SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

IBM CORPORATION
IBM SYSTEM STORAGE
SAN VOLUME CONTROLLER VERSION 4.3

SPC-1 V1.10.1

Submitted for Review: October 15, 2008
Submission Identifier: A00072

First Edition – October 2008

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AUDIT CERTIFICATION

Bruce McNutt
IBM Corporation
KBV/9062-2
9000 South Rita Road
Tucson, AZ 85744

August 22, 2008

The SPC Benchmark 1™ results listed below for the IBM System Storage SAN Volume Controller Version 4.3 were produced in compliance with the SPC Benchmark 1™ V1.10.1 Remote Audit requirements.

SPC Benchmark 1™ V1.10.1 Results	
Tested Storage Configuration (TSC) Name: IBM System Storage SAN Volume Controller Version 4.3	
Metric	**Reported Result**
SPC-1 IOPS™	274,997.58
SPC-1 Price-Performance	$11.79/SPC-1 IOPS™
Total ASU Capacity	61,007.564 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$3,242,858.69

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with V1.10.1 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.

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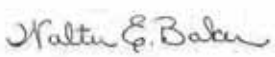
AUDIT CERTIFICATION *(CONT.)*

- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.
- The following Host System requirements, based on information supplied by 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
- The differences between the Tested Storage Configuration (TSC) used for the benchmark and Priced Storage Configuration were documented and, if applied to the TSC, would not have a negative impact on the reported SPC-1 performance.
- The submitted pricing information met all of the requirements and constraints of Clause 8 of the SPC-1 Benchmark Specification.
- The Full Disclosure Report (FDR) met all of the requirements in Clause 9 of the SPC-1 Benchmark Specification.
- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

Audit Notes:

There were no audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

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LETTER OF GOOD FAITH

IBM

Vice President & BLE, Disk Storage

IBM Technology & Systems Group
5600 Cottle Road, San Jose, California 95193

Phone: 408-256-7405
Fax: 408-256-7420

July 18, 2008

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 System Storage San Volume Controller Version 4.3

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,

Barry Rudolph

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 KBV/9062-2 9000 South Rita Road Tucson, AZ 85744 Phone: (520) 799-2460 FAX: (520) 799-2009
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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	V1.10.1
SPC-1 Workload Generator revision number	V2.00.04a
Date Results were first used publicly	October 15, 2008
Date the FDR was submitted to the SPC	October 15, 2008
Date the TSC is available for shipment to customers	currently available
Date the TSC completed audit certification	August 22, 2008

Tested Storage Product (TSP) Description

The IBM System Storage SAN Volume Controller (SVC) enables a single point of control for disparate, heterogeneous storage resources to help support improved business application availability and greater resource utilization. SAN Volume Controller is designed to pool storage volumes from IBM and non-IBM storage systems into a single reservoir of capacity for centralized management.

SAN Volume Controller combines hardware and software into an integrated, modular solution. Using IBM System x™ server technology in clustered pairs, SAN Volume Controller is designed to avoid potential single points of failure. SAN Volume Controller software is designed to operate as a highly available cluster supporting high performance and ease of use.

SAN Volume Controller is highly scalable. An "I/O Group" is formed by combining a redundant pair of System x servers. Each server includes a four-port 4 Gbps-capable host bus adapter (HBA), designed to allow the SAN Volume Controller to connect and operate at

up to 4 Gbps SAN fabric speed. Each I/O Group contains 8 GB of mirrored cache memory. Highly available I/O Groups are the basic configuration element of a SAN Volume Controller cluster. Adding I/O Groups to the cluster is designed to increase cluster performance and bandwidth.

SAN Volume Controller can scale out to support four I/O Groups, and it can scale up to support 1024 host servers. For every cluster, SAN Volume Controller support up to 4096 virtual disks.

Version 4.3 of SAN Volume Controller offers thin provisioning capability, configurable on a virtual disk basis. This SPC-1 Result demonstrates the performance of virtual disks configured for thin provisioning (referred to as Space Efficient virtual disks).

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: IBM System Storage SAN Volume Controller Version 4.3	
Metric	**Reported Result**
SPC-1 IOPS™	274,997.58
SPC-1 Price-Performance	$11.79/SPC-1 IOPS™
Total ASU Capacity	61,007.564 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$3,242,858.69

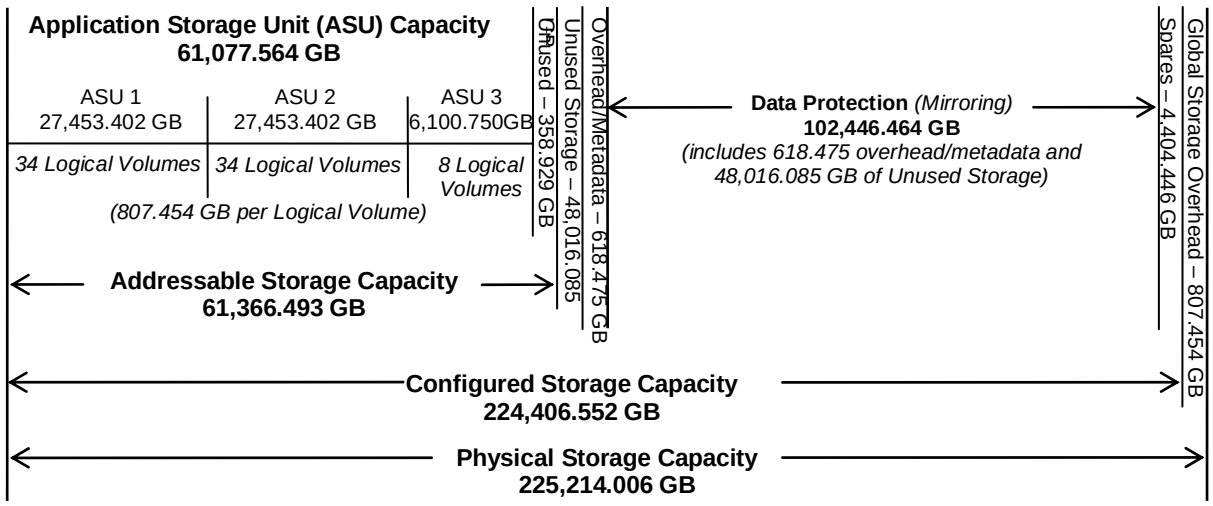
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

Storage Capacities and Relationships

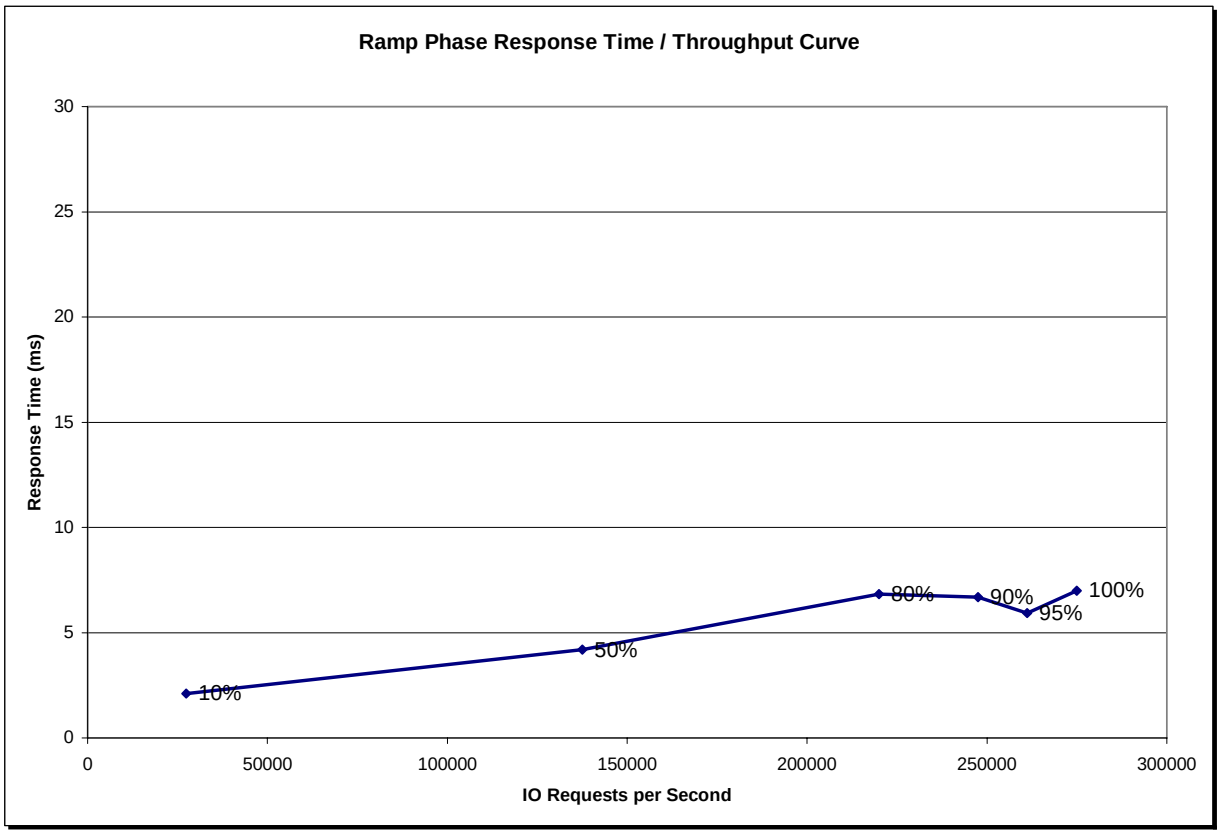
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



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	27,494.04	137,482.69	220,017.32	247,468.74	261,207.70	274,997.58
Average Response Time (ms):						
All ASUs	2.11	4.20	6.83	6.70	5.94	6.99
ASU-1	2.83	5.00	8.07	7.88	7.17	8.32
ASU-2	2.16	5.20	8.50	8.56	7.80	9.07
ASU-3	0.56	2.06	3.49	3.36	2.51	3.27
Reads	4.58	7.66	12.20	12.05	11.40	12.97
Writes	0.50	1.95	3.34	3.21	2.38	3.11

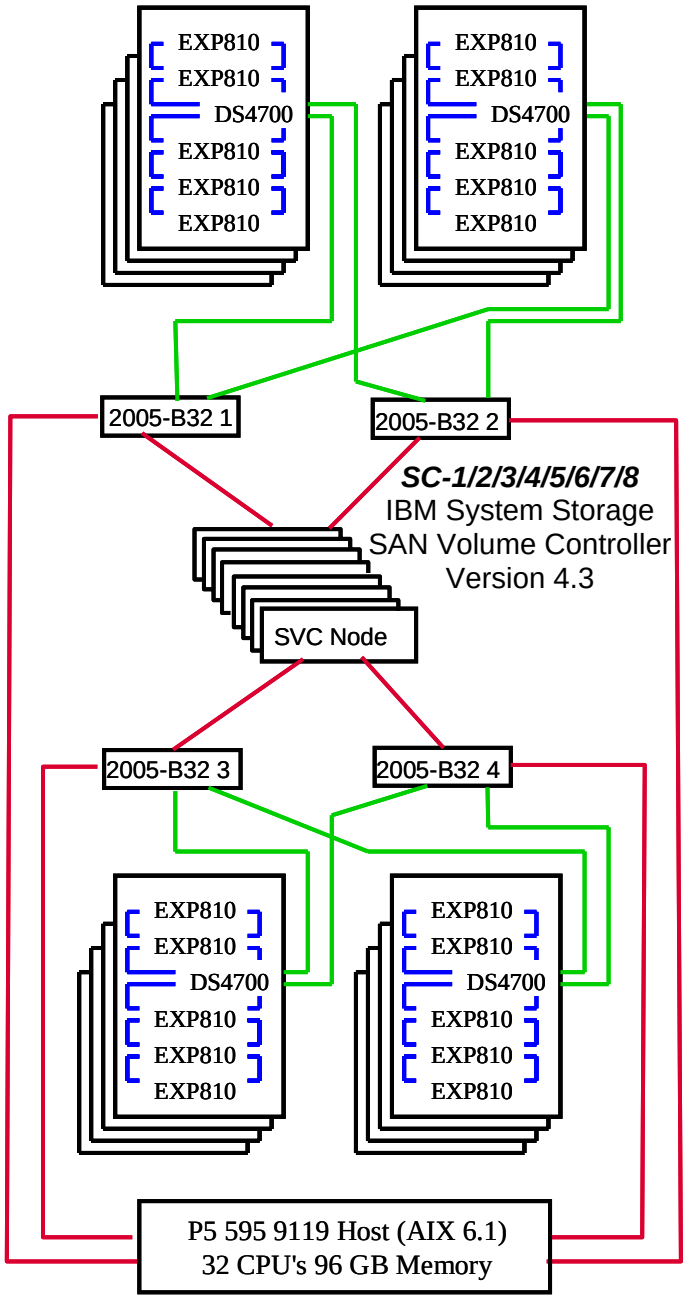
Tested Storage Configuration Pricing *(Priced Storage Configuration)*

Component	Comments	Quantity	Unit Price	Unit Maint	List w/ Maint	% discount	Total Price
SVC 3550 Storage Engine (2145-8G4)		8	16,500.00	6,696.00	185,568.00	30	129,897.60
UPS (2145-8G4 8115)		8	1,250.00	2,592.00	30,736.00	30	21,515.20
Master Console (2145-8G4 4001)		1	7,499.00	3,816.00	11,315.00	30	7,920.50
SVC Software license (base)	up to 100 TB	1	332,000.00	132,800.00	464,800.00	30	325,360.00
19 inch rack (7014-T42)		9	3,970.00	1,512.00	49,338.00	50	24,669.00
32 port fibre channel switch (2005-B32)	w/ 32 SFP, 32 ports enabled	4	38,573.00	2,657.00	164,920.00	20	131,936.00
DS 4700 with 16 15K RPM drives (146 GB)	w/ 4 SFP, 2 5m cables	16	45,243.00	11,250.00	903,888.00	37	569,449.44
EXP810 with 16 15K RPM drives (146 GB)	w/ 4 SFP, 2 1m cables	80	34,544.00	4,320.00	3,109,120.00	37	1,958,745.60
Ethernet switch (73P-2413)		2	135.99	30.00	331.98	42	192.55
Short wave 5m fibre channel cable (1814-70A 5605)		32	129.00		4,128.00	20	3,302.40
Short wave 25 m fibre channel cable (1814-70A 5625)		32	189.00		6,048.00	20	4,838.40
Ethernet 1.5 m cable (1814-70A 3802)		8	17.00		136.00	0	136.00
Ethernet 10 m cable (1814-70A 3804)		32	29.00		928.00	0	928.00
2 Gbit P5 595 adapter (5716)		32	1,999.00		63,968.00	0	63,968.00
Total Price							**3,242,858.69**

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

The TSC was configured with 1,534 active disk drives and the Priced Storage Configuration contained 1,536 disk drives. Adding two disk drives to the TSC would not have resulted in a negative impact to the reported SPC-1 performance.

Benchmark Configuration/Tested Storage Configuration Diagram



Notes:

All storage is managed by each node (single image).

Each EXP810 and DS4700 has 16 disks (total of 1536). Disks are 146 GB, 15K RPM.

Each switch has one zone for node-to-storage traffic, two zones for node-to-host traffic (even nodes to half of fcs's, odd nodes to half of fcs's).

Represents 1 FC path per line drawn
Represents 4 FC paths per line drawn
Represents 8 FC paths per line drawn

Benchmark Configuration/Tested Storage Configuration Components

Host Systems:	Tested Storage Configuration (TSC):
UID=HS-1	32 – 4 Gbit P5 595 HBAs
IBM P5 595 Model 9119	***UID=SC-1/2/3/4/5/6/7/8:*** 8 – System Storage SAN Volume Controllers per controller: 2 GB memory/cache 4 – 4 Gbit FC front-end physical connections *(32 total)* 4 – Backend physical connection pairs *(32 total pairs, 64 connections)*
32 – 1.9 GHz CPUs – 2 CPUs/POWER5 chip 32 KB L1 cache, 960 KB L2 cache, and 18 MB L3 cache per CPU	
96 GB main memory	
AIX 5.3	
PCI-X/RIO	4 – 32 port FC switches
WG	2 – Ethernet switches
	16 – DS4700 enclosures 80 – EXP810 enclosures 1,536 – 146 GB, 15K RPM disk drives *(16 disk drives per enclosure)*
	9 – 19 inch racks
	8 – UPS

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 9.2.4.4.1

A one page Benchmark Configuration (BC)/Tested Storage Configuration (TSC) diagram shall be included in the Executive Summary…

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 15 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Storage Network Configuration

Clause 9.2.4.4.1

…

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 9.2.4.4.2.*

Clause 9.2.4.4.2

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.2.4.4.1 contains a high-level illustration of the network configuration, the Executive Summary will contain a one page topology diagram of the storage network as illustrated in Figure 9-9.

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC), including the network configuration, is illustrated on page 15 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Host System Configuration

Clause 9.2.4.4.3

The FDR shall minimally contain, for each Host System running the Workload Generator, a listing of the following:

1. *Number and type of CPUs.*
2. *Main memory capacity.*
3. *Cache memory capacity.*
4. *Number and type of disk controllers or Host Bus Adapters.*

The details of the Host System configuration may be found on page 15 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Customer Tunable Parameters and Options

Clause 9.2.4.5.1

All Benchmark Configuration (BC) components with customer tunable parameter and options that have been altered from their default values must be listed in the FDR. The FDR entry for each of those components must include both the name of the component and the altered value of the parameter or option. If the parameter name is not self-explanatory to a knowledgeable practitioner, a brief description of the parameter's use must also be included in the FDR entry.

"Appendix B: Customer Tunable Parameters and Options" on page 60 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Description

Clause 9.2.4.5.2

The FDR must include sufficient information to recreate the logical representation of the TSC. In addition to customer tunable parameters and options (Clause 4.2.4.5.3), that information must include, at a minimum:

- *A diagram and/or description of the following:*
  - *All physical components that comprise the TSC. Those components are also illustrated in the BC Configuration Diagram in Clause 9.2.4.4.1 and/or the Storage Network Configuration Diagram in Clause 9.2.4.4.2.*
  - *The logical representation of the TSC, configured from the above components that will be presented to the Workload Generator.*
- *Listings of scripts used to create the logical representation of the TSC.*
- *If scripts were not used, a description of the process used with sufficient detail to recreate the logical representation of the TSC.*

"Appendix C: Tested Storage Configuration (TSC) Creation" on page 61 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.2.4.5.3

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 69.

SPC-1 DATA REPOSITORY

This portion of the Full Disclosure Report presents the detailed information that fully documents the various SPC-1 storage capacities and mappings used in the Tested Storage Configuration. "SPC-1 Data Repository Definitions" on page 56 contains definitions of terms specific to the SPC-1 Data Repository.

Storage Capacities and Relationships

Clause 9.2.4.6.1

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)	61,007.564
Addressable Storage Capacity	Gigabytes (GB)	61,366.493
Configured Storage Capacity	Gigabytes (GB)	224,406.552
Physical Storage Capacity	Gigabytes (GB)	225,214.006
Data Protection *(Mirrored)*	Gigabytes (GB)	112,203.276
Required Storage *(spares/metadata/overhead)*	Gigabytes (GB)	5,022.921
Global Storage Overhead	Gigabytes (GB)	807.454
Total Unused Storage	Gigabytes (GB)	96,750.028

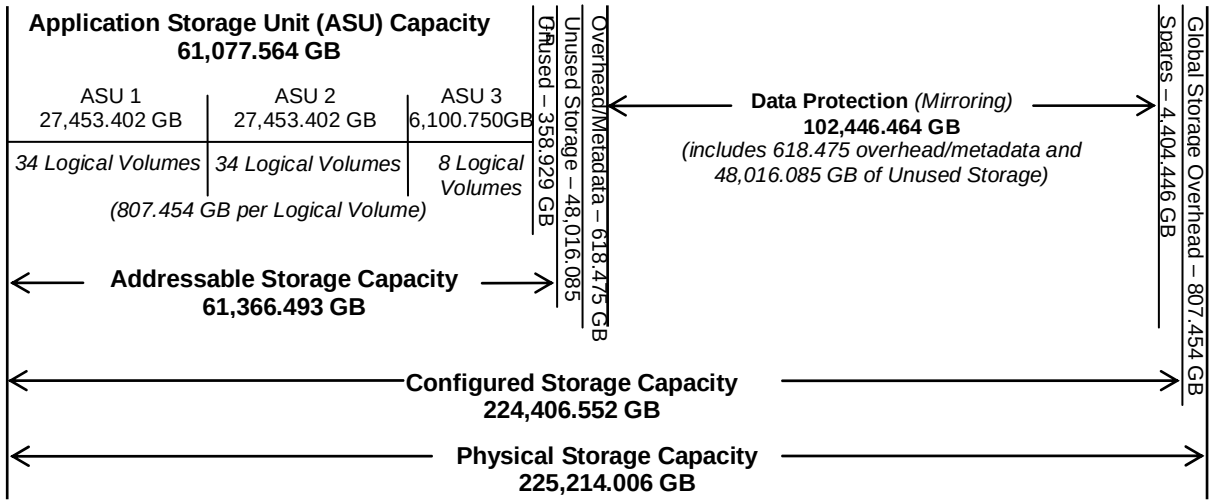
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	99.42%	27.19%	27.09%
Required for Data Protection *(Mirrored)*		50.00%	49.82%
Addressable Storage Capacity		27.35%	27.25%
Required Storage *(spares/metadata)*		2.24%	2.23%
Configured Storage Capacity			99.64%
Global Storage Overhead			0.36%
Unused Storage:			
Addressable	1.17%		
Configured		42.79%	
Physical			0.00%

The Physical Storage Capacity consisted of 225,214.006 GB distributed over 1,534 disk drives each with a formatted capacity of 136.732 GB. There was 0.000 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 807.454 GB (0.36%) of Physical Storage Capacity. There was 96,032.170 GB (42.79%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 99.42% of the Addressable Storage Capacity resulting in 358.929 GB (1.17%) of Unused Storage within the Addressable Storage Capacity.

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 9.2.4.6.2

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 (27,453.402 GB)	**ASU-2 (27,453.402 GB)**	**ASU-3 (6,100.760 GB)**
34 Logical Volume 807.454 GB per Logical Volume (807.453 GB used per Logical Volume)	34 Logical Volume 807.454 GB per Logical Volume (807.453 GB used per Logical Volume)	8 Logical Volume 807.454 GB per Logical Volume (762.595 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was "Mirrored" as described on page 12. See "ASU Configuration" in the **IOPS Test Results File** for more detailed configuration information.

SPC-1 BENCHMARK EXECUTION RESULTS

This portion of the Full Disclosure Report documents the results of the various SPC-1 Tests, Test Phases, and Test Runs. "SPC-1 Test Execution Definitions" on page 57 contains definitions of terms specific to the SPC-1 Tests, Test Phases, and Test Runs.

Clause 5.4.3

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

SPC-1 Tests, Test Phases, and Test Runs

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

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

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

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

Primary Metrics Test – Sustainability Test Phase

Clause 5.4.4.1.1

The Sustainability Test Phase has exactly one Test Run and shall demonstrate the maximum sustainable I/O Request Throughput within at least a continuous three (3) hour Measurement Interval. This Test Phase also serves to insure that the TSC has reached Steady State prior to reporting the final maximum I/O Request Throughput result (SPC-1 IOPS™).

Clause 5.4.4.1.2

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

Clause 5.4.4.1.4

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

Clause 9.2.4.7.1

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 71.

Sustainability Test Results File

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

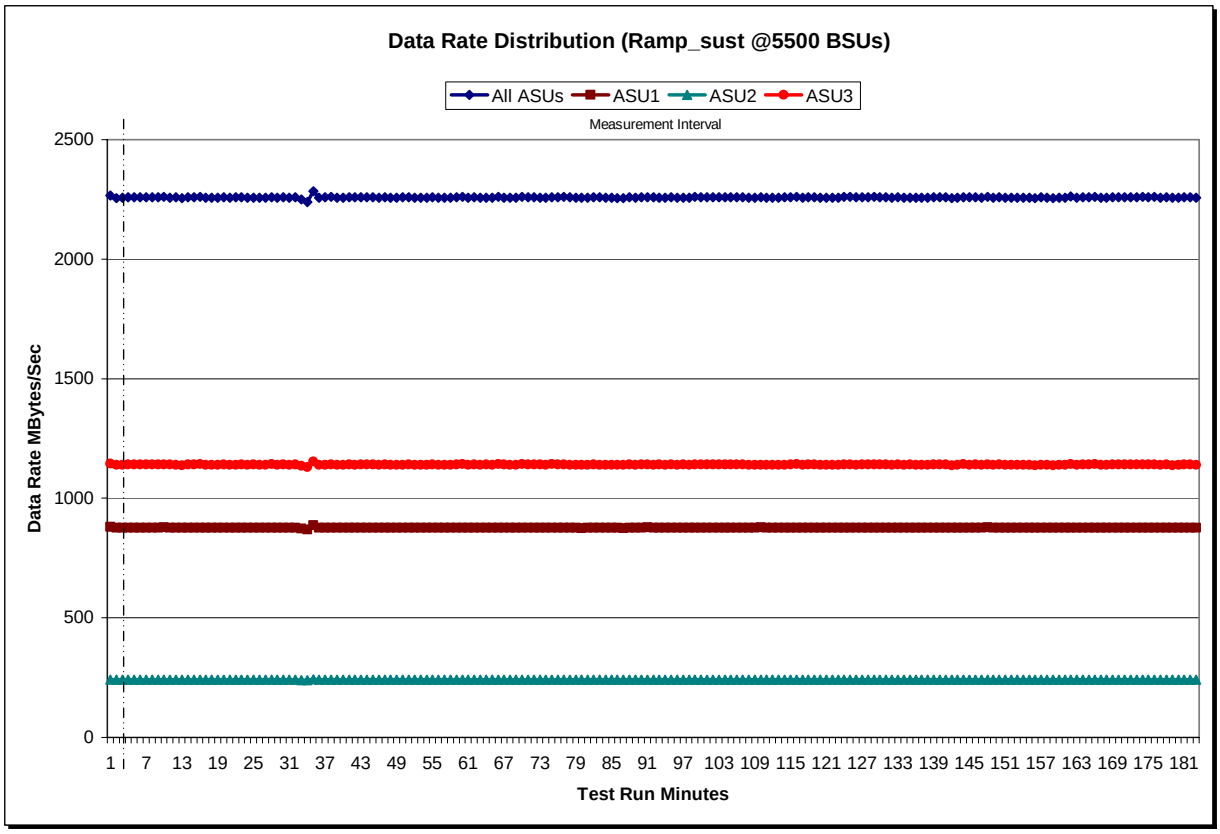
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	16:01:43	16:04:43	0-2	0:03:00
Measurement Interval	16:04:43	19:04:45	3-182	3:00:02

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	2,266.37	880.36	241.31	1,144.70	63	2,257.16	875.85	241.05	1,140.26	126	2,258.69	876.84	241.39	1,140.45
1	2,255.90	875.78	241.52	1,138.59	64	2,257.35	876.29	241.24	1,139.82	127	2,258.70	876.75	241.12	1,140.83
2	2,257.76	876.79	241.22	1,139.76	65	2,260.31	877.14	241.15	1,142.01	128	2,259.80	876.97	241.50	1,141.34
3	2,258.73	876.61	240.97	1,141.15	66	2,257.51	876.24	240.91	1,140.36	129	2,258.12	876.43	241.10	1,140.60
4	2,259.18	876.89	241.11	1,141.17	67	2,256.36	876.33	241.15	1,138.88	130	2,258.02	876.33	240.75	1,140.94
5	2,258.93	876.11	241.57	1,141.25	68	2,256.27	875.72	241.17	1,139.37	131	2,257.82	876.66	241.35	1,139.81
6	2,258.16	876.74	240.78	1,140.64	69	2,259.88	876.94	240.56	1,142.37	132	2,258.59	876.49	241.46	1,140.64
7	2,259.30	877.12	240.88	1,141.30	70	2,258.70	876.88	241.21	1,140.61	133	2,256.75	876.18	240.63	1,139.94
8	2,258.45	876.46	241.11	1,140.89	71	2,259.36	876.55	241.14	1,141.67	134	2,257.60	876.43	240.96	1,140.21
9	2,260.52	877.86	241.03	1,141.63	72	2,256.77	875.91	240.42	1,140.43	135	2,257.12	876.35	241.09	1,139.68
10	2,257.70	876.17	241.07	1,140.45	73	2,257.61	876.67	240.92	1,140.03	136	2,256.51	876.36	240.80	1,139.35
11	2,258.14	876.58	241.55	1,140.00	74	2,259.59	876.78	240.68	1,142.13	137	2,257.55	876.42	241.01	1,140.12
12	2,256.03	875.98	241.92	1,138.14	75	2,258.58	876.26	241.08	1,141.24	138	2,258.87	876.82	241.15	1,140.90
13	2,257.97	876.70	240.88	1,140.39	76	2,260.11	876.99	241.40	1,141.72	139	2,258.90	876.69	241.33	1,140.88
14	2,258.99	876.92	241.45	1,140.63	77	2,258.27	876.69	241.56	1,140.02	140	2,258.92	877.04	241.67	1,140.22
15	2,260.49	876.15	241.25	1,143.09	78	2,257.55	877.09	241.04	1,139.43	141	2,255.31	876.05	241.13	1,138.13
16	2,257.59	876.49	241.88	1,139.22	79	2,256.16	875.50	241.30	1,139.36	142	2,257.06	876.49	240.97	1,139.59
17	2,257.11	876.51	241.08	1,139.52	80	2,256.62	876.20	240.79	1,139.63	143	2,259.71	876.54	241.06	1,142.10
18	2,256.99	875.77	241.05	1,140.17	81	2,258.19	876.20	241.14	1,140.85	144	2,258.46	877.01	241.27	1,140.17
19	2,258.42	876.54	241.04	1,140.84	82	2,258.07	876.72	241.65	1,139.70	145	2,258.52	876.38	240.79	1,141.36
20	2,256.55	875.81	241.55	1,139.19	83	2,257.36	877.25	240.68	1,139.43	146	2,257.30	876.35	241.29	1,139.65
21	2,258.08	876.73	241.25	1,140.11	84	2,256.71	876.39	240.72	1,139.60	147	2,259.99	877.68	241.23	1,141.09
22	2,258.10	876.33	240.80	1,140.97	85	2,255.98	876.14	240.96	1,138.87	148	2,257.07	877.16	241.14	1,138.77
23	2,256.91	876.57	240.78	1,139.56	86	2,255.66	875.37	241.39	1,138.91	149	2,259.41	876.43	241.09	1,141.89
24	2,257.73	876.28	240.70	1,140.76	87	2,258.75	876.42	240.90	1,141.43	150	2,257.15	876.72	240.36	1,140.07
25	2,256.29	876.43	240.54	1,139.32	88	2,256.38	876.46	241.33	1,138.59	151	2,256.27	876.36	241.06	1,138.86
26	2,256.77	876.65	241.15	1,138.97	89	2,258.28	876.54	241.04	1,140.71	152	2,256.62	876.10	241.41	1,139.11
27	2,259.11	875.97	241.13	1,142.01	90	2,259.64	877.80	241.03	1,140.81	153	2,257.20	876.70	240.89	1,139.60
28	2,256.58	875.99	240.81	1,139.78	91	2,258.04	877.06	241.07	1,139.91	154	2,257.83	876.73	241.15	1,139.95
29	2,258.43	876.48	240.84	1,141.11	92	2,257.83	876.02	241.00	1,140.81	155	2,255.66	876.89	240.87	1,137.91
30	2,257.33	876.00	241.25	1,140.08	93	2,257.62	876.43	241.04	1,140.16	156	2,257.94	876.50	241.38	1,140.06
31	2,259.14	876.96	241.41	1,140.78	94	2,258.35	876.69	240.92	1,140.74	157	2,257.00	876.48	240.52	1,140.00
32	2,249.48	873.19	240.19	1,136.10	95	2,257.70	876.91	240.63	1,140.17	158	2,255.42	876.54	241.21	1,137.68
33	2,239.59	869.12	240.02	1,130.44	96	2,257.84	876.00	241.29	1,140.55	159	2,256.25	875.94	240.67	1,139.65
34	2,283.42	886.71	243.48	1,153.22	97	2,257.72	876.84	241.34	1,139.55	160	2,256.87	876.87	241.03	1,138.98
35	2,256.20	876.27	240.93	1,139.00	98	2,259.91	876.53	241.51	1,141.87	161	2,262.04	877.38	241.50	1,143.16
36	2,257.93	877.10	240.69	1,140.13	99	2,258.12	875.74	241.40	1,140.98	162	2,257.23	876.44	241.18	1,139.61
37	2,260.42	877.25	241.55	1,141.62	100	2,258.24	876.82	241.18	1,140.24	163	2,259.40	876.50	241.44	1,141.46
38	2,256.69	876.48	241.37	1,138.85	101	2,257.96	875.85	241.21	1,140.90	164	2,258.27	876.48	240.91	1,140.87
39	2,257.22	876.57	240.91	1,139.74	102	2,259.08	876.54	241.56	1,140.98	165	2,259.76	876.23	240.77	1,142.77
40	2,258.78	876.04	241.69	1,141.05	103	2,258.95	876.85	241.19	1,140.91	166	2,257.69	876.35	241.44	1,139.90
41	2,258.14	876.95	241.16	1,140.03	104	2,258.61	876.43	241.82	1,140.36	167	2,257.06	876.65	241.12	1,139.29
42	2,258.52	877.29	240.95	1,140.29	105	2,259.04	876.51	240.95	1,141.58	168	2,258.32	876.81	241.21	1,140.30
43	2,258.54	876.60	241.11	1,140.83	106	2,259.63	876.95	241.08	1,141.60	169	2,258.02	876.52	240.95	1,140.55
44	2,258.76	876.87	240.95	1,140.93	107	2,257.04	875.90	241.06	1,140.08	170	2,258.78	876.32	240.98	1,141.48
45	2,257.12	876.64	240.94	1,139.55	108	2,257.37	876.88	241.42	1,139.08	171	2,258.51	876.28	241.56	1,140.67
46	2,258.59	876.19	240.91	1,141.49	109	2,258.62	877.51	240.99	1,140.12	172	2,258.54	876.55	241.66	1,140.32
47	2,257.44	876.47	240.99	1,139.98	110	2,256.92	876.46	240.78	1,139.68	173	2,259.91	876.87	241.27	1,141.78
48	2,256.94	877.04	241.27	1,138.63	111	2,256.79	876.27	241.38	1,139.14	174	2,259.02	876.79	241.24	1,140.99
49	2,258.02	876.74	241.48	1,139.81	112	2,257.20	876.19	241.11	1,139.91	175	2,259.92	877.21	241.80	1,140.91
50	2,258.47	877.30	240.83	1,140.35	113	2,258.01	877.07	241.57	1,139.37	176	2,256.45	875.78	241.81	1,138.87
51	2,257.35	876.76	241.63	1,138.96	114	2,258.79	876.76	241.34	1,140.69	177	2,258.20	876.39	241.12	1,140.69
52	2,257.21	876.95	240.57	1,139.68	115	2,260.23	876.97	241.21	1,142.04	178	2,256.42	877.06	241.11	1,138.25
53	2,256.61	876.00	241.09	1,139.51	116	2,257.20	876.58	241.40	1,139.22	179	2,257.56	876.25	241.11	1,140.19
54	2,258.32	876.53	241.02	1,140.78	117	2,259.28	876.50	241.30	1,141.48	180	2,258.10	876.23	240.97	1,140.91
55	2,257.17	876.42	240.94	1,139.81	118	2,259.12	876.33	241.41	1,141.37	181	2,259.04	876.32	241.73	1,140.99
56	2,257.81	876.67	241.09	1,140.05	119	2,257.16	876.92	240.88	1,139.35	182	2,257.44	876.97	241.09	1,139.38
57	2,256.52	876.52	240.60	1,139.41	120	2,257.85	876.99	241.03	1,139.83					
58	2,259.04	876.27	241.17	1,141.61	121	2,257.22	876.70	241.33	1,139.19					
59	2,260.31	876.92	241.33	1,142.06	122	2,257.50	876.04	241.28	1,140.18					
60	2,257.28	876.34	240.99	1,139.95	123	2,259.74	877.26	241.33	1,141.14					
61	2,258.27	876.14	240.95	1,141.18	124	2,260.27	877.05	241.73	1,141.49					
62	2,257.49	877.13	240.80	1,139.57	125	2,258.76	877.23	241.79	1,139.74					

Sustainability – Data Rate Distribution Graph

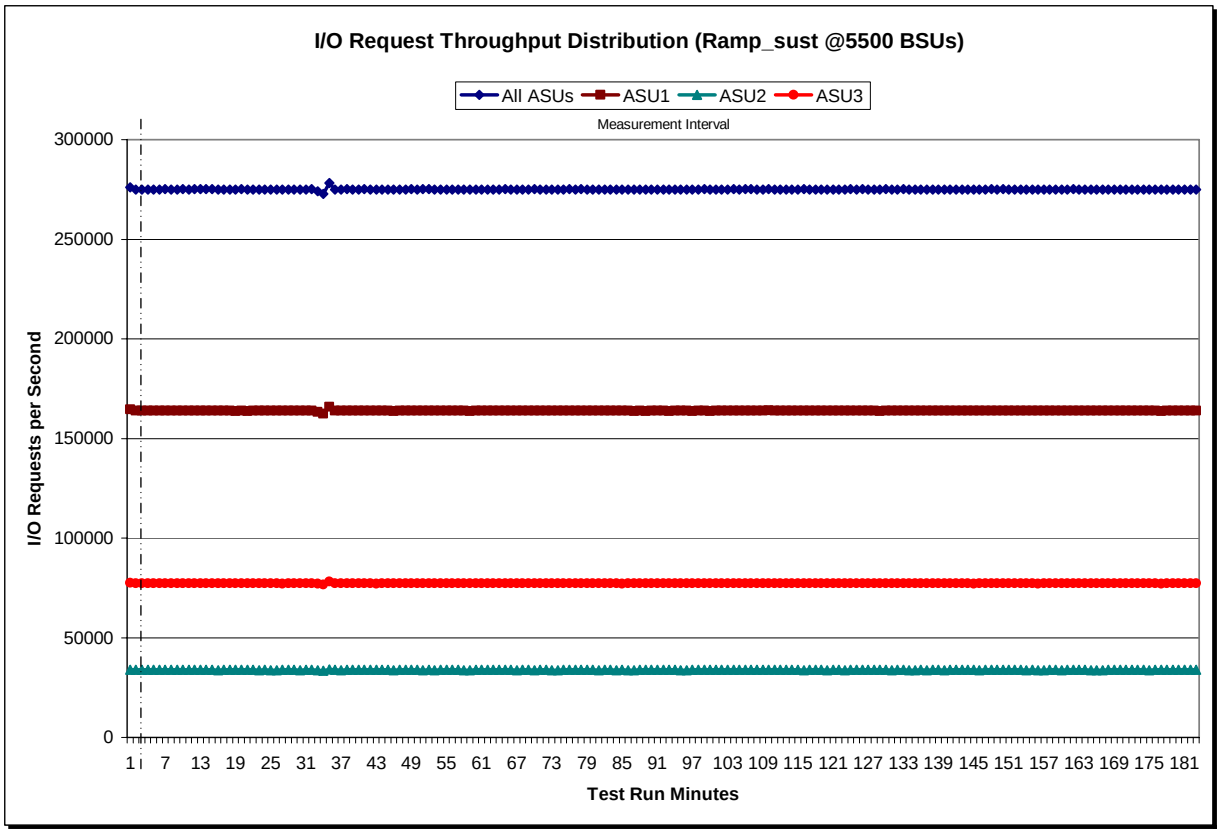


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	16:01:43	16:04:43	0-2	0:03:00
Measurement Interval	16:04:43	19:04:45	3-182	3:00:02

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	275,971.73	164,564.53	33,868.33	77,538.87	63	274,949.70	163,856.10	33,827.37	77,266.23	126	275,028.68	163,921.27	33,867.12	77,240.30
1	275,006.22	163,876.45	33,848.73	77,281.03	64	275,086.90	163,946.30	33,843.52	77,297.08	127	274,994.63	163,899.75	33,814.92	77,279.97
2	274,972.40	163,899.12	33,805.48	77,267.80	65	275,004.00	163,949.40	33,810.10	77,244.50	128	274,937.57	163,816.63	33,839.23	77,281.70
3	275,033.72	163,877.72	33,812.18	77,343.82	66	274,979.65	163,938.75	33,800.28	77,240.62	129	275,062.75	163,904.22	33,820.92	77,337.62
4	275,035.27	163,927.97	33,836.83	77,270.47	67	275,042.62	163,971.15	33,835.38	77,236.08	130	274,966.95	163,860.13	33,786.67	77,320.15
5	274,983.68	163,907.27	33,819.27	77,257.15	68	274,935.88	163,824.72	33,827.65	77,283.52	131	274,959.67	163,880.73	33,824.35	77,254.58
6	275,085.88	163,957.47	33,829.87	77,298.55	69	275,079.05	163,955.72	33,784.23	77,339.10	132	275,142.85	163,982.22	33,873.77	77,286.87
7	275,047.88	163,969.83	33,815.30	77,262.75	70	274,947.45	163,838.98	33,827.58	77,280.88	133	274,951.12	163,857.87	33,789.12	77,304.13
8	274,996.85	163,850.28	33,830.52	77,316.05	71	274,991.92	163,895.55	33,811.03	77,285.33	134	274,966.87	163,926.20	33,791.62	77,249.05
9	275,114.73	164,021.83	33,814.93	77,277.97	72	274,929.38	163,841.88	33,787.17	77,300.33	135	274,949.13	163,900.35	33,818.22	77,230.57
10	275,048.40	163,928.62	33,816.92	77,302.87	73	274,951.57	163,912.33	33,772.50	77,266.73	136	274,864.03	163,831.87	33,762.57	77,269.60
11	275,090.87	163,996.47	33,842.48	77,251.92	74	275,045.52	163,966.70	33,816.40	77,262.42	137	275,019.43	163,960.85	33,816.18	77,242.40
12	275,117.98	163,994.68	33,880.47	77,242.83	75	275,078.82	163,942.50	33,834.70	77,301.62	138	275,050.88	163,921.78	33,850.10	77,279.00
13	275,054.13	163,911.78	33,828.80	77,313.55	76	275,047.18	163,912.27	33,818.68	77,316.23	139	275,036.05	163,918.78	33,775.67	77,341.60
14	275,062.88	163,946.55	33,813.67	77,302.67	77	275,135.08	163,955.58	33,868.63	77,310.87	140	275,046.43	163,913.87	33,877.02	77,255.55
15	274,982.52	163,830.67	33,799.63	77,352.22	78	274,976.22	163,901.95	33,823.70	77,250.57	141	274,989.52	163,848.27	33,856.63	77,284.62
16	274,993.43	163,886.03	33,875.60	77,231.80	79	274,956.07	163,838.07	33,856.90	77,261.10	142	274,995.63	163,884.38	33,824.00	77,287.25
17	274,988.85	163,896.67	33,809.77	77,282.42	80	274,976.58	163,892.93	33,780.77	77,302.88	143	275,024.17	163,902.50	33,842.18	77,279.48
18	274,916.67	163,806.73	33,809.37	77,300.57	81	274,941.38	163,868.15	33,803.27	77,269.97	144	275,010.83	163,944.50	33,854.78	77,211.55
19	275,118.12	163,977.62	33,804.73	77,335.77	82	275,004.07	163,906.93	33,843.27	77,253.87	145	274,983.50	163,922.68	33,781.68	77,279.13
20	274,946.02	163,787.63	33,870.70	77,287.68	83	274,994.60	163,964.65	33,794.10	77,235.85	146	275,037.98	163,904.63	33,827.37	77,305.98
21	275,042.18	163,928.63	33,829.55	77,284.00	84	274,884.42	163,847.90	33,824.82	77,211.70	147	275,130.17	163,994.65	33,833.57	77,301.95
22	274,876.75	163,832.47	33,783.48	77,260.80	85	274,883.65	163,834.58	33,797.53	77,251.53	148	274,978.87	163,911.40	33,824.90	77,242.57
23	274,959.53	163,909.10	33,813.45	77,236.98	86	274,843.72	163,805.47	33,795.88	77,242.37	149	275,095.72	163,968.58	33,849.98	77,277.15
24	274,917.98	163,847.42	33,784.17	77,286.40	87	275,009.70	163,873.23	33,824.45	77,312.02	150	275,046.73	163,970.80	33,811.48	77,264.45
25	274,988.37	163,866.95	33,786.43	77,334.98	88	274,875.32	163,809.30	33,840.20	77,225.82	151	274,940.27	163,901.25	33,814.23	77,224.78
26	274,932.88	163,920.55	33,814.13	77,198.20	89	274,939.02	163,848.02	33,820.30	77,270.70	152	275,025.53	163,919.40	33,802.47	77,303.67
27	274,973.20	163,841.82	33,824.33	77,307.05	90	274,990.52	163,941.45	33,804.30	77,244.77	153	274,965.67	163,924.85	33,784.53	77,256.28
28	274,953.60	163,869.53	33,825.13	77,258.93	91	274,974.35	163,945.70	33,810.58	77,218.07	154	274,954.75	163,890.37	33,824.73	77,239.65
29	274,955.87	163,834.72	33,781.68	77,339.47	92	274,873.53	163,779.32	33,807.58	77,286.63	155	274,955.93	163,954.37	33,791.18	77,210.38
30	274,961.02	163,901.30	33,834.67	77,225.05	93	275,034.55	163,929.15	33,817.02	77,288.38	156	274,943.12	163,877.57	33,778.72	77,286.83
31	275,055.38	163,941.40	33,836.18	77,277.80	94	275,021.60	163,921.83	33,794.42	77,305.35	157	274,931.50	163,854.22	33,803.90	77,273.38
32	274,078.58	163,363.68	33,690.45	77,024.45	95	274,939.23	163,886.70	33,781.42	77,271.12	158	274,973.17	163,909.33	33,837.03	77,226.80
33	272,707.57	162,512.97	33,580.32	76,614.28	96	274,847.05	163,775.15	33,822.35	77,249.55	159	274,959.30	163,864.40	33,793.07	77,301.83
34	278,145.52	165,784.32	34,178.78	78,182.42	97	275,045.40	163,961.40	33,833.33	77,250.67	160	275,027.85	163,969.07	33,826.77	77,232.02
35	275,034.05	163,944.22	33,817.00	77,272.83	98	275,117.22	163,961.03	33,840.33	77,315.85	161	275,102.07	163,886.17	33,867.32	77,348.58
36	274,974.58	163,931.73	33,778.33	77,264.52	99	274,945.48	163,820.30	33,840.07	77,285.12	162	275,004.12	163,906.53	33,841.38	77,256.20
37	275,063.08	163,943.65	33,866.65	77,252.78	100	275,023.13	163,906.20	33,853.25	77,263.68	163	275,018.73	163,863.28	33,827.85	77,327.60
38	275,029.55	163,919.72	33,840.23	77,269.60	101	274,924.02	163,854.22	33,818.42	77,251.38	164	274,995.07	163,904.55	33,790.75	77,299.77
39	275,026.13	163,925.43	33,830.80	77,269.90	102	274,939.52	163,861.17	33,824.85	77,253.50	165	274,889.43	163,829.18	33,791.27	77,268.98
40	275,086.40	163,892.50	33,875.17	77,318.73	103	275,057.05	163,905.10	33,851.82	77,300.13	166	274,947.42	163,904.13	33,798.57	77,244.72
41	274,988.22	163,920.97	33,829.72	77,237.53	104	275,018.92	163,881.02	33,874.32	77,263.58	167	275,006.72	163,932.68	33,810.13	77,263.90
42	274,959.48	163,937.85	33,845.72	77,175.92	105	275,055.60	163,931.90	33,849.75	77,273.95	168	275,051.57	163,921.90	33,848.45	77,281.22
43	274,996.23	163,920.05	33,831.25	77,244.93	106	275,093.85	163,968.95	33,828.93	77,295.97	169	275,053.85	163,904.78	33,853.32	77,295.75
44	275,046.20	163,914.07	33,852.85	77,279.28	107	274,886.52	163,824.00	33,809.78	77,252.73	170	275,004.43	163,869.07	33,823.35	77,312.02
45	274,865.70	163,801.80	33,794.93	77,268.97	108	275,023.08	163,930.80	33,861.87	77,230.42	171	275,013.22	163,888.93	33,855.43	77,268.85
46	274,999.53	163,887.60	33,802.13	77,309.80	109	275,170.30	164,041.02	33,823.83	77,305.45	172	275,037.90	163,899.35	33,860.38	77,278.17
47	275,028.52	163,899.10	33,835.02	77,294.40	110	274,929.63	163,887.15	33,804.35	77,238.13	173	275,033.02	163,917.87	33,853.25	77,261.90
48	275,097.13	163,977.68	33,816.42	77,303.03	111	274,967.93	163,880.10	33,815.60	77,272.23	174	274,970.12	163,912.10	33,790.25	77,267.77
49	274,980.98	163,926.73	33,816.50	77,237.75	112	275,009.77	163,904.50	33,824.95	77,280.32	175	275,036.53	163,906.43	33,869.92	77,260.18
50	275,072.73	163,996.23	33,782.52	77,293.98	113	274,963.40	163,903.05	33,844.42	77,215.93	176	274,874.92	163,803.23	33,860.03	77,211.65
51	275,098.53	163,952.48	33,828.88	77,317.17	114	274,982.83	163,920.10	33,816.22	77,246.52	177	275,033.00	163,899.32	33,827.63	77,306.05
52	274,999.90	163,974.33	33,798.55	77,227.02	115	275,080.38	163,962.50	33,792.25	77,325.63	178	275,026.15	163,994.32	33,810.82	77,221.02
53	274,975.77	163,860.62	33,828.53	77,286.62	116	274,971.03	163,879.78	33,820.63	77,270.62	179	274,959.68	163,904.92	33,809.73	77,245.03
54	275,048.80	163,917.85	33,828.17	77,302.78	117	274,964.68	163,873.57	33,839.45	77,251.67	180	275,039.85	163,891.55	33,836.85	77,311.45
55	274,989.02	163,922.88	33,816.73	77,249.40	118	275,012.97	163,919.90	33,822.03	77,271.03	181	274,951.72	163,862.28	33,851.35	77,238.08
56	274,951.25	163,879.78	33,833.70	77,237.77	119	275,028.17	163,949.48	33,794.63	77,284.05	182	275,037.20	163,892.50	33,847.98	77,296.72
57	274,893.10	163,861.47	33,796.10	77,235.53	120	274,962.30	163,887.45	33,820.67	77,254.18	Average	274,998.97	163,902.92	33,822.57	77,273.48
58	274,919.12	163,780.67	33,798.50	77,339.95	121	275,051.53	163,919.18	33,839.88	77,292.47					
59	274,999.42	163,882.85	33,840.62	77,275.95	122	275,017.18	163,942.05	33,776.37	77,298.77					
60	274,957.00	163,839.32	33,831.68	77,286.00	123	275,148.57	163,994.20	33,849.72	77,304.65					
61	274,911.75	163,832.02	33,810.90	77,268.83	124	275,008.10	163,921.12	33,807.10	77,279.88					
62	274,962.93	163,874.08	33,807.52	77,281.33	125	275,090.20	163,998.03	33,870.08	77,222.08					

Sustainability – I/O Request Throughput Distribution Graph

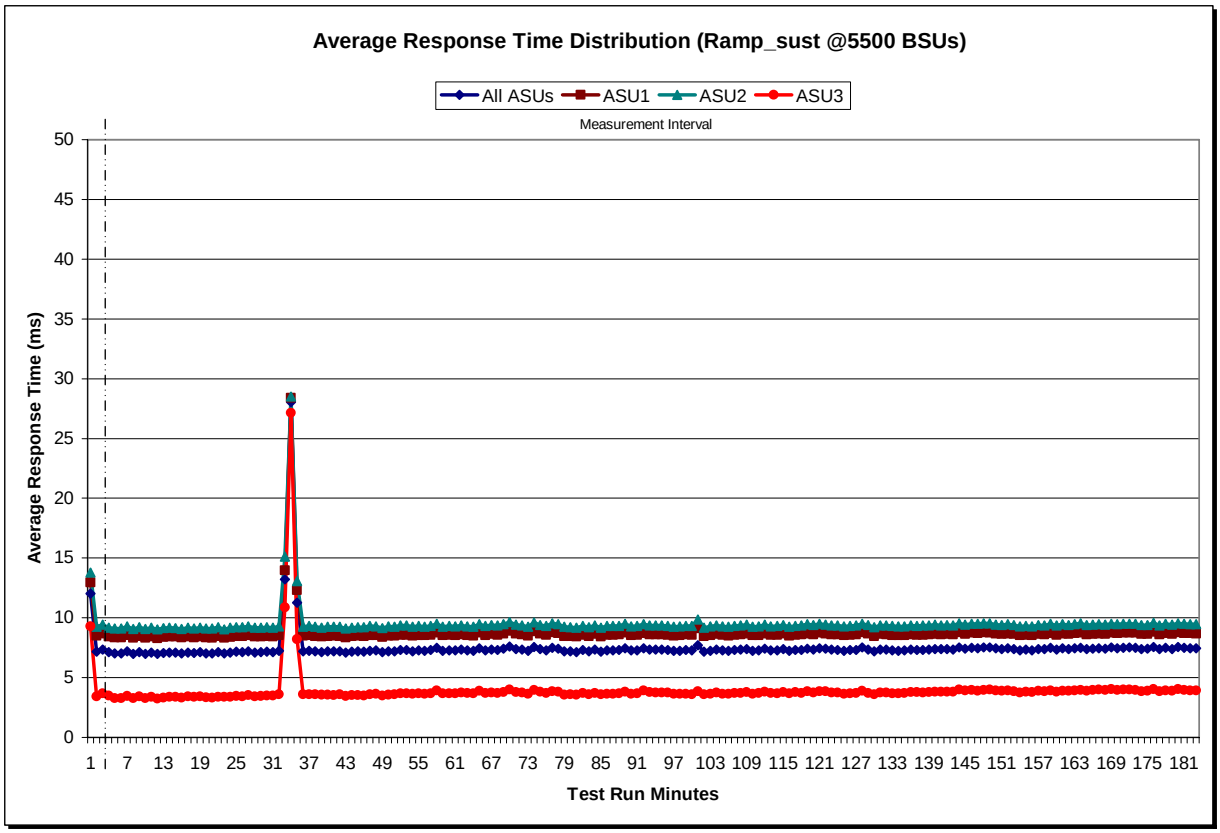


Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	16:01:43	16:04:43	0-2	0:03:00
Measurement Interval	16:04:43	19:04:45	3-182	3:00:02

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	12.02	12.94	13.77	9.30	63	7.23	8.50	9.26	3.66	126	7.32	8.59	9.36	3.72
1	7.16	8.50	9.24	3.42	64	7.46	8.74	9.48	3.87	127	7.51	8.80	9.51	3.90
2	7.35	8.67	9.43	3.66	65	7.27	8.54	9.31	3.69	128	7.36	8.66	9.41	3.71
3	7.12	8.41	9.16	3.50	66	7.35	8.63	9.38	3.76	129	7.19	8.46	9.23	3.59
4	7.02	8.35	9.10	3.29	67	7.31	8.58	9.35	3.71	130	7.34	8.62	9.35	3.73
5	7.02	8.36	9.10	3.29	68	7.41	8.69	9.46	3.78	131	7.33	8.59	9.36	3.75
6	7.21	8.55	9.28	3.47	69	7.61	8.89	9.66	3.99	132	7.27	8.54	9.32	3.68
7	6.99	8.31	9.07	3.29	70	7.39	8.67	9.44	3.76	133	7.25	8.52	9.28	3.66
8	7.14	8.48	9.21	3.42	71	7.33	8.61	9.37	3.75	134	7.26	8.53	9.29	3.70
9	6.99	8.31	9.07	3.29	72	7.24	8.51	9.26	3.65	135	7.34	8.59	9.35	3.78
10	7.09	8.41	9.18	3.37	73	7.57	8.85	9.63	3.97	136	7.31	8.56	9.32	3.78
11	6.97	8.29	9.05	3.25	74	7.39	8.67	9.41	3.80	137	7.32	8.58	9.35	3.76
12	7.05	8.39	9.13	3.31	75	7.29	8.56	9.33	3.70	138	7.34	8.61	9.36	3.78
13	7.10	8.43	9.18	3.38	76	7.49	8.79	9.54	3.84	139	7.38	8.64	9.42	3.82
14	7.09	8.41	9.15	3.37	77	7.42	8.70	9.45	3.81	140	7.36	8.62	9.37	3.82
15	7.02	8.35	9.09	3.30	78	7.18	8.47	9.24	3.55	141	7.38	8.64	9.40	3.83
16	7.11	8.42	9.17	3.40	79	7.19	8.46	9.22	3.61	142	7.35	8.60	9.37	3.82
17	7.05	8.36	9.10	3.37	80	7.14	8.42	9.17	3.55	143	7.54	8.78	9.55	4.01
18	7.12	8.43	9.18	3.42	81	7.29	8.57	9.31	3.69	144	7.41	8.65	9.42	3.92
19	7.04	8.36	9.10	3.34	82	7.19	8.46	9.23	3.61	145	7.49	8.74	9.51	3.95
20	7.02	8.33	9.10	3.32	83	7.34	8.63	9.37	3.71	146	7.45	8.71	9.49	3.90
21	7.13	8.46	9.23	3.40	84	7.17	8.43	9.20	3.59	147	7.53	8.79	9.56	3.98
22	7.02	8.32	9.05	3.37	85	7.28	8.57	9.33	3.65	148	7.52	8.76	9.53	4.01
23	7.08	8.40	9.16	3.38	86	7.27	8.56	9.32	3.63	149	7.43	8.68	9.44	3.92
24	7.15	8.46	9.21	3.46	87	7.30	8.59	9.34	3.66	150	7.39	8.64	9.40	3.87
25	7.13	8.45	9.20	3.43	88	7.46	8.76	9.50	3.80	151	7.44	8.68	9.46	3.92
26	7.22	8.52	9.27	3.54	89	7.26	8.55	9.30	3.65	152	7.39	8.64	9.41	3.85
27	7.10	8.41	9.17	3.41	90	7.28	8.56	9.32	3.68	153	7.28	8.53	9.28	3.74
28	7.12	8.41	9.18	3.46	91	7.47	8.72	9.48	3.93	154	7.33	8.57	9.33	3.82
29	7.15	8.44	9.20	3.50	92	7.35	8.62	9.37	3.77	155	7.29	8.52	9.29	3.79
30	7.12	8.41	9.17	3.48	93	7.33	8.60	9.36	3.75	156	7.39	8.65	9.39	3.87
31	7.24	8.52	9.30	3.61	94	7.34	8.62	9.37	3.75	157	7.37	8.61	9.37	3.87
32	13.23	13.96	15.11	10.85	95	7.31	8.57	9.32	3.74	158	7.47	8.72	9.50	3.93
33	28.06	28.40	28.50	27.15	96	7.22	8.50	9.25	3.63	159	7.34	8.58	9.35	3.83
34	11.26	12.32	13.07	8.22	97	7.25	8.53	9.28	3.65	160	7.44	8.68	9.47	3.90
35	7.21	8.50	9.25	3.59	98	7.29	8.59	9.34	3.65	161	7.39	8.63	9.41	3.90
36	7.25	8.54	9.31	3.62	99	7.26	8.55	9.32	3.61	162	7.46	8.72	9.47	3.91
37	7.20	8.47	9.25	3.59	100	7.71	9.09	9.86	3.84	163	7.50	8.75	9.52	3.95
38	7.14	8.41	9.17	3.55	101	7.18	8.45	9.19	3.59	164	7.38	8.61	9.38	3.90
39	7.19	8.48	9.24	3.57	102	7.25	8.54	9.27	3.62	165	7.43	8.65	9.43	3.95
40	7.19	8.48	9.25	3.54	103	7.34	8.63	9.36	3.73	166	7.46	8.68	9.46	4.00
41	7.20	8.48	9.25	3.59	104	7.27	8.56	9.29	3.64	167	7.43	8.66	9.42	3.97
42	7.08	8.36	9.12	3.46	105	7.22	8.51	9.24	3.62	168	7.52	8.75	9.52	4.03
43	7.15	8.44	9.19	3.51	106	7.30	8.58	9.32	3.71	169	7.47	8.71	9.45	3.95
44	7.18	8.48	9.22	3.54	107	7.33	8.62	9.38	3.69	170	7.51	8.75	9.51	3.99
45	7.15	8.45	9.21	3.49	108	7.38	8.66	9.42	3.76	171	7.52	8.77	9.52	4.00
46	7.24	8.54	9.32	3.59	109	7.24	8.52	9.24	3.64	172	7.49	8.74	9.50	3.96
47	7.26	8.54	9.29	3.65	110	7.28	8.55	9.29	3.70	173	7.38	8.64	9.39	3.84
48	7.11	8.39	9.15	3.50	111	7.41	8.68	9.43	3.83	174	7.40	8.65	9.38	3.89
49	7.22	8.50	9.27	3.58	112	7.28	8.55	9.30	3.71	175	7.57	8.82	9.58	4.04
50	7.21	8.48	9.26	3.60	113	7.28	8.56	9.32	3.67	176	7.36	8.61	9.36	3.85
51	7.30	8.58	9.35	3.68	114	7.38	8.66	9.41	3.77	177	7.47	8.72	9.50	3.93
52	7.30	8.58	9.35	3.68	115	7.22	8.48	9.25	3.66	178	7.39	8.62	9.41	3.90
53	7.22	8.49	9.25	3.63	116	7.32	8.57	9.34	3.77	179	7.54	8.78	9.55	4.03
54	7.27	8.55	9.31	3.68	117	7.32	8.60	9.35	3.72	180	7.48	8.73	9.49	3.94
55	7.24	8.52	9.26	3.65	118	7.42	8.68	9.48	3.85	181	7.45	8.69	9.47	3.92
56	7.29	8.57	9.34	3.68	119	7.34	8.62	9.38	3.74	182	7.44	8.68	9.46	3.93
57	7.47	8.74	9.50	3.91	120	7.47	8.75	9.50	3.86	Average	7.47	8.73	9.49	3.89
58	7.25	8.52	9.27	3.67	121	7.41	8.67	9.43	3.84					
59	7.27	8.55	9.33	3.66	122	7.33	8.60	9.37	3.76					
60	7.26	8.54	9.29	3.66	123	7.32	8.60	9.35	3.74					
61	7.33	8.60	9.36	3.73	124	7.25	8.54	9.30	3.63					
62	7.26	8.53	9.28	3.70	125	7.29	8.57	9.33	3.68					

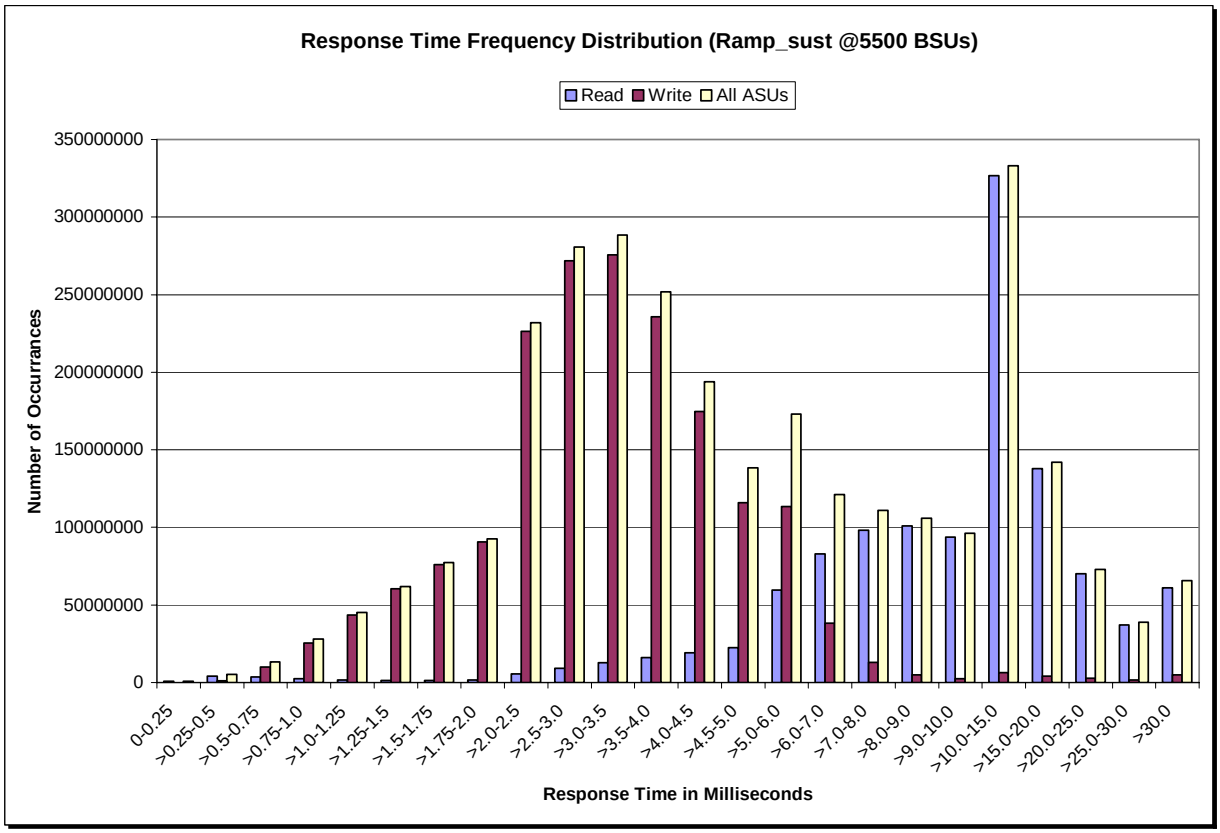
Sustainability – Average Response Time (ms) Distribution Graph



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	780,282	4,188,015	3,496,645	2,381,075	1,686,826	1,386,587	1,438,120	1,791,436
Write	1	1,148,508	9,907,587	25,640,130	43,602,513	60,473,564	75,868,264	90,765,544
All ASUs	780,283	5,336,523	13,404,232	28,021,205	45,289,339	61,860,151	77,306,384	92,556,980
ASU1	725,000	4,532,714	8,366,840	14,958,561	22,756,306	30,215,693	37,218,686	44,267,210
ASU2	55,282	441,393	1,454,489	3,192,961	5,157,491	6,985,153	8,669,853	10,345,704
ASU3	1	362,416	3,582,903	9,869,683	17,375,542	24,659,305	31,417,845	37,944,066
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	5,531,213	9,033,657	12,812,318	16,195,663	19,176,896	22,535,083	59,754,551	82,914,846
Write	226,201,987	271,691,385	275,683,981	235,747,225	174,661,257	115,949,448	113,422,624	38,221,492
All ASUs	231,733,200	280,725,042	288,496,299	251,942,888	193,838,153	138,484,531	173,177,175	121,136,338
ASU1	110,246,420	132,428,139	134,229,650	115,269,588	87,816,091	63,915,191	91,759,309	84,828,143
ASU2	25,873,079	31,106,735	31,354,990	26,528,165	19,463,824	13,044,456	14,938,771	11,026,161
ASU3	95,613,701	117,190,168	122,911,659	110,145,135	86,558,238	61,524,884	66,479,095	25,282,034
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	98,105,112	100,960,574	93,808,723	326,706,906	137,796,978	70,174,417	37,179,560	60,886,867
Write	12,917,601	5,038,259	2,563,587	6,301,656	4,184,965	2,635,577	1,695,437	4,941,909
All ASUs	111,022,713	105,998,833	96,372,310	333,008,562	141,981,943	72,809,994	38,874,997	65,828,776
ASU1	89,817,176	89,090,833	81,228,885	278,404,741	114,746,229	56,931,328	29,438,348	46,959,026
ASU2	12,145,569	13,470,518	13,571,342	51,452,199	25,279,148	14,636,172	8,603,130	16,486,872
ASU3	9,059,968	3,437,482	1,572,083	3,151,622	1,956,566	1,242,494	833,519	2,382,878

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 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.001	0.000	0.001	0.00	0.002	0.001	0.001	0.000

Primary Metrics Test – IOPS Test Phase

Clause 5.4.2.2

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 9.2.4.7.2

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 71.

IOPS Test Results File

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

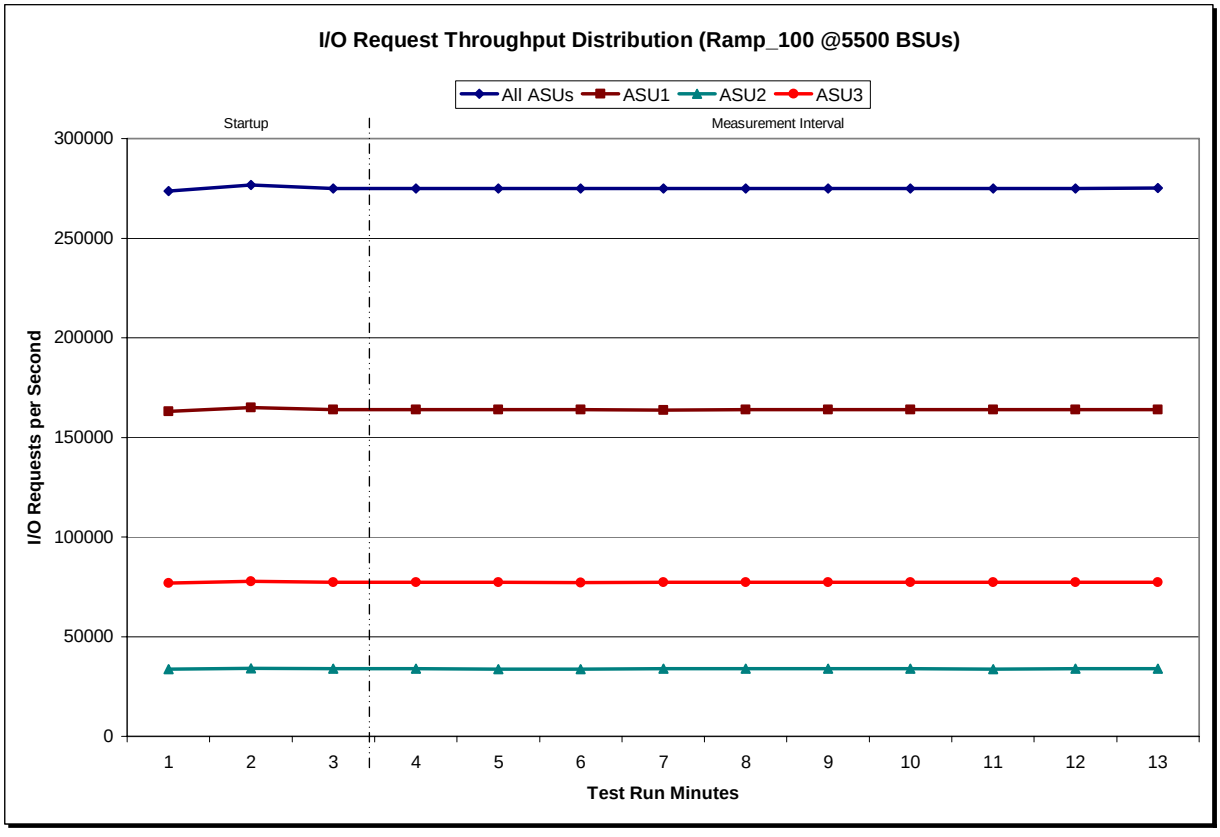
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

5500 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:10:07	19:13:08	0-2	0:03:01
Measurement Interval	19:13:08	19:23:11	3-12	0:10:03

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	273,574.13	163,051.48	33,665.45	76,857.20
1	276,632.50	164,905.65	34,018.43	77,708.42
2	274,906.02	163,827.77	33,804.57	77,273.68
3	275,028.62	163,948.77	33,811.40	77,268.45
4	274,927.40	163,894.33	33,788.12	77,244.95
5	274,953.03	163,956.22	33,785.68	77,211.13
6	274,937.10	163,819.37	33,828.08	77,289.65
7	275,024.70	163,893.15	33,812.10	77,319.45
8	275,030.32	163,943.08	33,816.60	77,270.63
9	274,952.15	163,908.30	33,813.87	77,229.98
10	275,004.37	163,911.85	33,797.52	77,295.00
11	275,044.08	163,951.13	33,838.33	77,254.62
12	275,074.07	163,954.60	33,846.60	77,272.87
Average	274,997.58	163,918.08	33,813.83	77,265.67

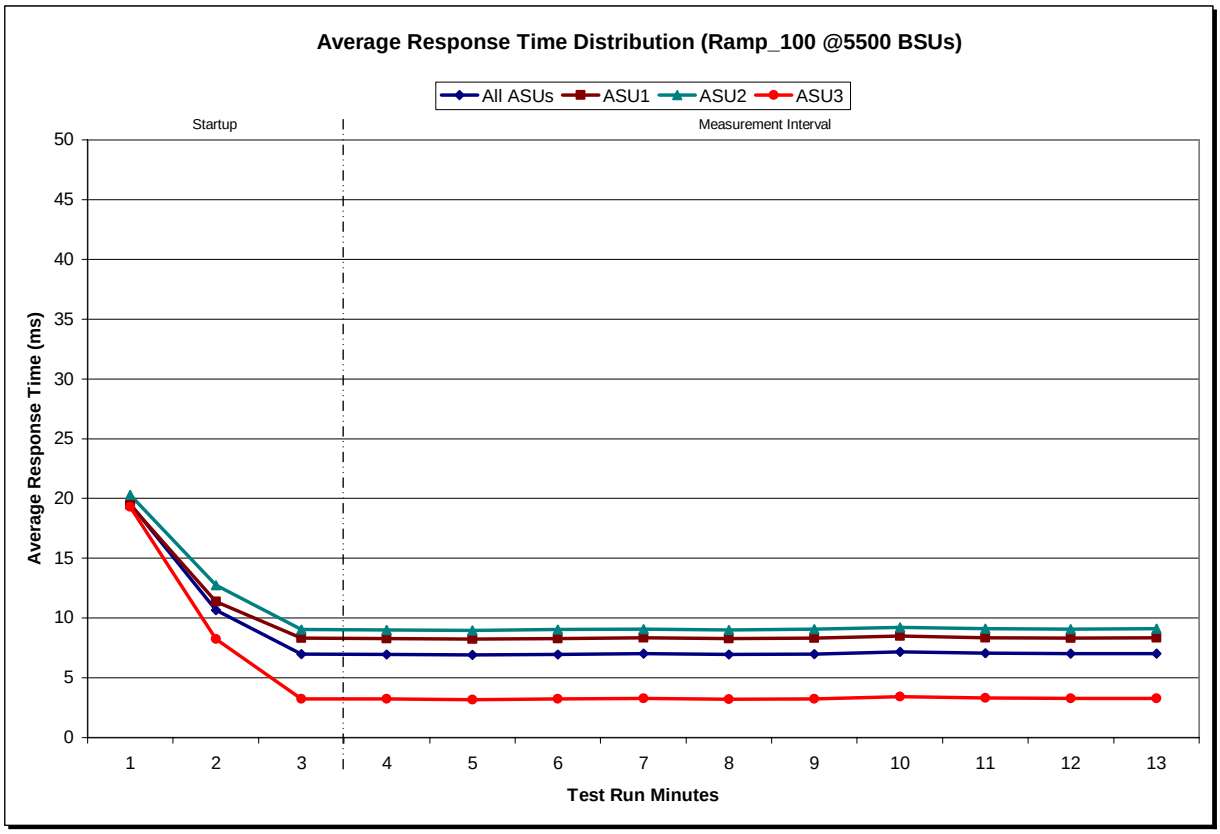
IOPS Test Run – I/O Request Throughput Distribution Graph



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

5500 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:10:07	19:13:08	0-2	0:03:01
Measurement Interval	19:13:08	19:23:11	3-12	0:10:03
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	19.54	19.49	20.31	19.31
1	10.67	11.39	12.74	8.25
2	6.98	8.32	9.04	3.24
3	6.95	8.28	9.02	3.22
4	6.90	8.23	8.97	3.17
5	6.96	8.29	9.04	3.23
6	7.01	8.34	9.08	3.28
7	6.93	8.27	9.01	3.19
8	6.99	8.32	9.06	3.25
9	7.15	8.48	9.21	3.41
10	7.04	8.37	9.09	3.32
11	7.00	8.33	9.08	3.29
12	7.02	8.34	9.11	3.29
Average	6.99	8.32	9.07	3.27

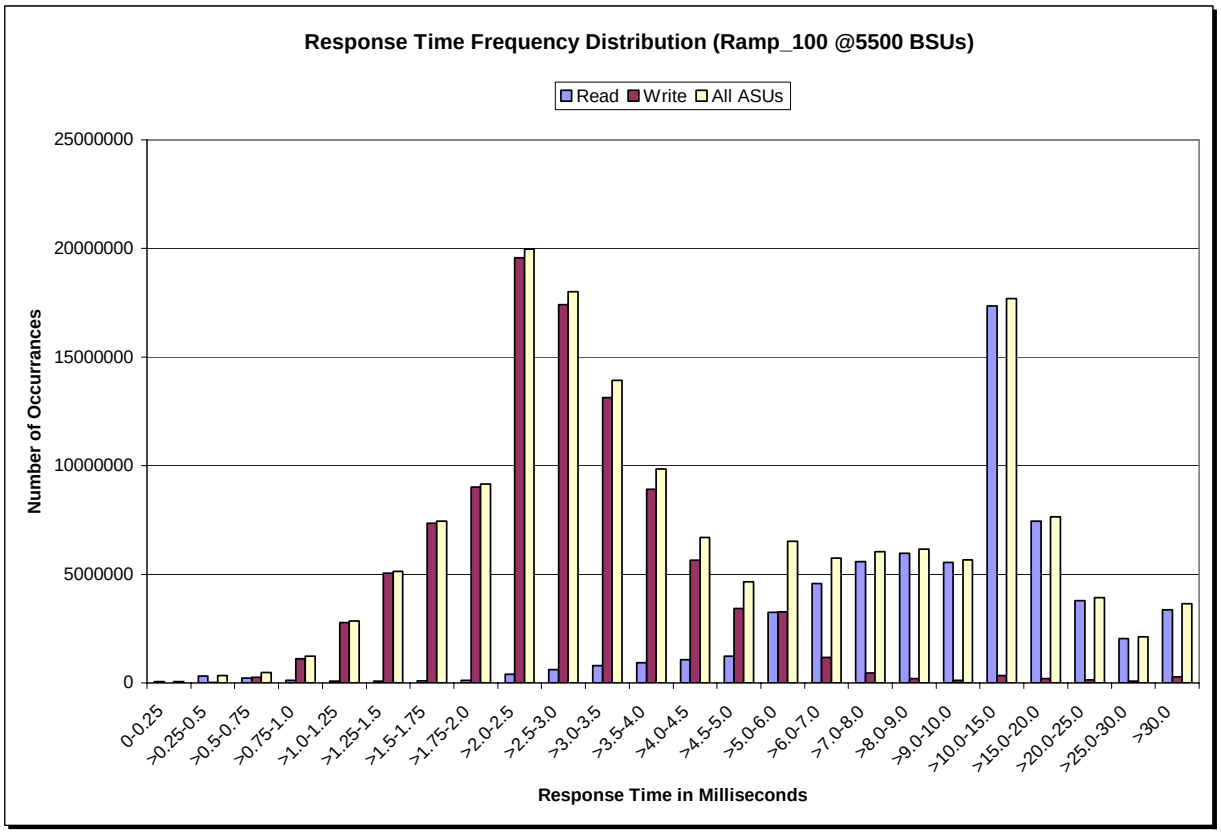
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	55778	316,247	216,470	119,370	78,651	72,855	90,975	125,704
Write	0	18,228	265,108	1,112,167	2,775,918	5,061,353	7,349,713	9,021,255
All ASUs	55778	334,475	481,578	1,231,537	2,854,569	5,134,208	7,440,688	9,146,959
ASU1	51875	304,700	340,648	676,534	1,453,179	2,540,189	3,610,559	4,359,304
ASU2	3903	24,142	47,920	143,370	335,322	595,733	849,923	1,025,651
ASU3	0	5,633	93,010	411,633	1,066,068	1,998,286	2,980,206	3,762,004
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	396,273	606,824	792,545	935,479	1,062,399	1,226,474	3,249,330	4,574,109
Write	19,578,291	17,405,270	13,132,926	8,914,946	5,641,023	3,431,705	3,268,622	1,177,812
All ASUs	19,974,564	18,012,094	13,925,471	9,850,425	6,703,422	4,658,179	6,517,952	5,751,921
ASU1	9,303,751	8,163,920	6,187,914	4,352,041	3,036,115	2,283,227	3,948,528	4,418,358
ASU2	2,184,288	1,907,002	1,430,183	979,422	638,522	420,902	560,695	549,041
ASU3	8,486,525	7,941,172	6,307,374	4,518,962	3,028,785	1,954,050	2,008,729	784,522
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	5,591,594	5,961,621	5,551,130	17,356,526	7,453,269	3,777,681	2,035,283	3,371,986
Write	453,805	207,252	121,862	335,622	202,530	141,420	86,429	274,921
All ASUs	6,045,399	6,168,873	5,672,992	17,692,148	7,655,799	3,919,101	2,121,712	3,646,907
ASU1	5,054,180	5,237,195	4,790,085	14,766,894	6,192,321	3,061,803	1,610,115	2,606,137
ASU2	680,510	797,350	812,647	2,762,001	1,369,270	790,827	469,378	910,027
ASU3	310,709	134,328	70,260	163,253	94,208	66,471	42,219	130,743

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
164,996,751	161,349,844	3,646,907

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 5.1.0 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	0.002	0.000	0.001	0.000	0.001	0.001	0.001	0.000

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.2.3

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 9.2.4.7.3

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 71.

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 - 5500 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:10:07	19:13:08	0-2	0:03:01
Measurement Interval	19:13:08	19:23:11	3-12	0:10:03

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	273,574.13	163,051.48	33,665.45	76,857.20
1	276,632.50	164,905.65	34,018.43	77,708.42
2	274,906.02	163,827.77	33,804.57	77,273.68
3	275,028.62	163,948.77	33,811.40	77,268.45
4	274,927.40	163,894.33	33,788.12	77,244.95
5	274,953.03	163,956.22	33,785.68	77,211.13
6	274,937.10	163,819.37	33,828.08	77,289.65
7	275,024.70	163,893.15	33,812.10	77,319.45
8	275,030.32	163,943.08	33,816.60	77,270.63
9	274,952.15	163,908.30	33,813.87	77,229.98
10	275,004.37	163,911.85	33,797.52	77,295.00
11	275,044.08	163,951.13	33,838.33	77,254.62
12	275,074.07	163,954.60	33,846.60	77,272.87
Average	274,997.58	163,918.08	33,813.83	77,265.67

95% Load Level - 5225 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:27:03	19:30:04	0-2	0:03:01
Measurement Interval	19:30:04	19:40:07	10.1	0:10:03

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	261,490.75	155,848.47	32,147.87	73,494.42
1	261,266.75	155,731.98	32,144.85	73,389.92
2	261,272.60	155,699.28	32,165.55	73,407.77
3	261,152.70	155,656.75	32,146.67	73,349.28
4	261,390.73	155,784.57	32,179.13	73,427.03
5	261,099.68	155,617.02	32,133.53	73,349.13
6	261,238.05	155,701.35	32,167.62	73,369.08
7	261,110.28	155,601.20	32,109.98	73,399.10
8	261,313.10	155,743.90	32,163.15	73,406.05
9	261,160.87	155,606.87	32,111.17	73,442.83
10	261,154.77	155,669.70	32,114.10	73,370.97
11	261,189.68	155,697.40	32,138.23	73,354.05
12	261,267.12	155,669.95	32,150.20	73,446.97
Average	261,207.70	155,674.87	32,141.38	73,391.45

90% Load Level - 4950 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:46:48	19:49:46	0-2	0:02:58
Measurement Interval	19:49:46	19:59:48	3-12	0:10:02

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	247,733.52	147,670.38	30,456.13	69,607.00
1	247,536.18	147,552.22	30,430.03	69,553.93
2	247,452.50	147,463.68	30,468.32	69,520.50
3	247,545.87	147,517.55	30,457.07	69,571.25
4	247,441.60	147,407.22	30,446.92	69,587.47
5	247,459.60	147,490.57	30,415.83	69,553.20
6	247,432.80	147,478.85	30,434.95	69,519.00
7	247,480.52	147,491.37	30,469.17	69,519.98
8	247,417.57	147,429.77	30,447.83	69,539.97
9	247,594.43	147,570.37	30,426.52	69,597.55
10	247,520.37	147,580.63	30,407.43	69,532.30
11	247,414.78	147,456.12	30,413.65	69,545.02
12	247,379.82	147,442.85	30,422.62	69,514.35
Average	247,468.74	147,486.53	30,434.20	69,548.01

80% Load Level - 4400 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:09:44	20:12:45	0-2	0:03:01
Measurement Interval	20:12:45	20:22:47	3-12	0:10:02

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	220,155.58	131,181.40	27,057.87	61,916.32
1	220,039.23	131,105.05	27,092.65	61,841.53
2	220,025.48	131,137.18	27,061.38	61,826.92
3	219,949.78	131,081.23	27,046.78	61,821.77
4	220,028.18	131,194.93	27,050.87	61,782.38
5	220,015.00	131,137.55	27,072.37	61,805.08
6	219,972.85	131,097.33	27,077.65	61,797.87
7	220,051.33	131,174.67	27,046.52	61,830.15
8	219,949.38	131,054.03	27,063.25	61,832.10
9	220,030.27	131,111.32	27,097.07	61,821.88
10	220,098.65	131,188.65	27,047.38	61,862.62
11	219,996.68	131,137.27	27,061.17	61,798.25
12	220,081.07	131,211.93	27,035.40	61,833.73
Average	220,017.32	131,138.89	27,059.85	61,818.58

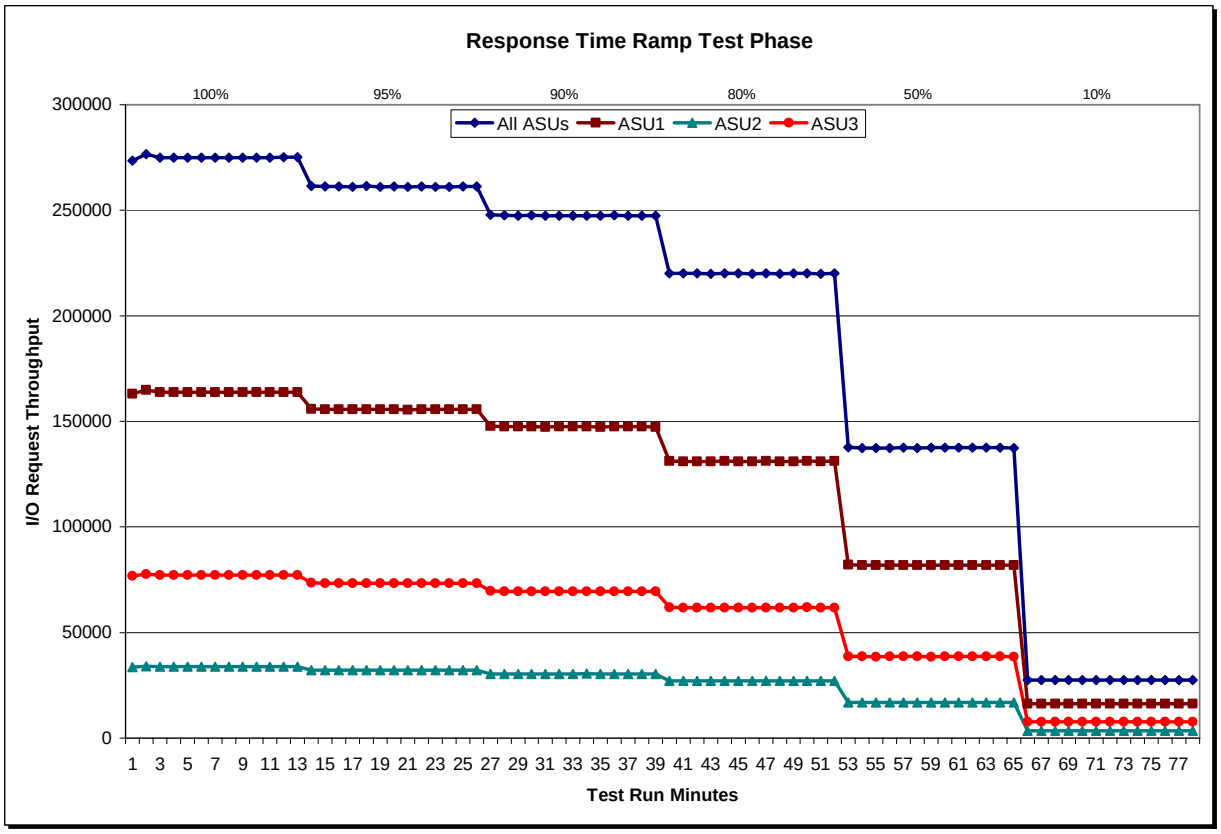
50% Load Level - 2750 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:33:14	20:36:15	0-2	0:03:01
Measurement Interval	20:36:15	20:46:16	3-12	0:10:01

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	137,708.68	82,089.58	16,924.87	38,694.23
1	137,456.98	81,910.20	16,900.40	38,646.38
2	137,463.43	81,956.62	16,922.07	38,584.75
3	137,456.95	81,922.40	16,876.98	38,657.57
4	137,508.18	81,924.00	16,904.40	38,679.78
5	137,428.63	81,879.08	16,920.10	38,629.45
6	137,469.60	81,986.67	16,889.57	38,593.37
7	137,555.18	81,994.73	16,905.22	38,655.23
8	137,492.38	81,936.43	16,919.05	38,636.90
9	137,481.65	81,896.03	16,917.80	38,667.82
10	137,503.77	81,960.08	16,919.15	38,624.53
11	137,493.63	81,929.80	16,899.38	38,664.45
12	137,436.87	81,912.58	16,910.82	38,613.47
Average	137,482.69	81,934.18	16,906.25	38,642.26

10% Load Level - 550 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:55:38	20:58:39	0-2	0:03:01
Measurement Interval	20:58:39	21:08:41	3-12	0:10:02

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	27,511.00	16,393.52	3,380.83	7,736.65
1	27,511.45	16,396.15	3,381.17	7,734.13
2	27,496.68	16,387.87	3,384.08	7,724.73
3	27,472.28	16,363.18	3,385.27	7,723.83
4	27,486.07	16,388.33	3,373.70	7,724.03
5	27,510.15	16,402.08	3,382.48	7,725.58
6	27,501.35	16,394.53	3,382.53	7,724.28
7	27,490.65	16,379.52	3,382.87	7,728.27
8	27,501.32	16,375.62	3,390.82	7,734.88
9	27,523.12	16,395.38	3,388.30	7,739.43
10	27,514.53	16,384.28	3,383.03	7,747.22
11	27,502.27	16,388.53	3,386.38	7,727.35
12	27,438.63	16,358.10	3,378.35	7,702.18
Average	27,494.04	16,382.96	3,383.37	7,727.71

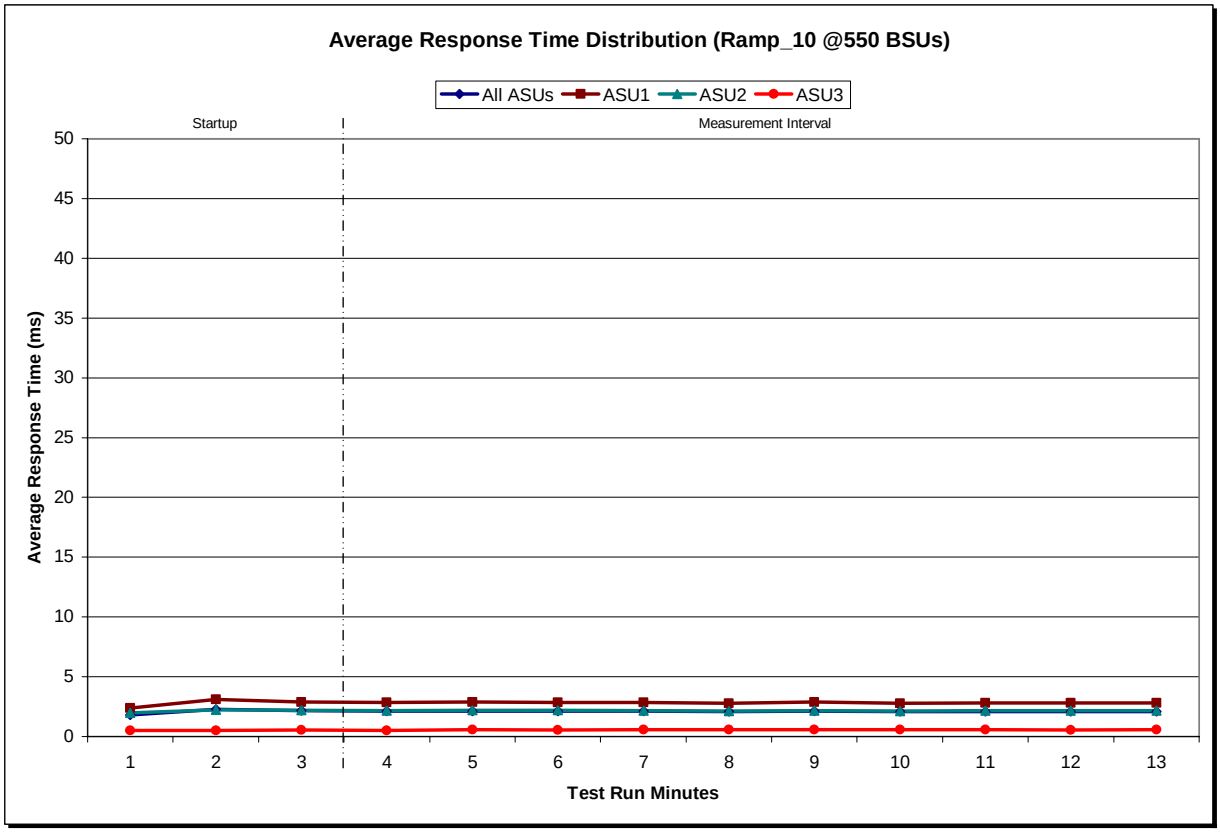
Response Time Ramp Distribution (IOPS) Graph



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

550 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:55:38	20:58:39	0-2	0:03:01
Measurement Interval	20:58:39	21:08:41	3-12	0:10:02
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.80	2.38	1.98	0.50
1	2.26	3.08	2.25	0.51
2	2.15	2.89	2.19	0.55
3	2.11	2.85	2.16	0.52
4	2.14	2.86	2.21	0.56
5	2.13	2.86	2.18	0.56
6	2.12	2.85	2.17	0.56
7	2.08	2.78	2.12	0.57
8	2.14	2.88	2.16	0.56
9	2.08	2.79	2.13	0.56
10	2.10	2.82	2.15	0.57
11	2.10	2.82	2.16	0.54
12	2.09	2.79	2.16	0.57
Average	2.11	2.83	2.16	0.56

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 5.1.0 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	0.0700	0.2098	0.0180	0.0701	0.0350	0.2811
COV	0.005	0.001	0.003	0.001	0.006	0.002	0.002	0.001

Repeatability Test

Clause 5.4.5

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

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

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

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 9.2.4.7.4

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 71.

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	***274,997.58***
Repeatability Test Phase 1	274,981.74
Repeatability Test Phase 2	274,987.85

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	***2.11 ms***
Repeatability Test Phase 1	2.10 ms
Repeatability Test Phase 2	2.14 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.

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

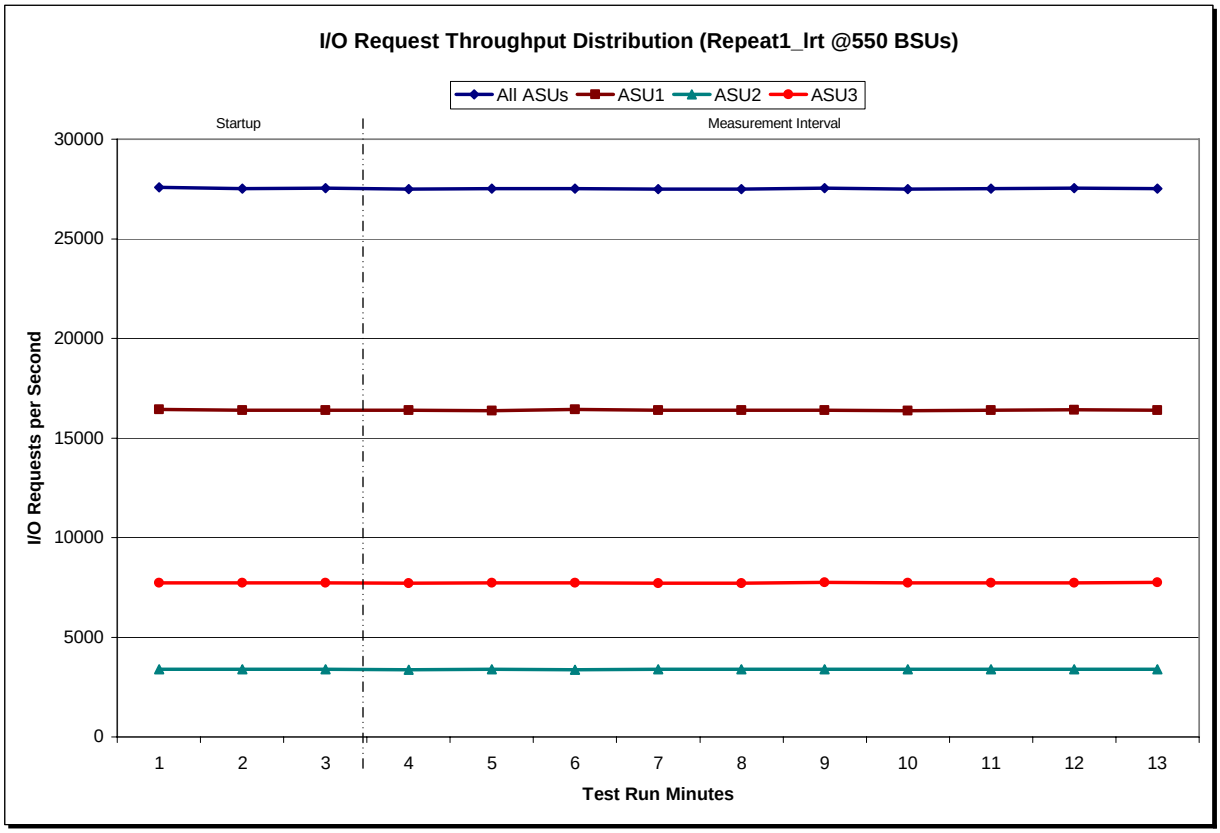
Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

550 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:12:31	22:15:31	0-2	0:03:00
Measurement Interval	22:15:31	22:25:32	3-12	0:10:01

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	27,577.28	16,442.35	3,392.92	7,742.02
1	27,516.13	16,392.60	3,383.42	7,740.12
2	27,530.43	16,395.47	3,395.68	7,739.28
3	27,488.65	16,394.43	3,377.87	7,716.35
4	27,506.52	16,378.35	3,391.52	7,736.65
5	27,517.88	16,427.28	3,364.48	7,726.12
6	27,485.72	16,387.95	3,390.12	7,707.65
7	27,492.10	16,390.07	3,381.73	7,720.30
8	27,535.08	16,398.47	3,383.73	7,752.88
9	27,487.57	16,376.12	3,385.60	7,725.85
10	27,516.97	16,394.82	3,380.77	7,741.38
11	27,534.45	16,407.33	3,388.12	7,739.00
12	27,524.02	16,386.73	3,383.08	7,754.20
Average	27,508.90	16,394.16	3,382.70	7,732.04

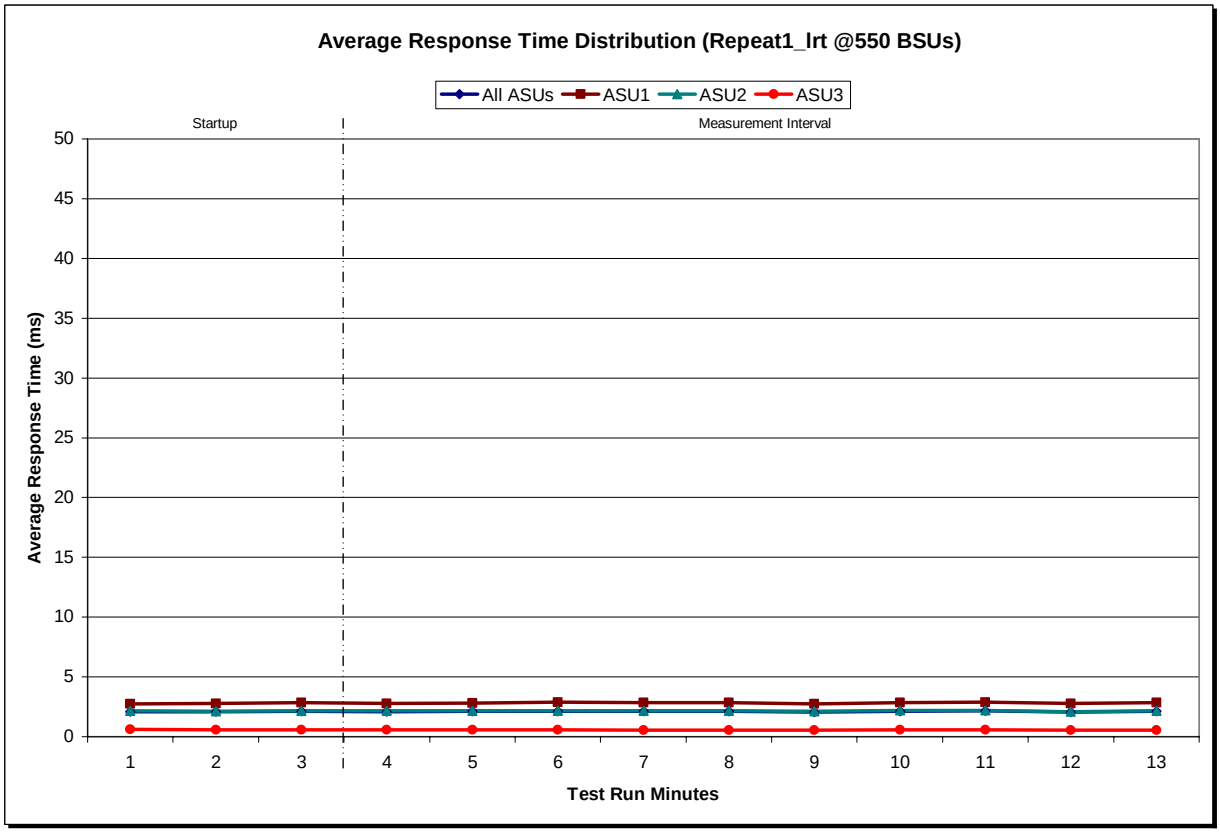
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

550 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:12:31	22:15:31	0-2	0:03:00
Measurement Interval	22:15:31	22:25:32	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.07	2.74	2.18	0.61
1	2.07	2.78	2.11	0.57
2	2.11	2.83	2.16	0.56
3	2.07	2.76	2.16	0.56
4	2.11	2.82	2.17	0.57
5	2.14	2.88	2.17	0.56
6	2.12	2.85	2.17	0.55
7	2.13	2.86	2.16	0.55
8	2.04	2.73	2.12	0.55
9	2.12	2.83	2.18	0.58
10	2.14	2.88	2.20	0.56
11	2.06	2.77	2.09	0.55
12	2.11	2.84	2.15	0.55
Average	2.10	2.82	2.16	0.56

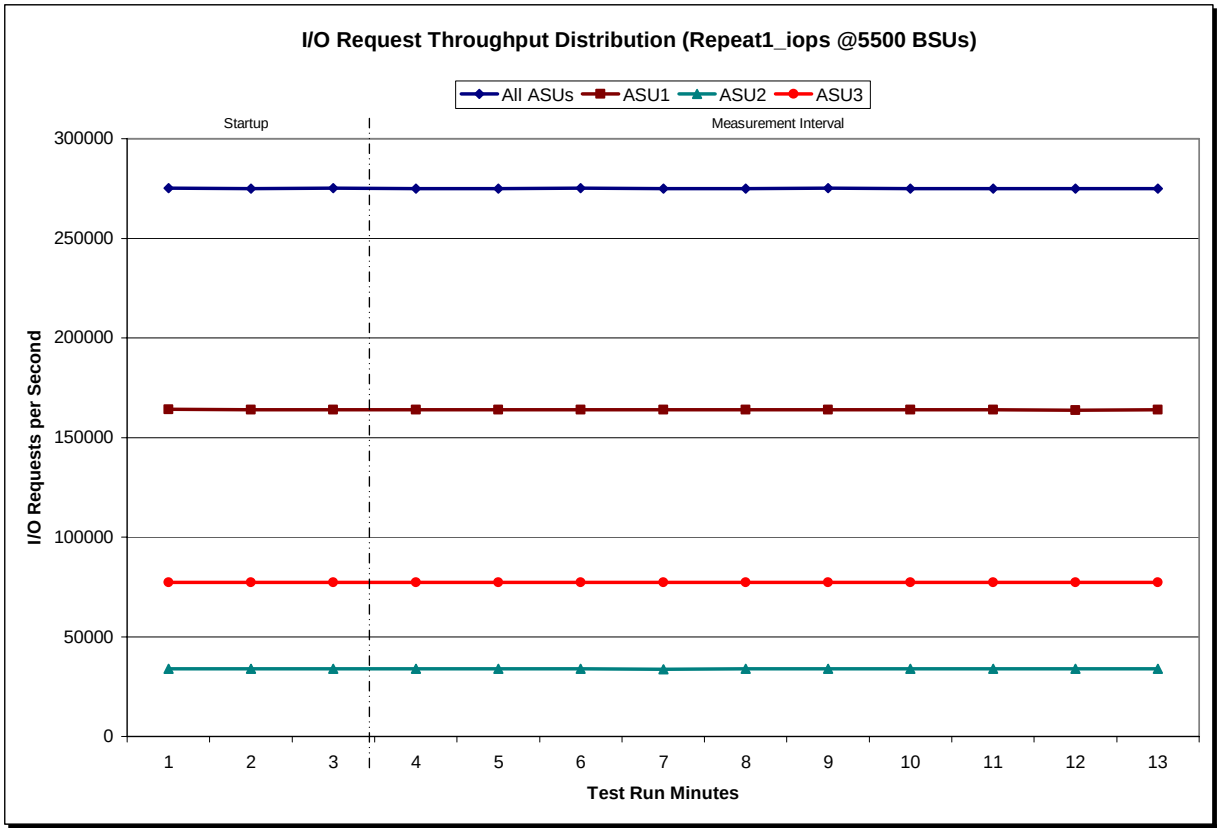
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

5500 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:29:32	22:32:33	0-2	0:03:01
Measurement Interval	22:32:33	22:42:36	3-12	0:10:03
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	275,262.25	164,095.07	33,864.28	77,302.90
1	274,974.52	163,933.87	33,804.02	77,236.63
2	275,055.23	163,928.93	33,869.72	77,256.58
3	274,968.58	163,861.38	33,829.10	77,278.10
4	274,971.13	163,894.98	33,812.83	77,263.32
5	275,061.37	163,923.02	33,814.88	77,323.47
6	274,959.10	163,876.85	33,785.48	77,296.77
7	274,949.87	163,852.53	33,811.92	77,285.42
8	275,057.90	163,969.02	33,842.25	77,246.63
9	274,959.95	163,896.67	33,828.68	77,234.60
10	275,050.48	163,898.77	33,837.55	77,314.17
11	274,883.28	163,771.73	33,846.95	77,264.60
12	274,955.73	163,864.22	33,835.57	77,255.95
Average	274,981.74	163,880.92	33,824.52	77,276.30

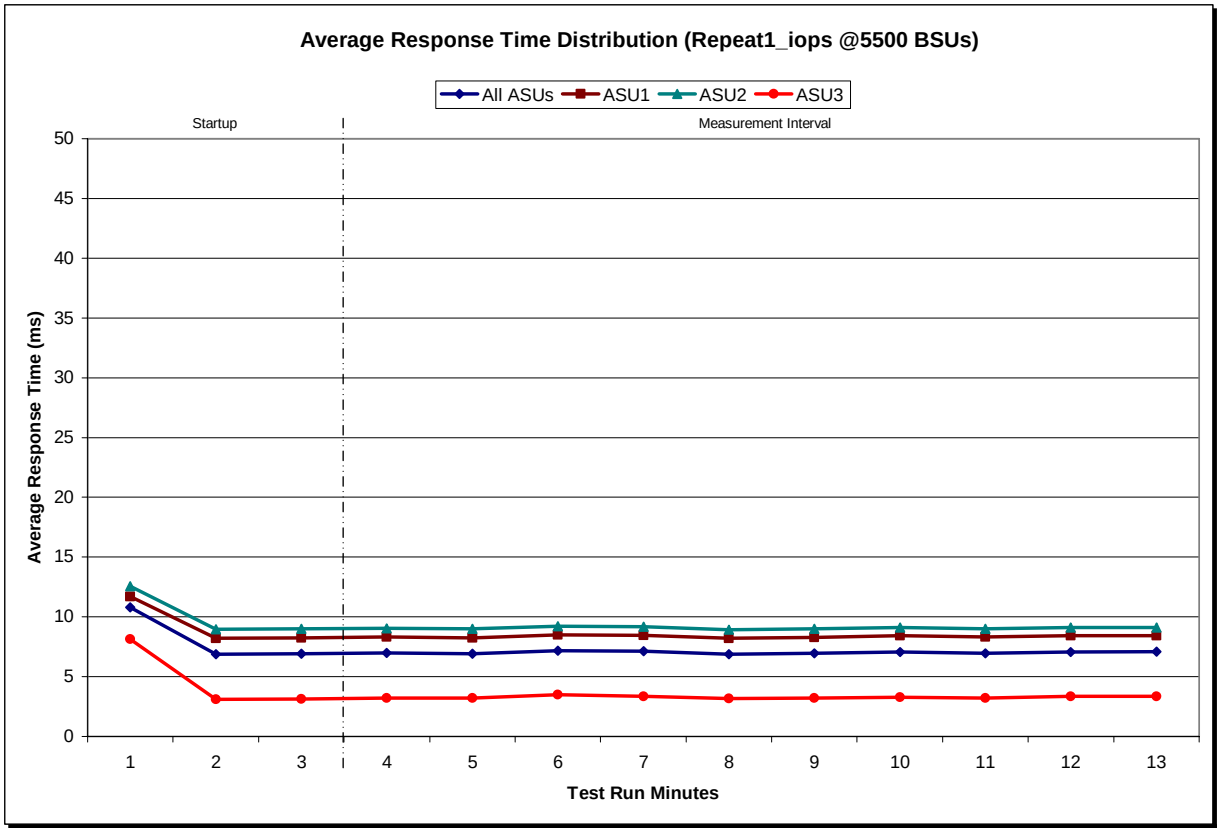
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

5500 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:29:32	22:32:33	0-2	0:03:01
Measurement Interval	22:32:33	22:42:36	3-12	0:10:03
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	10.81	11.71	12.57	8.13
1	6.86	8.21	8.96	3.08
2	6.91	8.26	9.01	3.13
3	6.97	8.32	9.05	3.20
4	6.92	8.25	9.00	3.19
5	7.18	8.50	9.21	3.49
6	7.12	8.47	9.18	3.36
7	6.89	8.22	8.94	3.17
8	6.95	8.28	9.02	3.21
9	7.05	8.41	9.09	3.29
10	6.96	8.31	9.02	3.22
11	7.07	8.41	9.12	3.34
12	7.08	8.42	9.11	3.34
Average	7.02	8.36	9.07	3.28

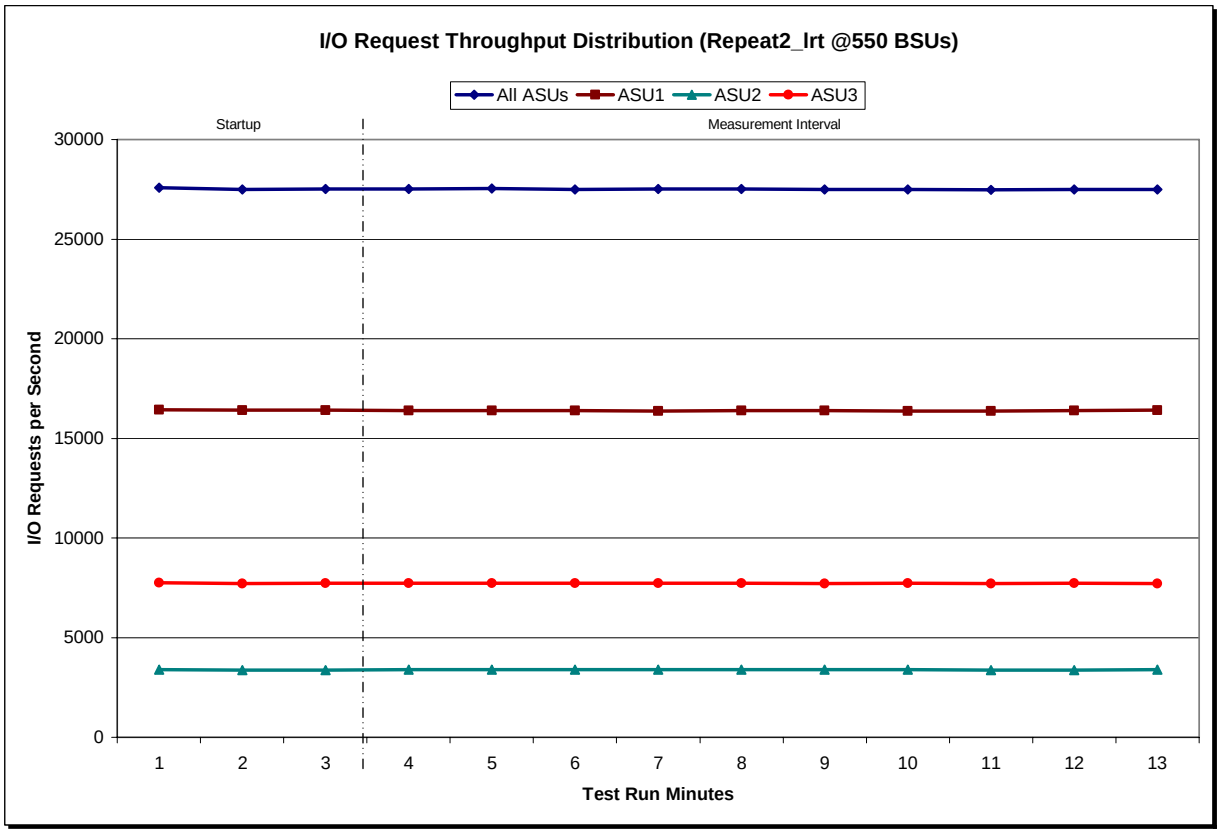
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

550 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:46:57	22:49:57	0-2	0:03:00
Measurement Interval	22:49:57	22:59:58	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	27,576.58	16,442.50	3,387.90	7,746.18
1	27,493.80	16,408.02	3,372.20	7,713.58
2	27,519.55	16,408.72	3,378.78	7,732.05
3	27,510.02	16,390.23	3,382.43	7,737.35
4	27,534.42	16,399.62	3,396.43	7,738.37
5	27,501.17	16,390.10	3,382.27	7,728.80
6	27,508.05	16,381.45	3,385.68	7,740.92
7	27,510.55	16,385.33	3,400.28	7,724.93
8	27,486.67	16,394.10	3,384.03	7,708.53
9	27,496.02	16,376.50	3,383.68	7,735.83
10	27,474.82	16,375.75	3,380.02	7,719.05
11	27,498.27	16,394.48	3,377.20	7,726.58
12	27,504.95	16,405.53	3,389.77	7,709.65
Average	27,502.49	16,389.31	3,386.18	7,727.00

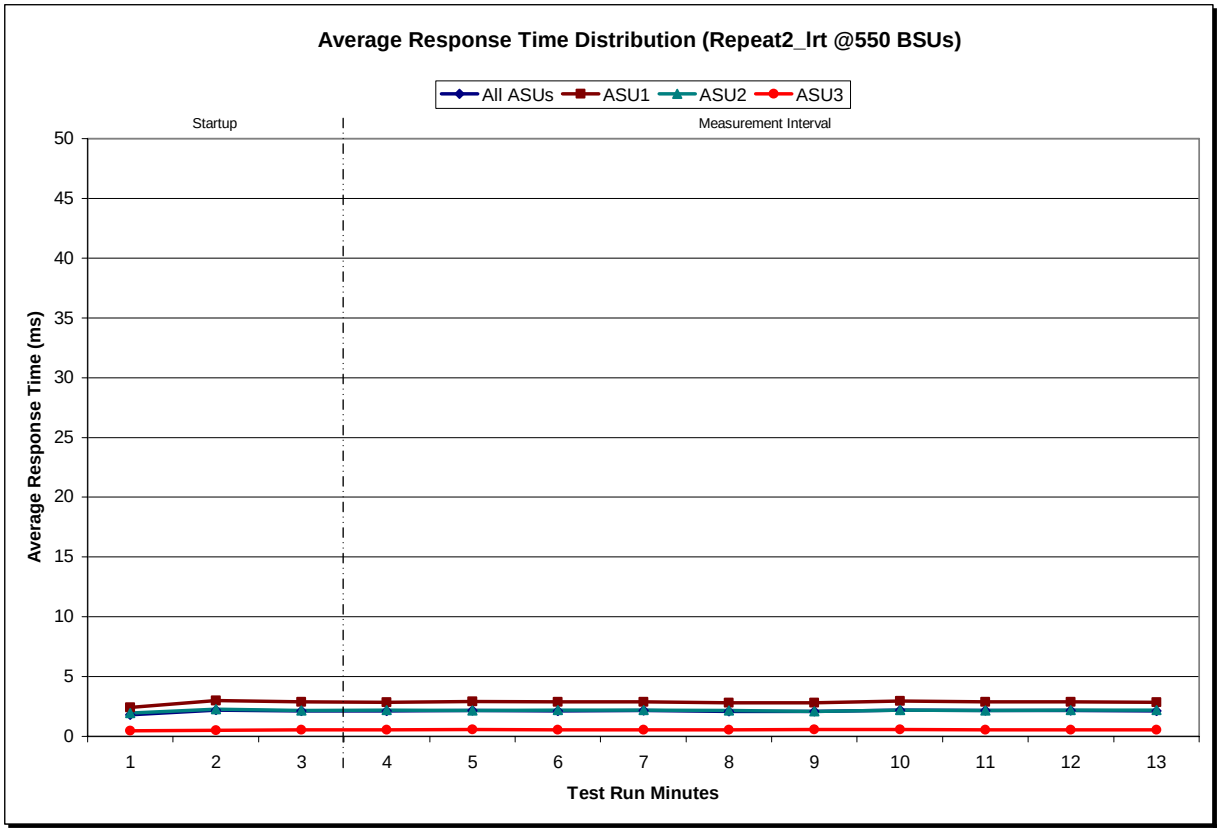
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

550 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:46:57	22:49:57	0-2	0:03:00
Measurement Interval	22:49:57	22:59:58	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.81	2.41	1.95	0.49
1	2.20	2.99	2.25	0.51
2	2.13	2.87	2.18	0.53
3	2.12	2.85	2.19	0.54
4	2.17	2.92	2.17	0.58
5	2.14	2.88	2.18	0.55
6	2.15	2.89	2.18	0.56
7	2.10	2.82	2.17	0.54
8	2.08	2.79	2.09	0.56
9	2.18	2.94	2.18	0.57
10	2.14	2.89	2.16	0.55
11	2.15	2.89	2.18	0.56
12	2.13	2.86	2.18	0.54
Average	2.14	2.87	2.17	0.55

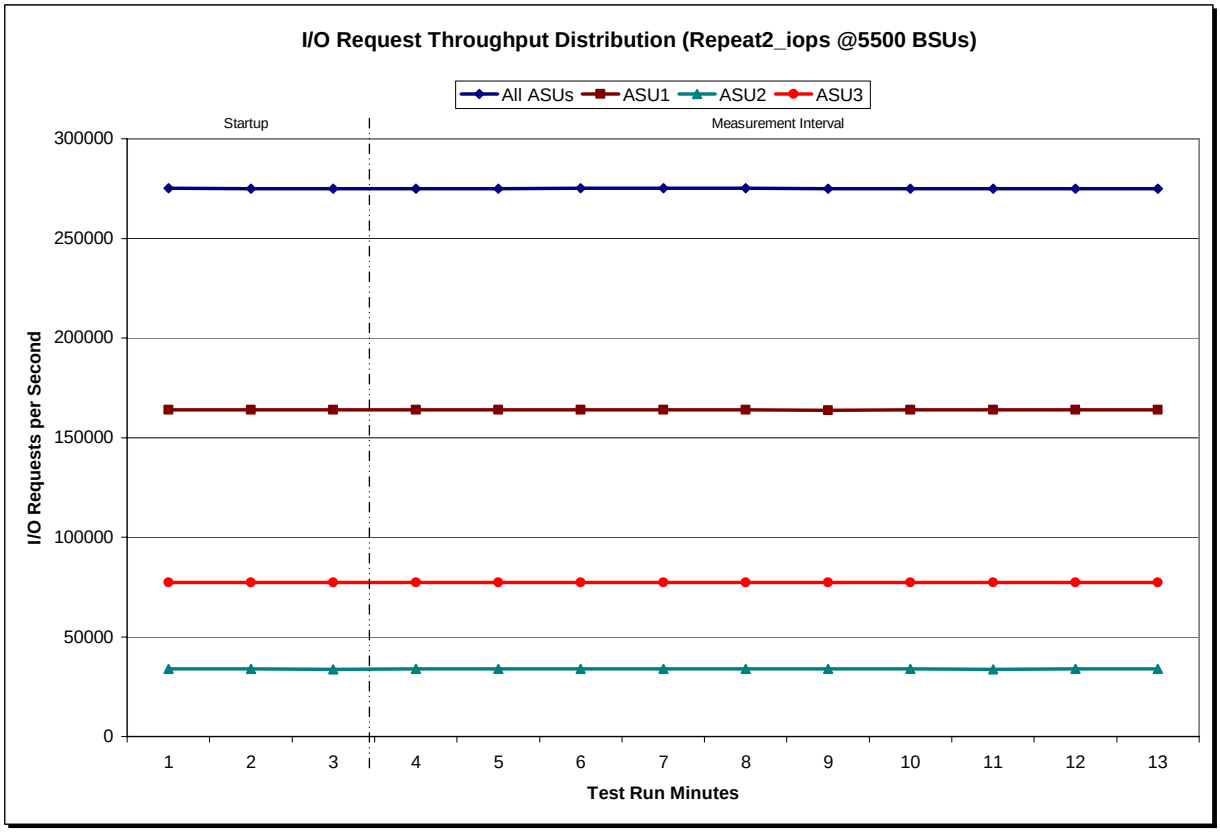
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

5500 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:03:58	23:06:59	0-2	0:03:01
Measurement Interval	23:06:59	23:17:03	3-12	0:10:04
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	275,206.77	163,997.03	33,826.30	77,383.43
1	275,041.77	163,937.85	33,830.35	77,273.57
2	274,944.22	163,873.83	33,752.87	77,317.52
3	274,893.90	163,841.62	33,805.28	77,247.00
4	275,025.33	163,888.10	33,815.95	77,321.28
5	275,068.38	163,938.60	33,829.17	77,300.62
6	275,061.48	163,959.62	33,808.80	77,293.07
7	275,078.97	163,950.93	33,844.52	77,283.52
8	274,862.63	163,743.27	33,831.85	77,287.52
9	274,966.25	163,831.15	33,869.80	77,265.30
10	274,950.87	163,916.95	33,788.53	77,245.38
11	274,979.73	163,909.05	33,811.55	77,259.13
12	274,990.90	163,824.03	33,813.23	77,353.63
Average	274,987.85	163,880.33	33,821.87	77,285.65

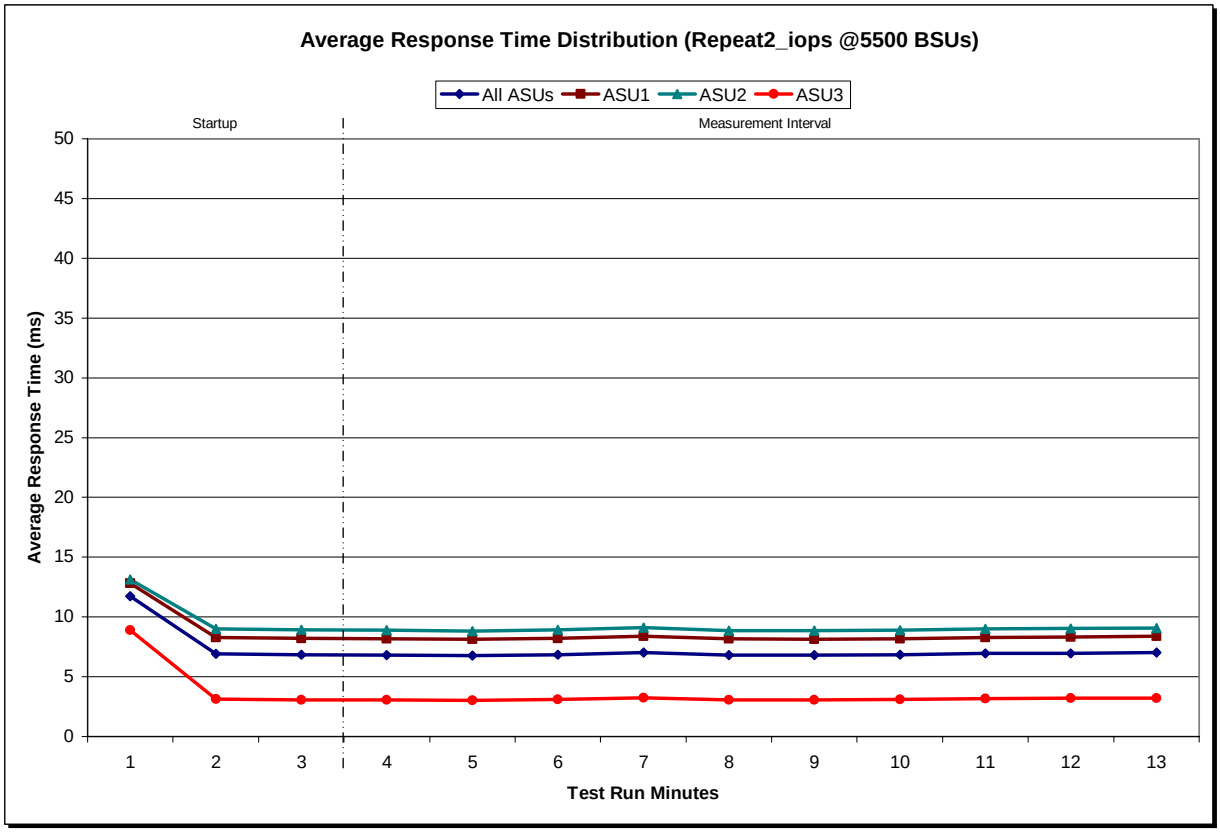
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

5500 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:03:58	23:06:59	0-2	0:03:01
Measurement Interval	23:06:59	23:17:03	3-12	0:10:04
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	11.75	12.82	13.15	8.88
1	6.93	8.29	9.00	3.13
2	6.85	8.19	8.95	3.08
3	6.82	8.16	8.89	3.05
4	6.78	8.12	8.84	3.03
5	6.85	8.20	8.94	3.08
6	7.03	8.38	9.11	3.24
7	6.81	8.15	8.86	3.06
8	6.80	8.14	8.87	3.06
9	6.84	8.18	8.90	3.10
10	6.94	8.29	9.00	3.16
11	6.96	8.31	9.02	3.21
12	7.01	8.38	9.08	3.21
Average	6.88	8.23	8.95	3.12

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 5.1.0 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	0.0699	0.2100	0.0180	0.0700	0.0349	0.2811
COV	0.005	0.002	0.003	0.001	0.003	0.004	0.004	0.001

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

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

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2099	0.0180	0.0701	0.0351	0.2810
COV	0.003	0.001	0.002	0.002	0.004	0.003	0.005	0.001

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2811
COV	0.001	0.000	0.001	0.001	0.001	0.001	0.002	0.000

Data Persistence Test

Clause 6

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

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

The SPC-1 Workload Generator will write 16 block I/O requests at random over the total Addressable Storage Capacity of the TSC for ten (10) minutes at a minimum of 25% of the load used to generate the SPC-1 IOP™ 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 Benchmark Configuration will be shutdown and restarted using a power off/power on cycle at the end of the above sequence of write operations. In addition, any caches employing battery backup must be flushed/emptied.

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

Clause 9.2.4.8

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 71.

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	101,372,064
Total Number of Logical Blocks Verified	82,944,080
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 must be the date at which all components are committed to be available.

The FDR shall state: "The Priced Storage Configuration, as documented in this Full Disclosure Report will be available for shipment to customers on MMMM DD, YYYY." Where Priced Storage Configuration is the TSC Configuration Name as described in Clause 9.2.4.3.3 and MMMM is the alphanumeric month, DD is the numeric day, and YYYY is the numeric year of the date that the Priced Storage Configuration, as documented, is available for shipment to customers as described above.

The IBM System Storage SAN Volume Controller Version 4.3 as documented in this Full Disclosure Report is currently available for customer purchase and shipment.

PRICING INFORMATION

Clause 9.2.4.11

A statement of the respective calculations for pricing must be included.

Clause 9.2.4.11.3

A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration must be included.

Pricing information may found in the Tested Storage Configuration Pricing section on page 14. 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 9.2.4.10

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 System Storage SAN Volume Controller Version 4.3.

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

RAID5: User data is distributed across the disks in the array. Check data corresponding to user data is distributed across multiple disks in the form of bit-by-bit parity.

Mirroring: Two or more identical copies of user data are maintained on separate disks.

Other Protection Level: Any data protection other than **RAID5** or **Mirroring**.

Unprotected: There is no data protection provided.

SPC-1 Test Execution Definitions

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

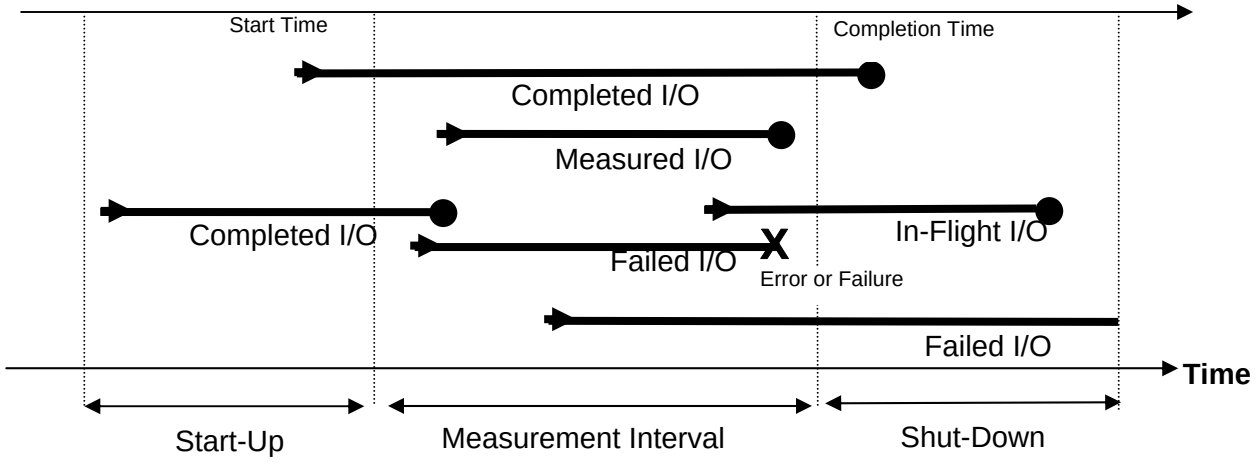
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

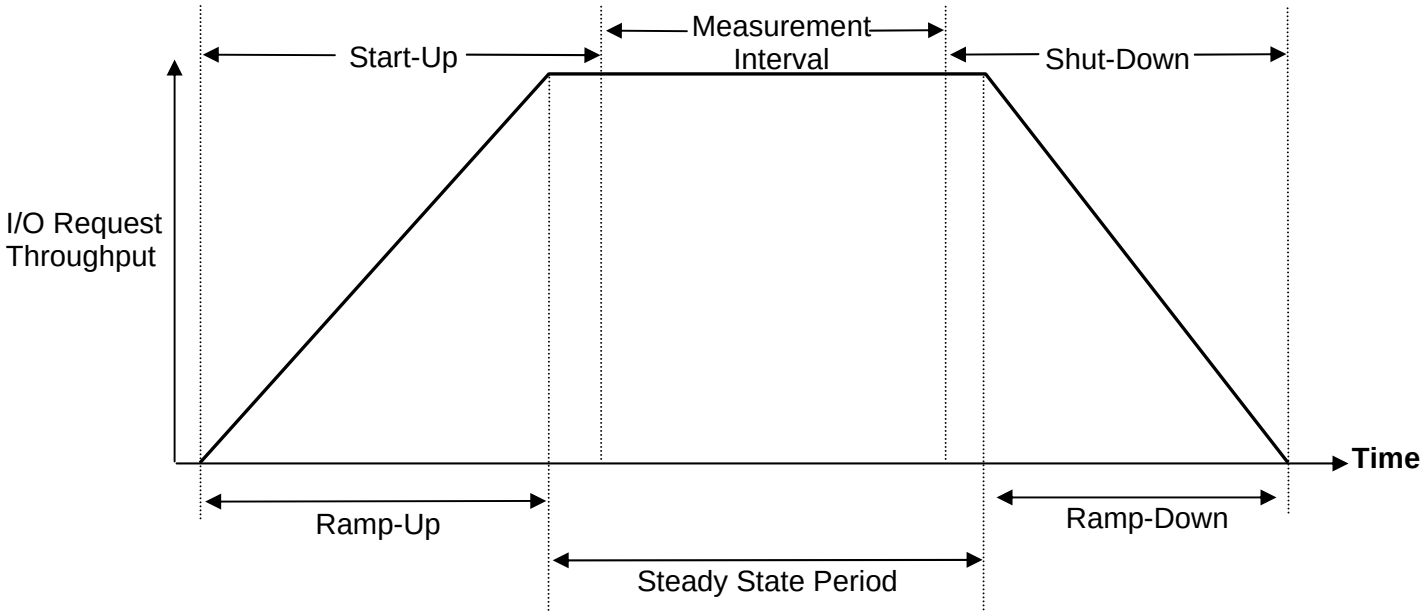
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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

I/O Completion Types



SPC-1 Test Run Components



APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

The AIX queue depth was to 40 from the default value of 20.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

Create RAID-10 Arrays

Within each DS4700, eight RAID-10 arrays are defined, with one LUN per array. The odd LUNs are assigned to DS4700 controller "a", and are created with the script **defineRAID10_a.script**. The even LUNs are assigned to DS4700 controller "b", and are created with the script **defineRAID10_b.script**. Both scripts are called repeatedly (for each DS4700) by **defineRAID10.bat**. This script also invokes the SVC "detectmdisk" function, which causes SVC to discover the LUNs and place them into its list of available mDisks. Most LUNs are defined to incorporate the capacity from 12 physical disks; however, due to the use of 2 physical disks in each DS4700 for spares, one LUN is defined to incorporate the capacity from 10 physical disks.

defineRAID10.bat

```
plink perfclus_local svctask detectmdisk
ping -n 30 192.168.1.31
plink perfclus_local svcinfo lsmdisk > afternone

SMcli -n "A1" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "A2" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "B1" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "B2" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "C1" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "C2" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "D1" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "D2" -f defineRAID10_a.script
ping -n 30 192.168.1.31
@rem ping local address for short delay
plink perfclus_local svctask detectmdisk
ping -n 30 192.168.1.31
plink perfclus_local svcinfo lsmdisk > afters1list

SMcli -n "A1" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "A2" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "B1" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "B2" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "C1" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "C2" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "D1" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "D2" -f defineRAID10_b.script
```

```
ping -n 30 192.168.1.31
plink perfclus_local svctask detectmdisk
ping -n 30 192.168.1.31
plink perfclus_local svcinfo lsmdisk > afters2list

SMcli -n "E1" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "E2" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "F1" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "F2" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "G1" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "G2" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "H1" -f defineRAID10_a.script
plink perfclus_local svctask detectmdisk
SMcli -n "H2" -f defineRAID10_a.script
ping -n 30 192.168.1.31
plink perfclus_local svctask detectmdisk
ping -n 30 192.168.1.31
plink perfclus_local svcinfo lsmdisk > afters3list

SMcli -n "E1" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "E2" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "F1" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "F2" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "G1" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "G2" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "H1" -f defineRAID10_b.script
plink perfclus_local svctask detectmdisk
SMcli -n "H2" -f defineRAID10_b.script
ping -n 30 192.168.1.31
plink perfclus_local svctask detectmdisk
ping -n 30 192.168.1.31
plink perfclus_local svcinfo lsmdisk > afters4list
```

defineRAID10_a.script

```
set drive[12,1] HotSpare=True;
set drive[12,2] HotSpare=True;

create logicalDrive drives=(12,3 12,4 12,5 12,6 12,7 12,8 12,9 12,10 12,11 12,12)
RAIDLevel=1
segmentSize=256
userLabel="1"
owner=a;
set logicalDrive["1"] logicalUnitNumber=1 hostGroup=defaultGroup;

create logicalDrive drives=(12,13 12,14 12,15 12,16 13,1 13,2 13,3 13,4 13,5 13,6 13,7 13,8)
RAIDLevel=1
segmentSize=256
userLabel="3"
owner=a;
```

```
set logicalDrive["3"] logicalUnitNumber=3 hostGroup=defaultGroup;

create logicalDrive drives=(13,9 13,10 13,11 13,12 13,13 13,14 13,15 13,16 14,1 14,2 14,3 14,4)
RAIDLevel=1
segmentSize=256
userLabel="5"
owner=a;
set logicalDrive["5"] logicalUnitNumber=5 hostGroup=defaultGroup;


create logicalDrive drives=(14,5 14,6 14,7 14,8 14,9 14,10 14,11 14,12 14,13 14,14 14,15 14,16)
RAIDLevel=1
segmentSize=256
userLabel="7"
owner=a;
set logicalDrive["7"] logicalUnitNumber=7 hostGroup=defaultGroup;

set storageSubsystem defaultHostType=12 cacheBlockSize=16;
set allLogicalDrives mirrorEnabled=TRUE writeCacheEnabled=TRUE
cacheWithoutBatteryEnabled=FALSE readAheadMultiplier=1;
```

defineRAID10_b.script

```
create logicalDrive drives=(81,1 81,2 81,3 81,4 81,5 81,6 81,7 81,8 81,9 81,10 81,11 81,12)
RAIDLevel=1
segmentSize=256
userLabel="2"
owner=b;
set logicalDrive["2"] logicalUnitNumber=2 hostGroup=defaultGroup;

create logicalDrive drives=(81,13 81,14 81,15 81,16 15,1 15,2 15,3 15,4 15,5 15,6 15,7 15,8)
RAIDLevel=1
segmentSize=256
userLabel="4"
owner=b;
set logicalDrive["4"] logicalUnitNumber=4 hostGroup=defaultGroup;

create logicalDrive drives=(15,9 15,10 15,11 15,12 15,13 15,14 15,15 15,16 16,1 16,2 16,3 16,4)
RAIDLevel=1
segmentSize=256
userLabel="6"
owner=b;
set logicalDrive["6"] logicalUnitNumber=6 hostGroup=defaultGroup;


create logicalDrive drives=(16,5 16,6 16,7 16,8 16,9 16,10 16,11 16,12 16,13 16,14 16,15 16,16)
RAIDLevel=1
segmentSize=256
userLabel="8"
owner=b;
set logicalDrive["8"] logicalUnitNumber=8 hostGroup=defaultGroup;

set storageSubsystem defaultHostType=12 cacheBlockSize=16;
set allLogicalDrives mirrorEnabled=TRUE writeCacheEnabled=TRUE
cacheWithoutBatteryEnabled=FALSE readAheadMultiplier=1;
```

Create Definitions for Host System Connectivity

For each of the 32 HBA's in the host processor, the script **mkhost.bat** defines an SVC host connection using the appropriate WWPN. Due to the usage in AIX, these host paths are also referred to as "fcs's".

mkhost.bat

```
plink perfclus_local svctask mkhost -force -name fcs0 -hbawwpn 10000000C944431B
plink perfclus_local svctask mkhost -force -name fcs1 -hbawwpn 10000000C9424FD5
plink perfclus_local svctask mkhost -force -name fcs2 -hbawwpn 10000000C94259CC
plink perfclus_local svctask mkhost -force -name fcs3 -hbawwpn 10000000C942518A
plink perfclus_local svctask mkhost -force -name fcs4 -hbawwpn 10000000C94030FD
plink perfclus_local svctask mkhost -force -name fcs5 -hbawwpn 10000000C942498B
plink perfclus_local svctask mkhost -force -name fcs6 -hbawwpn 10000000C94256F7
plink perfclus_local svctask mkhost -force -name fcs7 -hbawwpn 10000000C9427F7E
plink perfclus_local svctask mkhost -force -name fcs8 -hbawwpn 10000000C9444479
plink perfclus_local svctask mkhost -force -name fcs9 -hbawwpn 10000000C944446C
plink perfclus_local svctask mkhost -force -name fcs10 -hbawwpn 10000000C94443C8
plink perfclus_local svctask mkhost -force -name fcs11 -hbawwpn 10000000C9444524
plink perfclus_local svctask mkhost -force -name fcs12 -hbawwpn 10000000C94440F4
plink perfclus_local svctask mkhost -force -name fcs13 -hbawwpn 10000000C9403183
plink perfclus_local svctask mkhost -force -name fcs14 -hbawwpn 10000000C9427A39
plink perfclus_local svctask mkhost -force -name fcs15 -hbawwpn 10000000C942E674
plink perfclus_local svctask mkhost -force -name fcs16 -hbawwpn 10000000C944454D
plink perfclus_local svctask mkhost -force -name fcs17 -hbawwpn 10000000C94079D7
plink perfclus_local svctask mkhost -force -name fcs18 -hbawwpn 10000000C94443C9
plink perfclus_local svctask mkhost -force -name fcs19 -hbawwpn 10000000C9427DB5
plink perfclus_local svctask mkhost -force -name fcs20 -hbawwpn 10000000C94443C0
plink perfclus_local svctask mkhost -force -name fcs21 -hbawwpn 10000000C9444199
plink perfclus_local svctask mkhost -force -name fcs22 -hbawwpn 10000000C944425F
plink perfclus_local svctask mkhost -force -name fcs23 -hbawwpn 10000000C94443DA
plink perfclus_local svctask mkhost -force -name fcs24 -hbawwpn 10000000C94441ED
plink perfclus_local svctask mkhost -force -name fcs25 -hbawwpn 10000000C9444428
plink perfclus_local svctask mkhost -force -name fcs26 -hbawwpn 10000000C9427F7F
plink perfclus_local svctask mkhost -force -name fcs27 -hbawwpn 10000000C944428C
plink perfclus_local svctask mkhost -force -name fcs28 -hbawwpn 10000000C9444204
plink perfclus_local svctask mkhost -force -name fcs29 -hbawwpn 10000000C9402F88
plink perfclus_local svctask mkhost -force -name fcs30 -hbawwpn 10000000C9444156
plink perfclus_local svctask mkhost -force -name fcs31 -hbawwpn 10000000C9444311
```

Define the mDisk Group

The **mkgroup_seq.cyg** script defines a pool of mDisk storage within the SVC, which is referred to as an mDisk group. The pool includes all storage accessible to SVC.

mkgroup_seq.cyg

```
#!/usr/bin/bash
#run in cygwin command line
mlist=`plink perfclus_local svcinfo lsmdisk -nohdr | awk -v ORS="" '{ print (FNR==1?"":":") $2 }'`
plink perfclus_local svctask mkmdiskgrp -name thebiggroup -ext 256 -mdisk $mlist
```

Define the vDisks (LUNs)

The script **mk128sevd_8node_seq.cyg** defines 128 vDisks (LUNs) that will be presented to the Host System. These vDisks vary in size, due to the varying physical arrays as defined

in the DS4700. The defined vDisks include 112 vDisks of size 459 GiB and 16 vDisks of size 383 GiB.

The vDisk parameter settings used in the script specify that the vDisk storage should be managed in a space efficient manner. For this reason, the actual physical space is not occupied until the "Fill each vDisk with zeros" step described below. After that step, the physical space occupied by each vDisk is slightly larger than its specified LUN capacity. This difference represents the space that has been set aside for Space Efficient metadata.

mk128sevd_8node_seq.cyg

```
#!/usr/bin/bash
#execute in cygwin command line
i=0
while [[ $i -le 127 ]]
   do
   let lode="1 + ((i%32) / 4)"
   let iogrp="((i%32) / 8)"
   let j="((i%32)%4)*32 + (i/4)"
   cap=`plink perfclus_local svcinfo lsmdisk md$j | grep capacity | awk  -F"[ .]" '{print $2}'`
   let hcap="cap*9/16"
   let rcap="hcap+1"
   plink perfclus_local svctask mkvdisk -vtype seq -mdisk md$j \
      -size $hcap -unit gb -rsize $rcap -grainsize 256 -mdiskgrp thebiggroup -iogrp io_grp$iogrp \
      -name vd$i -node lode$lode
   let i="i+1"
   done
```

Define vDisk Paths

Define two paths through which each vDisk can be seen by the host. This is done by the script **mapfcs128to32.cyg**. This step completes the configuration in SVC. The remaining steps are performed in the host AIX system.

mapfcs128to32.cyg

```
#!/usr/bin/bash
# run in cygwin command line
# Maps each vdisk to two fcs's.

# The fcs's are organized
# into groups of four, with two groups in each switch.
fcsarray=( \
 21  2  7 25       16 15  6 26   \
 23 11  1 24        19  4  0 29   \
 22  9  5 27       20 12  8 28   \
 18 10 13 31        17 14  3 30 )

i=0
while [[ $i -le 31 ]]
   do
   let k="i - ((i/4)%2)*4" #odd and even nodes are handled symmetrically except for offset of 4
   let j="(k%4)*8 + k/8 + ((i/4)%2)*4"
   plink perfclus_local svctask mkvdiskhostmap -force -host fcs${fcsarray[j]} vd$i
   let aj="(k%4)*8 + k/8 + (1-(i/4)%2)*4 +8-16*((j%16)/8)"
   plink perfclus_local svctask mkvdiskhostmap -force -host fcs${fcsarray[aj]} vd$i
   repeat=1
   while [[ $repeat -le 3 ]]
```

```
    do
    let ii="i+32*repeat"
    plink perfclus_local svctask mkvdiskhostmap -force -host fcs${fcsarray[j]} vd$ii
    plink perfclus_local svctask mkvdiskhostmap -force -host fcs${fcsarray[aj]} vd$ii
    let repeat="repeat+1"
    done
let i="i+1"
done
```

Discover each vDisk

To discover the vDisks available to the Host System, the AIX command "cfgmgr" was invoked. The process of discovery uses MPIO; as a result, one hdisk is found for each vDisk, which is accessible via a primary and an alternate path.

Increase hdisk queue depth

The script **`setqd.sh`** sets the queue depth of each hdisk to 40.

setqd.sh

```
# Sets queue lengths

hfield=$(lsdev -Cc disk | grep 'SAN Volume' | awk '{print $1}')
for h in $hfield
do
chdev -l $h -a queue_depth=40
done
```

Fill each vDisk with zeros

To fill all vDisks with zeros, invoke the script: **`fillhd.sh 256 "SAN Volume Controller".`** For each hdisk known to AIX as type "SAN Volume Controller", this utility launches a DD job in batch mode to fill the capacity of the hdisk with binary zeros.

fillhd.sh 256 "SAN Volume Controller"

```
# fills hdisks of a specified type with zeros, assuming a specified partition size
# important: assumes hdisks are not in a volume group
if [[ ($# -lt 2) ]]
then
echo "Usage: fillhd psize type.  Blanks without quotes permitted in type"
return
fi
psize=$1
shift
type=$@

hfield=$(lsdev -Cc disk | grep "$type" | awk '{print $1}')
mkvg -fy tempvg -S -s $psize $hfield
lsvg -p tempvg > tempvglist
varyoffvg tempvg
exportvg tempvg
for h in $hfield
do
npp=`cat tempvglist | grep "$h " | awk '{print $3}'`
let lastblk="psize*(npp+1)"
```

```
dd if=/dev/zero bs=1048576 count=$lastblk of=/dev/r$h &
done
echo "Write processing started. Processing will complete asynchronously."
```

Create a striped volume group

Form the vDisks (which after discovery also correspond to AIX hdisks) into a logical volume group, and define a set of striped logical volumes. Each striped logical volume contains 3008 partitions, with a partition size of 256 MiB. The striping for each logical volume repeats four times a pattern that takes 6 partitions from each vDisk that has 1835 available partitions and 5 partitions from each vdisk that has 1531 available partitions. These actions are done by invoking: **`mapthem.sh 3008 256 1835 6 1531 5`**.

The resulting set of raw logical volumes, rmap1, rmap2, ..., rmap76, were those used to specify the ASU storage for the test.

mapthem.sh

```
# makes striped volume group from two hdisk sizes using map; makes vols with a specified number of specified
meg partitions.
# important: assumes MPIO, assumes specified map rotation divides LV partitions.
if [[ ($# -lt 6) ]]
then
   echo "Usage: mapthem LV partitions psize \n\
   Large hdisk total & 1 pass partitions \n\
   Small hdisk total & 1 pass partitions \n\
   LV partitions must be divisible by total partitions in a pass (not checked)"
   exit
fi
partspervol=$1
psize=$2

hfield=$(lsdev -Cc disk | grep 'SAN Volume' | awk '{print $1}')
mkvg -fy mapstripevg -S -s $psize $hfield

hnum=`echo $hfield | wc -w`
parts=`lsvg mapstripevg | grep "FREE PPs:" | awk '{print $6}'`
let numlv="parts / partspervol"
let usedparts="partspervol * numlv"
print "creating $numlv logical volumes"
print "these will use $usedparts out of $parts available partitions"

maplate1=`lsvg -p mapstripevg | awk '{print $1 " " $4}' | grep " $3" | awk '{print $1 ":"}'`

maplate2=`lsvg -p mapstripevg | awk '{print $1 " " $4}' | grep " $5" | awk '{print $1 ":"}'`

hnum1=`echo $maplate1 | wc -w`
hnum2=`echo $maplate2 | wc -w`
let passsize="$4*hnum1 + $6*hnum2"
let lvpass="$1/passsize"

i=1
j=1
l=1
while [[ $l -le $numlv ]]
do
let mapend="l*$4*lvpass"
echo "" > mapstripevg.map
```

```
  while [[ $i -le $mapend ]]
    do
    echo "$maplate1" | sed "s/:/:$i/g" >> mapstripevg.map
    let k="(i-1)%$4+1"
    if [[ $k -le $6 ]]
    then
      echo "$maplate2" | sed "s/:/:$j/g" >> mapstripevg.map
      let j="j+1"
    fi
    let i="i+1"
    done

  mklv -b n -y map$l -x 32512  -m mapstripevg.map mapstripevg $partspervol
  let l="l+1"
  done
```

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, is listed below.

```
javaparms="-Xms1536m -Xmx1536m -Xss96k -Xgcpolicy:optavgpause"
sd=default,size=807453m
#sd=default,size=25000m
sd=asu1_1,lun=/dev/rmap1
sd=asu1_2,lun=/dev/rmap2
sd=asu1_3,lun=/dev/rmap3
sd=asu1_4,lun=/dev/rmap4
sd=asu1_5,lun=/dev/rmap5
sd=asu1_6,lun=/dev/rmap6
sd=asu1_7,lun=/dev/rmap7
sd=asu1_8,lun=/dev/rmap8
sd=asu1_9,lun=/dev/rmap9
sd=asu1_10,lun=/dev/rmap10
sd=asu1_11,lun=/dev/rmap11
sd=asu1_12,lun=/dev/rmap12
sd=asu1_13,lun=/dev/rmap13
sd=asu1_14,lun=/dev/rmap14
sd=asu1_15,lun=/dev/rmap15
sd=asu1_16,lun=/dev/rmap16
sd=asu1_17,lun=/dev/rmap17
sd=asu1_18,lun=/dev/rmap18
sd=asu1_19,lun=/dev/rmap19
sd=asu1_20,lun=/dev/rmap20
sd=asu1_21,lun=/dev/rmap21
sd=asu1_22,lun=/dev/rmap22
sd=asu1_23,lun=/dev/rmap23
sd=asu1_24,lun=/dev/rmap24
sd=asu1_25,lun=/dev/rmap25
sd=asu1_26,lun=/dev/rmap26
sd=asu1_27,lun=/dev/rmap27
sd=asu1_28,lun=/dev/rmap28
sd=asu1_29,lun=/dev/rmap29
sd=asu1_30,lun=/dev/rmap30
sd=asu1_31,lun=/dev/rmap31
sd=asu1_32,lun=/dev/rmap32
sd=asu1_33,lun=/dev/rmap33
sd=asu1_34,lun=/dev/rmap34
sd=asu2_1,lun=/dev/rmap35
sd=asu2_2,lun=/dev/rmap36
sd=asu2_3,lun=/dev/rmap37
sd=asu2_4,lun=/dev/rmap38
sd=asu2_5,lun=/dev/rmap39
sd=asu2_6,lun=/dev/rmap40
sd=asu2_7,lun=/dev/rmap41
sd=asu2_8,lun=/dev/rmap42
sd=asu2_9,lun=/dev/rmap43
sd=asu2_10,lun=/dev/rmap44
sd=asu2_11,lun=/dev/rmap45
sd=asu2_12,lun=/dev/rmap46
sd=asu2_13,lun=/dev/rmap47
sd=asu2_14,lun=/dev/rmap48
sd=asu2_15,lun=/dev/rmap49
sd=asu2_16,lun=/dev/rmap50
sd=asu2_17,lun=/dev/rmap51
sd=asu2_18,lun=/dev/rmap52
```

```
  sd=asu2_19,lun=/dev/rmap53
  sd=asu2_20,lun=/dev/rmap54
  sd=asu2_21,lun=/dev/rmap55
  sd=asu2_22,lun=/dev/rmap56
  sd=asu2_23,lun=/dev/rmap57
  sd=asu2_24,lun=/dev/rmap58
  sd=asu2_25,lun=/dev/rmap59
  sd=asu2_26,lun=/dev/rmap60
  sd=asu2_27,lun=/dev/rmap61
  sd=asu2_28,lun=/dev/rmap62
  sd=asu2_29,lun=/dev/rmap63
  sd=asu2_30,lun=/dev/rmap64
  sd=asu2_31,lun=/dev/rmap65
  sd=asu2_32,lun=/dev/rmap66
  sd=asu2_33,lun=/dev/rmap67
  sd=asu2_34,lun=/dev/rmap68
  #sd=asu3_1,size=762595m,lun=/dev/rmap69
  sd=asu3_1,size=762595m,lun=/dev/rmap69
  sd=asu3_2,size=762595m,lun=/dev/rmap70
  sd=asu3_3,size=762595m,lun=/dev/rmap71
  sd=asu3_4,size=762595m,lun=/dev/rmap72
  sd=asu3_5,size=762595m,lun=/dev/rmap73
  sd=asu3_6,size=762595m,lun=/dev/rmap74
  sd=asu3_7,size=762595m,lun=/dev/rmap75
  sd=asu3_8,size=762595m,lun=/dev/rmap76
```

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.

```
export PATH=/usr/java14/bin:$PATH
export SPC1HOME=/perform/spc1install
export CLASSPATH=$SPC1HOME
export LIBPATH=$SPC1HOME/aix
export IBM_JAVADUMP_OUTOFMEMORY=false
export IBM_HEAPDUMP_OUTOFMEMORY=false
java -Xoptionsfile=javaopts.cfg metrics -b 5500
java -Xoptionsfile=javaopts.cfg repeat1 -b 5500
java -Xoptionsfile=javaopts.cfg repeat2 -b 5500
java -Xoptionsfile=javaoptsp.cfg persist1 -b 5500
```

Persistence Test Run 2

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

```
export PATH=/usr/java14/bin:$PATH
export SPC1HOME=/perform/spc1install
export CLASSPATH=$SPC1HOME
export LIBPATH=$SPC1HOME/aix
export IBM_JAVADUMP_OUTOFMEMORY=false
export IBM_HEAPDUMP_OUTOFMEMORY=false
java -Xoptionsfile=javaoptsp.cfg persist2
```