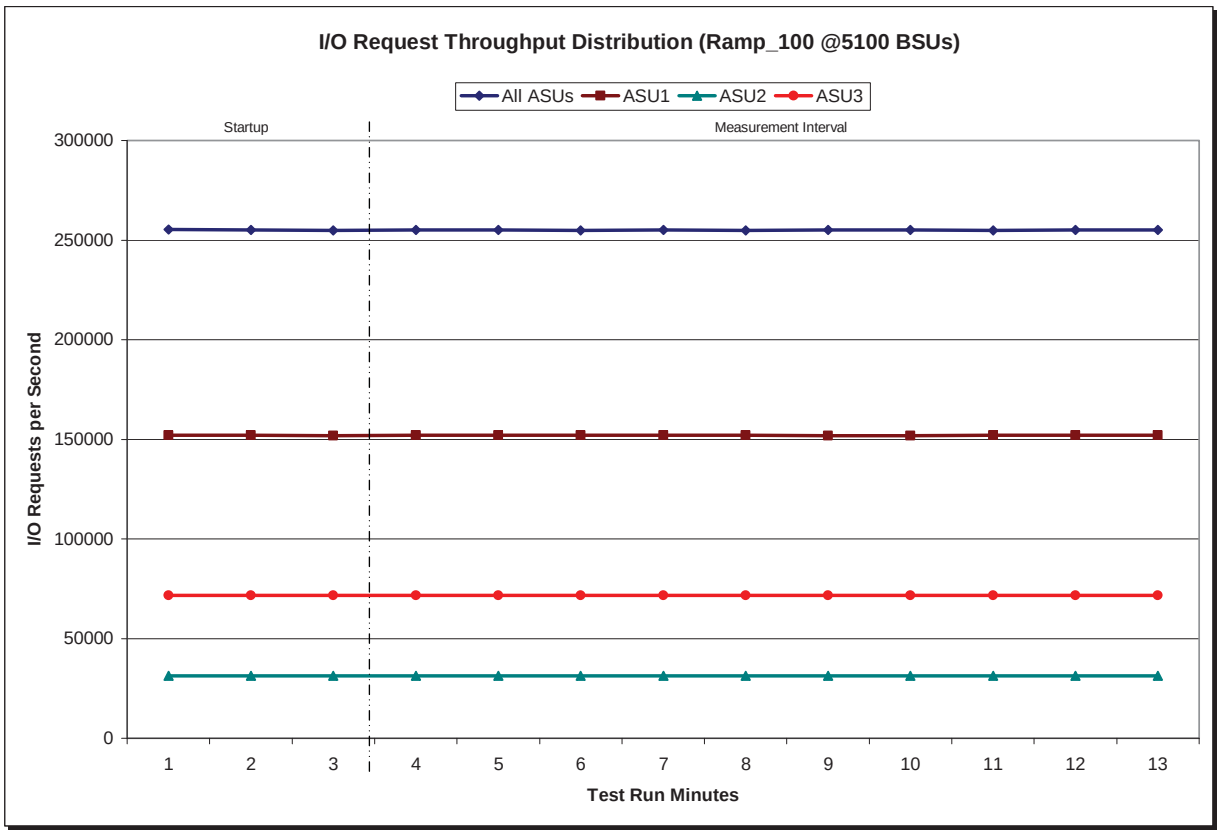
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

5100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	16:22:36	16:25:37	0-2	0:03:01
Measurement Interval	16:25:37	16:35:37	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	255,187.62	152,129.37	31,405.98	71,652.27
1	255,021.63	152,005.38	31,344.60	71,671.65
2	254,872.77	151,926.35	31,328.68	71,617.73
3	255,028.40	152,019.52	31,376.92	71,631.97
4	254,972.70	152,019.67	31,329.50	71,623.53
5	254,954.08	151,962.33	31,356.62	71,635.13
6	255,040.68	151,980.38	31,405.58	71,654.72
7	254,946.03	151,970.37	31,331.93	71,643.73
8	255,001.75	151,926.52	31,392.47	71,682.77
9	255,001.23	151,940.13	31,360.50	71,700.60
10	254,967.18	151,971.45	31,328.23	71,667.50
11	255,013.92	151,980.57	31,343.05	71,690.30
12	255,016.10	151,971.88	31,376.52	71,667.70
Average	***254,994.21***	***151,974.28***	***31,360.13***	***71,659.80***

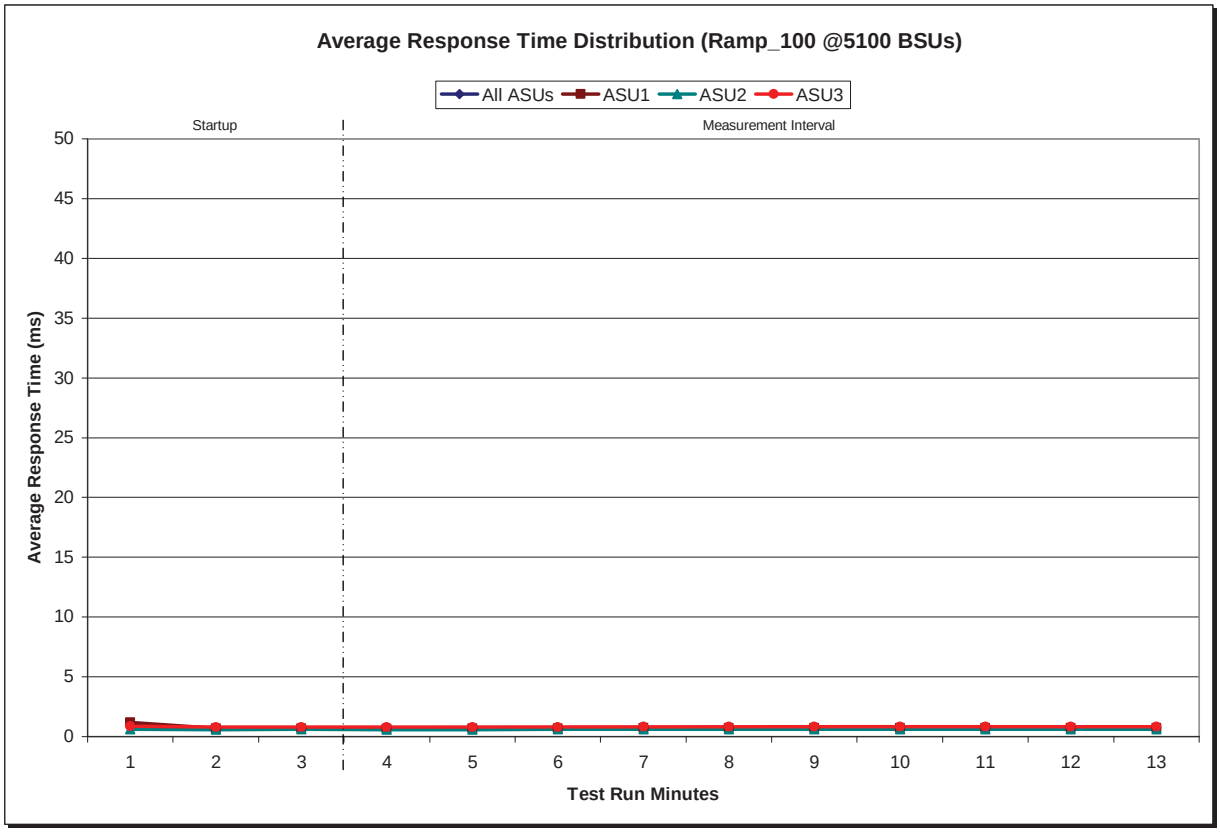
IOPS Test Run – I/O Request Throughput Distribution Graph



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

5100\ BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	16:22:36	16:25:37	0-2	0:03:01
Measurement Interval	16:25:37	16:35:37	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.02	1.19	0.63	0.86
1	0.70	0.68	0.59	0.80
2	0.70	0.68	0.59	0.80
3	0.69	0.66	0.58	0.79
4	0.69	0.67	0.59	0.80
5	0.71	0.69	0.60	0.81
6	0.73	0.71	0.61	0.83
7	0.74	0.72	0.61	0.83
8	0.73	0.71	0.61	0.82
9	0.73	0.71	0.61	0.82
10	0.73	0.71	0.61	0.82
11	0.75	0.73	0.62	0.84
12	0.72	0.71	0.60	0.82
Average	***0.72***	***0.70***	***0.60***	***0.82***

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



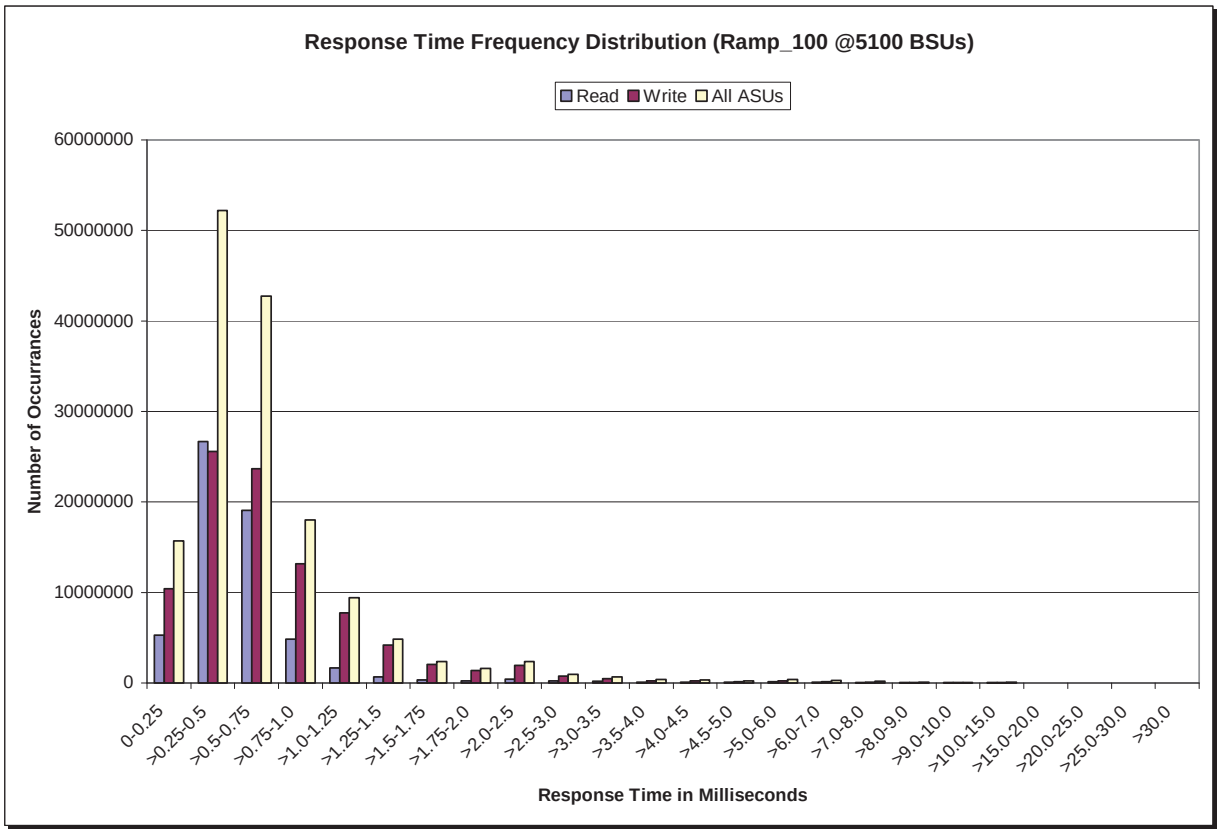
IOPS Test Run – Response Time Frequency Distribution Data

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	5,262,656	26,660,898	19,073,090	4,865,251	1,674,993	644,929	341,010	236,842
Write	10,434,986	25,559,365	23,661,641	13,167,444	7,739,922	4,198,809	2,051,372	1,380,066
All ASUs	15,697,642	52,220,263	42,734,731	18,032,695	9,414,915	4,843,738	2,392,382	1,616,908
ASU1	8,915,549	34,459,810	26,865,267	9,511,532	4,368,181	2,060,769	928,717	630,153
ASU2	2,838,929	6,879,695	4,841,713	1,938,774	1,000,482	518,332	246,557	163,034
ASU3	3,943,164	10,880,758	11,027,751	6,582,389	4,046,252	2,264,637	1,217,108	823,721

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	440,156	213,978	177,638	111,549	118,339	78,883	132,791	104,500
Write	1,940,290	748,590	483,095	254,795	237,959	149,539	229,440	164,560
All ASUs	2,380,446	962,568	660,733	366,344	356,298	228,422	362,231	269,060
ASU1	1,045,125	495,671	389,668	235,783	243,846	161,283	263,986	208,761
ASU2	225,289	67,807	35,867	15,973	13,408	7,707	10,918	6,549
ASU3	1,110,032	399,090	235,198	114,588	99,044	59,432	87,327	53,750

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	70,436	46,015	27,144	39,636	6,784	3,154	866	-
Write	101,195	65,608	36,638	49,717	6,179	2,560	975	1
All ASUs	171,631	111,623	63,782	89,353	12,963	5,714	1,841	1
ASU1	141,623	97,396	57,287	83,564	12,888	5,714	1,841	1
ASU2	2,952	1,208	505	348	8	-	-	-
ASU3	27,056	13,019	5,990	5,441	67	-	-	-

IOPS Test Run –Response Time Frequency Distribution Graph



IOPS Test Run – I/O Request Information

I/O Requests Completed in the Measurement Interval	I/O Requests Completed with Response Time = or < 30 ms	I/O Requests Completed with Response Time > 30 ms
152,996,284	192,996,283	1

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 5.3.13.2

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 5.3.13.3

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	0.001	0.001	0.000	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 13.

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 9.4.3.7.3

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 64.

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 tables and graphs for completeness.

100% Load Level - 5100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	16:22:36	16:25:37	0-2	0:03:01
Measurement Interval	16:25:37	16:35:37	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	255,187.62	152,129.37	31,405.98	71,652.27
1	255,021.63	152,005.38	31,344.60	71,671.65
2	254,872.77	151,926.35	31,328.68	71,617.73
3	255,028.40	152,019.52	31,376.92	71,631.97
4	254,972.70	152,019.67	31,329.50	71,623.53
5	254,954.08	151,962.33	31,356.62	71,635.13
6	255,040.68	151,980.38	31,405.58	71,654.72
7	254,946.03	151,970.37	31,331.93	71,643.73
8	255,001.75	151,926.52	31,392.47	71,682.77
9	255,001.23	151,940.13	31,360.50	71,700.60
10	254,967.18	151,971.45	31,328.23	71,667.50
11	255,013.92	151,980.57	31,343.05	71,690.30
12	255,016.10	151,971.88	31,376.52	71,667.70
Average	254,994.21	151,974.28	31,360.13	71,659.80

95% Load Level - 4845 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	16:36:53	16:39:54	0-2	0:03:01
Measurement Interval	16:39:54	16:49:54	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	242,431.58	144,565.85	29,785.37	68,080.37
1	242,279.08	144,390.18	29,806.10	68,082.80
2	242,238.25	144,346.55	29,790.82	68,100.88
3	242,308.57	144,390.48	29,785.73	68,132.35
4	242,480.15	144,529.38	29,835.05	68,115.72
5	242,107.78	144,351.47	29,747.85	68,008.47
6	242,269.88	144,398.93	29,795.57	68,075.38
7	242,217.95	144,393.83	29,781.27	68,042.85
8	242,202.63	144,317.73	29,806.12	68,078.78
9	242,289.70	144,420.25	29,803.45	68,066.00
10	242,265.38	144,378.98	29,793.73	68,092.67
11	242,258.08	144,379.68	29,834.92	68,043.48
12	242,183.32	144,332.28	29,787.40	68,063.63
Average	242,258.35	144,389.30	29,797.11	68,071.93

90% Load Level - 4590 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	16:51:08	16:54:09	0-2	0:03:01
Measurement Interval	16:54:09	17:04:09	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	229,663.50	136,840.73	28,268.75	64,554.02
1	229,440.55	136,777.93	28,212.43	64,450.18
2	229,390.88	136,720.62	28,199.62	64,470.65
3	229,465.68	136,774.93	28,228.03	64,462.72
4	229,490.85	136,776.35	28,227.08	64,487.42
5	229,501.18	136,791.90	28,259.57	64,449.72
6	229,539.77	136,798.90	28,214.68	64,526.18
7	229,596.48	136,851.90	28,275.62	64,468.97
8	229,434.68	136,758.18	28,224.70	64,451.80
9	229,483.38	136,758.50	28,263.53	64,461.35
10	229,450.10	136,796.53	28,210.53	64,443.03
11	229,410.83	136,737.40	28,217.88	64,455.55
12	229,528.05	136,810.57	28,221.37	64,496.12
Average	229,490.10	136,785.52	28,234.30	64,470.29

80% Load Level - 4080 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:05:22	17:08:23	0-2	0:03:01
Measurement Interval	17:08:23	17:18:23	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	204,132.22	121,654.32	25,134.33	57,343.57
1	203,964.87	121,591.15	25,070.42	57,303.30
2	204,051.07	121,635.47	25,114.77	57,300.83
3	204,040.90	121,595.05	25,120.70	57,325.15
4	203,983.63	121,564.70	25,089.22	57,329.72
5	203,977.33	121,558.55	25,074.57	57,344.22
6	203,947.35	121,529.37	25,100.58	57,317.40
7	203,995.93	121,595.82	25,077.55	57,322.57
8	203,944.20	121,515.33	25,103.58	57,325.28
9	204,019.00	121,624.48	25,078.15	57,316.37
10	203,997.95	121,624.48	25,077.07	57,296.40
11	204,022.15	121,604.58	25,091.38	57,326.18
12	204,025.45	121,577.87	25,129.03	57,318.55
Average	203,995.39	121,579.02	25,094.18	57,322.18

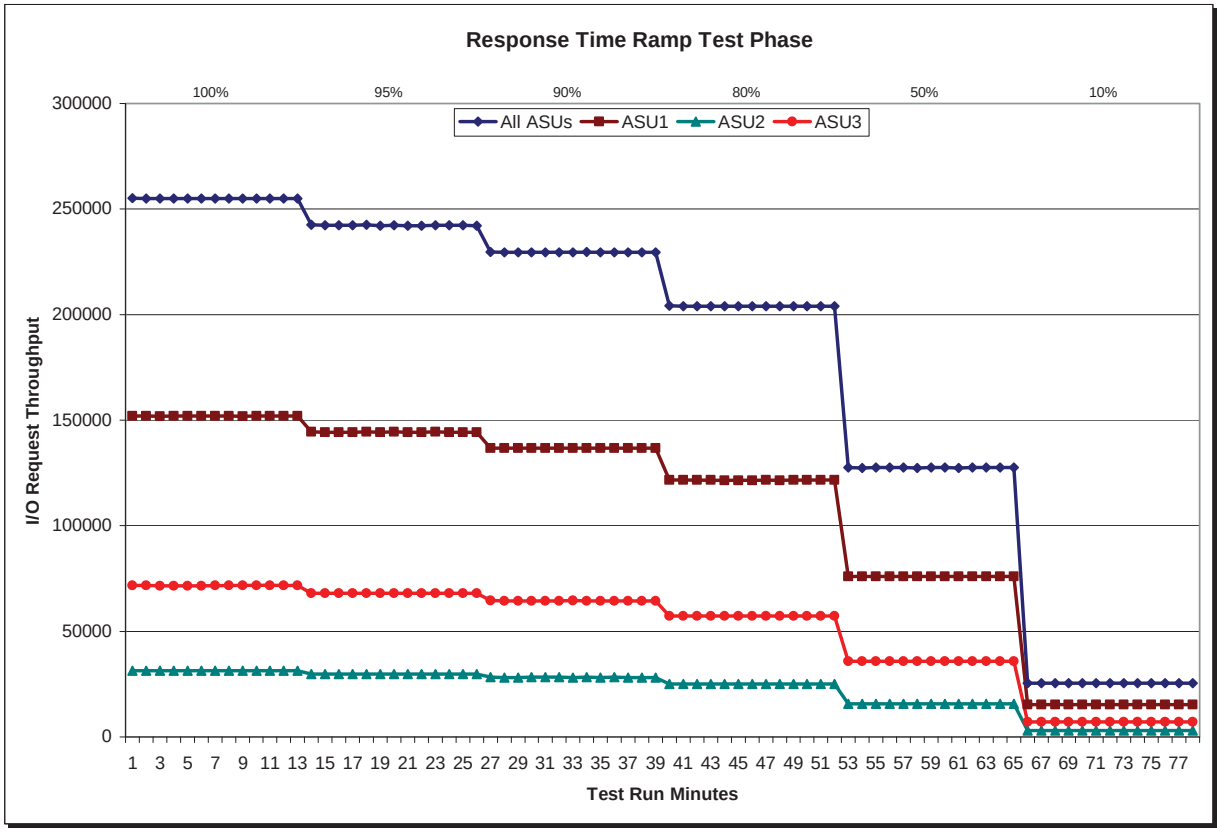
50% Load Level - 2550 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:19:29	17:22:30	0-2	0:03:01
Measurement Interval	17:22:30	17:32:30	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	127,528.27	76,027.22	15,678.53	35,822.52
1	127,465.53	76,025.50	15,659.13	35,780.90
2	127,612.17	76,074.92	15,691.47	35,845.78
3	127,509.68	76,023.80	15,663.53	35,822.35
4	127,530.82	75,979.50	15,702.65	35,848.67
5	127,476.60	75,990.43	15,680.47	35,805.70
6	127,500.88	75,997.28	15,676.88	35,826.72
7	127,551.95	76,020.72	15,706.23	35,825.00
8	127,476.15	75,961.57	15,680.72	35,833.87
9	127,577.08	76,043.02	15,665.23	35,868.83
10	127,531.72	75,977.77	15,721.40	35,832.55
11	127,504.93	76,020.38	15,673.03	35,811.52
12	127,553.58	76,046.98	15,668.03	35,838.57
Average	127,521.34	76,006.15	15,683.82	35,831.38

10% Load Level - 510 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:33:28	17:36:29	0-2	0:03:01
Measurement Interval	17:36:29	17:46:29	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	25,498.08	15,192.40	3,135.50	7,170.18
1	25,507.63	15,213.40	3,129.23	7,165.00
2	25,528.40	15,222.10	3,148.73	7,157.57
3	25,504.10	15,214.57	3,131.80	7,157.73
4	25,484.92	15,185.45	3,139.88	7,159.58
5	25,520.93	15,215.85	3,136.88	7,168.20
6	25,511.05	15,201.88	3,148.00	7,161.17
7	25,512.47	15,204.05	3,141.63	7,166.78
8	25,504.88	15,222.85	3,132.42	7,149.62
9	25,475.67	15,190.47	3,130.52	7,154.68
10	25,518.92	15,206.65	3,133.37	7,178.90
11	25,500.35	15,189.50	3,140.75	7,170.10
12	25,520.83	15,227.13	3,144.35	7,149.35
Average	25,505.41	15,205.84	3,137.96	7,161.61

Response Time Ramp Distribution (IOPS) Graph

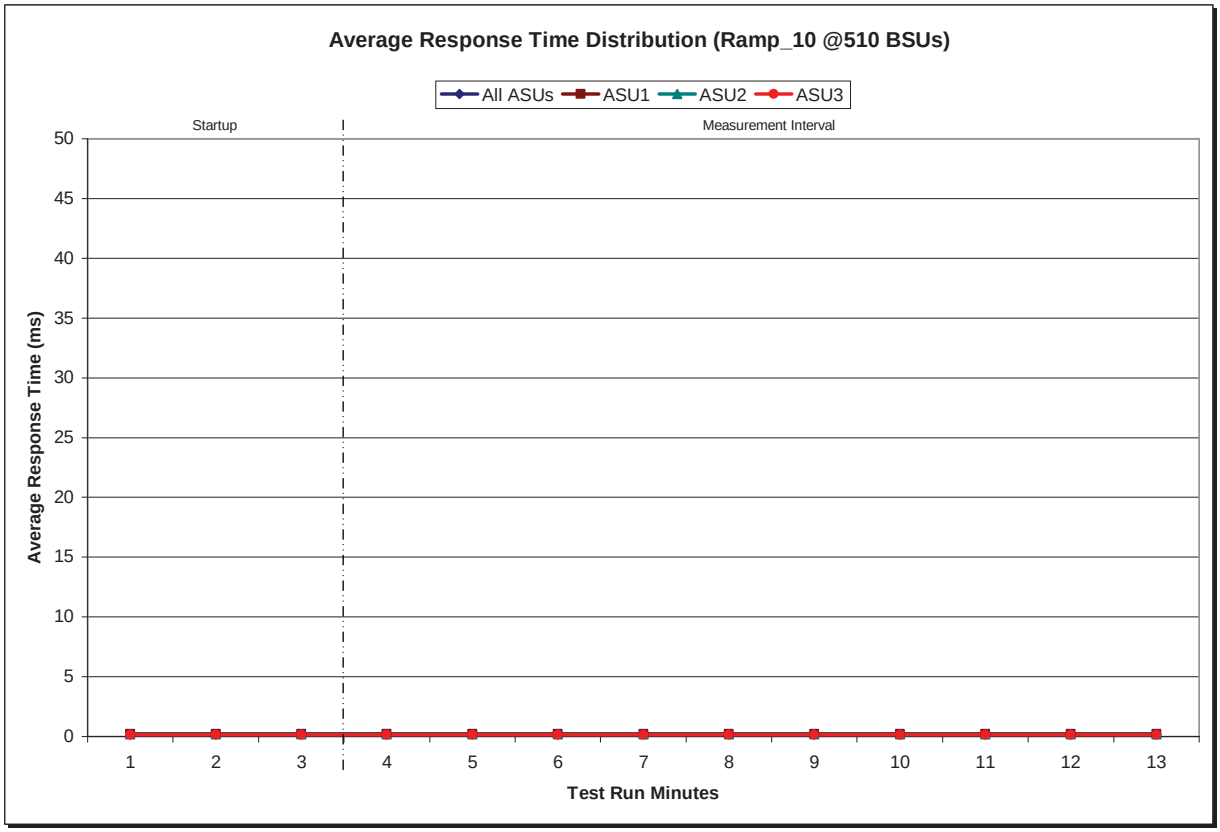


SPC-1 LRT™ Average Response Time (ms) Distribution Data

510 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:33:28	17:36:29	0-2	0:03:01
Measurement Interval	17:36:29	17:46:29	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	0.19	0.21	0.18	0.15
1	0.19	0.21	0.17	0.15
2	0.19	0.21	0.17	0.15
3	0.19	0.21	0.17	0.15
4	0.19	0.21	0.17	0.15
5	0.19	0.21	0.17	0.15
6	0.19	0.21	0.17	0.15
7	0.19	0.21	0.17	0.15
8	0.19	0.21	0.17	0.15
9	0.19	0.21	0.17	0.15
10	0.19	0.21	0.17	0.15
11	0.19	0.21	0.17	0.15
12	0.19	0.21	0.17	0.15
Average	0.19	0.21	0.17	0.15

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 5.3.13.2

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 5.3.13.3

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	0.2811	0.0699	0.2102	0.0180	0.0700	0.0350	0.2808
COV	0.004	0.001	0.003	0.002	0.006	0.003	0.004	0.001

Repeatability Test

Clause 5.4.5

The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ primary metric and 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 9.4.3.7.4

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 64.

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	***254,994.21***
Repeatability Test Phase 1	254,969.29
Repeatability Test Phase 2	254,993.70

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	***0.19 ms***
Repeatability Test Phase 1	0.19 ms
Repeatability Test Phase 2	0.19 ms

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

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

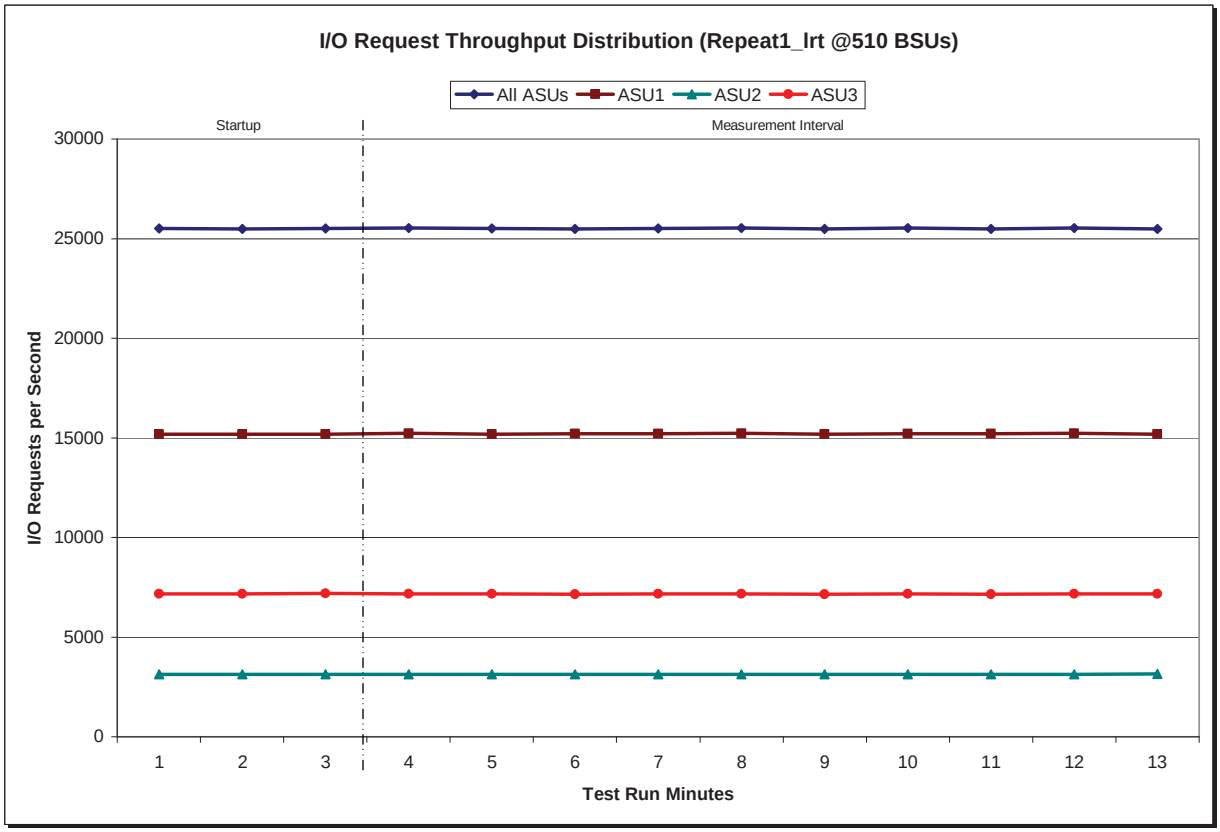
Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

510 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:47:47	17:50:47	0-2	0:03:00
Measurement Interval	17:50:47	18:00:47	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	25,497.65	15,192.87	3,133.70	7,171.08
1	25,479.30	15,188.13	3,127.67	7,163.50
2	25,513.27	15,193.07	3,133.53	7,186.67
3	25,535.15	15,224.62	3,139.45	7,171.08
4	25,504.50	15,193.47	3,132.60	7,178.43
5	25,494.10	15,204.17	3,139.58	7,150.35
6	25,511.10	15,210.48	3,131.30	7,169.32
7	25,529.65	15,224.78	3,127.20	7,177.67
8	25,483.35	15,193.55	3,134.80	7,155.00
9	25,530.43	15,212.23	3,138.18	7,180.02
10	25,489.08	15,197.30	3,140.20	7,151.58
11	25,531.68	15,226.07	3,136.50	7,169.12
12	25,492.77	15,186.73	3,144.03	7,162.00
Average	***25,510.18***	***15,207.34***	***3,136.39***	***7,166.46***

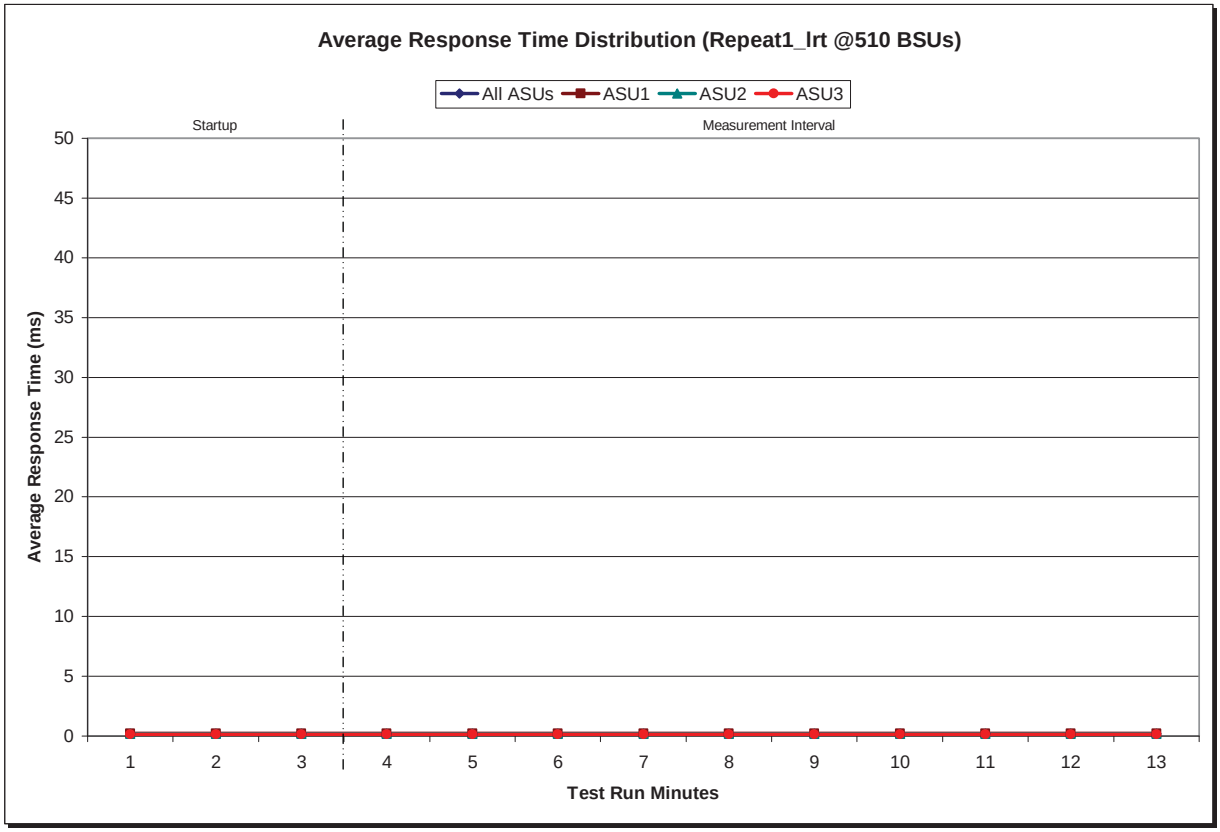
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

510 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:47:47	17:50:47	0-2	0:03:00
Measurement Interval	17:50:47	18:00:47	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.19	0.21	0.18	0.15
1	0.19	0.21	0.17	0.15
2	0.19	0.21	0.17	0.15
3	0.19	0.21	0.17	0.15
4	0.19	0.21	0.17	0.15
5	0.19	0.21	0.17	0.15
6	0.19	0.21	0.17	0.15
7	0.19	0.21	0.17	0.15
8	0.19	0.21	0.17	0.15
9	0.19	0.21	0.17	0.15
10	0.19	0.21	0.17	0.15
11	0.19	0.21	0.17	0.15
12	0.19	0.21	0.17	0.15
Average	***0.19***	***0.21***	***0.17***	***0.15***

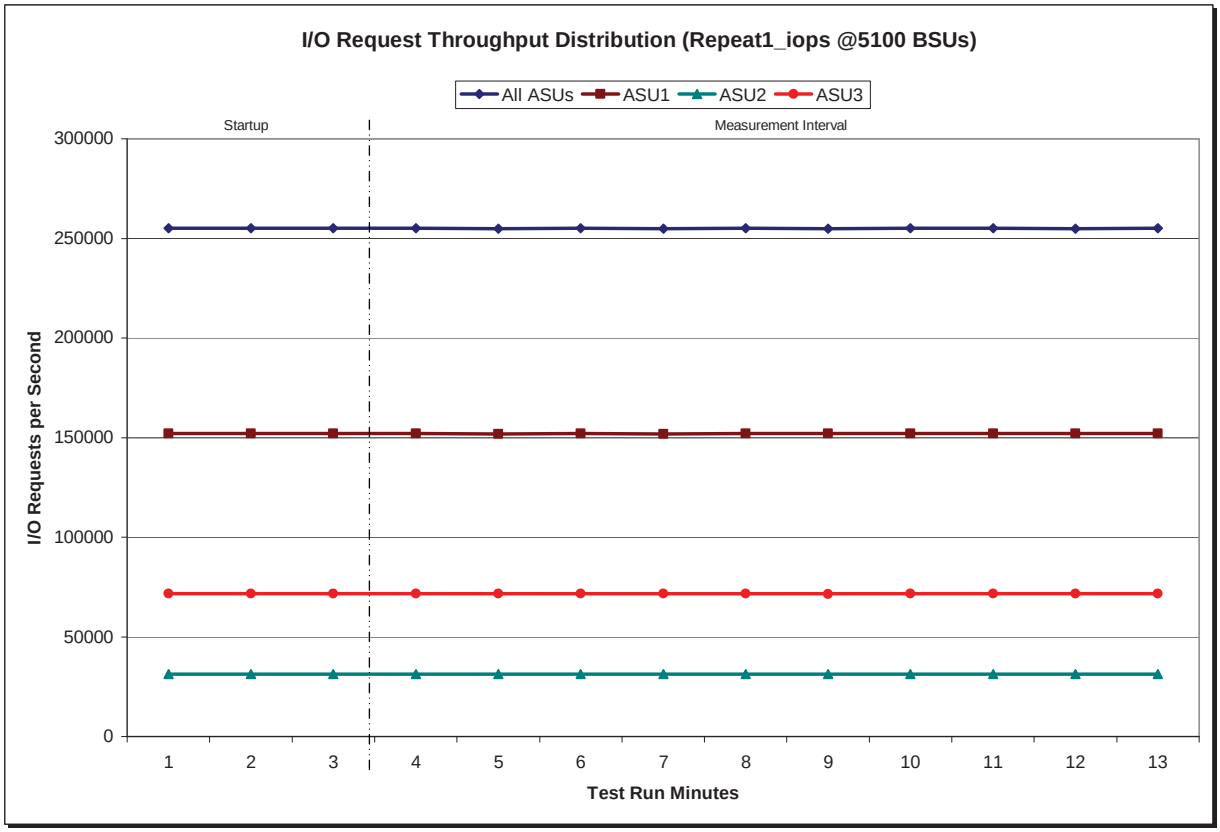
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

5100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:02:05	18:05:06	0-2	0:03:01
Measurement Interval	18:05:06	18:15:06	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	255,135.95	152,013.45	31,405.30	71,717.20
1	255,011.52	151,999.53	31,391.47	71,620.52
2	255,072.35	151,962.40	31,376.98	71,732.97
3	254,991.22	151,966.02	31,346.28	71,678.92
4	254,776.35	151,771.67	31,352.08	71,652.60
5	254,982.87	151,954.90	31,380.57	71,647.40
6	254,888.78	151,911.47	31,322.78	71,654.53
7	255,053.67	152,017.30	31,404.43	71,631.93
8	254,881.13	151,947.90	31,373.37	71,559.87
9	255,005.30	151,955.72	31,358.82	71,690.77
10	255,082.07	152,038.98	31,360.78	71,682.30
11	254,951.73	151,961.15	31,381.15	71,609.43
12	255,079.75	152,020.77	31,347.20	71,711.78
Average	***254,969.29***	***151,954.59***	***31,362.75***	***71,651.95***

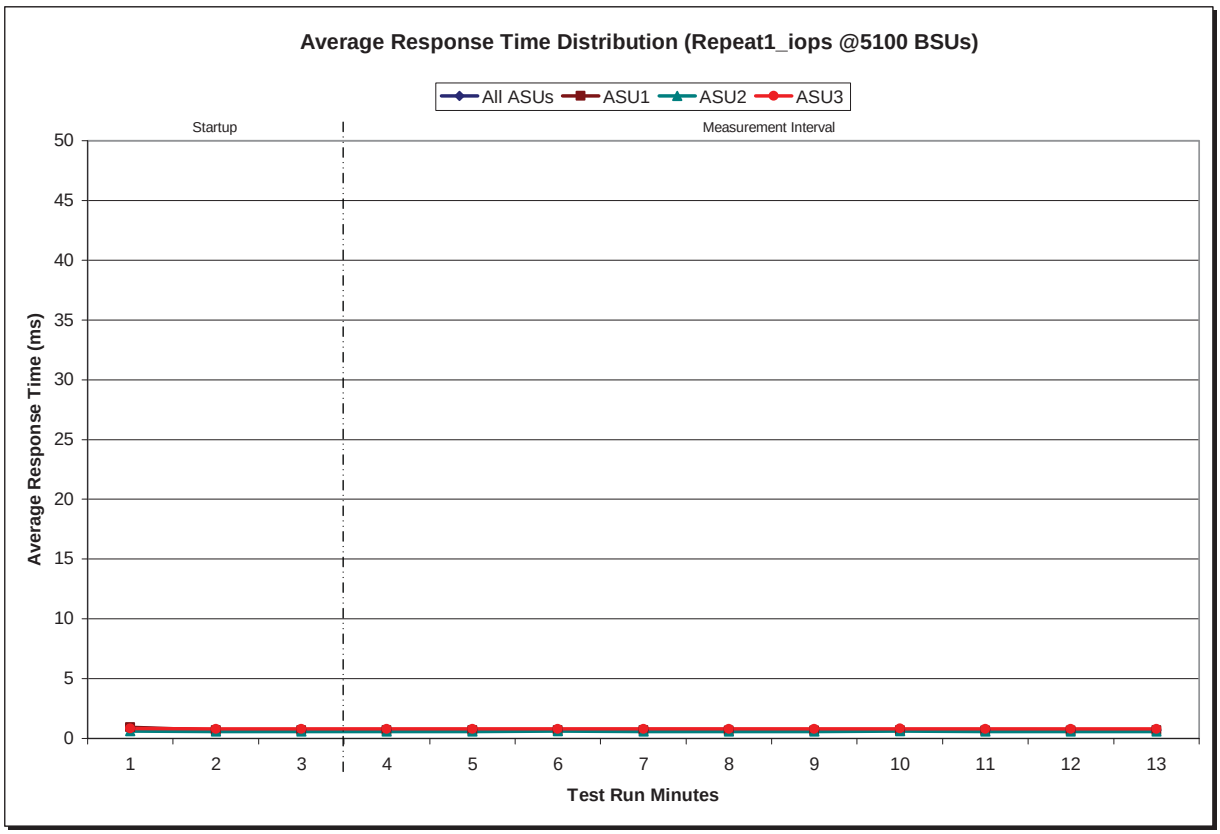
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

5100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:02:05	18:05:06	0-2	0:03:01
Measurement Interval	18:05:06	18:15:06	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.86	0.93	0.61	0.84
1	0.70	0.67	0.59	0.80
2	0.70	0.67	0.59	0.80
3	0.70	0.68	0.59	0.80
4	0.70	0.68	0.59	0.80
5	0.71	0.68	0.59	0.81
6	0.69	0.67	0.58	0.79
7	0.69	0.66	0.58	0.79
8	0.69	0.67	0.59	0.80
9	0.72	0.69	0.60	0.82
10	0.68	0.65	0.58	0.78
11	0.69	0.66	0.58	0.79
12	0.69	0.67	0.59	0.80
Average	***0.70***	***0.67***	***0.59***	***0.80***

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

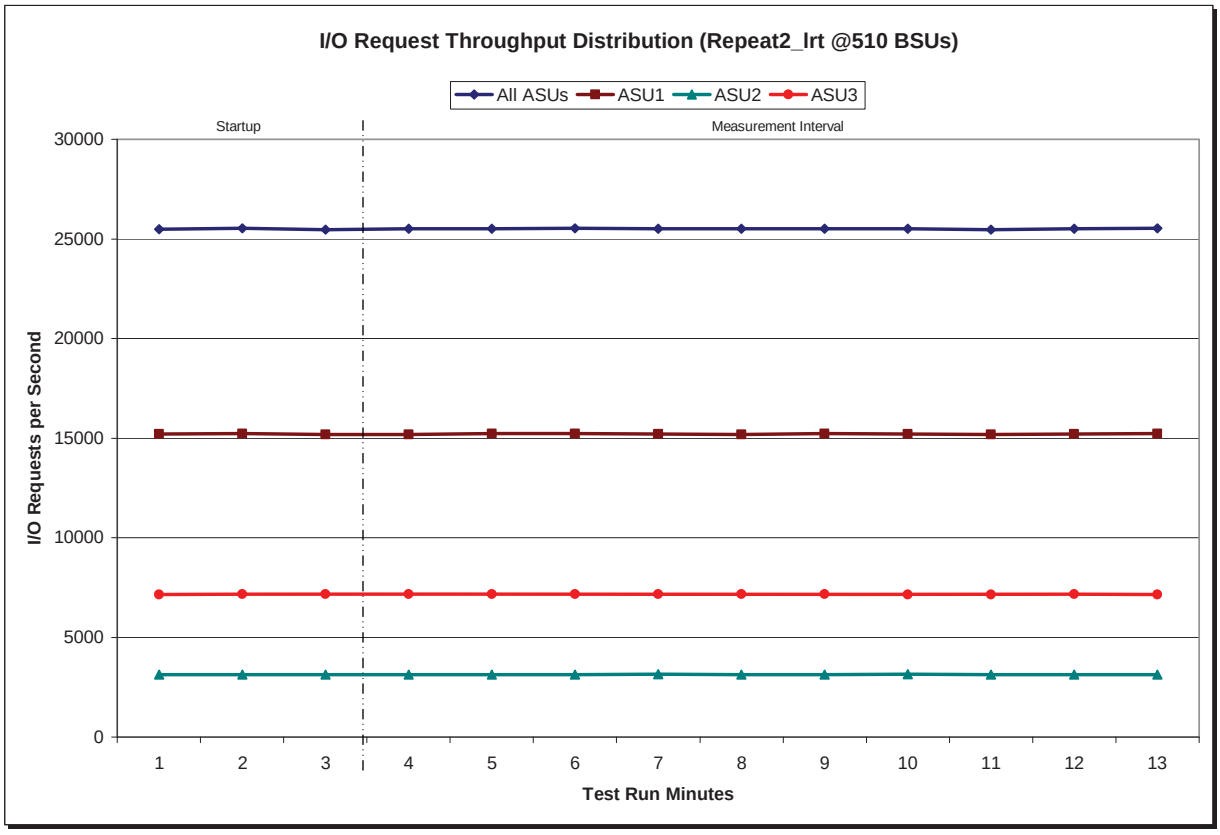


Repeatability 2 LRT – I/O Request Throughput Distribution Data

510 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:16:26	18:19:26	0-2	0:03:00
Measurement Interval	18:19:26	18:29:26	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	25,492.17	15,199.13	3,136.23	7,156.80
1	25,519.70	15,216.47	3,133.85	7,169.38
2	25,472.33	15,176.32	3,126.45	7,169.57
3	25,502.15	15,188.63	3,138.78	7,174.73
4	25,518.03	15,219.48	3,131.37	7,167.18
5	25,537.60	15,227.90	3,142.42	7,167.28
6	25,516.53	15,198.73	3,143.83	7,173.97
7	25,504.05	15,194.13	3,139.92	7,170.00
8	25,512.27	15,220.03	3,124.20	7,168.03
9	25,505.75	15,203.12	3,143.78	7,158.85
10	25,469.57	15,176.77	3,135.53	7,157.27
11	25,498.13	15,203.13	3,122.98	7,172.02
12	25,523.82	15,230.57	3,133.53	7,159.72
Average	*25,508.79*	*15,206.25*	*3,135.64*	*7,166.91*

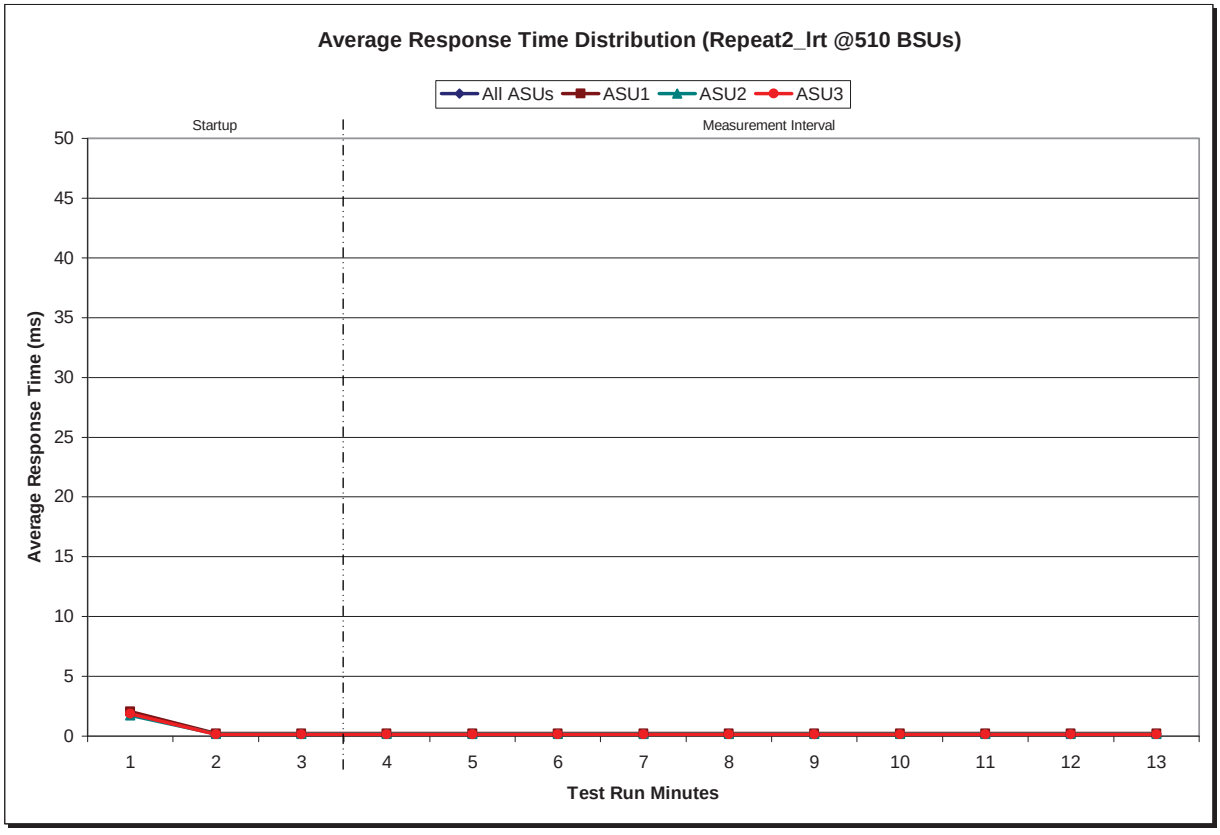
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

510 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:16:26	18:19:26	0-2	0:03:00
Measurement Interval	18:19:26	18:29:26	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.96	2.04	1.72	1.88
1	0.19	0.21	0.17	0.15
2	0.19	0.21	0.17	0.15
3	0.19	0.21	0.17	0.15
4	0.19	0.21	0.17	0.15
5	0.19	0.21	0.17	0.15
6	0.19	0.21	0.17	0.15
7	0.19	0.21	0.17	0.15
8	0.19	0.21	0.17	0.15
9	0.19	0.21	0.17	0.15
10	0.19	0.21	0.17	0.15
11	0.19	0.21	0.17	0.15
12	0.19	0.21	0.17	0.15
Average	***0.19***	***0.21***	***0.17***	***0.15***

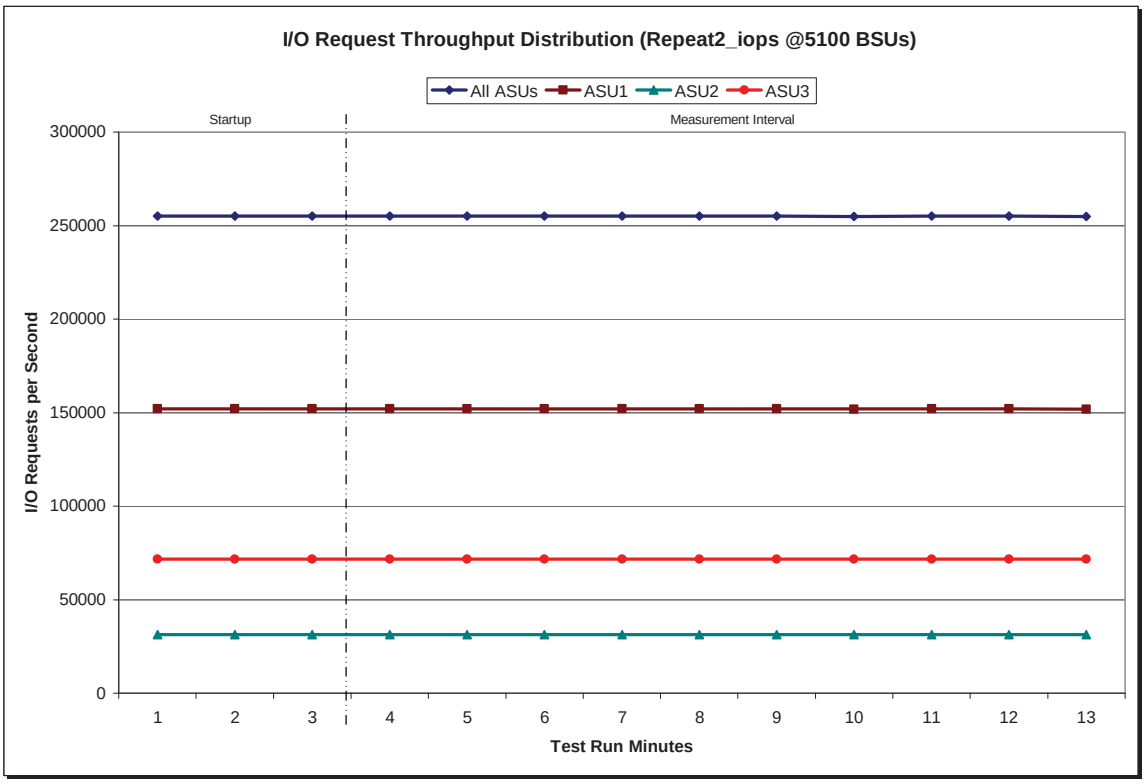
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

5100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:30:44	18:33:45	0-2	0:03:01
Measurement Interval	18:33:45	18:43:45	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	255,073.20	152,015.40	31,407.82	71,649.98
1	254,981.47	151,954.78	31,376.43	71,650.25
2	255,093.93	151,981.47	31,375.78	71,736.68
3	255,051.78	151,968.80	31,378.92	71,704.07
4	255,068.23	152,013.93	31,381.93	71,672.37
5	255,064.18	152,010.92	31,384.27	71,669.00
6	255,037.48	152,023.12	31,368.88	71,645.48
7	255,136.85	152,100.17	31,348.50	71,688.18
8	254,974.32	152,004.43	31,341.03	71,628.85
9	254,805.80	151,822.33	31,344.43	71,639.03
10	254,995.97	151,949.92	31,381.03	71,665.02
11	254,993.03	151,961.32	31,366.97	71,664.75
12	254,810.23	151,836.23	31,351.45	71,622.55
Average	***254,993.79***	***151,969.12***	***31,364.74***	***71,659.93***

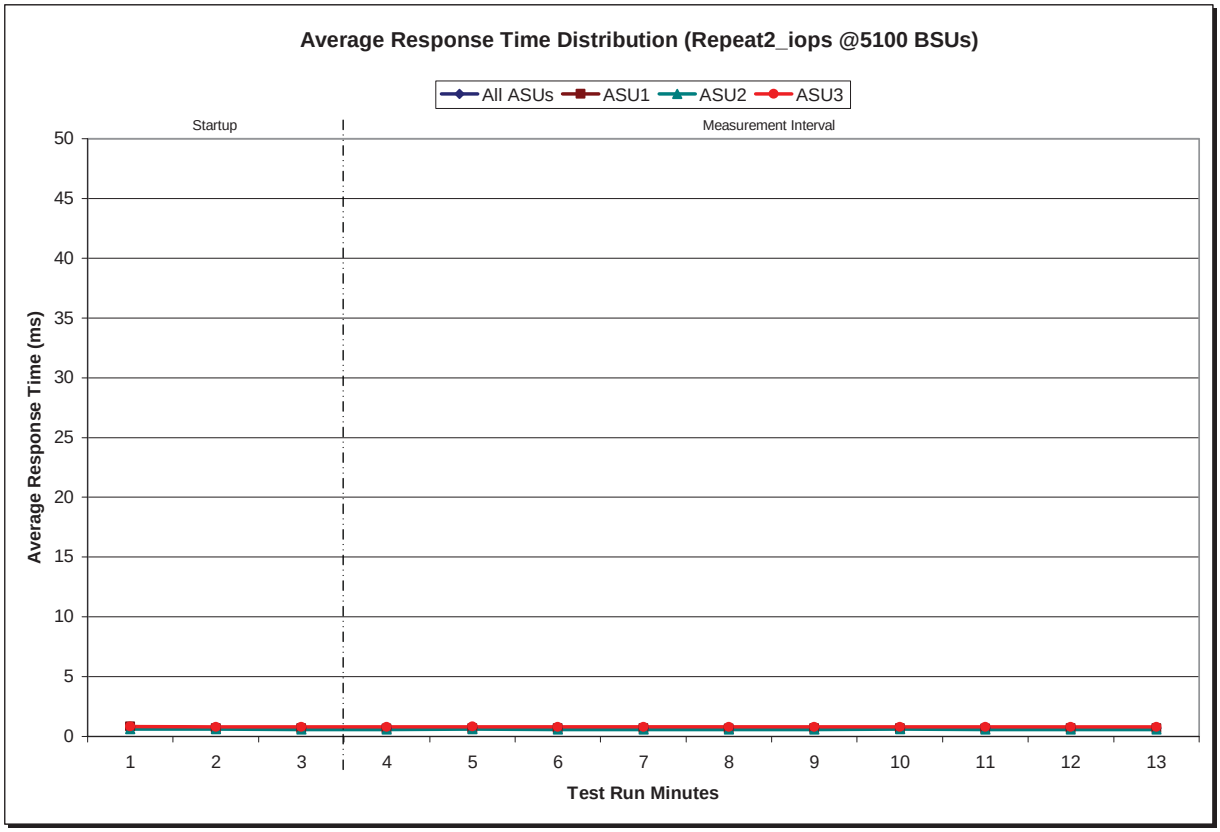
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

5100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:30:44	18:33:45	0-2	0:03:01
Measurement Interval	18:33:45	18:43:45	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.81	0.84	0.61	0.83
1	0.70	0.68	0.60	0.81
2	0.70	0.67	0.59	0.80
3	0.69	0.66	0.58	0.79
4	0.72	0.69	0.60	0.82
5	0.70	0.67	0.59	0.80
6	0.70	0.67	0.59	0.80
7	0.69	0.66	0.58	0.79
8	0.70	0.67	0.59	0.80
9	0.71	0.68	0.60	0.81
10	0.69	0.66	0.58	0.79
11	0.70	0.68	0.59	0.80
12	0.69	0.67	0.59	0.79
Average	***0.70***	***0.67***	***0.59***	***0.80***

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



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

Clause 3.4.3

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

Clauses 5.1.10 and 5.3.13.2

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 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2101	0.0180	0.0700	0.0350	0.2809
COV	0.005	0.001	0.004	0.002	0.005	0.002	0.003	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	0.2100	0.0180	0.0700	0.0250	0.2810
COV	0.001	0.000	0.001	0.001	0.002	0.001	0.001	0.001

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	0.2810	0.0701	0.2100	0.0181	0.0699	0.0349	0.2810
COV	0.004	0.001	0.002	0.002	0.005	0.003	0.005	0.001

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

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

Data Persistence Test

Clause 6

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

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

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

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

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

Clause 9.4.3.8

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

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

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 64.

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	473,443,104
Total Number of Logical Blocks Verified	214,161,008
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 9.2.4.9

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 Texas Memory Systems RamSan-620 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 found in the Priced Storage Configuration Pricing section on page 14.

TESTED STORAGE CONFIGURATION (TSC) AND PRICED STORAGE CONFIGURATION DIFFERENCES

Clause 9.4.3.3.7

The Executive Summary shall contain a pricing a list of all differenced 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 14.

ANOMALIES OR IRREGULARITIES

Clause 9.4.3.10

The FDR shall include a clear and complete description of any anomalies or irregularities encountered in the course of executing the SPC-1 benchmark that may in any way call into question the accuracy, verifiability, or authenticity of information published in this FDR.

There were no anomalies or irregularities encountered during the SPC-1 Onsite Audit of the Texas Memory Systems RamSan-620 .

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: This level will ensure data protection in the event of a single point of failure of any configured storage device. A brief description of the data protection utilized is included in the Executive Summary.

Unprotected: No claim of data protection is asserted in the event of a single point of failure.

SPC-1 Test Execution Definitions

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

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

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

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

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

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

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

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

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

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

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

Ramp-Up: The time required for the Benchmark Configuration (BC) to produce Steady State throughput after the Workload Generator begins submitting I/O Requests to the TSC for execution.

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

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

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

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

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

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

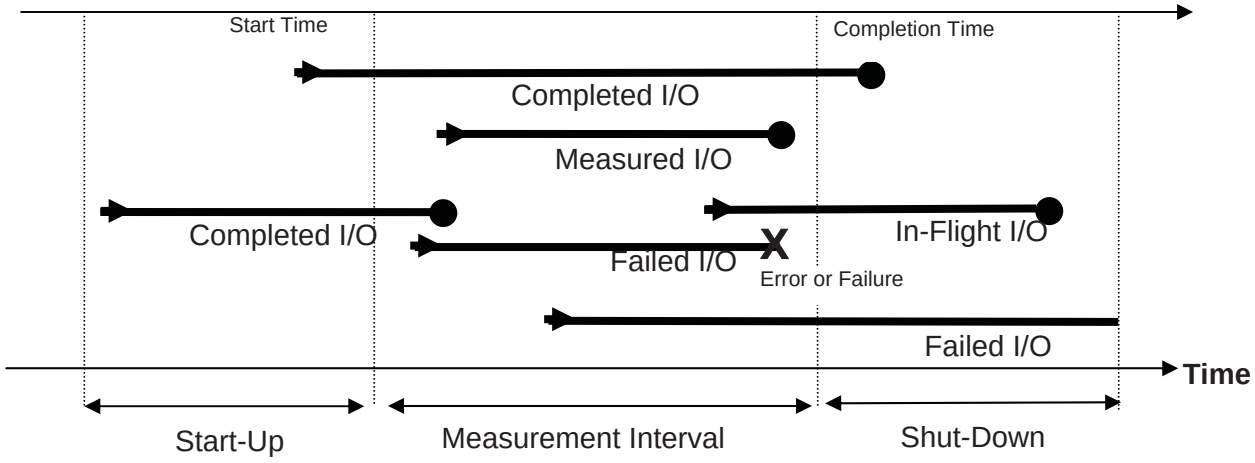
Test: A collection of Test Phases and or Test Runs sharing a common objective.

Test Run: The execution of SPC-1 for the purpose of producing or supporting an SPC-1 test result. SPC-1 Test Runs may have a finite and measured Ramp-Up period, Start-Up

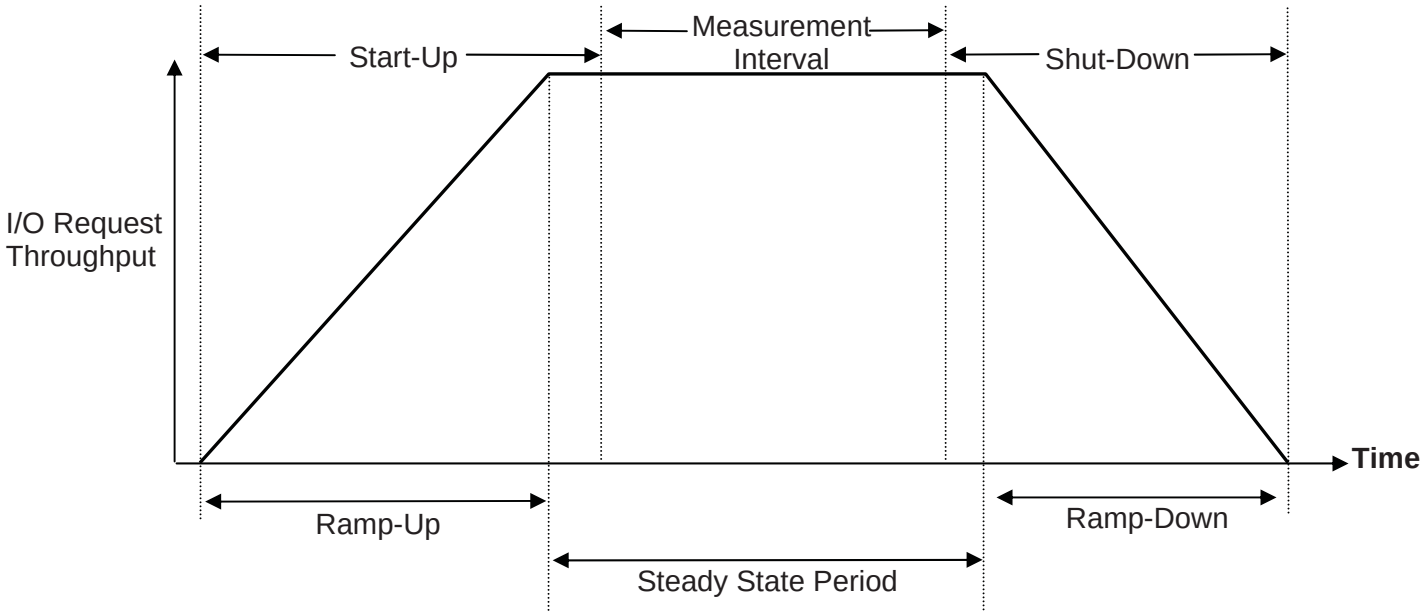
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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

I/O Completion Types



SPC-1 Test Run Components



APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

The only customer tunable parameter or option changed from its default value was the System Storage Mode to include the Active Spare protection. The details for changing this option are presented in *"Appendix C: Tested Storage Configuration (TSC) Creation"*.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

From first use, the RamSan-620 is rack-mounted, networked, and fiber cables are attached to respective host ports. Once an IP assigned using the Front Panel menu, the user may manage the system.

The first step to LUN configuration is to configure the System Storage Mode to include Active Spare protection. To accomplish this, login to the Web-based GUI at the assigned IP address of the RamSan-620. Then click the "System Storage Modes" toolbar button to open the dialog for choosing the preferred storage mode. The system defaults to Max Capacity Storage Mode which does not incorporate the Active Spare module for extra resiliency. For this configuration, we wish to have the extra resiliency so select the Active Spare Storage Mode option, click Next, and authorize the change through re-authentication of the administrator's password.

After this change, the Logical Unit configuration is defined as normal. The Total Capacity of the system is reduced by the capacity of the spare Solid State Device.

The next step is to create the LUNs that are the SPC-1 Logical Volumes. The LUNs are created by using either the Web GUI on the RamSan-620 for wizard-based configuration or by logging into the CLI through Serial, Telnet, or SSH protocols.

Using the CLI, the LUNs are created by the following commands:

```
lu create asu_1 2203259502592 0
lu create asu_2 2203259502592 1
lu create asu_3 489624174592 2
```

After the 3 LUNs have been created, access policies are used to grant access through each of the 8 available 4Gb ports. These access policies are applied with the commands:

```
lu access add asu_1_1 asu_1 fc-1a open
```

```
lu access add asu_1_2 asu_1 fc-2a open
lu access add asu_1_3 asu_1 fc-3a open
lu access add asu_1_4 asu_1 fc-4a open
lu access add asu_1_5 asu_1 fc-1b open
lu access add asu_1_6 asu_1 fc-2b open
lu access add asu_1_7 asu_1 fc-3b open
lu access add asu_1_8 asu_1 fc-4b open
lu access add asu_2_1 asu_2 fc-1a open
lu access add asu_2_2 asu_2 fc-2a open
lu access add asu_2_3 asu_2 fc-3a open
lu access add asu_2_4 asu_2 fc-4a open
lu access add asu_2_5 asu_2 fc-1b open
lu access add asu_2_6 asu_2 fc-2b open
lu access add asu_2_7 asu_2 fc-3b open
lu access add asu_2_8 asu_2 fc-4b open
lu access add asu_3_1 asu_3 fc-1a open
lu access add asu_3_2 asu_3 fc-2a open
lu access add asu_3_3 asu_3 fc-3a open
lu access add asu_3_4 asu_3 fc-4a open
lu access add asu_3_5 asu_3 fc-1b open
lu access add asu_3_6 asu_3 fc-2b open
lu access add asu_3_7 asu_3 fc-3b open
lu access add asu_3_8 asu_3 fc-4b open
```

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

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

```
host=master
#slaves=(slave1,slave2,slave3,slave4,slave5,slave6,slave7,slave8,slave9,slave10)


#c441,c442,c443,c444,c445,c446,c447,c448,c449,c4410
#c451,c452,c453,c454,c455,c456,c457,c458,c459,c4510
#c461,c462,c463,c464,c465,c466,c467,c468,c469,c4610
#c471,c472,c473,c474,c475,c476,c477,c478,c479,c4710
#c641,c642,c643,c644,c645,c646,c647,c648,c649,c6410
#c651,c652,c653,c654,c655,c656,c657,c658,c659,c6510
#c661,c662,c663,c664,c665,c666,c667,c668,c669,c6610
#c671,c672,c673,c674,c675,c676,c677,c678,c679,c6710
#c681,c682,c683,c684,c685,c686,c687,c688,c689,c6810
#c691,c692,c693,c694,c695,c696,c697,c698,c699,c6910
#c701,c702,c703,c704,c705,c706,c707,c708,c709,c7010
#c711,c712,c713,c714,c715,c716,c717,c718,c719,c7110

slaves=(c441,c442,c443,c444,c445,c446,c447,c451,c452,c453,c454,c455,c456,c457,c461,c
462,c463,c464,c465,c466,c467,c471,c472,c473,c474,c475,c476,c477,c681,c682,c683,c684,
c685,c686,c687,c691,c692,c693,c694,c695,c696,c697,c701,c702,c703,c704,c705,c706,c707
,c711,c712,c713,c714,c715,c716,c717)


sd=asu1_1,lun=\\.\PhysicalDrive1
sd=asu2_1,lun=\\.\PhysicalDrive2
sd=asu3_1,lun=\\.\PhysicalDrive3
```

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

```
sd=asu1_1,lun=\\.\PhysicalDrive1
sd=asu2_1,lun=\\.\PhysicalDrive2
sd=asu3_1,lun=\\.\PhysicalDrive3
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

Primary Metrics Test, Repeatability Test, and Persistence Test Run 1

The following script was used 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 Persistence Test Run 1 in an uninterrupted sequence.

```
REM Prep to Run METRICS
del spc1.cfg /Q
copy metrics_spc1.cfg spc1.cfg

java -Xmx512m -Xss64k metrics -b 5100

REM Repeat 1
java -Xmx512m -Xms512m repeat1 -b 5100

REM Repeat 2
java -Xmx512m -Xms512m repeat2 -b 5100

del spc1.cfg /Q
copy persist1.cfg spc1.cfg

java -Xmx900m -Xms900m -Xss64k persist1 -b 5100
```

Persistence Test Run 2

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

```
cd \spc\spc1

del spc1.cfg /Q
copy persist1.cfg spc1.cfg

java -Xmx900m -Xms900m -Xss64k persist2
```

Slave JVM Initiation

Each Slave JVM on each Host System was initiated by executing a BAT file with the appropriate Slave JVM identifier that referenced the appropriate parameter file. The BAT file and an example parameter file appear below.

slave.bat

```
cd \spc\spc1
java -Xmx512m -Xms512m -Xss64k spc1 -fslave%1.txt
```

slave1.txt

```
master=spcadmin
host=c441
sd=asu1_1,lun=\\.\PhysicalDrive1
sd=asu2_1,lun=\\.\PhysicalDrive2
sd=asu3_1,lun=\\.\PhysicalDrive3
```