SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

3PAR INC.
3PAR INSERV® F400 STORAGE SERVER

SPC-1 V1.10.1

Submitted for Review: April 27, 2009
Submission Identifier: A00079

First Edition – April 2009

Trademarks

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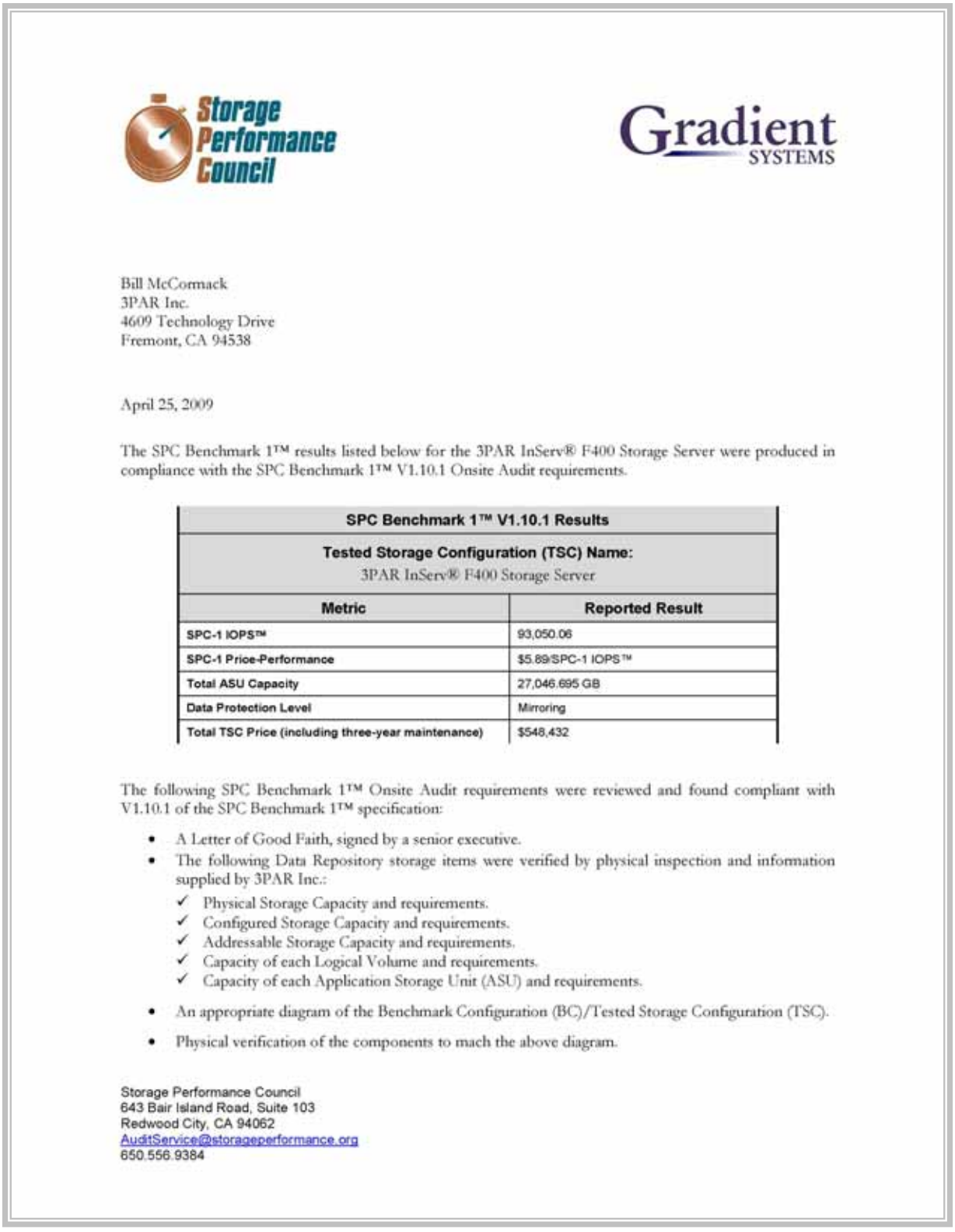
AUDIT CERTIFICATION



Bill McCormack
3PAR Inc.
4609 Technology Drive
Fremont, CA 94538

April 25, 2009

The SPC Benchmark 1™ results listed below for the 3PAR InServ® F400 Storage Server were produced in compliance with the SPC Benchmark 1™ V1.10.1 Onsite Audit requirements.

SPC Benchmark 1™ V1.10.1 Results	
Tested Storage Configuration (TSC) Name: 3PAR InServ® F400 Storage Server	
Metric	**Reported Result**
SPC-1 IOPS™	93,050.06
SPC-1 Price-Performance	$5.89/SPC-1 IOPS™
Total ASU Capacity	27,046.695 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$548,432

The following SPC Benchmark 1™ Onsite 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 by physical inspection and information supplied by 3PAR Inc.:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of each Application Storage Unit (ASU) and requirements.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Physical verification of the components to mach the above diagram.

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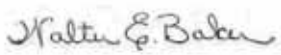
AUDIT CERTIFICATION *(CONT.)*

- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters that were changed from default values.
- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.
- The following Host System requirements were verified by physical inspection and information supplied by 3PAR Inc.:
  - ✓ The type of Host System including the number of processors and main memory.
  - ✓ The presence and version number of the SPC-1 Workload Generator on the Host System.
  - ✓ The TSC boundary within the Host System.
- The execution of each Test, Test Phase, and Test Run was observed and found compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification.
- The Test Results Files and resultant Summary Results Files received from 3PAR Inc. for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability Test
- There were no differences between the Tested Storage Configuration (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.
- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

Audit Notes:

There were no audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

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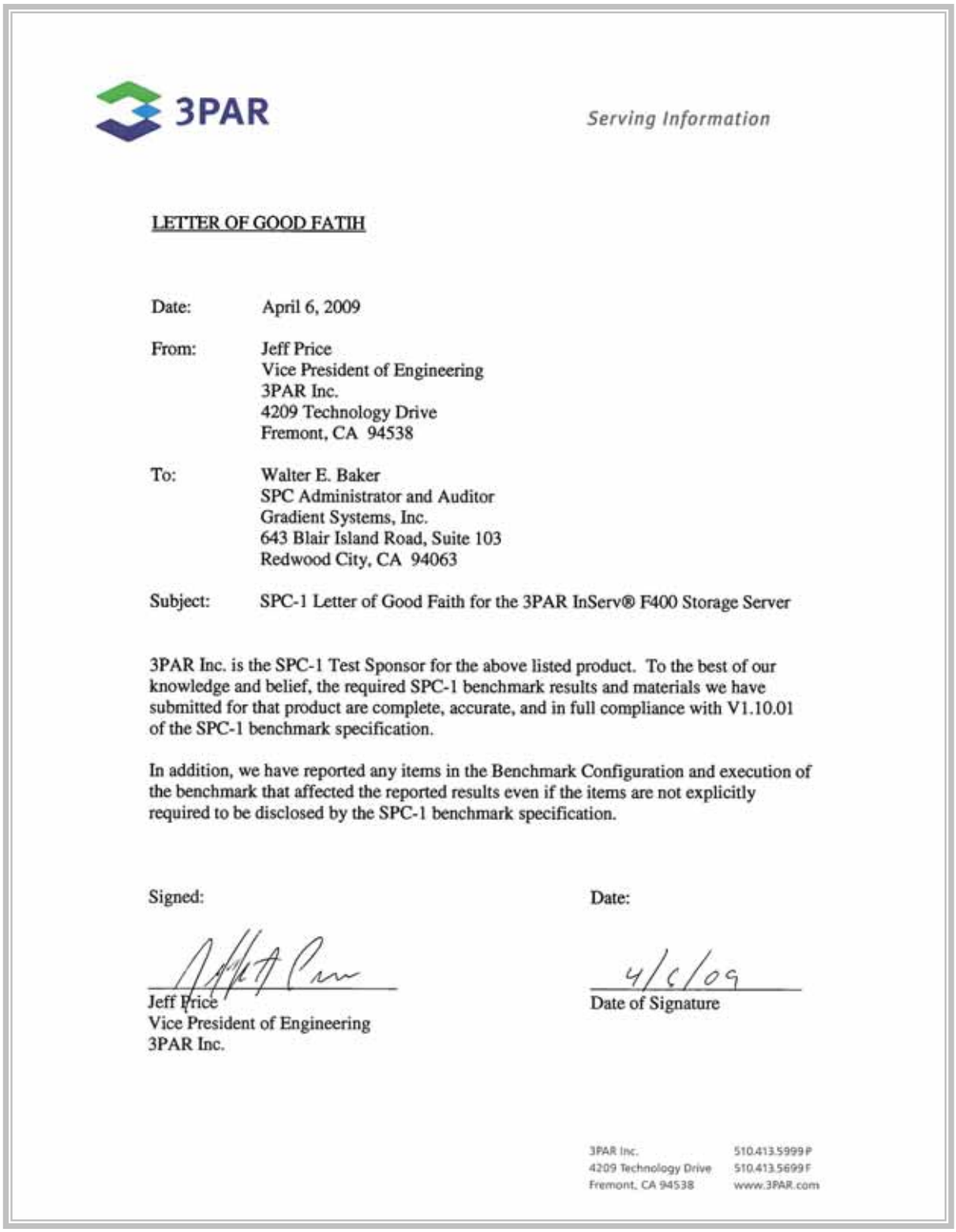
LETTER OF GOOD FAITH



3PAR

Serving Information

LETTER OF GOOD FATIH

Date: April 6, 2009

From: Jeff Price
Vice President of Engineering
3PAR Inc.
4209 Technology Drive
Fremont, CA 94538

To: Walter E. Baker
SPC Administrator and Auditor
Gradient Systems, Inc.
643 Blair Island Road, Suite 103
Redwood City, CA 94063

Subject: SPC-1 Letter of Good Faith for the 3PAR InServ® F400 Storage Server

3PAR Inc. is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with V1.10.01 of the SPC-1 benchmark specification.

In addition, we have reported any items in the Benchmark Configuration and execution of the benchmark that affected the reported results even if the items are not explicitly required to be disclosed by the SPC-1 benchmark specification.

Signed: Date:

Jeff Price
Vice President of Engineering
3PAR Inc.

4/6/09
Date of Signature

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EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	3PAR Inc. – http://www.3par.com Bill McCormack – bill.mccormack@3par.com 4609 Technology Drive Fremont, CA 94538 Phone: (510) 897-2784 FAX: (510) 413-5998
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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	April 27, 2009
Date the FDR was submitted to the SPC	April 27, 2009
Date the TSC is available for shipment to customers	April 6, 2009
Date the TSC completed audit certification	April 25, 2009

Tested Storage Product (TSP) Description

3PAR designed the 3PAR InServ® F400 Storage Server from the ground up to overcome the limitations of midrange arrays. The midrange storage market has long been conditioned to compromise scalability and performance in order to reduce storage costs and meet shrinking IT budgets. As a result of these constraints, organizations often end up purchasing and deploying multiple midrange arrays to meet their storage needs – resulting in the datacenter sprawl of midrange arrays.

The InServ F400 is the first quad-controller array designed for the midrange. It offers the same innovative cache-coherent mesh backplane architecture and high-end features as the InServ T-Class arrays, but in a scaled-down array tailored to mid-sized deployments. The InServ F400 boasts 3PAR's Mesh-Active architecture, which applies all node resources to each LUN concurrently, delivering far more headroom for application consolidation in a virtualized datacenter. As mixed workloads are generated by application consolidation, the 3PAR Gen3 ASIC in each F400 Controller Node parallelizes metadata processing and data movement to deliver high and predictable levels of performance to all concurrently running applications, and high utilization rates for all purchased resources.

The InServ F400 shares the same 3PAR InForm® Operating System and supports all the same advanced software features as the other members of the InServ family of arrays, including 3PAR Thin Provisioning, 3PAR Virtual Domains, 3PAR Dynamic Optimization, 3PAR Virtual Copy, and 3PAR Remote Copy.

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: 3PAR InServ® F400 Storage Server	
Metric	**Reported Result**
SPC-1 IOPS™	93,050.06
SPC-1 Price-Performance	$5.89/SPC-1 IOPS™
Total ASU Capacity	27,046.695 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$548,432

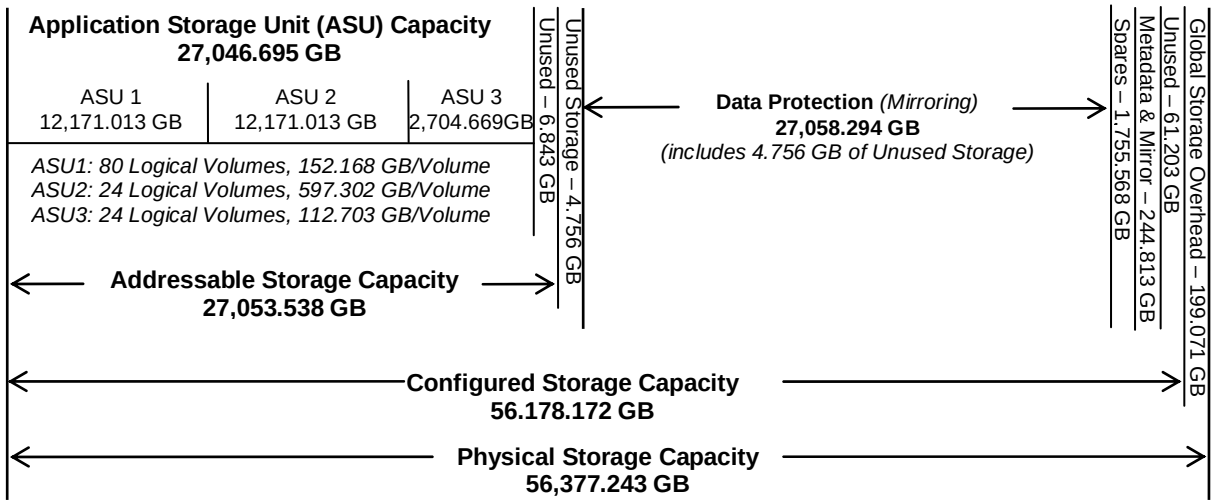
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

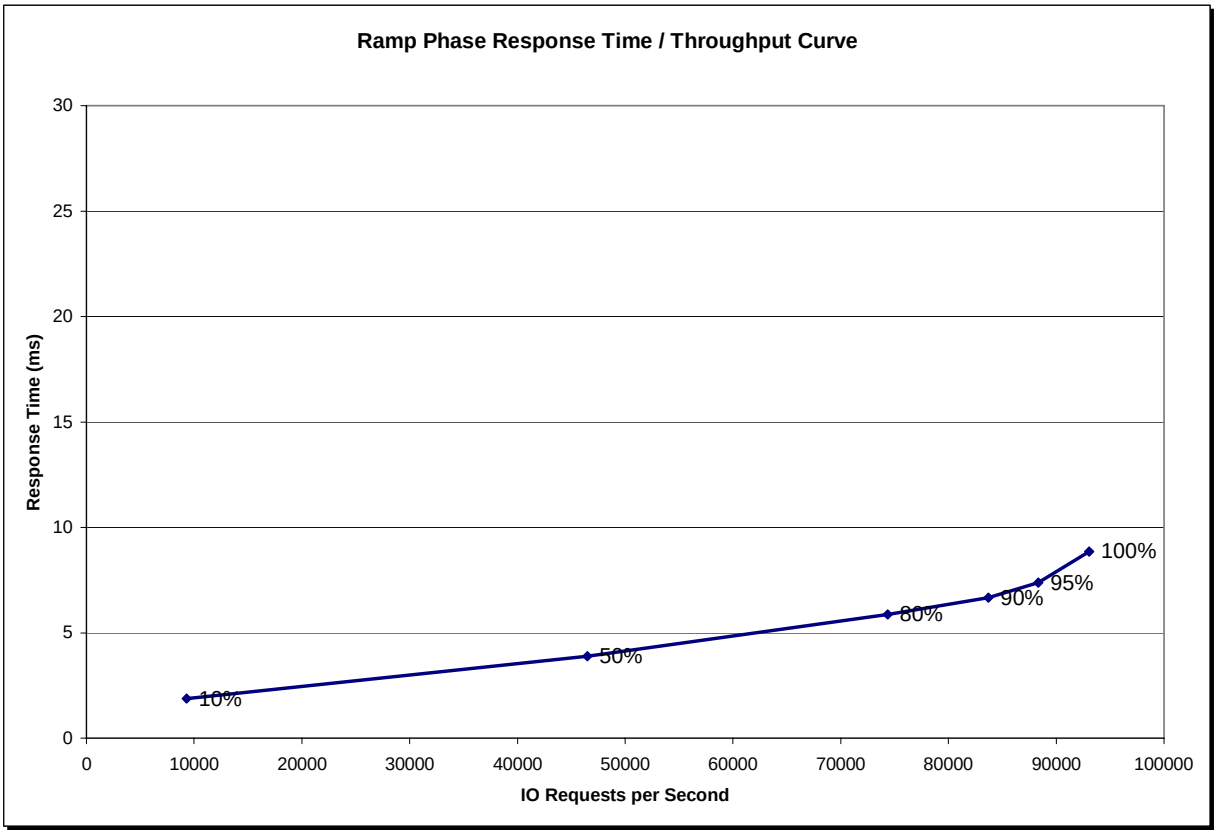
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



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	9,297.82	46,497.43	74,380.83	83,701.45	88,335.76	93,050.06
Average Response Time (ms):						
All ASUs	1.87	3.89	5.87	6.66	7.37	8.85
ASU-1	2.49	4.76	7.05	7.91	8.61	10.03
ASU-2	1.95	5.52	8.76	9.96	10.84	11.95
ASU-3	0.54	1.34	2.10	2.55	3.22	4.99
Reads	4.01	8.04	12.13	13.61	14.66	16.39
Writes	0.48	1.19	1.79	2.13	2.63	3.94

Tested Storage Configuration Pricing *(Priced Storage Configuration)*

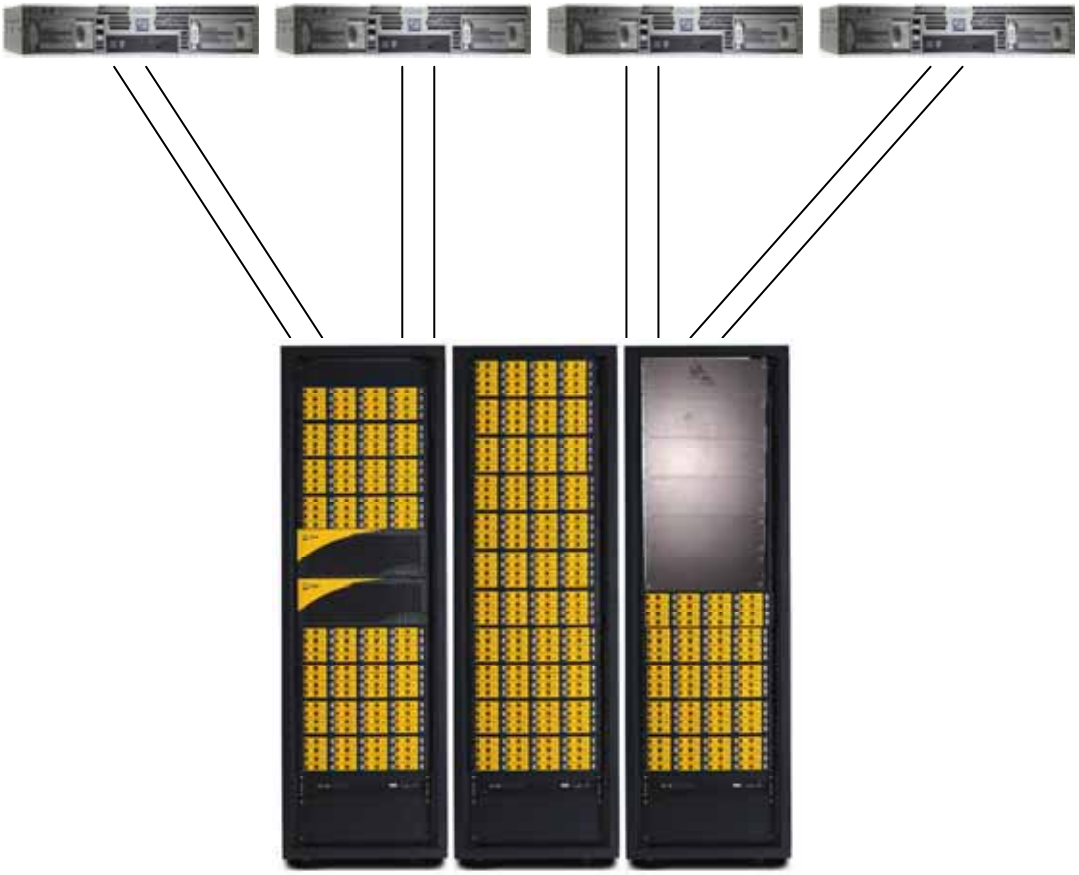
Item	Description	Quantity	Price
980-200013	2.33GHZ F-CLASS CONTROLLER NODE		
	(includes one 4-PORT FC ADAPTER FOR F-CLASS (4 GBIT/S) per node)	2	
980-200017	4GB CONTROL CACHE (2 x 2GB DIMMS) FOR F-CLASS	4	
980-200016	6GB DATA CACHE (3 x 2GB DIMMS) FOR F-CLASS	4	
980-200014	2-PORT FIBRE CHANNEL ADAPTER FOR F-CLASS (4 GBIT/S)	8	
980-200012	INSERV F400 BASE CONFIGURATION		
	(includes two 4-PORT FC ADAPTER FOR F-CLASS (4 GBIT/S))	1	
981-200018	DRIVE CHASSIS (16-DISK, 4GBIT/S)	24	
983-200028	DAISY CHAIN CONNECTOR FOR DRIVE CHASSIS (16-DISK, 4 GBIT/S)	24	
981-200019	4 x 146GB SINGLE-DRIVE MAGAZINES (15K, 4 GBIT/S)	96	
982-200000	2M FIBER CABLE 50/125 (LC-LC)	16	
982-0021	10M FIBER CABLE 50/125 (LC-LC)	32	
982-0023	50M FIBER CABLE 50/125 (LC-LC)	8	
982-200012	2M BASE CABINET FOR F400	1	
982-200013	2M EXPANSION CABINET KIT (WITH REDUNDANT PDU PAIR) FOR F-CLASS	2	
982-0014	REGIONAL KIT, NORTH AMERICA	3	
985-0001	SERVICE PROCESSOR	1	
987-200181	INFORM SUITE (F400) - 4 x 146GB 15K RPM MAGAZINES LTU	96	
985-200222	INSTALLATION AND SET-UP 4 NODES F-CLASS, CABINET	1	
985-200239	HW MAINT 24X7 4HR RESP, PRICE PER NODE FOR 4 NODES F-CLASS	4	
985-200248	INFORM SUITE SW MAINT, PRICE PER NODE FOR 4 NODES F-CLASS	4	
	3PAR InServ F400 Storage Server Package --Includes 3-years Service (24x7 4-Hour Response)		**$ 544,863.80**
QLE2462	Qlogic QLE2462 PCI-EXPRESS Host Bus Adapter	4	**$ 3,568.00**
	Total		**$ 548,431.80**

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 1/2/3/4
Sun Fire X2200 M2 Servers
4 – 4 Gb/s Dual Port HBAs
(1 per server)



SC 1/2/3/4
3PAR InServ® F400 Storage Server
24 GB Data Cache, 16 GB Control Cache
4 – 4 Gb/s QuadPort FC Adapters
8 – 4 Gb/s DualPort FC Adapters
(4 adapters – front-end, 4 adapters – backend)
384 – 146.8 GB 15K RPM Disks

Benchmark Configuration/Tested Storage Configuration Components

Host Systems:	Tested Storage Configuration (TSC):
UID=HS-1/2/3/4	4 – QLE2462 4Gb dual port HBAs *(1 per server)*
4 – Sun Fire X2200 M2 Servers	***UID=SC-1/2/3/4:*** 3PAR InServ® F400 Storage Server 4 – F-Class Controller Nodes 24 GB data cache 16 GB control cache 4 – 4Gb DualPort FC Adapters *(2 ports/adapter used for front-end)* 4 – 4Gb DualPort FC Adapters *(2 ports/adapter used for backend)* 4 – 4Gb QuadPort FC Adapters *(4 ports/adapter used for backend)*
Each server with: 2 – 2.8 GHZ dual core AMD Opteron processors each core with 64 KB I-cache, 64 KB D-cache and1 MB L2 cache	
8192 MB main memory	
Solaris 10 10/08	
PCIe	
WG	2 – 2M Expansion Cabinet Kits
	384 – 146.8 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), including the network configuration, is illustrated on page 15 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Host System Configuration

Clause 9.2.4.4.3

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

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

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

Customer Tunable Parameters and Options

Clause 9.2.4.5.1

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

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

Tested Storage Configuration (TSC) Description

Clause 9.2.4.5.2

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

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

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

SPC-1 Workload Generator Storage Configuration

Clause 9.2.4.5.3

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

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in "Appendix D: SPC-1 Workload Generator Storage Commands and Parameters" on page 65.

SPC-1 DATA REPOSITORY

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

Storage Capacities and Relationships

Clause 9.2.4.6.1

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

SPC-1 Storage Capacities

SPC-1 Storage Capacities		
Storage Hierarchy Component	**Units**	**Capacity**
Total ASU Capacity	Gigabytes (GB)	27,046.695
Addressable Storage Capacity	Gigabytes (GB)	27,053.538
Configured Storage Capacity	Gigabytes (GB)	56,178.172
Physical Storage Capacity	Gigabytes (GB)	56,178.172
Data Protection *(Mirrored)*	Gigabytes (GB)	27,058.294
Required Storage *(spares/metadata/overhead)*	Gigabytes (GB)	2,009.893
Global Storage Overhead	Gigabytes (GB)	199.071
Total Unused Storage	Gigabytes (GB)	74.890

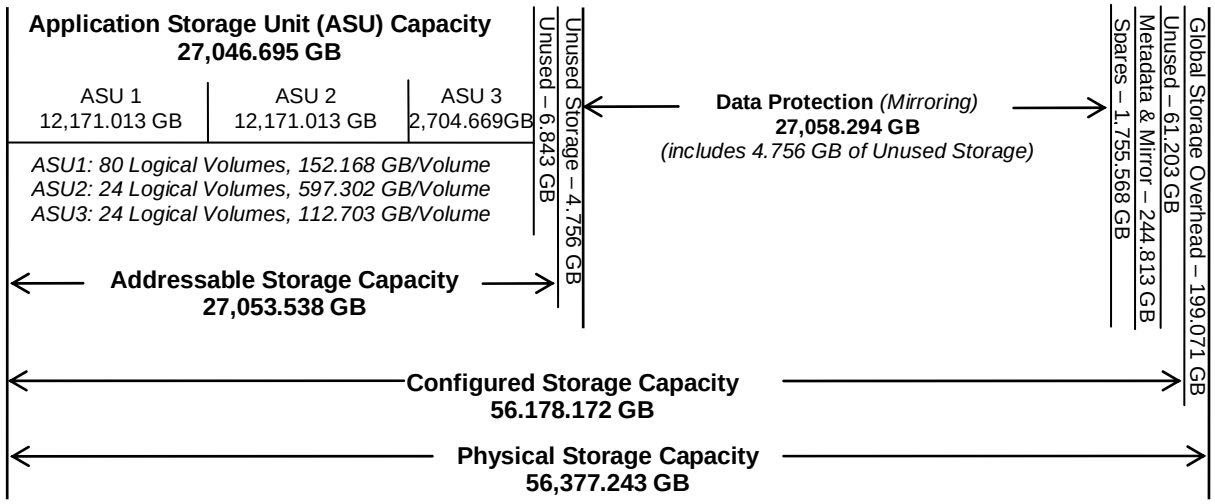
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	99.97%	48.14%	47.97%
Required for Data Protection *(Mirrored)*		48.17%	48.00%
Addressable Storage Capacity		48.16%	47.99%
Required Storage *(spares/metadata)*		3.58%	3.57%
Configured Storage Capacity			99.65%
Global Storage Overhead			0.35%
Unused Storage:			
Addressable	0.03%		
Configured		0.11%	
Physical			0.00%

The Physical Storage Capacity consisted of 56,377.243 GB distributed over 384 disk drives each with a formatted capacity of 146.816 GB. There was 0.00 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 199.071 GB (0.35%) of Physical Storage Capacity. There was 61.203 GB (0.11%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 99.97% of the Addressable Storage Capacity resulting in 6.43 GB (0.03%) 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 (12,171.013 GB)	**ASU-2 (12,171.013 GB)**	**ASU-3 (2,704.669 GB)**
80 Logical Volumes 152.168 GB per Logical Volume (152.138 GB used per Logical Volume)	24 Logical Volumes 507.302 GB per Logical Volume (507l.126 GB used per Logical Volume)	Logical Volumes 112.703 GB per Logical Volume (112.695 GB used per Logical Volume)

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

SPC-1 BENCHMARK EXECUTION RESULTS

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

Clause 5.4.3

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

SPC-1 Tests, Test Phases, and Test Runs

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

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

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

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

Primary Metrics Test – Sustainability Test Phase

Clause 5.4.4.1.1

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

Clause 5.4.4.1.2

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

Clause 5.4.4.1.4

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

Clause 9.2.4.7.1

For the Sustainability Test Phase the FDR shall contain:

1. *A Data Rate Distribution graph and data table.*
2. *I/O Request Throughput Distribution graph and data table.*
3. *A Response Time Frequency Distribution graph and table.*
4. *An Average Response Time Distribution graph and table.*
5. *The human readable Test Run Results File produced by the Workload Generator (may be included in an appendix).*
6. *A listing or screen image of all input parameters supplied to the Workload Generator (may be included in an appendix).*
7. *The Measured Intensity Multiplier for each I/O stream.*
8. *The variability of the Measured Intensity Multiplier, as defined in Clause 5.3.13.3.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 70.

Sustainability Test Results File

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

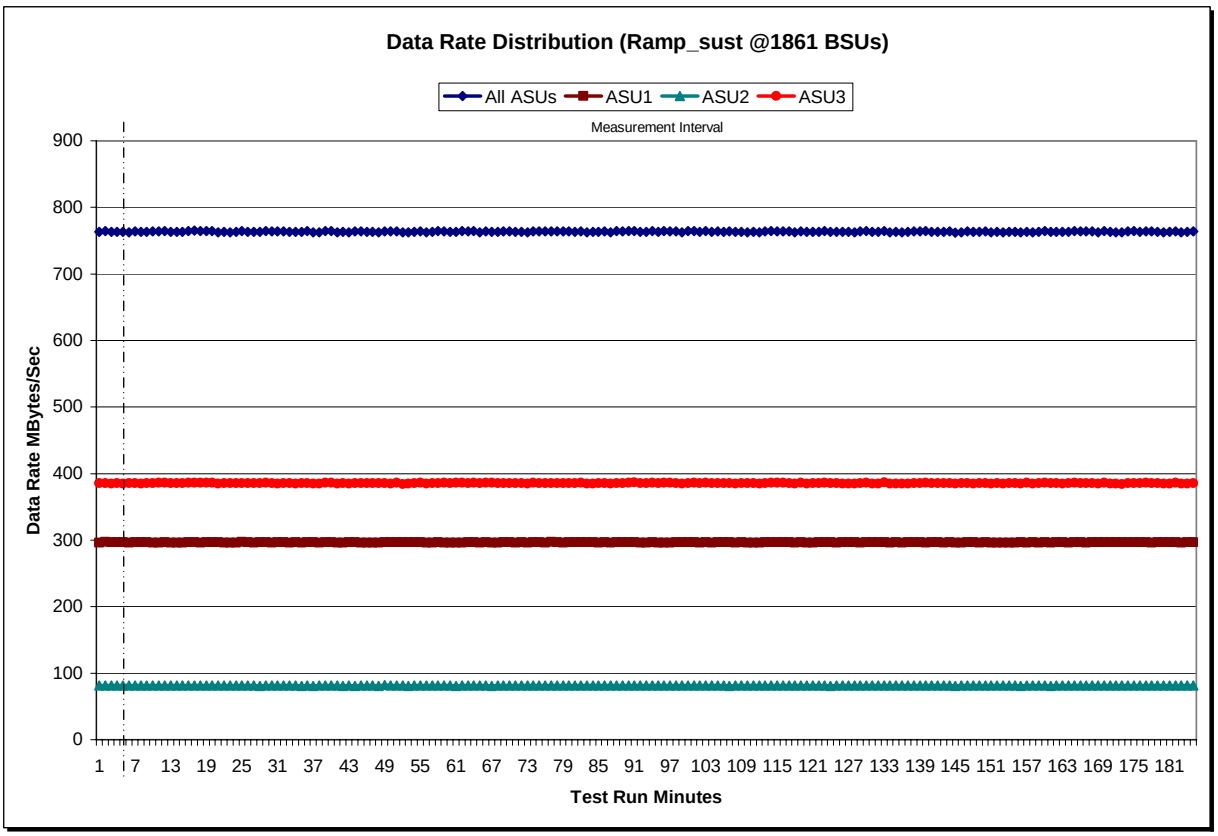
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	18:30:44	18:35:44	0-4	0:05:00
Measurement Interval	18:35:44	21:35:44	5-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	763.17	295.97	81.38	385.82	63	764.80	297.04	81.58	386.18	126	763.10	296.55	81.85	384.70
1	764.45	297.14	81.52	385.79	64	762.95	295.84	81.45	385.66	127	762.88	296.66	81.33	384.89
2	763.35	296.51	81.77	385.06	65	764.18	296.85	81.43	385.90	128	763.79	296.36	81.79	385.63
3	763.25	296.44	81.32	385.49	66	763.56	296.34	81.32	385.90	129	764.28	296.57	81.55	386.16
4	763.50	296.75	81.73	385.02	67	763.44	296.28	81.75	385.42	130	763.45	296.79	81.59	385.06
5	762.95	296.35	81.35	385.25	68	764.17	297.05	81.52	385.60	131	763.08	296.62	81.50	384.97
6	763.89	296.90	81.68	385.30	69	763.98	296.84	81.50	385.64	132	764.83	296.48	81.65	386.70
7	763.08	296.64	81.52	384.92	70	763.12	296.05	81.61	385.47	133	762.95	296.05	81.80	385.11
8	763.38	296.59	81.53	385.26	71	763.52	296.44	81.71	385.36	134	763.45	296.76	81.56	385.13
9	763.90	296.40	81.72	385.78	72	762.68	296.31	81.59	384.78	135	762.48	296.27	81.45	384.75
10	764.07	296.36	81.69	386.02	73	764.20	296.55	81.69	385.96	136	763.18	296.96	81.50	384.72
11	764.45	296.81	81.58	386.06	74	763.71	296.57	81.44	385.69	137	763.97	296.52	81.85	385.60
12	763.26	296.04	81.54	385.69	75	763.85	296.28	81.75	385.82	138	763.71	296.48	81.39	385.84
13	763.28	296.39	81.45	385.44	76	764.02	297.16	81.60	385.25	139	764.32	296.33	81.91	386.08
14	763.05	296.05	81.63	385.36	77	763.74	296.48	81.74	385.51	140	763.41	296.59	81.41	385.41
15	764.35	296.72	81.61	386.02	78	763.89	296.41	81.73	385.75	141	763.48	296.86	81.35	385.27
16	765.11	296.99	81.66	386.46	79	763.66	296.47	81.66	385.52	142	763.21	296.04	81.47	385.70
17	764.62	296.25	81.88	386.49	80	763.40	296.65	81.32	385.42	143	764.15	296.89	81.67	385.59
18	764.48	296.82	81.48	386.18	81	763.98	296.49	81.47	386.02	144	762.07	295.79	81.31	384.98
19	764.31	296.56	81.45	386.30	82	762.93	296.49	81.45	385.00	145	762.64	295.91	81.46	385.27
20	762.82	296.75	81.32	384.75	83	763.14	296.71	81.52	384.91	146	764.04	296.89	81.43	385.73
21	763.03	296.39	81.43	385.21	84	763.40	296.34	81.80	385.26	147	763.17	296.76	81.51	384.90
22	762.81	295.91	81.35	385.55	85	763.74	296.82	81.45	385.48	148	763.45	296.19	81.72	385.54
23	763.18	296.12	81.53	385.53	86	762.46	296.16	81.55	384.74	149	763.81	296.64	81.79	385.39
24	764.55	297.40	81.78	385.37	87	764.45	297.00	81.64	385.81	150	762.95	296.38	81.82	384.75
25	763.55	296.52	81.46	385.58	88	763.94	296.47	81.63	385.84	151	763.12	296.12	81.75	385.26
26	763.31	296.33	81.52	385.46	89	764.34	296.74	81.59	386.01	152	762.67	296.26	81.32	385.09
27	763.37	296.81	81.31	385.26	90	764.72	296.56	81.63	386.53	153	763.02	296.28	81.48	385.26
28	764.35	296.87	81.62	385.86	91	763.54	296.34	81.75	385.45	154	763.12	296.22	81.36	385.54
29	763.90	296.39	81.69	385.83	92	763.59	296.34	81.69	385.57	155	762.72	296.71	81.27	384.74
30	763.71	296.83	81.72	385.16	93	764.89	296.63	81.86	386.40	156	763.54	296.21	81.40	385.93
31	763.65	296.68	81.49	385.48	94	763.59	296.35	81.84	385.39	157	762.79	296.44	81.60	384.74
32	763.05	296.42	81.42	385.21	95	764.31	296.36	81.67	386.28	158	763.01	296.16	81.52	385.32
33	763.05	296.87	81.49	384.69	96	763.87	296.10	81.50	386.27	159	764.35	296.53	81.51	386.32
34	763.01	296.29	81.24	385.48	97	764.10	297.03	81.74	385.33	160	763.02	296.33	81.30	385.39
35	764.54	297.05	81.69	385.80	98	762.88	296.52	81.48	384.88	161	763.36	296.51	81.50	385.35
36	762.84	296.64	81.30	384.89	99	764.30	296.92	81.83	385.55	162	763.15	296.71	81.35	385.09
37	762.82	296.39	81.44	384.99	100	764.27	296.55	81.45	386.26	163	763.42	296.02	81.82	385.58
38	764.52	296.96	81.44	386.12	101	763.25	296.15	81.71	385.39	164	764.34	296.73	81.75	385.86
39	764.54	296.68	81.59	386.27	102	764.69	296.67	81.69	386.34	165	763.71	296.48	81.83	385.40
40	762.79	296.38	81.46	384.95	103	763.53	296.39	81.69	385.45	166	763.70	296.14	81.93	385.63
41	763.48	296.42	81.26	385.80	104	763.76	296.97	81.49	385.30	167	763.93	296.49	81.68	385.76
42	762.92	296.88	81.36	384.68	105	763.60	296.86	81.50	385.24	168	762.90	296.53	81.53	384.84
43	763.87	296.85	81.17	385.85	106	763.61	296.85	81.10	385.67	169	764.44	296.66	81.58	386.20
44	763.79	296.42	81.82	385.55	107	763.00	296.34	81.58	385.07	170	763.42	296.90	81.60	384.92
45	763.13	296.43	81.33	385.37	108	763.32	296.44	81.56	385.32	171	762.94	296.54	81.39	385.01
46	763.42	296.37	81.69	385.35	109	762.94	296.30	81.32	385.32	172	762.68	296.48	81.75	384.44
47	762.94	296.27	81.17	385.50	110	763.56	296.23	81.65	385.69	173	763.91	296.44	81.62	385.85
48	764.21	296.50	81.97	385.75	111	762.91	296.36	81.41	385.15	174	764.31	296.91	81.59	385.80
49	763.79	296.76	81.84	385.19	112	763.84	296.74	81.58	385.52	175	763.31	296.50	81.57	385.25
50	763.83	296.54	81.43	385.86	113	764.49	297.04	81.46	385.99	176	764.09	296.51	81.33	386.25
51	762.70	296.52	81.63	384.55	114	764.18	296.70	81.55	385.93	177	763.88	296.30	81.94	385.65
52	762.72	296.46	81.24	385.01	115	764.13	296.62	81.59	385.92	178	763.37	296.64	81.46	385.28
53	763.48	296.57	81.68	385.23	116	764.01	296.79	81.84	385.38	179	762.77	296.49	81.70	384.59
54	763.98	296.48	81.37	386.14	117	762.94	296.33	81.59	385.02	180	763.03	296.83	81.45	384.75
55	762.73	296.17	81.65	384.90	118	763.90	296.57	81.44	385.89	181	764.06	296.44	81.56	386.05
56	763.31	296.43	81.34	385.54	119	763.09	296.39	81.53	385.17	182	762.90	296.40	81.34	385.16
57	764.28	296.73	81.84	385.70	120	763.59	296.22	81.59	385.78	183	763.14	296.65	81.44	385.05
58	763.78	296.12	81.80	385.86	121	763.41	296.49	81.49	385.44	184	763.64	296.81	81.47	385.36
59	763.39	296.38	81.69	385.32	122	764.41	296.54	81.66	386.21					
60	763.38	296.24	81.25	385.89	123	763.51	296.62	81.30	385.59					
61	764.35	296.36	81.52	386.47	124	763.43	296.35	81.50	385.58					
62	764.22	296.76	81.63	385.84	125	763.41	296.67	81.66	385.07					

Sustainability – Data Rate Distribution Graph

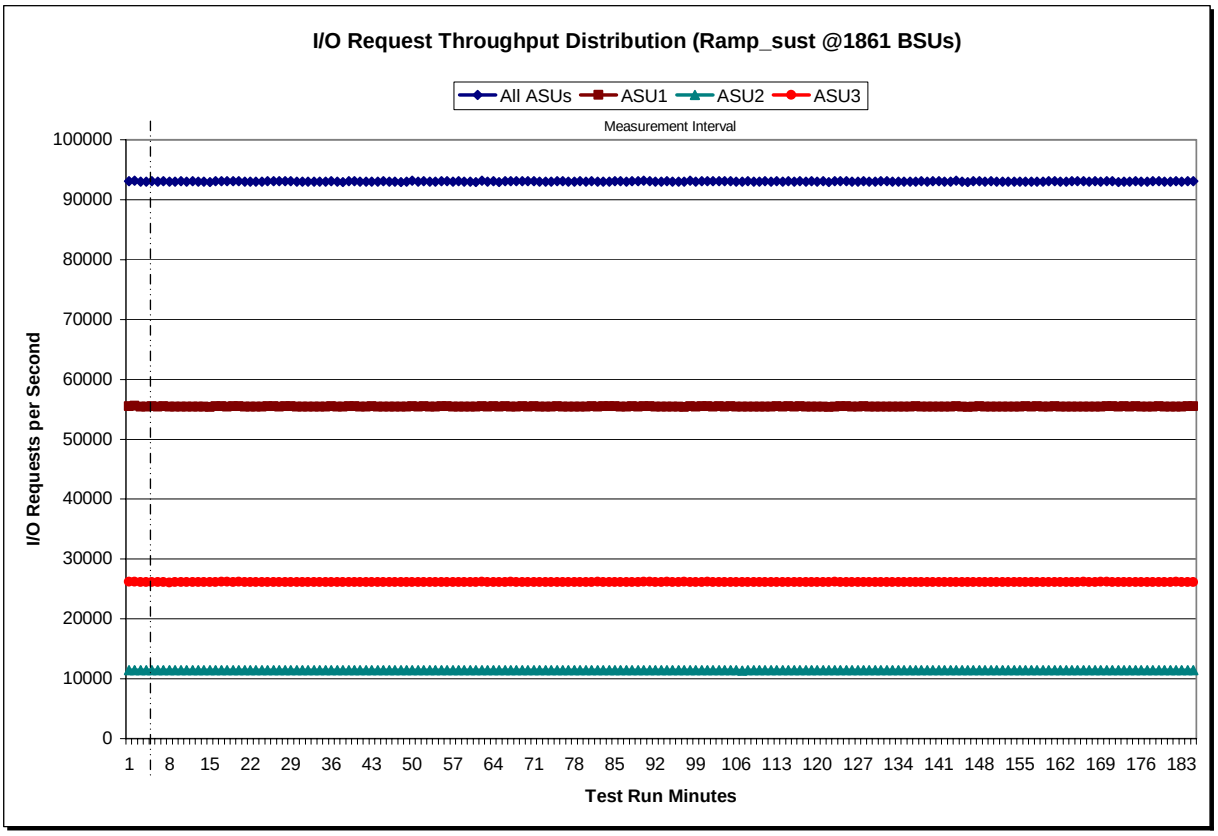


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	18:30:44	18:35:44	0-4	0:05:00
Measurement Interval	18:35:44	21:35:44	5-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	93,115.82	55,486.25	11,437.63	26,191.93	63	93,056.73	55,496.68	11,425.40	26,134.65	126	93,015.40	55,441.98	11,462.02	26,111.40
1	93,172.85	55,555.63	11,446.55	26,170.67	64	92,977.25	55,409.52	11,436.45	26,131.28	127	93,098.23	55,493.25	11,453.67	26,151.32
2	93,028.23	55,451.98	11,450.92	26,125.33	65	93,110.85	55,501.18	11,445.13	26,164.53	128	93,040.45	55,434.13	11,451.23	26,155.08
3	93,035.08	55,468.37	11,419.17	26,147.55	66	93,081.27	55,468.15	11,437.33	26,175.78	129	93,043.03	55,465.20	11,430.17	26,147.67
4	93,058.72	55,492.63	11,448.63	26,117.45	67	93,075.90	55,467.62	11,457.13	26,151.15	130	93,056.55	55,469.18	11,448.10	26,139.27
5	93,016.68	55,433.22	11,436.93	26,146.53	68	93,104.07	55,511.02	11,462.87	26,130.18	131	93,086.73	55,465.68	11,453.82	26,167.23
6	93,072.40	55,483.45	11,443.00	26,145.95	69	93,057.93	55,469.50	11,444.12	26,144.32	132	93,007.38	55,416.10	11,432.05	26,159.23
7	92,996.63	55,459.88	11,442.03	26,094.72	70	93,081.42	55,478.58	11,447.45	26,155.38	133	93,031.23	55,433.87	11,470.42	26,126.95
8	93,051.97	55,466.93	11,458.60	26,126.43	71	93,045.50	55,452.58	11,447.95	26,144.97	134	93,009.43	55,434.82	11,443.67	26,130.95
9	93,053.58	55,457.32	11,452.53	26,143.73	72	93,017.45	55,416.50	11,452.83	26,148.12	135	92,998.15	55,413.42	11,446.28	26,138.45
10	93,022.88	55,437.27	11,446.35	26,139.27	73	93,039.40	55,437.57	11,458.55	26,143.28	136	93,051.50	55,485.45	11,445.88	26,120.17
11	93,052.72	55,441.43	11,451.42	26,159.87	74	93,083.67	55,485.82	11,441.87	26,155.98	137	93,064.73	55,455.83	11,460.95	26,147.95
12	92,995.97	55,410.55	11,447.10	26,138.32	75	93,075.83	55,453.55	11,467.47	26,154.82	138	93,025.38	55,467.35	11,435.58	26,122.45
13	92,999.33	55,440.58	11,426.77	26,131.98	76	93,044.33	55,432.17	11,451.42	26,160.75	139	93,062.55	55,462.63	11,470.28	26,129.63
14	92,973.55	55,379.90	11,438.83	26,154.82	77	93,028.57	55,429.70	11,443.85	26,155.02	140	93,055.90	55,467.50	11,445.63	26,142.77
15	93,069.53	55,489.22	11,450.92	26,129.40	78	93,055.67	55,439.87	11,459.10	26,156.70	141	93,037.83	55,457.60	11,438.20	26,142.03
16	93,120.60	55,478.62	11,451.05	26,190.93	79	93,046.33	55,465.32	11,448.08	26,132.93	142	93,008.00	55,402.10	11,449.32	26,156.58
17	93,097.23	55,468.27	11,432.28	26,196.68	80	93,061.82	55,490.18	11,429.78	26,141.85	143	93,140.35	55,525.58	11,459.13	26,155.63
18	93,092.53	55,501.50	11,423.40	26,167.63	81	93,047.72	55,417.33	11,454.33	26,176.05	144	93,033.65	55,454.13	11,434.62	26,144.90
19	93,093.98	55,472.37	11,448.53	26,173.08	82	93,039.88	55,474.13	11,437.07	26,128.68	145	92,954.93	55,371.68	11,452.62	26,130.63
20	93,024.60	55,469.60	11,429.42	26,125.58	83	93,041.73	55,477.60	11,449.38	26,114.75	146	93,076.23	55,463.72	11,442.98	26,169.53
21	92,984.23	55,414.47	11,451.05	26,118.72	84	93,057.40	55,480.85	11,445.47	26,131.08	147	93,076.73	55,516.30	11,448.90	26,111.53
22	93,008.10	55,442.42	11,423.57	26,142.12	85	93,074.18	55,470.67	11,450.28	26,153.23	148	92,997.22	55,426.08	11,440.43	26,130.70
23	93,035.33	55,424.50	11,452.97	26,157.87	86	93,030.55	55,465.48	11,427.45	26,137.62	149	93,075.38	55,457.28	11,450.72	26,167.38
24	93,102.98	55,510.45	11,461.40	26,131.13	87	93,102.88	55,493.20	11,446.55	26,163.13	150	93,015.27	55,411.97	11,455.92	26,147.38
25	93,068.47	55,476.52	11,443.97	26,147.98	88	93,058.25	55,454.17	11,448.60	26,155.48	151	93,009.58	55,451.88	11,433.32	26,124.38
26	93,058.40	55,458.62	11,465.27	26,134.52	89	93,147.72	55,495.45	11,464.87	26,187.40	152	92,981.55	55,415.50	11,438.57	26,127.48
27	93,066.88	55,471.88	11,442.80	26,152.20	90	93,095.78	55,473.13	11,436.17	26,186.48	153	93,020.73	55,422.40	11,432.57	26,165.77
28	93,066.58	55,502.25	11,437.50	26,126.83	91	93,023.12	55,425.17	11,445.58	26,152.37	154	93,012.18	55,437.35	11,417.40	26,157.43
29	93,033.58	55,424.83	11,457.15	26,151.60	92	93,036.60	55,450.58	11,434.12	26,151.90	155	93,038.62	55,472.85	11,438.17	26,127.60
30	93,041.53	55,452.85	11,448.28	26,140.40	93	93,090.42	55,451.78	11,459.57	26,179.07	156	92,999.65	55,411.73	11,445.08	26,142.83
31	93,034.48	55,461.97	11,440.67	26,131.85	94	93,047.53	55,453.75	11,449.70	26,144.08	157	93,049.88	55,480.57	11,444.52	26,124.80
32	93,035.08	55,464.15	11,437.27	26,133.67	95	93,031.02	55,437.20	11,427.15	26,166.67	158	93,037.92	55,446.03	11,430.87	26,161.02
33	93,038.07	55,463.17	11,426.07	26,148.83	96	93,003.05	55,377.43	11,439.88	26,185.73	159	93,055.03	55,439.58	11,445.75	26,169.70
34	93,048.90	55,467.70	11,429.08	26,152.12	97	93,141.63	55,527.58	11,461.20	26,152.85	160	93,106.82	55,505.28	11,444.45	26,157.08
35	93,114.80	55,497.25	11,469.20	26,148.35	98	93,035.42	55,438.15	11,457.83	26,139.43	161	93,045.85	55,461.85	11,462.70	26,121.30
36	93,014.83	55,454.37	11,434.72	26,125.75	99	93,112.47	55,495.85	11,468.83	26,147.78	162	93,045.15	55,471.23	11,439.87	26,134.05
37	92,954.90	55,421.23	11,419.80	26,113.87	100	93,092.07	55,491.75	11,429.57	26,170.75	163	93,072.00	55,459.87	11,465.77	26,146.37
38	93,074.38	55,488.82	11,442.97	26,142.60	101	93,052.87	55,431.08	11,474.43	26,147.35	164	93,082.48	55,458.88	11,467.03	26,156.57
39	93,074.72	55,478.98	11,431.77	26,163.97	102	93,116.00	55,483.65	11,470.73	26,161.62	165	93,120.37	55,463.97	11,469.43	26,186.97
40	92,997.55	55,437.32	11,436.70	26,123.53	103	93,056.53	55,466.75	11,448.47	26,141.32	166	93,023.97	55,428.90	11,465.93	26,129.13
41	93,036.70	55,447.27	11,433.47	26,155.97	104	93,067.55	55,473.02	11,440.13	26,154.40	167	93,064.05	55,450.12	11,445.72	26,168.22
42	93,047.28	55,483.73	11,435.50	26,128.05	105	93,038.40	55,462.32	11,433.32	26,142.77	168	93,050.53	55,442.25	11,433.87	26,174.42
43	93,030.35	55,452.60	11,435.48	26,142.27	106	93,012.70	55,452.28	11,399.83	26,160.58	169	93,072.30	55,473.02	11,424.42	26,174.87
44	93,064.40	55,444.83	11,470.63	26,148.93	107	93,072.13	55,458.02	11,464.65	26,149.47	170	93,097.07	55,493.13	11,465.18	26,138.75
45	93,016.25	55,418.32	11,445.45	26,152.48	108	93,023.62	55,427.58	11,455.17	26,140.87	171	92,977.42	55,453.80	11,421.28	26,102.33
46	93,048.80	55,434.43	11,471.48	26,142.88	109	93,030.23	55,453.95	11,432.60	26,143.68	172	93,037.32	55,474.38	11,455.47	26,107.47
47	92,963.12	55,408.13	11,421.37	26,133.62	110	93,067.38	55,462.98	11,462.05	26,142.35	173	92,989.78	55,420.78	11,438.98	26,130.02
48	93,048.45	55,448.33	11,460.50	26,139.62	111	92,987.78	55,409.48	11,441.05	26,137.25	174	93,114.30	55,508.47	11,470.80	26,135.03
49	93,152.47	55,522.45	11,460.68	26,169.33	112	93,052.90	55,486.63	11,445.90	26,120.37	175	93,037.05	55,446.63	11,453.70	26,136.72
50	92,989.95	55,409.63	11,446.53	26,133.78	113	93,027.13	55,456.95	11,419.40	26,150.78	176	93,031.75	55,419.82	11,443.85	26,168.08
51	93,082.82	55,482.28	11,458.97	26,141.57	114	93,100.48	55,493.38	11,444.98	26,162.12	177	93,091.13	55,445.08	11,478.80	26,167.25
52	92,997.87	55,451.82	11,412.42	26,133.63	115	93,042.80	55,434.83	11,445.97	26,162.00	178	93,067.27	55,513.17	11,424.52	26,129.58
53	93,004.62	55,429.63	11,451.12	26,123.87	116	93,084.37	55,495.23	11,472.75	26,116.38	179	93,000.33	55,449.82	11,452.52	26,098.00
54	93,062.05	55,483.93	11,435.37	26,142.75	117	93,025.85	55,443.60	11,438.45	26,143.80	180	92,994.07	55,460.07	11,424.38	26,109.62
55	93,067.10	55,477.20	11,447.33	26,142.57	118	93,081.98	55,446.10	11,467.47	26,168.42	181	93,067.55	55,419.78	11,454.57	26,193.20
56	92,982.00	55,439.95	11,419.42	26,122.63	119	93,006.53	55,415.62	11,444.65	26,146.27	182	92,991.63	55,423.95	11,440.87	26,126.82
57	93,057.80	55,441.97	11,458.90	26,156.93	120	93,059.80	55,462.17	11,440.72	26,156.92	183	93,073.05	55,472.30	11,448.60	26,152.15
58	93,047.48	55,415.63	11,480.87	26,150.98	121	92,967.25	55,399.43	11,446.23	26,121.58	184	93,097.47	55,515.40	11,447.80	26,134.27
59	93,042.15	55,456.00	11,450.45	26,135.70	122	93,053.23	55,449.37	11,433.07	26,170.80	Average	93,047.73	55,456.28	11,445.93	26,145.52
60	92,971.17	55,403.28	11,414.62	26,153.27	123	93,063.23	55,479.88	11,440.88	26,142.47					
61	93,140.20	55,485.80	11,446.20	26,208.20	124	93,061.27	55,484.67	11,439.33	26,137.27					
62	93,011.52	55,445.13	11,445.73	26,120.65	125	93,014.80	55,455.65	11,451.02	26,108.13					

Sustainability – I/O Request Throughput Distribution Graph

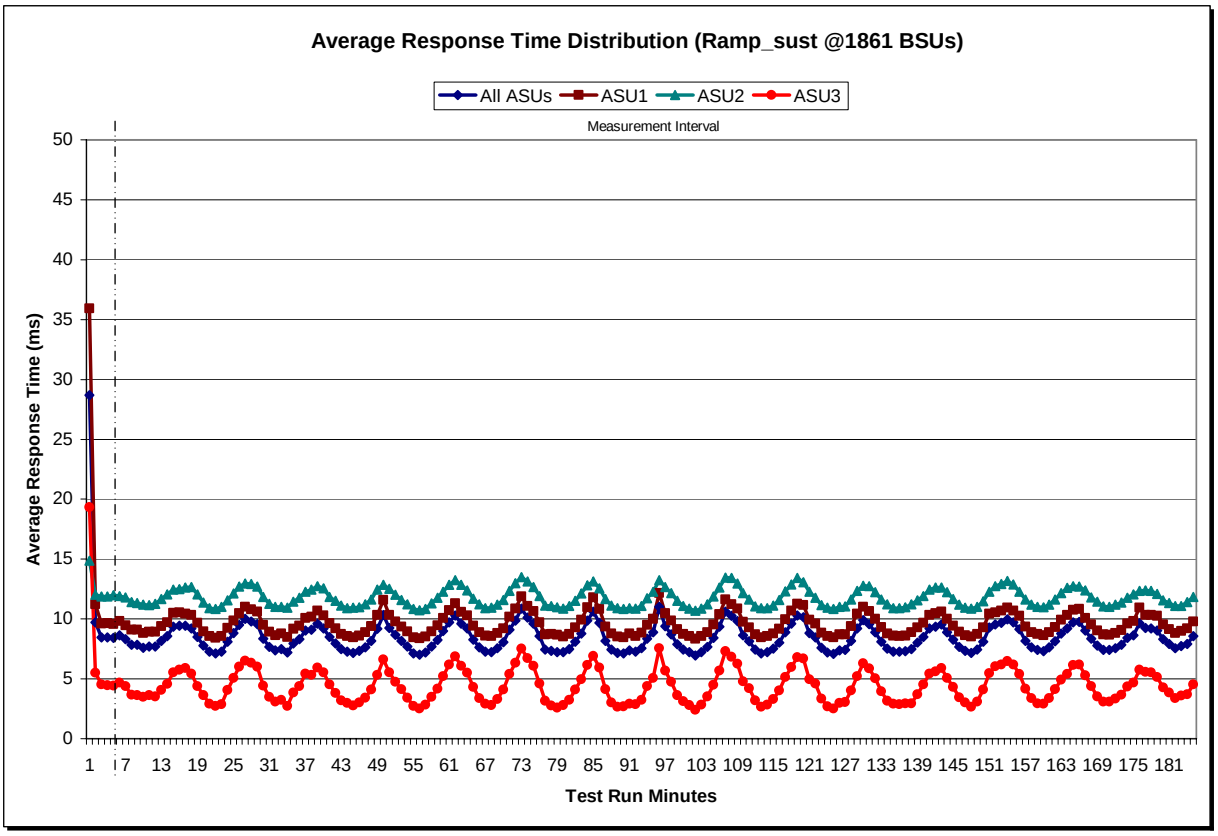


Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	18:30:44	18:35:44	0-4	0:05:00
Measurement Interval	18:35:44	21:35:44	5-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	28.67	35.93	14.87	19.32	63	9.21	10.29	12.37	5.51	126	7.42	8.73	11.03	3.06
1	9.73	11.24	12.03	5.51	64	8.27	9.42	11.71	4.32	127	8.16	9.39	11.62	4.04
2	8.47	9.62	11.86	4.53	65	7.64	8.91	11.22	3.38	128	9.21	10.45	12.35	5.21
3	8.45	9.64	11.87	4.45	66	7.28	8.60	10.90	2.90	129	9.90	11.00	12.79	6.29
4	8.43	9.58	11.97	4.44	67	7.25	8.58	10.96	2.79	130	9.56	10.65	12.74	5.86
5	8.65	9.84	11.93	4.67	68	7.57	8.83	11.18	3.30	131	8.89	10.02	12.23	5.04
6	8.33	9.47	11.79	4.39	69	8.08	9.23	11.59	4.11	132	8.11	9.34	11.62	3.97
7	7.85	9.09	11.42	3.66	70	9.10	10.18	12.33	5.40	133	7.51	8.80	11.22	3.16
8	7.83	9.09	11.35	3.62	71	9.85	10.86	12.99	6.35	134	7.28	8.59	10.89	2.91
9	7.60	8.80	11.18	3.50	72	10.85	11.88	13.49	7.53	135	7.25	8.56	10.92	2.89
10	7.72	8.93	11.16	3.65	73	10.11	11.07	13.16	6.75	136	7.30	8.61	10.96	2.93
11	7.69	8.92	11.26	3.52	74	9.62	10.67	12.67	6.07	137	7.50	8.88	11.22	2.95
12	8.18	9.39	11.65	4.08	75	8.55	9.71	11.91	4.62	138	8.01	9.30	11.54	3.72
13	8.56	9.72	12.06	4.58	76	7.46	8.73	11.13	3.16	139	8.51	9.68	11.91	4.53
14	9.35	10.52	12.45	5.53	77	7.36	8.76	11.09	2.76	140	9.22	10.34	12.47	5.44
15	9.44	10.53	12.50	5.77	78	7.25	8.69	10.97	2.57	141	9.37	10.46	12.62	5.63
16	9.43	10.45	12.62	5.89	79	7.22	8.54	10.87	2.81	142	9.55	10.64	12.64	5.90
17	9.23	10.32	12.66	5.42	80	7.49	8.75	11.09	3.24	143	8.90	10.02	12.23	5.07
18	8.49	9.69	12.07	4.39	81	8.11	9.30	11.52	4.10	144	8.28	9.44	11.67	4.32
19	7.77	8.97	11.38	3.62	82	8.80	9.92	12.15	4.95	145	7.67	8.94	11.19	3.45
20	7.27	8.57	10.92	2.93	83	9.86	10.99	12.82	6.17	146	7.34	8.63	10.96	3.03
21	7.12	8.43	10.85	2.72	84	10.60	11.82	13.13	6.92	147	7.16	8.51	10.86	2.65
22	7.27	8.57	11.00	2.88	85	9.68	10.85	12.56	5.95	148	7.44	8.75	11.01	3.11
23	8.08	9.26	11.57	4.05	86	8.18	9.37	11.67	4.12	149	8.09	9.27	11.48	4.09
24	8.80	9.87	12.14	5.07	87	7.45	8.78	11.11	3.02	150	9.27	10.45	12.26	5.46
25	9.49	10.46	12.71	6.01	88	7.16	8.51	10.90	2.65	151	9.54	10.53	12.73	6.03
26	10.00	11.03	12.97	6.52	89	7.14	8.47	10.85	2.71	152	9.69	10.68	12.92	6.18
27	9.80	10.79	12.93	6.34	90	7.39	8.77	10.90	2.93	153	9.96	10.94	13.17	6.49
28	9.58	10.62	12.72	6.01	91	7.25	8.58	10.86	2.87	154	9.71	10.71	12.88	6.21
29	8.37	9.50	11.84	4.44	92	7.55	8.85	11.09	3.25	155	9.15	10.27	12.27	5.41
30	7.68	8.92	11.28	3.48	93	8.34	9.52	11.74	4.38	156	8.17	9.34	11.62	4.18
31	7.36	8.63	11.02	3.08	94	8.91	10.01	12.27	5.09	157	7.63	8.90	11.20	3.38
32	7.50	8.78	11.02	3.25	95	11.00	12.17	13.26	7.55	158	7.41	8.76	11.02	2.96
33	7.18	8.51	10.93	2.73	96	9.40	10.47	12.69	5.70	159	7.32	8.64	10.97	2.93
34	7.96	9.17	11.45	3.87	97	8.71	9.86	12.16	4.74	160	7.62	8.89	11.18	3.39
35	8.30	9.44	11.76	4.38	98	7.88	9.14	11.50	3.63	161	8.15	9.33	11.61	4.13
36	9.05	10.10	12.28	5.42	99	7.45	8.73	11.08	3.15	162	8.80	9.93	12.18	4.93
37	9.09	10.17	12.46	5.33	100	7.23	8.58	10.88	2.79	163	9.23	10.34	12.59	5.40
38	9.60	10.68	12.76	5.93	101	6.96	8.35	10.67	2.40	164	9.71	10.76	12.73	6.15
39	9.23	10.29	12.55	5.53	102	7.25	8.56	10.88	2.85	165	9.75	10.82	12.72	6.20
40	8.49	9.65	11.86	4.55	103	7.68	8.90	11.22	3.54	166	9.02	10.08	12.39	5.30
41	7.97	9.20	11.51	3.81	104	8.41	9.54	11.87	4.49	167	8.37	9.54	11.80	4.38
42	7.49	8.75	11.13	3.22	105	9.36	10.42	12.64	5.71	168	7.79	9.05	11.44	3.52
43	7.28	8.55	10.92	2.98	106	10.63	11.62	13.46	7.31	169	7.43	8.73	11.05	3.11
44	7.17	8.47	10.93	2.76	107	10.27	11.23	13.41	6.84	170	7.40	8.69	11.00	3.09
45	7.34	8.62	10.99	3.04	108	9.83	10.87	12.96	6.28	171	7.57	8.81	11.20	3.35
46	7.65	8.90	11.23	3.43	109	8.65	9.76	12.17	4.78	172	7.84	9.07	11.37	3.67
47	8.18	9.40	11.64	4.09	110	8.14	9.27	11.64	4.21	173	8.41	9.62	11.78	4.36
48	9.19	10.33	12.46	5.32	111	7.45	8.70	11.06	3.22	174	8.65	9.82	12.07	4.68
49	10.35	11.58	12.85	6.62	112	7.13	8.46	10.91	2.65	175	9.65	10.93	12.36	5.75
50	9.25	10.33	12.52	5.53	113	7.25	8.58	10.90	2.83	176	9.25	10.34	12.37	5.57
51	8.66	9.80	12.04	4.75	114	7.54	8.79	11.12	3.32	177	9.23	10.33	12.34	5.54
52	8.15	9.35	11.57	4.13	115	8.03	9.18	11.59	4.03	178	9.05	10.26	12.09	5.16
53	7.70	8.98	11.25	3.43	116	8.90	9.96	12.30	5.15	179	8.31	9.55	11.55	4.27
54	7.13	8.44	10.85	2.72	117	9.63	10.68	12.90	5.97	180	7.92	9.13	11.34	3.85
55	7.01	8.37	10.71	2.51	118	10.28	11.27	13.44	6.79	181	7.56	8.81	11.08	3.40
56	7.21	8.52	10.83	2.83	119	10.14	11.15	13.08	6.71	182	7.73	8.99	11.09	3.59
57	7.70	8.95	11.30	3.48	120	8.82	9.93	12.26	4.96	183	7.93	9.20	11.41	3.72
58	8.26	9.46	11.77	4.17	121	8.47	9.60	11.79	4.62	184	8.57	9.79	11.84	4.54
59	8.98	10.06	12.29	5.24	122	7.59	8.85	11.15	3.36	Average	8.39	9.58	11.79	4.38
60	9.71	10.72	12.85	6.21	123	7.20	8.56	10.93	2.71					
61	10.29	11.30	13.25	6.87	124	7.09	8.47	10.84	2.52					
62	9.61	10.59	12.87	6.09	125	7.38	8.71	11.03	2.97					

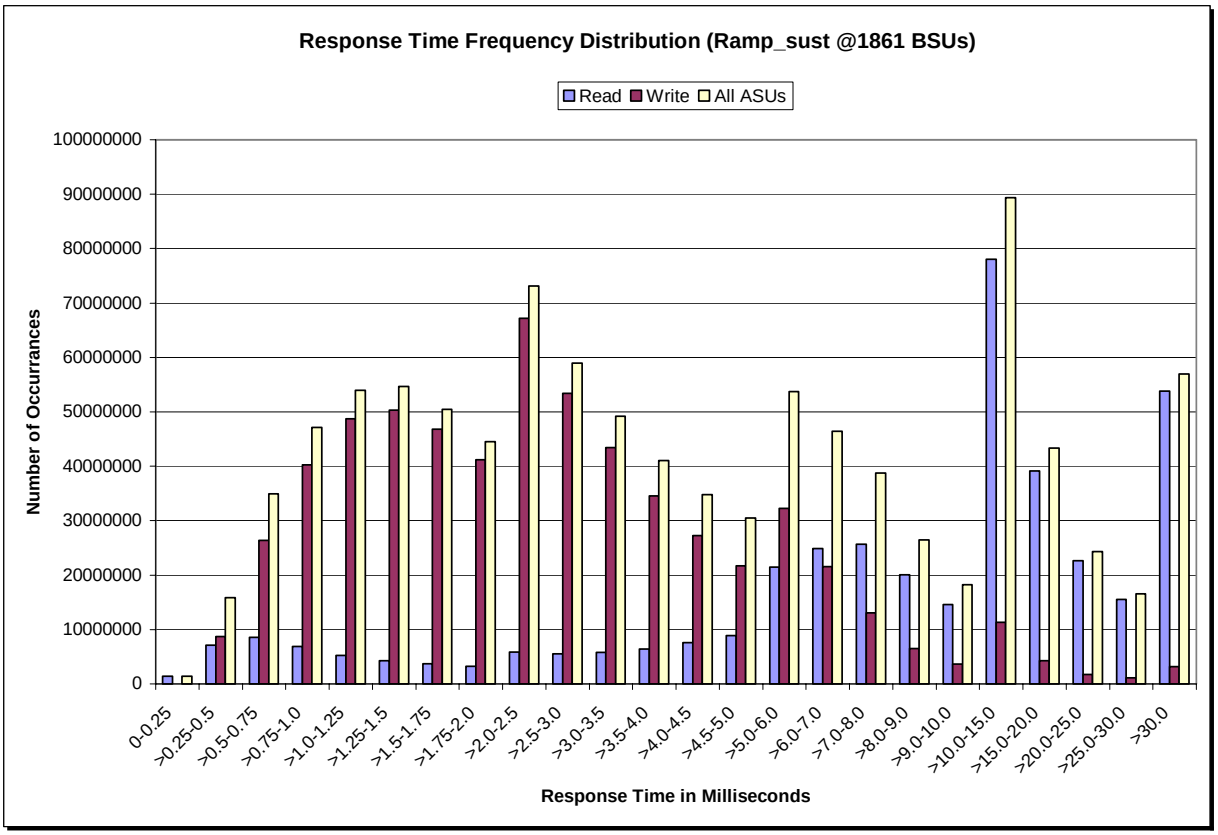
Sustainability – Average Response Time (ms) Distribution Graph



Sustainability – Response Time Frequency Distribution Data

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	1,394,093	7,138,320	8,529,718	6,907,900	5,265,493	4,297,671	3,689,921	3,277,667
Write	29,464	8,691,054	26,382,960	40,262,816	48,693,611	50,345,169	46,809,262	41,225,067
All ASUs	1,423,557	15,829,374	34,912,678	47,170,716	53,959,104	54,642,840	50,499,183	44,502,734
ASU1	1,075,606	10,909,266	21,753,606	27,743,656	30,400,437	29,702,958	26,567,531	22,739,831
ASU2	345,161	3,037,596	5,704,174	7,050,377	7,596,477	7,350,475	6,528,747	5,541,375
ASU3	2,790	1,882,512	7,454,898	12,376,683	15,962,190	17,589,407	17,402,905	16,221,528
Response Time (ms)	**>2.0-2.5**	**>2.5-3.0**	**>3.0-3.5**	**>3.5-4.0**	**>4.0-4.5**	**>4.5-5.0**	**>5.0-6.0**	**>6.0-7.0**
Read	5,883,731	5,566,021	5,777,918	6,457,510	7,589,863	8,837,433	21,446,654	24,853,487
Write	67,223,308	53,419,417	43,425,389	34,587,597	27,229,494	21,705,502	32,243,781	21,552,436
All ASUs	73,107,039	58,985,438	49,203,307	41,045,107	34,819,357	30,542,935	53,690,435	46,405,923
ASU1	36,288,966	28,769,281	23,749,216	19,626,254	16,640,826	14,782,004	27,423,493	26,368,958
ASU2	8,701,968	6,667,042	5,203,879	3,933,036	2,933,672	2,271,426	3,642,072	3,307,447
ASU3	28,116,105	23,549,115	20,250,212	17,485,817	15,244,859	13,489,505	22,624,870	16,729,518
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	25,635,010	20,032,167	14,599,423	78,048,064	39,125,506	22,643,117	15,516,535	53,814,615
Write	13,092,212	6,471,720	3,607,671	11,360,772	4,252,929	1,722,740	1,073,561	3,178,810
All ASUs	38,727,222	26,503,887	18,207,094	89,408,836	43,378,435	24,365,857	16,590,096	56,993,425
ASU1	24,823,893	18,406,697	13,169,008	68,939,015	34,255,582	19,785,195	13,474,458	41,531,502
ASU2	3,277,656	2,771,067	2,080,762	11,240,803	5,656,650	3,205,783	2,269,394	13,298,814
ASU3	10,625,673	5,326,123	2,957,324	9,229,018	3,466,203	1,374,879	846,244	2,163,109

Sustainability – Response Time Frequency Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

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

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 70.

IOPS Test Results File

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

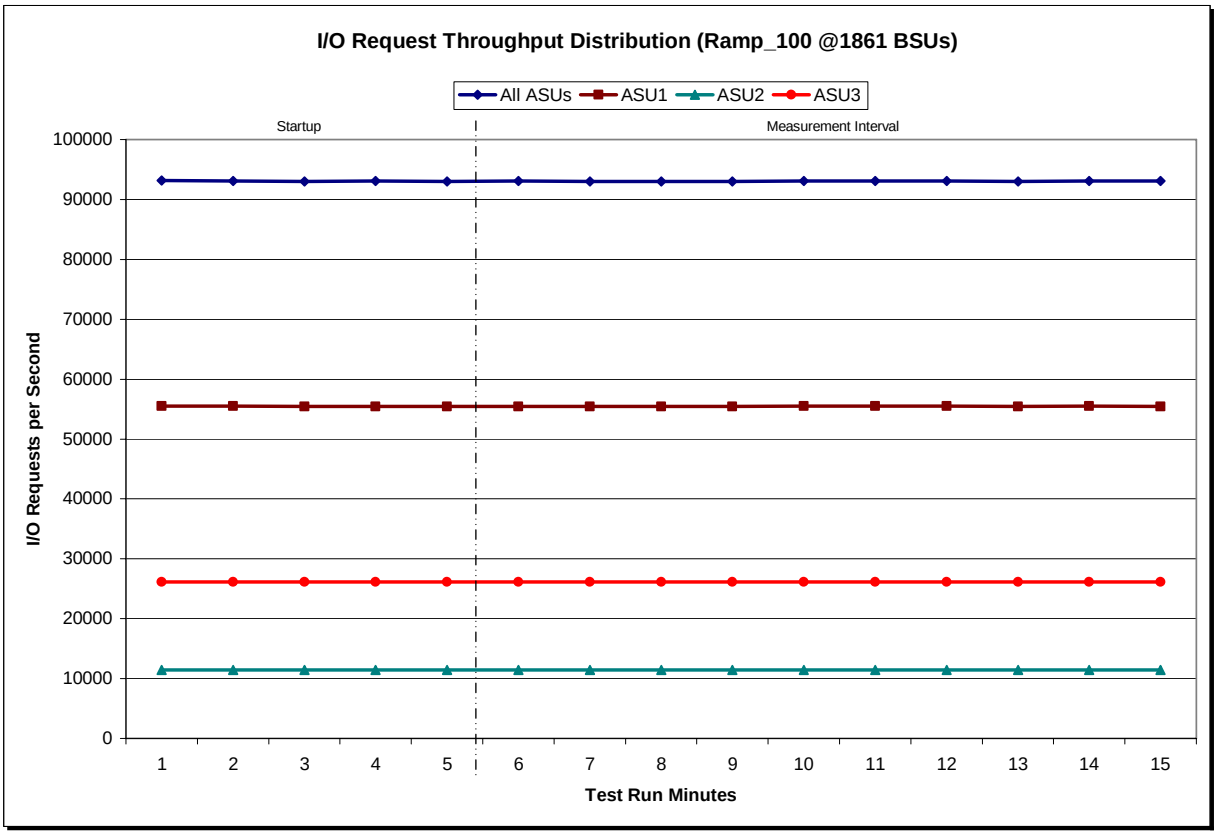
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

1861 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:35:53	21:40:54	0-4	0:05:01
Measurement Interval	21:40:54	21:50:54	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	93,131.15	55,532.03	11,454.55	26,144.57
1	93,078.42	55,477.22	11,438.47	26,162.73
2	93,016.73	55,406.23	11,442.47	26,168.03
3	93,065.82	55,470.05	11,462.58	26,133.18
4	93,002.67	55,422.32	11,442.42	26,137.93
5	93,066.70	55,466.80	11,462.82	26,137.08
6	93,045.43	55,440.95	11,451.98	26,152.50
7	93,004.28	55,403.88	11,446.50	26,153.90
8	93,006.10	55,444.98	11,445.67	26,115.45
9	93,100.42	55,481.80	11,454.02	26,164.60
10	93,100.42	55,497.92	11,456.77	26,145.73
11	93,055.52	55,478.07	11,437.23	26,140.22
12	92,998.87	55,431.77	11,436.48	26,130.62
13	93,060.02	55,515.32	11,424.92	26,119.78
14	93,062.85	55,447.62	11,452.90	26,162.33
Average	93,050.06	55,460.91	11,446.93	26,142.22

IOPS Test Run – I/O Request Throughput Distribution Graph

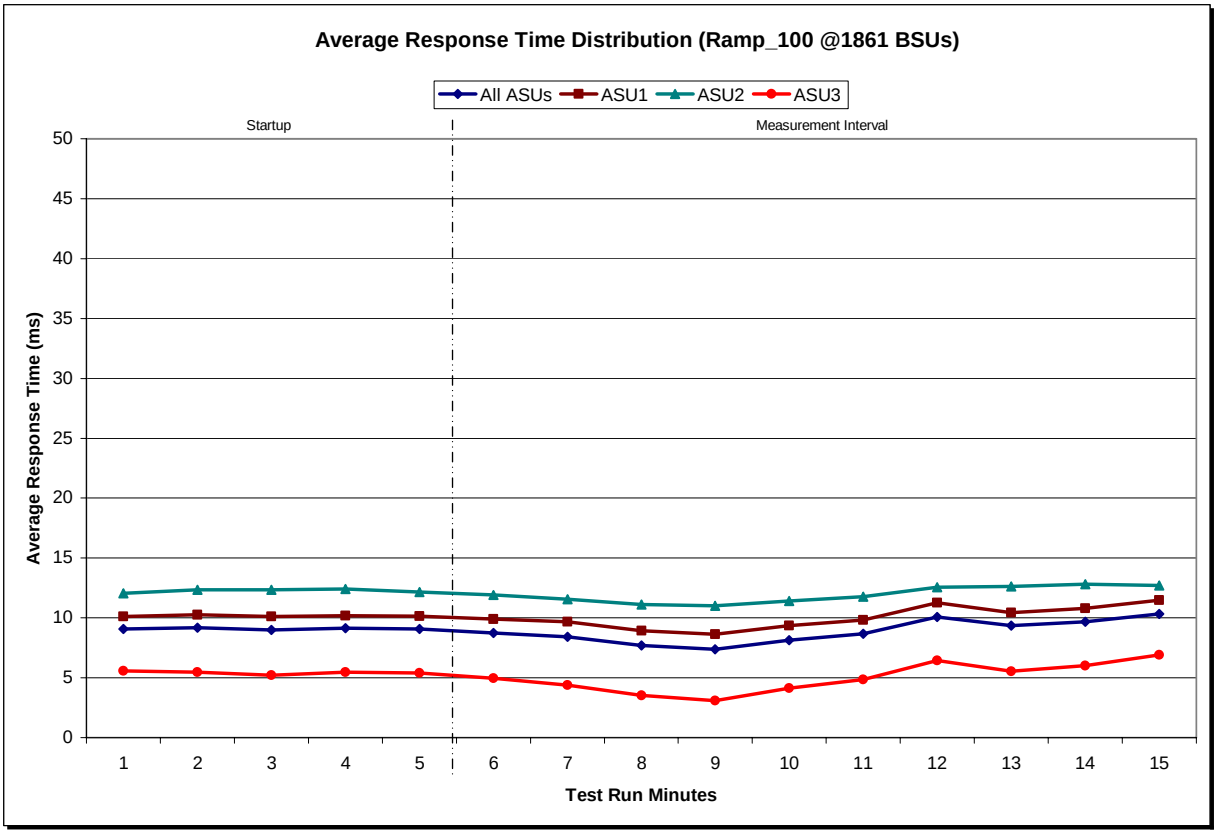


IOPS Test Run – Average Response Time (ms) Distribution Data

1861 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:35:53	21:40:54	0-4	0:05:01
Measurement Interval	21:40:54	21:50:54	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	9.07	10.10	12.06	5.57
1	9.17	10.24	12.36	5.49
2	9.01	10.11	12.35	5.22
3	9.13	10.18	12.42	5.47
4	9.07	10.15	12.18	5.41
5	8.75	9.89	11.91	4.95
6	8.44	9.70	11.55	4.41
7	7.69	8.94	11.14	3.53
8	7.38	8.63	11.03	3.11
9	8.13	9.35	11.42	4.13
10	8.68	9.83	11.78	4.87
11	10.07	11.26	12.56	6.44
12	9.35	10.45	12.65	5.55
13	9.70	10.79	12.83	6.02
14	10.35	11.48	12.70	6.92
Average	8.85	10.03	11.95	4.99

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



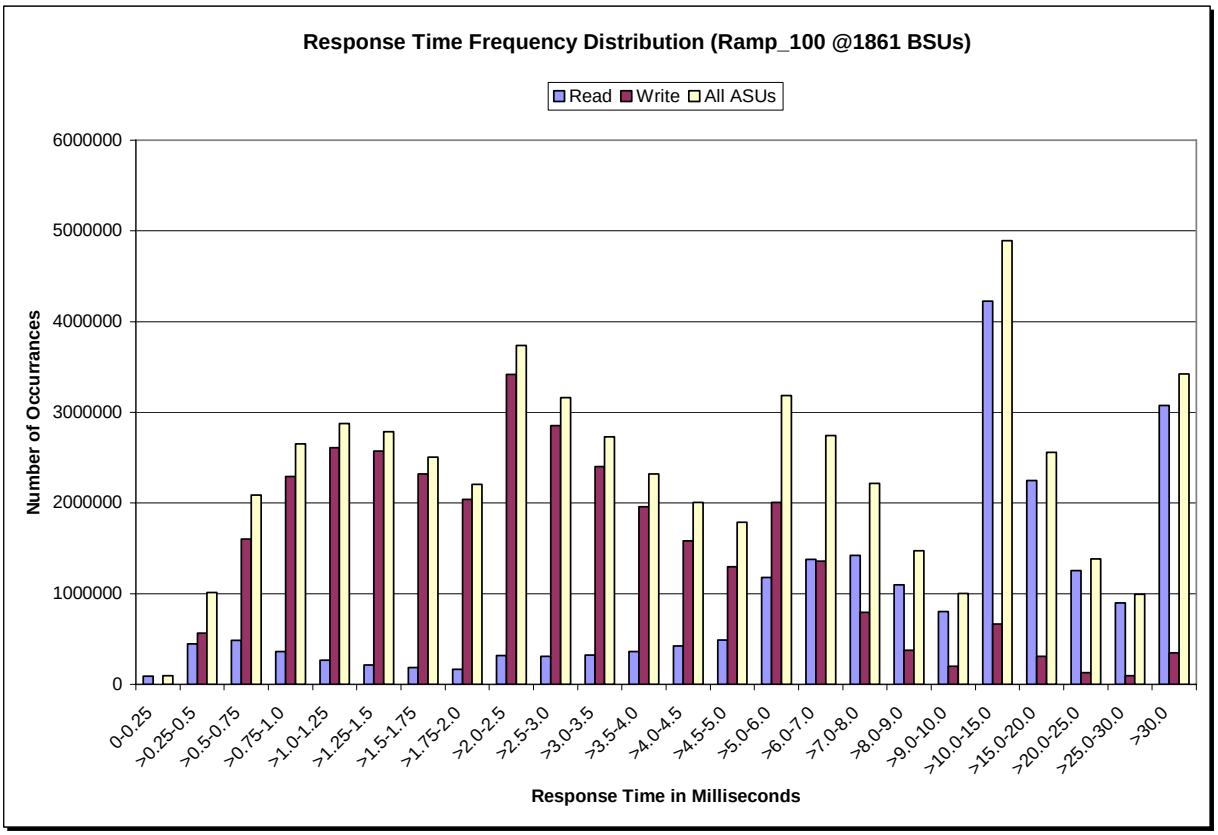
IOPS Test Run – Response Time Frequency Distribution Data

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	91241	447,742	484,544	360,624	264,713	214,251	186,007	168,601
Write	2377	567,150	1,602,236	2,293,933	2,609,719	2,571,493	2,320,018	2,038,323
All ASUs	93618	1,014,892	2,086,780	2,654,557	2,874,432	2,785,744	2,506,025	2,206,924
ASU1	70481	695,844	1,289,280	1,546,867	1,602,338	1,505,513	1,324,552	1,149,971
ASU2	22876	194,948	341,492	395,576	404,004	374,814	326,297	281,182
ASU3	261	124,100	456,008	712,114	868,090	905,417	855,176	775,771

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	317,563	309,710	325,034	360,848	421,846	487,343	1,180,022	1,381,105
Write	3,418,280	2,851,225	2,402,841	1,960,858	1,585,377	1,298,936	2,006,386	1,360,446
All ASUs	3,735,843	3,160,935	2,727,875	2,321,706	2,007,223	1,786,279	3,186,408	2,741,551
ASU1	1,925,734	1,620,072	1,378,924	1,149,913	971,085	847,846	1,537,618	1,474,885
ASU2	463,768	377,088	303,131	232,767	173,467	132,854	205,785	184,334
ASU3	1,346,341	1,163,775	1,045,820	939,026	862,671	805,579	1,443,005	1,082,332

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	1,422,866	1,098,288	801,299	4,227,398	2,246,583	1,253,165	896,588	3,074,526
Write	791,663	377,660	201,277	664,560	311,349	129,669	95,051	346,558
All ASUs	2,214,529	1,475,948	1,002,576	4,891,958	2,557,932	1,382,834	991,639	3,421,084
ASU1	1,378,148	1,010,594	723,639	3,751,039	1,980,507	1,103,481	785,816	2,451,913
ASU2	182,511	153,225	115,313	614,047	327,436	178,596	131,621	750,886
ASU3	653,870	312,129	163,624	526,872	249,989	100,757	74,202	218,285

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
55,829,292	52,408,208	3,421,084

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2811	0.0700	0.2100	0.0180	0.0700	0.0350	0.2809
COV	0.002	0.001	0.001	0.001	0.003	0.001	0.002	0.001

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.2.3

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

The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 13.

In addition, the Average Response Time measured during the 10% Test Run is the value for the SPC-1 LRT™ metric. That value represents the Average Response Time of a lightly loaded TSC.

Clause 9.2.4.7.3

The following content shall appear in the FDR for the Response Time Ramp Phase:

1. *A Response Time Ramp Distribution.*
2. *The human readable Test Run Results File produced by the Workload Generator for each Test Run within the Response Time Ramp Test Phase.*
3. *For the 10% Load Level Test Run (SPC-1 LRT™ metric) an Average Response Time Distribution.*
4. *A listing or screen image of all input parameters supplied to the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 70.

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 - 1861 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:35:53	21:40:54	0-4	0:05:01
Measurement Interval	21:40:54	21:50:54	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	93,131.15	55,532.03	11,454.55	26,144.57
1	93,078.42	55,477.22	11,438.47	26,162.73
2	93,016.73	55,406.23	11,442.47	26,168.03
3	93,065.82	55,470.05	11,462.58	26,133.18
4	93,002.67	55,422.32	11,442.42	26,137.93
5	93,066.70	55,466.80	11,462.82	26,137.08
6	93,045.43	55,440.95	11,451.98	26,152.50
7	93,004.28	55,403.88	11,446.50	26,153.90
8	93,006.10	55,444.98	11,445.67	26,115.45
9	93,100.42	55,481.80	11,454.02	26,164.60
10	93,100.42	55,497.92	11,456.77	26,145.73
11	93,055.52	55,478.07	11,437.23	26,140.22
12	92,998.87	55,431.77	11,436.48	26,130.62
13	93,060.02	55,515.32	11,424.92	26,119.78
14	93,062.85	55,447.62	11,452.90	26,162.33
Average	93,050.06	55,460.91	11,446.93	26,142.22

95% Load Level - 1767 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:51:00	21:56:01	0-4	0:05:01
Measurement Interval	21:56:01	22:06:01	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	88,433.68	52,726.02	10,856.12	24,851.55
1	88,322.95	52,629.20	10,873.73	24,820.02
2	88,347.43	52,635.82	10,858.78	24,852.83
3	88,333.37	52,684.37	10,858.93	24,790.07
4	88,336.28	52,633.70	10,869.57	24,833.02
5	88,407.03	52,674.12	10,865.93	24,866.98
6	88,313.50	52,620.25	10,875.75	24,817.50
7	88,328.80	52,682.63	10,853.75	24,792.42
8	88,345.58	52,655.93	10,871.50	24,818.15
9	88,264.30	52,576.68	10,860.03	24,827.58
10	88,320.45	52,609.88	10,861.82	24,848.75
11	88,358.25	52,629.10	10,898.17	24,830.98
12	88,401.00	52,714.00	10,864.58	24,822.42
13	88,286.22	52,629.33	10,845.68	24,811.20
14	88,332.42	52,656.38	10,855.00	24,821.03
Average	88,335.76	52,644.83	10,865.22	24,825.70

90% Load Level - 1674 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:06:07	22:11:08	0-4	0:05:01
Measurement Interval	22:11:08	22:21:08	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	83,647.25	49,884.15	10,273.43	23,489.67
1	83,676.05	49,885.97	10,287.93	23,502.15
2	83,664.08	49,917.53	10,293.67	23,452.88
3	83,615.27	49,832.80	10,298.17	23,484.30
4	83,667.42	49,877.45	10,267.95	23,522.02
5	83,740.07	49,909.42	10,285.10	23,545.55
6	83,727.30	49,915.28	10,293.10	23,518.92
7	83,712.55	49,890.32	10,284.68	23,537.55
8	83,693.10	49,871.42	10,298.13	23,523.55
9	83,665.27	49,870.07	10,307.50	23,487.70
10	83,690.92	49,871.52	10,306.45	23,512.95
11	83,685.33	49,893.72	10,297.35	23,494.27
12	83,615.25	49,810.33	10,299.55	23,505.37
13	83,760.05	49,927.62	10,321.28	23,511.15
14	83,724.68	49,878.12	10,305.30	23,541.27
Average	83,701.45	49,883.78	10,299.85	23,517.83

80% Load Level - 1488 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:21:14	22:26:15	0-4	0:05:01
Measurement Interval	22:26:15	22:36:15	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	74,421.20	44,365.30	9,153.08	20,902.82
1	74,419.23	44,354.13	9,154.87	20,910.23
2	74,407.50	44,370.55	9,133.32	20,903.63
3	74,344.77	44,303.00	9,174.05	20,867.72
4	74,434.12	44,352.95	9,151.12	20,930.05
5	74,337.52	44,309.93	9,146.65	20,880.93
6	74,418.68	44,352.22	9,159.10	20,907.37
7	74,406.87	44,329.38	9,161.05	20,916.43
8	74,400.65	44,337.35	9,166.80	20,896.50
9	74,392.17	44,349.13	9,150.17	20,892.87
10	74,355.55	44,314.97	9,162.22	20,878.37
11	74,375.05	44,304.25	9,155.12	20,915.68
12	74,322.18	44,303.52	9,149.52	20,869.15
13	74,403.15	44,374.17	9,148.03	20,880.95
14	74,396.52	44,322.65	9,165.00	20,908.87
Average	74,380.83	44,329.76	9,156.37	20,894.71

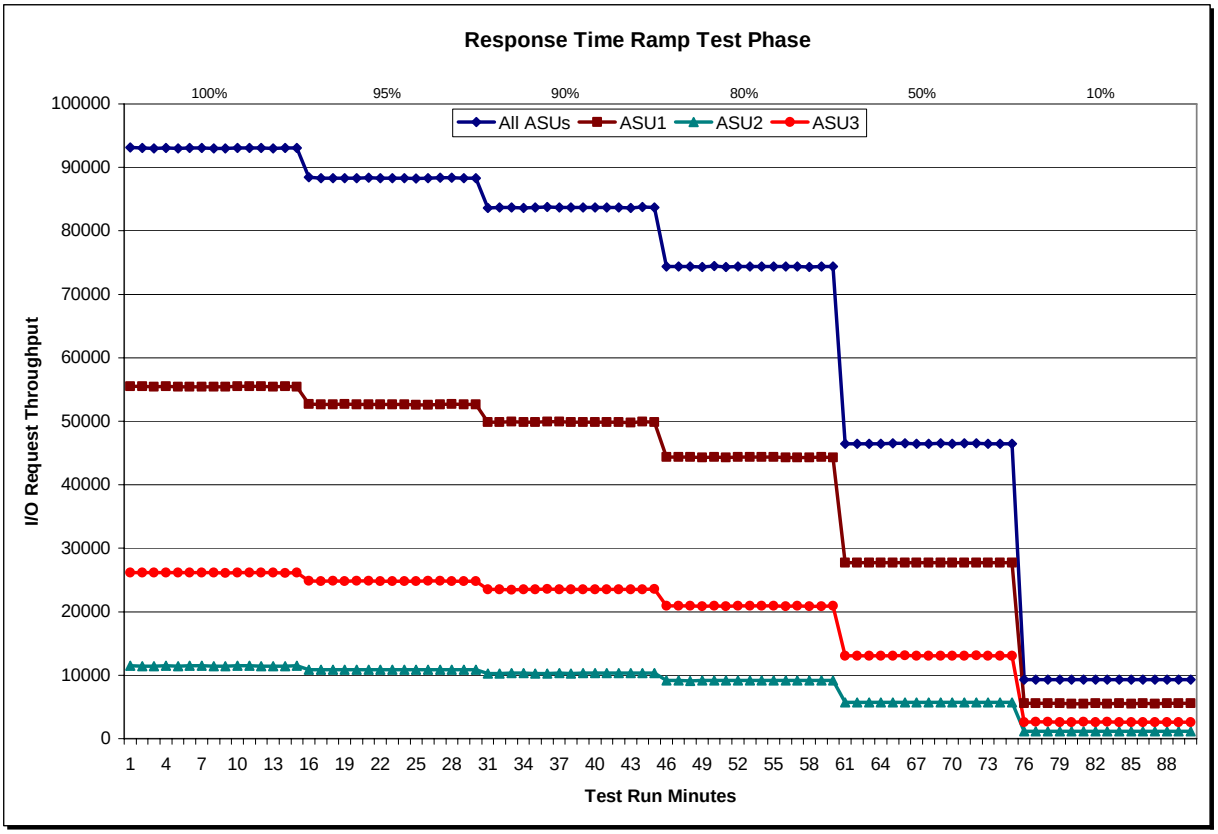
50% Load Level - 930 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:36:20	22:41:21	0-4	0:05:01
Measurement Interval	22:41:21	22:51:21	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	46,493.58	27,715.83	5,718.75	13,059.00
1	46,459.65	27,695.88	5,710.57	13,053.20
2	46,435.45	27,684.10	5,713.55	13,037.80
3	46,482.67	27,697.30	5,721.07	13,064.30
4	46,540.08	27,749.57	5,721.35	13,069.17
5	46,511.48	27,699.85	5,733.12	13,078.52
6	46,498.18	27,718.60	5,713.03	13,066.55
7	46,489.13	27,701.13	5,718.90	13,069.10
8	46,504.22	27,721.45	5,717.85	13,064.92
9	46,469.62	27,698.50	5,715.52	13,055.60
10	46,512.45	27,731.77	5,724.63	13,056.05
11	46,535.07	27,727.52	5,728.87	13,078.68
12	46,481.93	27,732.83	5,714.65	13,034.45
13	46,472.52	27,694.93	5,724.85	13,052.73
14	46,499.72	27,717.00	5,712.70	13,070.02
Average	46,497.43	27,714.36	5,720.41	13,062.66

10% Load Level - 186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:51:26	22:56:27	0-4	0:05:01
Measurement Interval	22:56:27	23:06:27	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	9,299.68	5,545.17	1,145.35	2,609.17
1	9,307.93	5,549.08	1,140.92	2,617.93
2	9,317.83	5,552.77	1,145.73	2,619.33
3	9,294.32	5,538.42	1,146.72	2,609.18
4	9,287.00	5,529.87	1,146.35	2,610.78
5	9,303.28	5,530.22	1,155.60	2,617.47
6	9,310.72	5,547.02	1,148.77	2,614.93
7	9,303.95	5,536.02	1,145.97	2,621.97
8	9,302.35	5,546.58	1,150.52	2,605.25
9	9,288.48	5,535.93	1,145.65	2,606.90
10	9,299.43	5,541.78	1,149.57	2,608.08
11	9,284.03	5,534.43	1,140.03	2,609.57
12	9,294.00	5,538.05	1,144.80	2,611.15
13	9,307.25	5,550.92	1,141.52	2,614.82
14	9,284.72	5,538.32	1,136.65	2,609.75
Average	9,297.82	5,539.93	1,145.91	2,611.99

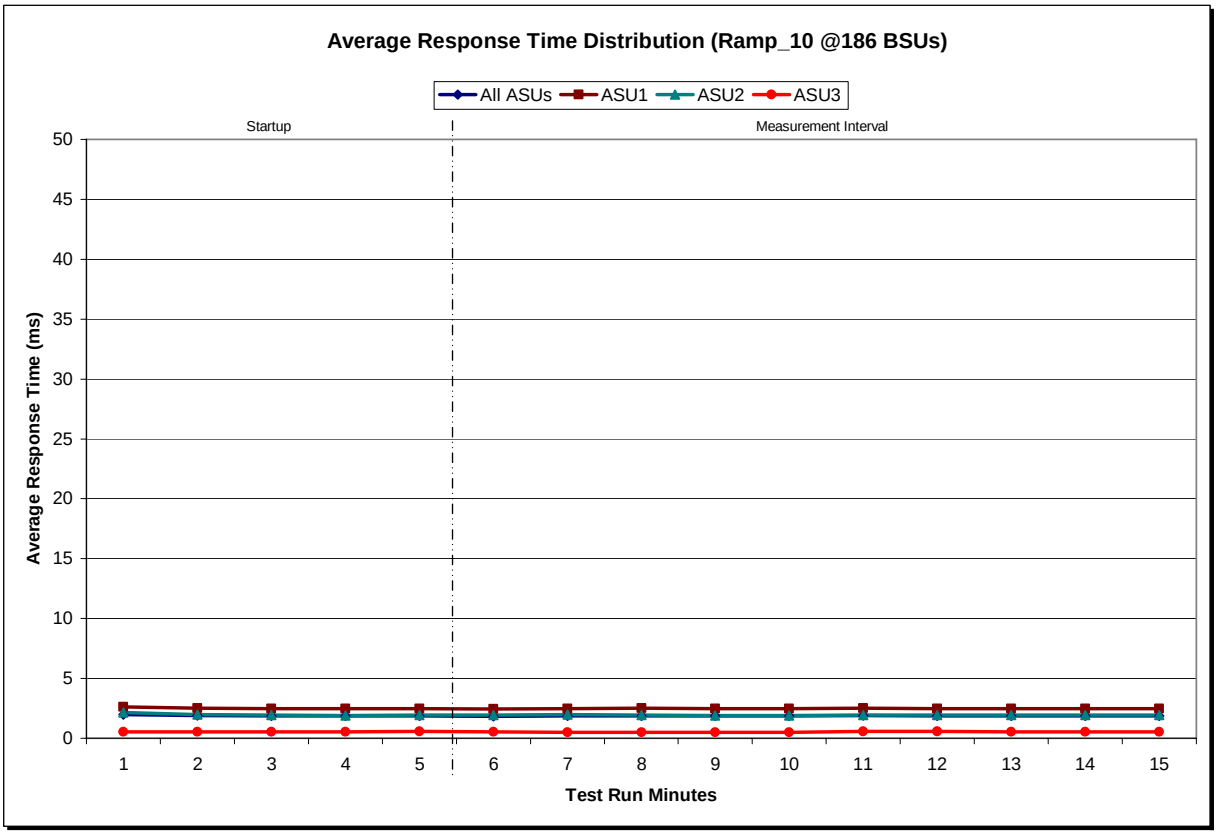
Response Time Ramp Distribution (IOPS) Graph



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

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:51:26	22:56:27	0-4	0:05:01
Measurement Interval	22:56:27	23:06:27	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.98	2.63	2.16	0.54
1	1.90	2.53	1.98	0.54
2	1.88	2.50	1.94	0.54
3	1.86	2.48	1.89	0.53
4	1.89	2.50	1.96	0.56
5	1.85	2.47	1.93	0.52
6	1.88	2.49	1.99	0.52
7	1.88	2.51	1.96	0.52
8	1.87	2.49	1.91	0.52
9	1.86	2.47	1.91	0.52
10	1.89	2.50	1.96	0.57
11	1.88	2.49	1.94	0.57
12	1.87	2.48	1.95	0.55
13	1.88	2.50	1.95	0.55
14	1.87	2.48	1.94	0.54
Average	1.87	2.49	1.95	0.54

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



SPC-1 LRT™ (10%) – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2806	0.0701	0.2101	0.0180	0.0702	0.0350	0.2809
COV	0.005	0.002	0.005	0.001	0.011	0.006	0.008	0.002

Repeatability Test

Clause 5.4.5

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

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

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

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 70.

Repeatability Test Results File

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

	SPC-1 IOPS™
Primary Metrics	***93,050.06***
Repeatability Test Phase 1	93,045.83
Repeatability Test Phase 2	93,055.52

The SPC-1 IOPS™ values in the above table were generated using 100% of the specified Business Scaling Unit (BSU) load level. Each of the Repeatability Test Phase values for SPC-1 IOPS™ must greater than 95% of the reported SPC-1 IOPS™ Primary Metric.

	SPC-1 LRT™
Primary Metrics	***1.87 ms***
Repeatability Test Phase 1	1.88 ms
Repeatability Test Phase 2	1.90 ms

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

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

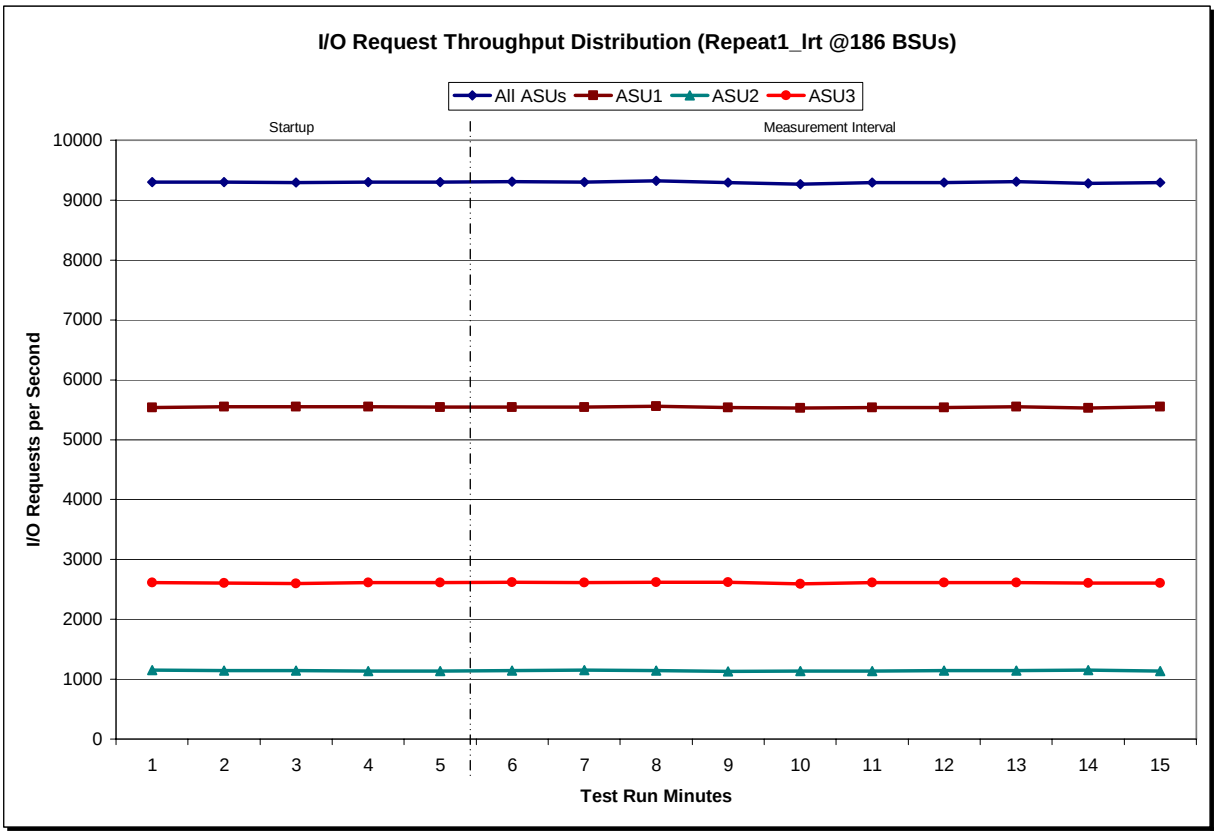
Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:06:40	23:11:40	0-4	0:05:00
Measurement Interval	23:11:40	23:21:40	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	9,303.67	5,539.62	1,149.25	2,614.80
1	9,299.05	5,552.88	1,141.30	2,604.87
2	9,294.15	5,547.20	1,146.77	2,600.18
3	9,302.90	5,551.23	1,138.38	2,613.28
4	9,298.57	5,542.07	1,140.55	2,615.95
5	9,305.72	5,540.50	1,143.55	2,621.67
6	9,303.32	5,540.87	1,148.78	2,613.67
7	9,320.55	5,558.08	1,141.13	2,621.33
8	9,293.73	5,538.98	1,132.98	2,621.77
9	9,262.33	5,530.32	1,140.10	2,591.92
10	9,293.42	5,539.80	1,138.90	2,614.72
11	9,296.35	5,538.62	1,144.73	2,613.00
12	9,306.52	5,554.03	1,141.15	2,611.33
13	9,282.50	5,528.80	1,148.60	2,605.10
14	9,296.15	5,552.42	1,140.87	2,602.87
Average	9,296.06	5,542.24	1,142.08	2,611.74

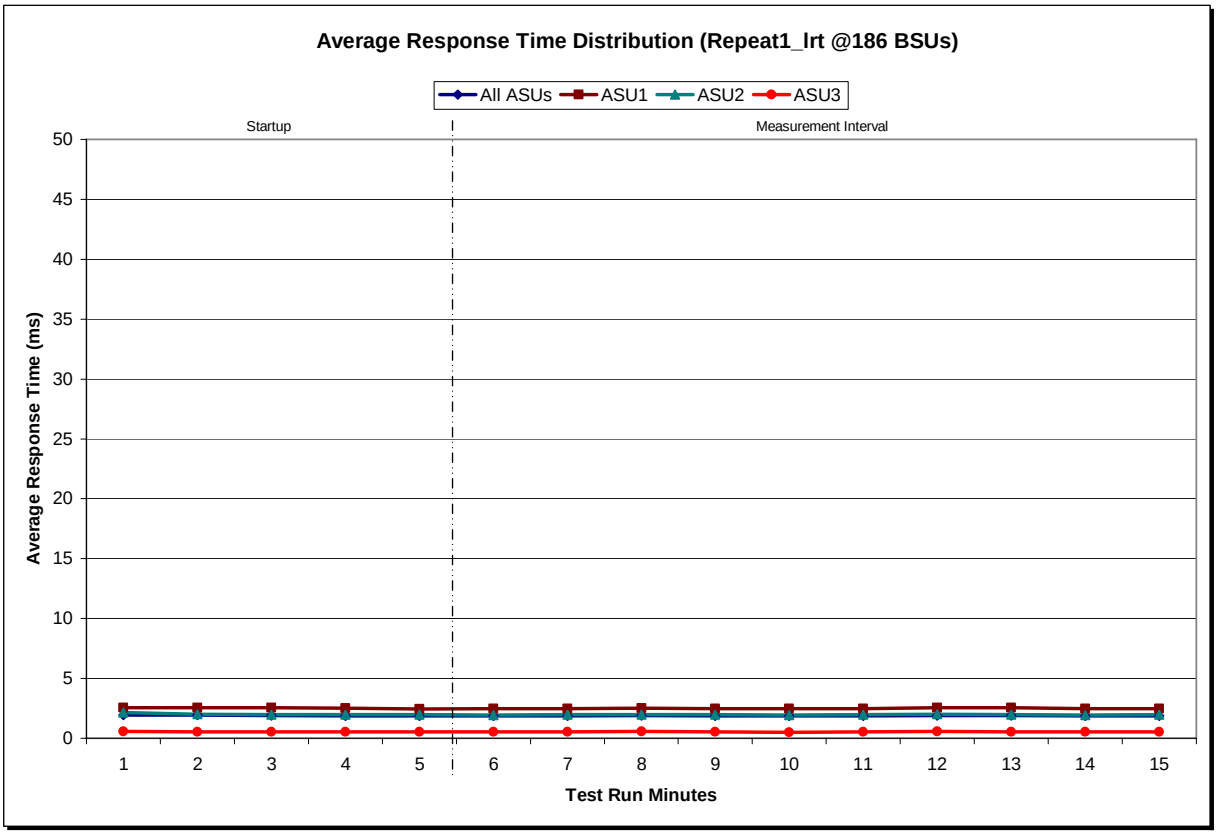
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:06:40	23:11:40	0-4	0:05:00
Measurement Interval	23:11:40	23:21:40	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.96	2.56	2.17	0.57
1	1.93	2.56	2.01	0.55
2	1.91	2.55	1.98	0.53
3	1.88	2.51	1.97	0.52
4	1.86	2.47	1.98	0.53
5	1.87	2.49	1.95	0.54
6	1.87	2.48	1.98	0.54
7	1.90	2.52	1.98	0.57
8	1.87	2.48	1.97	0.52
9	1.86	2.47	1.93	0.52
10	1.88	2.50	1.99	0.53
11	1.92	2.54	2.01	0.57
12	1.91	2.54	1.99	0.53
13	1.87	2.49	1.95	0.53
14	1.88	2.49	1.99	0.54
Average	1.88	2.50	1.98	0.54

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

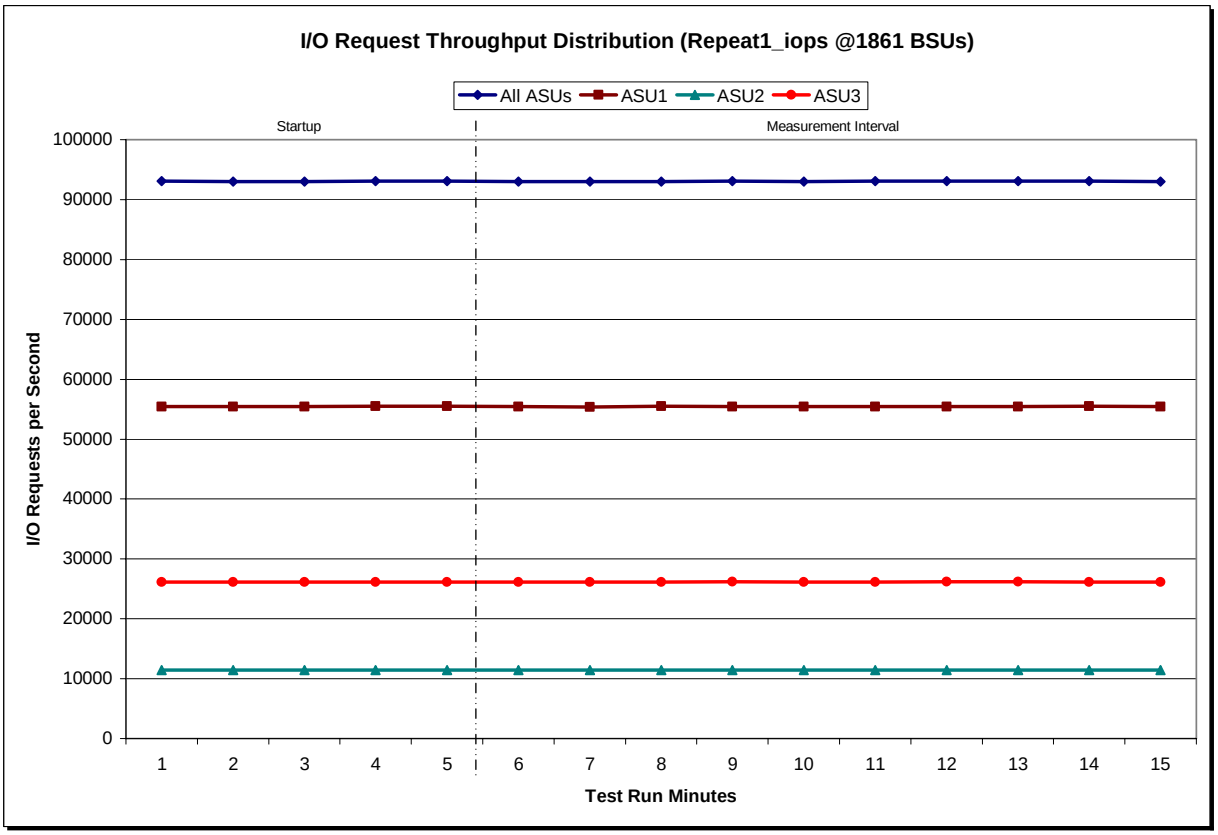


Repeatability 1 IOPS – I/O Request Throughput Distribution Data

1861 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:21:46	23:26:47	0-4	0:05:01
Measurement Interval	23:26:47	23:36:47	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	93,076.28	55,451.00	11,457.55	26,167.73
1	93,040.57	55,465.92	11,462.05	26,112.60
2	93,038.88	55,461.85	11,463.03	26,114.00
3	93,085.53	55,474.70	11,476.07	26,134.77
4	93,064.98	55,478.12	11,448.82	26,138.05
5	93,017.07	55,434.00	11,440.30	26,142.77
6	92,987.40	55,390.03	11,458.45	26,138.92
7	93,051.97	55,485.98	11,425.05	26,140.93
8	93,089.70	55,452.08	11,442.97	26,194.65
9	93,027.22	55,463.92	11,438.63	26,124.67
10	93,055.95	55,465.83	11,449.45	26,140.67
11	93,075.98	55,465.90	11,440.13	26,169.95
12	93,066.33	55,464.12	11,428.10	26,174.12
13	93,065.03	55,487.17	11,454.48	26,123.38
14	93,021.65	55,402.22	11,450.02	26,169.42
Average	93,045.83	55,451.13	11,442.76	26,151.95

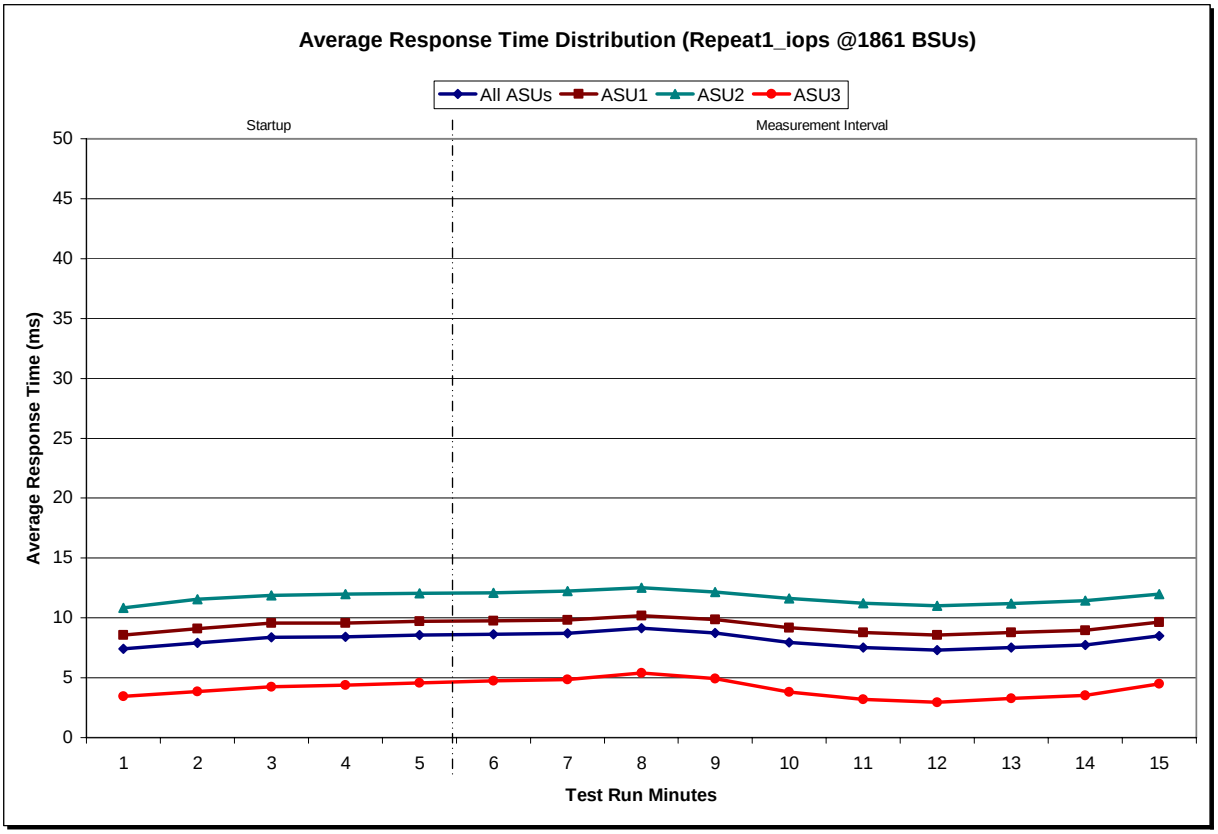
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

1861 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:21:46	23:26:47	0-4	0:05:01
Measurement Interval	23:26:47	23:36:47	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	7.41	8.56	10.83	3.47
1	7.94	9.11	11.57	3.85
2	8.37	9.58	11.90	4.25
3	8.42	9.58	11.97	4.41
4	8.57	9.73	12.07	4.58
5	8.64	9.75	12.10	4.76
6	8.73	9.81	12.25	4.88
7	9.13	10.19	12.51	5.39
8	8.75	9.85	12.18	4.92
9	7.96	9.16	11.61	3.80
10	7.52	8.78	11.22	3.22
11	7.29	8.56	11.00	2.97
12	7.52	8.78	11.21	3.26
13	7.75	8.98	11.44	3.52
14	8.48	9.65	12.00	4.49
Average	8.18	9.35	11.75	4.12

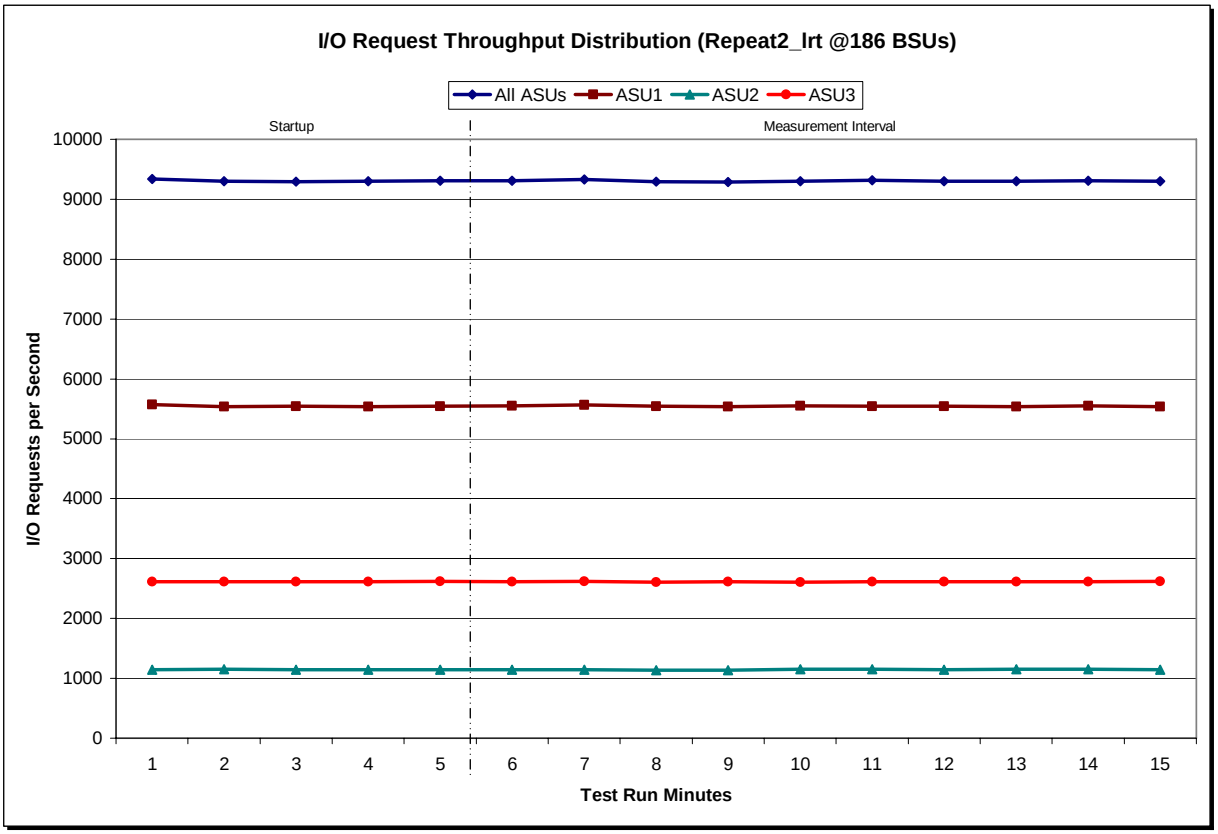
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:37:01	23:42:01	0-4	0:05:00
Measurement Interval	23:42:01	23:52:01	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	9,334.10	5,574.25	1,143.57	2,616.28
1	9,304.77	5,537.07	1,151.02	2,616.68
2	9,295.53	5,543.77	1,141.77	2,610.00
3	9,302.13	5,539.50	1,145.72	2,616.92
4	9,307.57	5,544.83	1,141.82	2,620.92
5	9,305.65	5,548.98	1,144.48	2,612.18
6	9,328.83	5,563.38	1,147.30	2,618.15
7	9,293.85	5,545.93	1,140.68	2,607.23
8	9,284.78	5,535.13	1,137.50	2,612.15
9	9,304.42	5,548.88	1,149.20	2,606.33
10	9,313.40	5,546.77	1,150.43	2,616.20
11	9,300.97	5,545.73	1,143.70	2,611.53
12	9,299.03	5,537.35	1,148.83	2,612.85
13	9,306.37	5,547.17	1,148.75	2,610.45
14	9,299.43	5,534.73	1,145.12	2,619.58
Average	9,303.67	5,545.41	1,145.60	2,612.67

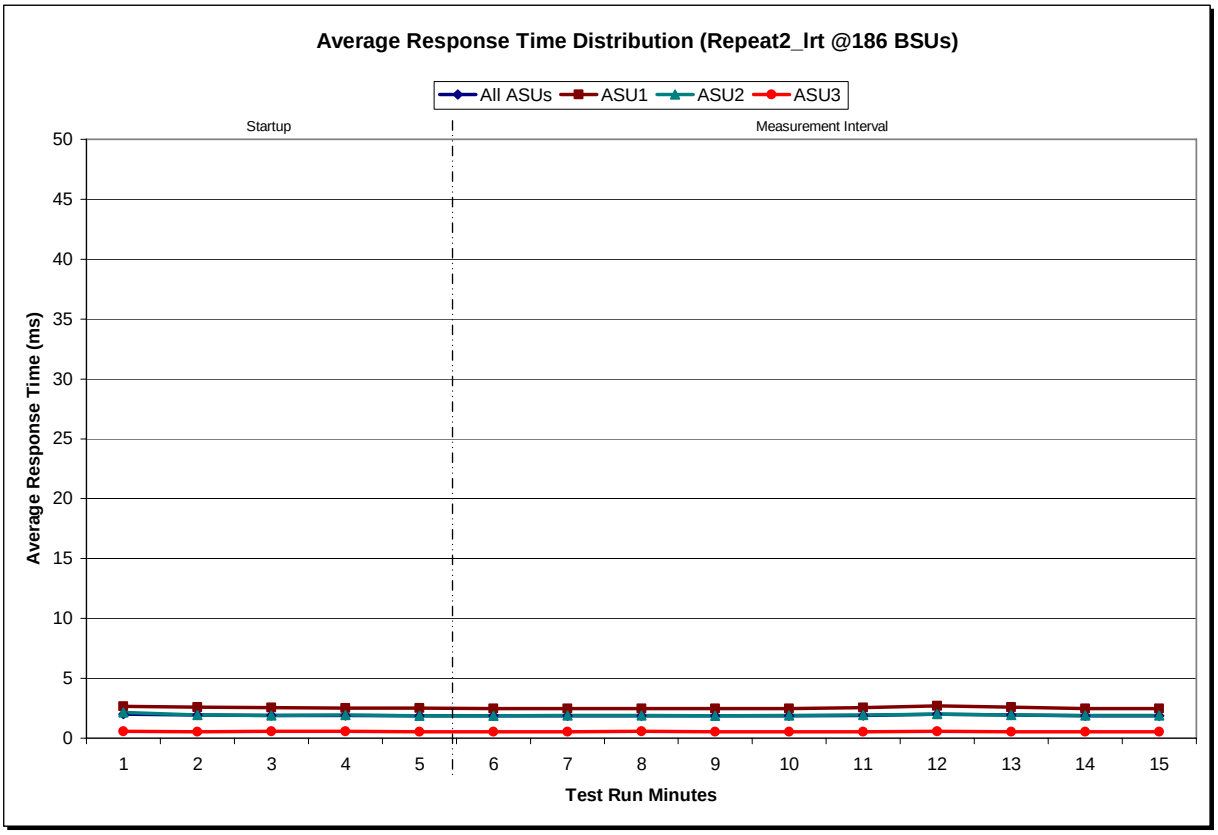
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:37:01	23:42:01	0-4	0:05:00
Measurement Interval	23:42:01	23:52:01	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.01	2.66	2.15	0.56
1	1.94	2.60	1.95	0.54
2	1.91	2.55	1.92	0.56
3	1.90	2.53	1.93	0.56
4	1.87	2.50	1.88	0.54
5	1.86	2.49	1.87	0.53
6	1.87	2.50	1.90	0.54
7	1.88	2.50	1.89	0.56
8	1.88	2.50	1.88	0.56
9	1.88	2.50	1.92	0.54
10	1.91	2.54	1.95	0.53
11	2.01	2.70	2.03	0.56
12	1.93	2.58	1.95	0.55
13	1.87	2.50	1.91	0.52
14	1.87	2.50	1.91	0.54
Average	1.90	2.53	1.92	0.54

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

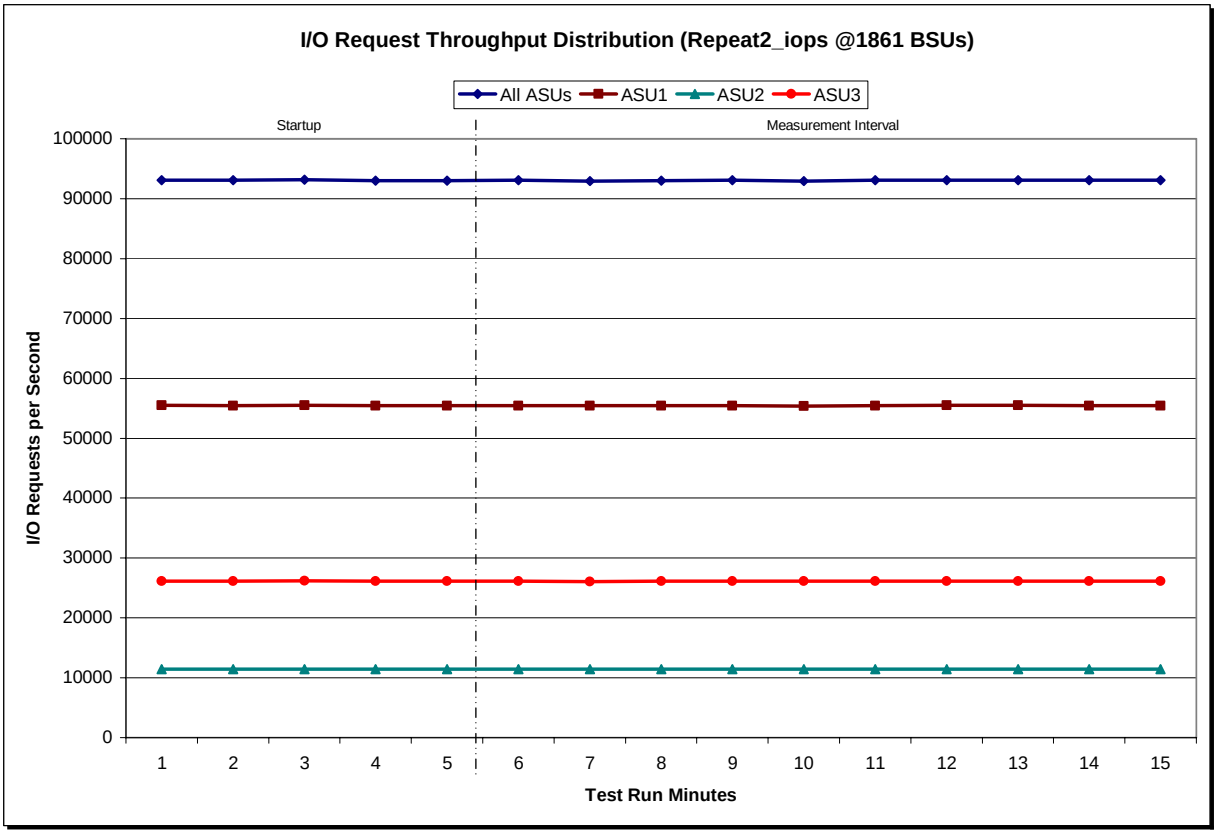


Repeatability 2 IOPS – I/O Request Throughput Distribution Data

1861 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:52:07	23:57:08	0-4	0:05:01
Measurement Interval	23:57:08	0:07:08	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	93,110.05	55,482.00	11,458.28	26,169.77
1	93,063.70	55,467.38	11,457.70	26,138.62
2	93,167.47	55,492.77	11,456.20	26,218.50
3	93,044.03	55,425.65	11,471.20	26,147.18
4	93,041.93	55,466.97	11,440.77	26,134.20
5	93,077.65	55,468.22	11,449.73	26,159.70
6	92,978.33	55,451.60	11,431.93	26,094.80
7	93,034.38	55,437.43	11,442.13	26,154.82
8	93,066.00	55,459.78	11,457.72	26,148.50
9	92,976.53	55,390.62	11,455.77	26,130.15
10	93,092.55	55,467.25	11,464.50	26,160.80
11	93,114.28	55,530.85	11,450.85	26,132.58
12	93,085.92	55,509.05	11,442.92	26,133.95
13	93,075.90	55,449.45	11,461.23	26,165.22
14	93,053.60	55,453.15	11,430.70	26,169.75
Average	93,055.52	55,461.74	11,448.75	26,145.03

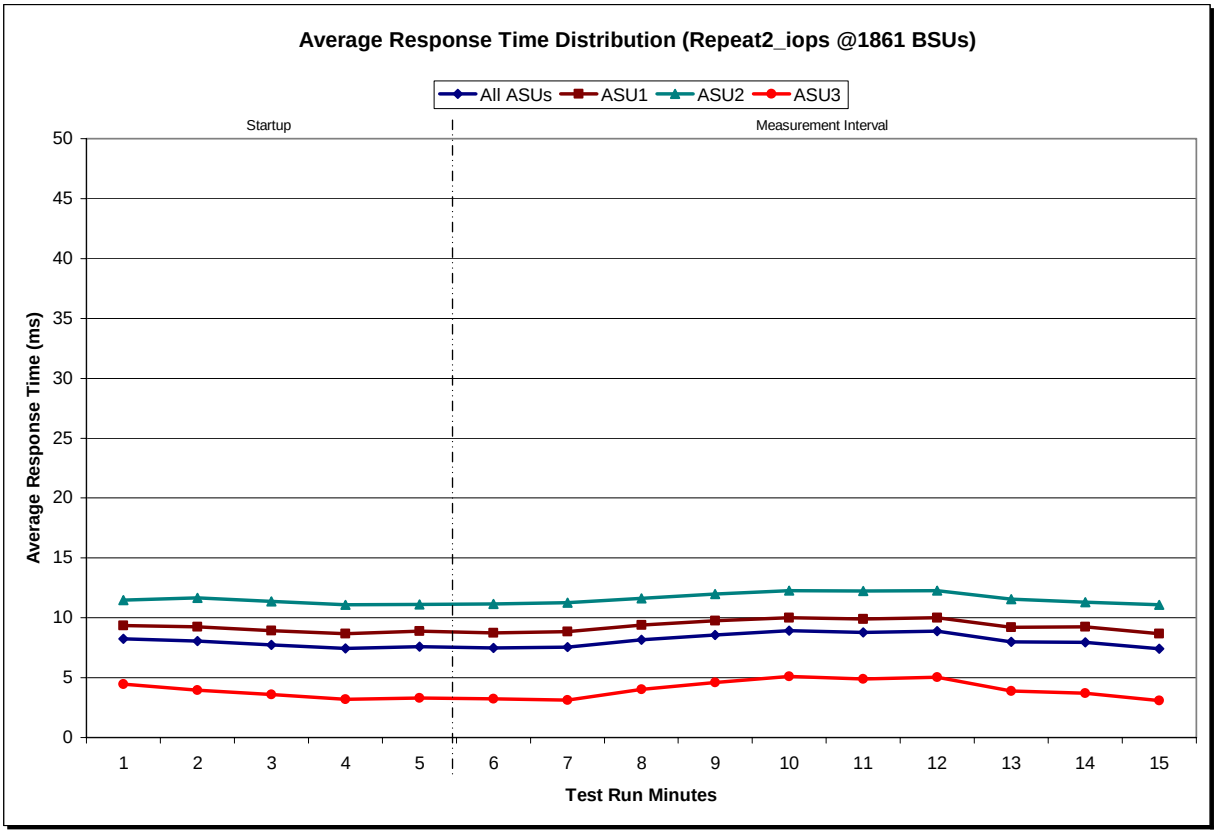
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

1861 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:52:07	23:57:08	0-4	0:05:01
Measurement Interval	23:57:08	0:07:08	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	8.24	9.36	11.48	4.46
1	8.07	9.26	11.67	3.96
2	7.73	8.94	11.37	3.59
3	7.45	8.69	11.08	3.22
4	7.60	8.90	11.12	3.30
5	7.49	8.74	11.16	3.23
6	7.54	8.86	11.26	3.12
7	8.16	9.39	11.64	4.02
8	8.58	9.74	12.00	4.62
9	8.92	10.02	12.27	5.12
10	8.79	9.91	12.24	4.90
11	8.89	10.01	12.26	5.02
12	8.00	9.20	11.56	3.90
13	7.94	9.25	11.32	3.69
14	7.40	8.68	11.09	3.09
Average	8.17	9.38	11.68	4.07

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



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

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0352	0.2813	0.0702	0.2096	0.0180	0.0699	0.0350	0.2810
COV	0.006	0.002	0.005	0.003	0.008	0.006	0.010	0.003

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2809	0.0700	0.2101	0.0180	0.0700	0.0350	0.2811
COV	0.002	0.001	0.001	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	0.0351	0.2812	0.0699	0.2097	0.0180	0.0701	0.0351	0.2808
COV	0.008	0.002	0.006	0.002	0.013	0.004	0.007	0.002

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

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

Data Persistence Test

Clause 6

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

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

The SPC-1 Workload Generator will write 16 block I/O requests at random over the total Addressable Storage Capacity of the TSC for ten (10) minutes at a minimum of 25% of the load used to generate the SPC-1 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 70.

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	223,155,200
Total Number of Logical Blocks Verified	144,636,096
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 3PAR InServ® F400 Storage Server as documented in this Full Disclosure Report became available April 6, 2009 for customer purchase and shipment.

PRICING INFORMATION

Clause 9.2.4.11

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

Clause 9.2.4.11.3

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

Pricing information may found in the Tested Storage Configuration Pricing section on page 14. A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration may be found in the Executive Summary portion of this document on page 14.

ANOMALIES OR IRREGULARITIES

Clause 9.2.4.10

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

There were no anomalies or irregularities encountered during the SPC-1 Onsite Audit of the 3PAR InServ® F400 Storage Server.

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.

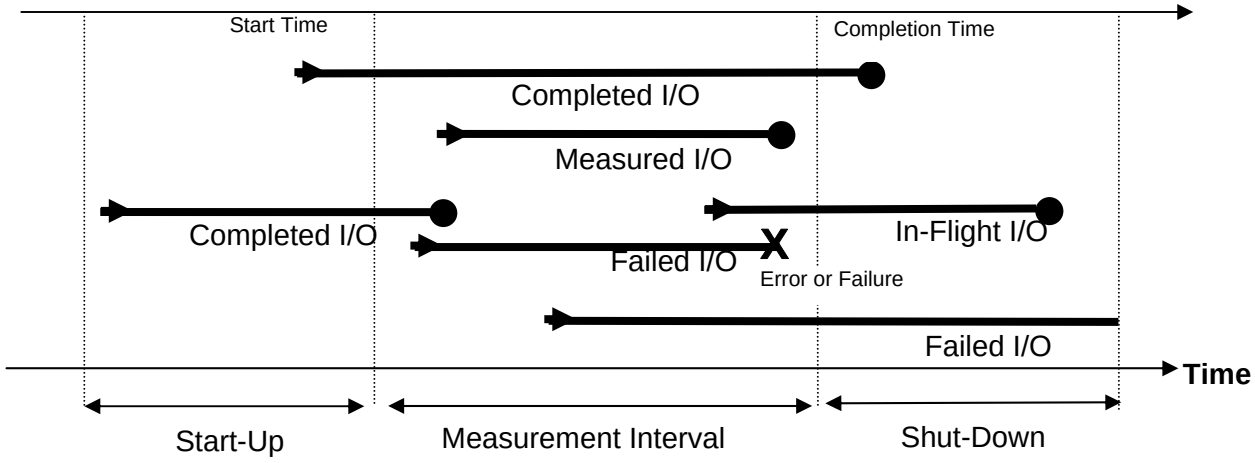
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

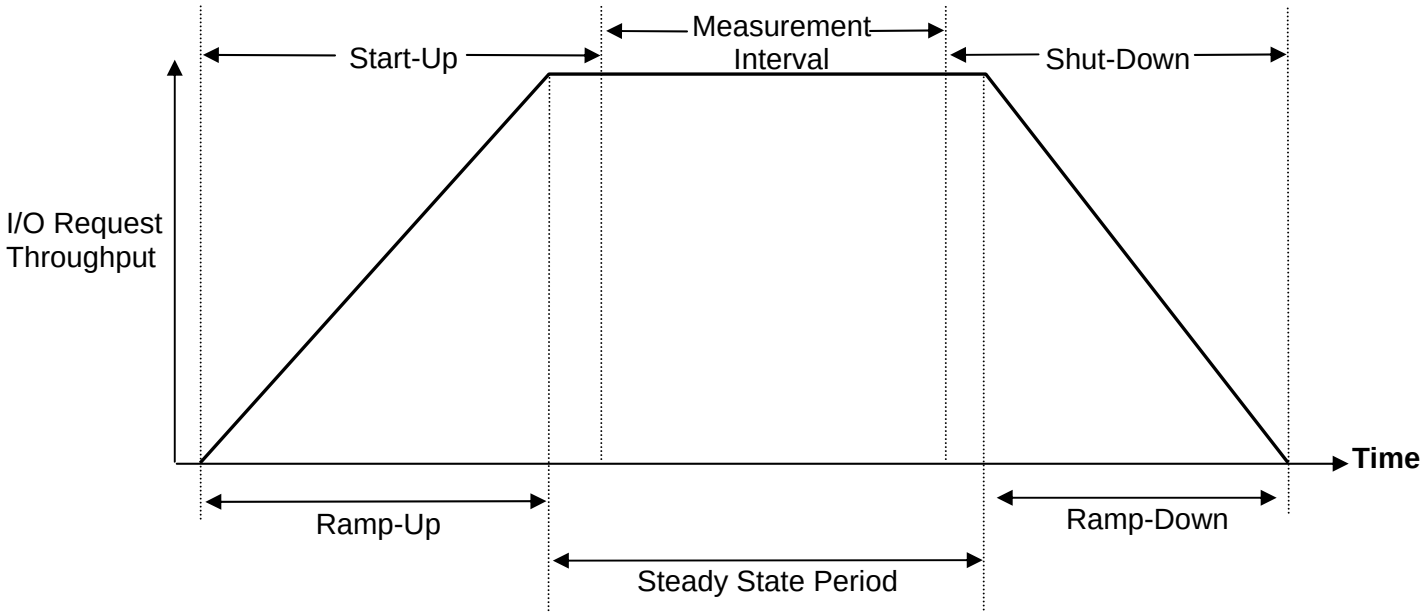
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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 customer tunable parameters and options that were changed from their default values are documented in Step #1 of "Setup Host Systems and discover the LUNs" in Appendix C: Tested Storage Configuration (TSC) Creation.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

Create the LUNs

The following three steps were executed to create and configure the LUNs that comprised the TSC:

1. Configure the InServ storage server ports to port personality 1 *(this is the recommended setting for Direct Connect with Solaris described in the 3PAR document "InForm OS 2.2.3/2.2.4 Solaris Sun/Qlogic/Emulex HBA Implementation Guide Part No. 320-200102 Rev B 1 ").*

   The following script was used for the two ports on each node:

```
# cat do_chgpersona
for n in 0 1 2 3
   do
   for s in  1
      do
      for p in  1 2
        do
        controlport persona 1 -f $n:$s:$p
        done
      done
   done
```

2. Create the host definitions (*associating a hostname with WWNs)* using the following script:

```
createhost  sun44n01  2101001B323380A8
createhost  sun45n01  210100E08BBE1D40
createhost  sun46n01  210100E08BBECA40
createhost  sun47n01  2101001B32317733
createhost  sun44n23  2100001B321380A8
createhost  sun45n23  210000E08B9E1D40
createhost  sun46n23  210000E08B9ECA40
createhost  sun47n23  2100001B32117733
```

3. Create the 128 volumes *(80 for ASU1, 24 for ASU2, and 24 for ASU3)* and export the VLUNs to the host using the following script:

```
# cat create_config
createcpg -t r1 -p -nd 0,1    cpg01
createcpg -t r1 -p -nd 2,3    cpg23

for i in `seq 0 2 78`; do createvv  cpg01 asu1_nd01.$(($i/2)) 145152;
                          createvv  cpg23 asu1_nd23.$(($i/2)) 145152;
                       done
for i in `seq 0 2 22`; do createvv  cpg01 asu2_nd01.$(($i/2)) 483840;
                          createvv  cpg23 asu2_nd23.$(($i/2)) 483840;
                       done
for i in `seq 0 2 22`; do createvv  cpg01 asu3_nd01.$(($i/2)) 107520;
                          createvv  cpg23 asu3_nd23.$(($i/2)) 107520;
                       done

createvlun -f  -cnt 40 asu1_nd01.0 0 sun44n01
createvlun -f  -cnt 12 asu2_nd01.0 40 sun44n01
```

```
createvlun -f  -cnt 12 asu3_nd01.0 52 sun44n01
createvlun -f  -cnt 40 asu1_nd01.0 0 sun45n01
createvlun -f  -cnt 12 asu2_nd01.0 40 sun45n01
createvlun -f  -cnt 12 asu3_nd01.0 52 sun45n01
createvlun -f  -cnt 40 asu1_nd01.0 0 sun46n01
createvlun -f  -cnt 12 asu2_nd01.0 40 sun46n01
createvlun -f  -cnt 12 asu3_nd01.0 52 sun46n01
createvlun -f  -cnt 40 asu1_nd01.0 0 sun47n01
createvlun -f  -cnt 12 asu2_nd01.0 40 sun47n01
createvlun -f  -cnt 12 asu3_nd01.0 52 sun47n01

createvlun -f  -cnt 40 asu1_nd23.0 0 sun44n23
createvlun -f  -cnt 12 asu2_nd23.0 40 sun44n23
createvlun -f  -cnt 12 asu3_nd23.0 52 sun44n23
createvlun -f  -cnt 40 asu1_nd23.0 0 sun45n23
createvlun -f  -cnt 12 asu2_nd23.0 40 sun45n23
createvlun -f  -cnt 12 asu3_nd23.0 52 sun45n23
createvlun -f  -cnt 40 asu1_nd23.0 0 sun46n23
createvlun -f  -cnt 12 asu2_nd23.0 40 sun46n23
createvlun -f  -cnt 12 asu3_nd23.0 52 sun46n23
createvlun -f  -cnt 40 asu1_nd23.0 0 sun47n23
createvlun -f  -cnt 12 asu2_nd23.0 40 sun47n23
createvlun -f  -cnt 12 asu3_nd23.0 52 sun47n23
```

Setup the Host Systems and discover the LUNs

The following steps were executed to setup each Host System and discover the LUNs created in the above steps.

1. For each Solaris host, following the guidelines in *"InForm OS 2.2.3/2.2. Solaris Sun/Qlogic/Emulex HBA Implementation Guide Part No. 320-200102 Rev B 1" (page 10, for Solaris 10)*:
   - add the following entry to the end of the file **/kernel/drv/scsi_vhci.conf**:

     ```
     device-type-scsi-options-list = "3PARdataVV", "symmetric-option";
     symmetric-option = 0x1000000;
     ```

   - Execute a reconfiguration boot (**reboot -- -r**) so the changes take effect.

2. On one of the Host Systems, partition the disks to create one Solaris partition. The following files were used to partition each disk in Step #3.

```
 #cat list.asu1
c4t50002AC00001013Ad0 c4t50002AC00002013Ad0 c4t50002AC00003013Ad0
c4t50002AC00004013Ad0 c4t50002AC00005013Ad0 c4t50002AC00006013Ad0
c4t50002AC00007013Ad0 c4t50002AC00008013Ad0 c4t50002AC00009013Ad0
c4t50002AC0000A013Ad0 c4t50002AC0000B013Ad0 c4t50002AC0000C013Ad0
c4t50002AC0000D013Ad0 c4t50002AC0000E013Ad0 c4t50002AC0000F013Ad0
c4t50002AC00010013Ad0 c4t50002AC00011013Ad0 c4t50002AC00012013Ad0
c4t50002AC00013013Ad0 c4t50002AC00014013Ad0 c4t50002AC00015013Ad0
c4t50002AC00016013Ad0 c4t50002AC00017013Ad0 c4t50002AC00018013Ad0
c4t50002AC00019013Ad0 c4t50002AC0001A013Ad0 c4t50002AC0001B013Ad0
c4t50002AC0001C013Ad0 c4t50002AC0001D013Ad0 c4t50002AC0001E013Ad0
c4t50002AC0001F013Ad0 c4t50002AC00020013Ad0 c4t50002AC00021013Ad0
c4t50002AC00022013Ad0 c4t50002AC00023013Ad0 c4t50002AC00024013Ad0
c4t50002AC00025013Ad0 c4t50002AC00026013Ad0 c4t50002AC00027013Ad0
c4t50002AC00028013Ad0 c4t50002AC00029013Ad0 c4t50002AC0002A013Ad0
c4t50002AC0002B013Ad0 c4t50002AC0002C013Ad0 c4t50002AC0002D013Ad0
```

```
c4t50002AC0002E013Ad0 c4t50002AC0002F013Ad0 c4t50002AC00030013Ad0
c4t50002AC00031013Ad0 c4t50002AC00032013Ad0 c4t50002AC00033013Ad0
c4t50002AC00034013Ad0 c4t50002AC00035013Ad0 c4t50002AC00036013Ad0
c4t50002AC00037013Ad0 c4t50002AC00038013Ad0 c4t50002AC00039013Ad0
c4t50002AC0003A013Ad0 c4t50002AC0003B013Ad0 c4t50002AC0003C013Ad0
c4t50002AC0003D013Ad0 c4t50002AC0003E013Ad0 c4t50002AC0003F013Ad0
c4t50002AC00040013Ad0 c4t50002AC00041013Ad0 c4t50002AC00042013Ad0
c4t50002AC00043013Ad0 c4t50002AC00044013Ad0 c4t50002AC00045013Ad0
c4t50002AC00046013Ad0 c4t50002AC00047013Ad0 c4t50002AC00048013Ad0
c4t50002AC00049013Ad0 c4t50002AC0004A013Ad0 c4t50002AC0004B013Ad0
c4t50002AC0004C013Ad0 c4t50002AC0004D013Ad0 c4t50002AC0004E013Ad0
c4t50002AC0004F013Ad0 c4t50002AC00050013Ad0
#cat list.asu2
c4t50002AC00051013Ad0 c4t50002AC00052013Ad0 c4t50002AC00053013Ad0
c4t50002AC00054013Ad0 c4t50002AC00055013Ad0 c4t50002AC00056013Ad0
c4t50002AC00057013Ad0 c4t50002AC00058013Ad0 c4t50002AC00059013Ad0
c4t50002AC0005A013Ad0 c4t50002AC0005B013Ad0 c4t50002AC0005C013Ad0
c4t50002AC0005D013Ad0 c4t50002AC0005E013Ad0 c4t50002AC0005F013Ad0
c4t50002AC00060013Ad0 c4t50002AC00061013Ad0 c4t50002AC00062013Ad0
c4t50002AC00063013Ad0 c4t50002AC00064013Ad0 c4t50002AC00065013Ad0
c4t50002AC00066013Ad0 c4t50002AC00067013Ad0 c4t50002AC00068013Ad0
#cat list.asu3
c4t50002AC00069013Ad0 c4t50002AC0006A013Ad0 c4t50002AC0006B013Ad0
c4t50002AC0006C013Ad0 c4t50002AC0006D013Ad0 c4t50002AC0006E013Ad0
c4t50002AC0006F013Ad0 c4t50002AC00070013Ad0 c4t50002AC00071013Ad0
c4t50002AC00072013Ad0 c4t50002AC00073013Ad0 c4t50002AC00074013Ad0
c4t50002AC00075013Ad0 c4t50002AC00076013Ad0 c4t50002AC00077013Ad0
c4t50002AC00078013Ad0 c4t50002AC00079013Ad0 c4t50002AC0007A013Ad0
c4t50002AC0007B013Ad0 c4t50002AC0007C013Ad0 c4t50002AC0007D013Ad0
c4t50002AC0007E013Ad0 c4t50002AC0007F013Ad0 c4t50002AC00080013Ad0
```

The following files show the partition used for each set of disks:

```
#cat partinfo_asu1

* Id    Act  Bhead  Bsect  Bcyl    Ehead  Esect  Ecyl    Rsect    Numsect
  191   128  0      0      0       0      0      0       16080    297250680
#cat partinfo_asu2

* Id    Act  Bhead  Bsect  Bcyl    Ehead  Esect  Ecyl    Rsect    Numsect
  191   128  0      0      0       0      0      0       16080    990873120
#cat partinfo_asu3

* Id    Act  Bhead  Bsect  Bcyl    Ehead  Esect  Ecyl    Rsect    Numsect
  191   128  0      0      0       0      0      0       16080    220170810
```

3. Execute the following script *(using the files shown in Step #2)* to format the disks:

```
# cat init.disks
for DISK in `cat list.asu1`
do
   fdisk -F partinfo_asu1 /dev/rdsk/${DISK}p0
done

for DISK in `cat list.asu2`
do
   fdisk -F partinfo_asu2 /dev/rdsk/${DISK}p0
done

for DISK in `cat list.asu3`
do
   fdisk -F partinfo_asu3 /dev/rdsk/${DISK}p0
done
```

4. After successful completion of Step #3, discover the LUNs on the other three Host System by executing a reconfiguration reboot (**reboot -- -r**) on each of the three Host Systems.

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

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

```
javaparms="-Xmx512m -Xss512k"
host=master
slaves=(slave101,slave102,slave103,slave104)

*ASU1
sd=asu1_1,lun=/dev/rdsk/c4t50002AC00001013Ad0s2,size=152137657728
sd=asu1_2,lun=/dev/rdsk/c4t50002AC00002013Ad0s2,size=152137657728
sd=asu1_3,lun=/dev/rdsk/c4t50002AC00003013Ad0s2,size=152137657728
sd=asu1_4,lun=/dev/rdsk/c4t50002AC00004013Ad0s2,size=152137657728
sd=asu1_5,lun=/dev/rdsk/c4t50002AC00005013Ad0s2,size=152137657728
sd=asu1_6,lun=/dev/rdsk/c4t50002AC00006013Ad0s2,size=152137657728
sd=asu1_7,lun=/dev/rdsk/c4t50002AC00007013Ad0s2,size=152137657728
sd=asu1_8,lun=/dev/rdsk/c4t50002AC00008013Ad0s2,size=152137657728
sd=asu1_9,lun=/dev/rdsk/c4t50002AC00009013Ad0s2,size=152137657728
sd=asu1_10,lun=/dev/rdsk/c4t50002AC0000A013Ad0s2,size=152137657728
sd=asu1_11,lun=/dev/rdsk/c4t50002AC0000B013Ad0s2,size=152137657728
sd=asu1_12,lun=/dev/rdsk/c4t50002AC0000C013Ad0s2,size=152137657728
sd=asu1_13,lun=/dev/rdsk/c4t50002AC0000D013Ad0s2,size=152137657728
sd=asu1_14,lun=/dev/rdsk/c4t50002AC0000E013Ad0s2,size=152137657728
sd=asu1_15,lun=/dev/rdsk/c4t50002AC0000F013Ad0s2,size=152137657728
sd=asu1_16,lun=/dev/rdsk/c4t50002AC00010013Ad0s2,size=152137657728
sd=asu1_17,lun=/dev/rdsk/c4t50002AC00011013Ad0s2,size=152137657728
sd=asu1_18,lun=/dev/rdsk/c4t50002AC00012013Ad0s2,size=152137657728
sd=asu1_19,lun=/dev/rdsk/c4t50002AC00013013Ad0s2,size=152137657728
sd=asu1_20,lun=/dev/rdsk/c4t50002AC00014013Ad0s2,size=152137657728
sd=asu1_21,lun=/dev/rdsk/c4t50002AC00015013Ad0s2,size=152137657728
sd=asu1_22,lun=/dev/rdsk/c4t50002AC00016013Ad0s2,size=152137657728
sd=asu1_23,lun=/dev/rdsk/c4t50002AC00017013Ad0s2,size=152137657728
sd=asu1_24,lun=/dev/rdsk/c4t50002AC00018013Ad0s2,size=152137657728
sd=asu1_25,lun=/dev/rdsk/c4t50002AC00019013Ad0s2,size=152137657728
sd=asu1_26,lun=/dev/rdsk/c4t50002AC0001A013Ad0s2,size=152137657728
sd=asu1_27,lun=/dev/rdsk/c4t50002AC0001B013Ad0s2,size=152137657728
sd=asu1_28,lun=/dev/rdsk/c4t50002AC0001C013Ad0s2,size=152137657728
sd=asu1_29,lun=/dev/rdsk/c4t50002AC0001D013Ad0s2,size=152137657728
sd=asu1_30,lun=/dev/rdsk/c4t50002AC0001E013Ad0s2,size=152137657728
sd=asu1_31,lun=/dev/rdsk/c4t50002AC0001F013Ad0s2,size=152137657728
sd=asu1_32,lun=/dev/rdsk/c4t50002AC00020013Ad0s2,size=152137657728
sd=asu1_33,lun=/dev/rdsk/c4t50002AC00021013Ad0s2,size=152137657728
sd=asu1_34,lun=/dev/rdsk/c4t50002AC00022013Ad0s2,size=152137657728
sd=asu1_35,lun=/dev/rdsk/c4t50002AC00023013Ad0s2,size=152137657728
sd=asu1_36,lun=/dev/rdsk/c4t50002AC00024013Ad0s2,size=152137657728
sd=asu1_37,lun=/dev/rdsk/c4t50002AC00025013Ad0s2,size=152137657728
sd=asu1_38,lun=/dev/rdsk/c4t50002AC00026013Ad0s2,size=152137657728
sd=asu1_39,lun=/dev/rdsk/c4t50002AC00027013Ad0s2,size=152137657728
sd=asu1_40,lun=/dev/rdsk/c4t50002AC00028013Ad0s2,size=152137657728
sd=asu1_41,lun=/dev/rdsk/c4t50002AC00029013Ad0s2,size=152137657728
sd=asu1_42,lun=/dev/rdsk/c4t50002AC0002A013Ad0s2,size=152137657728
sd=asu1_43,lun=/dev/rdsk/c4t50002AC0002B013Ad0s2,size=152137657728
sd=asu1_44,lun=/dev/rdsk/c4t50002AC0002C013Ad0s2,size=152137657728
sd=asu1_45,lun=/dev/rdsk/c4t50002AC0002D013Ad0s2,size=152137657728
sd=asu1_46,lun=/dev/rdsk/c4t50002AC0002E013Ad0s2,size=152137657728
sd=asu1_47,lun=/dev/rdsk/c4t50002AC0002F013Ad0s2,size=152137657728
sd=asu1_48,lun=/dev/rdsk/c4t50002AC00030013Ad0s2,size=152137657728
```

```
sd=asu1_49,lun=/dev/rdsk/c4t50002AC00031013Ad0s2,size=152137657728
sd=asu1_50,lun=/dev/rdsk/c4t50002AC00032013Ad0s2,size=152137657728
sd=asu1_51,lun=/dev/rdsk/c4t50002AC00033013Ad0s2,size=152137657728
sd=asu1_52,lun=/dev/rdsk/c4t50002AC00034013Ad0s2,size=152137657728
sd=asu1_53,lun=/dev/rdsk/c4t50002AC00035013Ad0s2,size=152137657728
sd=asu1_54,lun=/dev/rdsk/c4t50002AC00036013Ad0s2,size=152137657728
sd=asu1_55,lun=/dev/rdsk/c4t50002AC00037013Ad0s2,size=152137657728
sd=asu1_56,lun=/dev/rdsk/c4t50002AC00038013Ad0s2,size=152137657728
sd=asu1_57,lun=/dev/rdsk/c4t50002AC00039013Ad0s2,size=152137657728
sd=asu1_58,lun=/dev/rdsk/c4t50002AC0003A013Ad0s2,size=152137657728
sd=asu1_59,lun=/dev/rdsk/c4t50002AC0003B013Ad0s2,size=152137657728
sd=asu1_60,lun=/dev/rdsk/c4t50002AC0003C013Ad0s2,size=152137657728
sd=asu1_61,lun=/dev/rdsk/c4t50002AC0003D013Ad0s2,size=152137657728
sd=asu1_62,lun=/dev/rdsk/c4t50002AC0003E013Ad0s2,size=152137657728
sd=asu1_63,lun=/dev/rdsk/c4t50002AC0003F013Ad0s2,size=152137657728
sd=asu1_64,lun=/dev/rdsk/c4t50002AC00040013Ad0s2,size=152137657728
sd=asu1_65,lun=/dev/rdsk/c4t50002AC00041013Ad0s2,size=152137657728
sd=asu1_66,lun=/dev/rdsk/c4t50002AC00042013Ad0s2,size=152137657728
sd=asu1_67,lun=/dev/rdsk/c4t50002AC00043013Ad0s2,size=152137657728
sd=asu1_68,lun=/dev/rdsk/c4t50002AC00044013Ad0s2,size=152137657728
sd=asu1_69,lun=/dev/rdsk/c4t50002AC00045013Ad0s2,size=152137657728
sd=asu1_70,lun=/dev/rdsk/c4t50002AC00046013Ad0s2,size=152137657728
sd=asu1_71,lun=/dev/rdsk/c4t50002AC00047013Ad0s2,size=152137657728
sd=asu1_72,lun=/dev/rdsk/c4t50002AC00048013Ad0s2,size=152137657728
sd=asu1_73,lun=/dev/rdsk/c4t50002AC00049013Ad0s2,size=152137657728
sd=asu1_74,lun=/dev/rdsk/c4t50002AC0004A013Ad0s2,size=152137657728
sd=asu1_75,lun=/dev/rdsk/c4t50002AC0004B013Ad0s2,size=152137657728
sd=asu1_76,lun=/dev/rdsk/c4t50002AC0004C013Ad0s2,size=152137657728
sd=asu1_77,lun=/dev/rdsk/c4t50002AC0004D013Ad0s2,size=152137657728
sd=asu1_78,lun=/dev/rdsk/c4t50002AC0004E013Ad0s2,size=152137657728
sd=asu1_79,lun=/dev/rdsk/c4t50002AC0004F013Ad0s2,size=152137657728
sd=asu1_80,lun=/dev/rdsk/c4t50002AC00050013Ad0s2,size=152137657728
*ASU2
sd=asu2_1,lun=/dev/rdsk/c4t50002AC00051013Ad0s2,size=507125525760
sd=asu2_2,lun=/dev/rdsk/c4t50002AC00052013Ad0s2,size=507125525760
sd=asu2_3,lun=/dev/rdsk/c4t50002AC00053013Ad0s2,size=507125525760
sd=asu2_4,lun=/dev/rdsk/c4t50002AC00054013Ad0s2,size=507125525760
sd=asu2_5,lun=/dev/rdsk/c4t50002AC00055013Ad0s2,size=507125525760
sd=asu2_6,lun=/dev/rdsk/c4t50002AC00056013Ad0s2,size=507125525760
sd=asu2_7,lun=/dev/rdsk/c4t50002AC00057013Ad0s2,size=507125525760
sd=asu2_8,lun=/dev/rdsk/c4t50002AC00058013Ad0s2,size=507125525760
sd=asu2_9,lun=/dev/rdsk/c4t50002AC00059013Ad0s2,size=507125525760
sd=asu2_10,lun=/dev/rdsk/c4t50002AC0005A013Ad0s2,size=507125525760
sd=asu2_11,lun=/dev/rdsk/c4t50002AC0005B013Ad0s2,size=507125525760
sd=asu2_12,lun=/dev/rdsk/c4t50002AC0005C013Ad0s2,size=507125525760
sd=asu2_13,lun=/dev/rdsk/c4t50002AC0005D013Ad0s2,size=507125525760
sd=asu2_14,lun=/dev/rdsk/c4t50002AC0005E013Ad0s2,size=507125525760
sd=asu2_15,lun=/dev/rdsk/c4t50002AC0005F013Ad0s2,size=507125525760
sd=asu2_16,lun=/dev/rdsk/c4t50002AC00060013Ad0s2,size=507125525760
sd=asu2_17,lun=/dev/rdsk/c4t50002AC00061013Ad0s2,size=507125525760
sd=asu2_18,lun=/dev/rdsk/c4t50002AC00062013Ad0s2,size=507125525760
sd=asu2_19,lun=/dev/rdsk/c4t50002AC00063013Ad0s2,size=507125525760
sd=asu2_20,lun=/dev/rdsk/c4t50002AC00064013Ad0s2,size=507125525760
sd=asu2_21,lun=/dev/rdsk/c4t50002AC00065013Ad0s2,size=507125525760
sd=asu2_22,lun=/dev/rdsk/c4t50002AC00066013Ad0s2,size=507125525760
sd=asu2_23,lun=/dev/rdsk/c4t50002AC00067013Ad0s2,size=507125525760
sd=asu2_24,lun=/dev/rdsk/c4t50002AC00068013Ad0s2,size=507125525760
*ASU3
sd=asu3_1,lun=/dev/rdsk/c4t50002AC00069013Ad0s2,size=112694561280
sd=asu3_2,lun=/dev/rdsk/c4t50002AC0006A013Ad0s2,size=112694561280
sd=asu3_3,lun=/dev/rdsk/c4t50002AC0006B013Ad0s2,size=112694561280
sd=asu3_4,lun=/dev/rdsk/c4t50002AC0006C013Ad0s2,size=112694561280
sd=asu3_5,lun=/dev/rdsk/c4t50002AC0006D013Ad0s2,size=112694561280
```

```
sd=asu3_6,lun=/dev/rdsk/c4t50002AC0006E013Ad0s2,size=112694561280
sd=asu3_7,lun=/dev/rdsk/c4t50002AC0006F013Ad0s2,size=112694561280
sd=asu3_8,lun=/dev/rdsk/c4t50002AC00070013Ad0s2,size=112694561280
sd=asu3_9,lun=/dev/rdsk/c4t50002AC00071013Ad0s2,size=112694561280
sd=asu3_10,lun=/dev/rdsk/c4t50002AC00072013Ad0s2,size=112694561280
sd=asu3_11,lun=/dev/rdsk/c4t50002AC00073013Ad0s2,size=112694561280
sd=asu3_12,lun=/dev/rdsk/c4t50002AC00074013Ad0s2,size=112694561280
sd=asu3_13,lun=/dev/rdsk/c4t50002AC00075013Ad0s2,size=112694561280
sd=asu3_14,lun=/dev/rdsk/c4t50002AC00076013Ad0s2,size=112694561280
sd=asu3_15,lun=/dev/rdsk/c4t50002AC00077013Ad0s2,size=112694561280
sd=asu3_16,lun=/dev/rdsk/c4t50002AC00078013Ad0s2,size=112694561280
sd=asu3_17,lun=/dev/rdsk/c4t50002AC00079013Ad0s2,size=112694561280
sd=asu3_18,lun=/dev/rdsk/c4t50002AC0007A013Ad0s2,size=112694561280
sd=asu3_19,lun=/dev/rdsk/c4t50002AC0007B013Ad0s2,size=112694561280
sd=asu3_20,lun=/dev/rdsk/c4t50002AC0007C013Ad0s2,size=112694561280
sd=asu3_21,lun=/dev/rdsk/c4t50002AC0007D013Ad0s2,size=112694561280
sd=asu3_22,lun=/dev/rdsk/c4t50002AC0007E013Ad0s2,size=112694561280
sd=asu3_23,lun=/dev/rdsk/c4t50002AC0007F013Ad0s2,size=112694561280
sd=asu3_24,lun=/dev/rdsk/c4t50002AC00080013Ad0s2,size=112694561280
```

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

```
javaparms="-Xmx512m -Xss512k"

*ASU1
sd=asu1_1,lun=/dev/rdsk/c4t50002AC00001013Ad0s2,size=152137657728
sd=asu1_2,lun=/dev/rdsk/c4t50002AC00002013Ad0s2,size=152137657728
sd=asu1_3,lun=/dev/rdsk/c4t50002AC00003013Ad0s2,size=152137657728
sd=asu1_4,lun=/dev/rdsk/c4t50002AC00004013Ad0s2,size=152137657728
sd=asu1_5,lun=/dev/rdsk/c4t50002AC00005013Ad0s2,size=152137657728
sd=asu1_6,lun=/dev/rdsk/c4t50002AC00006013Ad0s2,size=152137657728
sd=asu1_7,lun=/dev/rdsk/c4t50002AC00007013Ad0s2,size=152137657728
sd=asu1_8,lun=/dev/rdsk/c4t50002AC00008013Ad0s2,size=152137657728
sd=asu1_9,lun=/dev/rdsk/c4t50002AC00009013Ad0s2,size=152137657728
sd=asu1_10,lun=/dev/rdsk/c4t50002AC0000A013Ad0s2,size=152137657728
sd=asu1_11,lun=/dev/rdsk/c4t50002AC0000B013Ad0s2,size=152137657728
sd=asu1_12,lun=/dev/rdsk/c4t50002AC0000C013Ad0s2,size=152137657728
sd=asu1_13,lun=/dev/rdsk/c4t50002AC0000D013Ad0s2,size=152137657728
sd=asu1_14,lun=/dev/rdsk/c4t50002AC0000E013Ad0s2,size=152137657728
sd=asu1_15,lun=/dev/rdsk/c4t50002AC0000F013Ad0s2,size=152137657728
sd=asu1_16,lun=/dev/rdsk/c4t50002AC00010013Ad0s2,size=152137657728
sd=asu1_17,lun=/dev/rdsk/c4t50002AC00011013Ad0s2,size=152137657728
sd=asu1_18,lun=/dev/rdsk/c4t50002AC00012013Ad0s2,size=152137657728
sd=asu1_19,lun=/dev/rdsk/c4t50002AC00013013Ad0s2,size=152137657728
sd=asu1_20,lun=/dev/rdsk/c4t50002AC00014013Ad0s2,size=152137657728
sd=asu1_21,lun=/dev/rdsk/c4t50002AC00015013Ad0s2,size=152137657728
sd=asu1_22,lun=/dev/rdsk/c4t50002AC00016013Ad0s2,size=152137657728
sd=asu1_23,lun=/dev/rdsk/c4t50002AC00017013Ad0s2,size=152137657728
sd=asu1_24,lun=/dev/rdsk/c4t50002AC00018013Ad0s2,size=152137657728
sd=asu1_25,lun=/dev/rdsk/c4t50002AC00019013Ad0s2,size=152137657728
sd=asu1_26,lun=/dev/rdsk/c4t50002AC0001A013Ad0s2,size=152137657728
sd=asu1_27,lun=/dev/rdsk/c4t50002AC0001B013Ad0s2,size=152137657728
sd=asu1_28,lun=/dev/rdsk/c4t50002AC0001C013Ad0s2,size=152137657728
sd=asu1_29,lun=/dev/rdsk/c4t50002AC0001D013Ad0s2,size=152137657728
sd=asu1_30,lun=/dev/rdsk/c4t50002AC0001E013Ad0s2,size=152137657728
sd=asu1_31,lun=/dev/rdsk/c4t50002AC0001F013Ad0s2,size=152137657728
sd=asu1_32,lun=/dev/rdsk/c4t50002AC00020013Ad0s2,size=152137657728
sd=asu1_33,lun=/dev/rdsk/c4t50002AC00021013Ad0s2,size=152137657728
sd=asu1_34,lun=/dev/rdsk/c4t50002AC00022013Ad0s2,size=152137657728
sd=asu1_35,lun=/dev/rdsk/c4t50002AC00023013Ad0s2,size=152137657728
sd=asu1_36,lun=/dev/rdsk/c4t50002AC00024013Ad0s2,size=152137657728
sd=asu1_37,lun=/dev/rdsk/c4t50002AC00025013Ad0s2,size=152137657728
```

```
sd=asu1_38,lun=/dev/rdsk/c4t50002AC00026013Ad0s2,size=152137657728
sd=asu1_39,lun=/dev/rdsk/c4t50002AC00027013Ad0s2,size=152137657728
sd=asu1_40,lun=/dev/rdsk/c4t50002AC00028013Ad0s2,size=152137657728
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sd=asu1_63,lun=/dev/rdsk/c4t50002AC0003F013Ad0s2,size=152137657728
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sd=asu1_66,lun=/dev/rdsk/c4t50002AC00042013Ad0s2,size=152137657728
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sd=asu1_70,lun=/dev/rdsk/c4t50002AC00046013Ad0s2,size=152137657728
sd=asu1_71,lun=/dev/rdsk/c4t50002AC00047013Ad0s2,size=152137657728
sd=asu1_72,lun=/dev/rdsk/c4t50002AC00048013Ad0s2,size=152137657728
sd=asu1_73,lun=/dev/rdsk/c4t50002AC00049013Ad0s2,size=152137657728
sd=asu1_74,lun=/dev/rdsk/c4t50002AC0004A013Ad0s2,size=152137657728
sd=asu1_75,lun=/dev/rdsk/c4t50002AC0004B013Ad0s2,size=152137657728
sd=asu1_76,lun=/dev/rdsk/c4t50002AC0004C013Ad0s2,size=152137657728
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sd=asu1_79,lun=/dev/rdsk/c4t50002AC0004F013Ad0s2,size=152137657728
sd=asu1_80,lun=/dev/rdsk/c4t50002AC00050013Ad0s2,size=152137657728
*ASU2
sd=asu2_1,lun=/dev/rdsk/c4t50002AC00051013Ad0s2,size=507125525760
sd=asu2_2,lun=/dev/rdsk/c4t50002AC00052013Ad0s2,size=507125525760
sd=asu2_3,lun=/dev/rdsk/c4t50002AC00053013Ad0s2,size=507125525760
sd=asu2_4,lun=/dev/rdsk/c4t50002AC00054013Ad0s2,size=507125525760
sd=asu2_5,lun=/dev/rdsk/c4t50002AC00055013Ad0s2,size=507125525760
sd=asu2_6,lun=/dev/rdsk/c4t50002AC00056013Ad0s2,size=507125525760
sd=asu2_7,lun=/dev/rdsk/c4t50002AC00057013Ad0s2,size=507125525760
sd=asu2_8,lun=/dev/rdsk/c4t50002AC00058013Ad0s2,size=507125525760
sd=asu2_9,lun=/dev/rdsk/c4t50002AC00059013Ad0s2,size=507125525760
sd=asu2_10,lun=/dev/rdsk/c4t50002AC0005A013Ad0s2,size=507125525760
sd=asu2_11,lun=/dev/rdsk/c4t50002AC0005B013Ad0s2,size=507125525760
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sd=asu2_13,lun=/dev/rdsk/c4t50002AC0005D013Ad0s2,size=507125525760
sd=asu2_14,lun=/dev/rdsk/c4t50002AC0005E013Ad0s2,size=507125525760
sd=asu2_15,lun=/dev/rdsk/c4t50002AC0005F013Ad0s2,size=507125525760
sd=asu2_16,lun=/dev/rdsk/c4t50002AC00060013Ad0s2,size=507125525760
sd=asu2_17,lun=/dev/rdsk/c4t50002AC00061013Ad0s2,size=507125525760
sd=asu2_18,lun=/dev/rdsk/c4t50002AC00062013Ad0s2,size=507125525760
sd=asu2_19,lun=/dev/rdsk/c4t50002AC00063013Ad0s2,size=507125525760
```

```
sd=asu2_20,lun=/dev/rdsk/c4t50002AC00064013Ad0s2,size=507125525760
sd=asu2_21,lun=/dev/rdsk/c4t50002AC00065013Ad0s2,size=507125525760
sd=asu2_22,lun=/dev/rdsk/c4t50002AC00066013Ad0s2,size=507125525760
sd=asu2_23,lun=/dev/rdsk/c4t50002AC00067013Ad0s2,size=507125525760
sd=asu2_24,lun=/dev/rdsk/c4t50002AC00068013Ad0s2,size=507125525760
*ASU3
sd=asu3_1,lun=/dev/rdsk/c4t50002AC00069013Ad0s2,size=112694561280
sd=asu3_2,lun=/dev/rdsk/c4t50002AC0006A013Ad0s2,size=112694561280
sd=asu3_3,lun=/dev/rdsk/c4t50002AC0006B013Ad0s2,size=112694561280
sd=asu3_4,lun=/dev/rdsk/c4t50002AC0006C013Ad0s2,size=112694561280
sd=asu3_5,lun=/dev/rdsk/c4t50002AC0006D013Ad0s2,size=112694561280
sd=asu3_6,lun=/dev/rdsk/c4t50002AC0006E013Ad0s2,size=112694561280
sd=asu3_7,lun=/dev/rdsk/c4t50002AC0006F013Ad0s2,size=112694561280
sd=asu3_8,lun=/dev/rdsk/c4t50002AC00070013Ad0s2,size=112694561280
sd=asu3_9,lun=/dev/rdsk/c4t50002AC00071013Ad0s2,size=112694561280
sd=asu3_10,lun=/dev/rdsk/c4t50002AC00072013Ad0s2,size=112694561280
sd=asu3_11,lun=/dev/rdsk/c4t50002AC00073013Ad0s2,size=112694561280
sd=asu3_12,lun=/dev/rdsk/c4t50002AC00074013Ad0s2,size=112694561280
sd=asu3_13,lun=/dev/rdsk/c4t50002AC00075013Ad0s2,size=112694561280
sd=asu3_14,lun=/dev/rdsk/c4t50002AC00076013Ad0s2,size=112694561280
sd=asu3_15,lun=/dev/rdsk/c4t50002AC00077013Ad0s2,size=112694561280
sd=asu3_16,lun=/dev/rdsk/c4t50002AC00078013Ad0s2,size=112694561280
sd=asu3_17,lun=/dev/rdsk/c4t50002AC00079013Ad0s2,size=112694561280
sd=asu3_18,lun=/dev/rdsk/c4t50002AC0007A013Ad0s2,size=112694561280
sd=asu3_19,lun=/dev/rdsk/c4t50002AC0007B013Ad0s2,size=112694561280
sd=asu3_20,lun=/dev/rdsk/c4t50002AC0007C013Ad0s2,size=112694561280
sd=asu3_21,lun=/dev/rdsk/c4t50002AC0007D013Ad0s2,size=112694561280
sd=asu3_22,lun=/dev/rdsk/c4t50002AC0007E013Ad0s2,size=112694561280
sd=asu3_23,lun=/dev/rdsk/c4t50002AC0007F013Ad0s2,size=112694561280
sd=asu3_24,lun=/dev/rdsk/c4t50002AC00080013Ad0s2,size=112694561280
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

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

The following script was used to execute the Primary Metrics Test *(Sustainability Test Phase, IOPS Test Phase, and Response Time Ramp Test Phase)*, Repeatability Test *(Repeatability Test Phase 1 and Repeatability Test Phase 2)*, and Persistence Test Run 1 in an uninterrupted sequence.

```
# cat part1SPCtest
#  input target bsu and a runidentifier
if [ $# -ne 2 ]
then
    echo "Error in $0 - Invalid Argument Count"
    echo "Syntax: $0 target(b) RunID  "
    exit
fi
bsu=$1
RunID=$2


#  do export
export LD_LIBRARY_PATH=/home/Nspc1/solx86

rundir=/home/Nspc1/results/$RunID.$bsu

mkdir -p $rundir


#  copy config file for multiple hosts
cp metric_SPC1.cfg SPC1.cfg

#
# Run metric test
#
java -Xms512m -Xmx512m -Xss512k metrics -b $bsu -s 300
#
#
#
# Repeatability Tests
#
java -Xms512m -Xmx512m -Xss512k repeat1 -b $bsu -s 300

java -Xms512m -Xmx512m -Xss512k repeat2 -b $bsu -s 300

#  save these off which will change when do persistence
cp SPC1.cfg $rundir/SPC1.cfg.metric
cp SPC1.parm $rundir/SPC1.parm.metric
#
# First Persistence Test
#

#  copy config file for just one host
cp persist_SPC1.cfg SPC1.cfg

java -Xms512m -Xmx512m -Xss512k persist1 -b $bsu
```

Persistence Test Run 2

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

```
# cat part2SPCtest
#  input target bsu and a runidentifier
if [ $# -ne 2 ]
then
    echo "Error in $0 - Invalid Argument Count"
    echo "Syntax: $0 target(b) RunID  "
    exit
fi
bsu=$1
RunID=$2

rundir=/home/Nspc1/results/$RunID.$bsu

# Output Directory created during part1

# this is after shutdown and restart of InServ

#
# Second Persistence Test
#

#  do export
export LD_LIBRARY_PATH=/home/Nspc1/solx86

java -Xms512m -Xmx512m -Xss512k persist2

# Save off results and key files

mv metrics $rundir
mv repeatability1 $rundir
mv repeatability2 $rundir
mv persistence1 $rundir
mv persistence2 $rundir

mv SPCOut $rundir
cp SPC1.cfg $rundir
cp SPC1.parm $rundir


sun2100z-01# exit
```

APPENDIX F: THIRD-PARTY QUOTATION

Host System HBAs