SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

IBM CORPORATION
IBM STORWIZE® V7000

SPC-1 V1.12

Submitted for Review: October 22, 2010
Submission Identifier: A00097

First Edition – October 2010

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AUDIT CERTIFICATION

Bruce McNutt
IBM Corporation
650 Harry Road C2 500
San Jose, CA 95120

October 22, 2010

The SPC Benchmark 1™ results listed below for the IBM Storwize® V7000 were produced in compliance with the SPC Benchmark 1™ 1.12 Remote Audit requirements.

SPC Benchmark 1™ 1.12 Results	
Tested Storage Configuration (TSC) Name: IBM Storwize® V7000	
Metric	**Reported Result**
SPC-1 IOPS™	56,510.85
SPC-1 Price-Performance	$7.24/SPC-1 IOPS™
Total ASU Capacity	14,442.309 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$409,410.86

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with 1.12 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 IBM Corporation:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of 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.
- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.

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Redwood City, CA 94062
AuditService@storageperformance.org
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AUDIT CERTIFICATION *(CONT.)*

- The following Host System requirements, based on information supplied by IBM Corporation:
  - ✓ 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 IBM Corporation for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability Test
- There were no differences between the Tested Storage Configuration (TSC) used for the benchmark and Priced Storage.
- 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

Walter E. Baker
SPC Auditor

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LETTER OF GOOD FAITH

IBM

Vice President and Disk Storage Business Line Executive

IBM Technology & Systems Group
3039 Cornwallis Road,
Research Triangle Park, NC 27709

Phone: 1-919-543-6345
Fax: 1-919-543-2856

October 1, 2010

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

Subject: SPC-1 Letter of Good Faith for the IBM Storwize V7000.

IBM Corporation is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with Version 1.10.1 of the SPC-1 benchmark specification.

Our disclosure of the Benchmark configuration and execution of the benchmark includes all items that, to the best of our knowledge and belief, materially affect the reported results, regardless of whether such items are explicitly required to be disclosed by the SPC-1 benchmark specification.

Sincerely,

Doug Balog

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	IBM Corporation – http://www.ibm.com Bruce McNutt – bmcnutt@us.ibm.com 650 Harry Road C2 500 San Jose, CA 95120 Phone: (408) 927-2717 FAX: 0086 28 62905793
Test Sponsor Alternate Contact	IBM Corporation – http://www.ibm.com Barry Whyte – barry.whyte@uk.ibm.com IBM Hursley Park Hursley, UK SO212JN Phone: 011-44-1-96-281-7566
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	V1.12
SPC-1 Workload Generator revision number	V2.1.0
Date Results were first used publicly	October 22, 2010
Date the FDR was submitted to the SPC	October 22, 2010
Date the priced storage configuration is available for shipment to customers	November 12, 2010
Date the TSC completed audit certification	October 22, 2010

Tested Storage Product (TSP) Description

The IBM Storwize V7000 disk system, IBM's newest midrange disk storage offering, uses IBM System Storage SAN Volume Controller technology to deliver high performance, advanced function, high availability, and modular and scalable storage capacity.

- Supports RAID 0, 1, 5, 6, and 10
- Provides SAN-attached 8 Gbps Fibre Channel (FC) host connectivity and 1 GbE iSCSI host connectivity
- Supports intermix of SAS drives, Nearline SAS drives, and Solid-state drives within the IBM Storwize V7000 Control Enclosure and IBM Storwize V7000 Expansion

Enclosures (up to twenty-four 2.5-inch disk drives or twelve 3.5 inch disk drives in each Enclosure).

- Includes IBM Easy Tier technology for automatically moving heavily used data extents onto high-performance storage
- Supports attachment of other storage devices via the Fibre Channel interface, just as the SAN Volume Controller
- Supports a complete set of SAN Volume Controller functions including FlashCopy, RemoteCopy, VDisk Mirroring, thin provisioning, and a revised web-based user interface for both products new with this release

This submission demonstrates the ability of this product to provide a single image view of both its own internal storage and that of an attached DS5020 controller. Identical Vdisks are presented to Windows representing both types of storage.

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: IBM Storwize® V7000	
Metric	**Reported Result**
SPC-1 IOPS™	56,510.85
SPC-1 Price-Performance	$7.24/SPC-1 IOPS™
Total ASU Capacity	14,422.309 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$409,410.86

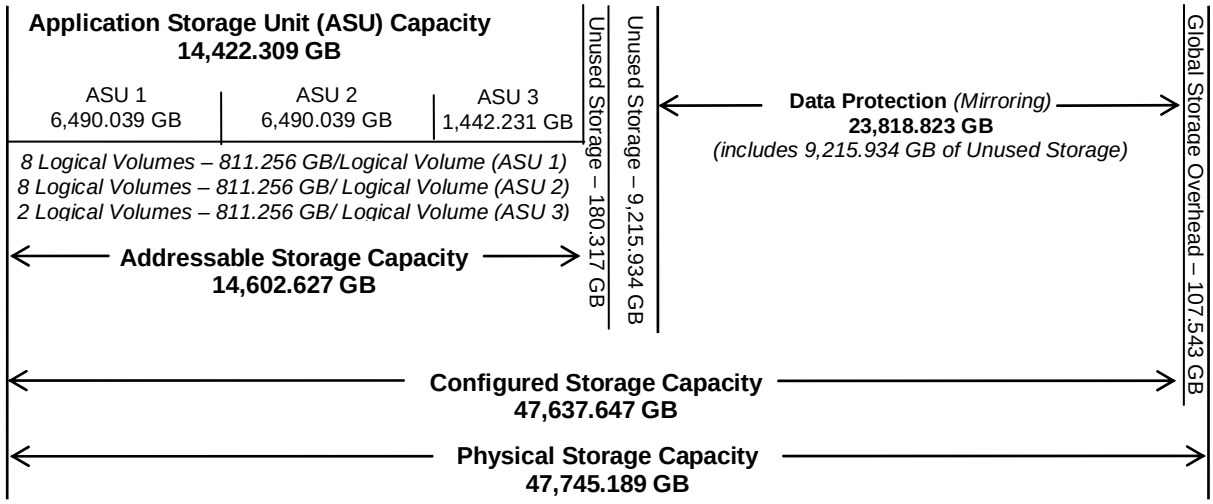
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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 ***Mirroring*** configures two or more identical copies of user data.

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	30.21%
Protected Application Utilization	60.79%
Unused Storage Ratio	38.98%

Application Utilization: Total ASU Capacity *(14,442.309 GB)* divided by Physical Storage Capacity *(47,745.189 GB)*

Protected Application Utilization: (Total ASU Capacity *(14,442.309 GB)* plus total Data Protection Capacity *(23,818.823 GB)* minus unused Data Protection Capacity *(9,215.934 GB)* divided by Physical Storage Capacity *(47,745.189 GB)*

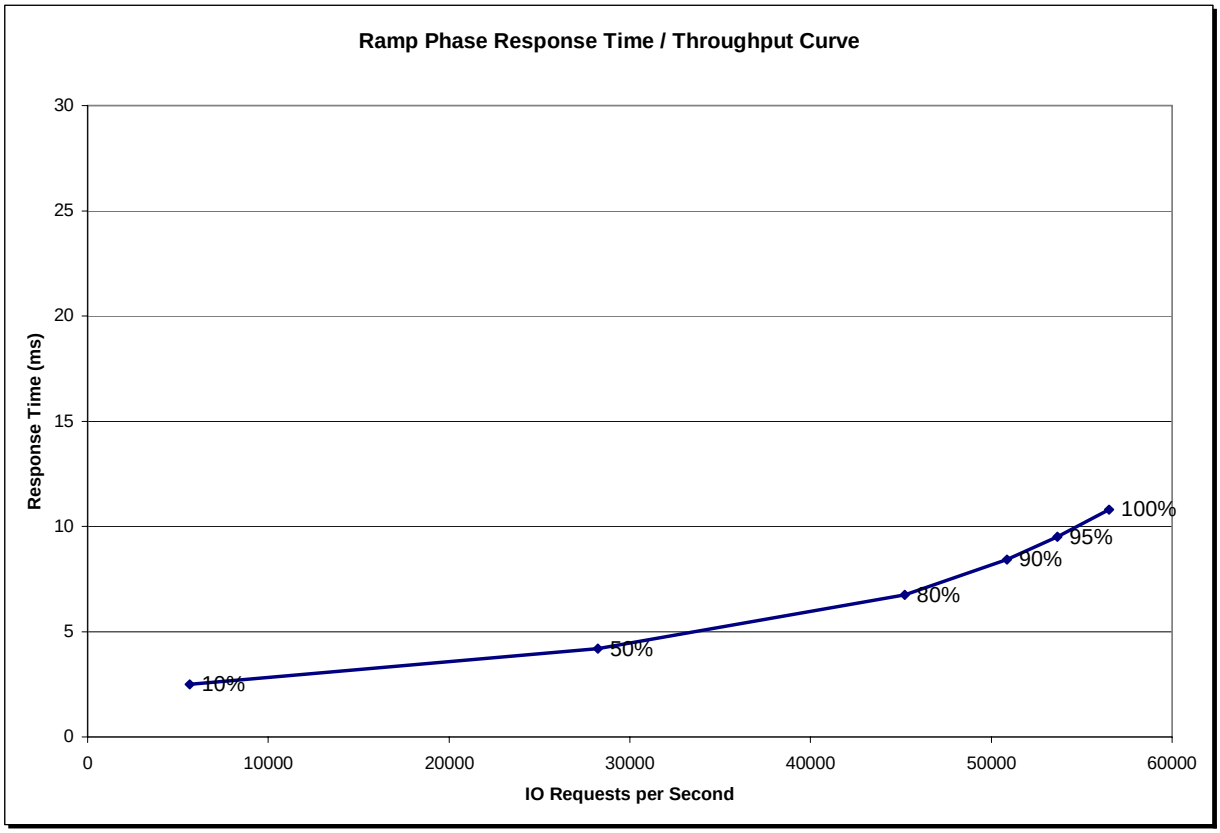
Unused Storage Ratio: Total Unused Capacity *(18,612.186 GB)* divided by Physical Storage Capacity *(47,745.189 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 21-22 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	5,652.64	28,241.46	45,206.64	50,858.54	53,655.64	56,510.85
Average Response Time (ms):						
All ASUs	2.50	4.19	6.74	8.43	9.51	10.80
ASU-1	3.35	5.54	8.61	10.53	11.81	13.40
ASU-2	3.29	5.95	11.61	15.86	18.28	20.88
ASU-3	0.36	0.56	0.63	0.73	0.79	0.88
Reads	5.87	9.80	16.15	20.31	22.94	26.09
Writes	0.31	0.54	0.61	0.70	0.76	0.85

Priced Storage Configuration Pricing

Description	Qty	Unit Price	extended	% discount	discounted price
Storwize V7000 base storage enclosure (2076-124) w/8SFPs (8Gb)	1	$25,000	$25,000	39	$ 15,250.00
Storwize V7000 Base SW	1	$18,000	$18,000	39	$ 10,980.00
Storwize V7000 expansion enclosure (2076-224)	4	$6,000	$24,000	39	$ 14,640.00
Storwize V7000 Base SW	4	$18,000	$72,000	39	$ 43,920.00
SAS 1M Cables to attach Control Enclosures to Expansion Enclosures	16	$59	$944	39	$ 575.84
2.5" 10K 300GB SAS HDD's	120	$1,099	$131,880	39	$ 80,446.80
External Virtualization license	5	$18,000	$90,000	39	$ 54,900.00
DS5020 Controller w/4 SFPs (8 Gb)	1	$22,500	$22,500	39	$ 13,725.00
EXP810 Expansion Enclosure w/4 SFPs (4 Gb) per enclosure	4	$6,000	$24,000	39	$ 14,640.00
3.5" 15K 146 GB FC HDD's	80	$1,605	$128,400	39	$ 78,324.00
DS5020 33-64 Disk Drive Attach	1	$2,000	$2,000	39	$ 1,220.00
DS5020 65-112 Disk Drive Attach	1	$4,000	$4,000	39	$ 2,440.00
DS5020 Windows Host Kit	1	$1,250	$1,250	39	$ 762.50
24 port fibre channel switch (2498-B24) w/8 active ports, 8 SFPs (8 Gb)	2	$7,890	$15,780	20	$ 12,624.00
Short wave 5m fibre channel cable (1814-20A 5605)	20	$129	$2,580	20	$ 2,064.00
Short wave 25 m fibre channel cable (1814-20A 5625)	4	$189	$756	20	$ 604.80
19 inch rack (7014-T42)	1	$2,970	$2,970	50	$ 1,485.00
Dual port 8 Gbps FC HBA (42D0510)	2	$1,299	$2,598	0	$ 2,598.00
HW/SW Total					*$ 351,199.94*
Maintenance for Software					
Base SW	5	$7,200	$36,000	39	$ 21,960.00
Virtualization	5	$7,200	$36,000	39	$ 21,960.00
WSU for Hardware					
Storwize V7000 Controller Enclosure	1	$4,200	$4,200	39	$ 2,562.00
Storwize V7000 Expansion Enclosure	4	$1,921	$7,684	39	$ 4,687.24
Warranty Upgrade to 3 year 24x7x4 for DS5020 Incl EXPs	1	$8,488	$8,488	39	$ 5,177.68
Warranty/Maintenance Upgrade to 3 year 24x7x4 for Switch	1	$2,330	$2,330	20	$ 1,864.00
Total Warranty/Maintenance					*$ 58,210.92*
Grand Total					**$ 409,410.86**

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

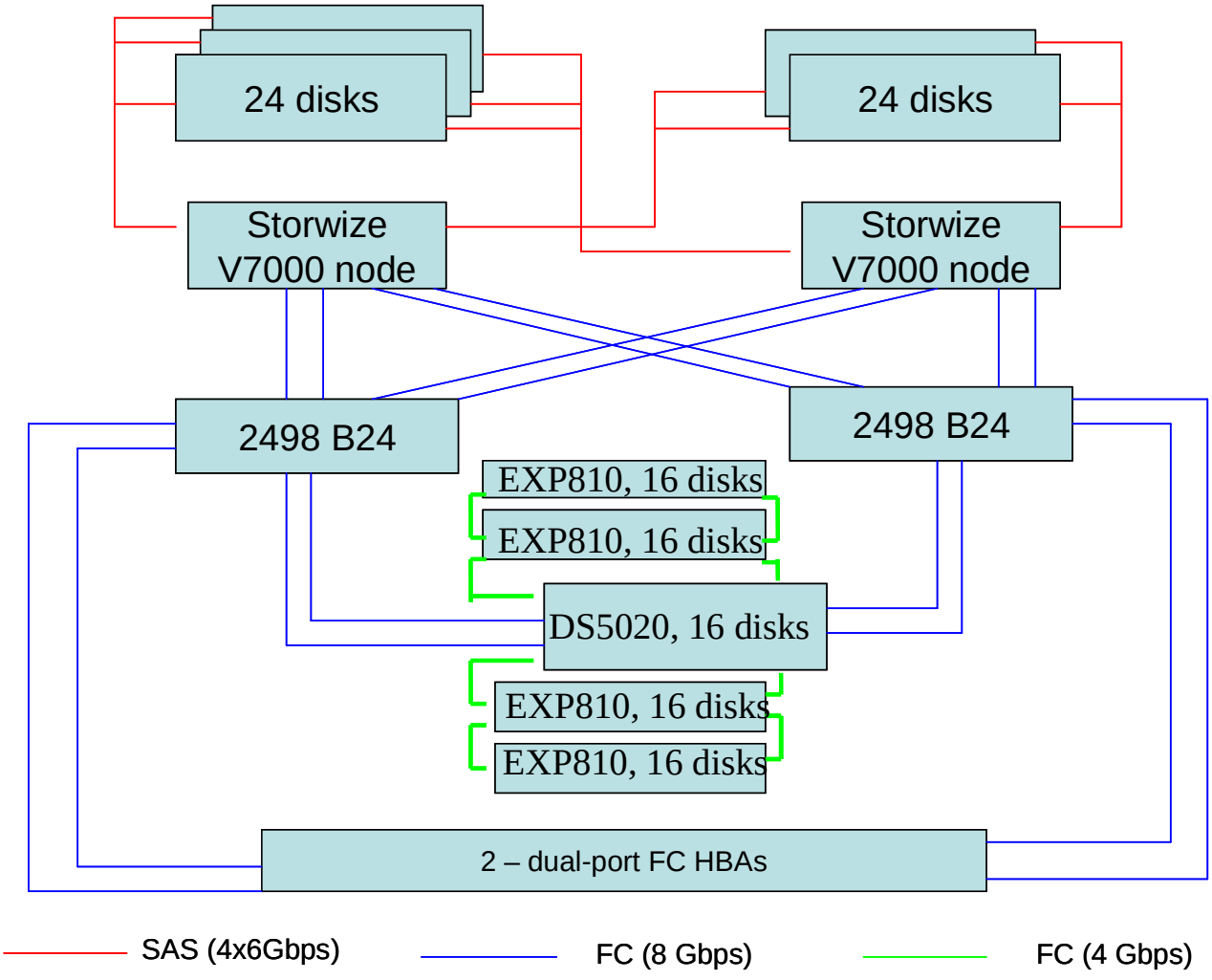
- Acknowledgement of new and existing problems with four (4) hours.
- Onsite present of a qualified maintenance engineer or provision of a customer replaceable part within four (4) hours of the above acknowledgement for any hardware failure that results in an inoperative Price Storage Configuration that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

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

Each of the two 2498 B24 switches in the TSC was enabled for 24 ports and configured with 20 SFPs. The benchmark measurements utilized 8 ports and 8 SFPs in each switch.

Each of the two 2498 B24 switches included in the Priced Storage Configuration was enabled for 8 ports and configured with 8 SFPs. This difference, if applied to the TSC, would not affect the reported benchmark measurements.

Priced Storage Configuration Diagram



2498 B24: 24-port fibre channel switch

DS5020: DS5020 Controller with 16 15K RPM 146GB disk drives.

EXP810: Four EXP810 Expansion Enclosures each with 16 15K RPM 146GB disk drives.

24 disks: One Storwize® V7000 base storage enclosure and four Storwize® V7000 Expansion Enclosures, each with 24 10K RPM 146GB disk drives.

Priced Storage Configuration Components

Priced Storage Configuration:
2 – 8 Gb dual port FC HBAs *(model 42D0510)*
IBM Storwize® V7000 ***(2-node cluster)*** 8 GB memory/cache per node *(16 GB total)* 4 – 8 Gbps switch-to-host FC connections shared by both nodes 2 – 4x6Gbps SAS connections per node *(internal disk drives)* 4 – 8 Gbps switch-to-DS5020 FC connections *(external disk drives)* 8 – 8 Gb SFPs 24 – 10K RPM 300 GB disk drives 4 – Storwize® V7000 Expansion Enclosures with 24 10K RPM 300 GB disk drives
1 – DS5020 Controller with four 8 Gb SFPs and 16 15K RPM 146 GB disk drives
4 – EXP810 Expansion Enclosure each with 16 15K RPM 146 GB disk drives and 4 SFPs *(4 Gb)*
1 – 19 inch rack with 2 12-plug PDUs
2 – 24-port fibre channel switches *(2498-B24*)
20 – short wave 5m fibre channel cables
4 – 25m fibre channel cables

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 18 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Storage Network Configuration

Clause 9.4.3.4.1

…

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

Clause 9.4.3.4.2

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.4.3.4.1 contains a high-level illustration of the network configuration, the Executive Summary will contain a one page topology diagram of the storage network as illustrated in Figure 9-9.

The storage network configuration is illustrated on page 18 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

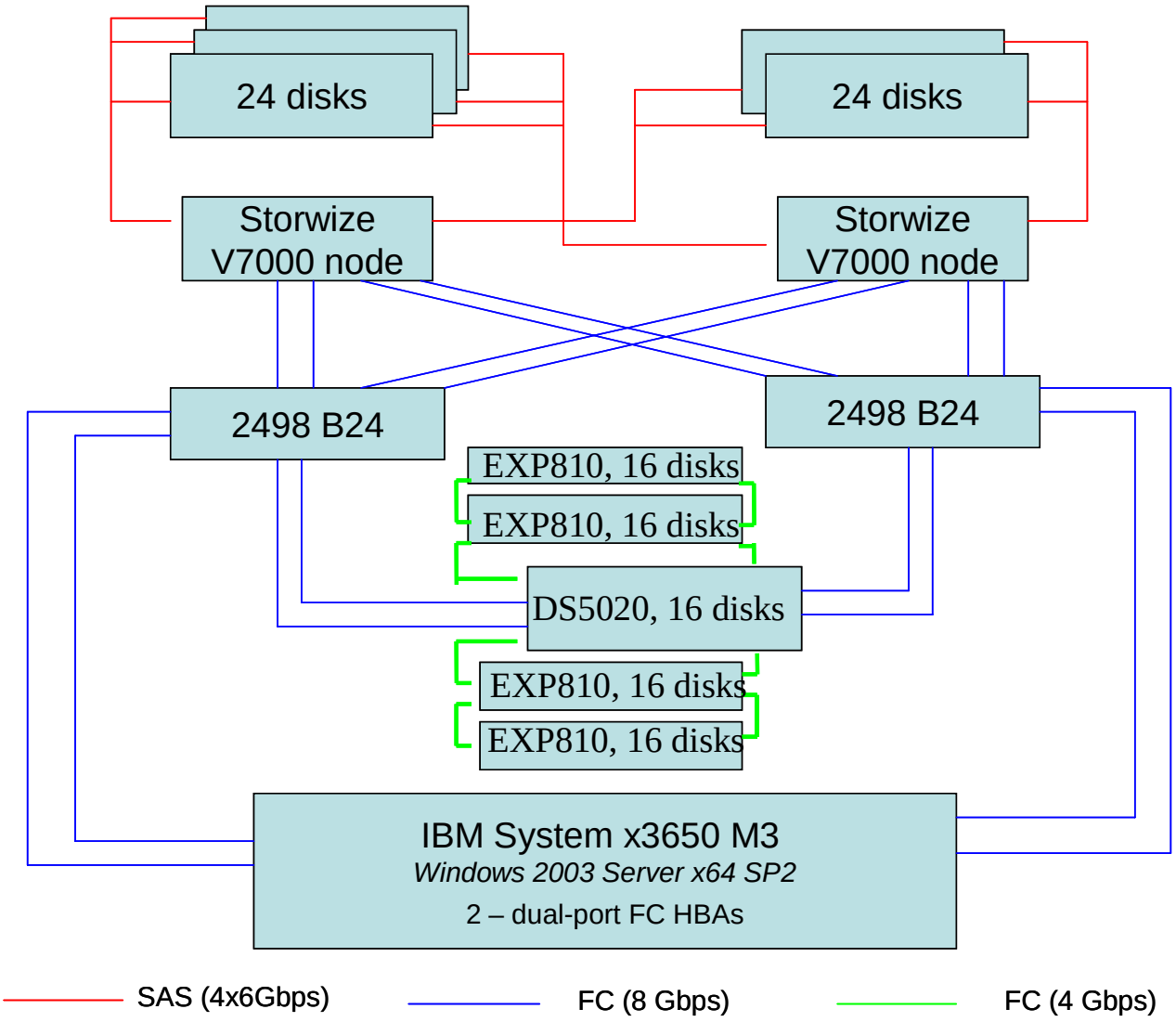
Host System and Tested Storage Configuration (TSC) Table of Components

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 19 *(Host System(s) and Tested Storage Configuration Components).*

Benchmark Configuration/Tested Storage Configuration Diagram



2498 B24: 24-port fibre channel switch

DS5020: DS5020 Controller with 16 15K RPM 146GB disk drives.

EXP810: Four EXP810 Expansion Enclosures each with 16 15K RPM 146GB disk drives.

24 disks: One Storwize® V7000 base storage enclosure and four Storwize® V7000 Expansion Enclosures, each with 24 10K RPM 146GB disk drives.

Host System(s) and Tested Storage Configuration Components

Host System:	Tested Storage Configuration (TSC):
IBM System X3650 M3	11 – 8 Gb PCIe dual port FC HBAs
1 – Intel Xeon 5600 2.26 GHz 6-core processor with 12 MB shared L3 cache	**IBM Storwize® V7000** ***(2-node cluster)*** 8 GB memory/cache per node *(16 GB total)* 4 – 8 Gbps switch-to-host FC connections shared by both nodes 2 – 4x6Gbps SAS connections per node *(internal disk drives)* 4 – 8 Gbps switch-to-DS5020 FC connections *(external disk drives)* 8 – 8 Gb SFPs 24 – 10K RPM 300 GB disk drives 4 – Storwize® V7000 expansion enclosures with 24 10K RPM 300 GB disk drives 1 – DS5020 Controller with four 8 Gb SFPs and 16 15K RPM 146 GB disk drives
28 GB main memory	
Windows 2003 Server x64 w/SP2	
SDDDSM – Storwize® V7000 Windows driver providing multipath management	
PCIe	
	4 – EXP810 Expansion Enclosure each with 16 15K RPM 146 GB disk drives and 4 SFPs *(4 Gb)*
	1 – 19 inch rack with 2 12-plug PDUs
	2 – 24-port fibre channel switches *(2498-B24*)
	20 – short wave 5m fibre channel cables
	4 – 25m fibre channel cables

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 63 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 64 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.4.3.5.3

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

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in "Appendix D: SPC-1 Workload Generator Storage Commands and Parameters" on page 72.

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 59 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)	14,422.309
Addressable Storage Capacity	Gigabytes (GB)	14,602.627
Configured Storage Capacity	Gigabytes (GB)	47,637.647
Physical Storage Capacity	Gigabytes (GB)	47,745.189
Data Protection *(Mirroring)*	Gigabytes (GB)	23,818.823
Required Storage	Gigabytes (GB)	0.000
Global Storage Overhead	Gigabytes (GB)	107.543
Total Unused Storage	Gigabytes (GB)	18,612.186

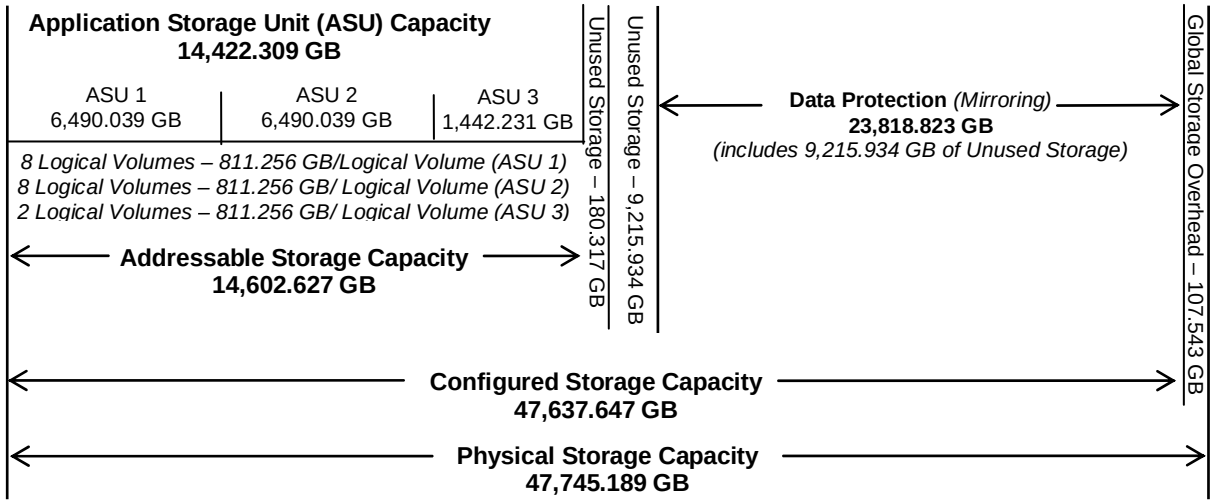
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	98.77%	30.28%	30.21%
Required for Data Protection *(Mirrored)*		50.00%	49.89%
Addressable Storage Capacity		30.65%	30.58%
Required Storage *(including spares)*		0.00%	0.00%
Configured Storage Capacity			99.77%
Global Storage Overhead			0.23%
Unused Storage:			
Addressable	1.23%		
Configured		38.69%	
Physical			0.00%

The Physical Storage Capacity consisted of 47.745.189 GB distributed over 120 disk drives each with a formatted capacity of 300.00 GB and 80 disk drives each with a formatted capacity of 146.815 GB. There was 0.000 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 107.543 GB (0.23%) of Physical Storage Capacity. There was 18,431.869 GB (38.69%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 98.77% of the Addressable Storage Capacity resulting in 180.317 GB (1.23%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(mirroring)* capacity was 23,818.823 GB of which 14,602.889 GB was utilized. The total Unused Storage was 18,612.186 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 (6,490.039 GB)	**ASU-2 (6,490.039 GB)**	**ASU-3 (1,442.231 GB)**
8 Logical Volumes 811.257 GB per Logical Volume (811.255 GB used per Logical Volume)	8 Logical Volumes 811.257 GB per Logical Volume (811.255 GB used per Logical Volume)	2 Logical Volumes 811.257 GB per Logical Volume (721.115 GB used per Logical Volume))

The Data Protection Level used for all Logical Volumes was "Mirrored" 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	30.21%
Protected Application Utilization	60.79%
Unused Storage Ratio	38.98%

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 60 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 73.

Sustainability Test Results File

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

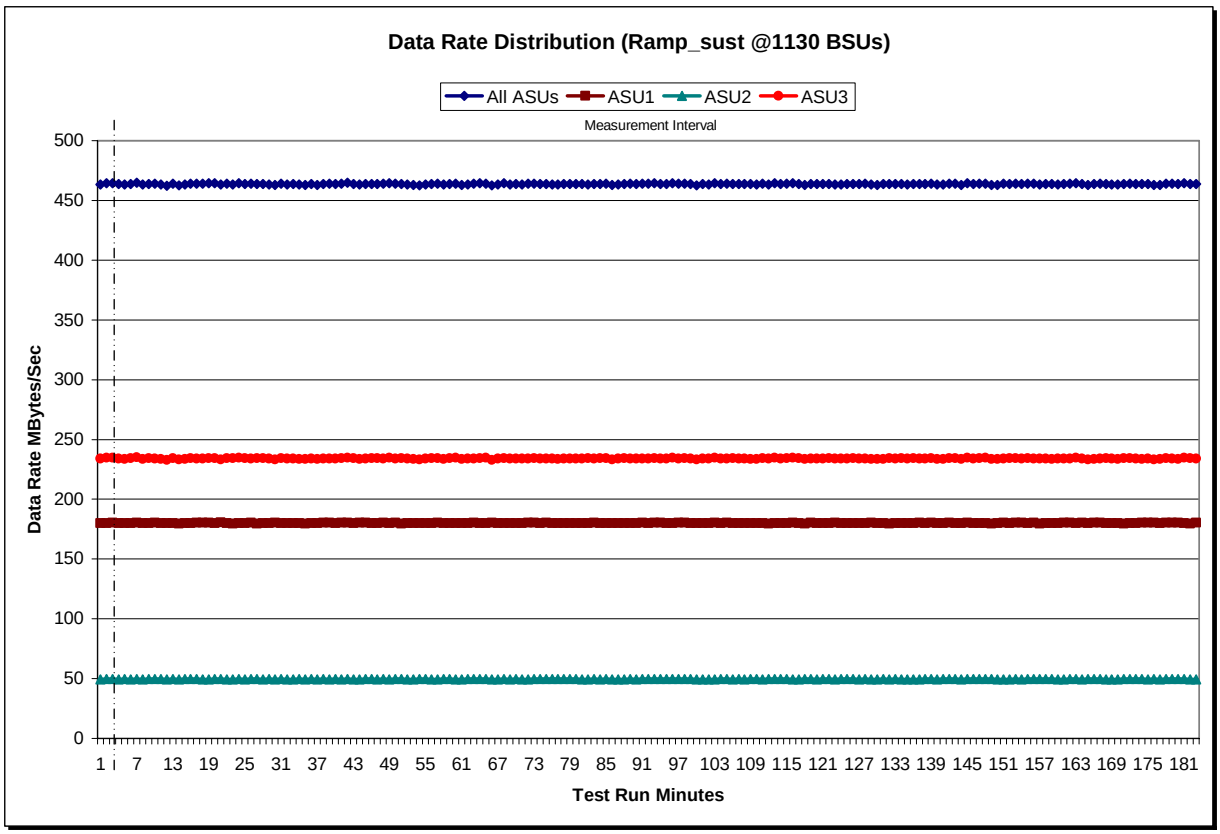
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	14:38:16	14:41:16	0-2	0:03:00
Measurement Interval	14:41:16	17:41:16	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	463.21	180.05	49.27	233.89	63	464.26	180.02	49.77	234.48	126	463.51	180.15	49.38	233.98
1	464.26	180.05	49.51	234.70	64	464.16	180.02	49.60	234.54	127	463.93	180.14	49.73	234.06
2	464.45	180.25	49.59	234.61	65	462.56	180.25	49.41	232.90	128	463.20	180.36	49.33	233.51
3	463.51	180.13	49.38	234.00	66	463.28	179.98	49.44	233.86	129	462.94	180.01	49.27	233.67
4	463.39	180.08	49.53	233.78	67	464.23	180.05	49.69	234.49	130	463.49	180.09	49.64	233.76
5	463.50	179.81	49.48	234.22	68	463.11	179.94	49.32	233.86	131	463.76	179.76	49.49	234.50
6	464.63	180.17	49.54	234.92	69	463.64	179.87	49.70	234.07	132	463.70	180.07	49.54	234.08
7	463.28	180.16	49.45	233.67	70	463.23	179.90	49.30	234.03	133	463.81	180.03	49.44	234.33
8	463.78	180.03	49.53	234.22	71	463.87	180.27	49.47	234.13	134	463.27	179.88	49.40	233.99
9	463.99	180.20	49.71	234.08	72	464.18	180.25	49.68	234.25	135	463.79	180.10	49.40	234.29
10	463.11	179.85	49.63	233.63	73	463.65	180.06	49.51	234.09	136	463.71	180.30	49.39	234.02
11	462.31	179.98	49.35	232.97	74	463.70	180.17	49.62	233.91	137	463.62	180.14	49.51	233.98
12	464.02	179.97	49.70	234.36	75	463.38	179.93	49.58	233.87	138	464.18	180.27	49.66	234.25
13	462.54	179.71	49.41	233.42	76	463.16	179.86	49.52	233.77	139	463.13	180.02	49.43	233.68
14	463.35	180.08	49.51	233.76	77	463.55	179.95	49.63	233.97	140	463.37	180.03	49.61	233.73
15	464.01	180.11	49.52	234.38	78	463.57	179.82	49.63	234.12	141	463.95	180.21	49.51	234.23
16	463.89	180.24	49.60	234.05	79	463.60	180.06	49.64	233.90	142	463.90	179.99	49.50	234.41
17	463.84	180.41	49.44	233.98	80	463.50	180.15	49.46	233.89	143	463.07	179.96	49.48	233.63
18	464.26	180.43	49.41	234.43	81	463.45	179.85	49.35	234.25	144	464.50	180.18	49.53	234.79
19	464.30	180.09	49.71	234.50	82	463.69	180.17	49.59	233.94	145	463.68	180.05	49.63	234.01
20	463.40	180.58	49.53	233.28	83	463.75	180.09	49.47	234.20	146	463.90	180.06	49.57	234.26
21	464.00	180.04	49.48	234.48	84	464.05	180.15	49.53	234.37	147	464.06	179.97	49.51	234.59
22	463.36	179.76	49.19	234.41	85	462.80	179.92	49.50	233.38	148	463.04	179.78	49.53	233.72
23	464.38	180.14	49.61	234.63	86	463.34	179.98	49.33	234.03	149	462.95	179.89	49.44	233.61
24	463.63	179.87	49.40	234.35	87	463.75	180.09	49.27	234.39	150	463.99	180.46	49.48	234.04
25	463.84	180.42	49.55	233.87	88	463.94	180.14	49.67	234.13	151	463.53	179.88	49.29	234.36
26	463.60	179.79	49.59	234.22	89	463.63	180.16	49.39	234.09	152	464.07	180.18	49.64	234.25
27	463.70	179.98	49.47	234.26	90	464.00	180.21	49.70	234.09	153	463.78	180.41	49.38	233.99
28	463.32	179.86	49.59	233.86	91	464.15	180.16	49.85	234.14	154	464.06	180.02	49.64	234.40
29	463.03	180.42	49.28	233.33	92	464.35	180.34	49.60	234.40	155	463.84	180.21	49.67	233.96
30	464.03	180.00	49.58	234.44	93	463.81	180.27	49.56	233.98	156	463.28	179.76	49.52	234.00
31	463.46	180.12	49.39	233.95	94	463.58	180.00	49.76	233.82	157	463.50	180.07	49.62	233.81
32	463.55	180.13	49.35	234.06	95	464.25	179.90	49.65	234.71	158	463.53	180.12	49.61	233.80
33	463.19	180.07	49.60	233.52	96	463.89	180.18	49.57	234.14	159	463.23	179.88	49.29	234.06
34	462.79	179.69	49.38	233.72	97	464.02	180.19	49.58	234.25	160	463.76	180.22	49.44	234.10
35	463.53	179.97	49.55	234.00	98	463.72	179.97	49.72	234.03	161	464.04	180.39	49.63	234.02
36	462.90	179.87	49.42	233.61	99	462.57	180.10	49.33	233.15	162	464.38	180.08	49.73	234.57
37	463.79	180.22	49.54	234.03	100	463.49	180.00	49.48	234.01	163	463.60	180.17	49.47	233.96
38	463.89	180.36	49.49	234.04	101	463.31	179.93	49.41	233.97	164	462.89	180.07	49.62	233.20
39	463.59	180.00	49.58	234.01	102	464.32	180.27	49.35	234.71	165	463.74	180.30	49.74	233.70
40	464.02	180.20	49.39	234.43	103	463.58	180.09	49.59	233.90	166	463.95	180.29	49.52	234.14
41	464.64	180.25	49.61	234.79	104	463.87	180.24	49.67	233.97	167	463.75	179.88	49.41	234.45
42	463.61	179.92	49.45	234.24	105	463.73	179.93	49.32	234.48	168	463.15	179.99	49.26	233.89
43	463.30	180.20	49.39	233.71	106	463.61	180.05	49.55	234.01	169	463.16	179.93	49.45	233.77
44	463.79	180.27	49.55	233.97	107	463.50	179.96	49.45	234.09	170	463.74	179.74	49.66	234.34
45	463.77	180.05	49.54	234.18	108	463.50	179.98	49.84	233.69	171	463.94	180.01	49.55	234.38
46	463.56	179.91	49.47	234.18	109	463.20	179.95	49.61	233.64	172	463.60	180.00	49.51	234.09
47	463.98	180.40	49.56	234.02	110	463.90	179.93	49.47	234.51	173	463.59	180.29	49.68	233.62
48	464.28	180.16	49.46	234.66	111	463.22	179.73	49.64	233.85	174	463.49	180.18	49.41	233.90
49	463.83	180.19	49.70	233.94	112	464.37	180.04	49.67	234.66	175	463.06	180.19	49.56	233.30
50	463.50	179.59	49.70	234.22	113	463.47	179.81	49.56	234.11	176	463.09	180.03	49.33	233.73
51	463.31	179.83	49.33	234.15	114	463.86	180.12	49.54	234.20	177	464.18	180.19	49.52	234.46
52	463.06	179.97	49.47	233.61	115	464.36	180.25	49.38	234.73	178	464.04	180.18	49.81	234.05
53	462.72	179.95	49.60	233.17	116	463.68	180.04	49.38	234.25	179	463.62	180.29	49.74	233.58
54	463.34	180.00	49.51	233.83	117	463.06	179.80	49.59	233.66	180	464.36	180.11	49.62	234.63
55	463.58	179.93	49.41	234.25	118	463.74	180.19	49.54	234.01	181	463.71	179.73	49.48	234.51
56	464.00	180.17	49.38	234.45	119	463.56	180.01	49.47	234.07	182	463.77	180.39	49.38	234.01
57	463.44	180.07	49.66	233.70	120	463.72	180.03	49.68	234.01					
58	463.80	179.81	49.63	234.35	121	463.74	179.92	49.55	234.28					
59	464.02	179.94	49.45	234.62	122	463.35	180.18	49.30	233.88					
60	463.04	180.15	49.43	233.46	123	463.36	179.91	49.65	233.81					
61	463.41	179.97	49.51	233.93	124	463.50	179.98	49.53	233.98					
62	463.86	180.17	49.72	233.98	125	463.81	179.86	49.53	234.42					

Sustainability – Data Rate Distribution Graph

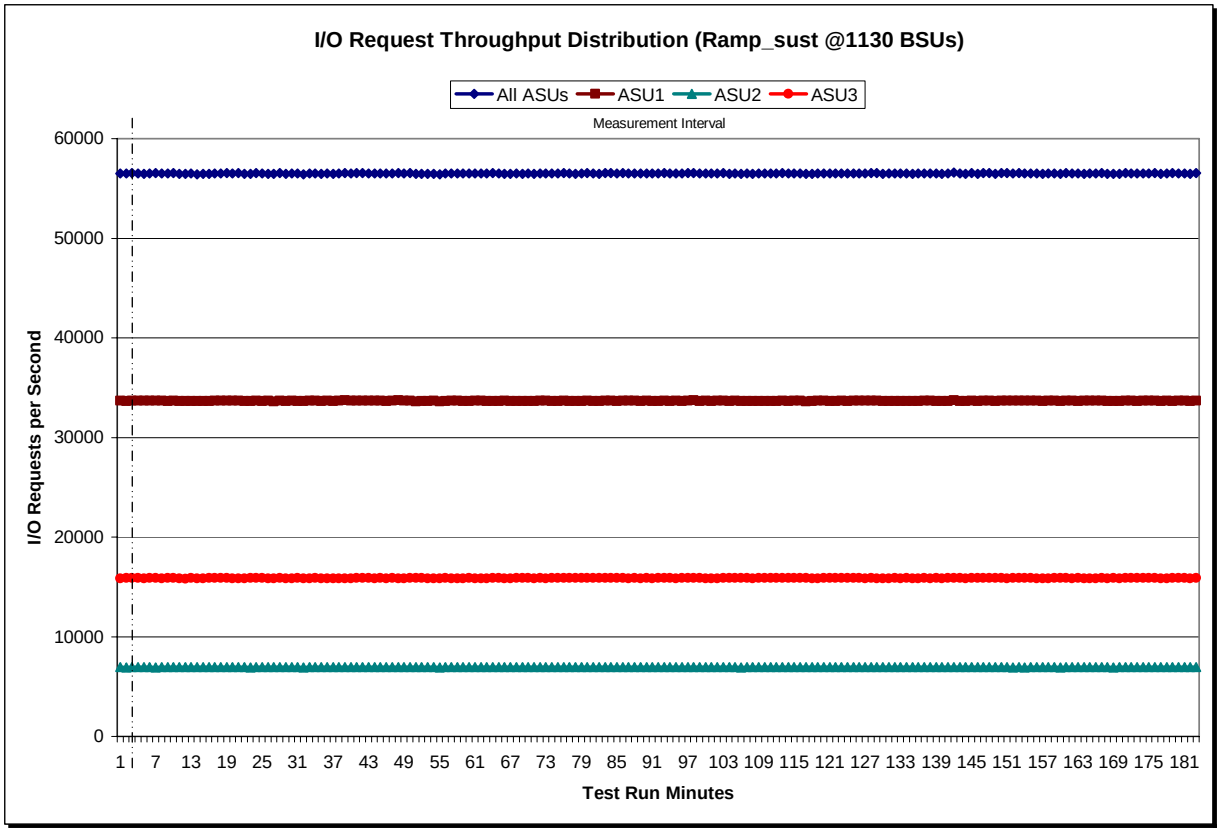


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	14:38:16	14:41:16	0-2	0:03:00
Measurement Interval	14:41:16	17:41:16	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	56,505.52	33,693.72	6,943.03	15,868.77	63	56,525.13	33,664.00	6,948.42	15,912.72	126	56,520.88	33,711.23	6,943.23	15,866.42
1	56,485.48	33,671.55	6,920.85	15,893.08	64	56,513.42	33,659.48	6,947.62	15,906.32	127	56,529.55	33,682.20	6,967.58	15,879.77
2	56,528.18	33,684.08	6,949.55	15,894.55	65	56,469.88	33,692.22	6,940.55	15,837.12	128	56,535.65	33,708.87	6,966.68	15,860.10
3	56,505.92	33,678.83	6,937.28	15,889.80	66	56,471.55	33,662.68	6,941.92	15,866.95	129	56,472.28	33,662.92	6,937.68	15,871.68
4	56,474.27	33,675.70	6,954.52	15,844.05	67	56,502.68	33,662.38	6,958.95	15,881.35	130	56,480.35	33,666.12	6,953.72	15,860.52
5	56,516.58	33,686.08	6,942.10	15,888.40	68	56,463.73	33,633.57	6,949.82	15,880.35	131	56,499.25	33,651.23	6,945.18	15,902.83
6	56,522.80	33,683.93	6,932.80	15,906.07	69	56,484.20	33,645.40	6,959.02	15,879.78	132	56,499.98	33,666.35	6,965.25	15,868.38
7	56,501.88	33,679.82	6,959.08	15,862.98	70	56,458.20	33,653.37	6,934.65	15,870.18	133	56,512.77	33,660.47	6,951.67	15,900.63
8	56,495.05	33,655.15	6,954.22	15,885.68	71	56,522.18	33,677.23	6,942.10	15,902.85	134	56,472.22	33,642.58	6,957.38	15,872.25
9	56,523.90	33,679.18	6,964.73	15,879.98	72	56,520.53	33,705.80	6,950.15	15,864.58	135	56,487.93	33,663.55	6,950.13	15,874.25
10	56,477.62	33,644.28	6,960.47	15,872.87	73	56,508.23	33,666.83	6,962.23	15,879.17	136	56,512.58	33,691.47	6,943.27	15,877.85
11	56,446.58	33,668.00	6,949.78	15,828.80	74	56,508.28	33,669.43	6,952.98	15,885.87	137	56,492.37	33,673.03	6,953.27	15,866.07
12	56,492.15	33,655.45	6,952.35	15,884.35	75	56,547.53	33,706.12	6,965.98	15,875.43	138	56,501.48	33,659.18	6,948.53	15,893.77
13	56,429.25	33,630.47	6,940.62	15,858.17	76	56,491.78	33,664.00	6,952.50	15,875.28	139	56,476.77	33,650.95	6,960.25	15,865.57
14	56,470.05	33,665.90	6,940.92	15,863.23	77	56,470.12	33,631.15	6,953.68	15,885.28	140	56,499.40	33,664.55	6,949.07	15,885.78
15	56,472.63	33,649.33	6,939.22	15,884.08	78	56,508.32	33,671.65	6,953.38	15,883.28	141	56,582.37	33,728.95	6,943.33	15,910.08
16	56,506.82	33,672.53	6,945.88	15,888.40	79	56,554.15	33,706.20	6,971.75	15,876.20	142	56,505.05	33,657.85	6,945.57	15,901.63
17	56,519.97	33,700.92	6,943.42	15,875.63	80	56,479.93	33,660.55	6,939.72	15,879.67	143	56,459.05	33,661.07	6,933.62	15,864.37
18	56,552.78	33,709.02	6,953.67	15,890.10	81	56,477.32	33,630.08	6,950.22	15,897.02	144	56,549.37	33,697.67	6,953.03	15,898.67
19	56,518.67	33,685.48	6,965.67	15,867.52	82	56,549.75	33,697.88	6,962.32	15,889.55	145	56,476.73	33,638.92	6,955.75	15,882.07
20	56,532.62	33,701.15	6,961.97	15,869.50	83	56,557.85	33,703.62	6,953.73	15,900.50	146	56,539.33	33,690.03	6,957.38	15,891.92
21	56,468.22	33,654.50	6,942.35	15,871.37	84	56,512.07	33,669.07	6,944.30	15,898.70	147	56,525.63	33,679.20	6,955.17	15,891.27
22	56,477.55	33,664.88	6,928.15	15,884.52	85	56,534.23	33,691.52	6,959.50	15,883.22	148	56,449.42	33,640.27	6,934.32	15,874.83
23	56,524.23	33,689.77	6,934.37	15,900.10	86	56,502.67	33,693.50	6,948.45	15,860.72	149	56,527.05	33,694.50	6,952.80	15,879.75
24	56,500.83	33,664.93	6,943.45	15,892.45	87	56,505.38	33,674.13	6,939.45	15,891.80	150	56,535.38	33,700.37	6,962.23	15,872.78
25	56,473.13	33,672.57	6,944.03	15,856.53	88	56,493.92	33,665.32	6,954.68	15,873.92	151	56,493.95	33,680.25	6,932.35	15,881.35
26	56,436.62	33,617.80	6,956.55	15,862.27	89	56,512.27	33,696.23	6,937.15	15,878.88	152	56,546.92	33,708.22	6,961.28	15,877.42
27	56,540.43	33,688.68	6,947.35	15,904.40	90	56,484.85	33,669.22	6,946.78	15,868.85	153	56,522.10	33,693.55	6,931.85	15,896.70
28	56,465.27	33,661.73	6,943.92	15,859.62	91	56,505.62	33,642.82	6,970.50	15,892.30	154	56,520.58	33,674.48	6,954.18	15,891.92
29	56,496.77	33,710.48	6,933.87	15,852.42	92	56,540.85	33,697.97	6,958.15	15,884.73	155	56,504.33	33,676.88	6,962.32	15,865.13
30	56,501.45	33,653.77	6,950.55	15,897.13	93	56,489.15	33,660.37	6,942.90	15,885.88	156	56,440.17	33,633.98	6,946.45	15,859.73
31	56,405.13	33,633.68	6,925.73	15,845.72	94	56,489.17	33,686.13	6,960.37	15,842.67	157	56,519.12	33,697.88	6,953.57	15,867.67
32	56,508.03	33,699.72	6,957.12	15,851.20	95	56,521.27	33,654.48	6,964.08	15,902.70	158	56,511.60	33,673.55	6,955.88	15,882.17
33	56,505.85	33,684.52	6,937.85	15,883.48	96	56,537.87	33,702.72	6,960.25	15,874.90	159	56,457.87	33,651.82	6,920.60	15,885.45
34	56,469.95	33,658.07	6,950.53	15,861.35	97	56,560.27	33,731.73	6,946.18	15,882.35	160	56,531.43	33,700.65	6,949.42	15,881.37
35	56,491.65	33,673.13	6,956.15	15,862.37	98	56,501.02	33,659.27	6,964.78	15,876.97	161	56,507.03	33,674.90	6,958.12	15,874.02
36	56,445.38	33,656.62	6,945.08	15,843.68	99	56,492.38	33,684.43	6,950.97	15,856.98	162	56,493.12	33,658.60	6,944.85	15,889.67
37	56,506.75	33,678.03	6,959.03	15,869.68	100	56,486.00	33,666.28	6,959.32	15,860.40	163	56,476.92	33,688.20	6,948.83	15,839.88
38	56,533.68	33,716.68	6,950.33	15,866.67	101	56,492.80	33,679.65	6,939.20	15,873.95	164	56,495.05	33,692.10	6,948.92	15,854.03
39	56,508.27	33,704.47	6,937.63	15,866.17	102	56,533.93	33,695.67	6,949.18	15,889.08	165	56,517.67	33,700.10	6,959.00	15,858.57
40	56,531.95	33,696.42	6,947.02	15,888.52	103	56,469.13	33,652.10	6,935.98	15,881.05	166	56,532.83	33,705.15	6,945.67	15,882.02
41	56,523.20	33,678.37	6,947.20	15,897.63	104	56,497.87	33,683.77	6,938.08	15,876.02	167	56,440.90	33,640.20	6,934.12	15,866.58
42	56,512.17	33,688.03	6,942.00	15,882.13	105	56,473.87	33,643.70	6,930.92	15,899.25	168	56,449.85	33,636.48	6,931.88	15,881.48
43	56,491.60	33,681.98	6,949.02	15,860.60	106	56,486.90	33,660.15	6,944.55	15,882.20	169	56,442.45	33,662.42	6,934.03	15,846.00
44	56,520.15	33,687.17	6,951.85	15,881.13	107	56,453.63	33,653.48	6,940.68	15,859.47	170	56,548.33	33,711.65	6,947.63	15,889.05
45	56,486.02	33,665.52	6,948.07	15,872.43	108	56,490.43	33,636.45	6,961.97	15,892.02	171	56,516.53	33,676.47	6,953.55	15,886.52
46	56,507.97	33,680.85	6,948.13	15,878.98	109	56,497.17	33,662.08	6,952.25	15,882.83	172	56,495.03	33,657.37	6,955.07	15,882.60
47	56,530.57	33,717.27	6,944.22	15,869.08	110	56,512.82	33,670.82	6,943.72	15,898.28	173	56,516.98	33,687.75	6,949.55	15,879.68
48	56,503.90	33,689.83	6,946.33	15,867.73	111	56,515.95	33,666.50	6,965.23	15,884.22	174	56,499.72	33,673.57	6,940.00	15,886.15
49	56,543.18	33,672.60	6,960.85	15,909.73	112	56,530.33	33,682.35	6,966.38	15,881.60	175	56,545.17	33,713.77	6,952.20	15,879.20
50	56,477.42	33,625.38	6,964.55	15,887.48	113	56,515.22	33,658.93	6,962.65	15,893.63	176	56,464.70	33,643.73	6,951.90	15,869.07
51	56,469.07	33,645.52	6,942.87	15,880.68	114	56,493.55	33,677.62	6,935.97	15,879.97	177	56,490.62	33,686.63	6,933.13	15,870.85
52	56,453.57	33,647.15	6,953.75	15,852.67	115	56,521.87	33,684.85	6,947.05	15,889.97	178	56,526.80	33,660.88	6,971.53	15,894.38
53	56,478.25	33,677.77	6,951.77	15,848.72	116	56,459.87	33,627.65	6,935.43	15,896.78	179	56,508.85	33,681.27	6,946.53	15,881.05
54	56,400.52	33,612.40	6,930.13	15,857.98	117	56,459.65	33,657.63	6,944.33	15,857.68	180	56,496.37	33,672.90	6,935.03	15,888.43
55	56,484.43	33,651.92	6,947.12	15,885.40	118	56,489.85	33,677.73	6,946.75	15,865.37	181	56,458.10	33,647.73	6,951.93	15,858.43
56	56,517.20	33,689.55	6,956.87	15,870.78	119	56,503.15	33,678.37	6,940.45	15,884.33	182	56,537.33	33,710.72	6,947.37	15,879.25
57	56,513.80	33,691.95	6,954.27	15,867.58	120	56,496.83	33,659.32	6,959.15	15,878.37	***Average***	***56,499.90***	***33,673.23***	***6,949.24***	***15,877.42***
58	56,485.15	33,668.20	6,959.63	15,857.32	121	56,482.50	33,656.35	6,948.02	15,878.13					
59	56,510.00	33,661.62	6,953.10	15,895.28	122	56,510.37	33,692.20	6,941.57	15,876.60					
60	56,482.48	33,678.42	6,937.07	15,867.00	123	56,514.10	33,670.52	6,950.10	15,893.48					
61	56,506.15	33,689.57	6,948.65	15,867.93	124	56,503.88	33,681.57	6,940.62	15,881.70					
62	56,506.07	33,671.07	6,960.77	15,874.23	125	56,516.95	33,672.20	6,961.18	15,883.57					

Sustainability – I/O Request Throughput Distribution Graph

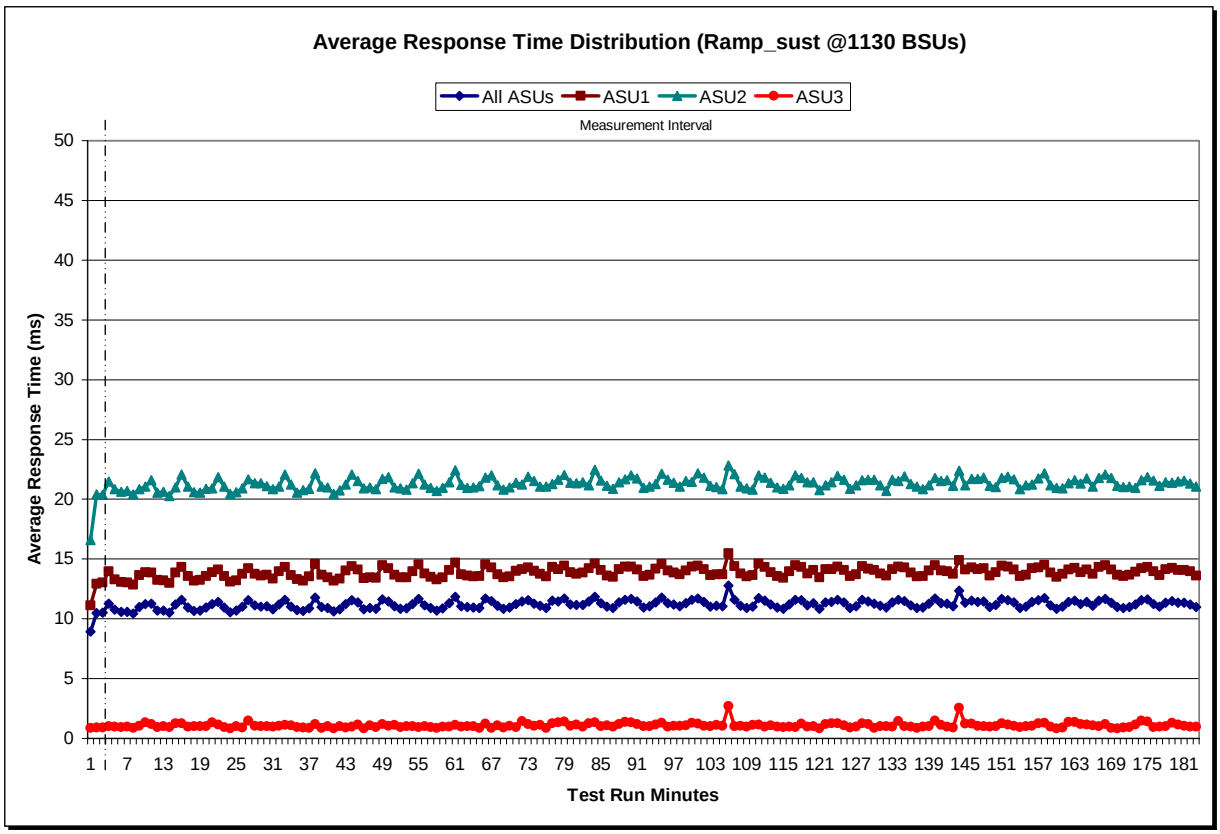


Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	14:38:16	14:41:16	0-2	0:03:00
Measurement Interval	14:41:16	17:41:16	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	8.91	11.12	16.59	0.87	63	10.94	13.55	20.99	1.02	126	11.06	13.73	21.15	0.98
1	10.47	12.94	20.41	0.91	64	10.92	13.58	21.09	0.85	127	11.60	14.41	21.60	1.28
2	10.53	13.04	20.36	0.90	65	11.69	14.53	21.81	1.21	128	11.45	14.19	21.62	1.17
3	11.25	13.98	21.47	1.01	66	11.48	14.31	22.00	0.87	129	11.28	14.06	21.62	0.88
4	10.75	13.27	20.83	0.96	67	11.08	13.72	21.18	1.06	130	11.10	13.78	21.18	1.00
5	10.58	13.07	20.62	0.92	68	10.83	13.45	20.81	0.91	131	10.93	13.59	20.68	1.02
6	10.59	13.04	20.69	0.97	69	10.95	13.55	21.00	1.03	132	11.38	14.16	21.64	0.96
7	10.43	12.87	20.40	0.88	70	11.25	14.01	21.39	0.95	133	11.61	14.36	21.52	1.44
8	10.99	13.66	20.85	1.03	71	11.44	14.15	21.23	1.44	134	11.50	14.29	21.92	1.02
9	11.25	13.90	21.05	1.32	72	11.54	14.28	21.89	1.20	135	11.14	13.84	21.29	0.96
10	11.26	13.87	21.59	1.20	73	11.28	14.00	21.51	1.04	136	10.90	13.54	21.06	0.85
11	10.70	13.26	20.56	0.92	74	11.09	13.74	21.07	1.12	137	10.93	13.57	20.83	0.98
12	10.69	13.20	20.63	1.03	75	10.90	13.53	21.05	0.88	138	11.25	14.04	21.17	1.01
13	10.50	13.00	20.26	0.93	76	11.50	14.31	21.29	1.26	139	11.72	14.47	21.77	1.46
14	11.19	13.86	21.00	1.25	77	11.46	14.14	21.62	1.32	140	11.32	14.03	21.51	1.12
15	11.59	14.31	22.05	1.27	78	11.71	14.43	22.03	1.42	141	11.26	13.98	21.59	0.96
16	10.95	13.56	21.07	0.98	79	11.20	13.88	21.39	1.05	142	11.04	13.73	21.15	0.91
17	10.65	13.16	20.58	0.99	80	11.15	13.76	21.35	1.16	143	12.36	14.91	22.40	2.56
18	10.70	13.24	20.54	1.02	81	11.15	13.84	21.42	0.97	144	11.35	14.10	21.18	1.22
19	10.96	13.58	20.89	1.01	82	11.44	14.24	21.16	1.26	145	11.53	14.30	21.72	1.21
20	11.23	13.89	20.92	1.34	83	11.85	14.63	22.45	1.35	146	11.40	14.14	21.72	1.06
21	11.41	14.10	21.85	1.14	84	11.32	14.07	21.57	1.01	147	11.43	14.21	21.81	1.01
22	10.94	13.57	21.05	0.94	85	11.01	13.61	21.13	1.07	148	10.98	13.61	21.12	0.96
23	10.55	13.10	20.44	0.84	86	10.89	13.50	20.88	0.98	149	11.15	13.90	21.01	1.02
24	10.68	13.19	20.57	1.02	87	11.39	14.14	21.41	1.19	150	11.65	14.45	21.77	1.27
25	11.02	13.74	20.92	0.91	88	11.60	14.36	21.66	1.35	151	11.57	14.36	21.88	1.14
26	11.55	14.22	21.68	1.46	89	11.65	14.38	21.98	1.34	152	11.37	14.11	21.66	1.03
27	11.12	13.75	21.34	1.06	90	11.43	14.12	21.74	1.20	153	10.91	13.57	20.84	0.93
28	11.03	13.62	21.33	1.00	91	10.95	13.57	20.94	1.00	154	11.03	13.68	21.16	0.99
29	11.04	13.69	21.08	1.00	92	11.04	13.69	21.04	1.02	155	11.39	14.23	21.23	1.06
30	10.79	13.35	20.83	0.96	93	11.38	14.17	21.28	1.14	156	11.54	14.28	21.75	1.26
31	11.21	13.96	21.05	1.06	94	11.79	14.57	22.15	1.31	157	11.74	14.51	22.17	1.29
32	11.58	14.34	22.05	1.12	95	11.30	14.05	21.64	0.98	158	11.13	13.86	21.16	0.96
33	11.03	13.63	21.23	1.06	96	11.19	13.85	21.38	1.05	159	10.85	13.50	20.94	0.84
34	10.74	13.33	20.57	0.94	97	11.06	13.71	21.08	1.05	160	11.02	13.74	20.90	0.90
35	10.67	13.18	20.76	0.90	98	11.32	14.04	21.53	1.08	161	11.42	14.11	21.33	1.37
36	10.87	13.53	20.87	0.86	99	11.58	14.38	21.45	1.30	162	11.53	14.25	21.60	1.37
37	11.76	14.59	22.18	1.18	100	11.69	14.45	22.19	1.21	163	11.24	13.89	21.33	1.19
38	10.99	13.67	21.05	0.87	101	11.40	14.13	21.82	1.06	164	11.42	14.13	21.73	1.15
39	10.90	13.48	21.00	1.00	102	11.01	13.63	21.15	1.02	165	11.10	13.76	21.06	1.06
40	10.61	13.19	20.46	0.84	103	11.07	13.72	21.01	1.12	166	11.51	14.34	21.77	1.02
41	10.78	13.34	20.74	1.01	104	11.04	13.73	20.85	1.05	167	11.66	14.45	22.07	1.17
42	11.24	14.04	21.24	0.91	105	12.78	15.49	22.82	2.69	168	11.33	14.12	21.76	0.87
43	11.57	14.39	22.06	0.98	106	11.59	14.42	22.10	1.00	169	10.99	13.67	21.14	0.83
44	11.37	14.09	21.54	1.16	107	11.10	13.79	21.06	1.04	170	10.92	13.56	21.03	0.90
45	10.79	13.40	20.91	0.83	108	10.92	13.54	20.91	0.99	171	11.00	13.67	21.05	0.92
46	10.91	13.47	20.99	1.07	109	11.01	13.65	20.82	1.11	172	11.21	13.94	20.94	1.16
47	10.84	13.44	20.84	0.92	110	11.72	14.60	21.98	1.15	173	11.55	14.23	21.61	1.47
48	11.62	14.46	21.72	1.19	111	11.51	14.34	21.80	0.98	174	11.62	14.34	21.83	1.42
49	11.44	14.21	21.85	1.04	112	11.21	13.88	21.37	1.08	175	11.23	13.95	21.56	0.95
50	11.04	13.67	20.98	1.10	113	10.94	13.57	20.98	0.97	176	11.01	13.65	21.12	0.97
51	10.85	13.46	20.91	0.94	114	10.84	13.44	20.88	0.94	177	11.34	14.13	21.44	1.02
52	10.87	13.47	20.82	1.00	115	11.19	13.96	21.17	0.97	178	11.49	14.26	21.39	1.31
53	11.23	13.96	21.34	1.01	116	11.58	14.46	22.01	0.95	179	11.35	14.06	21.50	1.17
54	11.65	14.53	22.13	0.95	117	11.57	14.34	21.77	1.24	180	11.34	14.09	21.56	1.03
55	11.11	13.79	21.24	1.00	118	11.12	13.79	21.41	0.97	181	11.21	13.95	21.32	0.95
56	10.89	13.50	20.96	0.94	119	11.31	14.08	21.42	1.00	182	10.97	13.62	21.04	0.96
57	10.70	13.27	20.69	0.87	120	10.82	13.48	20.76	0.82	***Average***	***11.21***	***13.90***	***21.32***	***1.08***
58	10.88	13.47	20.95	0.96	121	11.36	14.13	21.16	1.19					
59	11.30	14.08	21.42	0.97	122	11.41	14.14	21.43	1.25					
60	11.83	14.68	22.43	1.13	123	11.60	14.35	21.94	1.25					
61	11.06	13.72	21.20	0.97	124	11.36	14.09	21.64	1.07					
62	10.96	13.60	20.96	0.99	125	10.91	13.56	20.88	0.91					

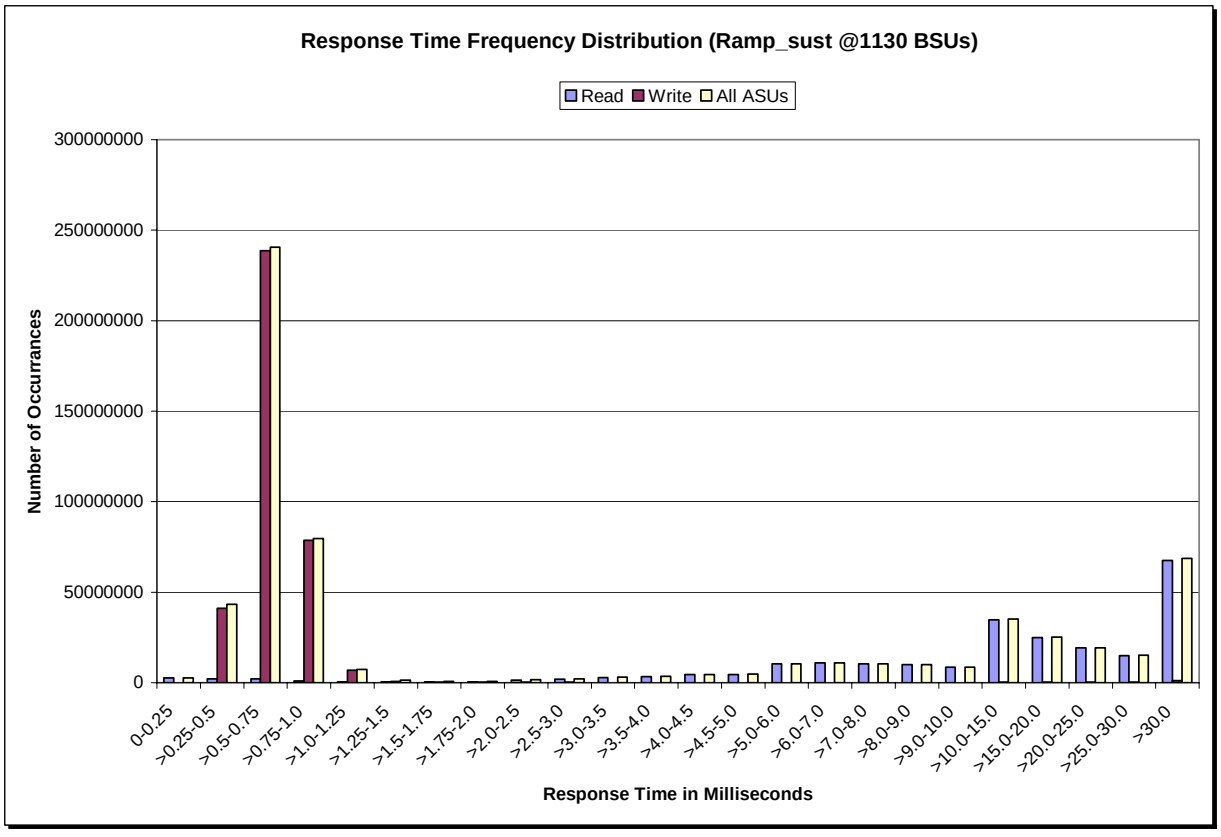
Sustainability – Average Response Time (ms) Distribution Graph



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	2,623,402	2,232,470	2,054,847	862,690	515,173	558,858	535,102	508,729
Write	16,550	41,103,326	238,552,739	78,752,392	6,852,968	831,583	250,444	123,438
All ASUs	2,639,952	43,335,796	240,607,586	79,615,082	7,368,141	1,390,441	785,546	632,167
ASU1	2,437,720	22,434,208	107,850,510	30,304,557	2,559,905	694,866	560,303	516,902
ASU2	197,664	5,453,496	25,543,936	6,871,980	593,744	173,298	92,208	54,727
ASU3	4,568	15,448,092	107,213,140	42,438,545	4,214,492	522,277	133,035	60,538
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	1,514,999	1,979,441	2,936,153	3,404,297	4,557,058	4,586,972	10,409,510	10,860,241
Write	164,104	142,895	112,308	92,258	71,448	66,862	94,126	75,545
All ASUs	1,679,103	2,122,336	3,048,461	3,496,555	4,628,506	4,653,834	10,503,636	10,935,786
ASU1	1,484,131	1,917,109	2,791,765	3,184,614	4,178,587	4,159,072	9,317,244	9,627,307
ASU2	117,770	139,620	204,791	269,886	416,911	464,693	1,143,677	1,275,178
ASU3	77,202	65,607	51,905	42,055	33,008	30,069	42,715	33,301
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	10,497,246	9,886,062	8,569,646	34,784,473	25,005,270	19,178,526	15,046,753	67,565,610
Write	73,708	68,275	67,312	299,085	242,031	179,534	143,400	1,148,350
All ASUs	10,570,954	9,954,337	8,636,958	35,083,558	25,247,301	19,358,060	15,190,153	68,713,960
ASU1	9,248,498	8,641,447	7,474,691	30,334,671	21,673,895	16,497,509	12,836,168	52,944,754
ASU2	1,290,218	1,283,162	1,133,239	4,618,703	3,464,415	2,777,286	2,286,345	15,184,692
ASU3	32,238	29,728	29,028	130,184	108,991	83,265	67,640	584,514

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	0.003	0.001	0.002	0.001	0.004	0.002	0.002	0.001

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 73.

IOPS Test Results File

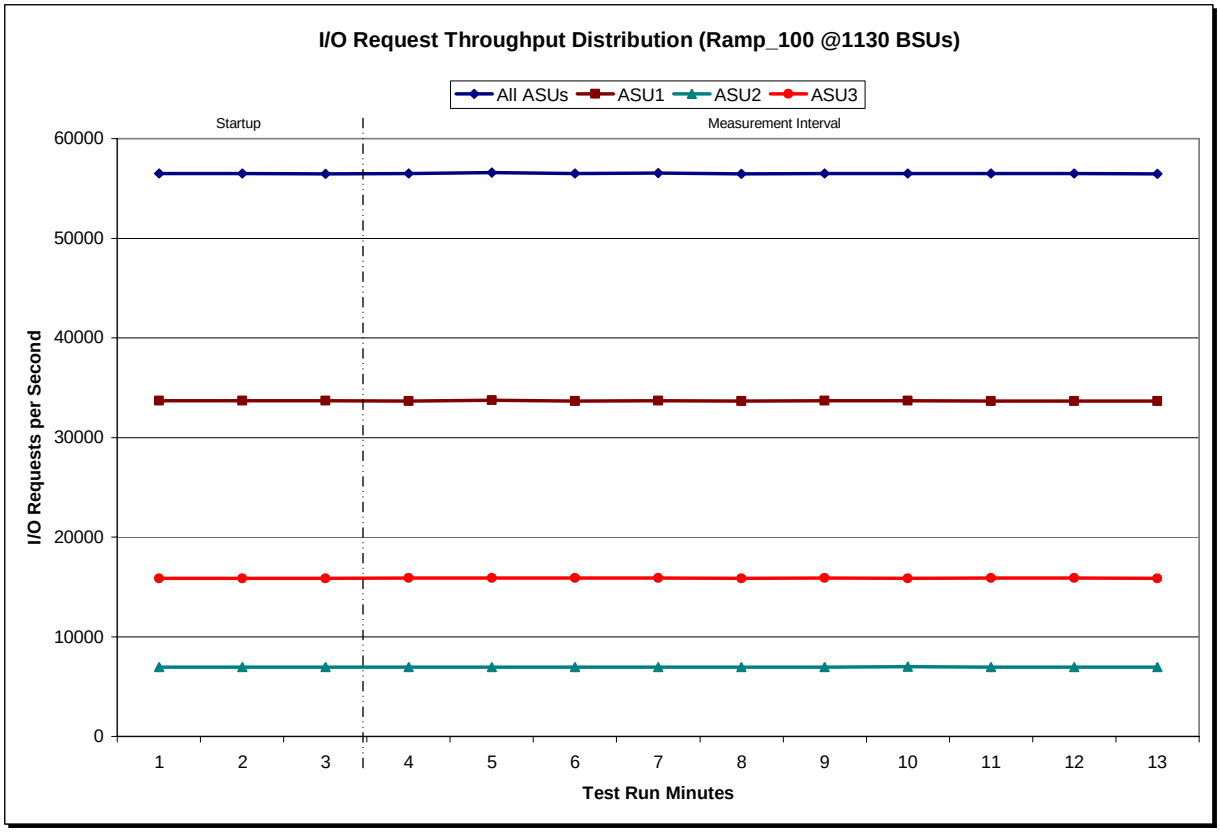
A link to the test results file generated from the IOPS Test Run is listed below.

IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

1130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:41:22	17:44:23	0-2	0:03:01
Measurement Interval	17:44:23	17:54:23	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	56,515.30	33,679.33	6,967.12	15,868.85
1	56,483.20	33,672.58	6,955.37	15,855.25
2	56,456.23	33,679.68	6,933.93	15,842.62
3	56,506.12	33,664.48	6,956.03	15,885.60
4	56,594.43	33,734.15	6,960.15	15,900.13
5	56,493.57	33,642.70	6,962.60	15,888.27
6	56,544.45	33,684.15	6,962.47	15,897.83
7	56,466.75	33,669.20	6,937.58	15,859.97
8	56,509.97	33,675.02	6,956.67	15,878.28
9	56,521.48	33,685.00	6,977.83	15,858.65
10	56,516.55	33,670.12	6,943.90	15,902.53
11	56,489.50	33,653.08	6,951.23	15,885.18
12	56,465.68	33,655.27	6,946.05	15,864.37
Average	***56,510.85***	***33,673.32***	***6,955.45***	***15,882.08***

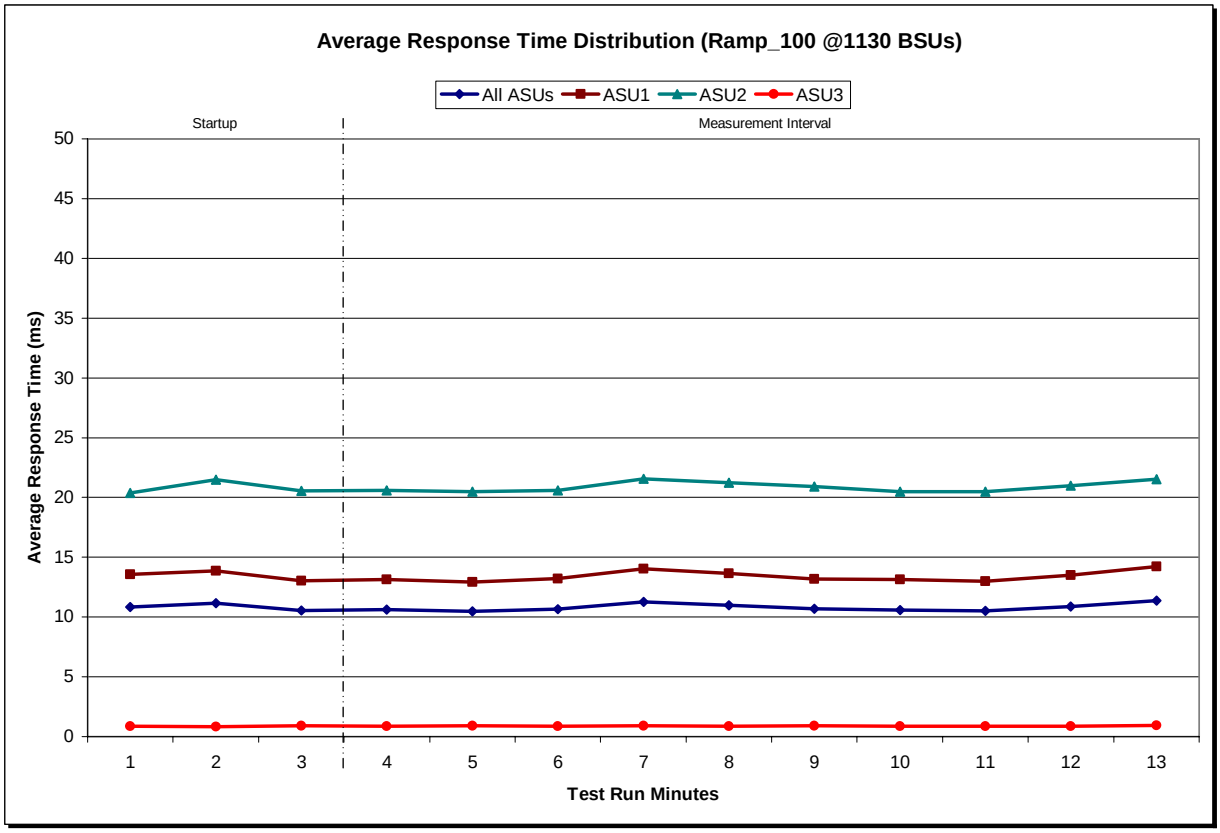
IOPS Test Run – I/O Request Throughput Distribution Graph



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

1130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:41:22	17:44:23	0-2	0:03:01
Measurement Interval	17:44:23	17:54:23	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	10.85	13.57	20.39	0.87
1	11.15	13.86	21.50	0.84
2	10.56	13.05	20.57	0.89
3	10.61	13.14	20.60	0.87
4	10.46	12.91	20.48	0.89
5	10.64	13.19	20.59	0.88
6	11.28	14.06	21.56	0.89
7	10.99	13.65	21.24	0.86
8	10.68	13.18	20.90	0.90
9	10.59	13.12	20.48	0.86
10	10.50	12.99	20.49	0.87
11	10.87	13.51	20.97	0.86
12	11.38	14.21	21.52	0.94
Average	***10.80***	***13.40***	***20.88***	***0.88***

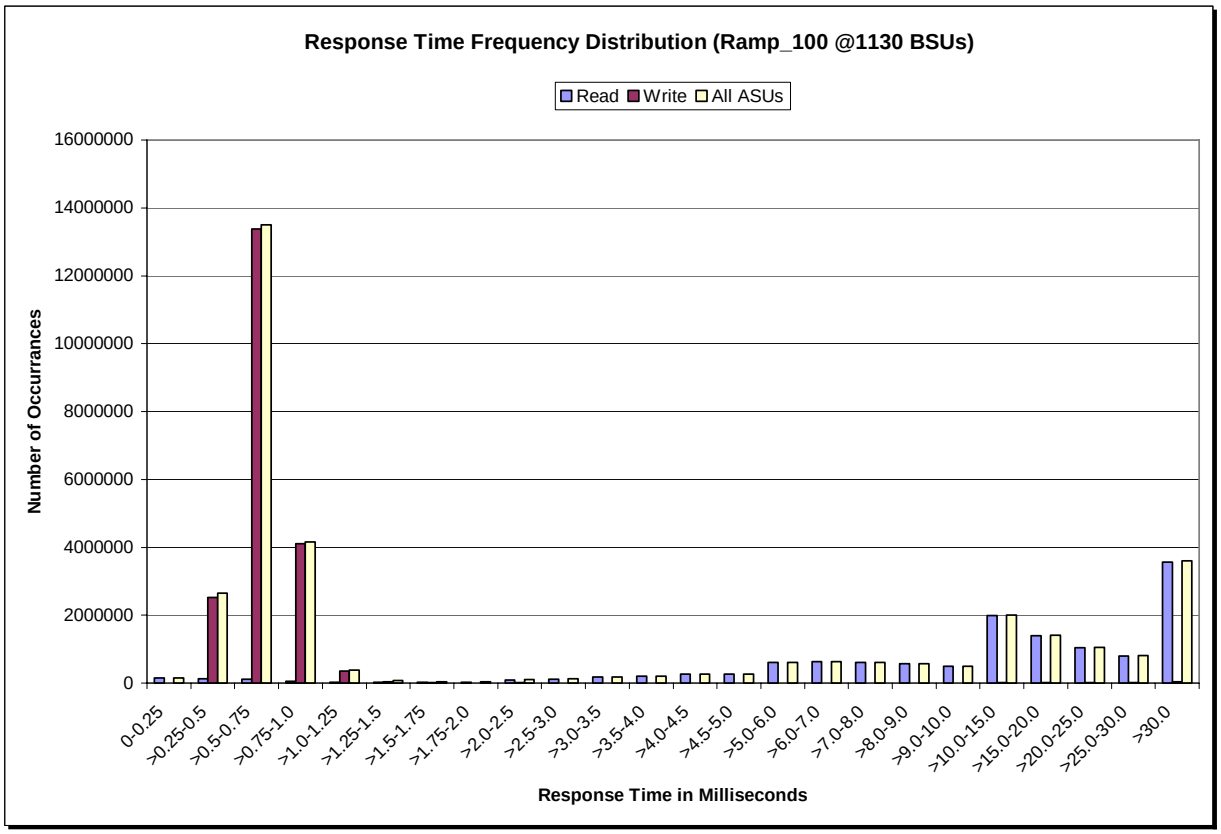
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	156,704	126,666	117,444	49,106	29,631	31,564	31,242	29,641
Write	1,264	2,520,973	13,380,146	4,108,745	352,991	42,358	11,588	5,302
All ASUs	157,968	2,647,639	13,497,590	4,157,851	382,622	73,922	42,830	34,943
ASU1	146,584	1,382,346	6,038,379	1,549,232	130,362	37,319	31,520	29,297
ASU2	11,015	326,789	1,426,079	360,807	31,847	9,486	4,988	3,039
ASU3	369	938,504	6,033,132	2,247,812	220,413	27,117	6,322	2,607
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	88,565	114,458	171,439	196,666	264,172	265,527	603,845	631,118
Write	7,404	6,185	4,702	2,950	2,322	1,995	3,835	3,859
All ASUs	95,969	120,643	176,141	199,616	266,494	267,522	607,680	634,977
ASU1	85,824	109,776	161,908	182,542	241,301	239,612	539,423	558,977
ASU2	6,748	8,041	11,973	15,735	24,112	27,043	66,531	74,244
ASU3	3,397	2,826	2,260	1,339	1,081	867	1,726	1,756
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	609,246	573,492	493,998	1,986,631	1,392,714	1,040,784	803,189	3,562,414
Write	3,107	2,815	2,325	10,468	8,240	7,140	6,778	38,070
All ASUs	612,353	576,307	496,323	1,997,099	1,400,954	1,047,924	809,967	3,600,484
ASU1	535,400	500,384	430,258	1,726,926	1,203,432	893,315	683,724	2,765,630
ASU2	75,574	74,641	65,062	265,500	193,806	151,348	123,028	815,672
ASU3	1,379	1,282	1,003	4,673	3,716	3,261	3,215	19,182

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
33,805,818	30,305,334	3,600,484

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	0.2809	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.003	0.001	0.001	0.001	0.003	0.003	0.002	0.001

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.4.3

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

The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 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 73.

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 - 1130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:41:22	17:44:23	0-2	0:03:01
Measurement Interval	17:44:23	17:54:23	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	56,515.30	33,679.33	6,967.12	15,868.85
1	56,483.20	33,672.58	6,955.37	15,855.25
2	56,456.23	33,679.68	6,933.93	15,842.62
3	56,506.12	33,664.48	6,956.03	15,885.60
4	56,594.43	33,734.15	6,960.15	15,900.13
5	56,493.57	33,642.70	6,962.60	15,888.27
6	56,544.45	33,684.15	6,962.47	15,897.83
7	56,466.75	33,669.20	6,937.58	15,859.97
8	56,509.97	33,675.02	6,956.67	15,878.28
9	56,521.48	33,685.00	6,977.83	15,858.65
10	56,516.55	33,670.12	6,943.90	15,902.53
11	56,489.50	33,653.08	6,951.23	15,885.18
12	56,465.68	33,655.27	6,946.05	15,864.37
Average	56,510.85	33,673.32	6,955.45	15,882.08

95% Load Level - 1073 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	17:54:27	17:57:28	0-2	0:03:01
Measurement Interval	17:57:28	18:07:28	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	53,682.43	31,970.37	6,617.18	15,094.88
1	53,601.22	31,956.17	6,587.40	15,057.65
2	53,680.22	31,974.27	6,606.65	15,099.30
3	53,645.28	31,982.80	6,595.33	15,067.15
4	53,681.32	32,007.47	6,598.03	15,075.82
5	53,606.23	31,956.05	6,601.80	15,048.38
6	53,676.98	32,000.75	6,591.17	15,085.07
7	53,684.38	32,004.97	6,604.03	15,075.38
8	53,672.38	32,003.33	6,616.22	15,052.83
9	53,639.28	31,973.20	6,605.17	15,060.92
10	53,668.48	31,992.10	6,595.92	15,080.47
11	53,626.65	31,970.25	6,586.62	15,069.78
12	53,655.42	31,964.13	6,605.92	15,085.37
Average	53,655.64	31,985.51	6,600.02	15,070.12

90% Load Level - 1017 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:07:32	18:10:33	0-2	0:03:01
Measurement Interval	18:10:33	18:20:33	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	50,845.12	30,286.30	6,247.03	14,311.78
1	50,825.23	30,272.73	6,255.67	14,296.83
2	50,848.87	30,284.30	6,270.98	14,293.58
3	50,846.78	30,302.88	6,275.47	14,268.43
4	50,888.85	30,322.97	6,261.78	14,304.10
5	50,843.83	30,305.02	6,246.02	14,292.80
6	50,851.02	30,311.35	6,250.22	14,289.45
7	50,857.92	30,317.27	6,242.72	14,297.93
8	50,845.97	30,341.52	6,257.97	14,246.48
9	50,897.75	30,340.23	6,261.72	14,295.80
10	50,818.83	30,266.98	6,248.78	14,303.07
11	50,879.07	30,347.22	6,252.78	14,279.07
12	50,855.38	30,320.40	6,249.73	14,285.25
Average	50,858.54	30,317.58	6,254.72	14,286.24

80% Load Level - 904 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:20:37	18:23:38	0-2	0:03:01
Measurement Interval	18:23:38	18:33:38	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	45,200.85	26,947.03	5,560.32	12,693.50
1	45,230.87	26,958.70	5,567.57	12,704.60
2	45,222.03	26,935.35	5,577.08	12,709.60
3	45,165.57	26,935.43	5,547.87	12,682.27
4	45,251.88	26,996.63	5,557.08	12,698.17
5	45,227.43	26,959.98	5,562.18	12,705.27
6	45,221.30	26,949.98	5,561.57	12,709.75
7	45,172.82	26,930.07	5,549.52	12,693.23
8	45,232.87	26,965.18	5,543.50	12,724.18
9	45,224.37	26,968.95	5,551.98	12,703.43
10	45,195.95	26,922.00	5,566.58	12,707.37
11	45,216.60	26,972.18	5,551.38	12,693.03
12	45,157.62	26,899.40	5,567.10	12,691.12
Average	45,206.64	26,949.98	5,555.88	12,700.78

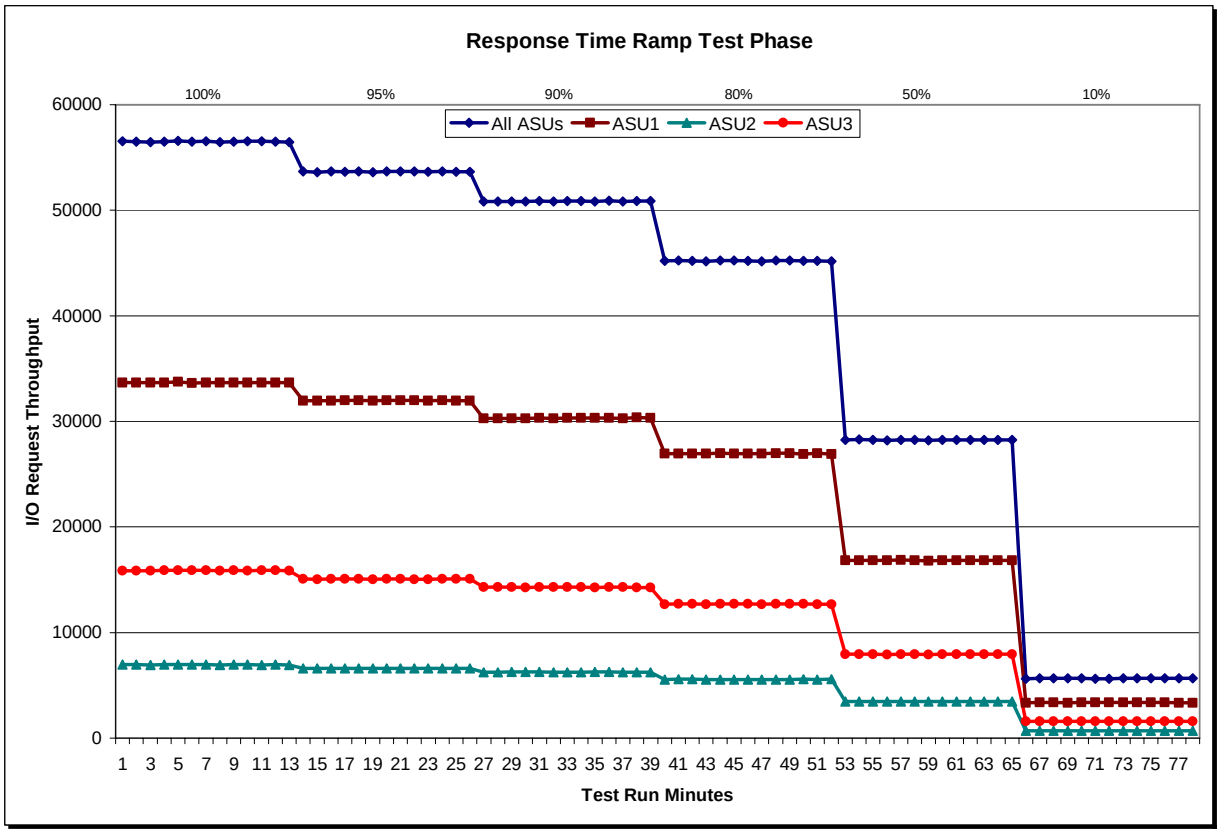
50% Load Level - 565 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:33:42	18:36:43	0-2	0:03:01
Measurement Interval	18:36:43	18:46:43	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	28,245.65	16,829.83	3,481.75	7,934.07
1	28,270.78	16,846.13	3,476.00	7,948.65
2	28,259.12	16,845.15	3,479.07	7,934.90
3	28,221.52	16,839.43	3,476.88	7,905.20
4	28,265.07	16,855.63	3,459.63	7,949.80
5	28,228.85	16,829.02	3,466.93	7,932.90
6	28,215.33	16,811.62	3,475.98	7,927.73
7	28,236.90	16,813.92	3,482.08	7,940.90
8	28,262.35	16,837.97	3,482.57	7,941.82
9	28,249.83	16,842.32	3,474.88	7,932.63
10	28,231.50	16,813.90	3,483.37	7,934.23
11	28,246.87	16,830.15	3,481.33	7,935.38
12	28,256.35	16,851.28	3,460.23	7,944.83
Average	28,241.46	16,832.52	3,474.39	7,934.54

10% Load Level - 113 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:46:46	18:49:47	0-2	0:03:01
Measurement Interval	18:49:47	18:59:47	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	5,630.43	3,354.85	697.97	1,577.62
1	5,665.25	3,381.62	693.50	1,590.13
2	5,663.08	3,386.67	691.53	1,584.88
3	5,648.58	3,359.83	698.03	1,590.72
4	5,661.33	3,377.80	692.95	1,590.58
5	5,644.78	3,363.22	692.90	1,588.67
6	5,644.03	3,365.35	696.25	1,582.43
7	5,661.63	3,366.38	701.45	1,593.80
8	5,660.72	3,378.55	694.03	1,588.13
9	5,655.72	3,374.37	692.73	1,588.62
10	5,650.97	3,371.13	693.27	1,586.57
11	5,648.47	3,359.32	702.08	1,587.07
12	5,650.18	3,362.20	697.02	1,590.97
Average	5,652.64	3,367.82	696.07	1,588.76

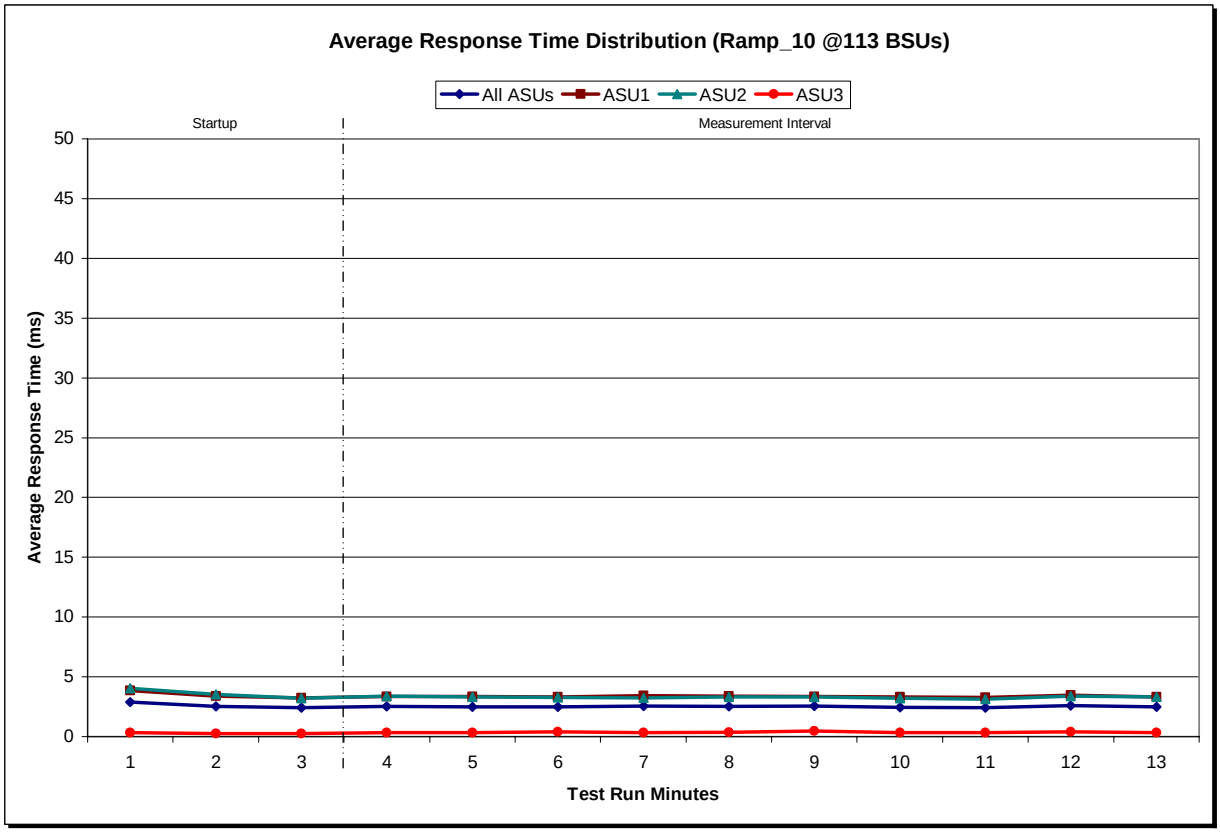
Response Time Ramp Distribution (IOPS) Graph



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

113 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:46:46	18:49:47	0-2	0:03:01
Measurement Interval	18:49:47	18:59:47	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.88	3.84	4.03	0.34
1	2.52	3.38	3.54	0.26
2	2.40	3.24	3.22	0.26
3	2.50	3.34	3.38	0.34
4	2.50	3.34	3.30	0.34
5	2.50	3.32	3.28	0.41
6	2.54	3.44	3.25	0.33
7	2.52	3.38	3.31	0.36
8	2.54	3.35	3.33	0.47
9	2.46	3.32	3.22	0.32
10	2.41	3.26	3.13	0.31
11	2.58	3.44	3.37	0.41
12	2.48	3.31	3.33	0.34
Average	***2.50***	***3.35***	***3.29***	***0.36***

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	0.0697	0.2100	0.0180	0.0701	0.0351	0.2811
COV	0.009	0.002	0.005	0.003	0.015	0.006	0.011	0.002

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 73.

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	***56,510.85***
Repeatability Test Phase 1	56,505.35
Repeatability Test Phase 2	56,502.68

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	***2.50 ms***
Repeatability Test Phase 1	2.48 ms
Repeatability Test Phase 2	2.50 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.

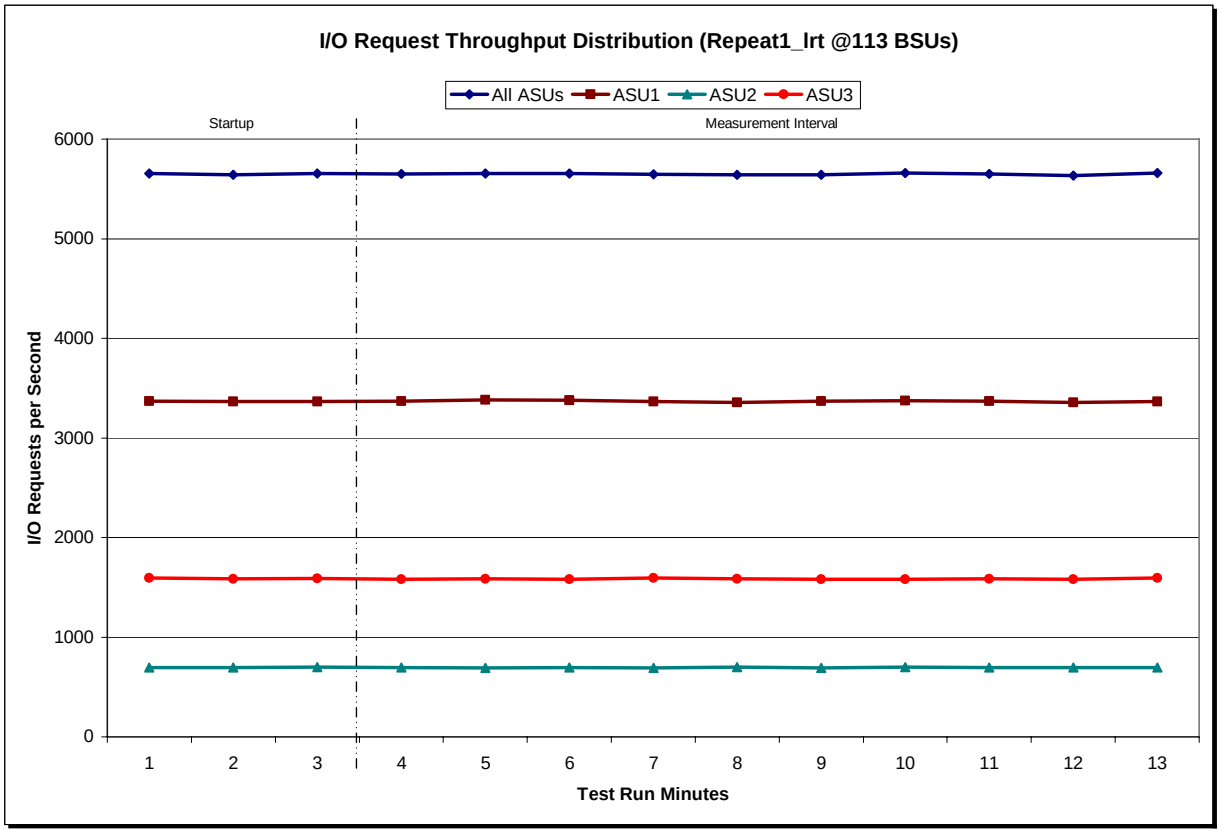
Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

113 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:59:53	19:02:53	0-2	0:03:00
Measurement Interval	19:02:53	19:12:53	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	5,655.67	3,368.62	694.18	1,592.87
1	5,642.58	3,363.72	693.72	1,585.15
2	5,653.02	3,363.72	697.87	1,591.43
3	5,648.10	3,370.48	696.73	1,580.88
4	5,655.93	3,380.53	691.92	1,583.48
5	5,654.23	3,376.53	695.15	1,582.55
6	5,646.98	3,363.40	690.28	1,593.30
7	5,642.42	3,356.47	698.95	1,587.00
8	5,643.33	3,368.98	693.27	1,581.08
9	5,658.17	3,375.02	700.07	1,583.08
10	5,648.45	3,369.03	695.92	1,583.50
11	5,634.22	3,357.28	694.40	1,582.53
12	5,658.85	3,366.35	696.57	1,595.93
Average	***5,649.07***	***3,368.41***	***695.33***	***1,585.34***

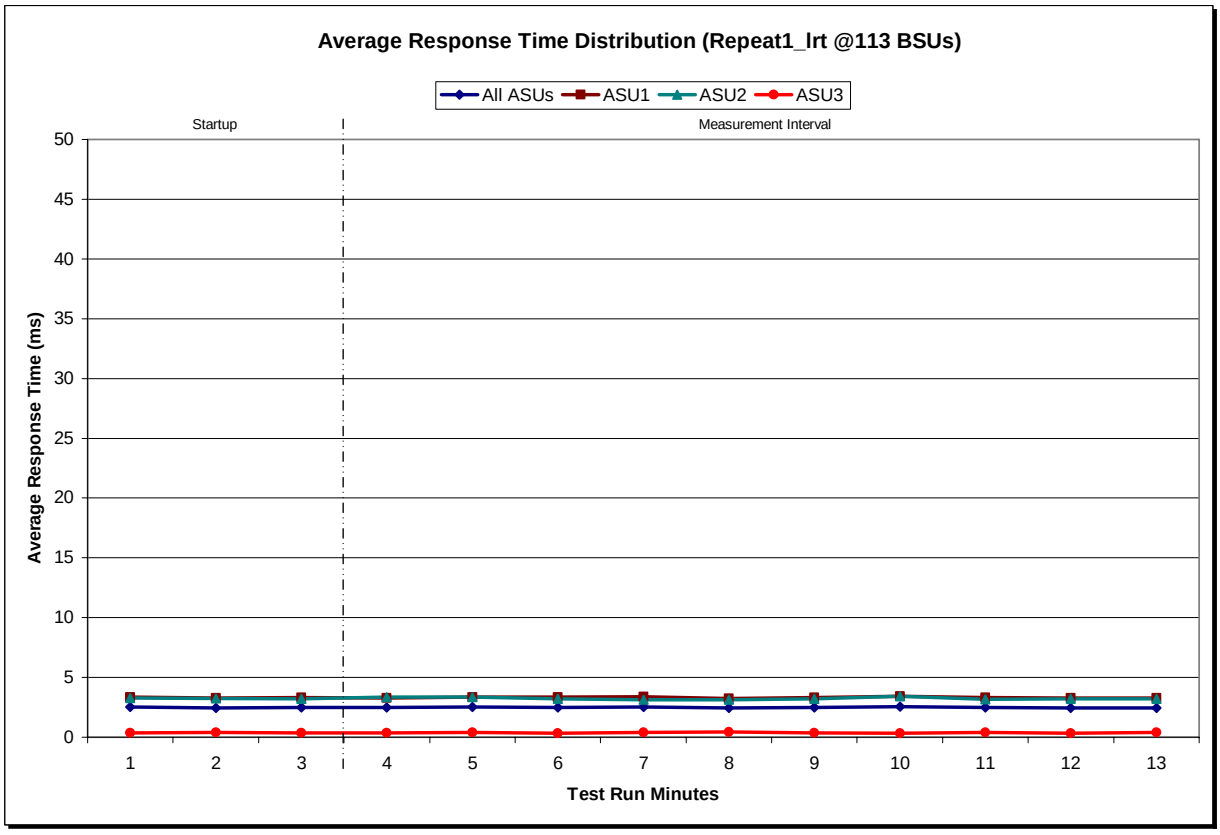
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

113 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:59:53	19:02:53	0-2	0:03:00
Measurement Interval	19:02:53	19:12:53	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.50	3.35	3.27	0.38
1	2.46	3.27	3.25	0.41
2	2.48	3.33	3.22	0.37
3	2.47	3.28	3.35	0.36
4	2.53	3.36	3.36	0.40
5	2.49	3.36	3.19	0.34
6	2.51	3.38	3.13	0.39
7	2.43	3.24	3.15	0.41
8	2.47	3.32	3.19	0.36
9	2.55	3.42	3.42	0.32
10	2.48	3.32	3.18	0.41
11	2.43	3.27	3.20	0.31
12	2.45	3.27	3.22	0.39
Average	***2.48***	***3.32***	***3.24***	***0.37***

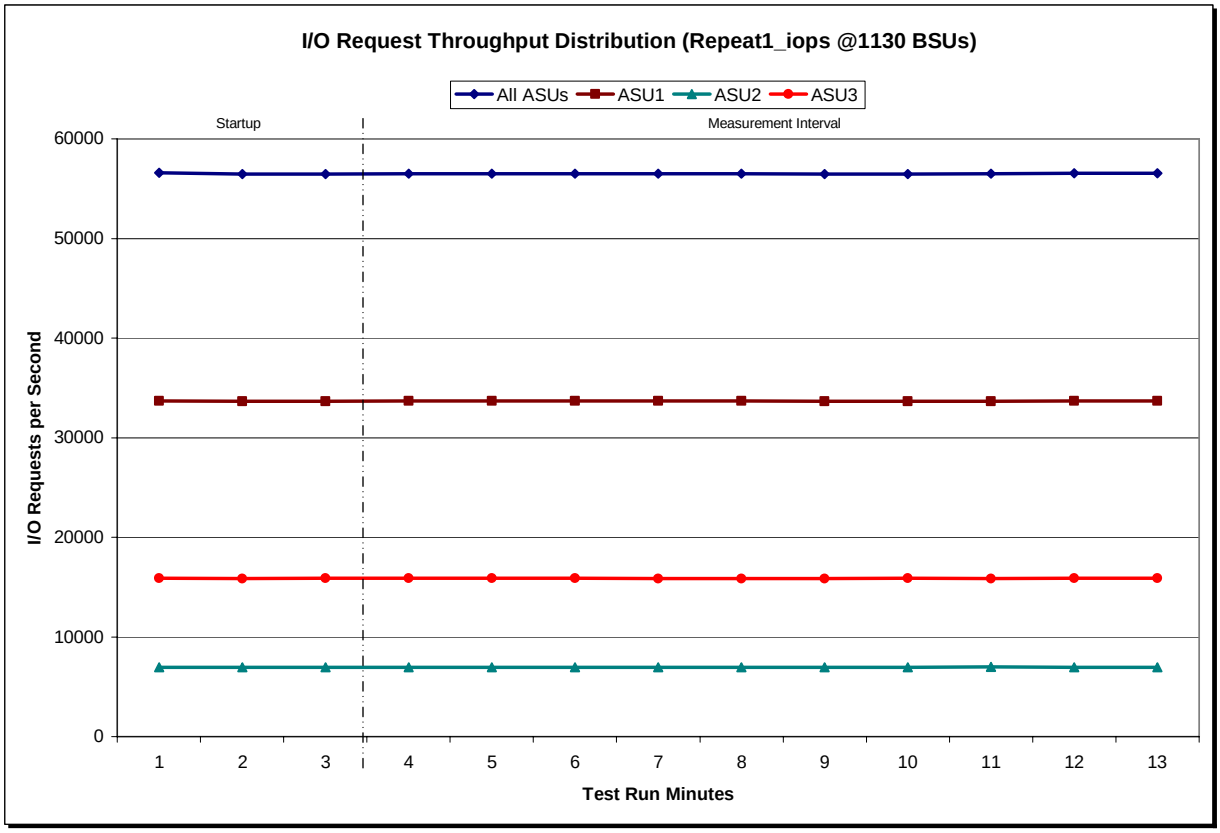
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

1130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:12:57	19:15:58	0-2	0:03:01
Measurement Interval	19:15:58	19:25:58	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	56,567.38	33,700.82	6,963.83	15,902.73
1	56,465.25	33,661.93	6,934.28	15,869.03
2	56,468.57	33,637.38	6,946.10	15,885.08
3	56,503.45	33,679.15	6,945.13	15,879.17
4	56,498.15	33,684.53	6,938.27	15,875.35
5	56,512.17	33,695.50	6,941.18	15,875.48
6	56,494.82	33,705.45	6,938.73	15,850.63
7	56,521.38	33,686.48	6,967.48	15,867.42
8	56,454.15	33,640.77	6,956.83	15,856.55
9	56,476.12	33,656.08	6,944.80	15,875.23
10	56,504.57	33,658.18	6,976.40	15,869.98
11	56,557.92	33,690.67	6,974.32	15,892.93
12	56,530.75	33,695.40	6,947.88	15,887.47
Average	***56,505.35***	***33,679.22***	***6,953.10***	***15,873.02***

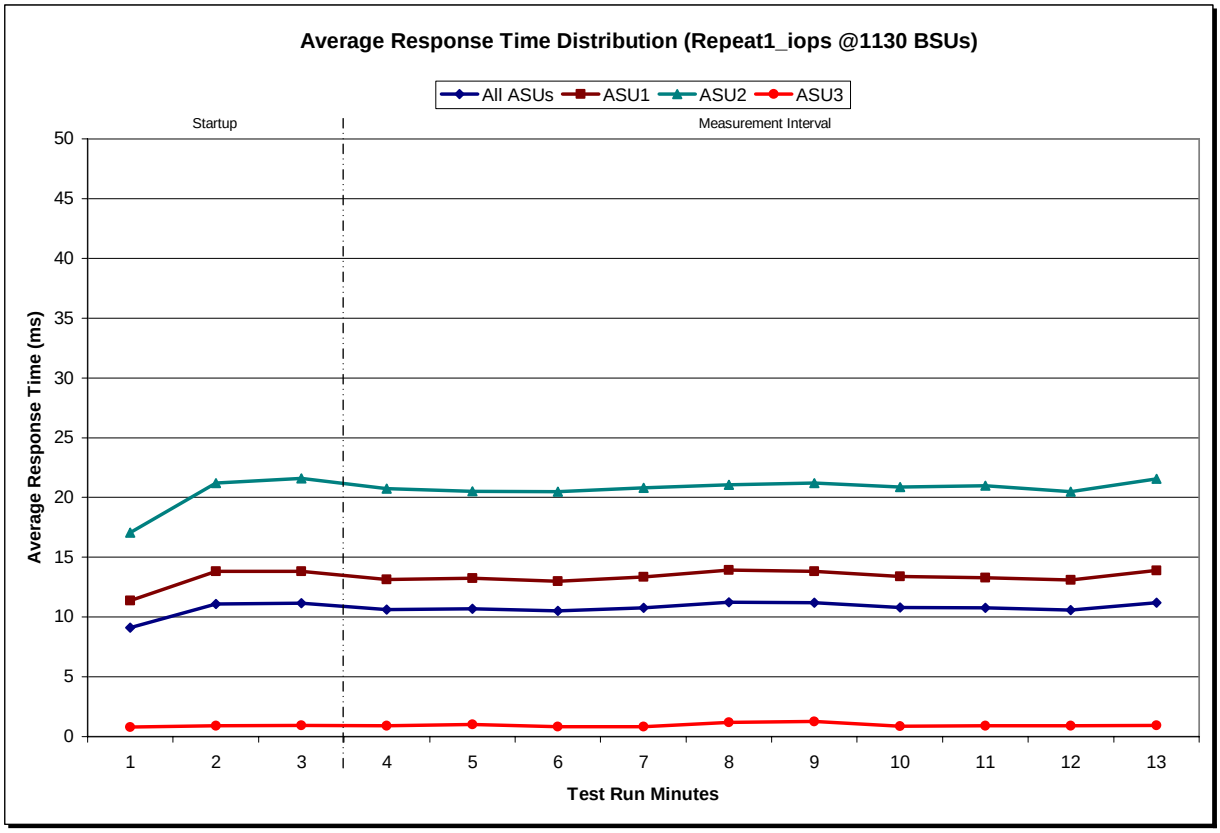
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

1130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:12:57	19:15:58	0-2	0:03:01
Measurement Interval	19:15:58	19:25:58	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	9.11	11.39	17.06	0.79
1	11.09	13.82	21.19	0.90
2	11.15	13.82	21.59	0.93
3	10.63	13.13	20.75	0.90
4	10.70	13.24	20.53	1.01
5	10.50	13.00	20.48	0.84
6	10.77	13.37	20.81	0.84
7	11.23	13.92	21.05	1.20
8	11.20	13.81	21.21	1.25
9	10.79	13.40	20.88	0.85
10	10.76	13.29	20.99	0.91
11	10.59	13.11	20.49	0.89
12	11.20	13.91	21.55	0.95
Average	***10.84***	***13.42***	***20.87***	***0.96***

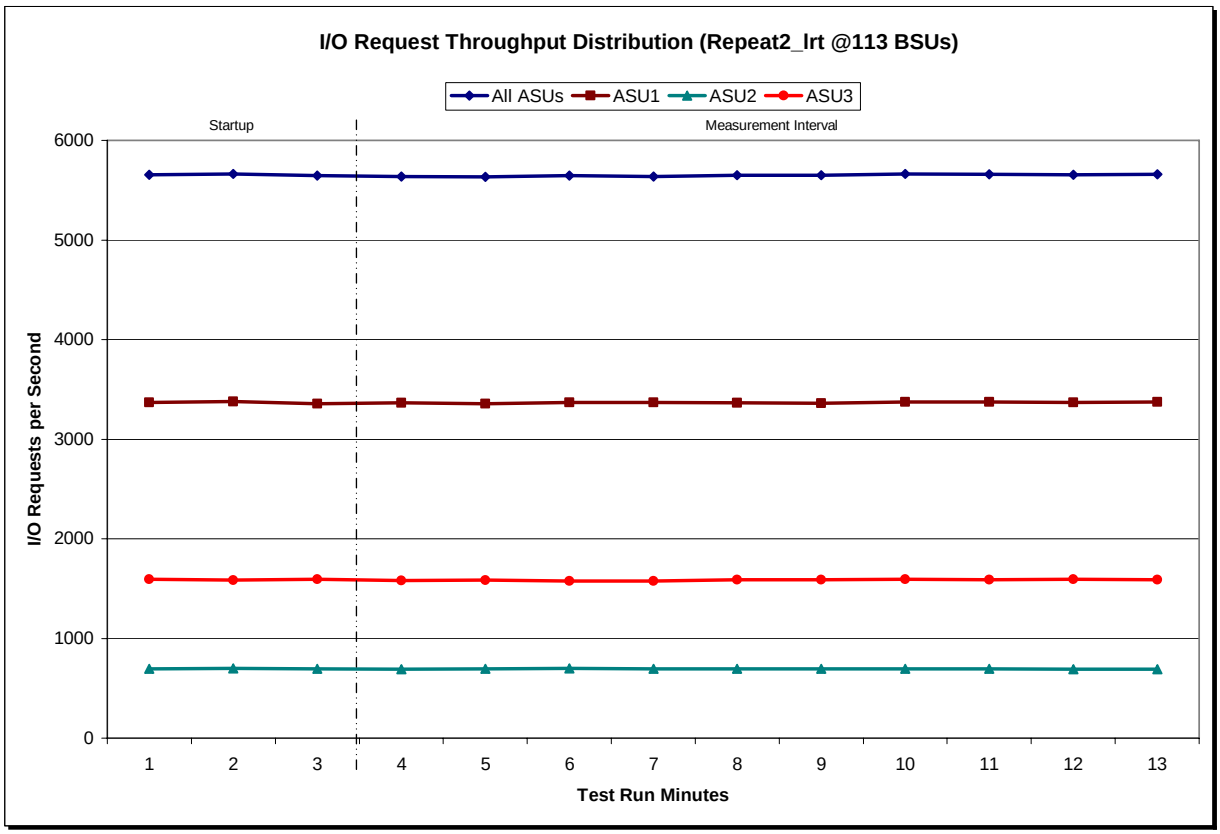
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

113 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:26:05	19:29:05	0-2	0:03:00
Measurement Interval	19:29:05	19:39:05	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	5,656.38	3,367.22	696.53	1,592.63
1	5,664.03	3,376.27	701.32	1,586.45
2	5,647.55	3,358.52	694.48	1,594.55
3	5,635.50	3,364.77	690.87	1,579.87
4	5,632.85	3,354.45	694.10	1,584.30
5	5,644.12	3,367.23	699.92	1,576.97
6	5,638.37	3,367.57	694.13	1,576.67
7	5,651.30	3,366.53	693.80	1,590.97
8	5,648.60	3,362.73	695.03	1,590.83
9	5,661.63	3,375.45	694.10	1,592.08
10	5,659.62	3,374.45	694.65	1,590.52
11	5,655.78	3,371.10	692.62	1,592.07
12	5,657.20	3,375.20	691.83	1,590.17
Average	***5,648.50***	***3,367.95***	***694.11***	***1,586.44***

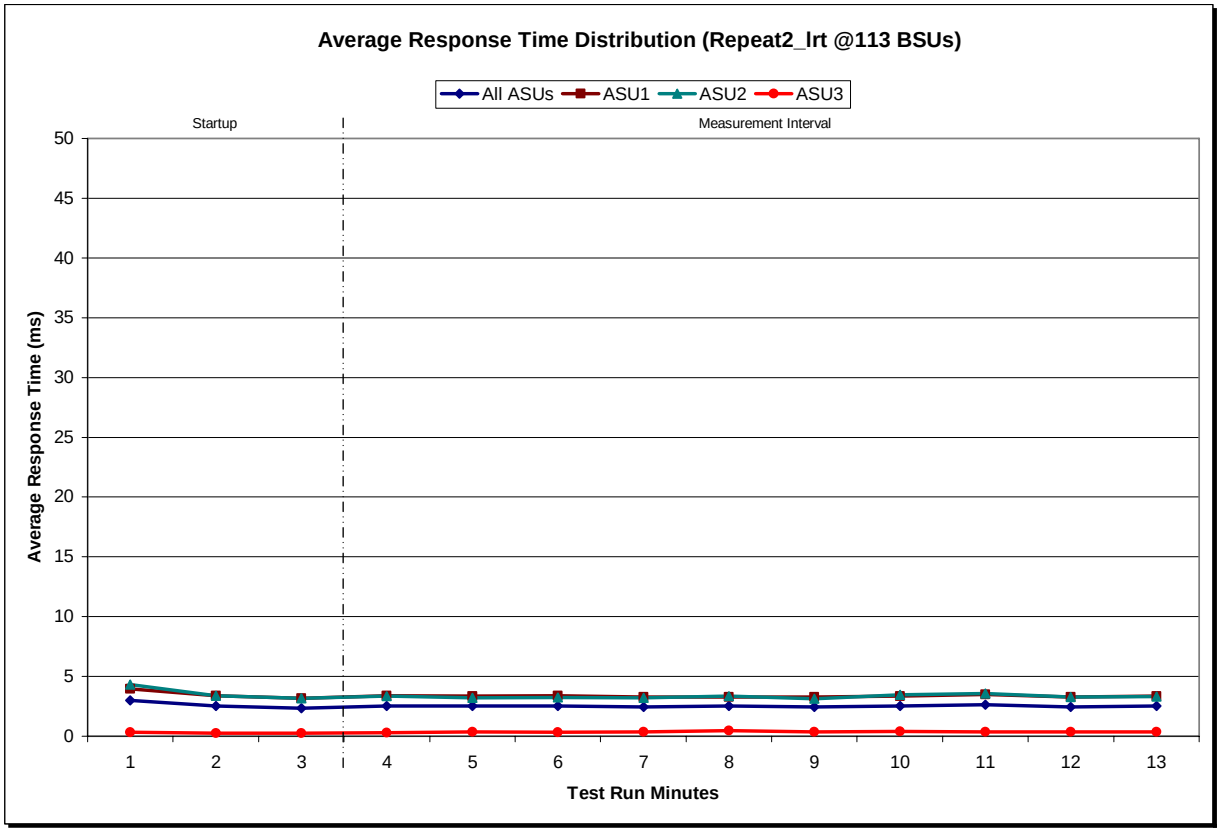
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

113 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:26:05	19:29:05	0-2	0:03:00
Measurement Interval	19:29:05	19:39:05	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.98	3.95	4.33	0.31
1	2.50	3.38	3.37	0.26
2	2.34	3.16	3.17	0.26
3	2.51	3.38	3.34	0.28
4	2.50	3.37	3.20	0.37
5	2.51	3.38	3.22	0.33
6	2.45	3.28	3.19	0.35
7	2.51	3.29	3.34	0.49
8	2.44	3.29	3.12	0.37
9	2.54	3.36	3.45	0.38
10	2.62	3.50	3.57	0.35
11	2.45	3.27	3.27	0.35
12	2.50	3.35	3.33	0.36
Average	***2.50***	***3.35***	***3.30***	***0.36***

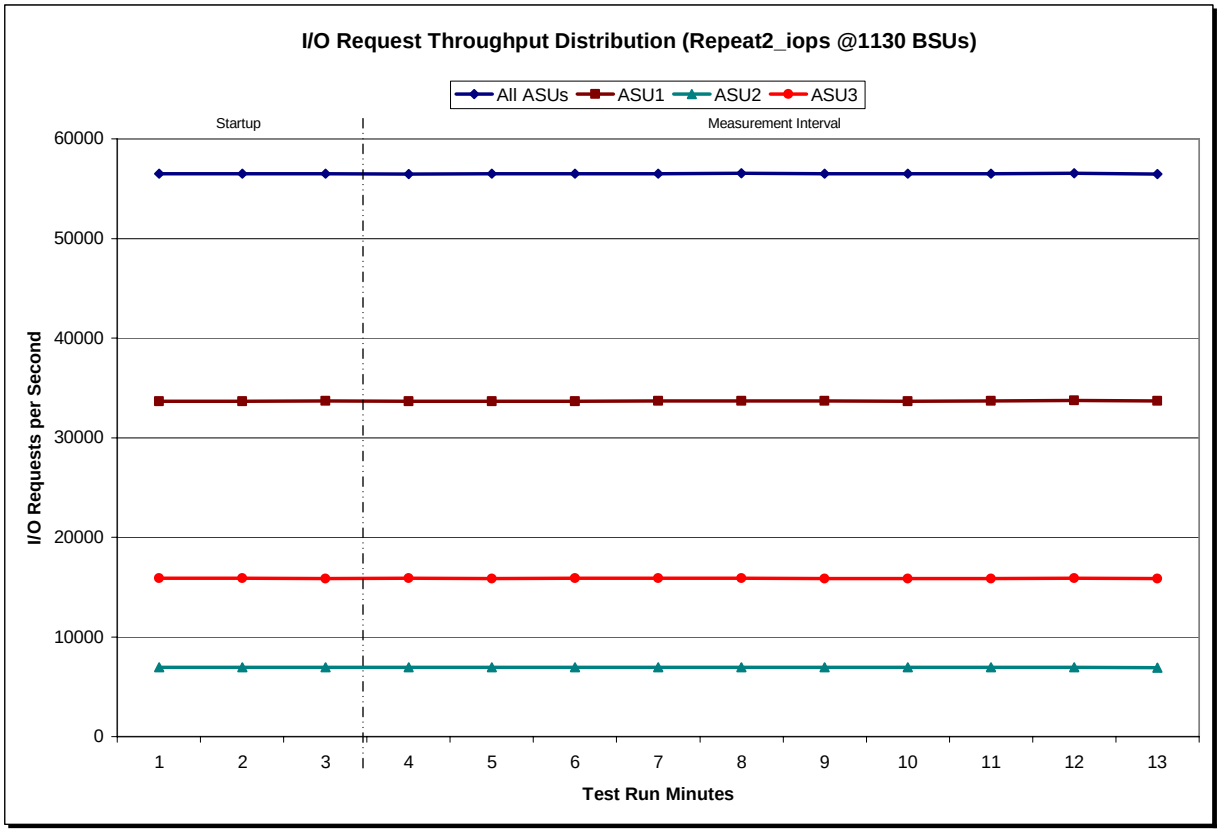
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

1130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:39:10	19:42:11	0-2	0:03:01
Measurement Interval	19:42:11	19:52:11	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	56,490.23	33,663.37	6,951.17	15,875.70
1	56,504.35	33,659.22	6,942.52	15,902.62
2	56,507.07	33,687.60	6,949.52	15,869.95
3	56,477.87	33,630.88	6,950.32	15,896.67
4	56,485.93	33,662.78	6,951.77	15,871.38
5	56,521.65	33,670.43	6,956.32	15,894.90
6	56,516.15	33,692.97	6,937.07	15,886.12
7	56,528.52	33,683.43	6,941.28	15,903.80
8	56,488.05	33,672.18	6,958.95	15,856.92
9	56,483.67	33,653.02	6,961.60	15,869.05
10	56,509.78	33,696.57	6,955.88	15,857.33
11	56,546.68	33,726.35	6,941.15	15,879.18
12	56,468.45	33,692.37	6,932.25	15,843.83
Average	***56,502.68***	***33,678.10***	***6,948.66***	***15,875.92***

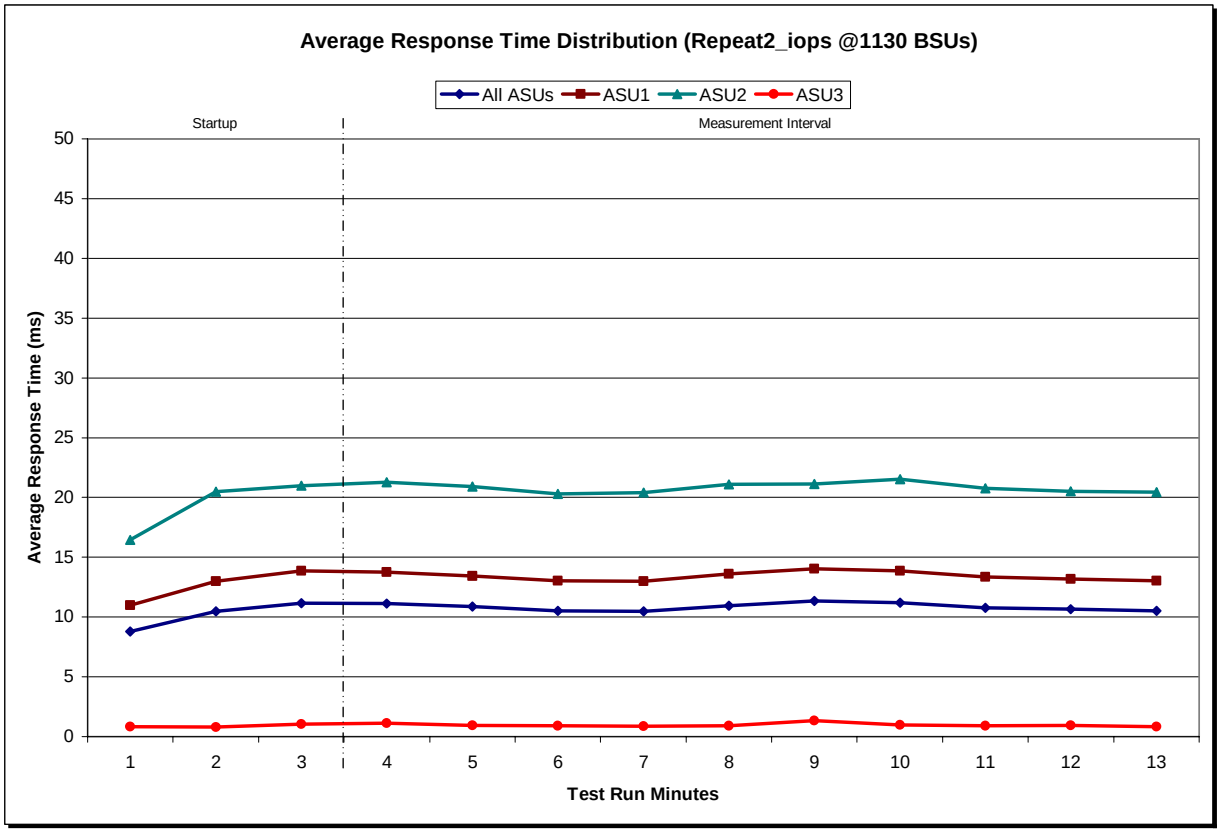
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

1130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:39:10	19:42:11	0-2	0:03:01
Measurement Interval	19:42:11	19:52:11	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	8.79	10.97	16.44	0.83
1	10.49	13.01	20.48	0.80
2	11.14	13.86	20.99	1.05
3	11.11	13.73	21.27	1.13
4	10.85	13.44	20.93	0.95
5	10.51	13.03	20.29	0.90
6	10.49	12.99	20.42	0.86
7	10.95	13.60	21.08	0.92
8	11.35	14.04	21.14	1.32
9	11.20	13.88	21.53	0.98
10	10.77	13.35	20.79	0.89
11	10.64	13.18	20.53	0.93
12	10.52	13.04	20.45	0.81
Average	***10.84***	***13.43***	***20.84***	***0.97***

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	0.0352	0.2808	0.0703	0.2100	0.0180	0.0701	0.0350	0.2806
COV	0.013	0.002	0.007	0.004	0.011	0.006	0.013	0.003

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	0.2811	0.0700	0.2100	0.0180	0.0700	0.0350	0.2809
COV	0.002	0.001	0.002	0.001	0.004	0.002	0.003	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	0.2813	0.0701	0.2100	0.0180	0.0700	0.0349	0.2809
COV	0.009	0.003	0.007	0.003	0.015	0.006	0.010	0.003

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	0.2101	0.0180	0.0700	0.0350	0.2810
COV	0.004	0.001	0.002	0.001	0.004	0.002	0.003	0.001

Data Persistence Test

Clause 6

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

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

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

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

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

Clause 9.4.3.8

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

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

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 73.

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	134,646,416
Total Number of Logical Blocks Verified	102,946,768
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 IBM Storwize® V7000 as documented in this Full Disclosure Report will become available on November 12, 2010 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 Remote Audit of the IBM Storwize® V7000 .

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.

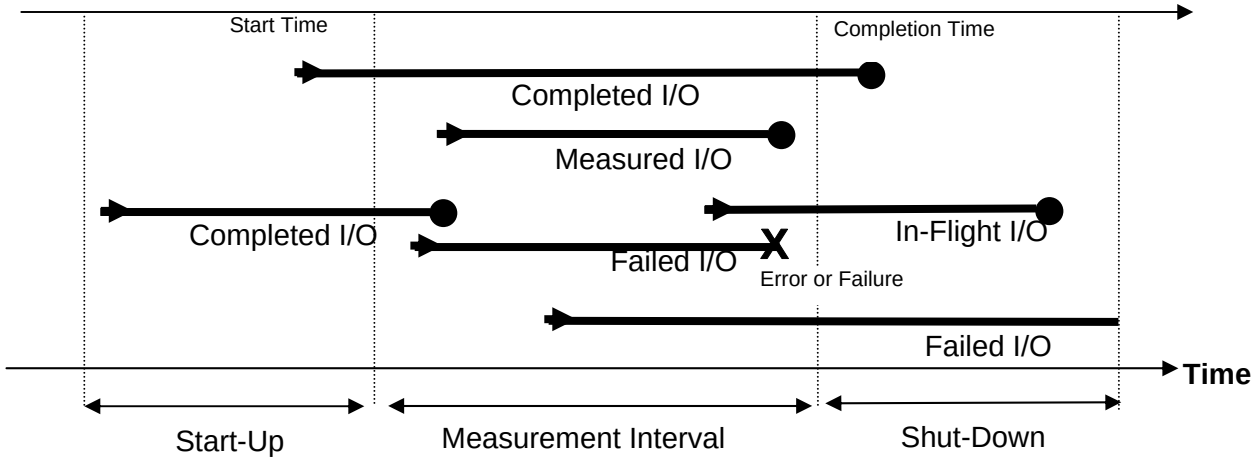
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

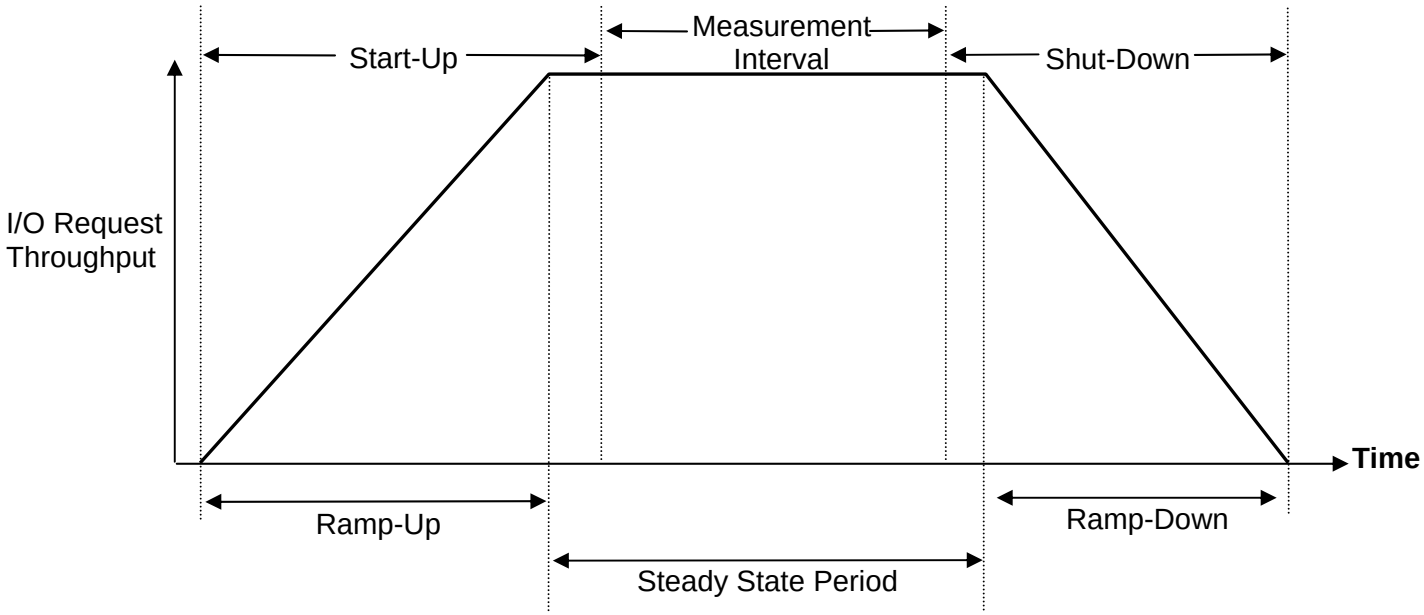
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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

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

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

SAN Volume Controller (SVC) Configuration

Each script listed below with the ***cyg*** file descriptor is submitted using PuTTY, a well known freeware package. In each of those scripts ***$plink*** is replace with the command ***plink name_of_cluster***, where ***name_of_cluster*** is a saved network location for the TSC.

The ***cyg*** scripts require the installation of Cygwin (http://www.cygwin.com/) and are executed as standard shell scripts in a Cygwin command window on the Host System.

The ***ds5020_tbird.configure*** script uses SANtricity Storage Manager CLI facility and is executed from a Window command window as follows:

SMcli {ip address} -f ds5020_tbird.configure

All of the referenced scripts appear at the end of this section.

Create RAID-10 Arrays and MDisks

All 200 disk drives *(120 internal and 80 external)* are organized into RAID-10 arrays with 8 disks per array. The RAID-10 arrays, comprised of 120 internal disk drives, are created by the ***mk_arrays_internal.cyg*** script. The RAID-10 arrays, comprised of the 80 external disk drives, are created by the DS5020 Storage Manager with the ***ds5020_tbird.configure*** script.

Create the VDisks

Execution of the ***mk_arrays_internal.cyg script*** and ***ds5020_tbird.configure*** scripts results in 25 MDisks as seen by the SVC *(15 internal MDisks and 10 external MDisks)*. All of the MDisks are then presented as 25 VDisks using the ***mk25vd_2node.cyg*** script.

Create the host paths

Execution of the ***mkhost.cyg*** script creats a list of host paths.

Assign primary and alternate host paths

Each VDisk is assigned two primary and two alternate host paths using the ***mapfcs25_all.cyg script***, which assigns paths from the list created in the previous step.

Windows Configuration

In Windows, multipath management was provided by SDDDSM, which is included as the driver for the Storwize V7000.

The Windows Diskpart command line utility was used to execute a script, ***dpmake.bat***, to create the Windows logical volumes used in the benchmark measurements.The ***dpmake.bat*** script was created by execution of the Cygwin script, ***mkdiskpart.cyg***, in a Cygwin command window as follows:

mkdiskpart.cyg 4 28 dpmake.bat

The resulting ***dpmake.bat*** script contained the Diskpart commands to:

- Scan the Windows "physical disks"
- Create 18 logical volumes using a stripe size of 30,947 MiB across "physical disks" 4-28 for a total capacity of 773,675 MiB per logical volume
- Assign drive letters E-V to the 18 striped logical volumes

All of the referenced scripts appear at the end of this section.

mk_arrays_internal.cyg

```
#!/bin/bash

# script to create performance based arrays from vanilla cluster
#
# input attribs
#
# $1 raid type      - raid0, raid1, raid10, raid5, raid6
# $2 drive type     - sas_ssd, sas_hdd, nearline
# $3 components     - [0-16]
# $4 array per mdg  - number of mdisk per group

if [[ $1 == "" || $2 == "" ]]
then
   echo "Usage : mk_arrays
            level      [raid0|raid1|raid10|raid5|raid6]
          drive      [sas_ssd|sas_hdd|nearline]
            components     [0-16]
            arrays per mdg     [number of mdisk per group]"
   exit
fi


level=$1
type=$2
comps=$3
count=$4

# lets just confirm we are doing the right thing

echo "#####################################################################
#
#  mk_arrays
#
#  Making $level arrays using $type drives
#  Will make with $comps components per array
#  and put $count arrays in each mdisk group
#
#####################################################################
"

sleep 2
echo "CTRL-C now if not correct..."
sleep 5

# now lets find the drives that are needed

let i=0
```

```
for d in $($plink svcinfo lsdrive | grep $type | awk {'print $1'})
do

   # this makes elements addressable via ${drive_array[$num]}

   drive_array[$i]=$d
   let i=i+1
done

let real_num=i
let num_drives=i-1          # with a base of 0

let array_count=real_num/comps
let tmp=array_count*comps
let spare=real_num-tmp

# so now we have found num_drives to use and we can start

echo "Found $real_num matching the desired type...
   which means... $array_count arrays
   and $spare unused...
"
sleep 2

echo "So lets make them...
"

let j=0
let m=0
let mdg=0

# j is the current drive index into the array
# m is the number of arrays already in this mdiskgrp

echo "Making a new mdiskgrp ... Group$mdg"
$plink svctask mkmdiskgrp -name Group$mdg -ext 256


s0=0
e0=0

for c in $(seq 1 1 $array_count)
do

   this_array="${drive_array[$j]}"

   let tmpcomp=comps-1

   for d in $(seq 1 1 $tmpcomp)
   do
     let j=j+1
     let next_id=${drive_array[$j]}
     this_array="$this_array:$next_id"
   done

   # so got drive list, lets see how many mdisk in this group

   if [[ $m -ge $count ]]
   then
      let mdg=mdg+1
      echo "Making a new mdiskgrp ... Group$mdg"
      $plink svctask mkmdiskgrp -name Group$mdg -ext 256
```

```
       let m=0
    fi

    echo "mkarray -level $level -drive $this_array $sync_str Group$mdg"
    $plink svctask mkarray -level $level -drive $this_array $sync_str Group$mdg
    let j=j+1
    let m=m+1
done
```

ds5020_tbird.configure

```
set storagesubsystem cacheBlockSize=8;

set storagesubsystem cacheFlushStart=80;
set storagesubsystem cacheFlushStop=20;

create logicaldrive diskDrives=(2,2 85,2 3,1 0,1 0,2 1,1 2,1 85,1) raidLevel=1
userLabel="1" arrayUserLabel="0" owner=A segmentSize=256 dssPreAllocate=true
securityType=none;
create logicaldrive diskDrives=(85,4 3,3 0,3 1,2 1,3 2,3 85,3 3,2) raidLevel=1
userLabel="2" arrayUserLabel="1" owner=B segmentSize=256 dssPreAllocate=true
securityType=none;
create logicaldrive diskDrives=(3,5 0,5 1,4 2,4 2,5 85,5 3,4 0,4) raidLevel=1
userLabel="3" arrayUserLabel="2" owner=A segmentSize=256 dssPreAllocate=true
securityType=none;
create logicaldrive diskDrives=(0,7 1,6 2,6 85,6 85,7 3,6 0,6 1,5) raidLevel=1
userLabel="4" arrayUserLabel="3" owner=B segmentSize=256 dssPreAllocate=true
securityType=none;
create logicaldrive diskDrives=(1,8 2,8 85,8 3,7 3,8 0,8 1,7 2,7) raidLevel=1
userLabel="5" arrayUserLabel="4" owner=A segmentSize=256 dssPreAllocate=true
securityType=none;
create logicaldrive diskDrives=(2,10 85,10 3,9 0,9 0,10 1,9 2,9 85,9) raidLevel=1
userLabel="6" arrayUserLabel="5" owner=B segmentSize=256 dssPreAllocate=true
securityType=none;
create logicaldrive diskDrives=(85,12 3,11 0,11 1,10 1,11 2,11 85,11 3,10)
raidLevel=1 userLabel="7" arrayUserLabel="6" owner=A segmentSize=256
dssPreAllocate=true securityType=none;
create logicaldrive diskDrives=(3,13 0,13 1,12 2,12 2,13 85,13 3,12 0,12)
raidLevel=1 userLabel="8" arrayUserLabel="7" owner=B segmentSize=256
dssPreAllocate=true securityType=none;
create logicaldrive diskDrives=(0,15 1,14 2,14 85,14 85,15 3,14 0,14 1,13)
raidLevel=1 userLabel="9" arrayUserLabel="8" owner=A segmentSize=256
dssPreAllocate=true securityType=none;
create logicaldrive diskDrives=(1,16 2,16 85,16 3,15 3,16 0,16 1,15 2,15)
raidLevel=1 userLabel="10" arrayUserLabel="9" owner=B segmentSize=256
dssPreAllocate=true securityType=none;

set logicaldrive["1"] readAheadMultiplier=0;
set logicaldrive["2"] readAheadMultiplier=0;
set logicaldrive["3"] readAheadMultiplier=0;
set logicaldrive["4"] readAheadMultiplier=0;
set logicaldrive["5"] readAheadMultiplier=0;
set logicaldrive["6"] readAheadMultiplier=0;
set logicaldrive["7"] readAheadMultiplier=0;
set logicaldrive["8"] readAheadMultiplier=0;
set logicaldrive["9"] readAheadMultiplier=0;
set logicaldrive["10"] readAheadMultiplier=0;

set logicaldrive["1"] mediaScanEnabled=false;
set logicaldrive["2"] mediaScanEnabled=false;
set logicaldrive["3"] mediaScanEnabled=false;
set logicaldrive["4"] mediaScanEnabled=false;
```

```
set logicaldrive["5"] mediaScanEnabled=false;
set logicaldrive["6"] mediaScanEnabled=false;
set logicaldrive["7"] mediaScanEnabled=false;
set logicaldrive["8"] mediaScanEnabled=false;
set logicaldrive["9"] mediaScanEnabled=false;
set logicaldrive["10"] mediaScanEnabled=false;

set logicaldrive ["1"] logicalUnitNumber=0 hostGroup=defaultGroup;
set logicaldrive ["2"] logicalUnitNumber=1 hostGroup=defaultGroup;
set logicaldrive ["3"] logicalUnitNumber=2 hostGroup=defaultGroup;
set logicaldrive ["4"] logicalUnitNumber=3 hostGroup=defaultGroup;
set logicaldrive ["5"] logicalUnitNumber=4 hostGroup=defaultGroup;
set logicaldrive ["6"] logicalUnitNumber=5 hostGroup=defaultGroup;
set logicaldrive ["7"] logicalUnitNumber=6 hostGroup=defaultGroup;
set logicaldrive ["8"] logicalUnitNumber=7 hostGroup=defaultGroup;
set logicaldrive ["9"] logicalUnitNumber=8 hostGroup=defaultGroup;
set logicaldrive ["10"] logicalUnitNumber=9 hostGroup=defaultGroup;
```

mk25vd_2node.cyg

```
#!/usr/bin/bash
#execute in cygwin command line
i=0
while [[ $i -le 24 ]]
    do
    let lode="1 + ((i%8) / 4)"
    iogrp=0
    $plink svctask mkvdisk \
       -size 544 -unit gb -mdiskgrp Group0 -iogrp io_grp$iogrp \
       -name vd$i -node lode$lode
    let i="i+1"
    done
```

mkhost.cyg

```
$plink svctask mkhost -force -name fcs0 -hbawwpn 2100001B3283C44C
$plink svctask mkhost -force -name fcs1 -hbawwpn 2100001B3283664C
$plink svctask mkhost -force -name fcs2 -hbawwpn 2101001B32A3C44C
$plink svctask mkhost -force -name fcs3 -hbawwpn 2101001B32A3664C
```

mapfcs25_all.cyg script

```
i=0
while [[ $i -le 25 ]]
    do
    $plink svctask mkvdiskhostmap -force -host fcs0 vd$i
    $plink svctask mkvdiskhostmap -force -host fcs1 vd$i
    $plink svctask mkvdiskhostmap -force -host fcs2 vd$i
    $plink svctask mkvdiskhostmap -force -host fcs3 vd$i
    let i="i+1"
    done
```

mkdiskpart.cyg

```
#!/usr/bin/bash
# run in cygwin command line
#Makes batch input to create 18 striped volumes from specified disks with the
diskpart utility.
if [[ $# -lt 3 ]]
  then
  echo "usage: mkdiskpart N1 N2 <name of batch file>."
  return
```

```
  fi
letter=( E F G H I J K L M N O P Q R S T U V )
echo "rescan" > $3
i=$1
while [[ $i -le $2 ]]
do
  echo "select disk $i" >> $3
  echo "clean" >> $3
  echo "convert dynamic align=65536" >> $3
  if [[ $i -eq $1 ]]
  then
    disklist=$i
  else
    disklist=$disklist,$i
  fi
  let i="i+1"
done
echo "select volume 0" >> $3
i=0
while [[ $i -le 17 ]]
do
  echo "create volume stripe size=30947 disk=$disklist" >> $3
  echo "assign letter ${letter[$i]}" >> $3
  let i="i+1"
done
echo "exit" >> $3
```

dpmake.bat

```
rescan
select disk 4
clean
convert dynamic align=65536
select disk 5
clean
convert dynamic align=65536
select disk 6
clean
convert dynamic align=65536
select disk 7
clean
convert dynamic align=65536
select disk 8
clean
convert dynamic align=65536
select disk 9
clean
convert dynamic align=65536
select disk 10
clean
convert dynamic align=65536
select disk 11
clean
convert dynamic align=65536
select disk 12
clean
convert dynamic align=65536
select disk 13
clean
convert dynamic align=65536
select disk 14
clean
```

```
convert dynamic align=65536
select disk 15
clean
convert dynamic align=65536
select disk 16
clean
convert dynamic align=65536
select disk 17
clean
convert dynamic align=65536
select disk 18
clean
convert dynamic align=65536
select disk 19
clean
convert dynamic align=65536
select disk 20
clean
convert dynamic align=65536
select disk 21
clean
convert dynamic align=65536
select disk 22
clean
convert dynamic align=65536
select disk 23
clean
convert dynamic align=65536
select disk 24
clean
convert dynamic align=65536
select disk 25
clean
convert dynamic align=65536
select disk 26
clean
convert dynamic align=65536
select disk 27
clean
convert dynamic align=65536
select disk 28
clean
convert dynamic align=65536
select volume 0
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter E
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter F
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter G
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter H
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter I
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter J
```

```
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter K
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter L
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter M
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter N
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter O
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter P
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter Q
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter R
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter S
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter T
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter U
create volume stripe size=30947
disk=4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28
assign letter V
exit
```

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, Repeatability and Persistence Tests, is listed below.

```
javaparms="-Xms384m -Xmx768m -Xss128k"
sd=default,size=811254897704
sd=asu1_1,lun=\\.\E:
sd=asu1_2,lun=\\.\F:
sd=asu1_3,lun=\\.\G:
sd=asu1_4,lun=\\.\H:
sd=asu1_5,lun=\\.\I:
sd=asu1_6,lun=\\.\J:
sd=asu1_7,lun=\\.\K:
sd=asu1_8,lun=\\.\L:
sd=asu2_1,lun=\\.\M:
sd=asu2_2,lun=\\.\N:
sd=asu2_3,lun=\\.\O:
sd=asu2_4,lun=\\.\P:
sd=asu2_5,lun=\\.\Q:
sd=asu2_6,lun=\\.\R:
sd=asu2_7,lun=\\.\S:
sd=asu2_8,lun=\\.\T:
sd=asu3_1,size=721115464625,lun=\\.\U:
sd=asu3_2,size=721115464625,lun=\\.\V:
```

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.

```
date /T > caplist.txt
time /T >> caplist.txt
plink spc1clus svcinfo lsdrive >> caplist.txt
plink spc1clus svcinfo lsmdisk -bytes >> caplist.txt
type hostcap.bat | diskpart >> caplist.txt
java -Xmx768m -Xms384m -Xss128k metrics -b 1130
java -Xmx768m -Xms384m -Xss128k repeat1 -b 1130
java -Xmx768m -Xms384m -Xss128k repeat2 -b 1130
java -Xmx1280m -Xms1280m -Xss64k persist1 -b 1130
date /T > caplist2.txt
time /T >> caplist2.txt
plink spc1clus svcinfo lsdrive >> caplist2.txt
plink spc1clus svcinfo lsmdisk -bytes >> caplist2.txt
type hostcap.bat | diskpart >> caplist2.txt
```

Persistence Test Run 2

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

```
java -Xmx1280m -Xms1280m -Xss64k persist2
```