SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

IBM CORPORATION
IBM SYSTEM STORAGE DS8300 TURBO

SPC-1 V1.10.1

Submitted for Review: December 5, 2006
Submission Identifier: A00049

First Edition – December 2006

Trademarks

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AUDIT CERTIFICATION

Bruce McNutt
IBM Corporations
KBV/9062-2
9000 South Rita Road
Tucson, AZ 8744

December 4, 2006

The SPC Benchmark 1™ results listed below for the IBM System Storage DS8300 Turbo 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 DS8300 Turbo	
Metric	**Reported Result**
SPC-1 IOPS™	123,033.40
SPC-1 Price-Performance	$18.99/SPC-1 IOPS™
Total ASU Capacity	9,103.360 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$2,336,626.45

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

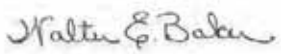
- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified using information supplied by IBM Corporations:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity 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).

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

AUDIT CERTIFICATION *(CONT.)*

- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters.
- Commands and parameters used to configure the SPC-1 Workload Generator.
- The following Host System requirements were reviewed using documentation supplied by IBM Corporations:
  - ✓ The type of Host System including the number of processors and main memory.
  - ✓ The presence and version number of the Workload Generator on the Host System.
  - ✓ The TSC boundary within the Host System.
- The Test Results Files and resultant Summary Results Files received from IBM Corporations for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability Test
- There were no differences between the Tested Storage Configuration (TSC) used for the benchmark and Priced Storage Configuration.
- The submitted pricing information met all of the requirements and constraints of Clause 8 of the SPC-1 Benchmark Specification.
- The Full Disclosure Report (FDR) met all of the requirements in Clause 9 of the SPC-1 Benchmark Specification.

Respectfully,



Walter E. Baker
SPC Auditor

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LETTER OF GOOD FAITH

Vice President & BLE, Disk Storage

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

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

November 20, 2006

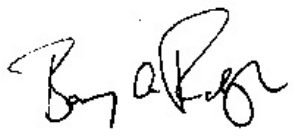
Mr. Walter E. Baker, SPC Auditor
Gradient Systems, Inc.
643 Bair Island Road, Suite 103
Redwood City, CA 94063

Subject: SPC-1 Letter of Good Faith for the IBM System Storage DS8300 Turbo

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	
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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	December 5, 2006
Date the FDR was submitted to the SPC	December 5, 2006
Date the TSC is available for shipment to customers	currently available
Date the TSC completed audit certification	December 4, 2006

Tested Storage Product (TSP) Description

The IBM System Storage DS8300 Turbo is a high-performance, high capacity storage system designed to deliver scalability, resiliency and total value. Created specifically for the mission-critical workloads of medium and large enterprises, the DS8300 Turbo can help consolidate system storage, support tiered storage requirements, simplify storage management, and support system availability to address the need of businesses operating in an on demand world.

The DS8300 Turbo supports non-disruptive microcode changes, designed to help maintain data availability, and uses 64-bit IBM POWER5 microprocessors in a dual 4-way processor complex to help reduce cycle time and accelerate response times, giving users fast access to vital information. It also features many redundant, hot-swappable components to help support continuous operations. Furthermore, each system is built to monitor its internal functions. If a potential problem is detected, the DS8300 Turbo can automatically "call home" to alert service personnel that a potential problem could be developing.

The DS8300 Turbo supports 4 Gbps FC/IBM FICON® high bandwidth connectivity for fast access to data and scales up to 320 TB of physical capacity that can be accessed by a wide variety of servers. To help accommodate ongoing workload fluctuations, the DS8300 Turbo supports the addition or deletion of volumes "on-the-fly" to help meet sudden spikes in demand or to react to other changes.

The DS8300 Turbo is a modular system that is designed to be built upon and upgraded from one model to another in the field, helping organizations respond swiftly to changing business requirements. Additional information for the IBM System Storage DS8300 Turbo is available at http://www-03.ibm.com/servers/storage/disk/ds8000/index.html.

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: IBM System Storage DS8300 Turbo	
Metric	**Reported Result**
SPC-1 IOPS™	123,033.40
SPC-1 Price-Performance	$18.99/SPC-1 IOPS™
Total ASU Capacity	9,103.360 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$2,336,626.45

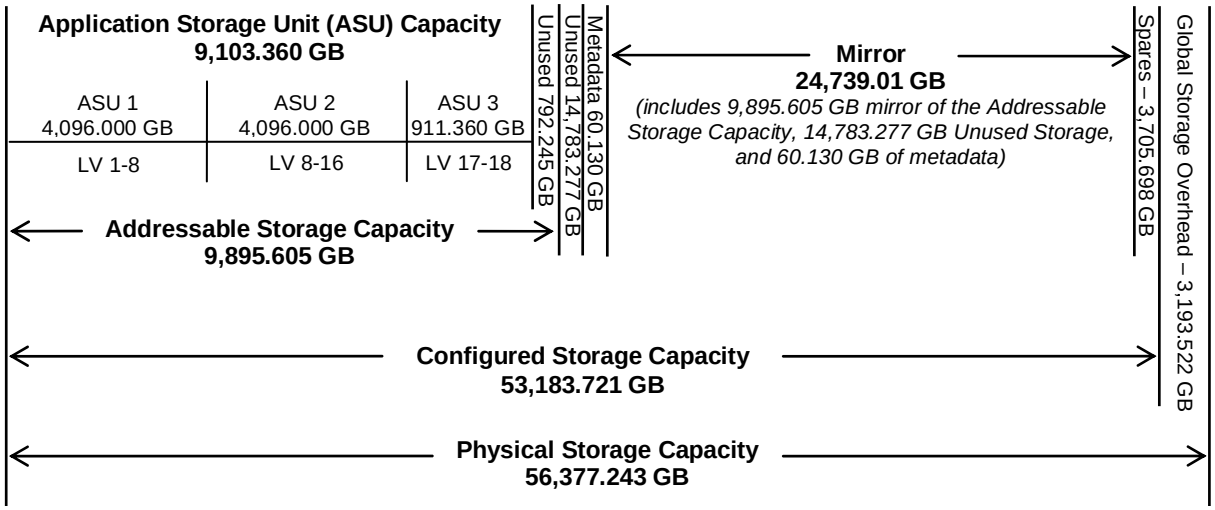
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

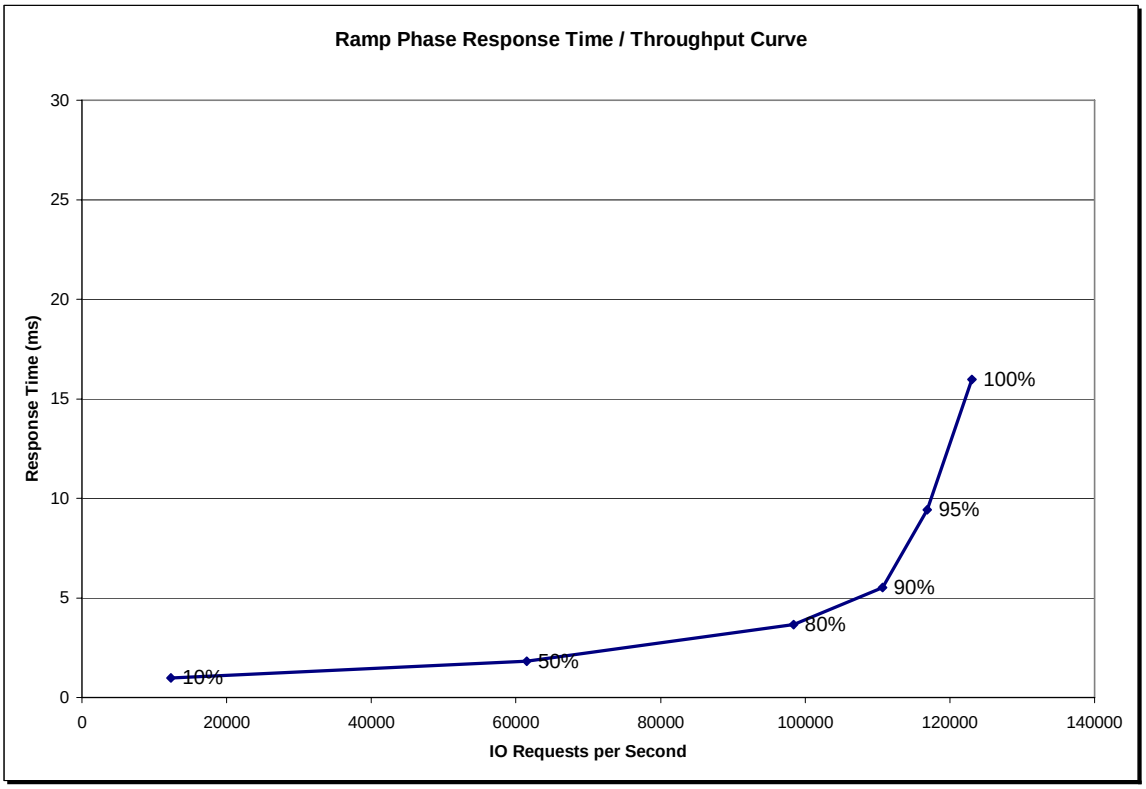
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



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	12,298.48	61,518.29	98,394.87	110,690.96	116,868.86	123,033.40
Average Response Time (ms):						
All ASUs	0.99	1.83	3.67	5.53	9.44	15.96
ASU-1	1.19	1.92	3.43	5.23	8.96	15.35
ASU-2	1.35	2.22	3.99	5.89	9.60	15.55
ASU-3	0.40	1.47	4.04	5.99	10.36	17.45
Reads	1.99	3.29	5.60	7.65	11.51	17.88
Writes	0.34	0.88	2.42	4.14	8.08	14.71

Tested Storage Configuration Pricing *(Priced Storage Configuration)*

Product	Description	Quantity	Unit Price	Unit Maint/mo.	Ext. Price	w/ 3yr maint	% discount	w/ discount
2421-932	System Storage DS8300	1	$114,945.00	$1,200.00	$114,945.00	$143,745.00	25	$107,808.75
1	9xE factory merge	2	$0.00	$0.00	$0.00	$0.00	25	$0.00
321	932 - 92E Position 1	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
322	932 - 92E Position 2	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
700	OEL Indicator	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
820	50.1 to 75.0 TB capacity	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
900	Non-Standby CoD	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
1050	Battery Assembly	3	$1,700.00	$0.00	$5,100.00	$5,100.00	25	$3,825.00
1090	Line Cord (US/LA/AP/Canada)	1	$1,900.00	$0.00	$1,900.00	$1,900.00	25	$1,425.00
1100	Management Console Internal	1	$7,480.00	$70.00	$7,480.00	$9,160.00	25	$6,870.00
1210	Disk Enclosure Pair	4	$10,000.00	$0.00	$40,000.00	$40,000.00	25	$30,000.00
1211	Disk Drive Cable Group 1	1	$1,000.00	$0.00	$1,000.00	$1,000.00	25	$750.00
1300	I/O Enclosure Pair	2	$10,340.00	$60.00	$20,680.00	$23,560.00	25	$17,670.00
1313	RIO-G Cable Group 3	1	$1,600.00	$0.00	$1,600.00	$1,600.00	25	$1,200.00
1421	9 um Fibre Cable (LC/SC)	8	$100.00	$0.00	$800.00	$800.00	25	$600.00
2016	73 GB 15K Drive Set *(16 drives per drive set)*	8	$22,220.00	$105.00	$177,760.00	$197,920.00	25	$148,440.00
3011	Device Adapter Pair	4	$10,000.00	$0.00	$40,000.00	$40,000.00	25	$30,000.00
3111	2Gb SW FCP/FICON Adapter	8	$18,880.00	$45.00	$151,040.00	$159,680.00	25	$119,760.00
4115	256 GB Processor Memory	1	$753,920.00	$1,280.00	$753,920.00	$784,640.00	25	$588,480.00
7001	OEL - 1 TB indicator	2	$0.00	$0.00	$0.00	$0.00	25	$0.00
7002	OEL - 5 TB indicator	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
7005	OEL - 50 TB indicator	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
9090	AC Voltage: 200V - 240V	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
9100	MC Keyboard - US English	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
2396-LFA	DS8000 Function Authorization	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
7001	OEL - 1 TB Unit	2	$6,497.65	$0.00	$12,995.30	$12,995.30	25	$9,746.48
7002	OEL - 5 TB Unit	1	$25,988.27	$0.00	$25,988.27	$25,988.27	25	$19,491.20
7005	OEL - 50 TB Unit	1	$132,382.69	$0.00	$132,382.69	$132,382.69	25	$99,287.02
2421-92E	System Storage DS8000 Enclosure Unit	1	$70,500.00	$125.00	$70,500.00	$73,500.00	25	$55,125.00
1	9xE factory merge	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
321	932 - 92E Position 1	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
1020	Power Module second pair	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
1050	Battery Assembly	3	$1,700.00	$0.00	$5,100.00	$5,100.00	25	$3,825.00
1090	Line Cord (US/LA/AP/Canada)	1	$1,900.00	$0.00	$1,900.00	$1,900.00	25	$1,425.00
1210	Disk Enclosure Pair	8	$10,000.00	$0.00	$80,000.00	$80,000.00	25	$60,000.00
1212	Disk Drive Cable Group 2	1	$1,900.00	$0.00	$1,900.00	$1,900.00	25	$1,425.00
1300	I/O Enclosure Pair	2	$10,340.00	$60.00	$20,680.00	$23,560.00	25	$17,670.00
1314	RIO-G Cable Group 4	1	$2,300.00	$0.00	$2,300.00	$2,300.00	25	$1,725.00
1411	50 um Fibre Cable (LC/SC)	8	$100.00	$0.00	$800.00	$800.00	25	$600.00
2216	146 GB 15K Drive Set *(16 drives per drive set)*	16	$41,228.00	$202.00	$659,648.00	$737,216.00	25	$552,912.00
3011	Device Adapter Pair	4	$10,000.00	$0.00	$40,000.00	$40,000.00	25	$30,000.00
3111	2Gb SW FCP/FICON Adapter	8	$18,880.00	$45.00	$151,040.00	$159,680.00	25	$119,760.00
9090	AC Voltage: 200V - 240V	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
2421-92E	System Storage DS8000 Enclosure Unit	1	$70,500.00	$125.00	$70,500.00	$73,500.00	25	$55,125.00
1	9xE factory merge	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
322	932 - 92E Position 2	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
1090	Line Cord (US/LA/AP/Canada)	1	$1,900.00	$0.00	$1,900.00	$1,900.00	25	$1,425.00
1210	Disk Enclosure Pair	4	$10,000.00	$0.00	$40,000.00	$40,000.00	25	$30,000.00
1214	Disk Drive Cable Group 4	1	$2,400.00	$0.00	$2,400.00	$2,400.00	25	$1,800.00
2016	73 GB 15K Drive Set *(16 drives per drive set)*	8	$22,220.00	$105.00	$177,760.00	$197,920.00	25	$148,440.00
9090	AC Voltage: 200V - 240V	1	$0.00	$0.00	$0.00	$0.00	25	$0.00
9119-5716	P5 595 adapter (2 Gbps, PCI-X)	32	$1,999.00	$0.00	$63,968.00	$63,968.00	0	$63,968.00
1249-19K	short wave FC cable (25 m)	32	$189.00	$0.00	$6,048.00	$6,048.00	0	$6,048.00
						TOTAL		**$2,336,626.45**

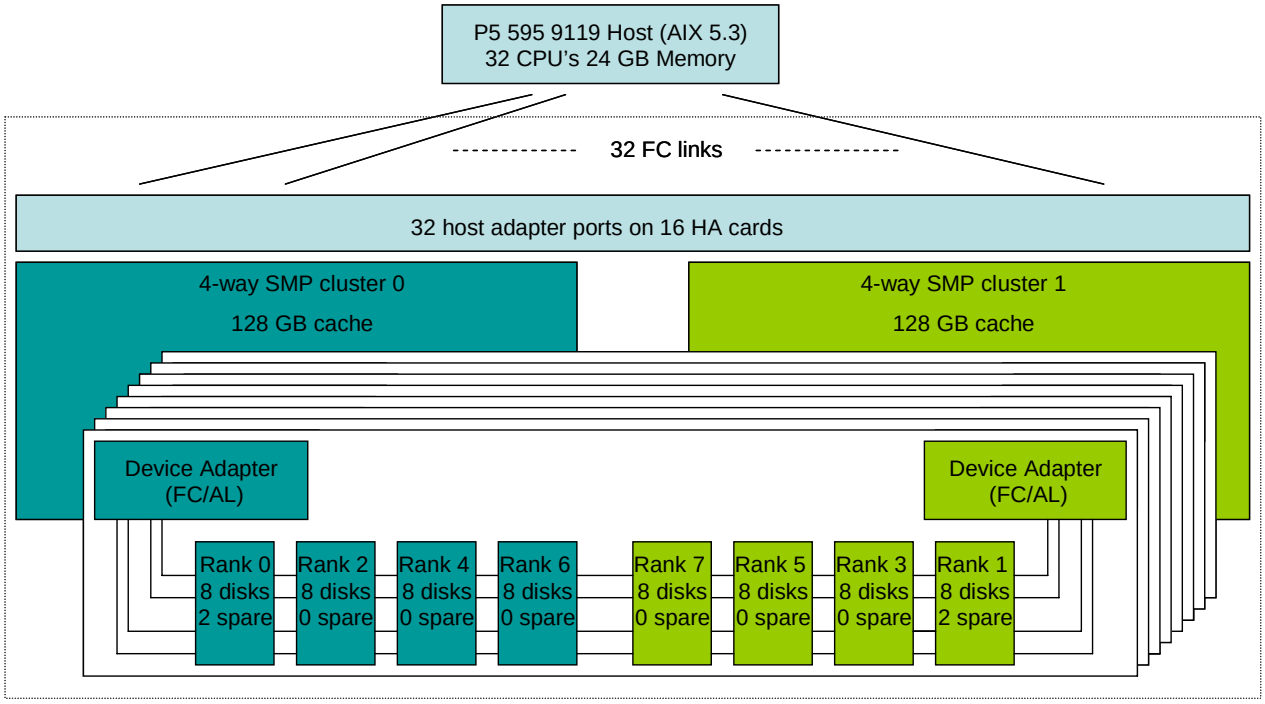
The above pricing provides maintenance/support for 24 hours per day, 7 days per week for three years with four hour acknowledgement and four hour subsequent response (support engineer onsite or customer replaceable part available). In addition, the above pricing includes a 25% IBM Field Delegation Discount, which is generally available.

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

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

Benchmark Configuration/Tested Storage Configuration Diagram

HS-1: IBM P5 595 Model 9119



SC-1: IBM System Storage DS8300 Turbo

Benchmark Configuration/Tested Storage Configuration Components

Host System:	Tested Storage Configuration (TSC):
UID=HS-1 **IBM P5 595 Model 9119**	32 – P5 595 adapters (2 Gb, PCI-X)
CPU: 32 – 1.9 GHz CPUs: 2 CPUs/POWER5 chip 32 KB L1 cache, 960 KB L2 cache, and 18 MB L3 cache per CPU	***UID=SC-1*** IBM System Storage DS8300 Turbo Each cluster contains: 4 – POWER5 CPUs 128 GB of processor memory (256 GB total)
Main memory: 24 GB	
Operating System: AIX 5.3 (32 bit)	16 – 2 Gb SW FCP/FICON adapters 32 host side, front-end ports 8 – 4 port, 2 Gb/s, FC-AL device adapter pairs 32 drive side, backend ports
Host System interconnect: PCI-X/RIO	
WG (SPC-1 Workload Generator)	
	16 – disk enclosure pairs (16 disk drives per enclosure)
	256 – 73 GB, 15K RPM disk drives
	256 – 146 GB, 15K RPM disk drives

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) was configured with local storage and, as such, did not employ a storage network.

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 59 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 60 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 73.

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 55 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)	9,103.360
Addressable Storage Capacity	Gigabytes (GB)	9,895.605
Configured Storage Capacity	Gigabytes (GB)	53,183.721
Physical Storage Capacity	Gigabytes (GB)	56,377.243
Data Protection (Mirroring)	Gigabytes (GB)	24,739.012
Required Storage/Spares	Gigabytes (GB)	3,705.698
Global Storage Overhead	Gigabytes (GB)	3,193.522
Total Unused Storage	Gigabytes (GB)	31,151.044

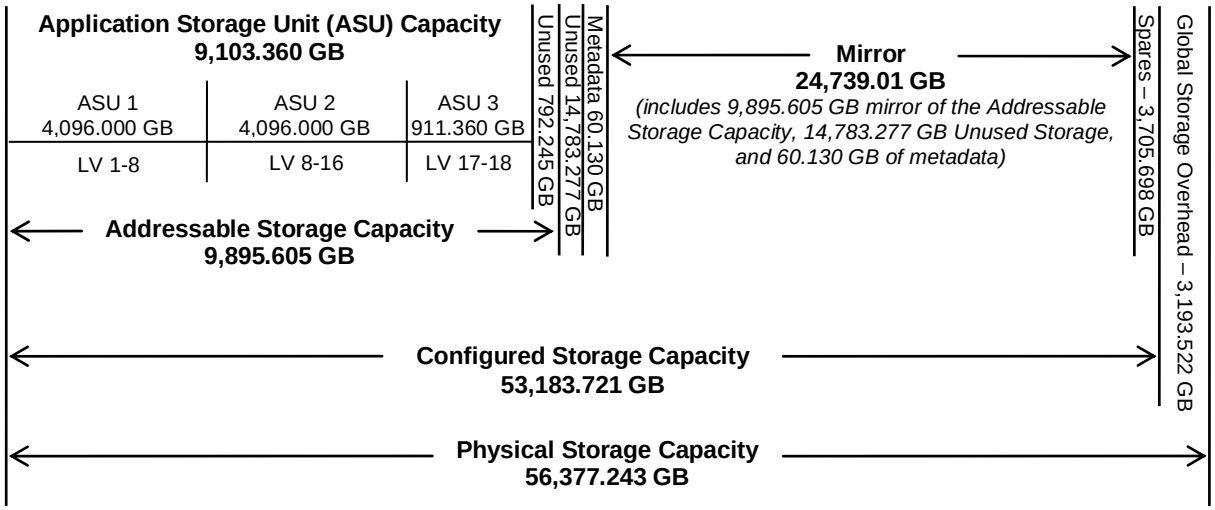
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	91.99%	17.12%	16.15%
Required for Data Protection (Mirroring)		46.52%	43.88%
Addressable Storage Capacity		18.61%	17.55%
Required Storage		6.97%	6.57%
Configured Storage Capacity			94.34%
Global Storage Overhead			5.66%
Unused Storage:			
Addressable	8.01%		
Configured		55.59%	
Physical			0.00%

The Physical Storage Capacity consisted of 56,377.243 GB distributed over 256 disk drives each with a formatted capacity of 68.366 GB plus 256 disk drives each with a formatted capacity of 136.733 GB. There was 0.00 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 3,193.522 GB (5.66%) of Physical Storage Capacity. There was 29,566.55 GB (55.59%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 91.99% of the Addressable Storage Capacity resulting in 792.245 GB (8.01%) 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 (4,096.000 GB)	**ASU-2 (4,096.000 GB)**	**ASU-3 (1,099.512 GB)**
8 Logical Volumes 549.756 GB per Logical Volume (512.000 GB used per Logical Volume)	8 Logical Volumes 549.756 GB per Logical Volume (512.000 GB used per Logical Volume)	2 Logical Volumes 549.756 GB per Logical Volume (455.680 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was Mirroring as described on page 11. 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 56 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 74.

Sustainability Test Results File

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

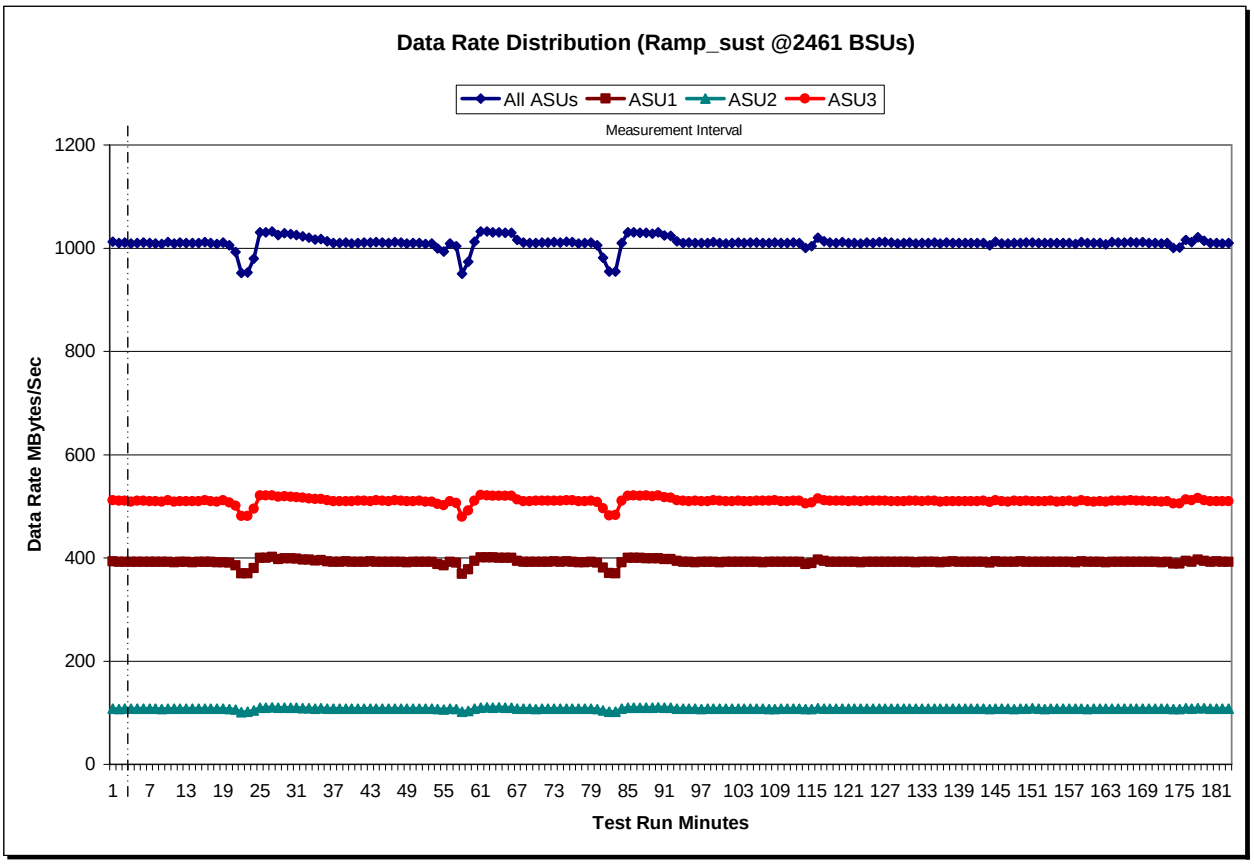
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	5:15:12	5:18:12	0-2	0:03:00
Measurement Interval	5:18:12	8:18:12	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	1,012.77	393.19	107.88	511.69	63	1,030.60	400.10	110.28	520.22	126	1,011.36	392.39	108.17	510.80
1	1,010.00	392.17	107.44	510.38	64	1,029.41	399.68	109.71	520.02	127	1,010.45	392.52	108.02	509.92
2	1,010.53	392.37	107.75	510.41	65	1,029.57	399.81	109.83	519.94	128	1,009.16	392.13	107.67	509.36
3	1,009.03	392.25	107.77	509.01	66	1,015.73	394.04	108.22	513.47	129	1,010.01	392.16	107.96	509.89
4	1,010.19	392.31	107.63	510.25	67	1,010.49	392.32	108.37	509.80	130	1,010.51	391.97	108.05	510.49
5	1,010.55	392.62	107.61	510.32	68	1,010.10	392.17	107.91	510.02	131	1,009.49	391.58	107.72	510.18
6	1,009.53	392.06	107.80	509.67	69	1,010.08	392.24	107.55	510.30	132	1,009.72	392.35	107.87	509.50
7	1,009.43	392.15	107.74	509.54	70	1,010.74	391.96	107.82	510.96	133	1,009.95	392.04	107.64	510.28
8	1,008.54	392.14	107.45	508.96	71	1,010.76	392.11	107.99	510.66	134	1,010.81	392.29	108.10	510.42
9	1,011.43	392.08	108.17	511.18	72	1,011.48	392.67	108.14	510.67	135	1,008.66	391.77	107.90	508.99
10	1,009.13	391.78	108.14	509.21	73	1,010.87	392.56	108.01	510.30	136	1,010.39	392.34	108.16	509.89
11	1,010.96	392.58	108.26	510.13	74	1,012.18	392.72	107.94	511.52	137	1,009.98	392.85	107.83	509.29
12	1,009.88	392.25	107.78	509.86	75	1,011.52	392.29	108.10	511.12	138	1,010.17	392.31	108.35	509.51
13	1,009.51	391.76	107.80	509.95	76	1,009.01	391.64	107.79	509.58	139	1,009.61	392.34	107.86	509.42
14	1,009.82	391.91	107.86	510.06	77	1,009.73	391.79	107.80	510.14	140	1,010.05	391.99	107.91	510.15
15	1,011.86	392.43	108.30	511.13	78	1,010.46	392.24	108.03	510.18	141	1,010.02	392.32	107.89	509.81
16	1,009.58	391.93	107.60	510.05	79	1,005.37	390.46	107.32	507.59	142	1,010.32	391.93	107.99	510.40
17	1,008.56	391.75	107.66	509.14	80	981.59	381.27	104.52	495.81	143	1,005.19	390.10	107.52	507.58
18	1,010.70	391.58	108.05	511.07	81	954.30	370.21	102.35	481.74	144	1,012.49	393.04	107.89	511.57
19	1,005.77	390.84	107.40	507.53	82	954.28	369.78	101.97	482.53	145	1,009.47	391.96	108.01	509.50
20	992.65	385.13	106.13	501.39	83	1,009.56	391.21	107.67	510.68	146	1,009.09	392.03	107.81	509.26
21	952.36	369.78	101.49	481.09	84	1,030.39	400.23	110.08	520.08	147	1,010.06	392.16	107.47	510.44
22	953.09	370.09	101.91	481.08	85	1,030.55	399.77	109.86	520.93	148	1,010.07	392.75	107.88	509.43
23	979.33	380.38	104.31	494.64	86	1,030.06	399.98	110.07	520.01	149	1,010.63	392.23	108.20	510.20
24	1,030.46	399.62	109.76	521.08	87	1,029.71	399.35	109.70	520.65	150	1,010.54	392.23	108.53	509.78
25	1,030.92	400.26	110.04	520.62	88	1,028.28	399.31	109.77	519.20	151	1,010.18	392.36	107.92	509.91
26	1,032.53	401.43	110.32	520.77	89	1,030.61	399.57	110.17	520.87	152	1,009.58	392.18	107.56	509.84
27	1,025.20	397.78	109.48	517.95	90	1,025.02	397.67	109.49	517.86	153	1,010.05	392.06	107.83	510.16
28	1,028.68	399.19	109.99	519.51	91	1,023.40	397.24	109.66	516.49	154	1,009.62	392.43	107.97	509.22
29	1,026.98	398.78	110.00	518.20	92	1,012.97	393.55	107.85	511.57	155	1,010.28	392.49	107.78	510.00
30	1,025.49	398.43	109.76	517.29	93	1,010.10	392.12	107.79	510.18	156	1,010.24	392.02	107.60	510.63
31	1,022.76	396.86	109.09	516.81	94	1,010.55	392.45	108.07	510.03	157	1,008.13	391.76	107.81	508.57
32	1,020.62	396.48	109.11	515.03	95	1,010.16	391.78	107.70	510.69	158	1,012.09	392.68	108.17	511.24
33	1,016.91	394.45	108.36	514.10	96	1,009.68	392.47	107.44	509.77	159	1,010.05	392.63	107.32	510.11
34	1,017.89	395.35	108.85	513.70	97	1,010.15	392.15	108.05	509.96	160	1,009.92	392.59	108.05	509.27
35	1,013.39	393.52	108.07	511.80	98	1,011.36	392.03	107.78	511.55	161	1,009.75	392.02	108.08	509.65
36	1,009.70	392.48	107.62	509.60	99	1,009.76	391.69	107.85	510.22	162	1,007.44	391.32	107.60	508.52
37	1,010.06	392.08	107.90	510.08	100	1,009.07	391.96	107.57	509.54	163	1,011.68	392.34	108.39	510.95
38	1,010.49	392.75	108.35	509.38	101	1,010.12	391.98	108.21	509.93	164	1,010.64	392.39	107.79	510.47
39	1,008.89	391.89	107.59	509.40	102	1,010.90	392.45	107.83	510.62	165	1,010.76	392.27	107.90	510.59
40	1,010.00	391.92	107.88	510.20	103	1,010.25	392.57	108.07	509.61	166	1,011.58	392.18	107.96	511.44
41	1,010.55	392.31	107.77	510.47	104	1,010.40	392.04	108.21	510.15	167	1,010.42	392.21	107.98	510.23
42	1,010.61	392.69	108.33	509.60	105	1,010.47	392.17	107.76	510.53	168	1,011.25	392.35	108.27	510.63
43	1,011.49	392.62	107.73	511.15	106	1,009.81	391.69	107.72	510.39	169	1,009.82	392.10	107.86	509.86
44	1,010.45	392.02	107.72	510.71	107	1,010.12	392.15	107.53	510.44	170	1,009.99	392.14	108.08	509.77
45	1,009.78	392.21	107.73	509.84	108	1,010.92	392.44	107.47	511.02	171	1,008.81	391.71	107.87	509.23
46	1,011.99	392.29	108.39	511.31	109	1,009.54	392.28	107.64	509.62	172	1,010.34	392.53	107.79	510.02
47	1,010.40	392.45	107.61	510.35	110	1,009.72	391.83	107.92	509.97	173	1,000.22	388.40	106.84	504.97
48	1,009.33	391.62	107.60	510.11	111	1,010.76	392.40	107.97	510.40	174	1,000.99	388.75	107.22	505.03
49	1,009.63	392.24	107.81	509.58	112	1,010.26	392.04	108.06	510.15	175	1,015.90	394.18	108.49	513.23
50	1,009.78	391.84	107.57	510.37	113	1,000.41	388.29	106.76	505.36	176	1,011.70	392.53	107.80	511.38
51	1,008.53	391.89	107.62	509.02	114	1,004.17	389.68	107.30	507.19	177	1,020.94	396.16	108.79	515.99
52	1,009.24	392.09	107.90	509.25	115	1,020.60	396.79	108.95	514.86	178	1,013.91	393.93	108.42	511.55
53	999.99	388.19	107.03	504.77	116	1,013.57	394.15	108.30	511.12	179	1,010.05	392.42	107.75	509.88
54	993.52	385.65	105.92	501.95	117	1,010.54	392.24	107.78	510.53	180	1,010.03	392.83	107.62	509.58
55	1,009.40	391.90	107.89	509.60	118	1,010.33	392.11	107.88	510.34	181	1,008.95	391.90	107.61	509.44
56	1,004.01	390.37	107.12	506.51	119	1,011.25	392.35	108.19	510.72	182	1,009.99	392.06	108.01	509.92
57	950.03	368.57	101.61	479.86	120	1,010.16	392.43	107.80	509.92					
58	973.67	377.80	104.09	491.78	121	1,010.33	391.98	107.88	510.48					
59	1,012.48	393.54	108.10	510.84	122	1,009.43	391.57	107.91	509.95					
60	1,032.56	400.48	110.09	521.99	123	1,010.46	392.21	107.88	510.37					
61	1,032.43	400.86	110.40	521.18	124	1,010.09	391.83	107.70	510.56					
62	1,030.80	400.64	110.03	520.13	125	1,011.23	392.65	107.89	510.69					

Sustainability – Data Rate Distribution Graph

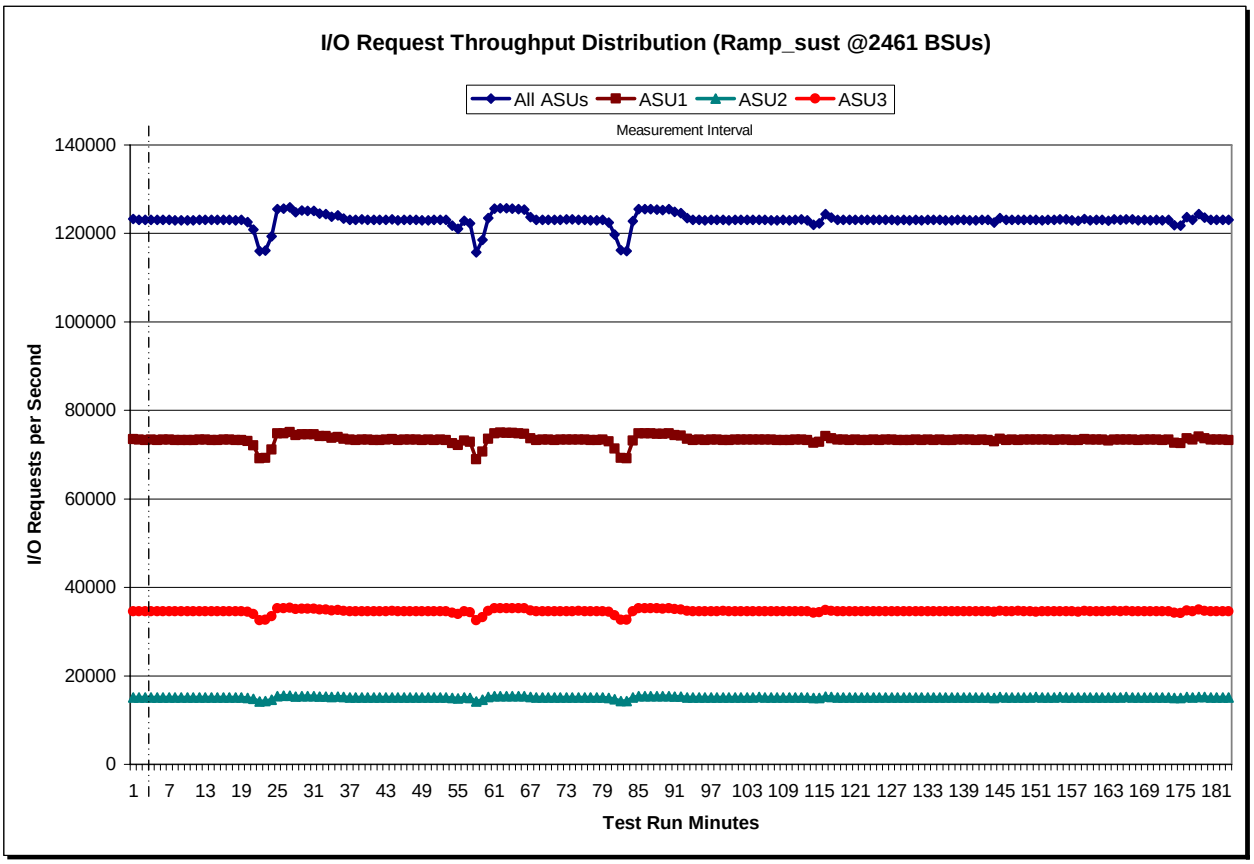


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	5:15:12	5:18:12	0-2	0:03:00
Measurement Interval	5:18:12	8:18:12	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	123,256.22	73,477.35	15,159.93	34,618.93	63	125,632.23	74,872.83	15,467.92	35,291.48	126	123,041.85	73,340.98	15,116.55	34,584.32
1	123,029.98	73,333.08	15,108.90	34,588.00	64	125,464.75	74,792.87	15,402.97	35,268.92	127	122,993.77	73,309.88	15,123.12	34,560.77
2	123,018.60	73,312.50	15,122.55	34,583.55	65	125,384.70	74,718.25	15,424.52	35,241.93	128	123,021.32	73,324.28	15,135.07	34,561.97
3	123,016.65	73,343.23	15,127.23	34,546.18	66	123,629.90	73,699.45	15,178.95	34,751.50	129	122,972.22	73,323.87	15,111.90	34,536.45
4	123,040.15	73,317.28	15,130.67	34,592.20	67	123,035.13	73,293.17	15,160.83	34,581.13	130	123,039.32	73,343.40	15,124.72	34,571.20
5	123,104.78	73,405.82	15,124.45	34,574.52	68	123,112.75	73,388.53	15,120.08	34,604.13	131	122,988.18	73,310.60	15,121.23	34,556.35
6	123,059.18	73,329.77	15,151.52	34,577.90	69	123,026.42	73,327.35	15,113.32	34,585.75	132	123,099.48	73,361.97	15,133.73	34,603.78
7	122,931.35	73,256.20	15,121.40	34,553.75	70	123,032.68	73,309.53	15,133.52	34,589.63	133	123,024.75	73,317.62	15,139.45	34,567.68
8	122,998.78	73,313.92	15,141.47	34,543.40	71	123,058.68	73,328.93	15,123.92	34,605.83	134	123,109.53	73,376.55	15,140.22	34,592.77
9	123,013.23	73,277.87	15,141.87	34,593.50	72	123,122.38	73,363.20	15,158.23	34,600.95	135	123,001.37	73,326.05	15,123.25	34,552.07
10	123,000.37	73,294.87	15,159.55	34,545.95	73	123,130.95	73,386.63	15,155.03	34,589.28	136	123,007.77	73,281.90	15,153.87	34,572.00
11	123,103.33	73,381.07	15,142.20	34,580.07	74	123,105.47	73,343.63	15,136.02	34,625.82	137	123,046.02	73,392.87	15,127.07	34,526.08
12	123,085.75	73,354.48	15,150.70	34,580.57	75	123,087.92	73,341.18	15,142.00	34,604.73	138	123,064.22	73,354.53	15,147.75	34,561.93
13	123,059.10	73,295.48	15,144.02	34,619.60	76	122,978.22	73,287.47	15,129.38	34,561.37	139	122,975.02	73,338.23	15,106.75	34,530.03
14	123,028.13	73,322.47	15,137.12	34,568.55	77	122,993.82	73,280.27	15,154.05	34,559.50	140	122,983.50	73,306.78	15,122.00	34,554.72
15	123,053.08	73,328.82	15,155.17	34,569.10	78	123,043.73	73,350.07	15,139.28	34,554.38	141	123,058.87	73,354.50	15,132.85	34,571.52
16	123,031.57	73,332.68	15,107.43	34,591.45	79	122,485.42	73,009.93	15,044.63	34,430.85	142	123,058.38	73,309.42	15,152.92	34,596.05
17	123,001.80	73,315.47	15,108.58	34,577.75	80	119,705.95	71,344.45	14,728.77	33,632.73	143	122,504.13	73,010.00	15,057.93	34,436.20
18	123,038.18	73,294.57	15,143.50	34,600.12	81	116,197.38	69,220.27	14,316.82	32,660.30	144	123,443.92	73,564.40	15,172.45	34,707.07
19	122,582.27	73,082.03	15,065.78	34,434.45	82	116,052.75	69,136.95	14,284.25	32,631.55	145	123,020.10	73,322.40	15,136.13	34,561.57
20	120,826.55	72,016.90	14,849.05	33,960.60	83	122,812.20	73,172.87	15,089.77	34,549.57	146	123,040.80	73,336.13	15,130.20	34,574.47
21	115,989.87	69,138.60	14,250.78	32,600.48	84	125,524.62	74,829.85	15,434.75	35,260.02	147	123,075.22	73,325.50	15,124.97	34,624.75
22	116,158.60	69,221.38	14,298.40	32,638.82	85	125,460.97	74,747.53	15,446.03	35,267.40	148	123,087.30	73,386.58	15,133.83	34,566.88
23	119,299.52	71,142.02	14,662.88	33,494.62	86	125,532.22	74,814.23	15,454.02	35,263.97	149	123,068.28	73,363.27	15,149.13	34,555.88
24	125,442.40	74,749.68	15,406.07	35,286.65	87	125,404.88	74,735.27	15,427.63	35,241.98	150	123,053.82	73,367.38	15,173.27	34,513.17
25	125,551.77	74,813.48	15,474.90	35,263.38	88	125,286.05	74,691.42	15,397.52	35,197.12	151	123,012.07	73,339.25	15,128.50	34,544.32
26	125,891.87	75,040.10	15,502.18	35,349.58	89	125,458.95	74,746.28	15,438.38	35,274.28	152	123,050.63	73,351.35	15,136.68	34,562.60
27	124,813.30	74,398.92	15,350.73	35,063.65	90	124,851.62	74,392.88	15,343.98	35,114.75	153	123,049.50	73,317.20	15,129.93	34,602.37
28	125,156.80	74,604.42	15,382.75	35,169.63	91	124,561.90	74,282.92	15,336.43	34,942.55	154	123,156.55	73,370.08	15,179.03	34,607.43
29	125,099.63	74,555.37	15,395.53	35,148.73	92	123,420.88	73,589.83	15,157.27	34,673.78	155	123,119.58	73,389.17	15,143.30	34,587.12
30	125,068.52	74,549.98	15,388.60	35,129.93	93	123,046.38	73,313.38	15,145.68	34,587.32	156	122,988.98	73,302.30	15,121.83	34,564.85
31	124,496.50	74,219.17	15,287.40	34,989.93	94	123,069.07	73,349.52	15,115.80	34,603.75	157	122,896.60	73,246.58	15,131.27	34,518.75
32	124,410.07	74,175.35	15,303.98	34,930.73	95	123,006.12	73,298.13	15,132.22	34,575.77	158	123,278.03	73,469.42	15,168.87	34,639.75
33	123,758.60	73,777.05	15,211.20	34,770.35	96	123,058.43	73,327.67	15,109.23	34,621.53	159	123,015.80	73,346.33	15,101.48	34,567.98
34	124,065.02	73,943.93	15,276.23	34,844.85	97	123,045.68	73,343.22	15,138.10	34,564.37	160	123,104.55	73,415.18	15,123.77	34,565.60
35	123,404.90	73,550.28	15,181.45	34,673.17	98	123,061.75	73,306.02	15,127.97	34,627.77	161	123,085.72	73,359.48	15,154.25	34,571.98
36	123,073.43	73,334.57	15,142.68	34,596.18	99	123,012.90	73,283.18	15,142.53	34,587.18	162	122,878.68	73,203.77	15,144.15	34,530.77
37	123,024.87	73,322.27	15,141.72	34,560.88	100	123,052.23	73,333.12	15,127.58	34,591.53	163	123,141.70	73,361.32	15,157.82	34,622.57
38	123,140.83	73,423.75	15,148.50	34,568.58	101	123,069.67	73,354.07	15,151.13	34,564.47	164	123,065.78	73,345.22	15,134.13	34,586.43
39	123,034.45	73,360.30	15,129.07	34,545.08	102	123,095.43	73,372.35	15,122.77	34,600.32	165	123,174.67	73,373.35	15,179.28	34,622.03
40	123,061.37	73,325.73	15,152.87	34,582.77	103	123,067.23	73,366.27	15,158.93	34,542.03	166	123,125.32	73,375.52	15,139.47	34,610.33
41	123,023.30	73,318.93	15,139.30	34,565.07	104	123,056.27	73,338.23	15,173.22	34,544.82	167	122,985.68	73,308.77	15,128.60	34,548.32
42	123,092.62	73,403.50	15,154.80	34,534.32	105	123,058.07	73,331.50	15,121.38	34,605.18	168	123,103.97	73,363.73	15,158.10	34,582.13
43	123,188.98	73,445.17	15,120.73	34,623.08	106	123,012.53	73,331.58	15,114.90	34,566.05	169	123,008.15	73,333.60	15,133.37	34,541.18
44	123,007.93	73,319.73	15,116.88	34,571.32	107	122,989.45	73,285.45	15,118.57	34,585.43	170	123,085.97	73,352.95	15,142.80	34,590.22
45	123,034.52	73,353.00	15,123.58	34,557.93	108	123,038.57	73,314.15	15,111.07	34,613.35	171	122,962.82	73,285.70	15,123.05	34,554.07
46	123,086.55	73,346.82	15,138.57	34,601.17	109	122,925.08	73,251.05	15,135.17	34,538.87	172	123,045.00	73,374.05	15,131.73	34,539.22
47	123,048.92	73,332.05	15,120.85	34,596.02	110	123,053.77	73,345.38	15,127.27	34,581.12	173	121,899.40	72,686.75	14,991.87	34,220.78
48	122,941.93	73,228.87	15,117.62	34,595.45	111	123,119.92	73,366.52	15,159.42	34,593.98	174	121,782.50	72,587.85	14,989.37	34,205.28
49	123,013.57	73,342.00	15,117.18	34,554.38	112	122,995.60	73,298.13	15,136.30	34,561.17	175	123,635.52	73,652.42	15,207.88	34,775.22
50	123,017.92	73,302.35	15,121.47	34,594.10	113	121,944.17	72,647.72	14,983.62	34,312.83	176	123,078.13	73,341.53	15,134.90	34,601.70
51	123,020.27	73,345.22	15,124.52	34,550.53	114	122,284.53	72,869.27	15,039.82	34,375.45	177	124,377.17	74,123.48	15,268.22	34,985.47
52	123,016.60	73,324.70	15,125.42	34,566.48	115	124,407.13	74,161.73	15,329.95	34,915.45	178	123,579.97	73,651.97	15,211.93	34,716.07
53	121,803.62	72,574.13	14,978.82	34,250.67	116	123,571.33	73,702.12	15,202.12	34,667.10	179	123,039.45	73,339.98	15,145.00	34,554.47
54	121,027.23	72,137.60	14,874.65	34,014.98	117	123,069.58	73,336.88	15,132.40	34,600.30	180	123,093.52	73,389.95	15,133.58	34,569.98
55	122,867.62	73,210.27	15,126.33	34,531.02	118	123,068.17	73,332.23	15,151.72	34,584.22	181	123,045.52	73,329.38	15,113.63	34,602.50
56	122,301.87	72,898.40	15,048.65	34,354.82	119	123,069.43	73,325.50	15,148.18	34,595.75	182	123,046.97	73,313.23	15,136.60	34,597.13
57	115,752.58	68,983.40	14,229.92	32,539.27	120	123,079.22	73,348.05	15,119.17	34,612.00	Average	123,049.35	73,337.03	15,134.94	34,577.38
58	118,549.62	70,646.72	14,591.73	33,311.17	121	123,059.97	73,325.72	15,136.77	34,597.48					
59	123,421.25	73,569.12	15,177.95	34,674.18	122	123,022.77	73,282.90	15,147.17	34,592.70					
60	125,564.15	74,823.03	15,428.33	35,312.78	123	123,052.05	73,327.45	15,138.27	34,586.33					
61	125,734.33	74,954.63	15,466.58	35,313.12	124	123,019.62	73,314.85	15,123.25	34,581.52					
62	125,642.35	74,921.62	15,442.78	35,277.95	125	123,037.27	73,342.73	15,136.32	34,558.22					

Sustainability – I/O Request Throughput Distribution Graph

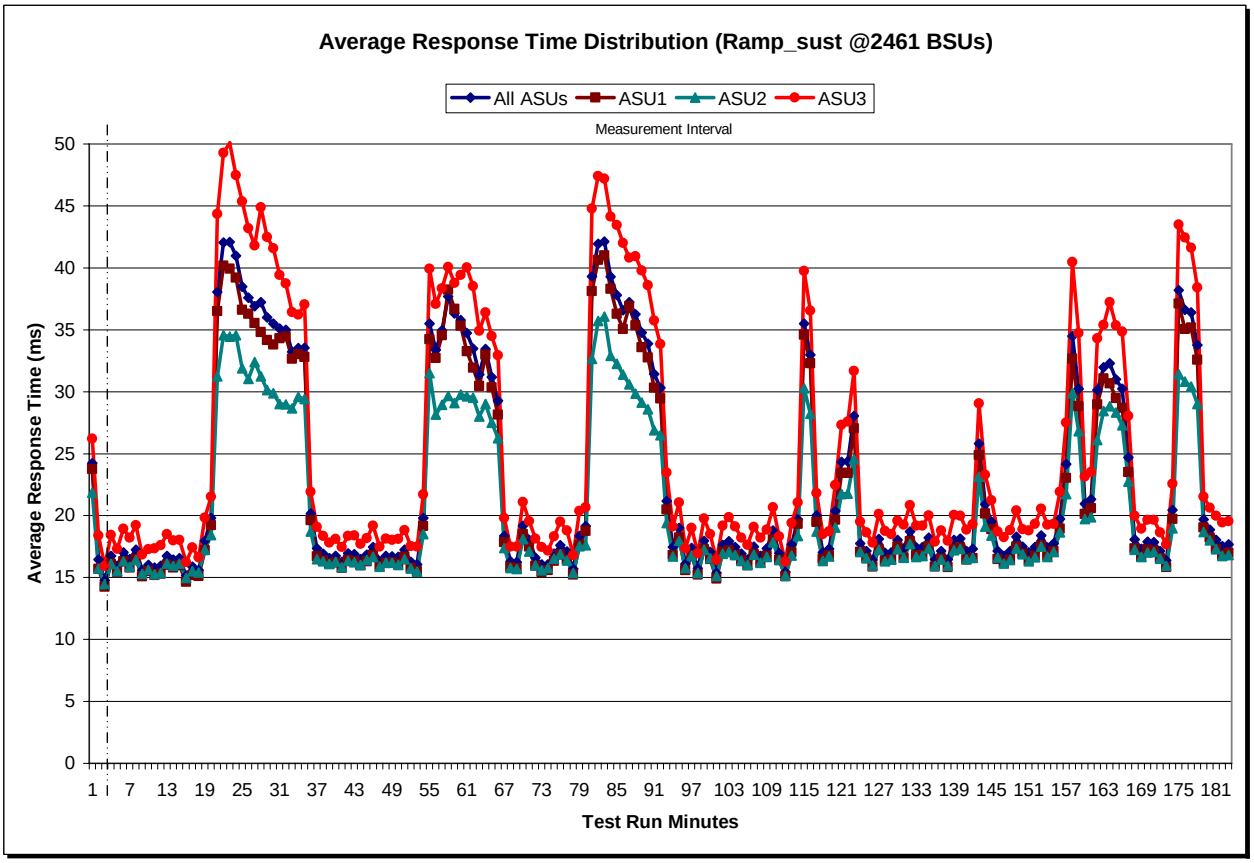


Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	5:15:12	5:18:12	0-2	0:03:00
Measurement Interval	5:18:12	8:18:12	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	24.22	23.77	21.85	26.19	63	33.44	32.97	29.01	36.39	126	18.09	17.31	17.24	20.13
1	16.47	15.71	15.71	18.40	64	31.17	30.36	27.50	34.49	127	17.01	16.33	16.30	18.75
2	14.75	14.25	14.48	15.92	65	29.26	28.16	26.23	32.92	128	17.03	16.46	16.47	18.49
3	16.75	16.09	16.10	18.43	66	18.35	17.86	17.40	19.82	129	18.04	17.48	17.27	19.59
4	15.95	15.39	15.52	17.32	67	16.30	15.85	15.76	17.49	130	17.34	16.59	16.61	19.25
5	17.04	16.29	16.32	18.93	68	16.23	15.73	15.70	17.51	131	18.71	17.91	17.71	20.83
6	16.48	15.79	15.86	18.20	69	19.19	18.51	18.09	21.10	132	17.44	16.78	16.67	19.17
7	17.24	16.47	16.41	19.22	70	18.03	17.50	17.10	19.54	133	17.47	16.81	16.74	19.19
8	15.60	15.07	15.29	16.86	71	16.58	15.96	15.99	18.13	134	18.20	17.52	17.34	20.02
9	16.03	15.52	15.61	17.27	72	16.04	15.46	15.60	17.45	135	16.45	15.89	15.95	17.88
10	15.80	15.17	15.28	17.35	73	16.05	15.57	15.78	17.18	136	17.15	16.52	16.44	18.78
11	15.95	15.30	15.39	17.58	74	16.92	16.34	16.51	18.33	137	16.45	15.84	15.95	17.98
12	16.73	16.02	16.13	18.49	75	17.59	16.84	16.87	19.50	138	18.04	17.27	17.22	20.04
13	16.45	15.82	15.96	18.01	76	17.09	16.44	16.37	18.78	139	18.13	17.43	17.30	20.00
14	16.57	15.97	16.13	18.04	77	15.69	15.24	15.36	16.80	140	17.14	16.46	16.47	18.87
15	15.14	14.66	14.99	16.23	78	18.37	17.61	17.53	20.36	141	17.32	16.54	16.61	19.28
16	15.87	15.21	15.50	17.43	79	19.16	18.77	17.59	20.67	142	25.82	24.86	23.15	29.03
17	15.58	15.13	15.39	16.63	80	39.31	38.12	32.63	44.77	143	20.90	20.15	19.10	23.27
18	17.95	17.20	17.23	19.85	81	41.93	40.63	35.71	47.41	144	19.49	18.90	18.41	21.22
19	19.78	19.24	18.44	21.52	82	42.13	41.00	36.07	47.19	145	17.13	16.50	16.58	18.71
20	38.06	36.50	31.25	44.33	83	39.28	38.31	32.91	44.14	146	16.73	16.15	16.12	18.25
21	42.04	40.16	34.57	49.29	84	37.80	36.28	32.26	43.44	147	17.13	16.47	16.42	18.83
22	42.10	39.92	34.45	50.06	85	36.56	35.06	31.40	42.01	148	18.28	17.48	17.35	20.39
23	40.96	39.21	34.54	47.49	86	37.23	36.91	30.58	40.83	149	17.48	16.93	16.88	18.92
24	38.49	36.60	31.90	45.37	87	36.23	35.33	29.83	40.94	150	17.03	16.35	16.32	18.80
25	37.58	36.30	31.01	43.18	88	34.77	33.59	29.11	39.77	151	17.47	16.75	16.63	19.34
26	36.90	35.52	32.38	41.81	89	33.87	32.74	28.59	38.59	152	18.39	17.56	17.49	20.54
27	37.21	34.82	31.23	44.90	90	31.42	30.32	26.88	35.75	153	17.43	16.73	16.67	19.27
28	36.00	34.15	30.14	42.48	91	30.31	29.43	26.51	33.84	154	17.75	17.14	17.05	19.35
29	35.51	33.81	29.87	41.58	92	21.18	20.47	19.40	23.46	155	19.74	18.94	18.64	21.94
30	35.09	34.31	29.01	39.43	93	17.45	16.81	16.69	19.13	156	24.14	23.04	21.76	27.50
31	34.98	34.44	28.99	38.75	94	18.99	18.23	17.95	21.06	157	34.49	32.64	29.88	40.45
32	33.23	32.66	28.66	36.44	95	16.11	15.60	15.76	17.34	158	30.24	28.84	26.80	34.72
33	33.50	33.02	29.60	36.22	96	17.39	16.75	16.76	19.02	159	20.93	20.13	19.74	23.16
34	33.56	32.78	29.42	37.04	97	15.73	15.21	15.36	16.97	160	21.32	20.59	19.89	23.50
35	20.15	19.61	18.72	21.94	98	17.97	17.26	17.24	19.77	161	30.12	28.98	26.09	34.29
36	17.34	16.70	16.47	19.07	99	17.07	16.50	16.54	18.51	162	31.95	31.05	28.45	35.39
37	16.90	16.33	16.32	18.37	100	15.36	14.90	15.13	16.42	163	32.29	30.68	28.85	37.21
38	16.57	16.08	16.10	17.81	101	17.65	17.07	16.93	19.18	164	31.00	29.48	28.34	35.36
39	16.73	16.18	16.26	18.11	102	17.91	17.16	17.06	19.88	165	30.24	28.67	27.30	34.84
40	16.26	15.78	15.83	17.47	103	17.47	16.83	16.81	19.12	166	24.69	23.49	22.75	28.06
41	16.95	16.42	16.34	18.36	104	16.90	16.39	16.33	18.23	167	18.08	17.35	17.23	19.99
42	16.87	16.29	16.23	18.40	105	16.44	15.96	16.01	17.65	168	17.31	16.67	16.67	18.95
43	16.48	15.99	16.00	17.72	106	17.50	16.88	16.85	19.08	169	17.90	17.25	17.04	19.67
44	16.85	16.31	16.41	18.18	107	16.75	16.17	16.20	18.23	170	17.86	17.17	17.08	19.66
45	17.46	16.82	16.68	19.18	108	17.33	16.75	16.66	18.85	171	17.13	16.54	16.53	18.65
46	16.33	15.87	15.89	17.49	109	18.77	18.07	17.85	20.67	172	16.38	15.86	15.94	17.69
47	16.72	16.15	16.20	18.15	110	16.96	16.43	16.42	18.33	173	20.43	19.73	18.98	22.56
48	16.71	16.19	16.19	18.04	111	15.43	15.09	15.14	16.27	174	38.20	37.12	31.41	43.48
49	16.65	16.10	16.01	18.12	112	17.67	17.04	16.79	19.39	175	36.61	35.05	30.83	42.44
50	17.26	16.67	16.50	18.84	113	19.70	19.33	18.34	21.07	176	36.40	35.18	30.42	41.60
51	16.26	15.78	15.73	17.52	114	35.50	34.58	30.28	39.75	177	33.78	32.57	29.02	38.42
52	16.06	15.51	15.47	17.48	115	32.98	32.30	28.23	36.53	178	19.70	19.04	18.70	21.53
53	19.79	19.16	18.49	21.70	116	20.03	19.46	18.73	21.82	179	18.87	18.21	18.01	20.63
54	35.51	34.24	31.51	39.94	117	17.04	16.49	16.33	18.51	180	18.05	17.30	17.28	19.98
55	33.38	32.71	28.17	37.06	118	17.31	16.78	16.69	18.73	181	17.53	16.80	16.72	19.42
56	34.94	34.57	28.95	38.35	119	20.37	19.65	19.05	22.47	182	17.68	16.98	16.83	19.53
57	37.70	38.24	29.68	40.06	120	24.32	23.44	21.73	27.31	Average	22.88	22.10	20.78	25.46
58	36.33	36.68	29.08	38.76	121	24.39	23.42	21.78	27.58					
59	35.78	35.31	29.75	39.43	122	28.03	27.03	24.54	31.67					
60	34.72	33.27	29.64	40.02	123	17.74	17.05	17.05	19.52					
61	33.48	31.93	29.53	38.51	124	17.14	16.54	16.56	18.65					
62	31.40	30.44	28.01	34.92	125	16.43	15.86	15.97	17.83					

Sustainability – Average Response Time (ms) Distribution Graph



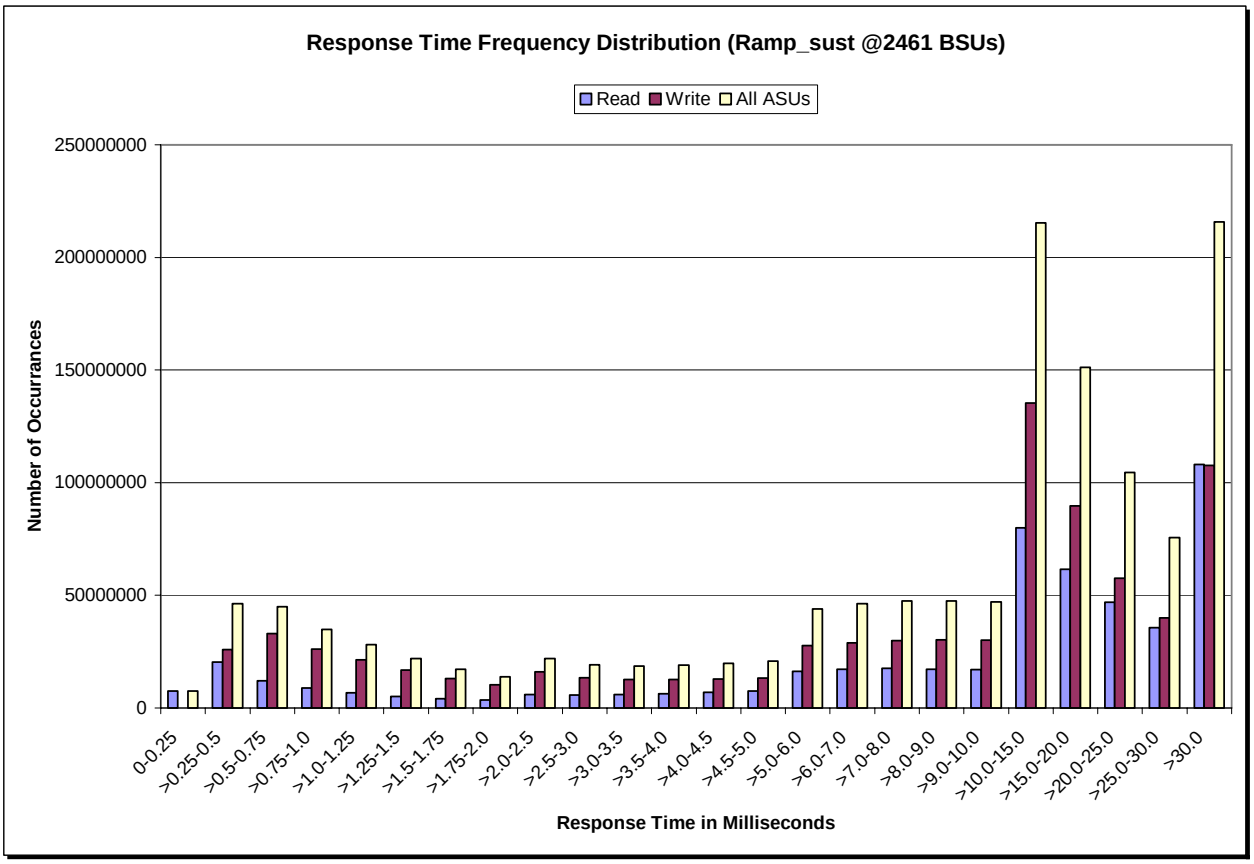
Sustainability – Response Time Frequency Distribution Data

Response	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	7,506,880	20,372,916	11,977,874	8,856,926	6,710,167	5,182,355	4,133,085	3,473,436
Write	-	25,985,147	33,037,696	26,078,413	21,327,472	16,753,977	13,076,781	10,366,757
All ASUs	7,506,880	46,358,063	45,015,570	34,935,339	28,037,639	21,936,332	17,209,866	13,840,193
ASU1	6,709,967	31,262,687	25,035,823	18,753,705	14,577,229	11,374,920	8,965,530	7,292,959
ASU2	796,913	6,181,160	5,358,009	4,020,281	3,115,313	2,434,917	1,910,245	1,541,701
ASU3	-	8,914,216	14,621,738	12,161,353	10,345,097	8,126,495	6,334,091	5,005,533

Response	>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	6,036,740	5,734,949	5,918,346	6,329,716	6,865,831	7,440,895	16,210,348	17,244,971
Write	16,024,116	13,367,712	12,693,768	12,722,794	12,959,108	13,295,323	27,737,856	28,977,532
All ASUs	22,060,856	19,102,661	18,612,114	19,052,510	19,824,939	20,736,218	43,948,204	46,222,503
ASU1	11,964,553	10,729,823	10,673,152	11,079,913	11,655,726	12,304,888	26,260,666	27,698,512
ASU2	2,493,812	2,211,006	2,192,576	2,266,790	2,381,554	2,514,950	5,384,454	5,700,422
ASU3	7,602,491	6,161,832	5,746,386	5,705,807	5,787,659	5,916,380	12,303,084	12,823,569

Response	>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	17,549,957	17,294,249	17,011,792	80,017,268	61,475,676	46,884,724	35,622,270	108,061,760
Write	29,863,203	30,299,611	30,084,098	135,371,985	89,701,868	57,685,945	39,913,726	107,693,728
All ASUs	47,413,160	47,593,860	47,095,890	215,389,253	151,177,544	104,570,669	75,535,996	215,755,488
ASU1	28,391,099	28,421,730	28,130,938	129,613,835	92,549,626	65,294,822	47,398,633	125,898,441
ASU2	5,854,096	5,863,948	5,796,827	26,736,653	19,191,450	13,837,401	10,316,439	25,356,285
ASU3	13,167,965	13,308,182	13,168,125	59,038,765	39,436,468	25,438,446	17,820,924	64,500,762

Sustainability – Response Time Frequency Distribution Graph



Sustainability – 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	0.001	0.001	0.001	0.003	0.001	0.002	0.001

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.*

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 74.

IOPS Test Results File

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

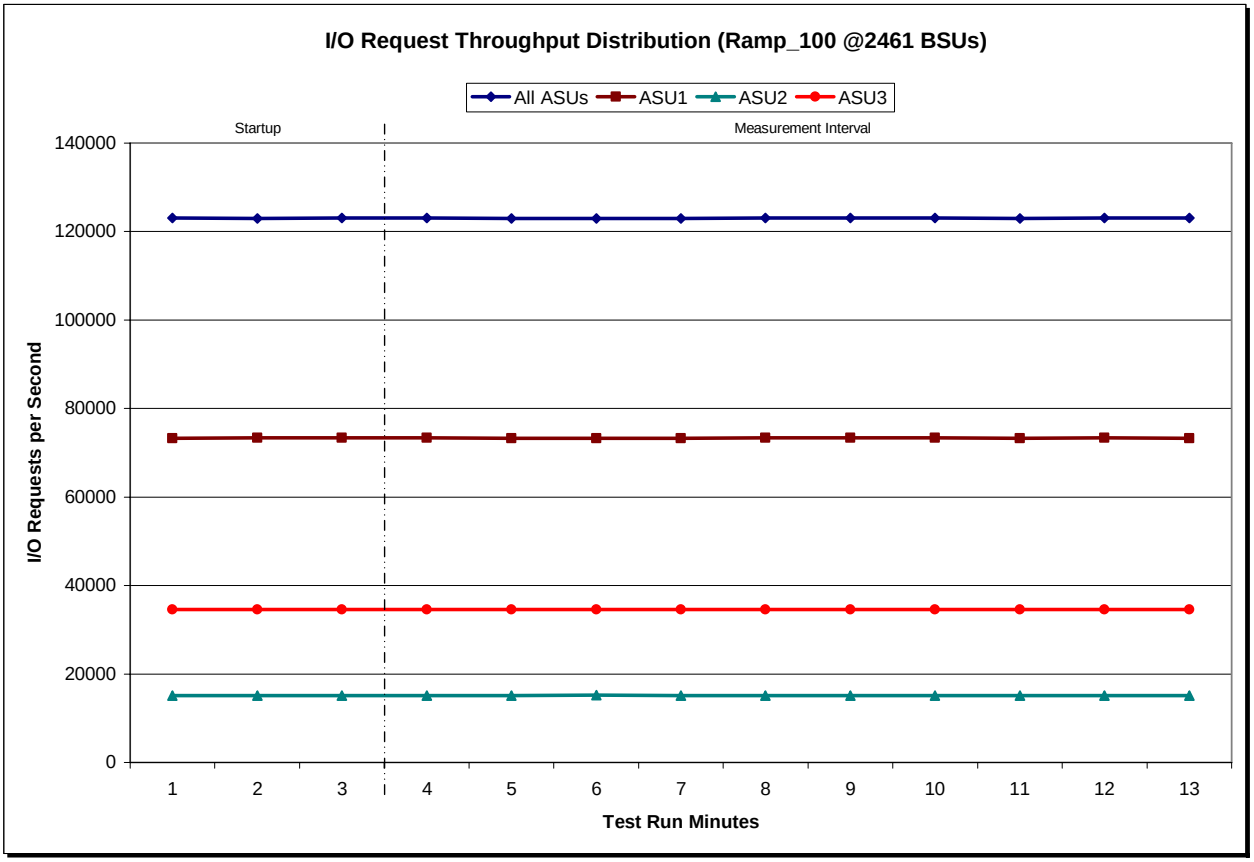
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

2461 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	8:19:00	8:22:01	0-2	0:03:01
Measurement Interval	8:22:01	8:32:01	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	123,076.45	73,324.88	15,157.03	34,594.53
1	123,015.82	73,359.15	15,127.47	34,529.20
2	123,105.90	73,359.03	15,146.25	34,600.62
3	123,085.65	73,334.05	15,144.87	34,606.73
4	123,006.33	73,266.45	15,133.45	34,606.43
5	122,986.15	73,250.62	15,172.70	34,562.83
6	122,949.40	73,293.03	15,124.20	34,532.17
7	123,052.83	73,350.62	15,142.03	34,560.18
8	123,063.05	73,328.55	15,127.05	34,607.45
9	123,058.90	73,347.33	15,113.80	34,597.77
10	123,012.75	73,325.23	15,121.97	34,565.55
11	123,063.38	73,360.28	15,127.07	34,576.03
12	123,055.55	73,321.18	15,143.10	34,591.27
Average	123,033.40	73,317.74	15,135.02	34,580.64

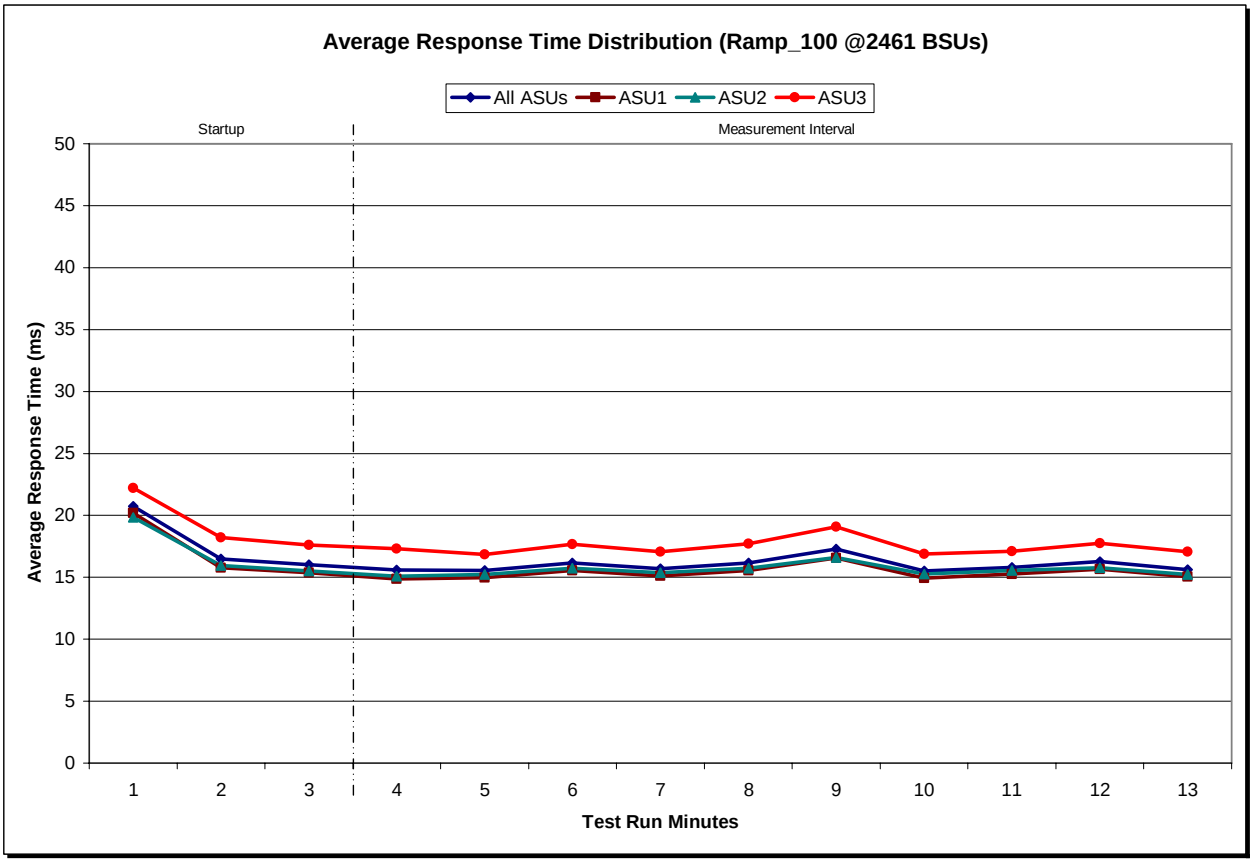
IOPS Test Run – I/O Request Throughput Distribution Graph



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

2461 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	8:19:00	8:22:01	0-2	0:03:01
Measurement Interval	8:22:01	8:32:01	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	20.73	20.21	19.83	22.22
1	16.49	15.78	15.96	18.22
2	16.01	15.37	15.50	17.59
3	15.58	14.87	15.07	17.32
4	15.53	14.98	15.22	16.83
5	16.17	15.55	15.72	17.69
6	15.70	15.12	15.37	17.07
7	16.18	15.54	15.74	17.71
8	17.26	16.55	16.59	19.07
9	15.52	14.93	15.26	16.88
10	15.80	15.25	15.55	17.09
11	16.25	15.65	15.75	17.76
12	15.63	15.03	15.22	17.07
Average	15.96	15.35	15.55	17.45

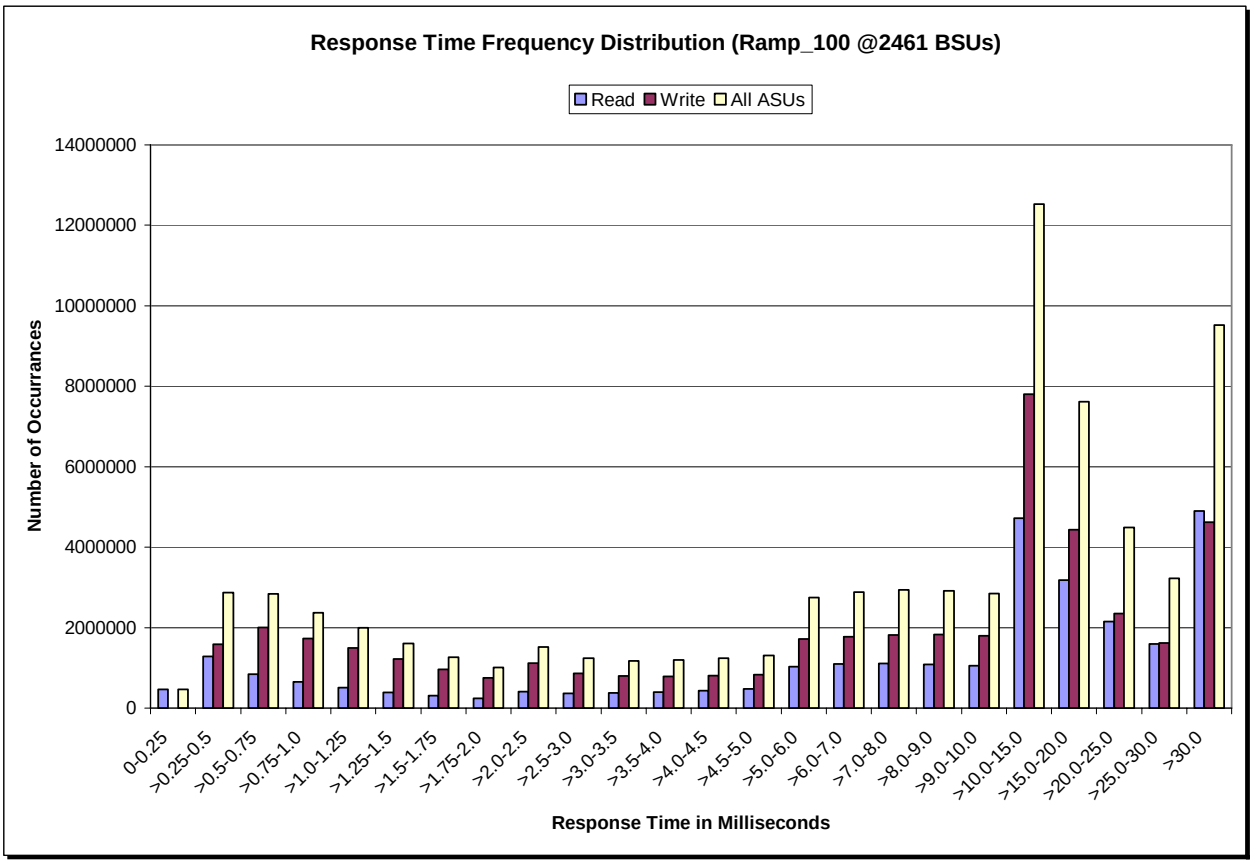
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	464580	1,288,043	837,615	649,861	505,499	391,398	305,805	248,046
Write	0	1,580,364	2,001,847	1,727,601	1,492,779	1,216,405	962,454	756,340
All ASUs	464580	2,868,407	2,839,462	2,377,462	1,998,278	1,607,803	1,268,259	1,004,386
ASU1	416284	1,949,354	1,625,706	1,311,409	1,063,693	848,169	664,511	528,044
ASU2	48296	377,705	339,773	276,242	225,192	179,061	140,651	111,386
ASU3	0	541,348	873,983	789,811	709,393	580,573	463,097	364,956
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	408,518	369,901	376,741	402,723	437,773	476,744	1,032,815	1,098,979
Write	1,115,361	868,316	798,301	790,255	806,618	829,271	1,714,604	1,778,620
All ASUs	1,523,879	1,238,217	1,175,042	1,192,978	1,244,391	1,306,015	2,747,419	2,877,599
ASU1	819,127	691,920	675,454	696,478	736,142	779,097	1,648,792	1,733,723
ASU2	170,677	142,300	136,884	141,937	149,115	158,243	337,553	355,957
ASU3	534,075	403,997	362,704	354,563	359,134	368,675	761,074	787,919
Response Time (ms)	**>7.0-8.0**	**>8.0-9.0**	**>9.0-10.0**	**>10.0-15.0**	**>15.0-20.0**	**>20.0-25.0**	**>25.0-30.0**	**>30.0**
Read	1,113,045	1,088,312	1,052,118	4,723,843	3,185,160	2,146,280	1,600,313	4,895,187
Write	1,823,283	1,831,740	1,798,838	7,799,728	4,432,884	2,345,717	1,622,877	4,624,218
All ASUs	2,936,328	2,920,052	2,850,956	12,523,571	7,618,044	4,491,997	3,223,190	9,519,405
ASU1	1,767,690	1,753,613	1,711,784	7,556,214	4,655,305	2,809,329	2,025,679	5,521,889
ASU2	364,595	361,347	351,559	1,551,797	960,263	591,093	441,433	1,167,684
ASU3	804,043	805,092	787,613	3,415,560	2,002,476	1,091,575	756,078	2,829,832

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
73,817,720	64,298,315	9,519,405

IOPS Test Run – 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	0.2809	0.0700	0.2100	0.0180	0.0700	0.0350	0.2811
COV	0.002	0.001	0.001	0.001	0.002	0.001	0.002	0.001

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.*

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 12.

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 74.

Response Time Ramp Test Results File

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

95% Load Level

90% Load Level

80% Load Level

50% Load Level

10% Load Level

Response Time Ramp Distribution (IOPS) Data

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

100% Load Level - 2461 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	8:19:00	8:22:01	0-2	0:03:01
Measurement Interval	8:22:01	8:32:01	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	123,076.45	73,324.88	15,157.03	34,594.53
1	123,015.82	73,359.15	15,127.47	34,529.20
2	123,105.90	73,359.03	15,146.25	34,600.62
3	123,085.65	73,334.05	15,144.87	34,606.73
4	123,006.33	73,266.45	15,133.45	34,606.43
5	122,986.15	73,250.62	15,172.70	34,562.83
6	122,949.40	73,293.03	15,124.20	34,532.17
7	123,052.83	73,350.62	15,142.03	34,560.18
8	123,063.05	73,328.55	15,127.05	34,607.45
9	123,058.90	73,347.33	15,113.80	34,597.77
10	123,012.75	73,325.23	15,121.97	34,565.55
11	123,063.38	73,360.28	15,127.07	34,576.03
12	123,055.55	73,321.18	15,143.10	34,591.27
Average	123,033.40	73,317.74	15,135.02	34,580.64

95% Load Level - 2337 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	8:32:31	8:35:32	0-2	0:03:01
Measurement Interval	8:35:32	8:45:32	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	116,905.83	69,656.95	14,371.23	32,877.65
1	116,865.68	69,680.02	14,368.07	32,817.60
2	116,899.32	69,628.68	14,404.88	32,865.75
3	116,810.95	69,597.82	14,390.35	32,822.78
4	116,889.83	69,671.40	14,404.35	32,814.08
5	116,868.78	69,642.62	14,390.50	32,835.67
6	116,901.02	69,661.12	14,361.03	32,878.87
7	116,889.07	69,690.75	14,361.22	32,837.10
8	116,867.00	69,653.63	14,367.45	32,845.92
9	116,883.73	69,651.92	14,398.98	32,832.83
10	116,854.68	69,623.37	14,390.57	32,840.75
11	116,915.58	69,704.90	14,361.77	32,848.92
12	116,807.95	69,617.42	14,383.75	32,806.78
Average	116,868.86	69,651.49	14,381.00	32,836.37

90% Load Level - 2214 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	8:46:01	8:49:02	0-2	0:03:01
Measurement Interval	8:49:02	8:59:02	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	110,754.20	66,000.33	13,629.22	31,124.65
1	110,677.43	65,968.32	13,618.47	31,090.65
2	110,637.53	65,941.67	13,606.52	31,089.35
3	110,737.23	66,000.27	13,642.77	31,094.20
4	110,688.70	65,991.87	13,608.72	31,088.12
5	110,777.97	65,979.57	13,643.30	31,155.10
6	110,696.73	65,996.73	13,602.75	31,097.25
7	110,687.38	66,008.28	13,616.42	31,062.68
8	110,694.87	65,983.42	13,621.88	31,089.57
9	110,641.87	65,973.82	13,600.03	31,068.02
10	110,697.07	65,963.72	13,624.60	31,108.75
11	110,646.27	65,939.85	13,616.53	31,089.88
12	110,641.55	65,927.78	13,611.52	31,102.25
Average	110,690.96	65,976.53	13,618.85	31,095.58

80% Load Level - 1968 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	8:59:29	9:02:30	0-2	0:03:01
Measurement Interval	9:02:30	9:12:30	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	98,513.58	58,712.72	12,120.00	27,680.87
1	98,403.72	58,657.35	12,100.05	27,646.32
2	98,283.92	58,582.07	12,089.65	27,612.20
3	98,424.23	58,672.15	12,114.52	27,637.57
4	98,418.58	58,655.13	12,104.22	27,659.23
5	98,309.03	58,578.17	12,097.60	27,633.27
6	98,428.62	58,657.42	12,096.33	27,674.87
7	98,401.75	58,650.47	12,105.85	27,645.43
8	98,346.75	58,638.42	12,113.18	27,595.15
9	98,401.68	58,651.28	12,100.08	27,650.32
10	98,432.83	58,671.33	12,087.53	27,673.97
11	98,475.12	58,710.85	12,111.85	27,652.42
12	98,310.05	58,612.40	12,078.70	27,618.95
Average	98,394.87	58,649.76	12,100.99	27,644.12

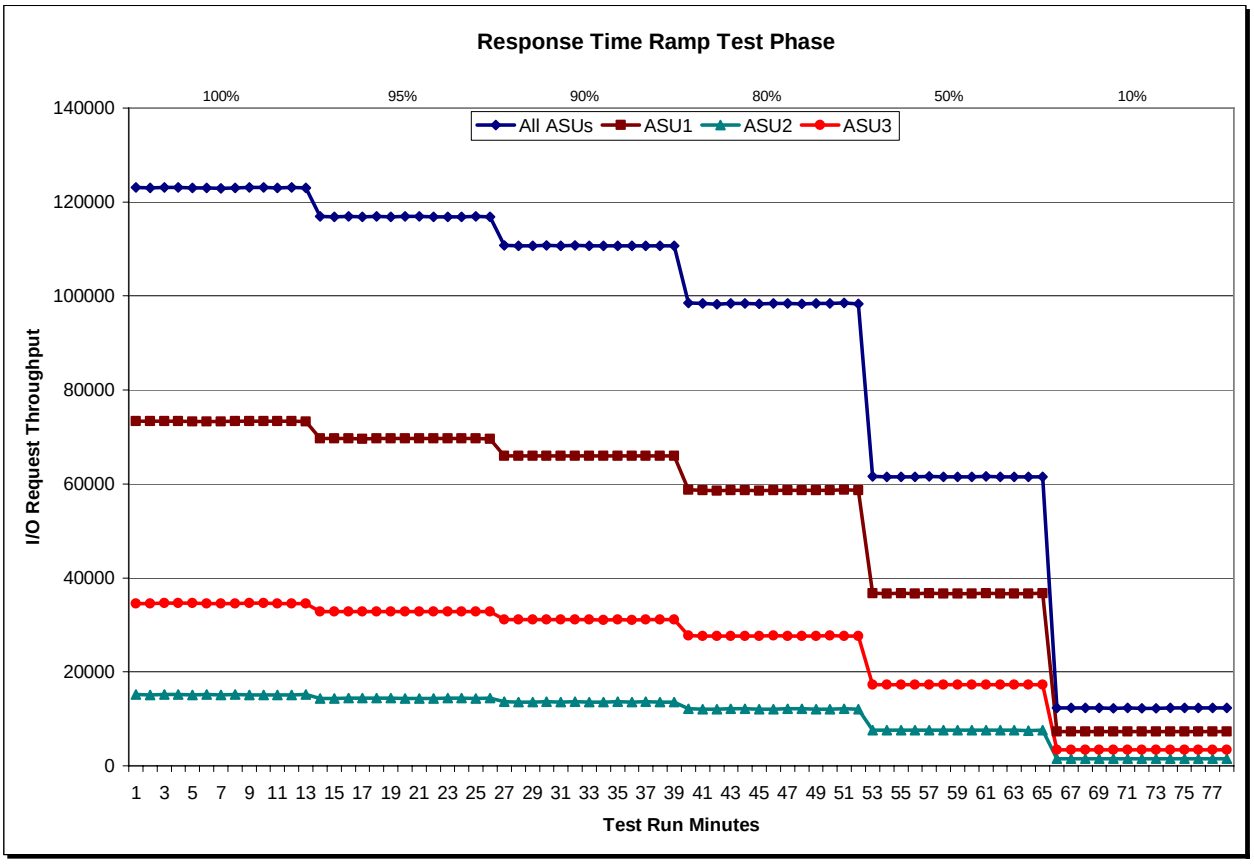
50% Load Level - 1230 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:12:51	9:15:52	0-2	0:03:01
Measurement Interval	9:15:52	9:25:52	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	61,558.22	36,691.98	7,566.43	17,299.80
1	61,521.98	36,659.98	7,592.47	17,269.53
2	61,494.93	36,686.13	7,560.80	17,248.00
3	61,464.85	36,626.53	7,563.47	17,274.85
4	61,554.48	36,693.25	7,577.27	17,283.97
5	61,468.10	36,643.42	7,549.55	17,275.13
6	61,515.82	36,643.37	7,567.57	17,304.88
7	61,526.25	36,669.33	7,557.77	17,299.15
8	61,577.10	36,692.73	7,585.55	17,298.82
9	61,538.75	36,681.52	7,568.98	17,288.25
10	61,492.95	36,637.33	7,572.00	17,283.62
11	61,495.42	36,657.23	7,543.18	17,295.00
12	61,549.18	36,697.20	7,557.98	17,294.00
Average	61,518.29	36,664.19	7,564.33	17,289.77

10% Load Level - 246 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:26:07	9:29:08	0-2	0:03:01
Measurement Interval	9:29:08	9:39:08	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	12,307.32	7,327.95	1,519.92	3,459.45
1	12,315.58	7,328.98	1,522.70	3,463.90
2	12,293.58	7,329.95	1,520.63	3,443.00
3	12,310.77	7,353.47	1,512.85	3,444.45
4	12,285.33	7,314.48	1,514.80	3,456.05
5	12,302.70	7,326.35	1,513.15	3,463.20
6	12,277.13	7,324.10	1,513.65	3,439.38
7	12,290.40	7,328.70	1,502.33	3,459.37
8	12,292.42	7,331.20	1,516.18	3,445.03
9	12,300.30	7,332.42	1,513.87	3,454.02
10	12,301.33	7,343.63	1,509.27	3,448.43
11	12,320.35	7,342.75	1,515.82	3,461.78
12	12,304.08	7,325.82	1,513.98	3,464.28
Average	12,298.48	7,332.29	1,512.59	3,453.60

Response Time Ramp Distribution (IOPS) Graph

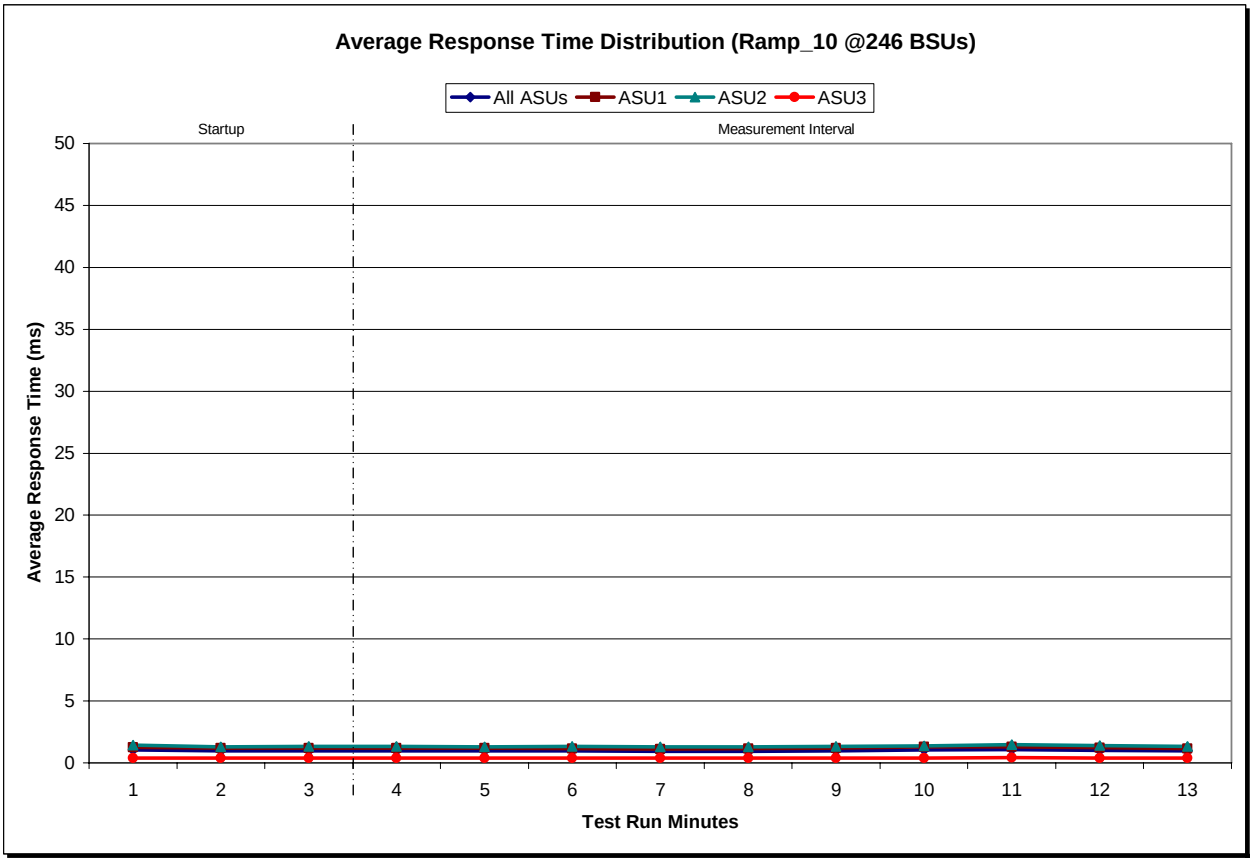


SPC-1 LRT™ Average Response Time (ms) Distribution Data

246 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:26:07	9:29:08	0-2	0:03:01
Measurement Interval	9:29:08	9:39:08	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	1.04	1.26	1.45	0.39
1	0.98	1.19	1.31	0.39
2	0.99	1.19	1.34	0.39
3	0.99	1.19	1.34	0.39
4	0.97	1.18	1.31	0.40
5	0.96	1.16	1.32	0.39
6	0.94	1.13	1.29	0.39
7	0.95	1.14	1.30	0.40
8	0.98	1.18	1.33	0.39
9	1.05	1.29	1.37	0.40
10	1.08	1.29	1.49	0.44
11	1.02	1.23	1.41	0.40
12	0.96	1.16	1.32	0.39
Average	0.99	1.19	1.35	0.40

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



SPC-1 LRT™ (10%) – 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	0.2812	0.0700	0.2100	0.0181	0.0699	0.0350	0.2808
COV	0.009	0.002	0.003	0.003	0.006	0.003	0.006	0.002

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.*

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 74.

Repeatability Test Results File

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

	SPC-1 IOPS™	SPC-1 LRT™
Primary Metrics	***123,03.40***	***0.99***
Repeatability Test Phase 1	123,057.37	0.94
Repeatability Test Phase 2	123,033.37	0.95

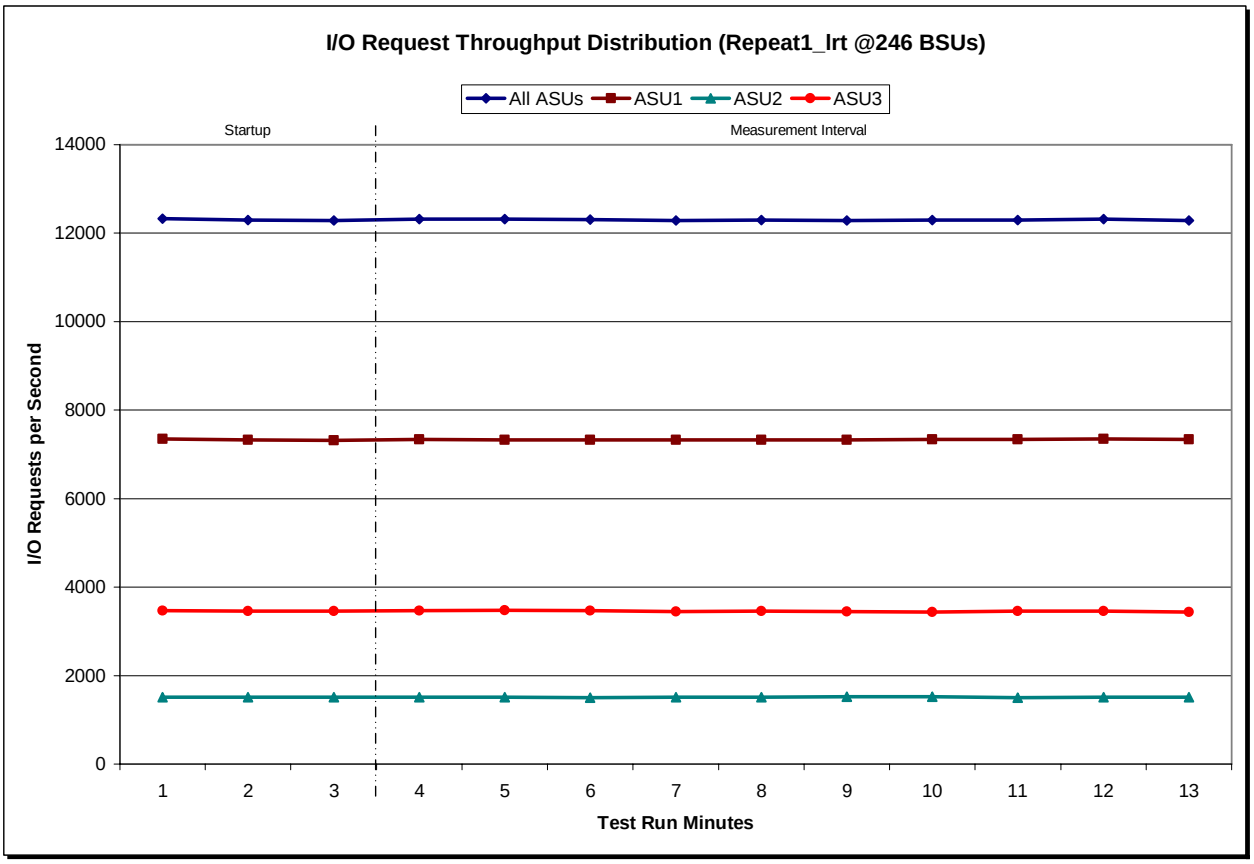
A link to the test result file generated from each Repeatability Test Run list is listed below.

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

246 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:39:59	9:42:59	0-2	0:03:00
Measurement Interval	9:42:59	9:52:59	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	12,327.82	7,350.05	1,512.63	3,465.13
1	12,300.65	7,326.98	1,516.65	3,457.02
2	12,282.72	7,315.32	1,507.82	3,459.58
3	12,315.55	7,333.07	1,512.80	3,469.68
4	12,311.80	7,327.38	1,507.17	3,477.25
5	12,306.15	7,331.00	1,506.43	3,468.72
6	12,288.55	7,326.53	1,513.70	3,448.32
7	12,296.48	7,330.25	1,509.57	3,456.67
8	12,288.37	7,323.35	1,519.28	3,445.73
9	12,300.62	7,342.25	1,519.63	3,438.73
10	12,295.20	7,333.28	1,506.13	3,455.78
11	12,311.77	7,348.57	1,510.23	3,452.97
12	12,287.50	7,335.18	1,510.92	3,441.40
Average	12,300.20	7,333.09	1,511.59	3,455.53

Repeatability 1 LRT – I/O Request Throughput Distribution Graph

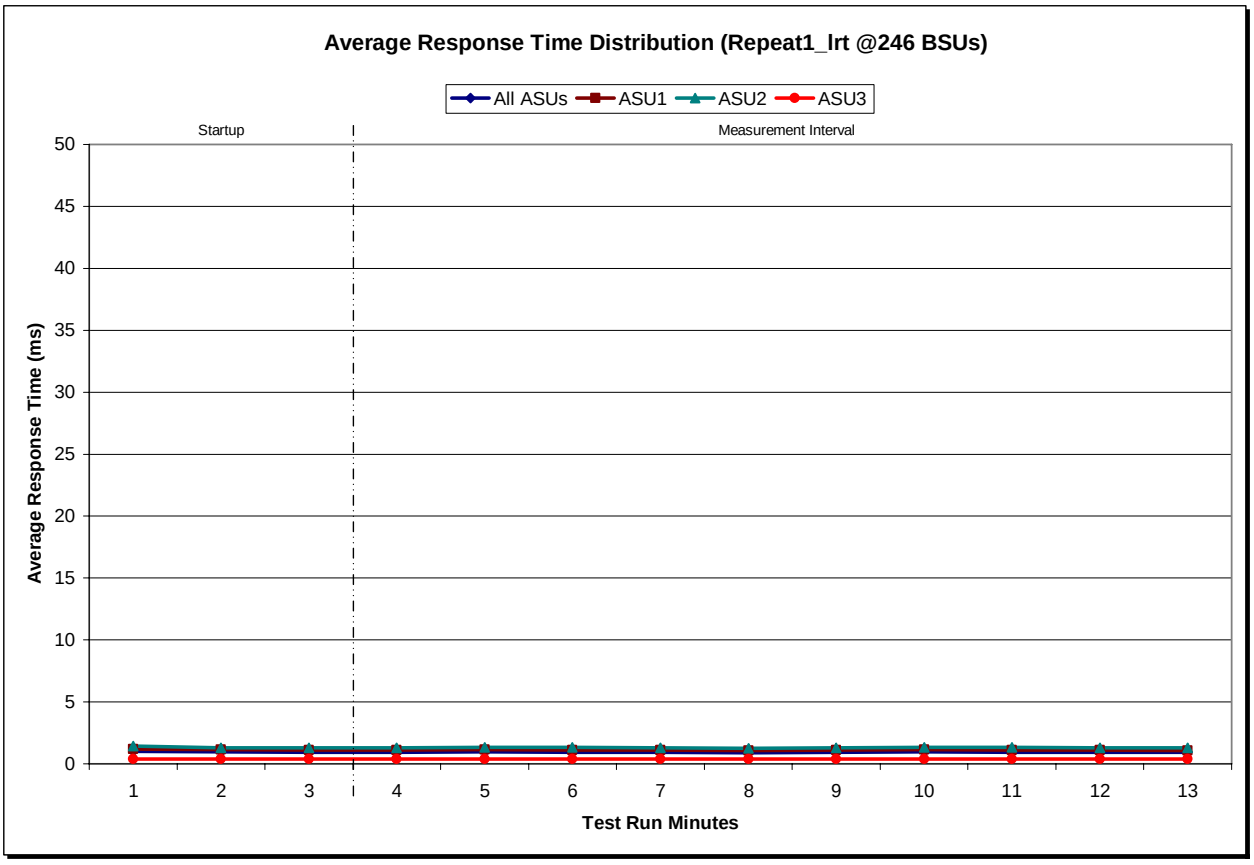


Repeatability 1 LRT –Average Response Time (ms) Distribution Data

246 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:39:59	9:42:59	0-2	0:03:00
Measurement Interval	9:42:59	9:52:59	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	1.00	1.19	1.45	0.40
1	0.95	1.15	1.30	0.39
2	0.93	1.11	1.29	0.39
3	0.93	1.11	1.29	0.39
4	0.96	1.15	1.35	0.39
5	0.95	1.13	1.33	0.39
6	0.93	1.11	1.30	0.39
7	0.91	1.08	1.25	0.39
8	0.92	1.10	1.28	0.39
9	0.95	1.14	1.32	0.39
10	0.94	1.12	1.32	0.39
11	0.94	1.13	1.31	0.39
12	0.92	1.10	1.28	0.39
Average	0.94	1.12	1.30	0.39

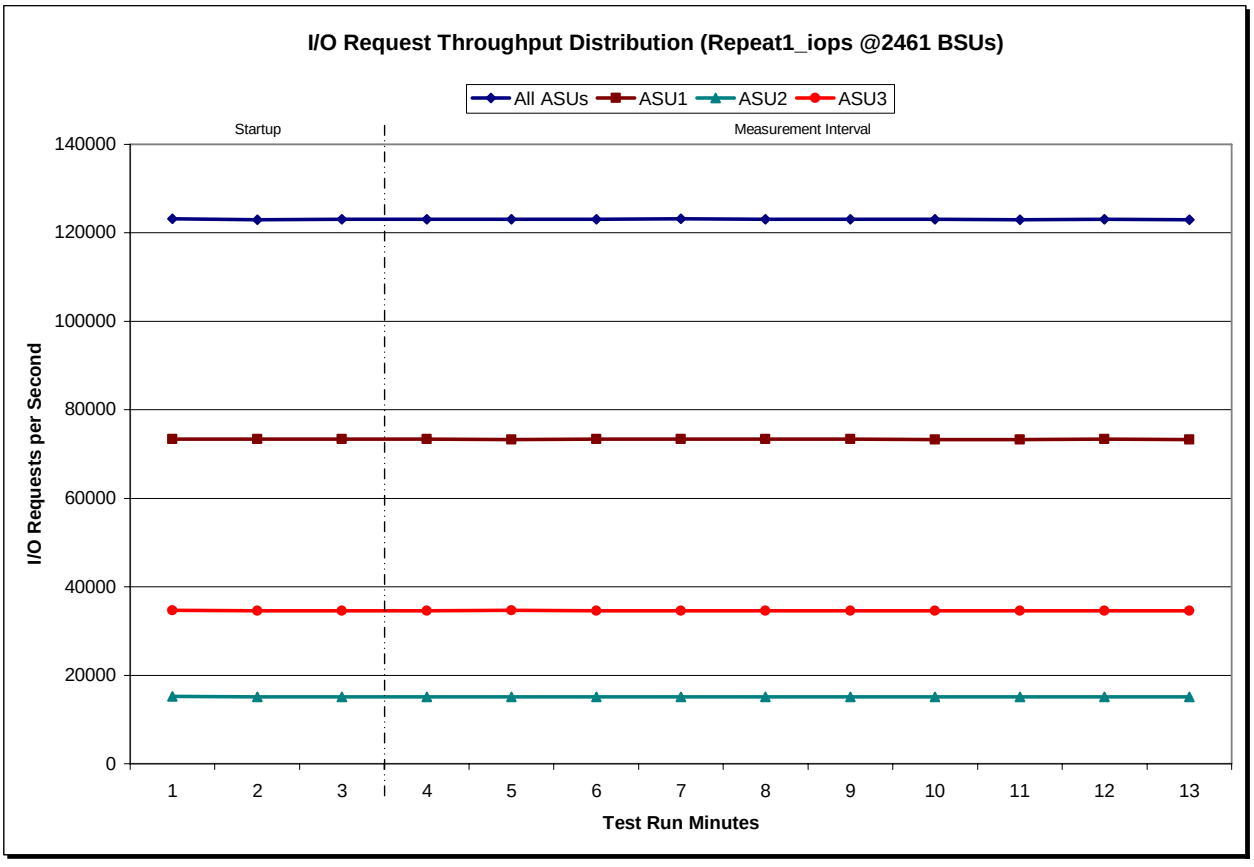
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

2461 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:53:34	9:56:35	0-2	0:03:01
Measurement Interval	9:56:35	10:06:35	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	123,154.85	73,358.42	15,171.90	34,624.53
1	122,996.60	73,352.98	15,103.92	34,539.70
2	123,114.98	73,358.62	15,152.37	34,604.00
3	123,035.98	73,332.43	15,115.73	34,587.82
4	123,106.08	73,319.32	15,141.98	34,644.78
5	123,078.10	73,349.83	15,122.45	34,605.82
6	123,118.38	73,381.97	15,133.07	34,603.35
7	123,056.75	73,338.35	15,154.22	34,564.18
8	123,049.57	73,342.78	15,162.37	34,544.42
9	123,036.17	73,321.67	15,118.20	34,596.30
10	123,005.78	73,317.65	15,119.62	34,568.52
11	123,078.23	73,391.28	15,113.12	34,573.83
12	123,008.60	73,317.87	15,132.12	34,558.62
Average	123,057.37	73,341.32	15,131.29	34,584.76

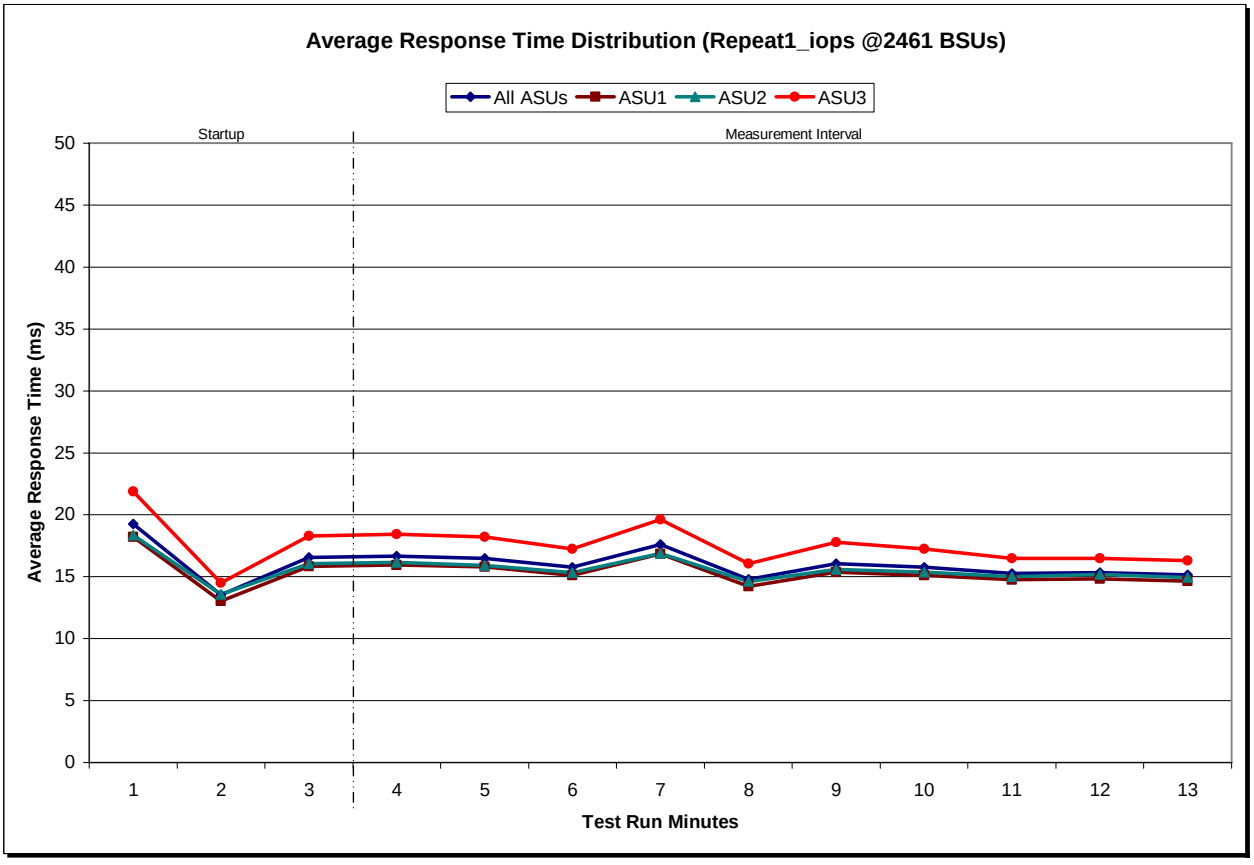
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

2461 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:53:34	9:56:35	0-2	0:03:01
Measurement Interval	9:56:35	10:06:35	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	19.26	18.22	18.36	21.87
1	13.52	13.04	13.58	14.52
2	16.55	15.85	16.05	18.27
3	16.68	15.95	16.16	18.44
4	16.48	15.79	15.90	18.20
5	15.75	15.13	15.32	17.25
6	17.62	16.83	16.88	19.61
7	14.79	14.24	14.60	16.05
8	16.07	15.37	15.57	17.77
9	15.76	15.13	15.37	17.26
10	15.26	14.75	15.02	16.47
11	15.35	14.84	15.19	16.48
12	15.15	14.63	14.95	16.31
Average	15.89	15.27	15.50	17.39

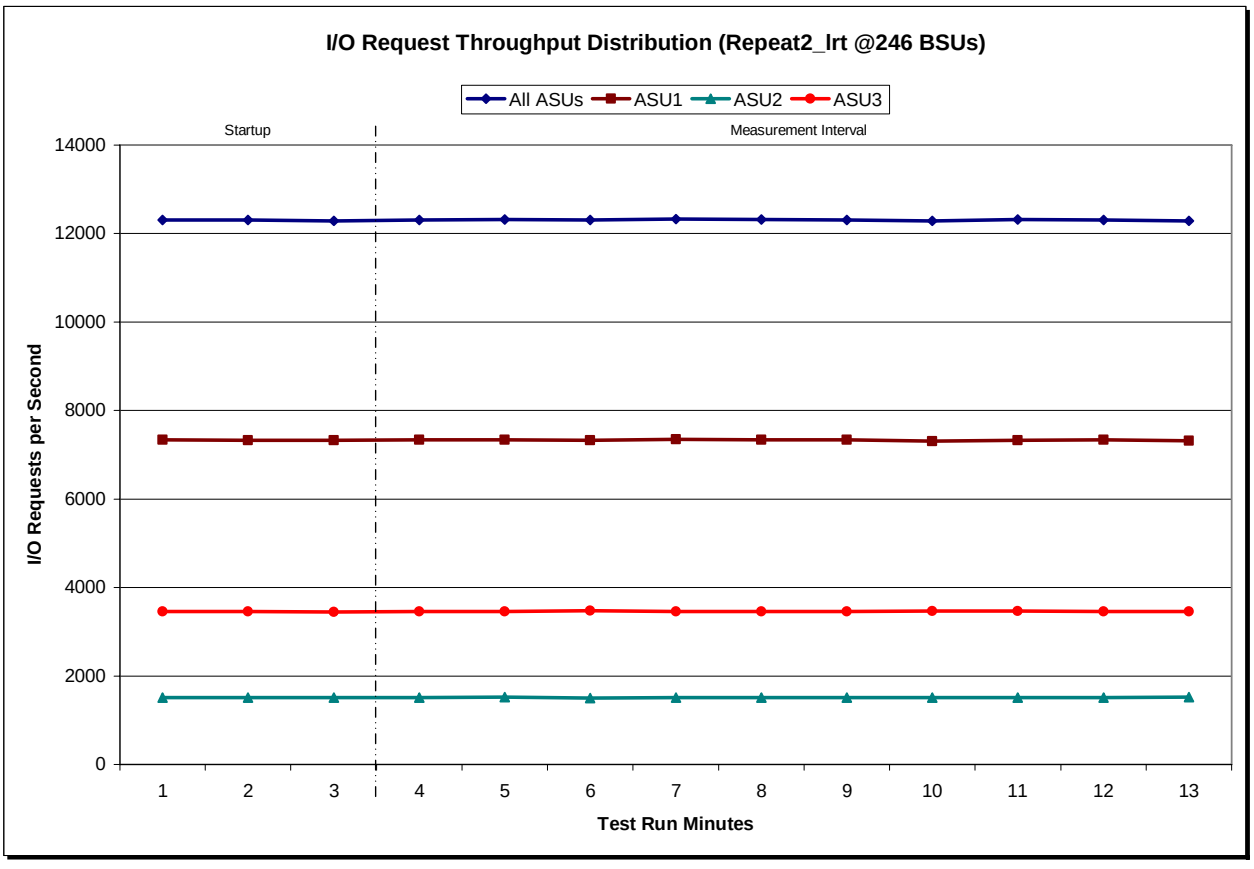
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

246 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:07:23	10:10:23	0-2	0:03:00
Measurement Interval	10:10:23	10:20:23	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	12,308.82	7,336.43	1,513.80	3,458.58
1	12,302.30	7,326.48	1,514.62	3,461.20
2	12,290.67	7,330.02	1,512.18	3,448.47
3	12,304.87	7,338.55	1,511.33	3,454.98
4	12,312.70	7,341.13	1,517.25	3,454.32
5	12,308.67	7,327.02	1,504.12	3,477.53
6	12,327.50	7,350.98	1,515.20	3,461.32
7	12,312.40	7,336.58	1,516.15	3,459.67
8	12,307.82	7,333.03	1,514.20	3,460.58
9	12,286.52	7,311.95	1,509.60	3,464.97
10	12,314.68	7,328.70	1,514.43	3,471.55
11	12,302.75	7,337.17	1,512.25	3,453.33
12	12,289.55	7,312.62	1,521.12	3,455.82
Average	12,306.75	7,331.77	1,513.57	3,461.41

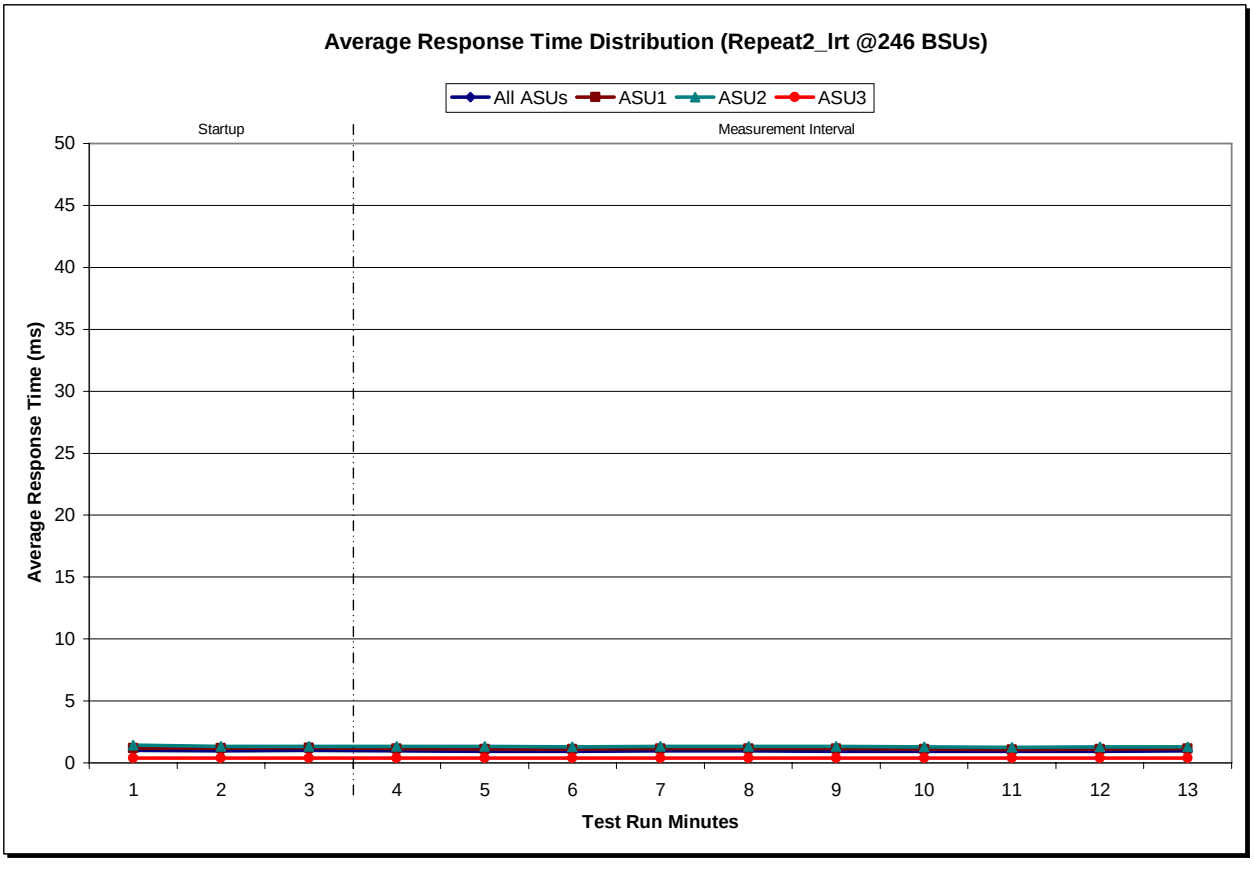
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

246 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:07:23	10:10:23	0-2	0:03:00
Measurement Interval	10:10:23	10:20:23	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.99	1.18	1.44	0.40
1	0.98	1.19	1.33	0.40
2	0.99	1.21	1.32	0.39
3	0.97	1.17	1.33	0.39
4	0.95	1.13	1.32	0.39
5	0.93	1.11	1.30	0.39
6	0.96	1.15	1.33	0.39
7	0.96	1.15	1.32	0.39
8	0.95	1.14	1.32	0.39
9	0.94	1.13	1.30	0.39
10	0.92	1.09	1.27	0.39
11	0.94	1.12	1.31	0.39
12	0.96	1.15	1.31	0.39
Average	0.95	1.14	1.31	0.39

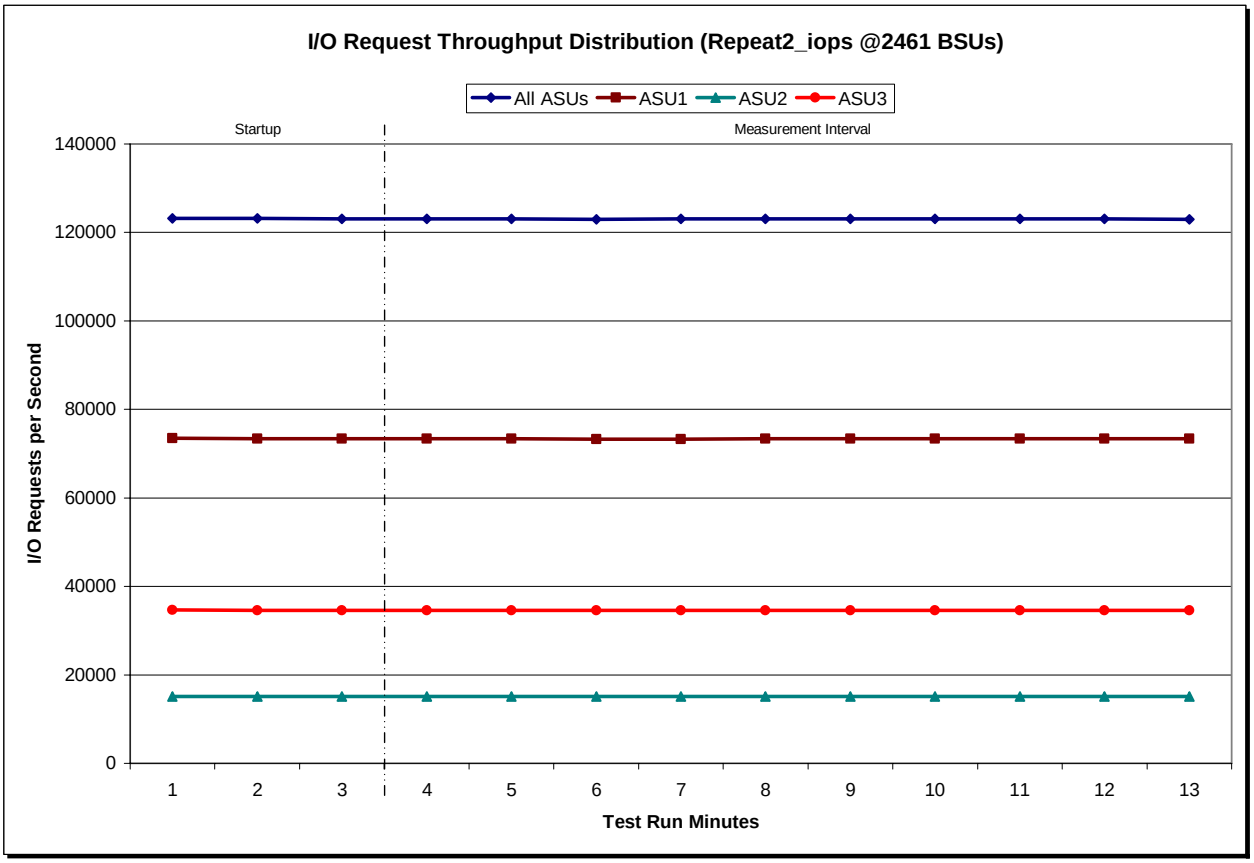
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

2461 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:20:57	10:23:58	0-2	0:03:01
Measurement Interval	10:23:58	10:33:58	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	123,197.53	73,433.82	15,134.63	34,629.08
1	123,145.02	73,413.78	15,123.62	34,607.62
2	123,037.78	73,339.38	15,134.90	34,563.50
3	123,021.18	73,328.30	15,113.42	34,579.47
4	123,096.88	73,358.45	15,148.55	34,589.88
5	122,993.92	73,291.65	15,145.72	34,556.55
6	123,033.65	73,319.12	15,134.20	34,580.33
7	123,055.22	73,380.73	15,125.93	34,548.55
8	123,027.80	73,353.83	15,103.95	34,570.02
9	123,030.18	73,332.22	15,132.85	34,565.12
10	123,027.93	73,369.98	15,126.02	34,531.93
11	123,032.87	73,329.37	15,152.77	34,550.73
12	123,014.08	73,330.08	15,111.68	34,572.32
Average	123,033.37	73,339.37	15,129.51	34,564.49

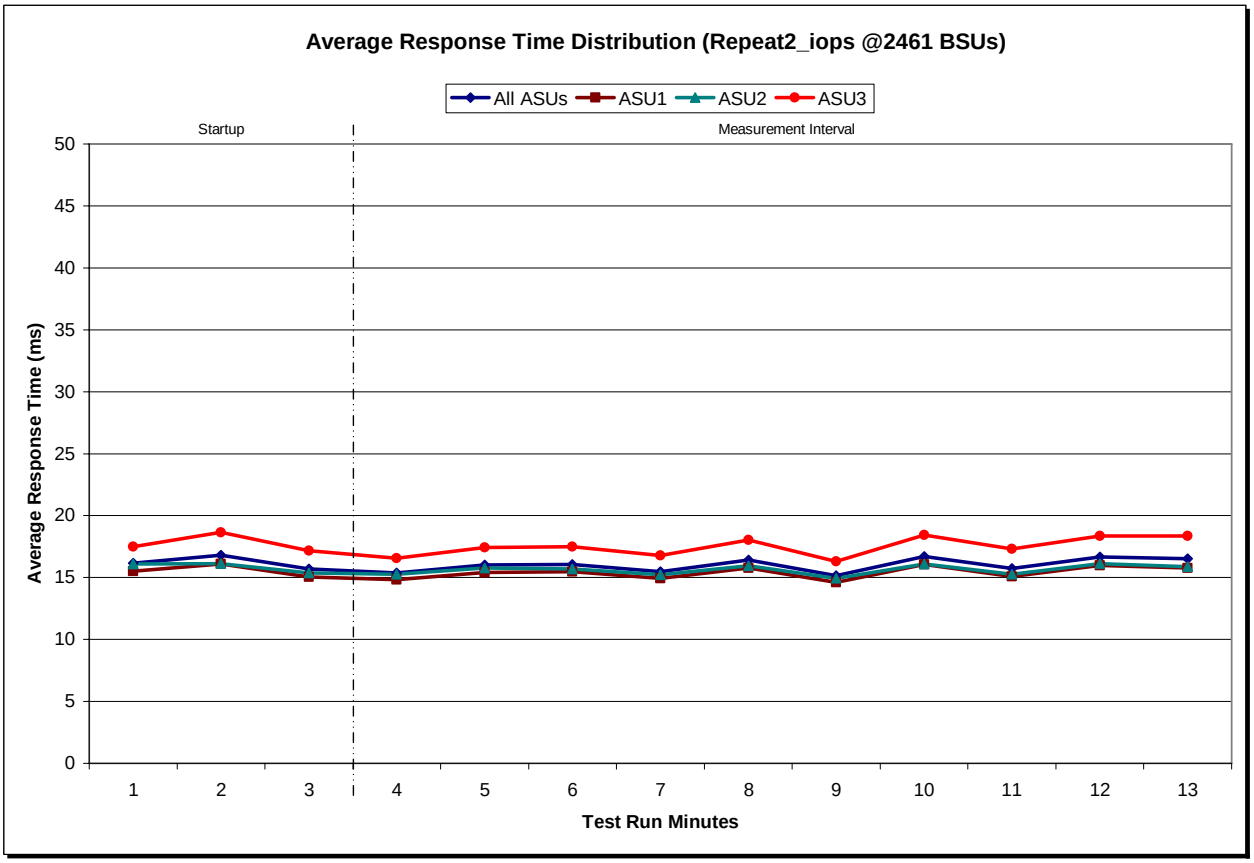
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

2461 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:20:57	10:23:58	0-2	0:03:01
Measurement Interval	10:23:58	10:33:58	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	16.15	15.53	16.09	17.50
1	16.81	16.09	16.12	18.64
2	15.69	15.06	15.38	17.17
3	15.37	14.83	15.27	16.56
4	16.01	15.40	15.75	17.41
5	16.07	15.48	15.70	17.49
6	15.49	14.95	15.22	16.76
7	16.41	15.75	15.93	18.02
8	15.14	14.63	14.94	16.32
9	16.72	16.05	16.10	18.41
10	15.72	15.07	15.28	17.30
11	16.66	15.98	16.13	18.35
12	16.51	15.77	15.89	18.34
Average	16.01	15.39	15.62	17.50

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



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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2811	0.0701	0.2100	0.0179	0.0699	0.0350	0.2809
COV	0.006	0.003	0.004	0.003	0.010	0.004	0.008	0.003

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.*

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	0.001	0.002	0.001	0.003	0.001	0.002	0.001

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0349	0.2809	0.0700	0.2099	0.0179	0.0699	0.0352	0.2813
COV	0.005	0.002	0.003	0.002	0.006	0.004	0.008	0.002

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2101	0.0180	0.0700	0.0350	0.2809
COV	0.002	0.001	0.001	0.001	0.002	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 74.

Data Persistence Test Results File

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

Persistence 1 Test Results File

Persistence 2 Test Results File

Data Persistence Test Results

Data Persistence Test Results	
Data Persistence Test Run Number: 1	
Total Number of Logical Blocks Written	208,107,504
Total Number of Logical Blocks Verified	143,526,400
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 DS8300 Turbo, 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 13. 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 13.

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 DS8300 Turbo.

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.

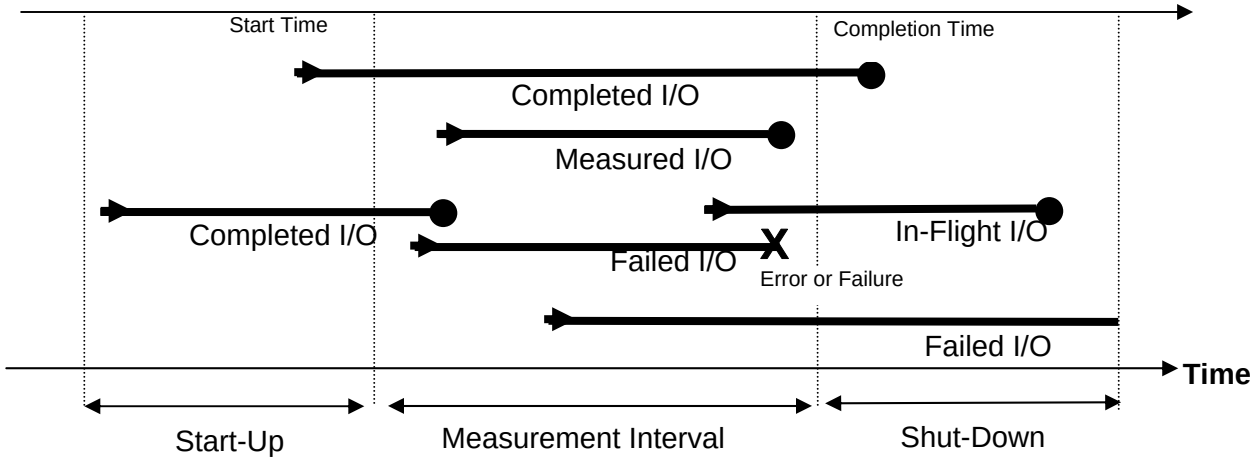
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

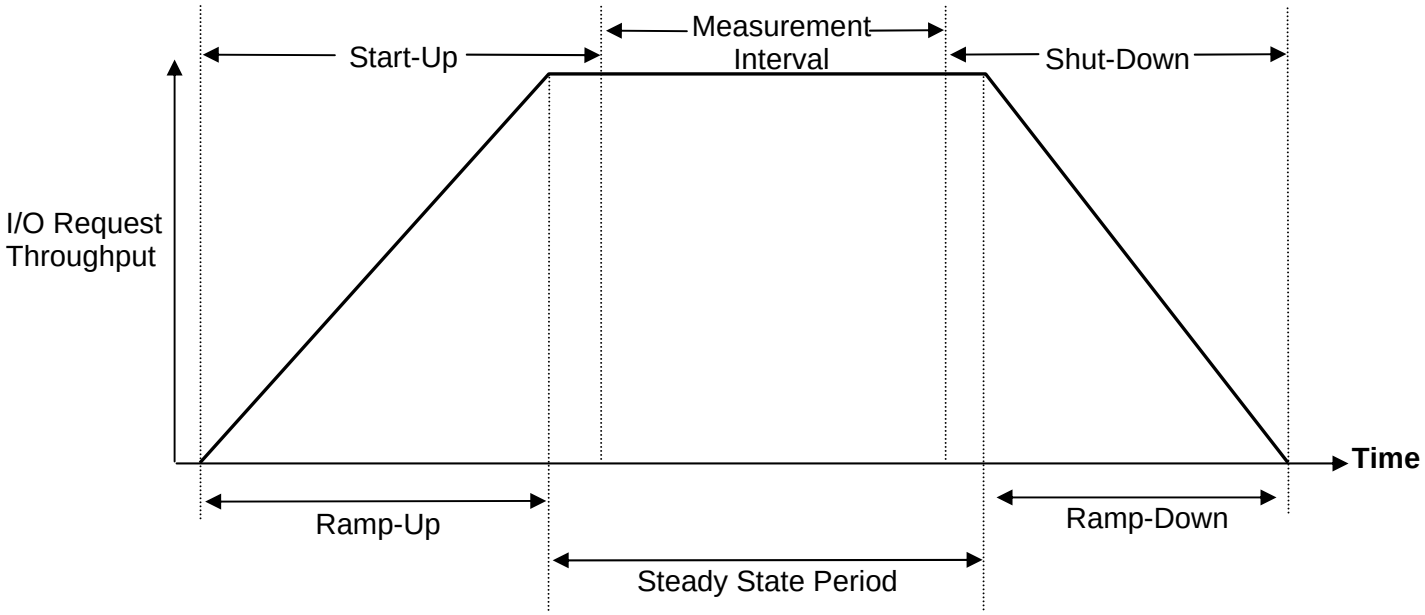
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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 following customer tunable parameters were changed from their default value as part of the Tested Storage Configuration creation and configuration process, which is documented in Appendix C: Tested Storage Configuration (TSC) Creation.

	Default Value	New Value
queue_depth	20	64
max_transfer	256K	1024K

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

Create the RAID-10 ranks

The first script, **step1_mkarray.txt**, groups the physical volumes into 64 RAID-10 arrays and the system automatically generates a set of array names, A0-A63. The next script, **step2_mkranks.txt**, defines the arrays, A0-A63, as 64 open system ranks, R0-R63. Even rank numbers belong to cluster 0 and odd numbered ranks belong to cluster 1. As in the previous script, the rank names are assigned by the system. The third script, **step3_rankpool.txt**, defines the ranks, R0-R63 to comprise a set of 64 "extent pools" (pools of available storage) with the names P0-P63.

step1_mkarray.txt

```
# Want array's to be created in increasing DA pair number order.
# and with 1st 2 arrays on each DA pair to be on the 3+3's.
# If lsarraysite does not report DA pairs in the order below, this script must be
changed.

# Arrays are A0 to A63
# Array sites are S1 to S64

# Default DA pair order is: 2,0,6,4,7,5,3,1
#       DA#  DAconfig#  Arrays  ArraySites
#       0     2nd       A0-A7     S9-S16
#       1     8th       A8-A15    S57-S64
#       2     1st       A16-A23   S1-S8
#       3     7th       A24-A31   S49-S56
#       4     4th       A32-A39   S25-S32
#       5     6th       A40-A47   S41-S48
#       6     3rd       A48-A55   S17-S24
#       7     5th       A56-A63   S33-S40

mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S9
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S11
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S10
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S12
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S13
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S14
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S15
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S16

mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S57
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S59
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S58
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S60
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S61
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S62
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S63
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S64

mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S1
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S3
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S2
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S4
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S5
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S6
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S7
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S8
```

```
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S49
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S51
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S50
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S52
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S53
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S54
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S55
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S56

mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S25
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S27
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S26
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S28
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S29
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S30
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S31
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S32

mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S41
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S43
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S42
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S44
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S45
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S46
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S47
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S48

mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S17
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S19
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S18
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S20
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S21
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S22
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S23
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S24

mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S33
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S35
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S34
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S36
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S37
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S38
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S39
mkarray -dev IBM.2107-7503471 -raidtype 10 -arsite S40

lsarray -dev IBM.2107-7503471 -l
```

step2_mkranks.txt

```
# Create ranks in order of increasing array number.
mkrank -dev IBM.2107-7503471 -array A0 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A1 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A2 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A3 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A4 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A5 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A6 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A7 -stgtype fb

mkrank -dev IBM.2107-7503471 -array A8 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A9 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A10 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A11 -stgtype fb
```

```
mkrank -dev IBM.2107-7503471 -array A12 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A13 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A14 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A15 -stgtype fb

mkrank -dev IBM.2107-7503471 -array A16 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A17 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A18 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A19 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A20 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A21 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A22 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A23 -stgtype fb

mkrank -dev IBM.2107-7503471 -array A24 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A25 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A26 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A27 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A28 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A29 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A30 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A31 -stgtype fb

mkrank -dev IBM.2107-7503471 -array A32 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A33 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A34 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A35 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A36 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A37 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A38 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A39 -stgtype fb

mkrank -dev IBM.2107-7503471 -array A40 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A41 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A42 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A43 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A44 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A45 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A46 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A47 -stgtype fb

mkrank -dev IBM.2107-7503471 -array A48 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A49 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A50 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A51 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A52 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A53 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A54 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A55 -stgtype fb

mkrank -dev IBM.2107-7503471 -array A56 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A57 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A58 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A59 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A60 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A61 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A62 -stgtype fb
mkrank -dev IBM.2107-7503471 -array A63 -stgtype fb
```

step3_rankpool.txt

```
chrank -dev IBM.2107-7503471 -extpool P0  R0
chrank -dev IBM.2107-7503471 -extpool P1  R1
chrank -dev IBM.2107-7503471 -extpool P2  R2
chrank -dev IBM.2107-7503471 -extpool P3  R3
chrank -dev IBM.2107-7503471 -extpool P4  R4
chrank -dev IBM.2107-7503471 -extpool P5  R5
chrank -dev IBM.2107-7503471 -extpool P6  R6
chrank -dev IBM.2107-7503471 -extpool P7  R7
chrank -dev IBM.2107-7503471 -extpool P8  R8
chrank -dev IBM.2107-7503471 -extpool P9  R9
chrank -dev IBM.2107-7503471 -extpool P10 R10
chrank -dev IBM.2107-7503471 -extpool P11 R11
chrank -dev IBM.2107-7503471 -extpool P12 R12
chrank -dev IBM.2107-7503471 -extpool P13 R13
chrank -dev IBM.2107-7503471 -extpool P14 R14
chrank -dev IBM.2107-7503471 -extpool P15 R15
chrank -dev IBM.2107-7503471 -extpool P16 R16
chrank -dev IBM.2107-7503471 -extpool P17 R17
chrank -dev IBM.2107-7503471 -extpool P18 R18
chrank -dev IBM.2107-7503471 -extpool P19 R19
chrank -dev IBM.2107-7503471 -extpool P20 R20
chrank -dev IBM.2107-7503471 -extpool P21 R21
chrank -dev IBM.2107-7503471 -extpool P22 R22
chrank -dev IBM.2107-7503471 -extpool P23 R23
chrank -dev IBM.2107-7503471 -extpool P24 R24
chrank -dev IBM.2107-7503471 -extpool P25 R25
chrank -dev IBM.2107-7503471 -extpool P26 R26
chrank -dev IBM.2107-7503471 -extpool P27 R27
chrank -dev IBM.2107-7503471 -extpool P28 R28
chrank -dev IBM.2107-7503471 -extpool P29 R29
chrank -dev IBM.2107-7503471 -extpool P30 R30
chrank -dev IBM.2107-7503471 -extpool P31 R31
chrank -dev IBM.2107-7503471 -extpool P32 R32
chrank -dev IBM.2107-7503471 -extpool P33 R33
chrank -dev IBM.2107-7503471 -extpool P34 R34
chrank -dev IBM.2107-7503471 -extpool P35 R35
chrank -dev IBM.2107-7503471 -extpool P36 R36
chrank -dev IBM.2107-7503471 -extpool P37 R37
chrank -dev IBM.2107-7503471 -extpool P38 R38
chrank -dev IBM.2107-7503471 -extpool P39 R39
chrank -dev IBM.2107-7503471 -extpool P40 R40
chrank -dev IBM.2107-7503471 -extpool P41 R41
chrank -dev IBM.2107-7503471 -extpool P42 R42
chrank -dev IBM.2107-7503471 -extpool P43 R43
chrank -dev IBM.2107-7503471 -extpool P44 R44
chrank -dev IBM.2107-7503471 -extpool P45 R45
chrank -dev IBM.2107-7503471 -extpool P46 R46
chrank -dev IBM.2107-7503471 -extpool P47 R47
chrank -dev IBM.2107-7503471 -extpool P48 R48
chrank -dev IBM.2107-7503471 -extpool P49 R49
chrank -dev IBM.2107-7503471 -extpool P50 R50
chrank -dev IBM.2107-7503471 -extpool P51 R51
chrank -dev IBM.2107-7503471 -extpool P52 R52
chrank -dev IBM.2107-7503471 -extpool P53 R53
chrank -dev IBM.2107-7503471 -extpool P54 R54
chrank -dev IBM.2107-7503471 -extpool P55 R55
chrank -dev IBM.2107-7503471 -extpool P56 R56
chrank -dev IBM.2107-7503471 -extpool P57 R57
chrank -dev IBM.2107-7503471 -extpool P58 R58
chrank -dev IBM.2107-7503471 -extpool P59 R59
```

```
chrank -dev IBM.2107-7503471 -extpool P60 R60
chrank -dev IBM.2107-7503471 -extpool P61 R61
chrank -dev IBM.2107-7503471 -extpool P62 R62
chrank -dev IBM.2107-7503471 -extpool P63 R63
```

Create the LUNs

Each rank is in 1-to-1 correspondence with an extent pool, from which LUNs are defined. The **step4_makevols.txt** script defines the 112 LUNs on the set of 64 RAID-10 ranks. The name of a rank identifies the DA to which the rank belongs and also assigns the rank a number, as illustrated by the Benchmark Configuration/Tested Storage Configuration Diagram on page 15. In ranks number 0 or 1, which contains spares, a single LUN of 128 GiB is defined. For all other ranks two LUNs of 128 GiB each are defined. After defining the LUNs, the script assigns each LUN to one of eight volume groups, V1-V8, so that paths can be assigned by groups of volumes.

step4_makevols.txt

```
# naming convention: da0r2_#h
#    DA pair 0
#    rank 2 for this DA pair
#    LUN ID #h is substituted with the following numbers(1020 or 1021)

mkfbvol -dev IBM.2107-7503471 -extpool P0  -type ds -cap 128 -name da0r0_#h 1000
mkfbvol -dev IBM.2107-7503471 -extpool P2  -type ds -cap 128 -name da0r2_#h 1020
1021
mkfbvol -dev IBM.2107-7503471 -extpool P4  -type ds -cap 128 -name da0r4_#h 1040
1041
mkfbvol -dev IBM.2107-7503471 -extpool P6  -type ds -cap 128 -name da0r6_#h 1060
1061
mkfbvol -dev IBM.2107-7503471 -extpool P1  -type ds -cap 128 -name da0r1_#h 1100
mkfbvol -dev IBM.2107-7503471 -extpool P3  -type ds -cap 128 -name da0r3_#h 1120
1121
mkfbvol -dev IBM.2107-7503471 -extpool P5  -type ds -cap 128 -name da0r5_#h 1140
1141
mkfbvol -dev IBM.2107-7503471 -extpool P7  -type ds -cap 128 -name da0r7_#h 1160
1161

mkfbvol -dev IBM.2107-7503471 -extpool P8  -type ds -cap 128 -name da1r0_#h 1200
mkfbvol -dev IBM.2107-7503471 -extpool P10 -type ds -cap 128 -name da1r2_#h 1220
1221
mkfbvol -dev IBM.2107-7503471 -extpool P12 -type ds -cap 128 -name da1r4_#h 1240
1241
mkfbvol -dev IBM.2107-7503471 -extpool P14 -type ds -cap 128 -name da1r6_#h 1260
1261
mkfbvol -dev IBM.2107-7503471 -extpool P9  -type ds -cap 128 -name da1r1_#h 1300
mkfbvol -dev IBM.2107-7503471 -extpool P11 -type ds -cap 128 -name da1r3_#h 1320
1321
mkfbvol -dev IBM.2107-7503471 -extpool P13 -type ds -cap 128 -name da1r5_#h 1340
1341
mkfbvol -dev IBM.2107-7503471 -extpool P15 -type ds -cap 128 -name da1r7_#h 1360
1361

mkfbvol -dev IBM.2107-7503471 -extpool P16 -type ds -cap 128 -name da2r0_#h 1400
mkfbvol -dev IBM.2107-7503471 -extpool P18 -type ds -cap 128 -name da2r2_#h 1420
1421
mkfbvol -dev IBM.2107-7503471 -extpool P20 -type ds -cap 128 -name da2r4_#h 1440
1441
mkfbvol -dev IBM.2107-7503471 -extpool P22 -type ds -cap 128 -name da2r6_#h 1460
1461
```

```
mkfbvol -dev IBM.2107-7503471 -extpool P17 -type ds -cap 128 -name da2r1_#h 1500
mkfbvol -dev IBM.2107-7503471 -extpool P19 -type ds -cap 128 -name da2r3_#h 1520
1521
mkfbvol -dev IBM.2107-7503471 -extpool P21 -type ds -cap 128 -name da2r5_#h 1540
1541
mkfbvol -dev IBM.2107-7503471 -extpool P23 -type ds -cap 128 -name da2r7_#h 1560
1561

mkfbvol -dev IBM.2107-7503471 -extpool P24 -type ds -cap 128 -name da3r0_#h 1600
mkfbvol -dev IBM.2107-7503471 -extpool P26 -type ds -cap 128 -name da3r2_#h 1620
1621
mkfbvol -dev IBM.2107-7503471 -extpool P28 -type ds -cap 128 -name da3r4_#h 1640
1641
mkfbvol -dev IBM.2107-7503471 -extpool P30 -type ds -cap 128 -name da3r6_#h 1660
1661
mkfbvol -dev IBM.2107-7503471 -extpool P25 -type ds -cap 128 -name da3r1_#h 1700
mkfbvol -dev IBM.2107-7503471 -extpool P27 -type ds -cap 128 -name da3r3_#h 1720
1721
mkfbvol -dev IBM.2107-7503471 -extpool P29 -type ds -cap 128 -name da3r5_#h 1740
1741
mkfbvol -dev IBM.2107-7503471 -extpool P31 -type ds -cap 128 -name da3r7_#h 1760
1761

mkfbvol -dev IBM.2107-7503471 -extpool P32 -type ds -cap 128 -name da4r0_#h 1800
mkfbvol -dev IBM.2107-7503471 -extpool P34 -type ds -cap 128 -name da4r2_#h 1820
1821
mkfbvol -dev IBM.2107-7503471 -extpool P36 -type ds -cap 128 -name da4r4_#h 1840
1841
mkfbvol -dev IBM.2107-7503471 -extpool P38 -type ds -cap 128 -name da4r6_#h 1860
1861
mkfbvol -dev IBM.2107-7503471 -extpool P33 -type ds -cap 128 -name da4r1_#h 1900
mkfbvol -dev IBM.2107-7503471 -extpool P35 -type ds -cap 128 -name da4r3_#h 1920
1921
mkfbvol -dev IBM.2107-7503471 -extpool P37 -type ds -cap 128 -name da4r5_#h 1940
1941
mkfbvol -dev IBM.2107-7503471 -extpool P39 -type ds -cap 128 -name da4r7_#h 1960
1961

mkfbvol -dev IBM.2107-7503471 -extpool P40 -type ds -cap 128 -name da5r0_#h 1A00
mkfbvol -dev IBM.2107-7503471 -extpool P42 -type ds -cap 128 -name da5r2_#h 1A20
1A21
mkfbvol -dev IBM.2107-7503471 -extpool P44 -type ds -cap 128 -name da5r4_#h 1A40
1A41
mkfbvol -dev IBM.2107-7503471 -extpool P46 -type ds -cap 128 -name da5r6_#h 1A60
1A61
mkfbvol -dev IBM.2107-7503471 -extpool P41 -type ds -cap 128 -name da5r1_#h 1B00
mkfbvol -dev IBM.2107-7503471 -extpool P43 -type ds -cap 128 -name da5r3_#h 1B20
1B21
mkfbvol -dev IBM.2107-7503471 -extpool P45 -type ds -cap 128 -name da5r5_#h 1B40
1B41
mkfbvol -dev IBM.2107-7503471 -extpool P47 -type ds -cap 128 -name da5r7_#h 1B60
1B61

mkfbvol -dev IBM.2107-7503471 -extpool P48 -type ds -cap 128 -name da6r0_#h 1C00
mkfbvol -dev IBM.2107-7503471 -extpool P50 -type ds -cap 128 -name da6r2_#h 1C20
1C21
mkfbvol -dev IBM.2107-7503471 -extpool P52 -type ds -cap 128 -name da6r4_#h 1C40
1C41
mkfbvol -dev IBM.2107-7503471 -extpool P54 -type ds -cap 128 -name da6r6_#h 1C60
1C61
mkfbvol -dev IBM.2107-7503471 -extpool P49 -type ds -cap 128 -name da6r1_#h 1D00
mkfbvol -dev IBM.2107-7503471 -extpool P51 -type ds -cap 128 -name da6r3_#h 1D20
1D21
```

```
mkfbvol -dev IBM.2107-7503471 -extpool P53 -type ds -cap 128 -name da6r5_#h 1D40
1D41
mkfbvol -dev IBM.2107-7503471 -extpool P55 -type ds -cap 128 -name da6r7_#h 1D60
1D61

mkfbvol -dev IBM.2107-7503471 -extpool P56 -type ds -cap 128 -name da7r0_#h 1E00
mkfbvol -dev IBM.2107-7503471 -extpool P58 -type ds -cap 128 -name da7r2_#h 1E20
1E21
mkfbvol -dev IBM.2107-7503471 -extpool P60 -type ds -cap 128 -name da7r4_#h 1E40
1E41
mkfbvol -dev IBM.2107-7503471 -extpool P62 -type ds -cap 128 -name da7r6_#h 1E60
1E61
mkfbvol -dev IBM.2107-7503471 -extpool P57 -type ds -cap 128 -name da7r1_#h 1F00
mkfbvol -dev IBM.2107-7503471 -extpool P59 -type ds -cap 128 -name da7r3_#h 1F20
1F21
mkfbvol -dev IBM.2107-7503471 -extpool P61 -type ds -cap 128 -name da7r5_#h 1F40
1F41
mkfbvol -dev IBM.2107-7503471 -extpool P63 -type ds -cap 128 -name da7r7_#h 1F60
1F61

rmvolgrp -dev IBM.2107-7503471 V0
rmvolgrp -dev IBM.2107-7503471 V1
rmvolgrp -dev IBM.2107-7503471 V2
rmvolgrp -dev IBM.2107-7503471 V3
rmvolgrp -dev IBM.2107-7503471 V4
rmvolgrp -dev IBM.2107-7503471 V5
rmvolgrp -dev IBM.2107-7503471 V6
rmvolgrp -dev IBM.2107-7503471 V7
rmvolgrp -dev IBM.2107-7503471 V8

mkvolgrp -dev IBM.2107-7503471 -hosttype pSeries V0
mkvolgrp -dev IBM.2107-7503471 -hosttype pSeries V1
mkvolgrp -dev IBM.2107-7503471 -hosttype pSeries V2
mkvolgrp -dev IBM.2107-7503471 -hosttype pSeries V3
mkvolgrp -dev IBM.2107-7503471 -hosttype pSeries V4
mkvolgrp -dev IBM.2107-7503471 -hosttype pSeries V5
mkvolgrp -dev IBM.2107-7503471 -hosttype pSeries V6
mkvolgrp -dev IBM.2107-7503471 -hosttype pSeries V7
mkvolgrp -dev IBM.2107-7503471 -hosttype pSeries V8

# Map lun's to the RIO port
chvolgrp -dev IBM.2107-7503471 -name rio_port_A -action replace -volume
1000,1020,1021,1040,1041,1060,1061,1200,1220,1221,1240,1241,1260,1261 V1
chvolgrp -dev IBM.2107-7503471 -name rio_port_B -action replace -volume
1800,1820,1821,1840,1841,1860,1861,1A00,1A20,1A21,1A40,1A41,1A60,1A61 V2
chvolgrp -dev IBM.2107-7503471 -name rio_port_C -action replace -volume
1D00,1D20,1D21,1D40,1D41,1D60,1D61,1F00,1F20,1F21,1F40,1F41,1F60,1F61 V3
chvolgrp -dev IBM.2107-7503471 -name rio_port_D -action replace -volume
1500,1520,1521,1540,1541,1560,1561,1700,1720,1721,1740,1741,1760,1761 V4
chvolgrp -dev IBM.2107-7503471 -name rio_port_E -action replace -volume
1C00,1C20,1C21,1C40,1C41,1C60,1C61,1E00,1E20,1E21,1E40,1E41,1E60,1E61 V5
chvolgrp -dev IBM.2107-7503471 -name rio_port_F -action replace -volume
1400,1420,1421,1440,1441,1460,1461,1600,1620,1621,1640,1641,1660,1661 V6
chvolgrp -dev IBM.2107-7503471 -name rio_port_G -action replace -volume
1100,1120,1121,1140,1141,1160,1161,1300,1320,1321,1340,1341,1360,1361 V7
chvolgrp -dev IBM.2107-7503471 -name rio_port_H -action replace -volume
1900,1920,1921,1940,1941,1960,1961,1B00,1B20,1B21,1B40,1B41,1B60,1B61 V8
```

Define the LUN access paths

The next step is to define the paths by which each LUN can be accessed by the Host System. First, the ports are defined to have standard open system fibre channel characteristics by the **step5_ports.txt** script. The path definitions are created by the **step6_paths.txt** script. Each host WWPN is assigned to one of the eight volume groups, V1-V8, so that each LUN is accessed via a set of four paths.

step5_ports.txt

```
setioport -dev IBM.2107-7503471 -topology fc-al I0000
setioport -dev IBM.2107-7503471 -topology fc-al I0001
setioport -dev IBM.2107-7503471 -topology fc-al I0002
setioport -dev IBM.2107-7503471 -topology fc-al I0003
setioport -dev IBM.2107-7503471 -topology fc-al I0030
setioport -dev IBM.2107-7503471 -topology fc-al I0031
setioport -dev IBM.2107-7503471 -topology fc-al I0032
setioport -dev IBM.2107-7503471 -topology fc-al I0033
setioport -dev IBM.2107-7503471 -topology fc-al I0100
setioport -dev IBM.2107-7503471 -topology fc-al I0101
setioport -dev IBM.2107-7503471 -topology fc-al I0102
setioport -dev IBM.2107-7503471 -topology fc-al I0103
setioport -dev IBM.2107-7503471 -topology fc-al I0130
setioport -dev IBM.2107-7503471 -topology fc-al I0131
setioport -dev IBM.2107-7503471 -topology fc-al I0132
setioport -dev IBM.2107-7503471 -topology fc-al I0133
setioport -dev IBM.2107-7503471 -topology fc-al I0200
setioport -dev IBM.2107-7503471 -topology fc-al I0201
setioport -dev IBM.2107-7503471 -topology fc-al I0202
setioport -dev IBM.2107-7503471 -topology fc-al I0203
setioport -dev IBM.2107-7503471 -topology fc-al I0230
setioport -dev IBM.2107-7503471 -topology fc-al I0231
setioport -dev IBM.2107-7503471 -topology fc-al I0232
setioport -dev IBM.2107-7503471 -topology fc-al I0233
setioport -dev IBM.2107-7503471 -topology fc-al I0300
setioport -dev IBM.2107-7503471 -topology fc-al I0301
setioport -dev IBM.2107-7503471 -topology fc-al I0302
setioport -dev IBM.2107-7503471 -topology fc-al I0303
setioport -dev IBM.2107-7503471 -topology fc-al I0330
setioport -dev IBM.2107-7503471 -topology fc-al I0331
setioport -dev IBM.2107-7503471 -topology fc-al I0332
setioport -dev IBM.2107-7503471 -topology fc-al I0333
setioport -dev IBM.2107-7503471 -topology fc-al I0400
setioport -dev IBM.2107-7503471 -topology fc-al I0401
setioport -dev IBM.2107-7503471 -topology fc-al I0402
setioport -dev IBM.2107-7503471 -topology fc-al I0403
setioport -dev IBM.2107-7503471 -topology fc-al I0430
setioport -dev IBM.2107-7503471 -topology fc-al I0431
setioport -dev IBM.2107-7503471 -topology fc-al I0432
setioport -dev IBM.2107-7503471 -topology fc-al I0433
setioport -dev IBM.2107-7503471 -topology fc-al I0500
setioport -dev IBM.2107-7503471 -topology fc-al I0501
setioport -dev IBM.2107-7503471 -topology fc-al I0502
setioport -dev IBM.2107-7503471 -topology fc-al I0503
setioport -dev IBM.2107-7503471 -topology fc-al I0530
setioport -dev IBM.2107-7503471 -topology fc-al I0531
setioport -dev IBM.2107-7503471 -topology fc-al I0532
setioport -dev IBM.2107-7503471 -topology fc-al I0533
setioport -dev IBM.2107-7503471 -topology fc-al I0600
setioport -dev IBM.2107-7503471 -topology fc-al I0601
setioport -dev IBM.2107-7503471 -topology fc-al I0602
setioport -dev IBM.2107-7503471 -topology fc-al I0603
```

```
setioport -dev IBM.2107-7503471 -topology fc-al I0630
setioport -dev IBM.2107-7503471 -topology fc-al I0631
setioport -dev IBM.2107-7503471 -topology fc-al I0632
setioport -dev IBM.2107-7503471 -topology fc-al I0633
setioport -dev IBM.2107-7503471 -topology fc-al I0700
setioport -dev IBM.2107-7503471 -topology fc-al I0701
setioport -dev IBM.2107-7503471 -topology fc-al I0702
setioport -dev IBM.2107-7503471 -topology fc-al I0703
setioport -dev IBM.2107-7503471 -topology fc-al I0730
setioport -dev IBM.2107-7503471 -topology fc-al I0731
setioport -dev IBM.2107-7503471 -topology fc-al I0732
setioport -dev IBM.2107-7503471 -topology fc-al I0733
```

step6_paths.txt

```
# Configure fibre channel I/O ports
# Note: Run "lsioport -dev IBM.2107-7503471" to get the I/O ports to configure.

# Run the line below on the AIX box to get the flipper adapter  wwpn's in order for
fcs0..31.
#          i=0; while ((i<=31)) do lscfg -vl fcs$i | grep Network; ((i=i+1)) done

# All IO ports should be Fibre Channel-SW FC-AL
#    setioport -dev IBM.2107-7503471 -topology fc-al I0021

# A DS8300 has 8 RIO ports.
# There are 32 flippers in persh2d- 4 per DS8300 RIO port.
# The flipper adapters are assigned in rotating fashion across the 8 RIO ports.
# The order below(V8, V7, V2, etc) is due to this script being written after
perfss07 was originally cabled to persh2d.
#    - Next new config, create then in increasing order(V1, V2, V3, etc).

# Make SCSI host ports and assign a volume group to them.

mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C944431B -profile "IBM pSeries -
AIX" -volgrp V8  sh2d_fcs0_G1_fc0102
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9424FD5 -profile "IBM pSeries -
AIX" -volgrp V7  sh2d_fcs1_H1_fc0502
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C94259CC -profile "IBM pSeries -
AIX" -volgrp V2  sh2d_fcs2_A1_fc0002
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C942518A -profile "IBM pSeries -
AIX" -volgrp V6  sh2d_fcs3_E1_fc0602
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C94030FD -profile "IBM pSeries -
AIX" -volgrp V1  sh2d_fcs4_B1_fc0402
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C942498B -profile "IBM pSeries -
AIX" -volgrp V4  sh2d_fcs5_C1_fc0702
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C94256F7 -profile "IBM pSeries -
AIX" -volgrp V5  sh2d_fcs6_F1_fc0202
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9427F7E -profile "IBM pSeries -
AIX" -volgrp V3  sh2d_fcs7_D1_fc0302
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9444479 -profile "IBM pSeries -
AIX" -volgrp V8  sh2d_fcs8_G3_fc0132
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C944446C -profile "IBM pSeries -
AIX" -volgrp V7  sh2d_fcs9_H3_fc0532
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C94443C8 -profile "IBM pSeries -
AIX" -volgrp V2 sh2d_fcs10_A3_fc0032
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9444524 -profile "IBM pSeries -
AIX" -volgrp V6 sh2d_fcs11_E3_fc0632
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C94440F4 -profile "IBM pSeries -
AIX" -volgrp V1 sh2d_fcs12_B3_fc0432
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9403183 -profile "IBM pSeries -
AIX" -volgrp V4 sh2d_fcs13_C3_fc0732
```

```
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9427A39 -profile "IBM pSeries -
AIX" -volgrp V5 sh2d_fcs14_F3_fc0232
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C942E674 -profile "IBM pSeries -
AIX" -volgrp V3 sh2d_fcs15_D3_fc0332
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C944454D -profile "IBM pSeries -
AIX" -volgrp V8 sh2d_fcs16_G4_fc0133
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C94079D7 -profile "IBM pSeries -
AIX" -volgrp V7 sh2d_fcs17_H4_fc0533
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C94443C9 -profile "IBM pSeries -
AIX" -volgrp V2 sh2d_fcs18_A4_fc0033
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9427DB5 -profile "IBM pSeries -
AIX" -volgrp V6 sh2d_fcs19_E4_fc0633
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C94443C0 -profile "IBM pSeries -
AIX" -volgrp V1 sh2d_fcs20_B4_fc0433
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9444199 -profile "IBM pSeries -
AIX" -volgrp V4 sh2d_fcs21_C4_fc0733
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C944425F -profile "IBM pSeries -
AIX" -volgrp V5 sh2d_fcs22_F4_fc0233
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C94443DA -profile "IBM pSeries -
AIX" -volgrp V3 sh2d_fcs23_D4_fc0333
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C94441ED -profile "IBM pSeries -
AIX" -volgrp V8 sh2d_fcs24_G2_fc0103
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9444428 -profile "IBM pSeries -
AIX" -volgrp V7 sh2d_fcs25_H2_fc0503
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9427F7F -profile "IBM pSeries -
AIX" -volgrp V2 sh2d_fcs26_A2_fc0003
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C944428C -profile "IBM pSeries -
AIX" -volgrp V6 sh2d_fcs27_E2_fc0603
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9444204 -profile "IBM pSeries -
AIX" -volgrp V1 sh2d_fcs28_B2_fc0403
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9402F88 -profile "IBM pSeries -
AIX" -volgrp V4 sh2d_fcs29_C2_fc0703
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9444156 -profile "IBM pSeries -
AIX" -volgrp V5 sh2d_fcs30_F2_fc0203
mkhostconnect -dev IBM.2107-7503471 -wwname 10000000C9444311 -profile "IBM pSeries -
AIX" -volgrp V3 sh2d_fcs31_D2_fc0303

lshostconnect
```

Discover the LUNs, create multi-path hdisks, set queue depth, and maximum transfer size

The **step8_discover.sh** script performs discovery on each of the 32 Host System paths. In this configuration AIX MPIO capability is utilized creating one multi-path hdisk that corresponds to each LUN. The script also sets the queue depth of each hdisk to 64 and the maximum transfer size to 1024 KiB

step8_discover.sh

```
#Configure Host Adapters for RIO Ports A1 through A4
for i in 2 26 10 18; do cfgmgr -vl fcs$i|grep Comp; done

#Configure Host Adapters for RIO Ports B1 through B4
for i in 4 28 12 20; do cfgmgr -vl fcs$i|grep Comp; done

#Configure Host Adapters for RIO Ports C1 through C4
for i in 5 29 13 21; do cfgmgr -vl fcs$i|grep Comp; done

#Configure Host Adapters for RIO Ports D1 through D4
for i in 7 31 15 23; do cfgmgr -vl fcs$i|grep Comp; done
```

```
#Configure Host Adapters for RIO Ports E1 through E4
for i in 3 27 11 19; do cfgmgr -vl fcs$i|grep Comp; done

#Configure Host Adapters for RIO Ports F1 through F4
for i in 6 30 14 22; do cfgmgr -vl fcs$i|grep Comp; done

#Configure Host Adapters for RIO Ports G1 through G4
for i in 0 24 8 16; do cfgmgr -vl fcs$i|grep Comp; done

#Configure Host Adapters for RIO Ports H1 through H4
for i in 1 25 9 17; do cfgmgr -vl fcs$i|grep Comp; done


# echo 'setting queue depth to 64 for hdisk4-115'
let i=4 ;while ((i<=115)) do rmdev -l hdisk$i; chdev -l hdisk$i -a queue_depth=64;
chdev -l hdisk$i -a max_transfer='0x100000'; mkdev -l hdisk$i;let i=i+1;done
```

Create logical volume group and logical volumes

A logical volume group is created using the native AIX Logical Volume Manager. It is a striped volume group with a pattern of striping designed so that the amount of space utilized in each rank is proportional to the number of disks in that rank. As illustrated in the Benchmark Configuration/Tested Storage Configuration Diagram on page15, 48 ranks have eight disks and zero spares, and are sometimes referred to as "4+4" ranks, 16 ranks have six disks and two spares, and are sometimes referred to as "3+3" ranks). The pattern of striping is accomplished with the **step9a_mkall.ksh** script, which calls **mkmap.ksh** as a subroutine. Once the striping pattern is defined, the **step9b_mkvg_spc1.txt** script creates the 18 logical volumes that comprise the SPC-1 ASUs.

step9a_mkall.ksh

```
#!/bin/ksh

LVS=18
i=1
while (( i <= LVS ))
do
     mkmap.ksh $i 13 > map$i
     maps="$maps map$i"
     (( i=i+1 ))
done

paste -d " " $maps | more
```

mkmap.ksh

```
#!/bin/ksh
#
# Creates mklv map files for creating spc1 LV config
#
if [ $# -ne 2 ]
then
   echo "usage: $0 <starting PP> <stripes>"
   exit 1
fi

#hdisks_3plus="4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64"
hdisks_3plus="4 11 18 25 32 39 46 53 60 67 74 81 88 95 102 109"
```

```
#hdisks="4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58
59 60 61 62 63 64 65 66 67"
hdisks="4 5 7 9 11 12 14 16 18 19 21 23 25 26 28 30 32 33 35 37 39 40 42 44 46 47 49
51 53 54 56 58 60 61 63 65 67 68 70 72 74 75 77 79 81 82 84 86 88 89 91 93 95 96 98
100 102 103 105 107 109 110 112 114"


starting_pp=$1
stripe_total=$2

j=1
stripes=1
pp3=$starting_pp
pp4=$starting_pp
while (( stripes <= stripe_total ))
do
     for hdisk in $hdisks
     do

# determine if 4+4 or 3+3: plus4=1 is 4+4, plus4=0 is 3+3
            plus4=1
            for z in $hdisks_3plus
            do
                  if [ $hdisk -eq $z ]
                        then plus4=0
                  fi
            done
#           echo "hdisk " $hdisk " " $plus4

# If 3+3, go ahead and print one PP per hdisk
            if [ plus4 -eq 0 ]
            then
                  print hdisk$hdisk:$pp3
            else
# If stripe 1 or 2 of group of 3, print one PP per hdisk
                  if [ j -le 2 ]
                  then
# If before the end of first lun on a 4+4 rank
                        if [ pp4 -le 252 ]
                        then
                              print hdisk$hdisk:$pp4
                        else
                              (( newhdisk = hdisk + 1 ))
                              (( newpp4 = pp4 - 252 ))
                              print hdisk$newhdisk:$newpp4
                        fi
# Else stripe 3 of group of 3, print 2 PP per 4+4 hdisk
                  else
# If before the end of first lun on a 4+4 rank
                        if [ pp4 -le 252 ]
                        then
                              (( k=pp4+1 ))
                              print hdisk$hdisk:$pp4-$k
# Else, skip to next hdisk and start with PP1
                        else
                              (( newhdisk = hdisk + 1 ))
                              (( newpp4 = pp4 - 252 ))
                              (( k=newpp4+1 ))
                              print hdisk$newhdisk:$newpp4-$k
                        fi
                  fi
            fi
```

```
      done
      (( j=j+1 ))
      (( pp3=pp3+18 ))

      if [ j -eq 3 ]
      then
            (( pp4=pp4 + starting_pp - 1 ))
      fi
      if [ j -le 3 ]
      then
            (( pp4=pp4+18 ))
      else
            (( pp4=pp4+37 - starting_pp ))
            j=1
      fi
      (( stripes=stripes+1 ))
done
```

step9b_mkvg_spc1.txt

```
# creates 18 logical volumes in a volume group with coarse striping

FIRST=4
LAST=115
hdisks=""

i=$FIRST
while [ i -le LAST ]
do
        hdisks="$hdisks hdisk$i"
        (( i=i+1 ))
done

mkvg -B -f -y stripevg -s 512 $hdisks

i=1
while [[ i -le 18 ]]
do
        mklv -y fat$i -m mkvg2/map$i stripevg 1024
        (( i=i+1 ))
done
```

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

The SPC-1 Workload Generator command and parameter file used in this benchmark is listed below.

```
javaparms="-Xms512m -Xmx768m -Xss128k -Xgcpolicy:optavgpause"
sd=asu1_1,size=512g,lun=/dev/rfat1
sd=asu1_2,size=512g,lun=/dev/rfat2
sd=asu1_3,size=512g,lun=/dev/rfat3
sd=asu1_4,size=512g,lun=/dev/rfat4
sd=asu1_5,size=512g,lun=/dev/rfat5
sd=asu1_6,size=512g,lun=/dev/rfat6
sd=asu1_7,size=512g,lun=/dev/rfat7
sd=asu1_8,size=512g,lun=/dev/rfat8
sd=asu2_1,size=512g,lun=/dev/rfat9
sd=asu2_2,size=512g,lun=/dev/rfat10
sd=asu2_3,size=512g,lun=/dev/rfat11
sd=asu2_4,size=512g,lun=/dev/rfat12
sd=asu2_5,size=512g,lun=/dev/rfat13
sd=asu2_6,size=512g,lun=/dev/rfat14
sd=asu2_7,size=512g,lun=/dev/rfat15
sd=asu2_8,size=512g,lun=/dev/rfat16
sd=asu3_1,size=455680m,lun=/dev/rfat17
sd=asu3_2,size=455680m,lun=/dev/rfat18
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

The following script was used to execute the Primary Metric 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. The contents of the **javaopts.cfg** are also listed below.

```
export PATH=$PATH:/usr/java14/bin
export SPC1HOME=/perform/spc1install
export CLASSPATH=$SPC1HOME
export LIBPATH=$SPC1HOME/aix
export IBM_JAVADUMP_OUTOFMEMORY=false
export IBM_HEAPDUMP_OUTOFMEMORY=false
java -Xoptionsfile=javaopts.cfg metrics -b 2461
java -Xoptionsfile=javaopts.cfg repeat1 -b 2461
java -Xoptionsfile=javaopts.cfg repeat2 -b 2461
java -Xoptionsfile=javaoptsp.cfg persist1 -b 2461
```

javaopts.cfg:

```
-Xms384m -Xmx768m -Xss128k -Xgcpolicy:subpool
```

The following script was used to execute Persistence Test Run 2. The contents of the **javaoptsp.cfg** are also listed below.

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

javaoptsp.cfg:

```
-Xms384m -Xmx768m -Xss128k -Xgcpolicy:optavgpause
```