SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

SUN MICROSYSTEMS, INC.
SUN STORAGETEK® 6540 ARRAY

SPC-1 V1.10.1

Submitted for Review: June 15, 2007
Submission Identifier: A00051

First Edition – June 2007

Trademarks

Table of Contents

AUDIT CERTIFICATION

Leah Schoeb
Sun Microsystems, Inc.
5300 Riata Park Court AUS05
Austin, TX 78721

June 15, 2007

The SPC Benchmark 1™ results listed below for the Sun StorageTek® 6540 Array 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: Sun StorageTek® 6540 Array	
Metric	**Reported Result**
SPC-1 IOPS™	46,491.72
SPC-1 Price-Performance	$6.62/SPC-1 IOPS™
Total ASU Capacity	6,890.000 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$307,710

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

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified using information supplied by Sun Microsystems, Inc.:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of each Application Storage Unit (ASU) and requirements.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters.

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

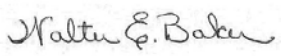
AUDIT CERTIFICATION *(CONT.)*

- Commands and parameters used to configure the SPC-1 Workload Generator.
- The following requirements, for each Host System, were reviewed using documentation supplied by Sun Microsystems, Inc.:
  - ✓ The type of Host System including the number of processors and main memory.
  - ✓ The presence and version number of the Workload Generator on the Host System.
  - ✓ The TSC boundary within the Host System.
- The Test Results Files and resultant Summary Results Files received from Sun Microsystems, 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 Tested Storage Configuration (TSC) and the Priced Storage Configuration.
- The submitted pricing information met all of the requirements and constraints of Clause 8 of the SPC-1 Benchmark Specification.
- The Full Disclosure Report (FDR) met all of the requirements in Clause 9 of the SPC-1 Benchmark Specification.

Audit Notes:

There were no audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

Storage Performance Council
643 Bair Island Road, Suite 103
Redwood City, CA 94062
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LETTER OF GOOD FAITH

Sun Microsystems, Inc.
500 Howard Street, Suite 300, San Francisco, CA 94105

24 May 2007

Walter E. Baker
Gradient Systems
643 Bair Island Rd. Suite 103
Redwood City, CA 94063-2755

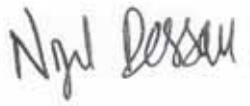
To: Walter E. Baker

Subject: SPC-1 Letter of Good Faith for the Sun StorageTek® 6540

Sun Microsystems 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 V1.10.1 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.

Thank you,



Nigel Dessau
Senior Vice President
Storage Marketing and Business Operations

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Sun Microsystems, Inc. – http://www.sun.com Leah Schoeb – leah.schoeb@sun.com 5300 Riata Park Court AUS08 Austin, TX 78721 Phone: (512) 401-1227 FAX: (512) 266-2523
Test Sponsor Alternate Contact	Sun Microsystems, Inc. – http://www.sun.com Jason Schaffer – jason.schaffer@sun.com 500 Eldorado Blvd. Broomfield, CO 80021 Phone: (303) 272-4743 FAX: (512) 266-2523
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	June 15, 2007
Date the FDR was submitted to the SPC	June 15, 2007
Date the TSC is available for shipment to customers	currently available
Date the TSC completed audit certification	June 14, 2007

Tested Storage Product (TSP) Description

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: Sun StorageTek® 6540 Array	
Metric	**Reported Result**
SPC-1 IOPS™	46,491.72
SPC-1 Price-Performance	$6.62/SPC-1 IOPS™
Total ASU Capacity	6,890.000 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$307,710

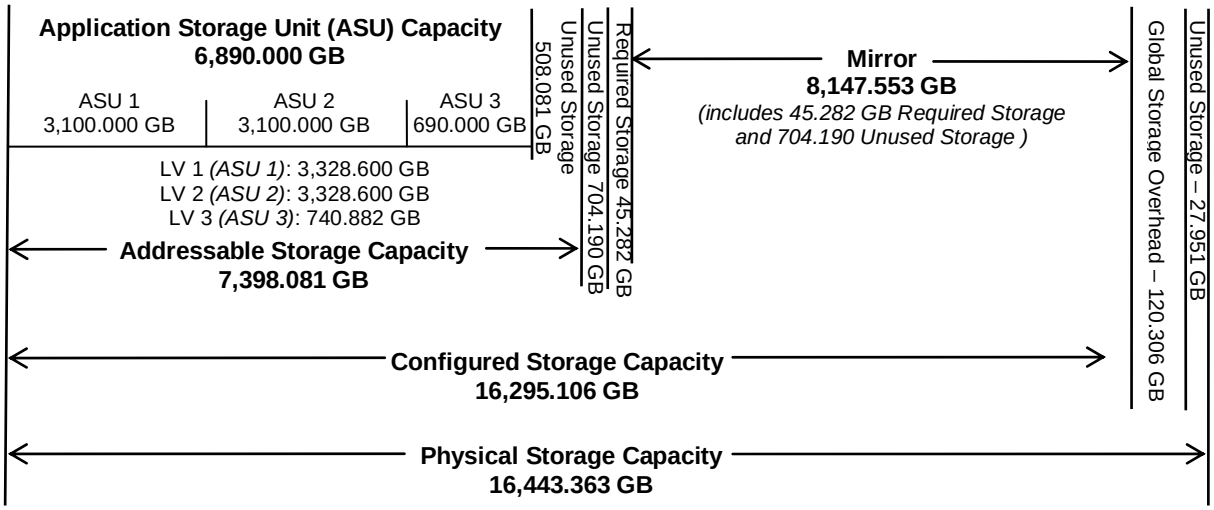
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

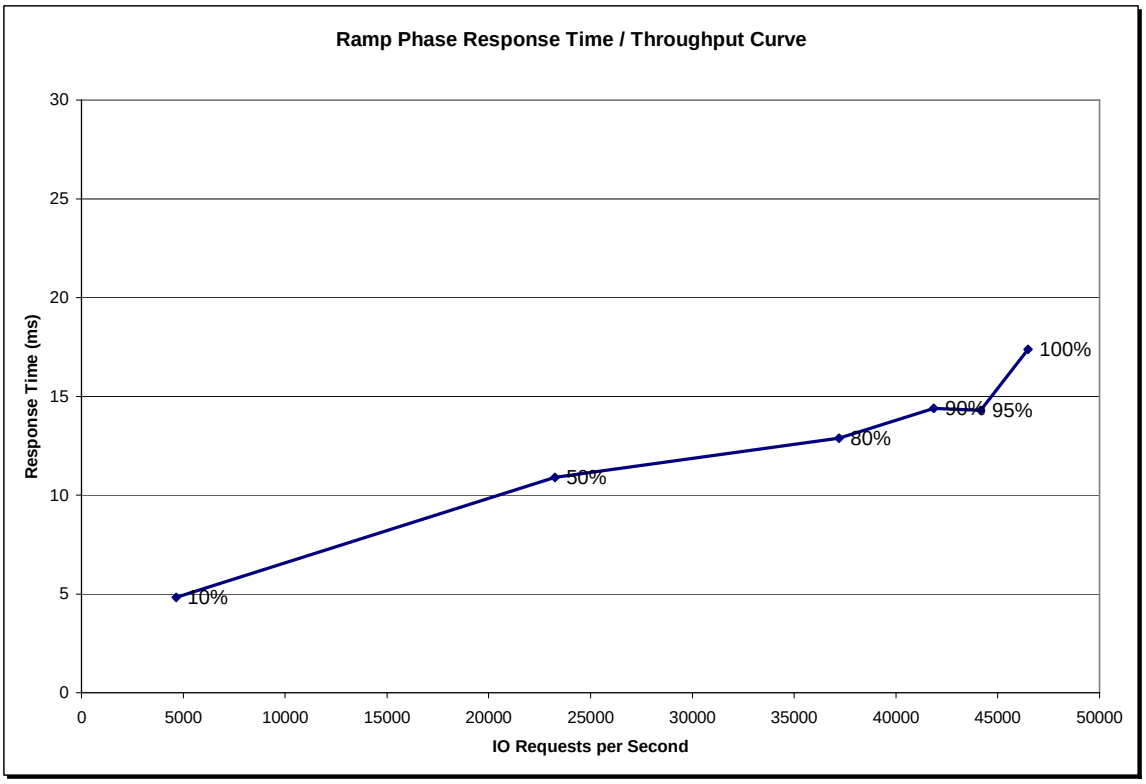
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



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	4,651.01	23,253.26	37,205.61	41,852.62	44,150.07	46,491.72
Average Response Time (ms):						
All ASUs	4.82	10.90	12.88	14.39	14.29	17.39
ASU-1	4.88	10.71	12.83	14.09	14.02	17.08
ASU-2	5.11	13.06	18.44	20.90	20.96	23.89
ASU-3	4.56	10.36	10.56	12.18	11.96	15.18
Reads	7.39	15.85	19.30	20.64	20.27	21.75
Writes	3.15	7.68	8.70	10.32	10.40	14.55

Tested Storage Configuration Pricing *(Priced Storage Configuration)*

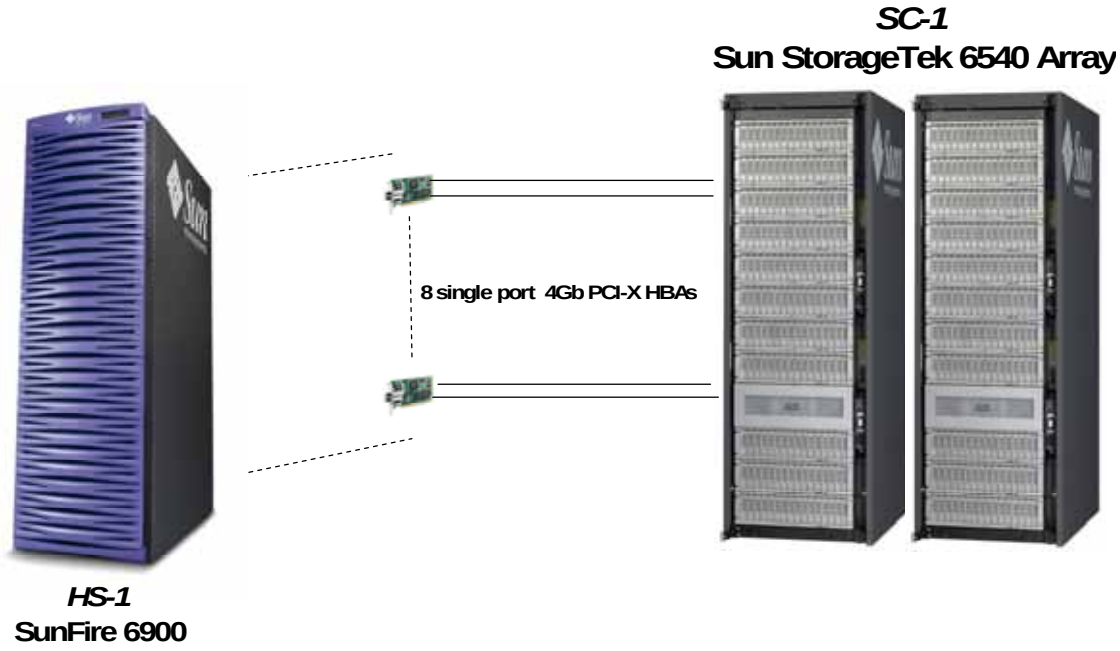
Part Number	Description	Quantity	US List	Total	discount	Ave. Price
TA6540M11A2-04FCZ	STK 6540 FC - 4GB RAID Controller Tray - 1x1	1	$70,000	$70,000	38%	$43,400
	- 2 Controllers w/ 2GB cache each					
	- All required cables included					
TACSM2M01A0B1168	STK CSM200 RM 0x1x16x73G15k	14	$27,495	$384,930	38%	$238,657
	- 16 73GB 15k rpm 4Gb drives					
	- All required cables included					
SG-XPCI1FC-QF4	4Gb PCI Express Single Port FC Host Based Adapter	8	$1,320	$10,560	38%	$6,547
W9D-ST6540-4-24-3G	3-yr Gold Service Maintainance for controller tray	1	$4,608	$4,608	38%	$2,857
	- 7/24 coverage					
	- 4 hour resonse time					
	- 4 hour resolution					
W9D-STCSM2-24-3G	3-yr Gold Service Maintainance for CSM200 expansion tray	13	$2,016	$26,208	38%	$16,249
	- 7/24 coverage					
	- 4 hr response time					
	- 4 hour resolution					
				$496,306		**$307,710**

The above pricing provides maintenance/support for 24 hours per day, 7 days per week for three years with four hour acknowledgement and four hour subsequent response (support engineer onsite or customer replaceable part available).

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

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

Benchmark Configuration/Tested Storage Configuration Diagram



Benchmark Configuration/Tested Storage Configuration Components

Host System:	Tested Storage Configuration (TSC):
UID=HS-1 **SunFire 6900**	8 – 4 Gb single port FC PCI-X HBAs
	UID=SC-1: **Sun StorageTek® 6540 Array**
24 – 1.2 GHz dual core UltraSPARC-IV processors 64 KB L1 cache per core, 2 MB L2 shared per dual core 32 MB L3 shared per dual core	1 Dual Controller 2 GB cache per controller *(4 GB total)*
	8 host connections *(front end)* 8 drive connections *(backend)*
48 GB main memory	14 – FC Expansion Trays
Solaris 10 update 3	224 – 73 GB 15K RPM disk drives
PCI-X	
WG	

In each of the following sections of this document, the appropriate Full Disclosure Report requirement, from the SPC-1 benchmark specification, is stated in italics followed by the information to fulfill the stated requirement.

CONFIGURATION INFORMATION

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

Clause 9.2.4.4.1

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

Storage Network Configuration

Clause 9.2.4.4.1

…

5. *If the TSC contains network storage, the diagram will include the network configuration. If a single diagram is not sufficient to illustrate both the Benchmark Configuration and network configuration in sufficient detail, the Benchmark Configuration diagram will include a high-level network illustration as shown in Figure 9-8. In that case, a separate, detailed network configuration diagram will also be included as described in Clause 9.2.4.4.2.*

Clause 9.2.4.4.2

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

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) was configured with local storage and, as such, did not employ a storage network.

Host System Configuration

Clause 9.2.4.4.3

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

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

The details of the Host System configuration may be found on page 14 *(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 58 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 59 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.2.4.5.3

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

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in "Appendix D: SPC-1 Workload Generator Storage Commands and Parameters" on page 73.

SPC-1 DATA REPOSITORY

This portion of the Full Disclosure Report presents the detailed information that fully documents the various SPC-1 storage capacities and mappings used in the Tested Storage Configuration. "SPC-1 Data Repository Definitions" on page 54 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)	6,890.000
Addressable Storage Capacity	Gigabytes (GB)	7,398.081
Configured Storage Capacity	Gigabytes (GB)	16,295.106
Physical Storage Capacity	Gigabytes (GB)	16,443.363
Data Protection (Mirroring)	Gigabytes (GB)	8,147.553
Required Storage/Metadata	Gigabytes (GB)	90.563
Global Storage Overhead	Gigabytes (GB)	120.306
Total Unused Storage	Gigabytes (GB)	2,543.057

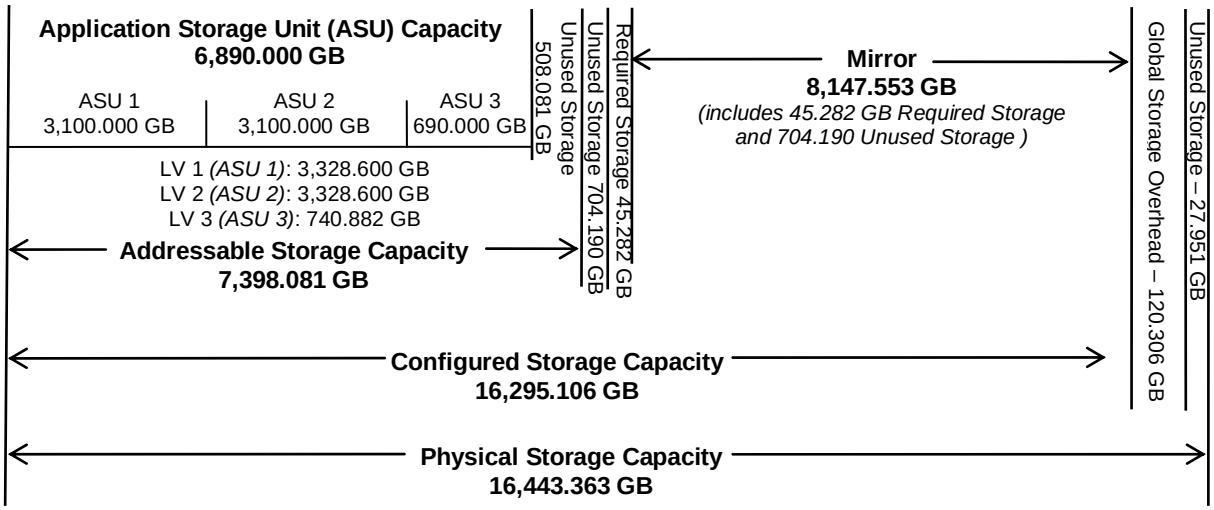
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	93.13%	42.28%	41.90%
Required for Data Protection (Mirroring)		50.00%	49.55%
Addressable Storage Capacity		45.40%	44.99%
Required Storage		0.56%	0.55%
Configured Storage Capacity			99.10%
Global Storage Overhead			0.73%
Unused Storage:			
Addressable	6.87%		
Configured		8.64%	
Physical			0.17%

The Physical Storage Capacity consisted of 16,443.363 GB distributed over 224 disk drives each with a formatted capacity of 73.408 GB. There was 27.95 GB (0.17%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 120.306 GB (0.73%) of Physical Storage Capacity. There was 1,408.380 GB (8.64%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 93.13% of the Addressable Storage Capacity resulting in 508.081 GB (6.87%) 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 (3,100.000 GB)	**ASU-2 (3,100.000 GB)**	**ASU-3 (690.000 GB)**
1 Logical Volume 3,100.000GB per Logical Volume (3,100.000 GB used per Logical Volume)	1 Logical Volume 3,100.000 GB per Logical Volume (3,100.000 GB used per Logical Volume)	1 Logical Volume 690.000 GB per Logical Volume (690.000 GB used per Logical Volume)

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

SPC-1 BENCHMARK EXECUTION RESULTS

This portion of the Full Disclosure Report documents the results of the various SPC-1 Tests, Test Phases, and Test Runs. "SPC-1 Test Execution Definitions" on page 55 contains definitions of terms specific to the SPC-1 Tests, Test Phases, and Test Runs.

Clause 5.4.3

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

SPC-1 Tests, Test Phases, and Test Runs

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

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

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

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

Primary Metrics Test – Sustainability Test Phase

Clause 5.4.4.1.1

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

Clause 5.4.4.1.2

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

Clause 5.4.4.1.4

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

Clause 9.2.4.7.1

For the Sustainability Test Phase the FDR shall contain:

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 74.

Sustainability Test Results File

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

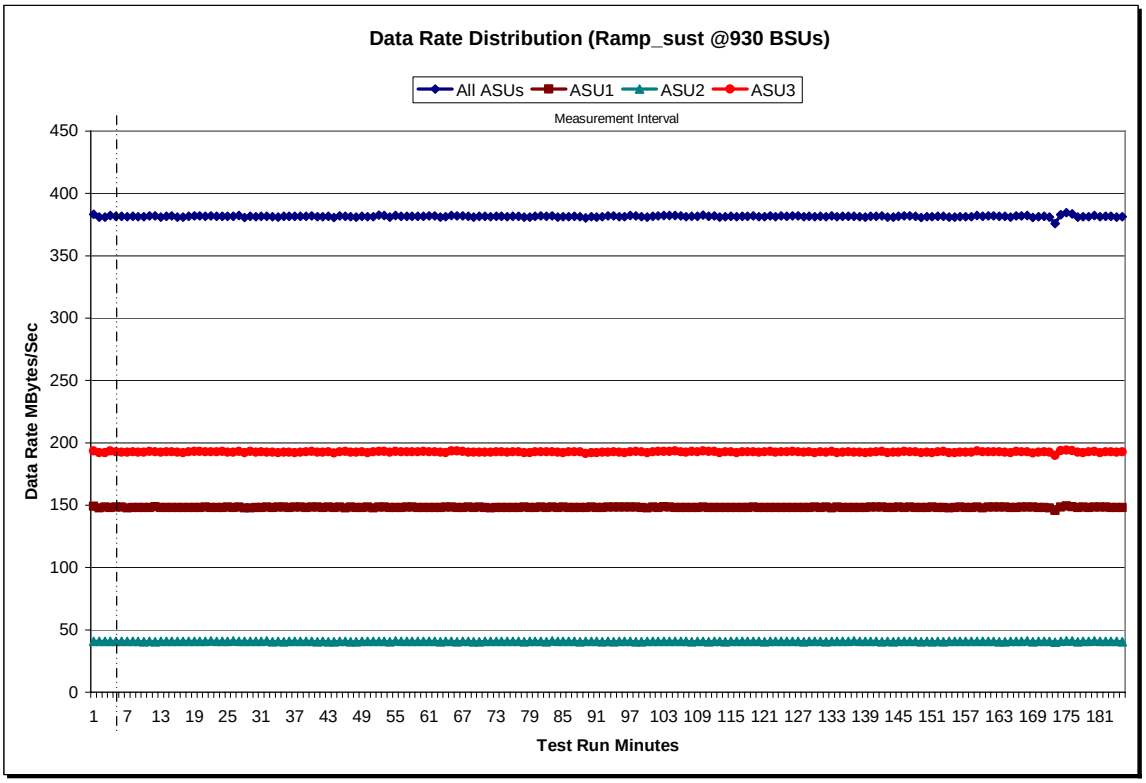
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	7:24:26	7:29:26	0-4	0:05:00
Measurement Interval	7:29:26	10:29:26	5-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	383.25	149.06	40.92	193.27	63	381.18	148.27	40.68	192.23	126	381.86	148.15	40.81	192.90
1	380.96	147.89	40.87	192.21	64	382.23	148.28	40.68	193.27	127	381.19	148.08	40.63	192.48
2	380.95	148.25	40.69	192.02	65	382.03	148.13	40.60	193.30	128	381.53	147.96	40.84	192.73
3	382.32	148.12	40.77	193.43	66	382.01	148.13	40.83	193.04	129	381.25	148.35	40.66	192.24
4	381.68	148.30	40.73	192.65	67	381.51	148.44	40.76	192.31	130	381.67	147.97	40.85	192.85
5	381.76	148.32	40.95	192.49	68	381.06	147.96	40.59	192.51	131	381.33	148.27	40.59	192.48
6	381.34	147.89	40.89	192.55	69	381.48	148.46	40.56	192.47	132	381.87	147.86	40.95	193.06
7	381.71	148.20	40.86	192.64	70	381.66	148.16	40.91	192.59	133	381.45	148.35	40.82	192.27
8	381.18	148.13	40.73	192.32	71	381.20	147.87	40.83	192.50	134	381.52	148.16	40.76	192.60
9	381.29	148.13	40.65	192.51	72	381.64	148.07	40.87	192.71	135	381.65	148.13	40.71	192.81
10	381.97	148.07	40.79	193.11	73	381.49	148.03	40.80	192.66	136	381.48	148.09	41.04	192.36
11	381.84	148.55	40.62	192.67	74	381.32	148.15	40.79	192.39	137	381.20	148.03	40.72	192.44
12	381.13	147.92	40.74	192.47	75	381.70	148.20	40.78	192.72	138	381.05	148.14	40.79	192.12
13	381.52	148.08	40.70	192.75	76	381.61	148.06	40.75	192.80	139	381.69	148.43	40.82	192.43
14	381.83	148.04	40.87	192.92	77	380.93	148.37	40.59	191.97	140	381.63	148.24	40.69	192.70
15	381.15	147.91	40.86	192.39	78	380.86	147.96	40.72	192.19	141	381.90	148.30	40.65	192.95
16	381.06	148.03	40.80	192.23	79	381.77	148.20	40.69	192.88	142	381.15	148.06	40.84	192.25
17	381.69	147.93	40.96	192.80	80	381.83	148.49	40.71	192.63	143	381.15	148.09	40.63	192.43
18	381.85	148.03	40.67	193.16	81	381.62	148.09	40.62	192.90	144	381.62	148.44	40.80	192.37
19	381.81	148.19	40.67	192.95	82	382.08	148.33	41.00	192.74	145	381.83	148.01	40.74	193.09
20	381.69	148.36	40.72	192.61	83	381.09	147.90	40.70	192.48	146	381.87	148.32	40.71	192.84
21	381.86	147.98	41.01	192.87	84	381.47	148.39	40.84	192.24	147	381.65	147.98	40.76	192.91
22	381.64	148.01	40.89	192.74	85	381.38	147.90	40.67	192.81	148	380.79	148.04	40.57	192.18
23	381.77	148.03	40.75	192.98	86	381.53	148.02	40.88	192.63	149	381.35	148.05	40.78	192.52
24	381.52	148.35	40.86	192.31	87	381.40	148.13	40.44	192.82	150	381.18	148.47	40.63	192.09
25	381.63	148.11	41.01	192.51	88	380.48	147.99	40.87	191.62	151	381.62	148.12	40.83	192.68
26	382.29	148.43	40.83	193.03	89	381.33	148.26	40.88	192.20	152	381.61	148.06	40.56	192.99
27	380.78	147.76	40.95	192.07	90	381.00	148.00	40.85	192.16	153	380.92	147.79	40.85	192.28
28	381.77	147.86	40.89	193.03	91	381.34	148.13	40.65	192.56	154	381.06	147.99	40.84	192.24
29	381.34	147.97	40.81	192.56	92	381.83	148.39	40.98	192.46	155	381.43	148.29	40.67	192.46
30	381.49	148.07	40.72	192.70	93	381.96	148.40	40.64	192.92	156	381.24	148.17	40.71	192.37
31	381.69	148.31	41.05	192.32	94	381.30	148.27	40.72	192.30	157	381.28	148.04	40.67	192.57
32	381.32	148.18	40.65	192.49	95	381.40	148.27	40.92	192.20	158	382.42	148.31	40.78	193.33
33	381.03	148.27	40.71	192.05	96	382.19	148.38	40.91	192.90	159	381.54	147.84	40.77	192.92
34	381.54	148.46	40.54	192.54	97	382.02	148.51	40.55	192.96	160	382.02	148.44	40.86	192.71
35	381.63	148.17	40.87	192.59	98	381.31	148.01	40.62	192.68	161	381.83	148.30	40.86	192.67
36	381.54	148.41	40.97	192.16	99	380.93	147.86	40.88	192.19	162	381.77	148.40	40.60	192.78
37	381.64	148.45	40.89	192.29	100	381.68	148.24	40.83	192.61	163	381.65	148.50	40.58	192.56
38	381.65	148.07	40.72	192.86	101	382.05	148.16	40.89	193.00	164	381.08	147.90	40.90	192.27
39	381.97	148.23	40.80	192.94	102	382.40	148.57	40.81	193.02	165	381.91	148.09	40.70	193.13
40	381.22	148.24	40.61	192.37	103	382.26	148.25	40.83	193.18	166	381.94	148.41	40.76	192.77
41	381.22	147.95	40.69	192.58	104	382.27	148.06	40.74	193.47	167	382.28	148.37	41.01	192.90
42	381.76	148.47	40.64	192.65	105	381.86	148.17	40.77	192.91	168	380.82	148.37	40.52	191.92
43	380.55	148.01	40.64	191.90	106	381.32	148.20	40.71	192.42	169	381.48	148.19	40.78	192.51
44	382.07	148.36	40.92	192.79	107	381.64	148.03	40.66	192.95	170	381.63	148.04	40.73	192.86
45	381.78	147.89	40.85	193.04	108	381.66	148.03	40.77	192.86	171	381.06	147.73	40.77	192.57
46	381.22	148.25	40.58	192.39	109	382.62	148.54	40.76	193.32	172	375.87	145.72	40.18	189.97
47	381.14	148.09	40.49	192.56	110	381.64	148.07	40.64	192.94	173	382.84	148.35	40.87	193.62
48	381.77	148.18	40.82	192.76	111	381.84	148.09	40.72	193.04	174	384.51	149.25	41.12	194.14
49	381.26	148.40	40.70	192.16	112	380.99	147.95	40.85	192.19	175	383.60	148.83	41.04	193.73
50	381.40	147.85	40.82	192.73	113	381.42	148.02	40.63	192.77	176	381.12	148.17	40.56	192.39
51	382.51	148.52	40.79	193.20	114	381.58	148.17	40.79	192.62	177	381.37	148.27	40.85	192.25
52	382.33	148.33	40.91	193.09	115	381.24	148.15	40.84	192.25	178	381.28	147.94	40.74	192.61
53	381.04	148.09	40.66	192.29	116	381.77	148.20	40.89	192.68	179	382.22	148.25	41.01	192.95
54	382.30	148.04	41.24	193.03	117	381.72	148.10	40.86	192.76	180	381.24	148.41	40.71	192.11
55	381.60	148.12	40.73	192.75	118	381.83	148.35	40.81	192.66	181	381.78	148.25	40.82	192.71
56	381.71	148.34	40.71	192.66	119	381.19	148.04	40.76	192.40	182	381.79	148.01	40.92	192.87
57	381.75	148.24	40.85	192.66	120	381.22	148.06	40.55	192.61	183	381.15	147.99	40.75	192.42
58	381.48	147.93	40.82	192.73	121	382.05	148.18	40.75	193.12	184	381.33	148.04	40.58	192.72
59	381.77	148.02	40.81	192.94	122	381.33	148.19	40.79	192.34					
60	381.91	148.20	40.85	192.86	123	381.88	148.06	40.96	192.86					
61	381.83	148.07	40.95	192.80	124	381.59	148.02	40.78	192.80					
62	381.12	148.08	40.55	192.48	125	381.97	148.16	40.84	192.97					

Sustainability – Data Rate Distribution Graph

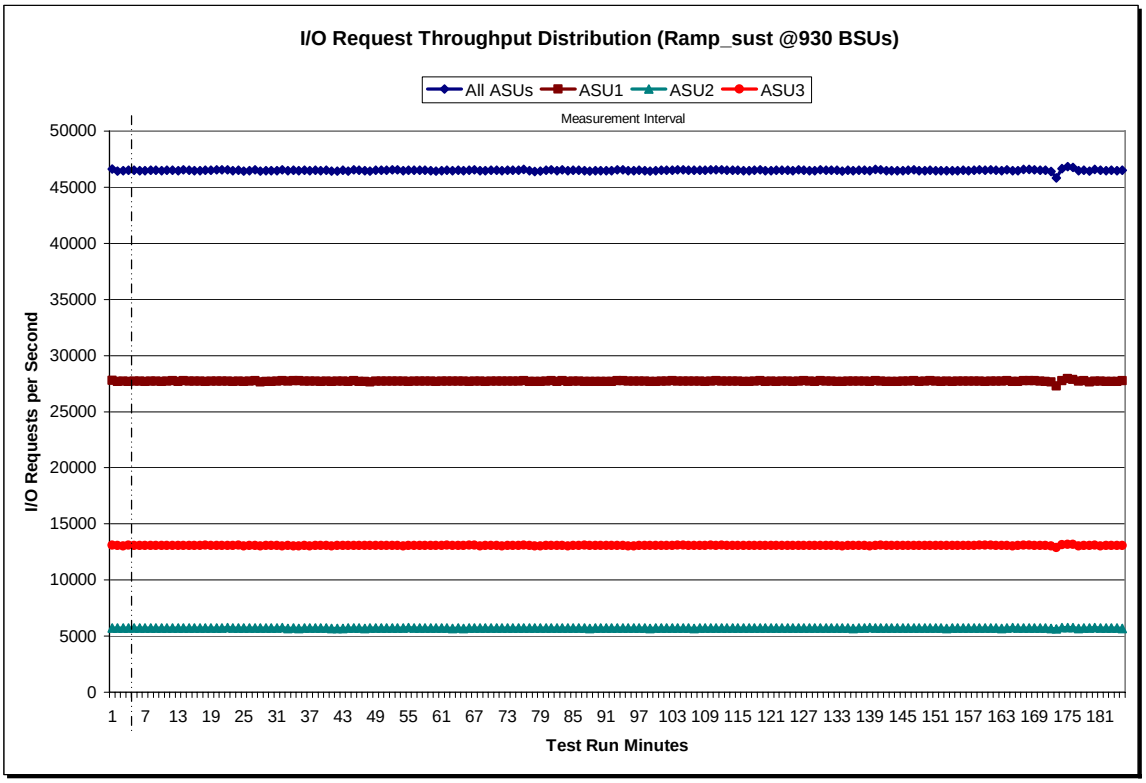


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	7:24:26	7:29:26	0-4	0:05:00
Measurement Interval	7:29:26	10:29:26	5-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2
0	46,632.25	27,805.33	5,734.25	13,092.67	63	46,498.40	27,719.23	5,720.42	13,058.75	126	46,520.72	27,741.47	5,720.42
1	46,454.22	27,686.77	5,718.37	13,049.08	64	46,482.00	27,705.83	5,705.13	13,071.03	127	46,485.10	27,714.77	5,710.60
2	46,489.72	27,732.50	5,724.47	13,032.75	65	46,503.33	27,693.90	5,714.75	13,094.68	128	46,480.37	27,692.40	5,728.03
3	46,499.17	27,694.25	5,706.05	13,098.87	66	46,531.65	27,702.65	5,733.27	13,095.73	129	46,534.08	27,736.50	5,724.07
4	46,520.98	27,731.73	5,711.70	13,077.55	67	46,468.48	27,708.68	5,717.65	13,042.15	130	46,515.35	27,721.08	5,725.10
5	46,486.27	27,703.75	5,725.63	13,056.88	68	46,486.57	27,691.70	5,710.07	13,084.80	131	46,495.80	27,717.07	5,705.97
6	46,487.93	27,694.08	5,724.53	13,069.32	69	46,520.20	27,731.12	5,720.32	13,068.77	132	46,496.58	27,691.75	5,725.37
7	46,514.77	27,728.12	5,714.10	13,072.55	70	46,497.85	27,708.87	5,729.47	13,059.52	133	46,438.10	27,697.05	5,714.92
8	46,504.63	27,713.08	5,722.37	13,069.18	71	46,479.77	27,710.02	5,722.08	13,047.67	134	46,505.22	27,717.02	5,717.78
9	46,465.93	27,685.22	5,716.75	13,063.97	72	46,505.87	27,712.40	5,721.30	13,072.17	135	46,486.10	27,704.28	5,705.20
10	46,499.70	27,711.60	5,713.32	13,074.78	73	46,513.72	27,732.58	5,729.02	13,052.12	136	46,511.10	27,701.97	5,735.10
11	46,515.08	27,745.53	5,716.13	13,053.42	74	46,500.90	27,717.58	5,720.03	13,063.28	137	46,494.20	27,713.77	5,717.32
12	46,478.30	27,697.83	5,718.55	13,061.92	75	46,566.48	27,736.47	5,735.33	13,094.68	138	46,457.18	27,689.60	5,742.28
13	46,527.70	27,742.05	5,718.80	13,066.85	76	46,478.52	27,693.63	5,710.82	13,074.07	139	46,566.85	27,760.43	5,734.78
14	46,517.05	27,731.67	5,730.85	13,054.53	77	46,410.93	27,669.57	5,707.42	13,033.95	140	46,528.68	27,701.98	5,721.05
15	46,471.32	27,701.03	5,713.23	13,057.05	78	46,453.83	27,688.73	5,721.43	13,043.67	141	46,480.05	27,695.95	5,708.40
16	46,482.53	27,705.22	5,715.67	13,061.65	79	46,516.38	27,735.42	5,711.32	13,069.65	142	46,456.42	27,689.50	5,716.87
17	46,491.48	27,677.42	5,726.35	13,087.72	80	46,544.87	27,738.98	5,726.62	13,079.27	143	46,465.37	27,686.70	5,713.57
18	46,497.28	27,700.45	5,715.15	13,081.68	81	46,477.57	27,698.48	5,715.28	13,063.80	144	46,489.58	27,715.45	5,721.98
19	46,533.48	27,727.40	5,728.90	13,077.18	82	46,528.85	27,736.73	5,734.23	13,057.88	145	46,504.52	27,711.62	5,722.68
20	46,527.70	27,722.25	5,729.22	13,076.23	83	46,462.15	27,692.40	5,723.03	13,046.72	146	46,535.95	27,738.92	5,725.45
21	46,533.38	27,714.10	5,751.22	13,068.07	84	46,494.95	27,723.62	5,715.28	13,056.05	147	46,480.60	27,688.83	5,719.58
22	46,484.05	27,689.07	5,727.23	13,067.75	85	46,499.17	27,718.78	5,707.73	13,072.65	148	46,477.85	27,718.52	5,709.57
23	46,514.53	27,715.60	5,710.40	13,088.53	86	46,483.95	27,679.62	5,711.40	13,092.93	149	46,509.37	27,737.25	5,721.08
24	46,444.28	27,696.42	5,709.75	13,038.12	87	46,438.78	27,673.97	5,703.08	13,061.73	150	46,488.00	27,724.68	5,710.52
25	46,481.28	27,701.02	5,720.25	13,060.02	88	46,480.95	27,698.50	5,716.62	13,065.83	151	46,473.82	27,699.65	5,713.52
26	46,539.57	27,736.32	5,722.03	13,081.22	89	46,472.92	27,693.27	5,720.38	13,059.27	152	46,485.87	27,717.28	5,694.13
27	46,421.03	27,658.02	5,733.67	13,029.35	90	46,463.90	27,678.72	5,732.33	13,052.85	153	46,467.73	27,692.82	5,716.20
28	46,487.63	27,697.42	5,728.03	13,062.18	91	46,489.28	27,699.08	5,706.58	13,083.62	154	46,476.85	27,705.75	5,711.00
29	46,482.43	27,679.10	5,723.52	13,079.82	92	46,540.12	27,755.15	5,715.82	13,069.15	155	46,492.38	27,720.47	5,712.88
30	46,490.23	27,710.05	5,714.75	13,065.43	93	46,533.27	27,744.12	5,711.38	13,077.77	156	46,479.38	27,705.35	5,717.57
31	46,541.67	27,746.80	5,745.93	13,048.93	94	46,471.95	27,715.05	5,711.35	13,045.55	157	46,496.97	27,700.73	5,723.47
32	46,489.03	27,711.23	5,701.92	13,075.88	95	46,465.58	27,719.18	5,725.98	13,020.42	158	46,535.13	27,716.98	5,728.60
33	46,494.48	27,743.55	5,715.33	13,035.60	96	46,497.87	27,713.62	5,726.02	13,058.23	159	46,491.88	27,669.50	5,730.05
34	46,470.03	27,736.03	5,693.25	13,040.75	97	46,487.28	27,708.98	5,706.33	13,071.97	160	46,539.95	27,735.03	5,717.02
35	46,507.53	27,716.77	5,731.30	13,059.47	98	46,438.40	27,673.77	5,700.92	13,063.72	161	46,525.47	27,723.03	5,739.08
36	46,470.15	27,705.00	5,724.62	13,040.53	99	46,464.53	27,682.92	5,729.85	13,051.77	162	46,480.98	27,734.92	5,695.33
37	46,514.70	27,724.63	5,721.23	13,068.83	100	46,518.40	27,735.60	5,725.08	13,057.72	163	46,554.68	27,768.72	5,715.85
38	46,464.37	27,682.78	5,706.50	13,075.08	101	46,505.87	27,712.93	5,719.57	13,073.37	164	46,467.37	27,674.87	5,746.43
39	46,510.10	27,727.98	5,717.37	13,064.75	102	46,508.55	27,742.65	5,710.73	13,055.17	165	46,470.67	27,697.83	5,716.95
40	46,440.77	27,698.25	5,704.42	13,038.10	103	46,555.85	27,731.82	5,735.72	13,088.32	166	46,562.68	27,739.42	5,732.65
41	46,449.18	27,701.53	5,696.65	13,051.00	104	46,547.70	27,721.67	5,724.50	13,101.53	167	46,562.60	27,739.95	5,731.33
42	46,508.52	27,734.95	5,699.38	13,074.18	105	46,503.80	27,710.78	5,720.47	13,072.55	168	46,542.47	27,759.10	5,719.88
43	46,450.03	27,671.43	5,710.73	13,067.87	106	46,492.42	27,729.38	5,702.13	13,060.90	169	46,501.88	27,721.00	5,726.70
44	46,544.93	27,742.62	5,722.00	13,080.32	107	46,510.03	27,730.77	5,708.27	13,071.00	170	46,493.80	27,692.75	5,723.93
45	46,505.62	27,699.22	5,722.83	13,083.57	108	46,495.70	27,698.95	5,718.02	13,078.73	171	46,387.68	27,643.52	5,704.82
46	46,459.67	27,686.12	5,699.60	13,073.95	109	46,532.98	27,724.45	5,712.70	13,095.83	172	45,817.48	27,297.22	5,637.90
47	46,450.68	27,659.95	5,715.83	13,074.90	110	46,544.32	27,744.42	5,720.63	13,079.27	173	46,634.28	27,765.20	5,744.20
48	46,508.50	27,707.57	5,737.78	13,063.15	111	46,545.18	27,718.12	5,735.37	13,091.70	174	46,837.68	27,918.37	5,759.23
49	46,492.32	27,718.77	5,720.80	13,052.75	112	46,499.40	27,703.10	5,726.12	13,070.18	175	46,773.22	27,847.67	5,766.98
50	46,508.40	27,718.40	5,721.70	13,068.30	113	46,526.23	27,727.73	5,721.50	13,077.00	176	46,468.97	27,728.35	5,702.98
51	46,526.92	27,733.25	5,710.27	13,083.40	114	46,493.02	27,715.45	5,719.63	13,057.93	177	46,514.20	27,737.62	5,709.87
52	46,545.97	27,734.33	5,726.82	13,084.82	115	46,468.28	27,687.27	5,725.20	13,055.82	178	46,445.23	27,657.80	5,715.12
53	46,472.05	27,722.25	5,712.60	13,037.20	116	46,478.92	27,687.90	5,723.83	13,067.18	179	46,564.13	27,732.22	5,741.60
54	46,512.73	27,686.33	5,749.12	13,077.28	117	46,490.75	27,704.08	5,727.70	13,058.97	180	46,497.55	27,730.98	5,730.42
55	46,514.92	27,712.87	5,725.58	13,076.47	118	46,528.38	27,739.68	5,721.28	13,067.42	181	46,472.07	27,697.08	5,713.52
56	46,498.80	27,711.25	5,722.83	13,064.72	119	46,474.55	27,690.53	5,722.50	13,061.52	182	46,490.92	27,682.23	5,736.58
57	46,505.93	27,702.17	5,736.42	13,067.35	120	46,485.23	27,700.60	5,717.72	13,066.92	183	46,459.70	27,685.07	5,721.78
58	46,474.17	27,706.37	5,705.88	13,061.92	121	46,492.87	27,696.55	5,721.18	13,075.13	184	46,519.03	27,735.88	5,701.50
59	46,451.18	27,666.60	5,713.63	13,070.95	122	46,524.17	27,713.32	5,727.12	13,083.73	**Average**	**46,496.93**	**27,710.60**	**5,719.87**
60	46,489.53	27,700.58	5,727.32	13,061.63	123	46,517.03	27,707.80	5,738.83	13,070.40				
61	46,522.92	27,708.45	5,728.85	13,085.62	124	46,476.17	27,687.20	5,720.43	13,068.53				
62	46,483.78	27,725.38	5,698.58	13,059.82	125	46,532.52	27,732.20	5,726.07	13,074.25				

Sustainability – I/O Request Throughput Distribution Graph

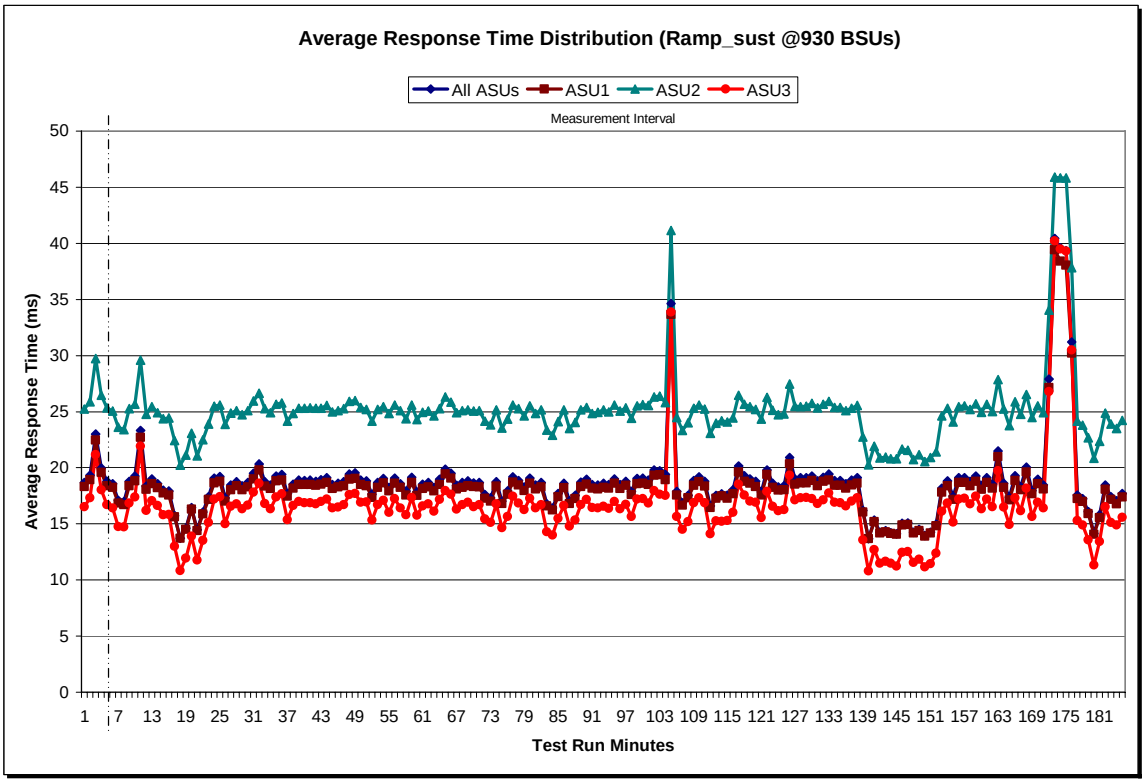


Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	7:24:26	7:29:26	0-4	0:05:00
Measurement Interval	7:29:26	10:29:26	5-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	18.67	18.33	25.25	16.52	63	18.95	18.50	25.26	17.16	126	18.99	18.53	25.47	17.12
1	19.33	18.92	25.88	17.33	64	19.87	19.43	26.33	17.96	127	19.12	18.66	25.45	17.31
2	23.00	22.47	29.74	21.16	65	19.50	19.07	25.83	17.63	128	19.13	18.65	25.50	17.35
3	19.98	19.57	26.45	18.03	66	18.44	18.11	24.90	16.31	129	19.26	18.86	25.75	17.25
4	18.77	18.41	25.33	16.69	67	18.67	18.27	25.08	16.70	130	18.82	18.41	25.36	16.81
5	18.56	18.24	25.06	16.41	68	18.82	18.40	25.17	16.93	131	19.16	18.78	25.66	17.13
6	17.09	16.83	23.62	14.76	69	18.63	18.31	25.04	16.51	132	19.45	18.91	25.91	17.76
7	16.98	16.71	23.41	14.73	70	18.67	18.28	25.09	16.69	133	18.87	18.44	25.37	16.91
8	18.81	18.39	25.27	16.85	71	17.61	17.29	24.17	15.43	134	18.85	18.42	25.37	16.89
9	19.27	18.83	25.65	17.40	72	17.32	17.02	23.82	15.11	135	18.59	18.18	25.10	16.61
10	23.33	22.71	29.57	21.93	73	18.75	18.36	25.17	16.76	136	18.91	18.48	25.31	17.02
11	18.36	18.06	24.77	16.20	74	17.03	16.80	23.54	14.65	137	19.11	18.62	25.57	17.32
12	19.00	18.58	25.45	17.08	75	17.92	17.65	24.33	15.66	138	16.20	16.07	22.73	13.59
13	18.58	18.20	24.92	16.62	76	19.20	18.71	25.61	17.46	139	13.68	13.68	20.25	10.80
14	18.01	17.73	24.37	15.81	77	18.86	18.47	25.27	16.86	140	15.32	15.19	21.93	12.71
15	17.93	17.58	24.44	15.84	78	18.30	17.95	24.63	16.25	141	14.24	14.18	20.87	11.47
16	15.72	15.61	22.43	13.01	79	19.09	18.63	25.51	17.28	142	14.38	14.30	20.97	11.67
17	13.70	13.71	20.22	10.82	80	18.45	18.09	24.83	16.43	143	14.22	14.16	20.81	11.47
18	14.60	14.51	21.13	11.96	81	18.70	18.30	25.17	16.71	144	14.11	14.08	20.81	11.23
19	16.46	16.31	23.08	13.90	82	16.78	16.60	23.37	14.29	145	15.04	14.89	21.66	12.45
20	14.48	14.40	21.08	11.77	83	16.43	16.24	22.89	14.00	146	15.09	14.96	21.56	12.53
21	16.05	15.88	22.50	13.55	84	17.71	17.43	24.12	15.49	147	14.25	14.17	20.74	11.56
22	17.41	17.15	23.91	15.12	85	18.63	18.23	25.14	16.62	148	14.51	14.38	21.18	11.85
23	19.09	18.65	25.50	17.22	86	17.07	16.82	23.51	14.79	149	13.95	13.91	20.54	11.16
24	19.24	18.78	25.61	17.42	87	17.54	17.24	24.06	15.34	150	14.25	14.20	20.91	11.46
25	17.30	17.03	23.88	15.01	88	18.72	18.34	25.16	16.72	151	14.96	14.83	21.43	12.40
26	18.47	18.04	24.88	16.57	89	18.99	18.52	25.39	17.16	152	18.18	17.83	24.63	16.12
27	18.75	18.38	25.08	16.76	90	18.51	18.16	24.84	16.46	153	18.81	18.40	25.31	16.85
28	18.39	18.04	24.75	16.34	91	18.46	18.09	24.96	16.42	154	17.46	17.18	24.09	15.15
29	18.67	18.30	25.09	16.65	92	18.62	18.24	25.17	16.56	155	19.10	18.68	25.44	17.22
30	19.52	18.99	25.95	17.84	93	18.50	18.17	24.99	16.36	156	19.12	18.67	25.53	17.27
31	20.32	19.82	26.62	18.62	94	19.01	18.61	25.59	16.98	157	18.78	18.40	25.19	16.76
32	18.77	18.36	25.27	16.80	95	18.50	18.15	25.05	16.34	158	19.25	18.78	25.69	17.45
33	18.46	18.13	24.92	16.33	96	18.80	18.43	25.33	16.74	159	18.42	18.06	24.95	16.33
34	19.25	18.81	25.65	17.40	97	17.89	17.61	24.39	15.65	160	19.13	18.68	25.66	17.22
35	19.41	18.91	25.77	17.66	98	19.03	18.56	25.51	17.19	161	18.55	18.17	25.01	16.53
36	17.70	17.47	24.15	15.37	99	19.09	18.61	25.63	17.23	162	21.49	20.99	27.88	19.74
37	18.55	18.17	24.82	16.64	100	18.90	18.50	25.54	16.83	163	18.61	18.24	25.22	16.49
38	18.91	18.49	25.29	17.00	101	19.81	19.34	26.31	17.96	164	17.34	17.14	23.77	14.95
39	18.87	18.49	25.30	16.87	102	19.74	19.37	26.37	17.63	165	19.28	18.85	25.87	17.31
40	18.89	18.52	25.35	16.87	103	19.39	18.94	25.82	17.52	166	18.33	18.03	24.77	16.16
41	18.80	18.42	25.30	16.78	104	34.63	33.64	41.15	33.86	167	20.06	19.61	26.53	18.18
42	18.93	18.53	25.31	17.00	105	17.89	17.58	24.48	15.66	168	17.95	17.68	24.49	15.66
43	19.12	18.68	25.55	17.22	106	16.88	16.67	23.32	14.52	169	18.96	18.57	25.52	16.91
44	18.50	18.14	24.99	16.42	107	17.54	17.30	24.03	15.19	170	18.46	18.09	24.92	16.41
45	18.62	18.29	25.07	16.48	108	18.85	18.44	25.32	16.88	171	27.88	27.13	34.04	26.78
46	18.75	18.38	25.26	16.70	109	19.18	18.74	25.59	17.32	172	40.44	39.41	45.91	40.23
47	19.44	18.96	25.90	17.60	110	18.79	18.35	25.24	16.88	173	39.61	38.39	45.83	39.48
48	19.54	19.06	25.99	17.72	111	16.61	16.45	23.09	14.12	174	39.35	38.04	45.83	39.30
49	18.91	18.51	25.40	16.93	112	17.54	17.29	23.97	15.26	175	31.22	30.19	37.82	30.51
50	18.83	18.40	25.20	16.94	113	17.69	17.51	24.20	15.24	176	17.55	17.25	24.15	15.31
51	17.63	17.36	24.17	15.34	114	17.56	17.29	24.08	15.28	177	17.24	16.99	23.78	14.92
52	18.68	18.26	25.19	16.71	115	18.05	17.69	24.45	16.01	178	16.09	15.92	22.69	13.58
53	19.05	18.65	25.44	17.09	116	20.16	19.61	26.46	18.55	179	14.15	14.08	20.85	11.34
54	18.24	17.92	24.86	16.02	117	19.30	18.80	25.67	17.55	180	15.80	15.56	22.35	13.43
55	19.10	18.62	25.59	17.26	118	19.00	18.60	25.45	17.03	181	18.48	18.08	24.89	16.52
56	18.58	18.26	25.09	16.42	119	18.78	18.34	25.19	16.92	182	17.43	17.18	23.91	15.13
57	17.91	17.56	24.37	15.81	120	17.84	17.58	24.34	15.54	183	17.08	16.78	23.51	14.90
58	19.17	18.69	25.59	17.36	121	19.81	19.39	26.27	17.88	184	17.72	17.38	24.24	15.59
59	17.87	17.53	24.31	15.76	122	18.63	18.26	25.13	16.56	**Average**	**18.69**	**18.33**	**25.16**	**16.64**
60	18.54	18.13	24.94	16.59	123	18.30	17.98	24.72	16.15					
61	18.70	18.29	25.07	16.77	124	18.38	18.04	24.81	16.28					
62	18.24	17.92	24.63	16.12	125	20.93	20.34	27.46	19.33					

Sustainability – Average Response Time (ms) Distribution Graph



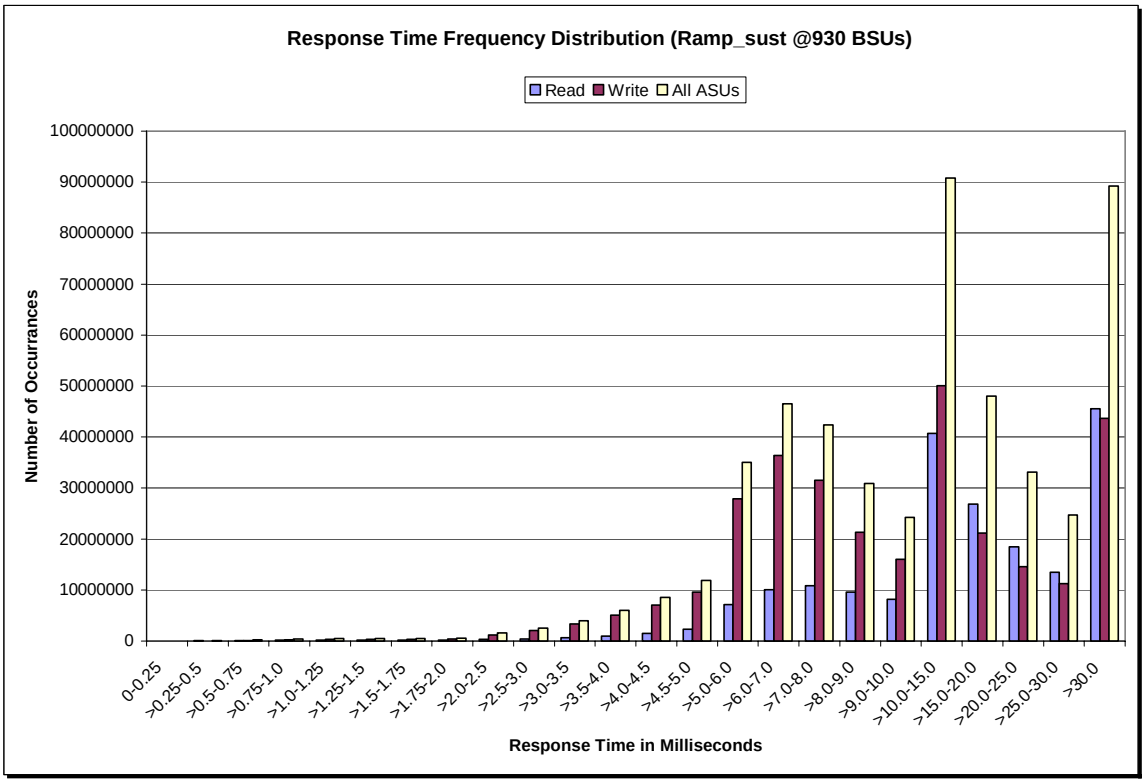
Sustainability – Response Time Frequency Distribution Data

Response	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	3,401	41,487	113,790	142,058	154,739	153,381	165,261	173,496
Write	-	20,067	98,718	246,744	353,797	351,434	343,656	408,634
All ASUs	3,401	61,554	212,508	388,802	508,536	504,815	508,917	582,130
ASU1	3,224	49,664	158,153	254,314	311,887	305,563	308,571	341,236
ASU2	177	5,557	19,819	38,800	50,861	50,890	52,403	61,457
ASU3	-	6,333	34,536	95,688	145,788	148,362	147,943	179,437

Response	>2.0-2.5	>2.5-3.0	>3.0-3.5	>3.5-4.0	>4.0-4.5	>4.5-5.0	>5.0-6.0	>6.0-7.0
Read	355,775	432,314	622,989	973,089	1,521,960	2,259,905	7,135,656	10,079,451
Write	1,224,671	2,073,659	3,323,870	5,048,590	7,054,199	9,614,088	27,899,173	36,403,661
All ASUs	1,580,446	2,505,973	3,946,859	6,021,679	8,576,159	11,873,993	35,034,829	46,483,112
ASU1	872,221	1,327,914	2,080,598	3,185,561	4,596,601	6,416,095	19,029,713	25,289,321
ASU2	169,123	264,862	409,358	609,620	847,972	1,157,904	3,432,667	4,617,743
ASU3	539,102	913,197	1,456,903	2,226,498	3,131,586	4,299,994	12,572,449	16,576,048

Response	>7.0-8.0	>8.0-9.0	>9.0-10.0	>10.0-15.0	>15.0-20.0	>20.0-25.0	>25.0-30.0	>30.0
Read	10,883,655	9,587,266	8,181,483	40,729,857	26,828,849	18,494,435	13,483,787	45,524,085
Write	31,521,473	21,350,821	16,043,911	50,050,146	21,154,715	14,604,924	11,237,389	43,695,599
All ASUs	42,405,128	30,938,087	24,225,394	90,780,003	47,983,564	33,099,359	24,721,176	89,219,684
ASU1	23,642,213	17,891,827	14,280,461	57,670,911	32,440,779	22,056,308	16,013,500	50,747,488
ASU2	4,261,996	3,184,822	2,527,533	9,890,836	5,656,007	4,176,500	3,358,932	16,928,613
ASU3	14,500,919	9,861,438	7,417,400	23,218,256	9,886,778	6,866,551	5,348,744	21,543,583

Sustainability – Response Time Frequency Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

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

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

Primary Metrics Test – IOPS Test Phase

Clause 5.4.2.2

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

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

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

Clause 9.2.4.7.2

For the IOPS Test Phase the FDR shall contain:

1. *I/O Request Throughput Distribution (data and graph).*
2. *A Response Time Frequency Distribution.*
3. *An Average Response Time Distribution.*
4. *The human readable Test Run Results File produced by the Workload Generator.*
5. *A listing or screen image of all input parameters supplied t the Workload Generator.*
6. *The total number of I/O Requests completed in the Measurement Interval as well as the number of I/O Requests with a Response Time less than or equal to 30 milliseconds and the number of I/O Requests with a Response Time greater than 30 milliseconds.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 74.

IOPS Test Results File

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

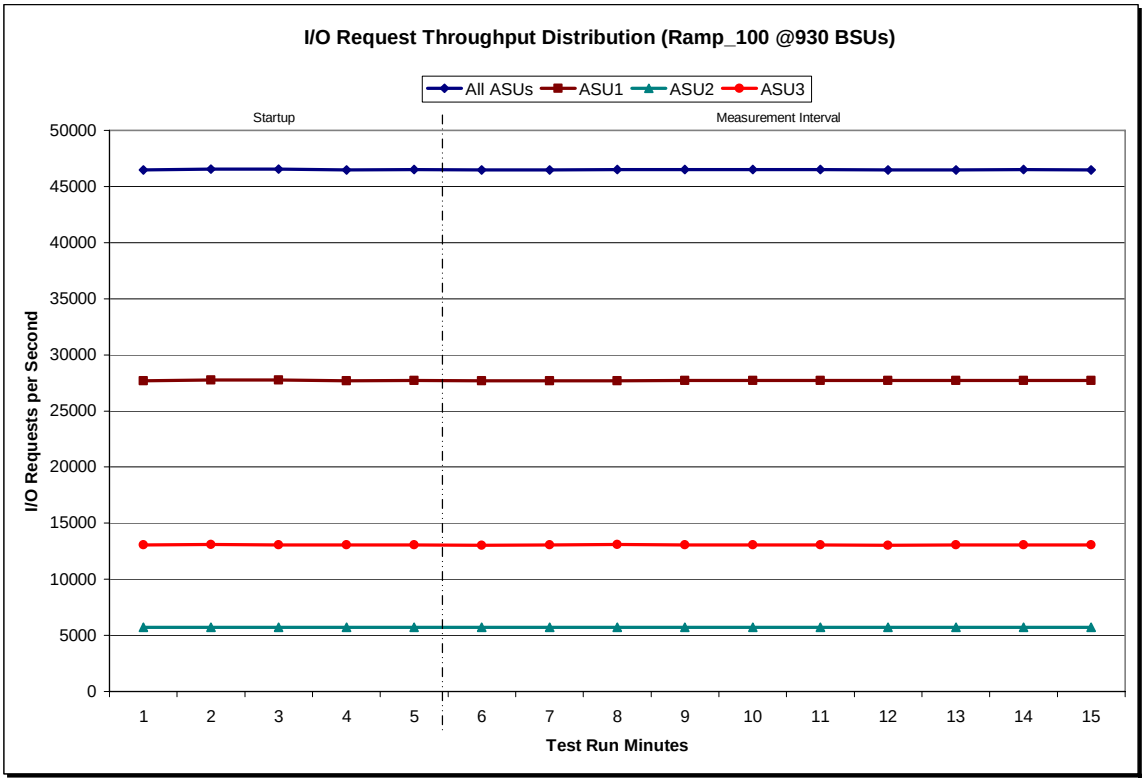
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

930 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:29:59	10:35:00	0-4	0:05:01
Measurement Interval	10:35:00	10:45:00	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	46,480.48	27,692.45	5,707.20	13,080.83
1	46,536.77	27,743.57	5,706.52	13,086.68
2	46,544.00	27,749.45	5,735.57	13,058.98
3	46,486.37	27,697.13	5,725.30	13,063.93
4	46,512.65	27,729.87	5,733.13	13,049.65
5	46,464.30	27,689.30	5,731.48	13,043.52
6	46,488.38	27,696.73	5,729.40	13,062.25
7	46,516.98	27,679.20	5,739.83	13,097.95
8	46,515.38	27,732.08	5,717.13	13,066.17
9	46,500.70	27,705.80	5,718.12	13,076.78
10	46,519.63	27,730.15	5,722.27	13,067.22
11	46,457.67	27,718.07	5,707.70	13,031.90
12	46,472.97	27,706.65	5,709.27	13,057.05
13	46,518.27	27,715.87	5,731.22	13,071.18
14	46,462.87	27,703.23	5,708.87	13,050.77
Average	46,491.72	27,707.71	5,721.53	13,062.48

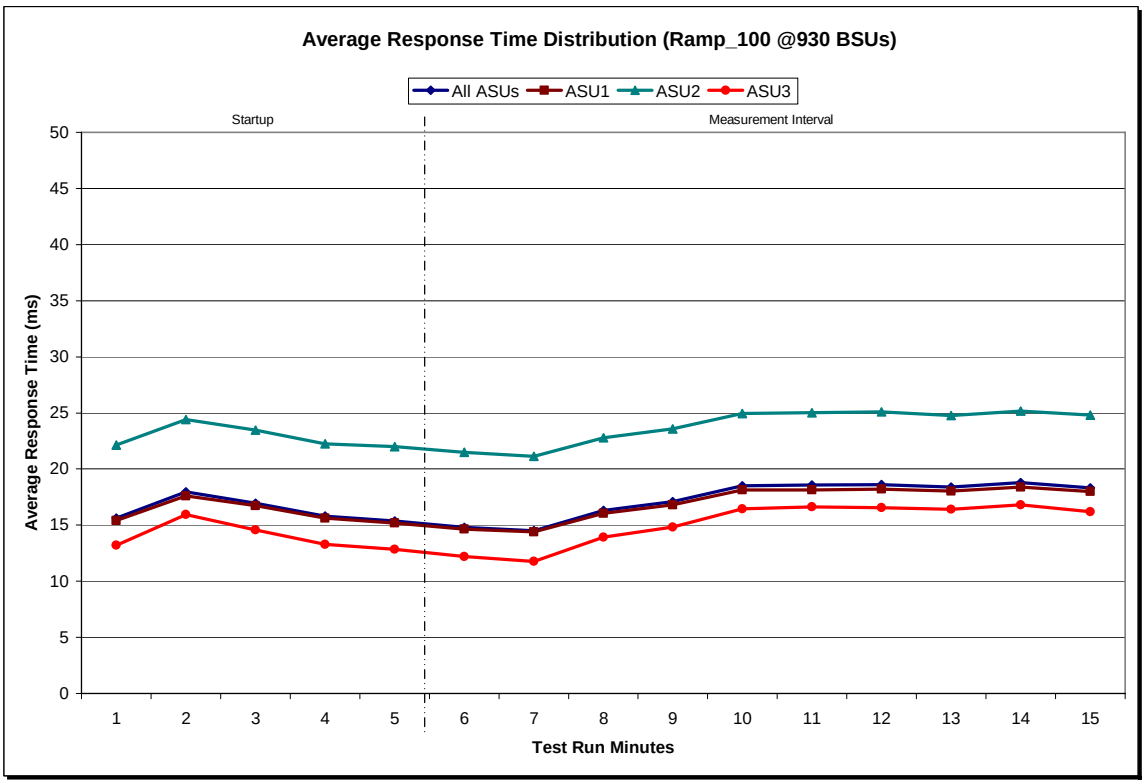
IOPS Test Run – I/O Request Throughput Distribution Graph



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

930 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:29:59	10:35:00	0-4	0:05:01
Measurement Interval	10:35:00	10:45:00	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	15.63	15.42	22.15	13.22
1	17.98	17.62	24.42	15.94
2	16.97	16.75	23.48	14.57
3	15.79	15.63	22.26	13.30
4	15.38	15.20	21.98	12.85
5	14.81	14.64	21.50	12.21
6	14.50	14.41	21.14	11.78
7	16.29	16.06	22.80	13.93
8	17.09	16.82	23.58	14.83
9	18.49	18.13	24.95	16.45
10	18.58	18.16	25.03	16.64
11	18.60	18.22	25.09	16.55
12	18.40	18.02	24.78	16.41
13	18.78	18.39	25.17	16.79
14	18.33	18.00	24.81	16.20
Average	17.39	17.08	23.89	15.18

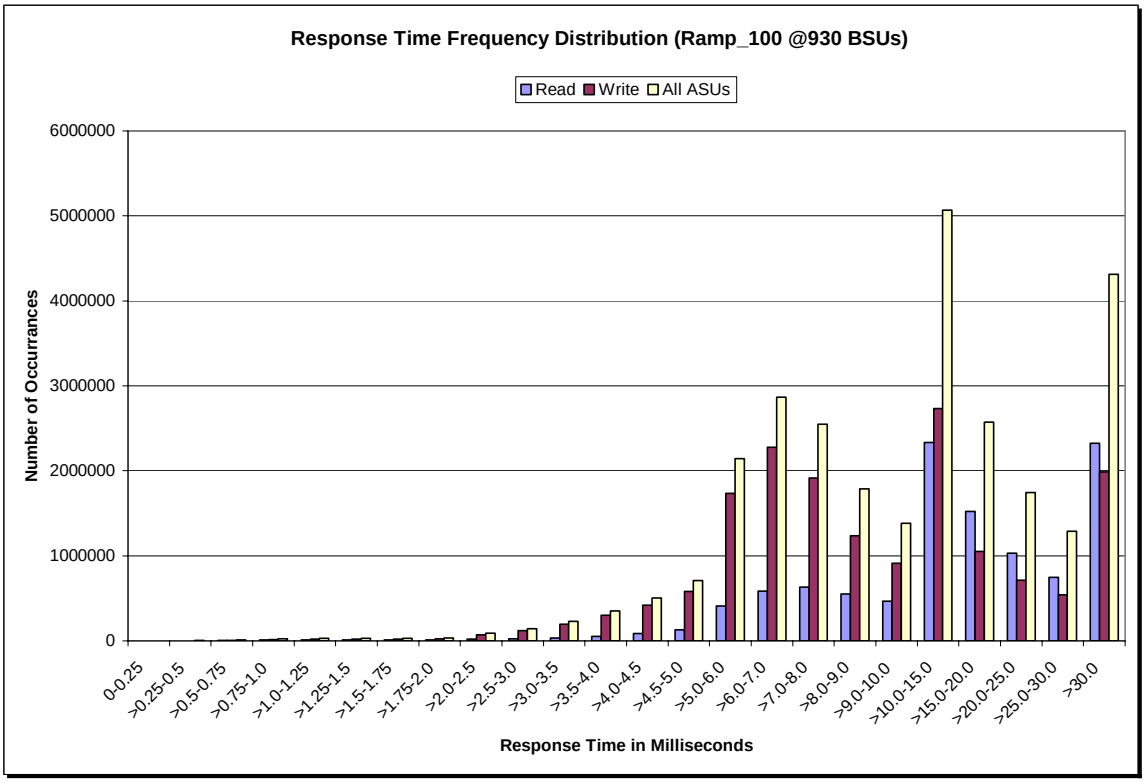
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	107	1,980	6,382	8,682	9,050	9,029	9,684	10,224
Write	0	721	4,759	13,820	20,191	20,221	19,557	22,931
All ASUs	107	2,701	11,141	22,502	29,241	29,250	29,241	33,155
ASU1	104	2,265	8,546	14,973	18,074	17,928	17,938	19,643
ASU2	3	225	1,053	2,260	2,911	2,924	2,992	3,537
ASU3	0	211	1,542	5,269	8,256	8,398	8,311	9,975
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	20,289	24,106	34,544	53,978	84,838	126,876	407,457	586,850
Write	69,788	120,758	194,683	297,554	419,427	582,100	1,735,655	2,279,010
All ASUs	90,077	144,864	229,227	351,532	504,265	708,976	2,143,112	2,865,860
ASU1	49,898	76,083	120,565	184,971	267,795	378,638	1,152,260	1,544,568
ASU2	9,600	15,312	23,975	35,594	50,398	70,030	210,216	284,198
ASU3	30,579	53,469	84,687	130,967	186,072	260,308	780,636	1,037,094
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	632,520	551,194	466,062	2,332,579	1,522,418	1,031,070	744,242	2,325,199
Write	1,915,752	1,236,235	915,171	2,733,919	1,051,328	713,004	542,864	1,985,597
All ASUs	2,548,272	1,787,429	1,381,233	5,066,498	2,573,746	1,744,074	1,287,106	4,310,796
ASU1	1,410,111	1,032,477	815,063	3,244,546	1,775,088	1,183,051	846,427	2,443,261
ASU2	255,337	183,104	143,003	549,418	306,461	225,208	180,825	874,252
ASU3	882,824	571,848	423,167	1,272,534	492,197	335,815	259,854	993,283

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
27,894,405	23,583,609	4,310,796

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2811	0.0700	0.2099	0.0180	0.0701	0.0350	0.2810
COV	0.004	0.001	0.003	0.001	0.003	0.003	0.002	0.001

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.2.3

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

The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 12.

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

Clause 9.2.4.7.3

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

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 74.

Response Time Ramp Test Results File

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

95% Load Level

90% Load Level

80% Load Level

50% Load Level

10% Load Level

Response Time Ramp Distribution (IOPS) Data

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

100% Load Level - 930 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:29:59	10:35:00	0-4	0:05:01
Measurement Interval	10:35:00	10:45:00	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	46,480.48	27,692.45	5,707.20	13,080.83
1	46,536.77	27,743.57	5,706.52	13,086.68
2	46,544.00	27,749.45	5,735.57	13,058.98
3	46,486.37	27,697.13	5,725.30	13,063.93
4	46,512.65	27,729.87	5,733.13	13,049.65
5	46,464.30	27,689.30	5,731.48	13,043.52
6	46,488.38	27,696.73	5,729.40	13,062.25
7	46,516.98	27,679.20	5,739.83	13,097.95
8	46,515.38	27,732.08	5,717.13	13,066.17
9	46,500.70	27,705.80	5,718.12	13,076.78
10	46,519.63	27,730.15	5,722.27	13,067.22
11	46,457.67	27,718.07	5,707.70	13,031.90
12	46,472.97	27,706.65	5,709.27	13,057.05
13	46,518.27	27,715.87	5,731.22	13,071.18
14	46,462.87	27,703.23	5,708.87	13,050.77
Average	46,491.72	27,707.71	5,721.53	13,062.48

95% Load Level - 883 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:45:19	10:50:20	0-4	0:05:01
Measurement Interval	10:50:20	11:00:20	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	44,160.70	26,309.70	5,438.87	12,412.13
1	44,109.95	26,281.58	5,435.38	12,392.98
2	44,197.25	26,318.12	5,442.03	12,437.10
3	44,092.80	26,290.48	5,430.30	12,372.02
4	44,133.73	26,292.13	5,422.83	12,418.77
5	44,143.32	26,301.65	5,425.83	12,415.83
6	44,130.63	26,312.88	5,420.03	12,397.72
7	44,154.65	26,297.60	5,434.53	12,422.52
8	44,185.30	26,352.93	5,417.22	12,415.15
9	44,145.12	26,310.45	5,418.48	12,416.18
10	44,163.07	26,303.00	5,443.63	12,416.43
11	44,174.30	26,324.72	5,412.32	12,437.27
12	44,113.93	26,259.90	5,426.37	12,427.67
13	44,150.03	26,304.45	5,436.40	12,409.18
14	44,140.30	26,299.22	5,435.08	12,406.00
Average	44,150.07	26,306.68	5,426.99	12,416.40

90% Load Level - 837 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:00:38	11:05:39	0-4	0:05:01
Measurement Interval	11:05:39	11:15:39	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	41,842.65	24,934.35	5,146.48	11,761.82
1	41,844.40	24,915.08	5,156.05	11,773.27
2	41,881.90	24,960.62	5,148.68	11,772.60
3	41,807.92	24,912.07	5,137.10	11,758.75
4	41,827.15	24,926.47	5,145.35	11,755.33
5	41,848.07	24,931.43	5,157.37	11,759.27
6	41,882.48	24,966.50	5,152.27	11,763.72
7	41,844.80	24,969.08	5,140.65	11,735.07
8	41,865.25	24,966.17	5,163.40	11,735.68
9	41,821.32	24,940.67	5,142.95	11,737.70
10	41,898.65	24,957.00	5,157.08	11,784.57
11	41,869.93	24,951.45	5,144.23	11,774.25
12	41,831.17	24,933.58	5,142.95	11,754.63
13	41,820.93	24,937.03	5,147.68	11,736.22
14	41,843.57	24,945.58	5,137.40	11,760.58
Average	41,852.62	24,949.85	5,148.60	11,754.17

80% Load Level - 720 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:15:56	11:20:57	0-4	0:05:01
Measurement Interval	11:20:57	11:30:57	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	37,254.23	22,187.72	4,583.07	10,483.45
1	37,186.63	22,159.88	4,579.47	10,447.28
2	37,243.65	22,201.05	4,585.28	10,457.32
3	37,162.58	22,141.97	4,567.35	10,453.27
4	37,209.20	22,177.90	4,566.78	10,464.52
5	37,255.95	22,206.27	4,579.50	10,470.18
6	37,182.92	22,158.52	4,579.22	10,445.18
7	37,239.53	22,206.75	4,570.75	10,462.03
8	37,189.73	22,150.33	4,586.25	10,453.15
9	37,213.40	22,181.42	4,587.52	10,444.47
10	37,202.50	22,203.67	4,564.47	10,434.37
11	37,159.42	22,149.05	4,571.20	10,439.17
12	37,184.53	22,169.65	4,560.57	10,454.32
13	37,205.60	22,183.07	4,572.12	10,450.42
14	37,222.48	22,176.38	4,570.18	10,475.92
Average	37,205.61	22,178.51	4,574.18	10,452.92

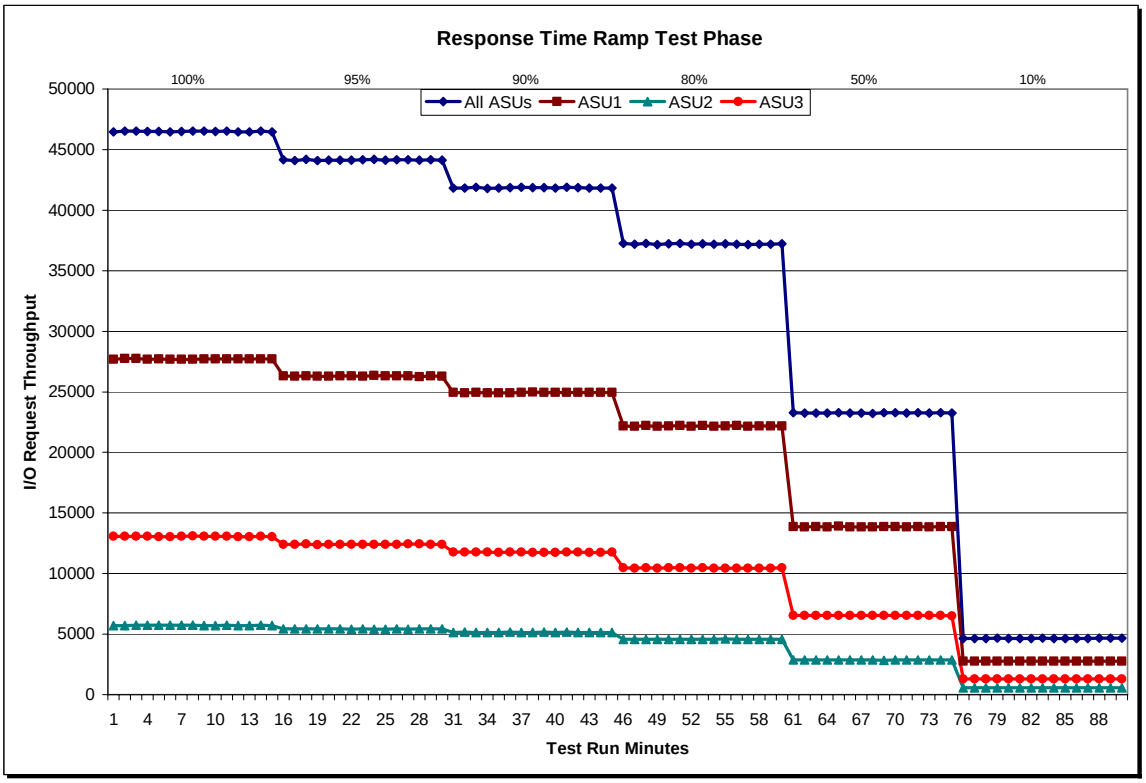
50% Load Level - 465 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:31:13	11:36:14	0-4	0:05:01
Measurement Interval	11:36:14	11:46:14	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	23,267.60	13,881.30	2,862.38	6,523.92
1	23,241.10	13,841.57	2,865.48	6,534.05
2	23,262.40	13,862.08	2,864.60	6,535.72
3	23,237.10	13,853.62	2,852.82	6,530.67
4	23,280.83	13,895.92	2,860.08	6,524.83
5	23,250.50	13,857.73	2,859.90	6,532.87
6	23,233.48	13,842.40	2,860.18	6,530.90
7	23,227.55	13,834.12	2,860.95	6,532.48
8	23,270.62	13,870.42	2,851.75	6,548.45
9	23,266.35	13,867.70	2,853.70	6,544.95
10	23,244.93	13,852.75	2,855.27	6,536.92
11	23,269.58	13,863.37	2,874.42	6,531.80
12	23,245.52	13,854.50	2,862.08	6,528.93
13	23,271.00	13,875.03	2,853.05	6,542.92
14	23,253.02	13,865.50	2,875.85	6,511.67
Average	23,253.26	13,858.35	2,860.72	6,534.19

10% Load Level - 90 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:46:27	11:51:28	0-4	0:05:01
Measurement Interval	11:51:28	12:01:28	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	4,646.27	2,771.42	571.73	1,303.12
1	4,646.02	2,773.15	569.90	1,302.97
2	4,641.10	2,763.05	576.13	1,301.92
3	4,660.07	2,774.77	573.98	1,311.32
4	4,636.75	2,761.30	568.18	1,307.27
5	4,645.58	2,766.62	571.62	1,307.35
6	4,652.90	2,775.55	568.73	1,308.62
7	4,659.07	2,780.92	572.42	1,305.73
8	4,644.10	2,767.15	572.73	1,304.22
9	4,639.00	2,769.33	572.63	1,297.03
10	4,646.75	2,773.63	571.60	1,301.52
11	4,650.15	2,774.90	571.50	1,303.75
12	4,658.20	2,779.03	573.53	1,305.63
13	4,658.25	2,769.63	579.50	1,309.12
14	4,656.08	2,776.73	568.73	1,310.62
Average	4,651.01	2,773.35	572.30	1,305.36

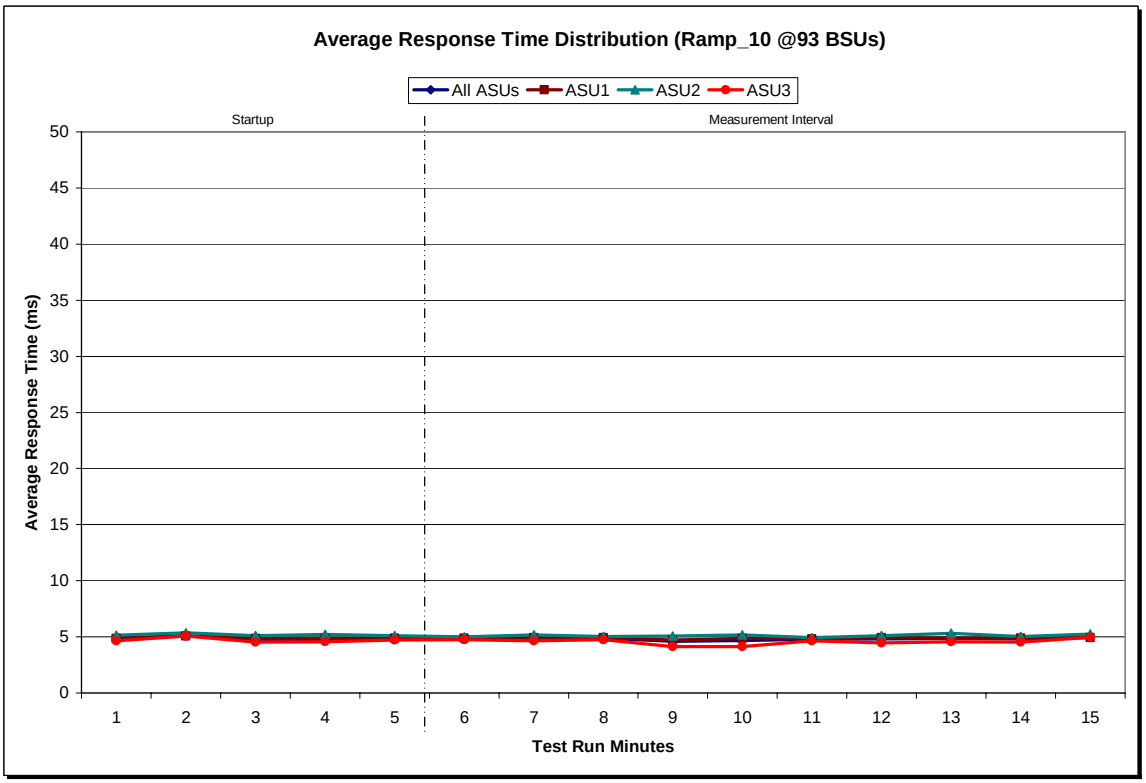
Response Time Ramp Distribution (IOPS) Graph



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

93 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:46:27	11:51:28	0-4	0:05:01
Measurement Interval	11:51:28	12:01:28	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	4.84	4.88	5.14	4.65
1	5.11	5.09	5.35	5.06
2	4.80	4.85	5.12	4.55
3	4.80	4.81	5.24	4.56
4	4.88	4.90	5.10	4.72
5	4.86	4.88	4.99	4.75
6	4.88	4.92	5.19	4.64
7	4.89	4.93	5.02	4.75
8	4.60	4.71	5.09	4.14
9	4.69	4.85	5.17	4.15
10	4.80	4.84	4.94	4.65
11	4.83	4.94	5.11	4.47
12	4.86	4.89	5.33	4.58
13	4.81	4.90	5.03	4.54
14	4.97	4.92	5.27	4.96
Average	4.82	4.88	5.11	4.56

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



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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0348	0.2817	0.0700	0.2097	0.0180	0.0699	0.0351	0.2807
COV	0.011	0.002	0.005	0.003	0.010	0.008	0.009	0.002

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

Repeatability Test

Clause 5.4.5

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

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

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

The second Test Run in each Test Phase is executed at the 100% load point. The I/O Request Throughput from the Test Runs is compared to the SPC-1 IOPS™ primary metric. Each I/O Request Throughput value must be greater than the SPC-1 IOPS™ primary metric minus 5%. In addition, the Average Response Time for each Test Run cannot exceed 30 milliseconds.

If any of the above constraints are not met, the benchmark measurement is invalid.

Clause 9.2.4.7.4

The following content shall appear in the FDR for each Test Run in the two Repeatability Test Phases:

1. *A table containing the results of the Repeatability Test.*
2. *An I/O Request Throughput Distribution graph and table.*
3. *An Average Response Time Distribution graph and table.*
4. *The human readable Test Run Results File produced by the Workload Generator.*
5. *A listing or screen image of all input parameters supplied to the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 74.

Repeatability Test Results File

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

	SPC-1 IOPS™	SPC-1 LRT™
Primary Metrics	***46,491.72***	***4.82***
Repeatability Test Phase 1	46,500.79	4.62
Repeatability Test Phase 2	46,496.39	4.77

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

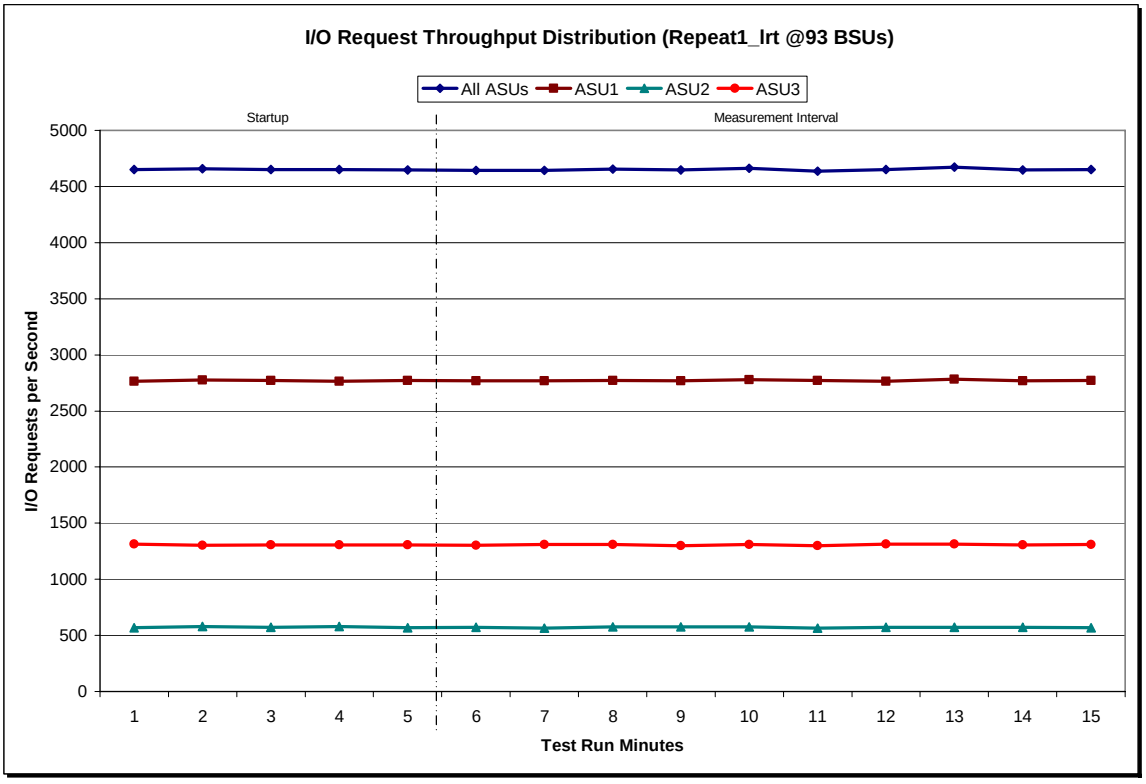
Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

93 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:02:49	12:07:49	0-4	0:05:00
Measurement Interval	12:07:49	12:17:49	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	4,649.10	2,763.65	570.43	1,315.02
1	4,657.92	2,775.58	578.77	1,303.57
2	4,651.83	2,772.67	571.53	1,307.63
3	4,652.48	2,765.48	579.20	1,307.80
4	4,647.10	2,771.12	569.22	1,306.77
5	4,644.12	2,768.28	572.75	1,303.08
6	4,643.52	2,766.80	566.12	1,310.60
7	4,655.60	2,772.80	574.20	1,308.60
8	4,646.80	2,769.92	576.27	1,300.62
9	4,663.37	2,778.22	575.00	1,310.15
10	4,634.92	2,770.93	565.97	1,298.02
11	4,652.25	2,766.18	573.62	1,312.45
12	4,671.60	2,783.87	573.07	1,314.67
13	4,647.43	2,767.75	572.82	1,306.87
14	4,650.18	2,770.17	569.42	1,310.60
Average	4,650.98	2,771.49	571.92	1,307.57

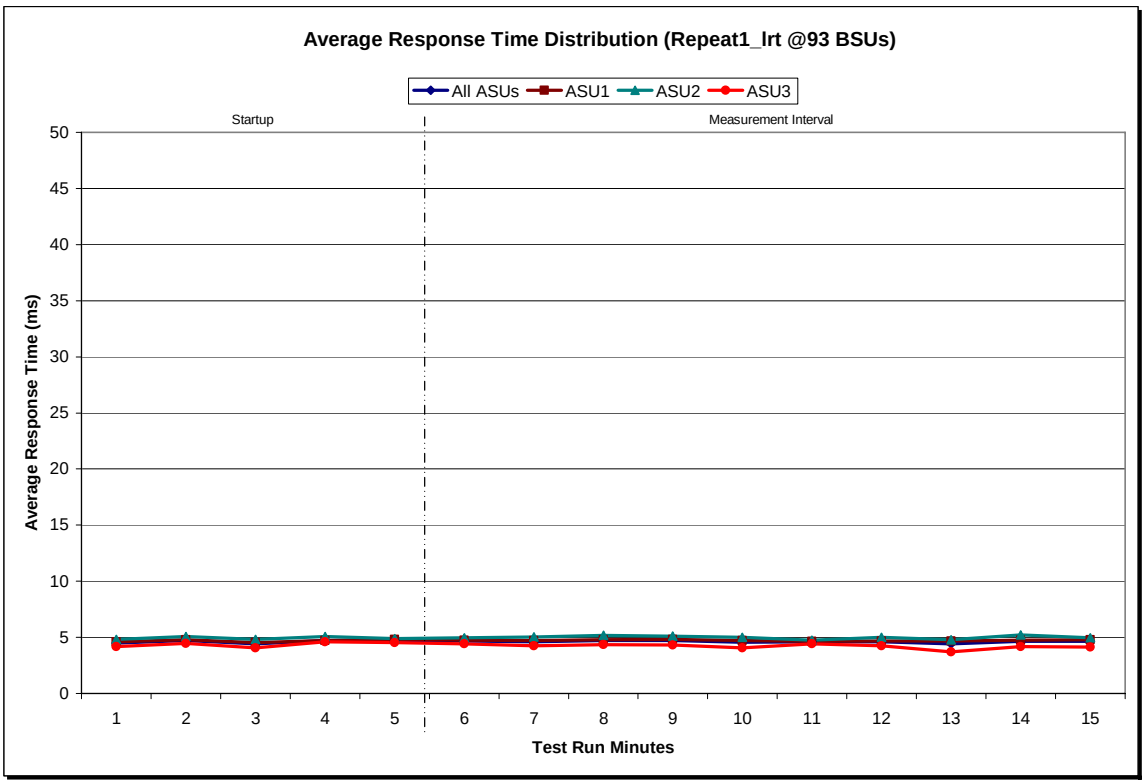
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

93 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:02:49	12:07:49	0-4	0:05:00
Measurement Interval	12:07:49	12:17:49	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	4.51	4.60	4.81	4.18
1	4.73	4.78	5.07	4.46
2	4.44	4.54	4.81	4.06
3	4.73	4.72	5.06	4.60
4	4.74	4.81	4.89	4.55
5	4.69	4.76	4.98	4.43
6	4.62	4.72	5.02	4.24
7	4.72	4.80	5.19	4.36
8	4.72	4.83	5.09	4.32
9	4.57	4.71	5.01	4.09
10	4.60	4.65	4.75	4.43
11	4.60	4.68	5.01	4.26
12	4.42	4.68	4.78	3.70
13	4.66	4.77	5.21	4.18
14	4.63	4.79	4.96	4.13
Average	4.62	4.74	5.00	4.21

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

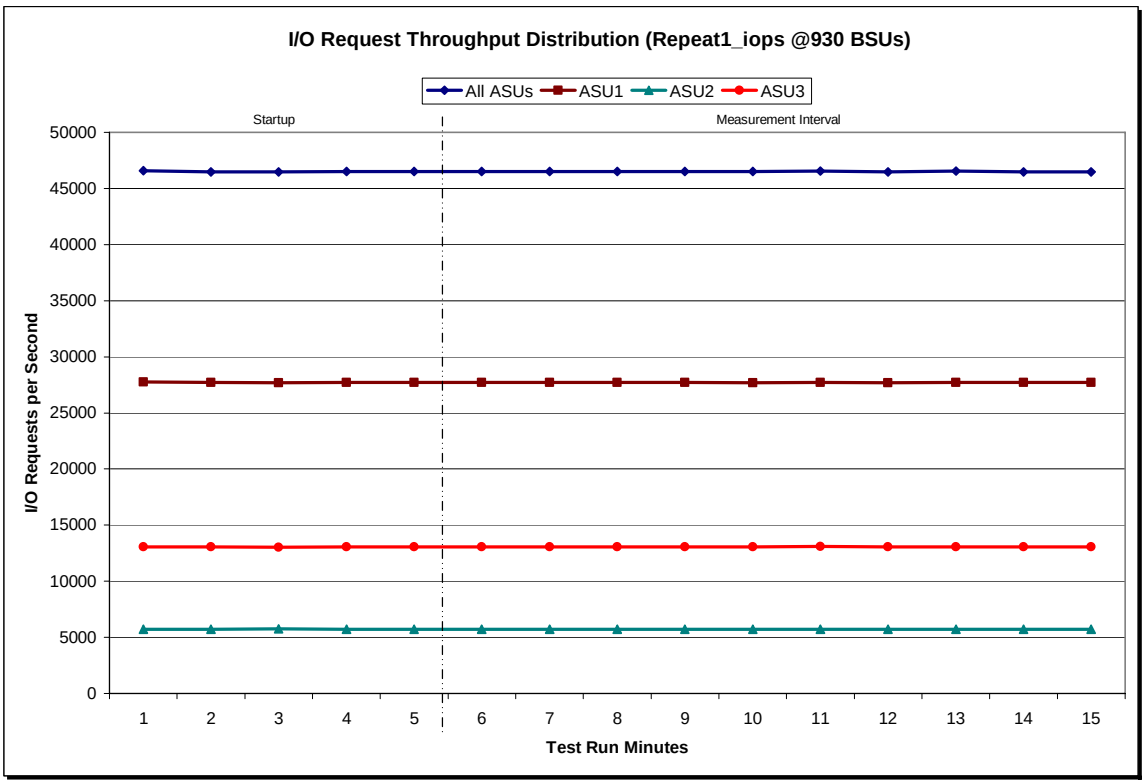


Repeatability 1 IOPS – I/O Request Throughput Distribution Data

930 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:18:12	12:23:13	0-4	0:05:01
Measurement Interval	12:23:13	12:33:13	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	46,574.07	27,764.55	5,730.03	13,079.48
1	46,483.03	27,705.67	5,714.33	13,063.03
2	46,486.72	27,697.62	5,746.40	13,042.70
3	46,494.23	27,721.62	5,715.27	13,057.35
4	46,501.70	27,711.15	5,730.30	13,060.25
5	46,498.57	27,700.13	5,717.67	13,080.77
6	46,512.55	27,732.10	5,718.85	13,061.60
7	46,501.77	27,714.07	5,719.12	13,068.58
8	46,507.13	27,705.80	5,727.32	13,074.02
9	46,493.42	27,698.00	5,738.63	13,056.78
10	46,541.52	27,723.37	5,727.18	13,090.97
11	46,476.58	27,690.73	5,723.63	13,062.22
12	46,528.43	27,715.78	5,730.48	13,082.17
13	46,462.85	27,701.07	5,709.62	13,052.17
14	46,485.07	27,705.03	5,716.97	13,063.07
Average	46,500.79	27,708.61	5,722.95	13,069.23

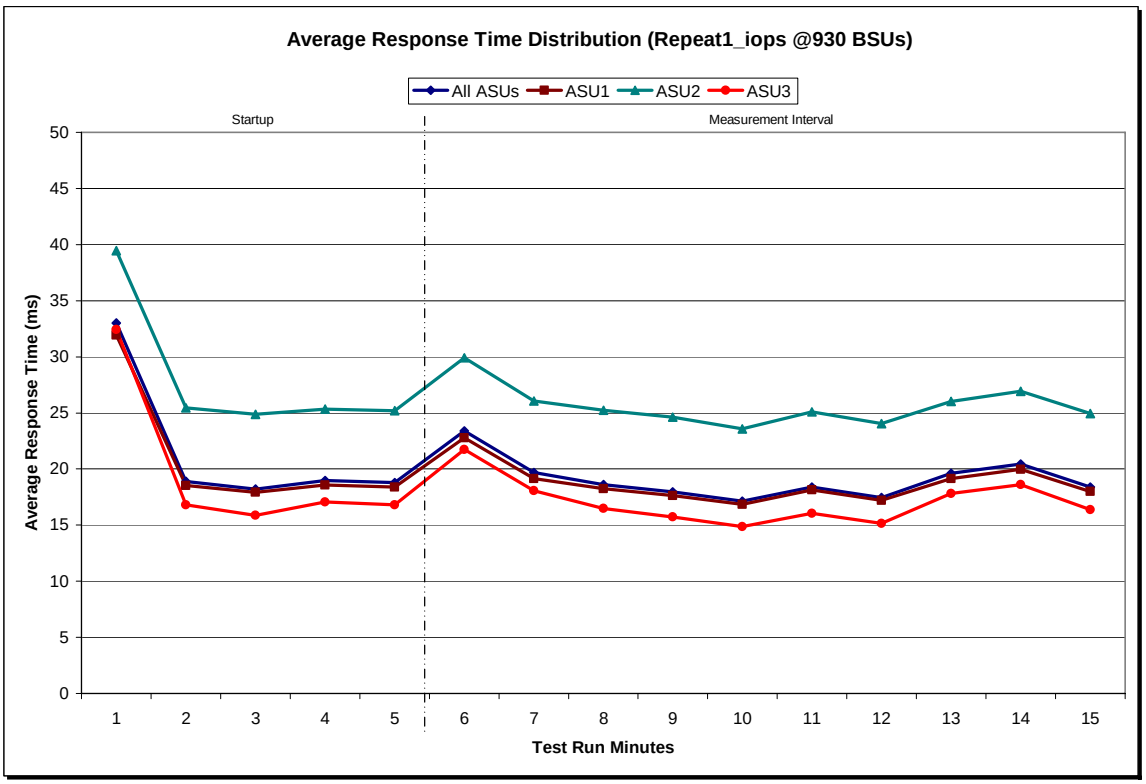
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

930 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:18:12	12:23:13	0-4	0:05:01
Measurement Interval	12:23:13	12:33:13	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	33.00	31.93	39.46	32.43
1	18.91	18.55	25.45	16.81
2	18.20	17.92	24.86	15.86
3	18.97	18.57	25.35	17.06
4	18.79	18.40	25.18	16.81
5	23.38	22.80	29.91	21.75
6	19.70	19.17	26.06	18.06
7	18.61	18.25	25.24	16.48
8	17.96	17.65	24.61	15.72
9	17.12	16.84	23.57	14.88
10	18.40	18.13	25.07	16.07
11	17.47	17.21	24.05	15.16
12	19.63	19.15	26.02	17.83
13	20.44	19.98	26.91	18.60
14	18.40	18.00	24.93	16.38
Average	19.11	18.72	25.64	17.09

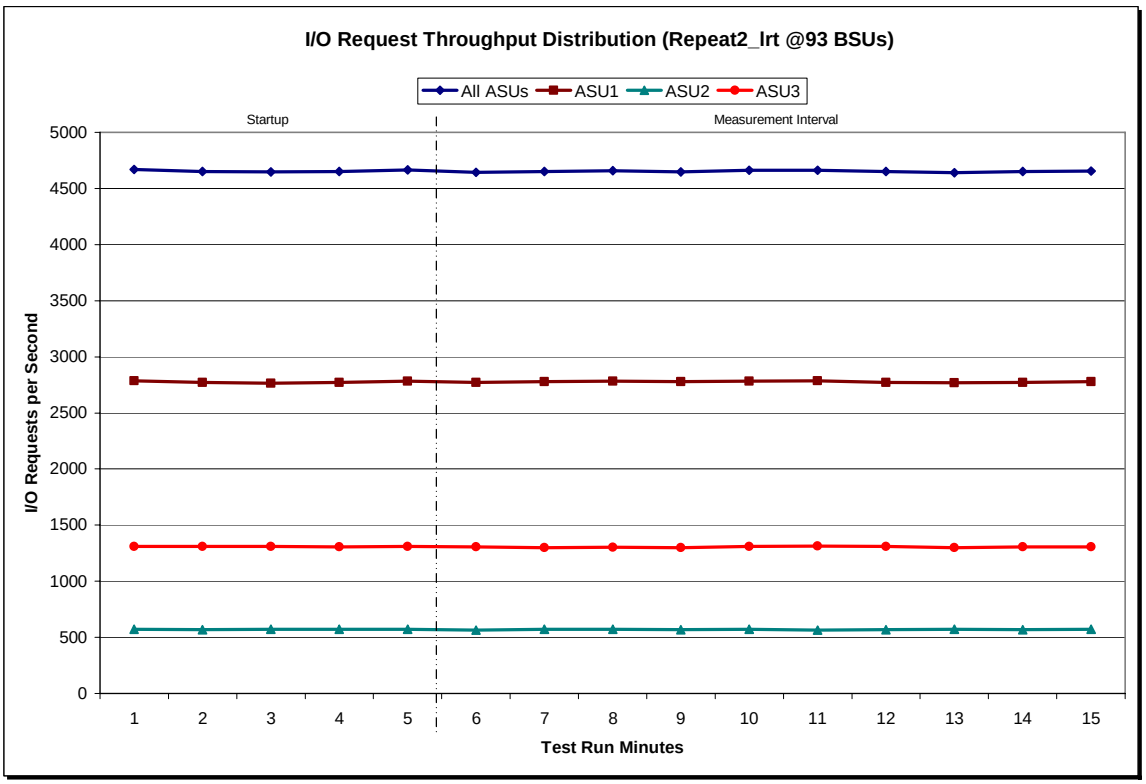
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

93 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:34:05	12:39:05	0-4	0:05:00
Measurement Interval	12:39:05	12:49:05	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	4,669.58	2,786.00	572.18	1,311.40
1	4,652.03	2,772.93	569.05	1,310.05
2	4,648.22	2,764.20	572.48	1,311.53
3	4,652.38	2,771.72	572.73	1,307.93
4	4,663.98	2,781.63	572.98	1,309.37
5	4,643.38	2,773.07	563.77	1,306.55
6	4,650.85	2,780.28	572.62	1,297.95
7	4,657.75	2,781.73	572.52	1,303.50
8	4,647.58	2,779.07	570.13	1,298.38
9	4,662.55	2,782.38	570.63	1,309.53
10	4,662.28	2,784.93	565.25	1,312.10
11	4,652.57	2,772.50	570.45	1,309.62
12	4,641.17	2,769.30	570.88	1,300.98
13	4,649.83	2,772.38	570.13	1,307.32
14	4,655.22	2,777.35	571.20	1,306.67
Average	4,652.32	2,777.30	569.76	1,305.26

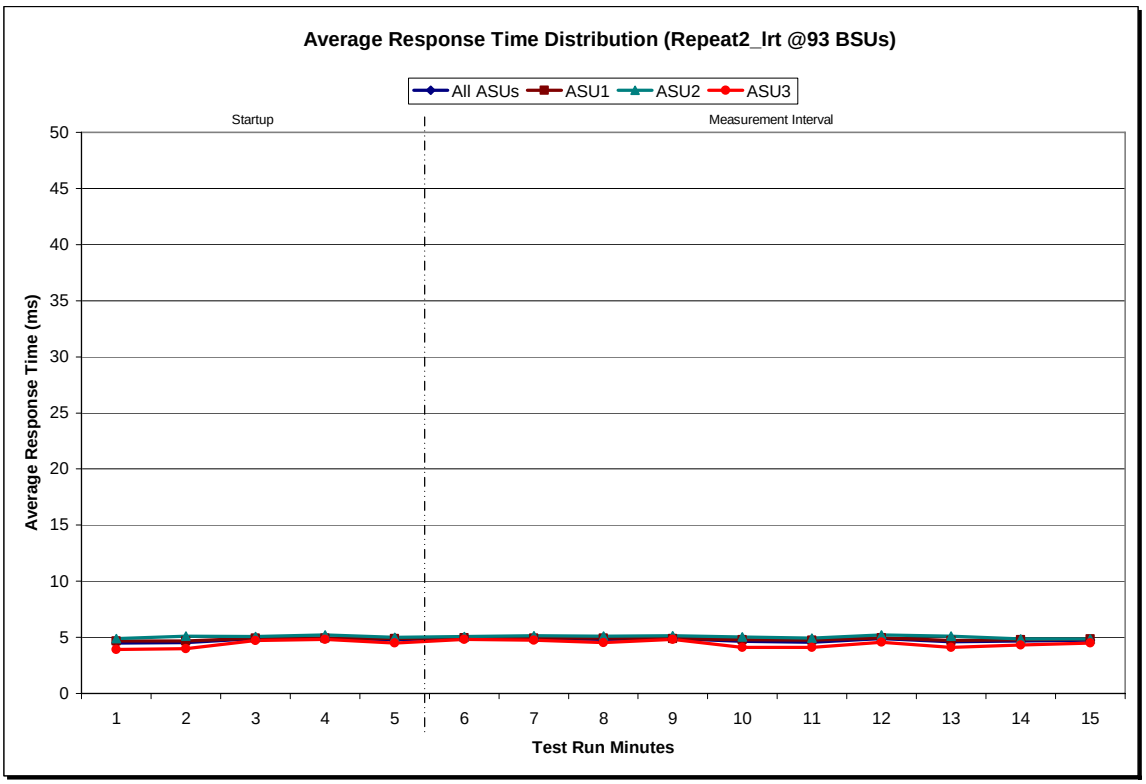
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

93 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:34:05	12:39:05	0-4	0:05:00
Measurement Interval	12:39:05	12:49:05	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	4.51	4.70	4.90	3.94
1	4.55	4.70	5.10	4.01
2	4.89	4.93	5.09	4.73
3	4.94	4.94	5.20	4.83
4	4.80	4.90	5.00	4.49
5	4.95	4.98	5.09	4.83
6	4.91	4.94	5.16	4.74
7	4.84	4.93	5.11	4.52
8	4.90	4.88	5.14	4.82
9	4.63	4.80	5.05	4.09
10	4.58	4.74	4.94	4.10
11	4.88	4.95	5.23	4.58
12	4.60	4.72	5.12	4.12
13	4.67	4.80	4.88	4.32
14	4.76	4.85	4.87	4.52
Average	4.77	4.86	5.06	4.46

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

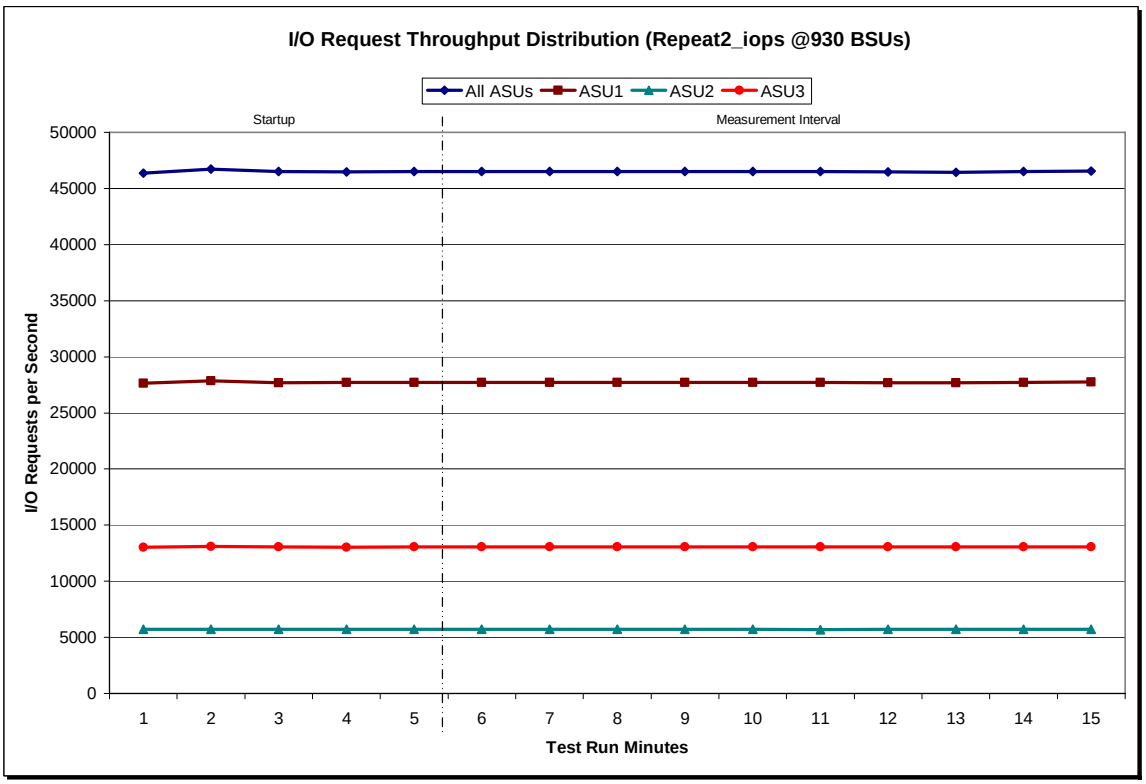


Repeatability 2 IOPS – I/O Request Throughput Distribution Data

930 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:49:28	12:54:29	0-4	0:05:01
Measurement Interval	12:54:29	13:04:29	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	46,358.57	27,628.38	5,709.47	13,020.72
1	46,719.05	27,863.90	5,734.98	13,120.17
2	46,491.53	27,690.58	5,729.12	13,071.83
3	46,485.10	27,716.02	5,729.92	13,039.17
4	46,491.07	27,707.07	5,711.42	13,072.58
5	46,496.03	27,718.82	5,719.05	13,058.17
6	46,517.35	27,709.60	5,736.92	13,070.83
7	46,503.45	27,715.20	5,721.88	13,066.37
8	46,498.07	27,721.42	5,706.42	13,070.23
9	46,508.90	27,723.13	5,719.57	13,066.20
10	46,502.17	27,720.88	5,699.38	13,081.90
11	46,468.37	27,690.58	5,712.45	13,065.33
12	46,436.53	27,666.65	5,718.53	13,051.35
13	46,501.27	27,727.55	5,709.77	13,063.95
14	46,531.77	27,743.15	5,734.72	13,053.90
Average	46,496.39	27,713.70	5,717.87	13,064.82

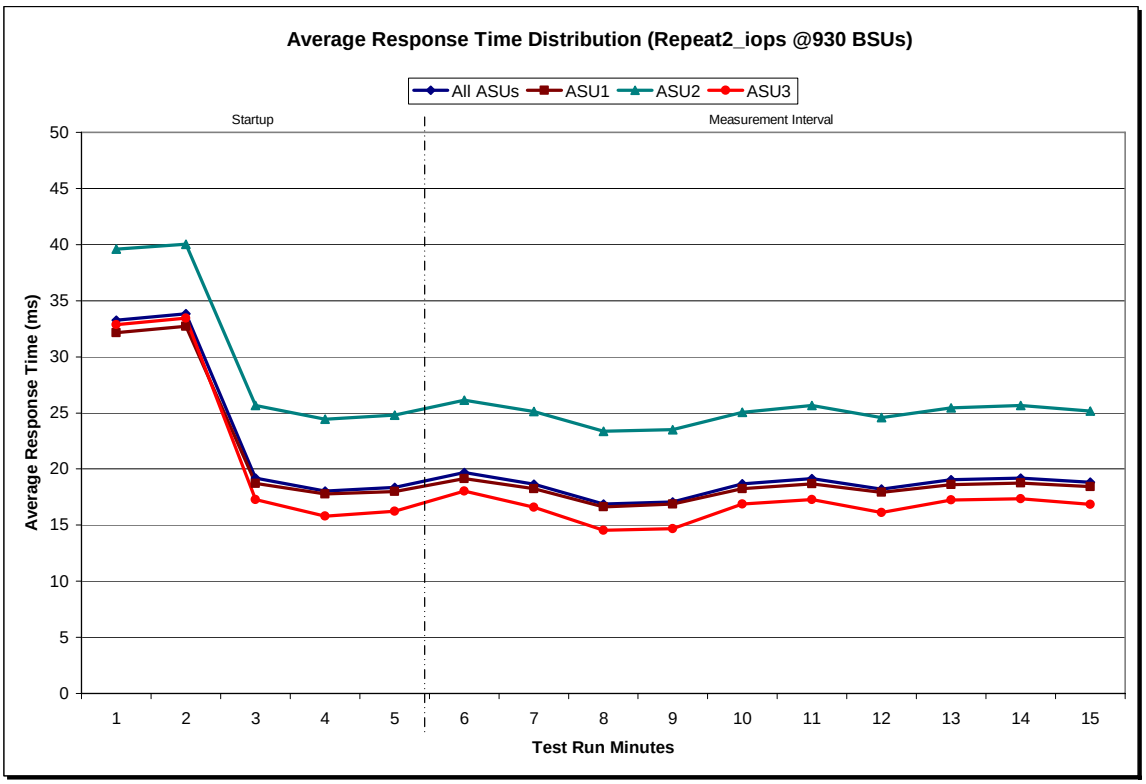
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

930 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:49:28	12:54:29	0-4	0:05:01
Measurement Interval	12:54:29	13:04:29	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	33.26	32.14	39.59	32.85
1	33.83	32.73	40.03	33.46
2	19.17	18.72	25.68	17.27
3	18.04	17.78	24.43	15.79
4	18.35	18.01	24.81	16.25
5	19.70	19.16	26.14	18.03
6	18.64	18.26	25.12	16.59
7	16.88	16.63	23.37	14.54
8	17.07	16.87	23.51	14.69
9	18.70	18.24	25.04	16.89
10	19.14	18.68	25.66	17.26
11	18.23	17.91	24.57	16.12
12	19.05	18.60	25.44	17.23
13	19.20	18.75	25.65	17.33
14	18.82	18.44	25.16	16.86
Average	18.54	18.15	24.97	16.56

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



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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0349	0.2810	0.0700	0.2100	0.0179.	0.0701	0.0350	0.2811
COV	0.005	0.004	0.007	0.003	0.011	0.008	0.004	0.003

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2099	0.0180	0.0700	0.0350	0.2811
COV	0.004	0.001	0.003	0.001	0.003	0.002	0.004	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	0.2809	0.0700	0.2110	0.0180	0.0696	0.0349	0.2806
COV	0.013	0.002	0.004	0.003	0.007	0.007	0.009	0.003

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

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

Data Persistence Test

Clause 6

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

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

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

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

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

Clause 9.2.4.8

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

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 74.

Data Persistence Test Results File

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

Persistence 1 Test Results File

Persistence 2 Test Results File

Data Persistence Test Results

Data Persistence Test Results	
Data Persistence Test Run Number: 1	
Total Number of Logical Blocks Written	111,352,688
Total Number of Logical Blocks Verified	88,714,080
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks	10 minutes
Size in Bytes of each Logical Block	512
Number of Failed I/O Requests in the process of the Test	0

In some cases the same address was the target of multiple writes, which resulted in more Logical Blocks Written than Logical Blocks Verified. In the case of multiple writes to the same address, the pattern written and verified must be associated with the last write to that address.

PRICED STORAGE CONFIGURATION AVAILABILITY DATE

Clause 9.2.4.9

The committed delivery data for general availability (Availability Date) of all products that comprise the Priced Storage Configuration must be reported. When the Priced Storage Configuration includes products or components with different availability dates, the reported Availability Date must be the date at which all components are committed to be available.

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

The Sun StorageTek® 6540 Array, as documented in this Full Disclosure Report is currently available for customer purchase and shipment.

PRICING INFORMATION

Clause 9.2.4.11

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

Clause 9.2.4.11.3

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

Pricing information may found in the Tested Storage Configuration Pricing section on page 13. A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration may be found in the Executive Summary portion of this document on page 13.

ANOMALIES OR IRREGULARITIES

Clause 9.2.4.10

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

There were no anomalies or irregularities encountered during the SPC-1 Onsite Audit of the Sun StorageTek® 6540 Array.

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.

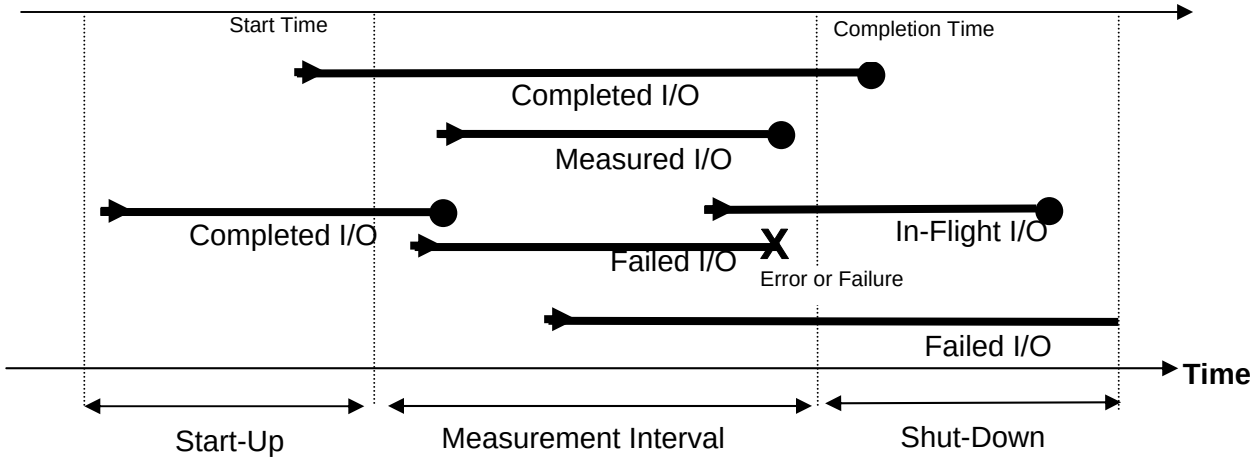
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

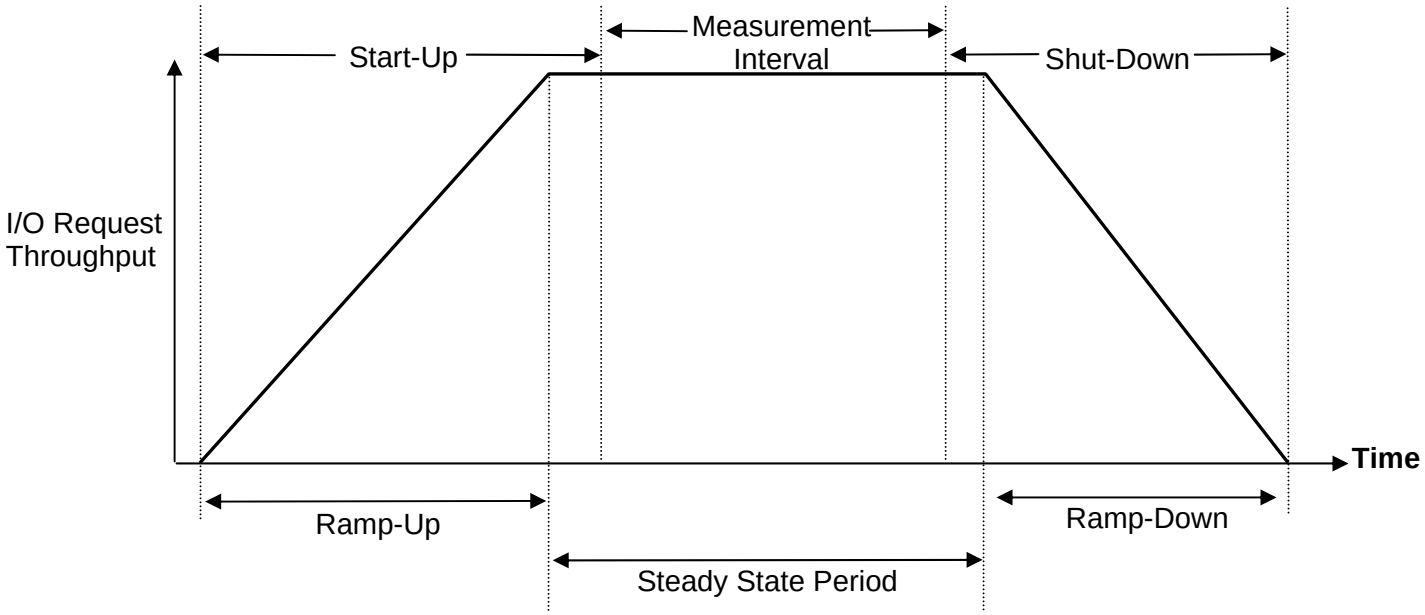
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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

Solaris Parameters

The following parameters were added to the Solaris **/etc/system** file for the configured Host System.

```
set vxio:vol_default_iodelay = 10
set vxio:vol_maxkiocount = 32768
set vxio:vol_maxioctl = 131072
set vxio:vol_maxio = 8192
set vxio:vol_maxspecialio = 10240
set maxpgio = 65536
set fastscan = 65536
set ufs:ufs_HW = 20971520
set ufs:ufs_LW = 15728640
set autoup = 1024
set tune_t_fsflushr = 1
set sq_max_size = 100
set sdd:sdd_max_throttle=256
set maxphys = 8388608
set sd:sd_max_throttle=256
```

Host Bus Adapter (HBA) Options

The following HBA options were changed in the "/kernel/drv/qlc.conf" file.

Option	Default	New Value
Execution Throttle	32	128
Login Retry Count	4	30
Enable Adapter Hard loop ID	0	1
Reset Delay	5	8
Port Down Retry Count	8	70
Link Down Timeout	0	60

LUN Parameters

The following parameters are set during the execution of the sscs command, which is documented in Appendix.

Automatic Cache Read Ahead: **off** (default is **on**)
Cache Read Ahead Multiplier: **0** (default is **1**)

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

The ST6540 is configured with fourteen (14) RAID 1 storage groups with one LUN per group. The configuration file **spc1-6540-cfg.txt** is used to configure the ST6540 via the **sscs** command. The **sscs** command is accessed via the "SUNWsesscs package" found in the CD that ships with the ST6540.

sscs import –f spc1-6540-cfg.txt array sbm-6540a

The above command performs the following:

- Probes ST6540 to ensure configuration file compatibility
- Creates fourteen (14) RAID 1 LUNs
- Presents all LUNs to the attached host
  - Read Ahead is disabled
  - Disk Scrubbing is disabled

*Note: **sbm-6540a**, in the above command, is the hostname assigned to the ST6540.*

The configuration file, **spc1-6540-cfg.txt** is listed below.

spc1-6540-cfg.txt

```
<?xml version="1.0" encoding="UTF-8"?>
<raidbaseview>
<raidsystem>
<name>sbm-6140a</name>
<unique_id>60%3A0A%3A0B%3A80%3A00%3A11%3AA9%3A2E%3A00%3A00%3A00%3A00%3A44%3A75%3A7E%
3ABA</unique_id>
<status>ok</status>
<manufacturer>SUN</manufacturer>
<model>6140</model>
<firmware_version>06.16.81.10</firmware_version>
<nvsram_version></nvsram_version>
<cache_size></cache_size>
<network>
<ip1>172.20.106.207</ip1>
<ip2>172.20.106.206</ip2>
<gateway1>172.20.106.248</gateway1>
<gateway2>172.20.106.248</gateway2>
<netmask1>255.255.255.0</netmask1>
<netmask2>255.255.255.0</netmask2>
</network>
<array_param>
<cache_block_size>16KB</cache_block_size>
<cache_flush_threshold>80</cache_flush_threshold>
<cache_flush_amount>80</cache_flush_amount>
<default_host_port_type>SOLARIS_MPXIO</default_host_port_type>
<default_media_scan>0</default_media_scan>
<default_failover_alert_delay>300</default_failover_alert_delay>
</array_param>
<premium_features>
<premium_name>Snapshot</premium_name>
<premium_name>ReplicationSet</premium_name>
<premium_name>VolumeCopy</premium_name>
<premium_name>StorageDomain</premium_name>
</premium_features>
<pools>
```

```
<pool>
<pool_name>spc1-pool</pool_name>
<pool_desc>null</pool_desc>
<pool_profile_name>SPC1</pool_profile_name>
<pool_total_capacity>123.725GB</pool_total_capacity>
<pool_avail_capacity>123.725GB</pool_avail_capacity>
</pool>
<pool>
<pool_name>Default</pool_name>
<pool_desc>null</pool_desc>
<pool_profile_name>Default</pool_profile_name>
<pool_total_capacity>0.000GB</pool_total_capacity>
<pool_avail_capacity>0.000GB</pool_avail_capacity>
</pool>
</pools>
<total_trays>4</total_trays>
<tray>
<idx>85</idx>
<type>FC</type>
<num_drive_slots>16</num_drive_slots>
<active_drives>85.15 85.14 85.13 85.12 85.11 85.10 85.9 85.8 85.7 85.6 85.5 85.4
85.3 85.2 85.1 85.16 </active_drives>
<disk_capacity>68.366GB</disk_capacity>
<hot_spare_drives></hot_spare_drives>
</tray>
<tray>
<idx>3</idx>
<type>FC</type>
<num_drive_slots>16</num_drive_slots>
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  </profile>
  <profile>
  <profile_name>NFS_Mirroring</profile_name>
  <profile_desc>Pre-configured+NFS+Mirroring+profile</profile_desc>
  <raid_level>RAID+1</raid_level>
  <optimal_num_drives>0</optimal_num_drives>
  <segment_size>512K</segment_size>
  <read_ahead>On</read_ahead>
  <drive_type>FC</drive_type>
  <factory_profile>yes</factory_profile>
  </profile>
  <profile>
  <profile_name>spc1-asu3</profile_name>
  <profile_desc>-</profile_desc>
  <raid_level>RAID+1</raid_level>
  <optimal_num_drives>0</optimal_num_drives>
  <segment_size>256K</segment_size>
  <read_ahead>Off</read_ahead>
  <drive_type>ANY</drive_type>
  <factory_profile>no</factory_profile>
  </profile>
  <profile>
  <profile_name>NFS_Striping</profile_name>
  <profile_desc>Pre-configured+NFS+Striping+profile</profile_desc>
  <raid_level>RAID+5</raid_level>
  <optimal_num_drives>0</optimal_num_drives>
  <segment_size>512K</segment_size>
  <read_ahead>On</read_ahead>
  <drive_type>FC</drive_type>
  <factory_profile>yes</factory_profile>
  </profile>
  <profile>
  <profile_name>spc1-asu2</profile_name>
  <profile_desc>-</profile_desc>
  <raid_level>RAID+1</raid_level>
  <optimal_num_drives>0</optimal_num_drives>
  <segment_size>512K</segment_size>
  <read_ahead>Off</read_ahead>
  <drive_type>ANY</drive_type>
  <factory_profile>no</factory_profile>
  </profile>
  <profile>
  <profile_name>High_Capacity_Computing</profile_name>
```

```
<profile_desc>Pre-configured+High+Capacity+Computing+profile</profile_desc>
<raid_level>RAID+5</raid_level>
<optimal_num_drives>0</optimal_num_drives>
<segment_size>512K</segment_size>
<read_ahead>On</read_ahead>
<drive_type>SATA</drive_type>
<factory_profile>yes</factory_profile>
</profile>
</profiles>
</raidsystem>
</raidbaseview>
```

LUN discovery via Solaris 10 SPARC

The script **config-6540-spc1.sh** is used on the host to discover and configure the LUNs in Solaris. It performs the following.

- Probes server and adds labels to all new LUN's
- Creates a prtvtoc output file (**prtvtoc.txt**)
- Creates a disk list text file (**disklist.txt**)
- Creates a Solaris Raid 0 config file using all fourteen (14) LUNs (**md.tab**)
- Creates a Solaris Raid 0 volume with three soft partitions for ASU,1,2,and 3

The **config-6540-spc1.sh** script is listed below.

config-6540-spc1.sh

```
#!/bin/ksh
#
# Label all new drives
#
clear
echo " "
echo " "
echo "Removing old Disk links and Meta devices"
echo " "
echo " "
sleep 2
metaclear -f d1 d2 d3 d10

# Probe server and remove all old device links
devfsadm -C
echo " "
echo " "
echo " Configuring new disks"
echo " "
echo " Configuring `ls /dev/rdsk/c34*d0s2 | wc -l ` disks"
sleep 5
echo " "
ls /dev/rdsk/c34*d0s2 > disks
echo " "
echo " Starting to Label all new disks"
sleep 5
cat disks | sed 's/s2\@/s2/g' > disk1
rm disks
```

```
C_disks=disk1
#
for f in `cat $C_disks`
do
format $f << EOFF
ty
0
y
label
y
quit
EOFF
done
echo " Finished Configuring `ls /dev/rdsk/c34*d0s2 | wc -l ` disks"
sleep 5
clear
####
# Create  prtvtoc.txt file
touch prtvtoc.txt
for x in `cat disk1`
do
prtvtoc $x >> prtvtoc.txt
done
#
# Create all meta devices
format > formatD << EOFF
EOFF
# Stop here for some tweaks
#
#
touch d10
echo "d10 1 14 \\" >> d10
grep -i flex formatD | awk '{print $2}' >> d10
echo "-i 100m" >>d10
echo " " >>d10
echo "d1 -p d10 3100g " >>d10
echo "d2 -p d10 3100g " >>d10
echo "d3 -p d10 690g" >>d10
#
echo " "
echo " Creating new md.tab file"
sleep 5
echo " "
#
# Create md.tab file
# Clean up md.tab file
cat d10 | sed 's/d0/d0s2 \\/g' >md.tab
##
# Copy new md.tab file to /etc/lvm
cp /etc/lvm/md.tab /etc/lvm/md.tab.old
mv md.tab /etc/lvm/md.tab

echo " New md.tab file has been created"
sleep 5
echo " Starting to create new metadevices."
sleep 5
# create metadevice
metainit d10
echo " "
metainit d3
echo " "
metainit d1
echo " "
```

```
metainit d2
sleep 5
## Display results
clear
# Remove config file
metastat
mv disk1 disklist.txt
rm d10 formatD
```

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

The contents of the SPC-1 Workload Generator command and parameter file used for the Primary Metrics, Repeatability, and Persistence Tests is listed below.

```
sd=asu1_1,lun=/dev/md/rdsk/d1,size=3100g
sd=asu2_1,lun=/dev/md/rdsk/d2,size=3100g
sd=asu3_1,lun=/dev/md/rdsk/d3,size=690g
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

The following script, **runspc16540.sh**, was used to execute the Primary Metrics and Repeatability Tests, as well as, Persistence Test Run 1.

```
#!/usr/bin/ksh
script=runspc16540.sh
output=Run-1
basedir=/spc/output/spc1/6540/bigdog/Post-Audit
outdir=$basedir/$output
mkdir -p $outdir
#
mailx -s $script-Started -r Javier.Chavez@sun.com
Javier.Chavez@sun.com,leah.schoeb@sun.com < $script
bsu=930
STEP=1
startup=300
while [[ $bsu -le 930 ]]
do
Outdir=$outdir/${bsu}
mkdir -p $Outdir
HostDir=$Outdir/Hostfiles
mkdir -p $HostDir
# Now we will get the config files from the host.
cp -r /spc/spc1/bigdog/6540-config $HostDir/
cp SPC1.cfg $HostDir
cp /etc/lvm/md.tab $HostDir
cp /etc/system $HostDir
cp /kernel/drv/qlc.conf $HostDir
cp $script $HostDir
#cp $script $HostDir/$script-P2
#
java -Xmx1024m -Xss1024k metrics -b $bsu -s $startup
sleep 15
mv metrics $Outdir
sleep 15
mailx -s spc1-6540-metrics-$bsu -r Javier.Chavez@sun.com
Javier.Chavez@sun.com,leah.schoeb@sun.com < $Outdir/metrics/summary.html
sleep 15
java -Xmx1024m -Xss1024k repeat1 -b $bsu -s $startup
sleep 15
java -Xmx1024m -Xss1024k repeat2 -b $bsu -s $startup
sleep 15
java -Xmx1024m persist1 -b $bsu
sleep 15
#java -Xmx1024m persist2
#sleep 15
mv repeatability1 $Outdir
mv repeatability2 $Outdir
mv persistence1 $Outdir
#mv persistence2 $Outdir
#mv asu* $Outdir
#mv SPCOut $Outdir
#
#
mailx -s spc1-6540-finished-$bsu -r Javier.Chavez@sun.com
Javier.Chavez@sun.com,leah.schoeb@sun.com < $Outdir/metrics/summary.html
#cd $outdir ;/bin/chmod -R 777 $Outdir ;mv $Outdir.zip $Outdir.zip-p1
cd $outdir ;/bin/chmod -R 777 $Outdir ;/usr/bin/zip -r $Outdir.zip $Outdir
touch $outdir/link ; echo " " >> $outdir/link
echo "  Use the link below to download the zipped file" >> $outdir/link
echo " " >> $outdir/link
```

```
echo http://sbm-220a.central.sun.com/export/$outdir/$bsu.zip >> $outdir/link
echo " " >> $outdir/link
echo "  Use the link below to take a lookat the output files" >> $outdir/link
echo " " >> $outdir/link
echo http://sbm-220a.central.sun.com/export/$outdir >> $outdir/link
mailx -s $script-is-finished theman@sun.com,leah.schoeb@sun.com < $outdir/link
rm $outdir/link
sleep 5
bsu=`expr $bsu + $STEP`
echo "All done .... sleeping for 5 minutes"
sleep 60
done
```

The following script, **runspc16540-P2.sh**, was used to execute Persistence Test Run 2.

```
#!/usr/bin/ksh
script=runspc16540.sh
output=Run-1
basedir=/spc/output/spc1/6540/bigdog/Post-Audit
outdir=$basedir/$output
#mkdir -p $outdir
#
mailx -s $script-Started -r Javier.Chavez@sun.com
Javier.Chavez@sun.com,leah.schoeb@sun.com < $script
bsu=930
STEP=1
startup=300
while [[ $bsu -le 930 ]]
do
Outdir=$outdir/${bsu}
#mkdir -p $Outdir
HostDir=$Outdir/Hostfiles
#mkdir -p $HostDir
# Now we will get the config files from the host.
#cp -r /spc/spc1/bigdog/6540-config $HostDir/
#cp SPC1.cfg $HostDir
#cp /etc/lvm/md.tab $HostDir
#cp /etc/system $HostDir
#cp /kernel/drv/qlc.conf $HostDir
#cp $script $HostDir
cp $script $HostDir/$script-P2
#
#java -Xmx1024m -Xss1024k metrics -b $bsu -s $startup
#sleep 15
#mv metrics $Outdir
#sleep 15
#mailx -s spc1-6540-metrics-$bsu -r Javier.Chavez@sun.com
Javier.Chavez@sun.com,leah.schoeb@sun.com < $Outdir/metrics/summary.html
#sleep 15
#java -Xmx1024m -Xss1024k repeat1 -b $bsu -s $startup
#sleep 15
#java -Xmx1024m -Xss1024k repeat2 -b $bsu -s $startup
#sleep 15
#java -Xmx1024m persist1 -b $bsu
#sleep 15
java -Xmx1024m persist2
sleep 15
#mv repeatability1 $Outdir
#mv repeatability2 $Outdir
```

```
#mv persistence1 $Outdir
mv persistence2 $Outdir
mv asu* $Outdir
mv SPCOut $Outdir
#
#
mailx -s spc1-6540-finished-$bsu -r Javier.Chavez@sun.com
Javier.Chavez@sun.com,leah.schoeb@sun.com < $Outdir/metrics/summary.html
cd $outdir ;/bin/chmod -R 777 $Outdir ;mv $Outdir.zip $Outdir.zip-p1
cd $outdir ;/bin/chmod -R 777 $Outdir ;/usr/bin/zip -r $Outdir.zip $Outdir
touch $outdir/link ; echo " " >> $outdir/link
echo "  Use the link below to download the zipped file" >> $outdir/link
echo " " >> $outdir/link
echo http://sbm-220a.central.sun.com/export/$outdir/$bsu.zip >> $outdir/link
echo " " >> $outdir/link
echo "  Use the link below to take a lookat the output files" >> $outdir/link
echo " " >> $outdir/link
echo http://sbm-220a.central.sun.com/export/$outdir >> $outdir/link
mailx -s $script-is-finished theman@sun.com,leah.schoeb@sun.com < $outdir/link
rm $outdir/link
sleep 5
bsu=`expr $bsu + $STEP`
echo "All done .... sleeping for 5 minutes"
sleep 60
done
```