



SPC BENCHMARK 1™
FULL DISCLOSURE REPORT
PILLAR DATA SYSTEMS, INC.
PILLAR AXIOM 600

SPC-1 V1.10.1

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AUDIT CERTIFICATION



Kurt Shoens
Pillar Data Systems, Inc.
2840 Junction Ave.
San Jose, CA 95134

January 6, 2009

The SPC Benchmark 1™ results listed below for the Pillar Axiom 600 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: Pillar Axiom 600	
Metric	Reported Result
SPC-1 IOPS™	64,992.77
SPC-1 Price-Performance	\$8.79/SPC-1 IOPS™
Total ASU Capacity	10,000,000 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	\$570,972.87

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

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified by physical inspection and information supplied by Pillar Data Systems, Inc.:
 - ✓ Physical Storage Capacity and requirements.
 - ✓ Configured Storage Capacity and requirements.
 - ✓ Addressable Storage Capacity and requirements.
 - ✓ Capacity of each Logical Volume and requirements.
 - ✓ Capacity of each Application Storage Unit (ASU) and requirements.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Physical verification of the components to match the above diagram.

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

AUDIT CERTIFICATION (CONT.)

Pillar Axiom 600
SPC-1 Audit Certification

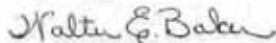
Page 2

- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters that were changed from default values.
- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.
- The following Host System requirements were verified by physical inspection and information supplied by Pillar Data Systems, Inc.:
 - ✓ The type of Host System including the number of processors and main memory.
 - ✓ The presence and version number of the SPC-1 Workload Generator on the Host System.
 - ✓ The TSC boundary within the Host System.
- The execution of each Test, Test Phase, and Test Run was observed and found compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification.
- The Test Results Files and resultant Summary Results Files received from Pillar Data Systems, Inc. for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
 - ✓ Data Persistence Test
 - ✓ Sustainability Test Phase
 - ✓ IOPS Test Phase
 - ✓ Response Time Ramp Test Phase
 - ✓ Repeatability Test
- There were no differences between the Tested Storage Configuration (TSC) used for the benchmark and Priced Storage Configuration.
- The submitted pricing information met all of the requirements and constraints of Clause 8 of the SPC-1 Benchmark Specification.
- The Full Disclosure Report (FDR) met all of the requirements in Clause 9 of the SPC-1 Benchmark Specification.
- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

Audit Notes:

There were no audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

Storage Performance Council
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Redwood City, CA 94062
AuditService@storageperformance.org
650.556.9384

LETTER OF GOOD FAITH**LETTER OF GOOD FAITH**

Date: December 18, 2008

From: Nancy Holleran
President & Chief Operating Officer
Pillar Data Systems
2840 Junction Ave
San Jose, CA 95134

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

Subject: SPC-1 Letter of Good Faith for the Pillar Axiom 600

Pillar Data Systems, 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.

Signed:

Date:

A handwritten signature in cursive script, appearing to read "Nancy Holleran", written over a horizontal line.

Nancy Holleran, President & COO
Pillar Data Systems

A handwritten date "12/18/08" written in cursive script over a horizontal line.

Date of Signature

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Pillar Data Systems, Inc. – http://www.pillardata.com Kurt Shoens – kshoens@pillardata.com 2840 Junction Ave. San Jose, CA 95134 Phone: (408) 503-4081 FAX: (408) 503-4050
Test Sponsor Alternate Contact	Pillar Data Systems, Inc. – http://www.pillardata.com Glen Shok – gshok@pillardata.com 2840 Junction Ave. San Jose, CA 95134 Phone: (408) 518-4777 FAX: (408) 503-4050
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	January 13, 2009
Date the FDR was submitted to the SPC	January 13, 2009
Date the TSC is available for shipment to customers	currently available
Date the TSC completed audit certification	January 6, 2009

Tested Storage Product (TSP) Description

As the first and only true application-aware storage system it provides the highest storage utilization rates in storage industry, the most advanced hardware and software fault tolerance capabilities, and a robust software feature set. The Axiom 600 is an ideal Enterprise storage platform for virtual infrastructure projects, IT data center reconstruction projects, and bringing applications online with the highest levels of performance. The Axiom 600 is priced very competitively by \$/GB, \$/IOP, or any other metric.

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: Pillar Axiom 600	
Metric	Reported Result
SPC-1 IOPS™	64,992.77
SPC-1 Price-Performance	\$8.79/SPC-1 IOPS™
Total ASU Capacity	10,000 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	\$570,972.87

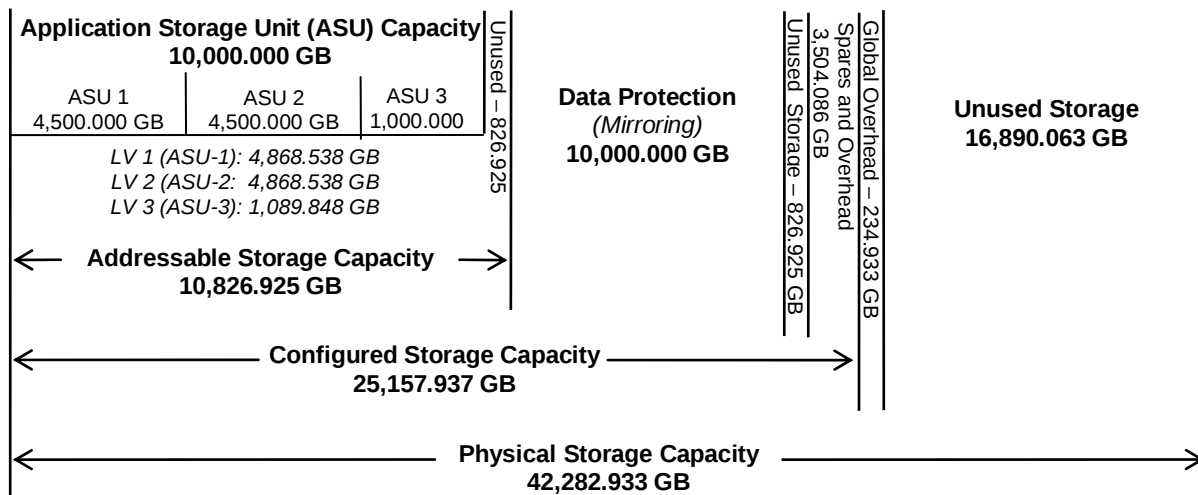
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

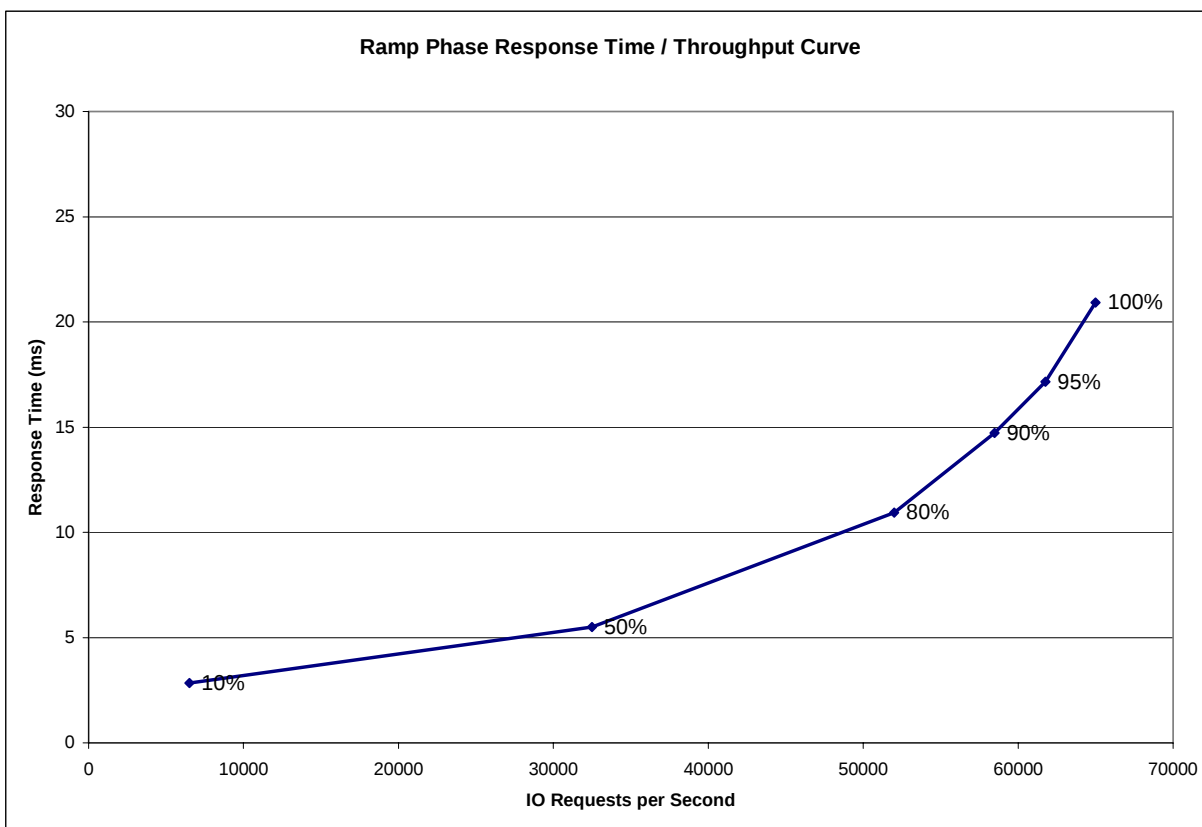
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



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	6,501.04	32,490.23	52,001.18	58,493.63	61,756.18	64,992.77
Average Response Time (ms):						
All ASUs	2.85	5.50	10.95	14.72	17.15	20.92
ASU-1	3.67	7.06	13.42	17.59	20.20	24.29
ASU-2	3.55	7.23	15.26	21.16	24.81	30.63
ASU-3	0.79	1.43	3.81	5.79	7.33	9.51
Reads	6.05	11.86	22.20	28.89	32.84	39.14
Writes	0.76	1.35	3.61	5.49	6.93	9.06

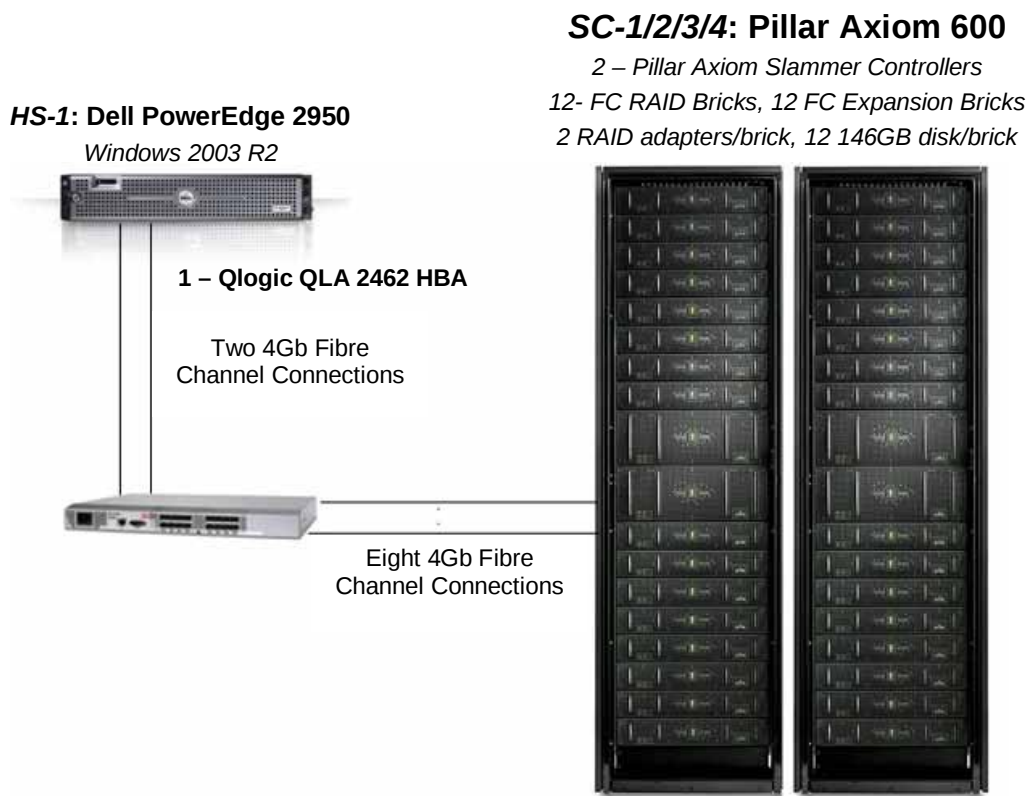
Tested Storage Configuration Pricing (*Priced Storage Configuration*)

	Hardware Part Number	Description	Quantity	Unit Price	Extended Price
Hardware					
	AXIOM-600-SYS	Axiom 600 Configuration			
	SLM-600-SAN	Axiom 600 SAN Slammer	2	\$35,750.00	\$71,500.00
	AXIOM PILOT	2U Pilot, DC, ROHS	1	\$5,070.00	\$5,070.00
	BRX-500-146F15R	Brick, FC RAID 146GB 15K	12	\$16,900.00	\$202,800.00
	BRX-500-146F15E	Brick, FC Expansion 146GB 15K	12	\$15,600.00	\$187,200.00
	1475-00066-30	Kit, Bayiong, ROHS	1	\$41.60	\$41.60
	RACK500-42U	Cabinet ASM, 42U	2	\$2,730.00	\$5,460.00
	PDU 500-1P30A	ASM, PDU, 30A, ROHS	4	\$677.30	\$2,709.20
	6050-00063-00	CBL, Power, 15FT, NEMA L6-30P	4	\$130.00	\$520.00
	6051-00032-00	CBL, Optical, Duplex LC	8	\$58.50	\$468.00
Software					
	AXONE-600-OS	AxiomONE Storage Manager	1	\$28,925.00	\$28,925.00
	AXONE-600-FCP	AxiomONE FCP Protocol	1	\$0.00	\$0.00
	AXONE-600-APM	AxiomONE Path Manager	1	\$0.00	\$0.00
Services					
	9010-00010-00	3 YR Software & Support	1	\$12,495.60	\$12,495.60
	9010-00080-00	3 YR - 4 Hour Parts Delivery	1	\$44,790.72	\$44,790.72
Brocade					
	BR-340-0008	Brocade 200	1	\$6,420.05	\$6,420.05
	XBR-R000070	Brocade Slide Rack Mount Kit	1	\$279.50	\$279.50
	200-SVC-RADV1	Brocade Advance Service	1	\$292.50	\$292.50
Qlogic HBA					
	2011-00010-00	QLE2462 Dual Port 4Gbps HBA	1	\$2,000.70	\$2,000.70
<i>This price reflects a 35% bottom line discount.</i>					\$570,972.87

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

The Tested Storage Configuration (TSC) utilized two Brocade switches due to the existing lab configuration, but did not exceed the capacity of the single Brocade 200 16-port switch included in the Priced Storage Configuration. There would be no performance impact if the TSC was configured using the single switch included in the Priced Storage Configuration.

Benchmark Configuration/Tested Storage Configuration Diagram



Benchmark Configuration/Tested Storage Configuration Components

Host System:	Tested Storage Configuration (TSC):
HS-1: Dell PowerEdge 2950	1 – QLA2462 2 port, 4Gbps Fibre Channel HBA
2 – 3.0 GHz Intel Xeon X5450 Processors with 12 MB L2 cache:	SC-1/2/3/4: Pillar Axiom 600
16 GB main memory	2 –Pillar Axiom Slammer Controllers each with:
Windows Server 2003 R2	Dual active/active data mover and manager
AxiomOne Storage Manager	24 GB cache (48 GB total)
PCIe:	4 –Fibre Channel front-end connections (8 total)
WG	8 –Fibre Channel backend connections (16 total)
	2 – 42U Cabinets
	12 – FC RAID Bricks, 12 – FC Expansion Bricks
	2 RAID adapters per brick
	12 – 146 GB disks per Brick (288 total)
	1 – Brocade 200 16-port switch

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), including the network configuration, is illustrated on page 14 (*Benchmark Configuration / Tested Storage Configuration Diagram*).

Host System Configuration

Clause 9.2.4.4.3

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

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

The details of the Host System configuration may be found on page 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 62 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 63 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.2.4.5.3

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

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

SPC-1 DATA REPOSITORY

This portion of the Full Disclosure Report presents the detailed information that fully documents the various SPC-1 storage capacities and mappings used in the Tested Storage Configuration. “SPC-1 Data Repository Definitions” on page 58 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)	10,000.000
Addressable Storage Capacity	Gigabytes (GB)	10,826.925
Configured Storage Capacity	Gigabytes (GB)	25,157.937
Physical Storage Capacity	Gigabytes (GB)	42,282.933
Data Protection (<i>Mirroring</i>)	Gigabytes (GB)	10,000.000
Required Storage (<i>spares/overhead/metadata</i>)	Gigabytes (GB)	3,504.086
Global Storage Overhead	Gigabytes (GB)	234.933
Total Unused Storage	Gigabytes (GB)	18,543.913

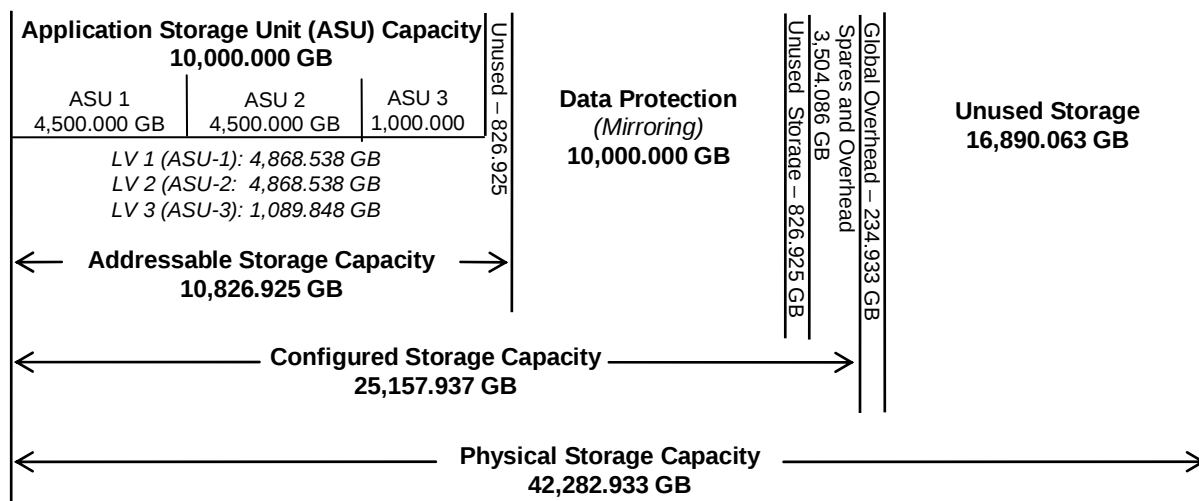
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	92.36%	39.75%	23.65%
Required for Data Protection (<i>Mirrored</i>)		39.75%	23.65%
Addressable Storage Capacity		43.04%	25.61%
Required Storage (<i>spares/overhead</i>)		13.93%	8.29%
Configured Storage Capacity			59.505
Global Storage Overhead			0.56%
Unused Storage:			
Addressable	7.64%		
Configured		3.29%	
Physical			39.95%

The Physical Storage Capacity consisted of 42,282.933 GB distributed over 288 disk drives each with a formatted capacity of 146.816 GB. There was 16,890.063 GB (39.95%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 234.933 GB (0.56%) of Physical Storage Capacity. There was 826.925 GB (3.29%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 92.36% of the Addressable Storage Capacity resulting in 826.925 GB (7.64%) of Unused Storage within the Addressable Storage Capacity.

SPC-1 Storage Capacities and Relationships Illustration

The various storage capacities configured in the benchmark result are illustrated below (not to scale).



Logical Volume Capacity and ASU Mapping

Clause 9.2.4.6.2

A table illustrating the capacity of each ASU and the mapping of Logical Volumes to ASUs shall be provided in the FDR. ... Logical Volumes shall be sequenced in the table from top to bottom per its position in the contiguous address space of each ASU. The capacity of each Logical Volume shall be stated. ... In conjunction with this table, the Test Sponsor shall provide a complete description of the type of data protection (see Clause 2.4.5) used on each Logical Volume.

Logical Volume Capacity and Mapping		
ASU-1 (4,500.000 GB)	ASU-2 (4,500.000 GB)	ASU-3 (1,000.000 GB)
1 Logical Volume 4,868.538 GB per Logical Volume (4,500.000 GB used per Logical Volume)	1 Logical Volume 4,868.538 GB per Logical Volume (4,500.000 GB used per Logical Volume)	1 Logical Volume 1,089.848 GB per Logical Volume (1,000.000 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was “Mirrored” as described on page 11. See “ASU Configuration” in the [IOPS Test Results File](#) for more detailed configuration information.

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 59 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 66.

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)

Ramp-Up/Start-Up Measurement Interval		Start 15:18:38	Stop 15:38:38	Interval 0-19	Duration 0:20:00									
Measurement Interval		15:38:38	18:38:38	20-199	3:00:00									
Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	471.00	182.82	50.09	238.09	67	532.91	207.36	56.79	268.75	134	534.15	207.13	56.97	270.05
1	559.90	217.56	60.10	282.24	68	533.45	207.40	56.95	269.10	135	533.26	206.92	56.96	269.38
2	561.31	217.99	60.08	283.23	69	532.94	206.97	56.82	269.15	136	533.95	207.13	57.15	269.66
3	541.67	210.38	57.92	273.38	70	532.43	206.85	56.89	268.69	137	533.17	207.36	56.74	269.07
4	533.20	207.12	56.80	269.28	71	534.43	207.06	57.00	270.37	138	533.52	207.25	56.90	269.37
5	533.42	207.51	57.10	268.82	72	533.14	207.13	56.74	269.27	139	533.12	207.13	56.91	269.08
6	534.07	207.27	56.86	269.93	73	533.31	207.10	56.90	269.32	140	532.87	207.11	56.94	268.83
7	532.53	206.96	57.09	268.48	74	533.39	206.93	56.78	269.68	141	533.25	207.22	57.07	268.96
8	534.62	207.30	57.08	270.24	75	532.94	206.85	57.07	269.02	142	533.51	207.53	56.98	268.99
9	533.83	207.38	56.92	269.53	76	533.24	206.85	57.21	269.18	143	532.77	206.70	57.11	268.96
10	533.80	206.97	56.99	269.83	77	532.86	207.10	57.16	268.60	144	533.52	206.92	57.00	269.60
11	533.57	207.33	57.08	269.17	78	534.41	207.12	57.20	270.09	145	533.66	207.18	56.87	269.61
12	533.00	206.66	56.77	269.57	79	533.24	207.30	57.03	268.92	146	533.34	207.20	56.81	269.33
13	532.74	207.27	56.97	268.51	80	533.21	207.19	57.19	268.83	147	533.00	207.13	56.93	268.95
14	533.47	207.28	56.99	269.20	81	534.42	207.37	57.14	269.90	148	533.85	207.02	56.97	269.86
15	533.46	206.98	57.10	269.38	82	533.61	207.72	56.67	269.21	149	533.19	207.15	56.91	269.12
16	532.71	207.02	56.98	268.71	83	533.06	206.91	56.89	269.27	150	533.60	207.16	57.21	269.22
17	533.52	206.88	56.70	269.94	84	533.59	207.18	57.23	269.17	151	533.48	207.24	56.77	269.48
18	533.85	207.23	57.15	269.48	85	533.56	206.96	57.20	269.40	152	533.11	207.18	56.90	269.04
19	533.19	207.15	56.89	269.16	86	533.88	207.16	57.12	269.60	153	532.78	206.91	56.65	269.22
20	534.05	207.22	57.04	269.79	87	533.87	207.13	57.28	269.46	154	533.68	207.20	57.12	269.36
21	532.80	206.95	56.88	268.97	88	533.66	206.87	57.04	269.75	155	532.74	206.84	56.65	269.25
22	533.86	206.89	57.09	269.87	89	533.47	207.37	57.03	269.07	156	533.80	207.10	57.28	269.42
23	533.18	207.44	57.10	268.64	90	533.86	207.22	57.18	269.46	157	533.20	207.05	57.24	268.91
24	533.67	207.07	57.15	269.45	91	533.37	206.91	57.08	269.38	158	532.89	207.02	56.81	269.06
25	533.30	207.29	56.88	269.13	92	533.49	207.35	57.02	269.11	159	532.94	206.97	56.90	269.06
26	533.42	207.06	57.05	269.31	93	533.41	207.22	56.79	269.40	160	533.75	206.91	57.14	269.71
27	534.12	207.25	57.09	269.77	94	533.27	207.30	56.84	269.13	161	533.96	207.28	56.91	269.77
28	533.50	207.04	56.96	269.50	95	533.34	207.16	57.20	268.98	162	534.08	207.15	56.94	269.98
29	533.46	207.02	57.02	269.41	96	533.49	207.46	57.12	268.91	163	533.36	207.31	56.89	269.16
30	533.27	207.18	57.03	269.06	97	533.24	207.12	57.10	269.03	164	533.37	207.15	57.22	269.01
31	533.29	207.22	56.97	269.11	98	532.81	206.87	56.99	268.95	165	532.90	206.70	57.16	269.04
32	532.91	206.72	56.88	269.32	99	533.42	206.80	56.86	269.76	166	533.82	207.14	56.92	269.76
33	533.20	207.18	56.94	269.08	100	532.89	207.24	57.08	268.56	167	532.94	206.76	57.04	269.13
34	533.24	207.16	56.85	269.23	101	533.27	207.04	57.04	269.20	168	533.32	206.90	56.84	269.58
35	533.58	207.27	57.27	269.05	102	533.05	206.92	56.86	269.27	169	533.85	207.20	56.87	268.78
36	533.10	206.70	57.08	269.33	103	534.50	207.41	56.91	270.19	170	534.87	207.33	57.14	270.41
37	532.60	206.86	56.84	268.90	104	533.41	207.06	56.88	269.47	171	533.61	207.24	57.13	269.24
38	533.57	207.07	56.95	269.55	105	533.93	207.32	56.98	269.63	172	534.17	207.07	57.11	269.99
39	533.56	207.22	57.24	269.10	106	533.52	207.30	56.81	269.41	173	533.03	206.83	56.91	269.28
40	533.82	207.42	57.07	269.32	107	533.43	206.82	57.00	269.61	174	533.57	206.91	56.87	269.79
41	533.63	207.18	56.94	269.51	108	533.55	207.43	57.02	269.10	175	532.71	206.99	57.00	268.72
42	533.94	207.76	56.98	269.20	109	533.34	207.33	56.79	269.21	176	533.22	206.96	57.04	269.23
43	534.36	207.45	57.19	269.72	110	533.02	207.23	56.75	269.04	177	532.80	207.13	56.80	268.86
44	533.64	207.33	56.91	269.40	111	532.78	207.17	56.83	268.78	178	533.41	206.89	56.77	269.76
45	532.85	206.73	57.07	269.05	112	533.65	207.29	57.01	269.35	179	533.76	207.18	57.13	269.45
46	533.79	207.63	57.15	269.01	113	532.83	207.08	56.90	268.85	180	534.48	207.46	56.94	270.07
47	532.68	206.83	57.03	268.82	114	533.35	206.72	56.96	269.68	181	532.60	206.77	57.00	268.84
48	533.33	206.87	56.93	269.52	115	533.69	207.10	56.87	269.71	182	534.14	207.20	56.90	270.04
49	533.95	207.60	57.00	269.34	116	533.28	206.99	56.84	269.45	183	534.07	207.07	57.22	269.78
50	532.89	207.25	56.99	268.65	117	533.59	207.42	56.82	269.36	184	533.17	207.22	56.91	269.04
51	533.65	207.37	56.71	269.57	118	533.85	206.86	57.19	269.80	185	533.81	207.28	57.25	269.28
52	533.49	206.86	56.98	269.65	119	533.26	207.15	56.77	269.35	186	533.53	207.25	57.18	269.10
53	533.39	207.32	57.11	268.96	120	534.04	207.35	57.01	269.68	187	533.06	207.40	56.80	268.86
54	533.81	207.14	56.92	269.75	121	532.93	206.93	57.00	269.00	188	533.42	207.01	57.00	269.41
55	533.22	206.86	57.21	269.15	122	533.26	207.17	57.10	268.99	189	533.66	206.96	57.04	269.67
56	534.13	207.35	57.24	269.54	123	533.89	207.39	56.75	269.76	190	532.95	207.19	56.83	268.93
57	533.72	207.23	57.04	269.45	124	533.75	206.95	57.02	269.78	191	532.49	207.34	57.05	268.10
58	534.02	207.50	56.72	269.80	125	534.01	207.34	57.09	269.57	192	533.50	207.26	56.98	269.27
59	533.51	207.25	57.01	269.26	126	533.52	207.13	56.74	269.65	193	533.61	206.87	57.07	269.68
60	533.38	206.89	56.86	269.63	127	533.60	206.88	57.03	269.70	194	532.77	207.23	57.06	268.48
61	533.94	207.15	57.07	269.71	128	533.45	206.97	57.01	269.48	195	533.09	207.10	56.98	269.01
62	532.50	207.10	57.05	268.35	129	533.39	207.17	56.78	269.44	196	533.21	207.17	56.98	269.05
63	533.63	207.03	57.19	269.41	130	533.014	207.16583	56.91667	268.9315	197	532.95	207.03	56.99	268.94
64	533.32	206.93	56.97	269.42	131	533.3975	207.206	57.04267	269.14883	198	533.56	207.26	57.19	269.11
65	533.68	207.22	56.96	269.50	132	533.69467	207.239	56.85333	269.60233	199	486.26	188.74	52.22	245.30
66	532.23	206.74	56.81	268.69	133	533.5325	207.29583	56.93733	269.29933					

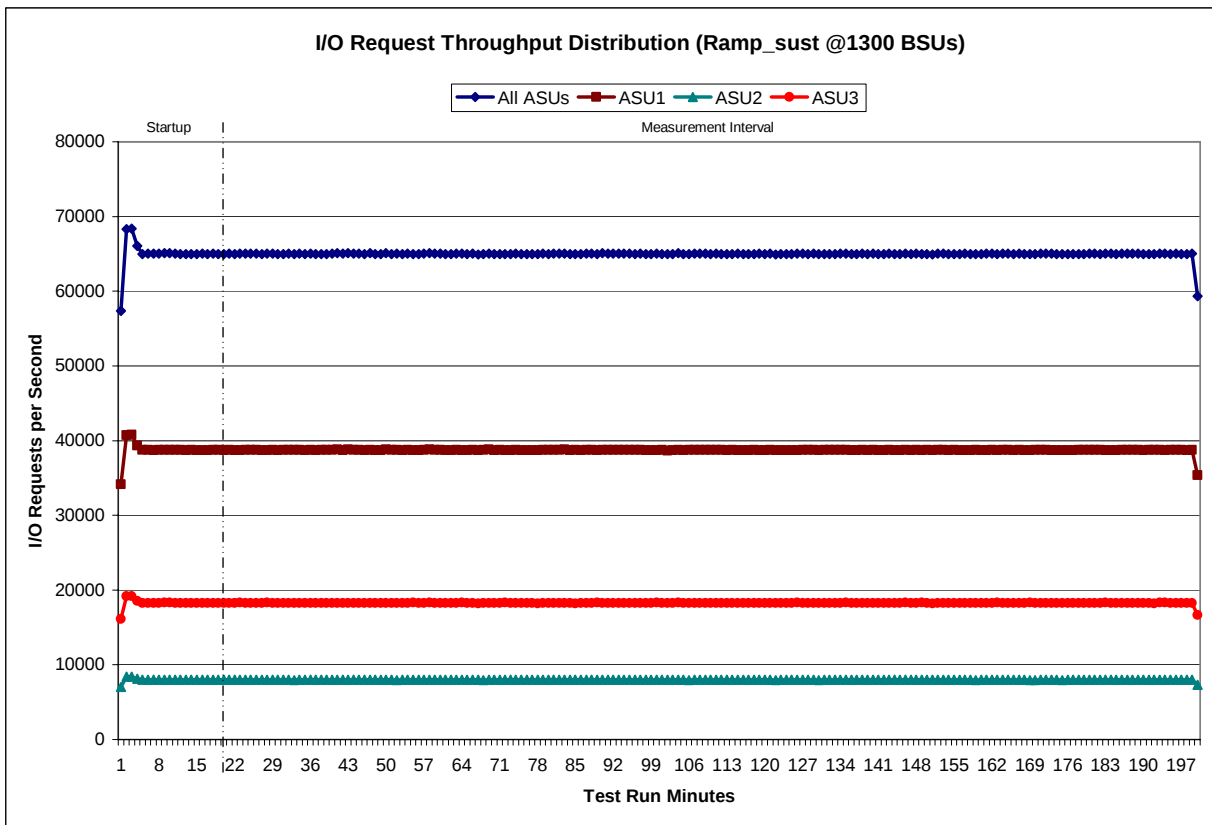
Sustainability – Data Rate Distribution Graph



Sustainability – I/O Request Throughput Distribution Data

Ramp-Up/Start-Up Measurement Interval		Start 15:18:38	Stop 15:38:38	Interval 0-19	Duration 0:20:00									
Measurement Interval		15:38:38	18:38:38	20-199	3:00:00									
Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	57,338.43	34,160.78	7,055.05	16,122.60	67	64,968.93	38,741.62	7,966.72	18,260.60	134	65,028.62	38,736.00	7,990.00	18,302.62
1	68,287.10	40,719.90	8,403.32	19,163.88	68	65,048.53	38,796.33	7,990.97	18,261.23	135	64,976.82	38,705.38	7,986.53	18,284.90
2	68,382.28	40,761.57	8,414.17	19,206.55	69	64,989.00	38,716.05	8,004.95	18,268.00	136	64,994.70	38,716.60	8,000.15	18,277.95
3	66,044.25	39,358.70	8,126.57	18,558.98	70	64,983.62	38,748.38	7,991.13	18,244.10	137	65,016.17	38,771.10	7,993.43	18,251.63
4	64,971.37	38,734.53	7,981.17	18,255.67	71	64,991.37	38,707.82	7,989.57	18,293.98	138	64,968.72	38,727.82	7,999.88	18,241.02
5	65,024.05	38,779.08	8,006.62	18,238.35	72	64,955.27	38,704.25	7,986.85	18,264.17	139	65,007.40	38,757.42	7,993.75	18,256.23
6	65,001.03	38,723.00	8,000.60	18,277.43	73	65,010.28	38,748.82	7,998.47	18,263.00	140	64,962.68	38,711.25	7,992.53	18,258.90
7	65,020.73	38,766.15	7,997.35	18,257.23	74	64,947.45	38,703.63	7,981.63	18,262.18	141	64,970.92	38,728.45	8,001.62	18,240.85
8	65,075.68	38,774.97	8,007.62	18,293.10	75	64,953.13	38,719.42	7,993.72	18,240.00	142	65,016.98	38,762.88	7,994.23	18,259.87
9	65,063.77	38,778.93	7,992.48	18,292.35	76	64,969.92	38,712.28	8,012.27	18,245.37	143	64,961.22	38,700.93	7,994.10	18,266.18
10	65,003.83	38,738.22	7,992.00	18,273.62	77	64,940.18	38,732.38	7,980.50	18,227.30	144	64,994.80	38,725.57	7,985.10	18,284.13
11	64,985.22	38,746.92	7,988.82	18,249.48	78	65,026.60	38,735.78	8,006.67	18,284.15	145	65,029.58	38,759.00	7,980.55	18,290.03
12	64,942.48	38,681.87	7,986.67	18,273.95	79	64,990.10	38,756.57	7,992.53	18,241.00	146	64,982.77	38,728.17	7,989.77	18,264.83
13	64,991.30	38,749.40	7,990.70	18,251.20	80	65,001.38	38,757.63	7,990.57	18,253.18	147	65,052.50	38,775.20	8,012.20	18,265.10
14	64,979.02	38,725.47	7,991.33	18,262.22	81	65,005.45	38,740.72	8,001.88	18,262.85	148	64,996.07	38,726.17	7,982.98	18,286.92
15	65,006.37	38,717.15	8,010.23	18,278.98	82	65,029.25	38,806.62	7,980.80	18,241.83	149	64,970.28	38,735.58	7,983.12	18,251.58
16	64,955.42	38,722.00	7,987.87	18,244.75	83	64,958.52	38,695.97	7,998.30	18,264.25	150	64,927.00	38,713.43	7,986.28	18,227.28
17	65,020.27	38,754.93	7,989.32	18,276.02	84	64,968.17	38,738.38	8,006.72	18,223.07	151	65,036.38	38,767.23	7,989.40	18,279.75
18	64,987.43	38,741.18	7,981.55	18,264.70	85	64,983.93	38,699.60	8,011.73	18,272.60	152	65,006.25	38,759.75	8,008.10	18,238.40
19	64,982.15	38,726.88	8,005.42	18,249.85	86	65,023.48	38,748.82	8,006.25	18,268.42	153	64,951.10	38,688.07	7,992.32	18,270.72
20	65,024.33	38,761.03	8,002.32	18,260.98	87	65,042.93	38,737.80	8,030.47	18,274.67	154	64,989.72	38,750.30	7,988.23	18,251.18
21	64,980.25	38,716.08	8,006.77	18,257.40	88	64,980.23	38,702.62	7,985.98	18,291.63	155	64,985.03	38,720.90	7,983.20	18,280.93
22	65,016.77	38,718.93	8,005.53	18,292.30	89	65,068.80	38,777.87	8,016.32	18,274.62	156	65,004.73	38,728.10	8,014.52	18,262.12
23	65,022.72	38,762.53	8,004.60	18,260.58	90	65,019.68	38,733.33	8,001.75	18,284.60	157	64,971.23	38,716.10	8,011.57	18,243.57
24	65,010.40	38,754.72	8,007.63	18,248.05	91	64,999.17	38,734.78	8,007.23	18,257.15	158	64,991.70	38,754.13	7,970.62	18,266.95
25	65,003.47	38,746.73	7,991.18	18,265.55	92	65,023.60	38,755.73	8,001.12	18,266.75	159	64,980.73	38,717.27	7,989.93	18,273.53
26	64,966.02	38,722.07	7,985.73	18,258.22	93	65,027.00	38,751.00	7,994.00	18,282.00	160	65,024.58	38,728.08	8,013.23	18,283.27
27	65,026.75	38,726.13	8,001.30	18,299.32	94	65,034.72	38,764.17	8,007.38	18,263.17	161	65,029.85	38,763.80	7,988.55	18,277.50
28	65,002.62	38,744.92	7,998.42	18,259.28	95	64,974.78	38,733.62	8,006.85	18,234.32	162	64,996.37	38,703.08	7,996.53	18,296.75
29	64,980.47	38,718.15	8,000.03	18,262.28	96	65,015.40	38,758.57	7,987.00	18,269.83	163	65,032.88	38,759.15	8,001.45	18,272.28
30	64,983.98	38,748.33	7,998.85	18,236.80	97	64,978.15	38,729.47	7,997.03	18,251.65	164	65,044.03	38,760.55	8,021.85	18,261.63
31	65,025.12	38,773.93	8,003.73	18,247.45	98	64,972.28	38,707.80	8,005.48	18,259.00	165	64,974.92	38,688.70	8,007.80	18,278.42
32	64,993.30	38,752.12	7,975.62	18,265.57	99	65,026.87	38,721.40	8,010.00	18,295.47	166	65,037.62	38,783.53	7,984.37	18,269.72
33	65,013.50	38,756.27	7,998.03	18,259.20	100	64,992.48	38,748.08	7,987.18	18,257.22	167	64,946.13	38,688.88	8,000.47	18,256.78
34	64,987.65	38,719.07	7,996.03	18,272.55	101	64,964.65	38,670.97	8,019.50	18,274.18	168	64,977.50	38,719.72	7,967.87	18,289.92
35	65,051.00	38,771.13	8,009.53	18,270.33	102	64,980.33	38,726.05	7,977.77	18,276.52	169	64,970.43	38,744.42	7,973.07	18,252.95
36	64,952.75	38,715.02	7,986.15	18,251.58	103	65,056.42	38,768.27	7,987.90	18,300.25	170	65,029.98	38,743.95	8,005.38	18,280.65
37	64,967.67	38,753.18	7,982.80	18,231.68	104	64,974.57	38,702.83	7,988.10	18,283.63	171	65,001.48	38,750.65	7,996.73	18,254.10
38	64,992.83	38,737.57	7,988.87	18,266.40	105	64,977.48	38,752.80	7,972.02	18,252.67	172	65,012.22	38,724.58	8,015.32	18,272.32
39	65,024.47	38,755.23	7,996.65	18,272.58	106	65,010.38	38,758.45	7,990.97	18,260.97	173	64,962.17	38,726.90	7,986.07	18,249.20
40	65,060.62	38,797.87	8,007.93	18,254.82	107	65,016.83	38,754.17	8,004.33	18,258.33	174	64,980.42	38,732.30	7,975.25	18,272.87
41	65,011.68	38,732.67	7,996.25	18,282.77	108	65,014.60	38,758.55	8,005.38	18,250.67	175	64,966.70	38,724.45	7,993.58	18,248.67
42	65,067.45	38,807.13	8,000.57	18,259.75	109	64,992.05	38,749.60	7,977.67	18,264.78	176	64,960.20	38,703.52	7,989.08	18,267.60
43	65,052.90	38,767.48	8,006.45	18,278.97	110	65,042.10	38,778.75	8,004.08	18,259.27	177	64,987.72	38,758.65	7,982.62	18,246.45
44	65,039.38	38,760.63	7,992.80	18,285.95	111	64,968.23	38,739.05	7,993.87	18,235.32	178	64,993.15	38,740.40	7,992.85	18,259.90
45	64,973.28	38,698.48	7,997.43	18,277.37	112	64,977.95	38,728.72	7,994.93	18,254.30	179	65,018.40	38,764.88	7,977.83	18,275.68
46	65,079.88	38,777.90	8,016.17	18,285.82	113	64,989.95	38,756.43	7,983.40	18,250.12	180	65,026.30	38,765.20	7,982.27	18,278.83
47	64,971.40	38,720.33	7,997.67	18,253.40	114	65,001.23	38,728.10	7,987.98	18,285.15	181	64,990.35	38,757.68	7,998.12	18,234.55
48	64,996.02	38,727.92	8,004.37	18,263.73	115	64,981.70	38,713.13	7,998.08	18,270.48	182	65,014.87	38,704.45	8,000.85	18,309.57
49	65,070.63	38,796.63	7,990.83	18,283.17	116	64,982.18	38,725.27	7,986.92	18,270.00	183	65,015.07	38,719.95	8,012.92	18,282.20
50	64,985.08	38,746.93	7,995.12	18,243.03	117	64,984.10	38,737.82	7,979.22	18,267.07	184	64,965.18	38,730.93	7,994.88	18,239.37
51	65,040.38	38,783.37	7,976.48	18,280.53	118	65,021.08	38,727.78	8,016.45	18,276.85	185	65,037.23	38,767.32	8,010.50	18,259.42
52	64,963.67	38,704.65	7,996.40	18,262.62	119	64,958.42	38,698.10	7,997.90	18,262.42	186	65,021.83	38,760.12	8,000.30	18,261.42
53	65,046.45	38,774.02	8,007.23	18,265.20	120	65,014.48	38,760.43	7,985.47	18,268.58	187	64,997.77	38,764.37	7,987.78	18,245.62
54	64,996.25	38,702.63	7,998.35	18,295.27	121	64,919.62	38,689.27	7,976.03	18,254.32	188	65,023.20	38,753.38	7,993.45	18,276.37
55	64,985.58	38,708.47	7,998.85	18,278.27	122	64,964.77	38,717.65	8,009.02	18,238.10	189	64,948.88	38,683.67	8,002.97	18,262.25
56	65,006.27	38,734.95	7,997.43	18,273.88	123	64,987.63	38,727.20	7,985.97	18,274.47	190	64,990.95	38,746.42	7,992.13	18,252.40
57	65,083.08	38,793.92	7,998.23	18,290.93	124	64,982.42	38,724.37	7,995.03	18,263.02	191	64,973.43	38,742.05	8,003.98	18,227.40
58	65,031.53	38,755.85	7,993.52	18,282.17	125	65,010.78	38,718.33	8,004.62	18,287.83	192	65,018.02	38,738.82	7,991.00	18,288.20
59	65,016.18	38,733.88	8,014.92	18,267.38	126	65,018.88	38,756.33	7,996.55	18,266.00	193	65,003.07	38,713.68	8,002.65	18,286.73
60	64,957.88	38,717.48	7,980.47	18,259.93	127	64,973.03	38,734.45	7,997.07	18,241.52	194	64,994.13	38,758.87	8,000.47	18,235.20
61	64,993.80	38,730.35	8,000.42	18,263.03	128	65,005.80	38,752.15	7,998.20	18,255.45	195	65,022.77	38,758.38	7,996.67	18,267.72
62	65,022.37	38,775.63	8,002.63	18,244.10										

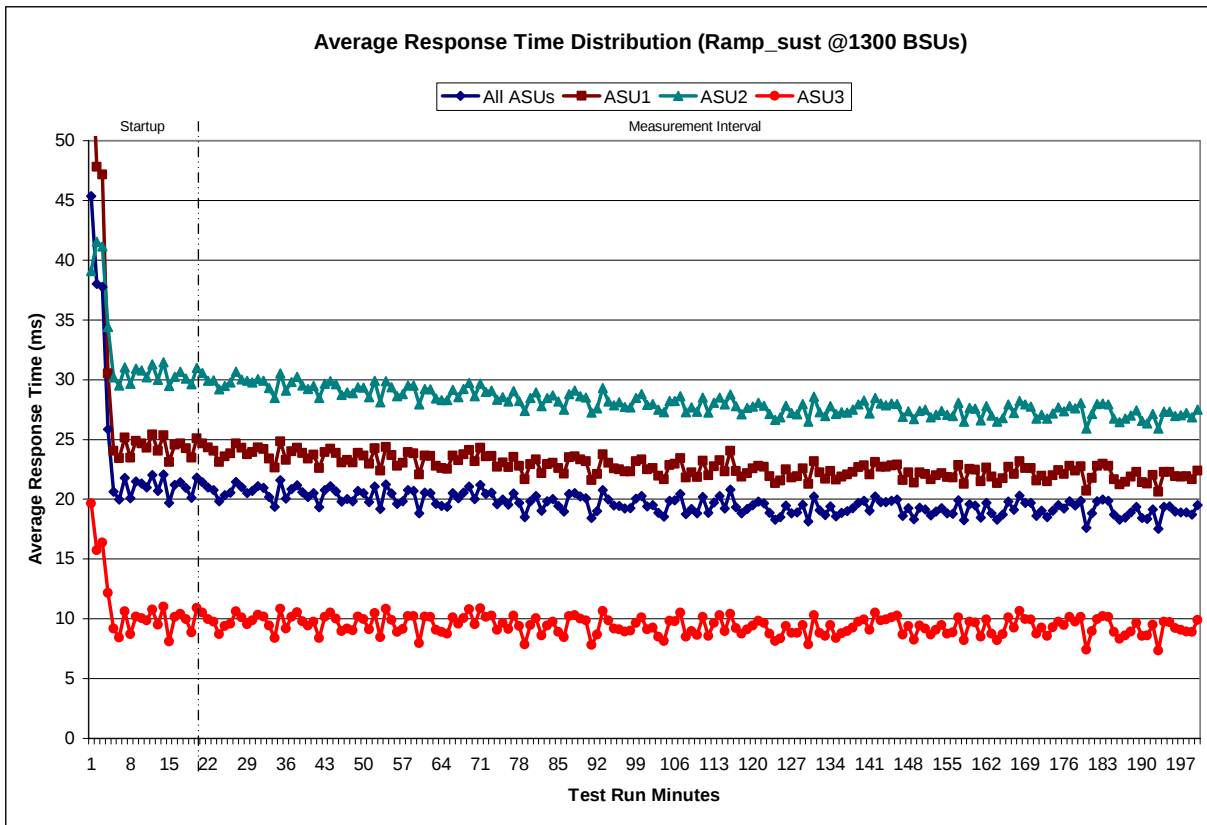
Sustainability – I/O Request Throughput Distribution Graph



Sustainability – Average Response Time (ms) Distribution Data

Ramp-Up/Start-Up Measurement Interval		Start 15:18:38	Stop 15:38:38	Interval 0-19	Duration 0:20:00									
Measurement Interval		15:38:38	18:38:38	20-199	3:00:00									
Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	45.35	58.76	39.09	19.67	67	20.57	23.74	29.25	10.05	134	18.57	21.62	27.13	8.37
1	38.03	47.80	41.53	15.73	68	21.07	24.13	29.72	10.79	135	18.85	21.88	27.29	8.77
2	37.77	47.15	41.15	16.38	69	20.02	23.20	28.61	9.54	136	19.02	22.06	27.26	8.98
3	25.85	30.54	34.41	12.16	70	21.19	24.30	29.67	10.89	137	19.26	22.27	27.49	9.24
4	20.61	24.03	30.22	9.16	71	20.46	23.57	28.97	10.17	138	19.69	22.66	27.95	9.77
5	19.97	23.42	29.50	8.44	72	20.54	23.62	29.07	10.27	139	19.88	22.83	28.24	9.94
6	21.79	25.16	31.04	10.61	73	19.58	22.72	28.33	9.08	140	19.04	22.07	27.16	9.08
7	20.08	23.45	29.67	8.73	74	19.97	23.07	28.56	9.66	141	20.23	23.11	28.47	10.52
8	21.48	24.86	30.91	10.18	75	19.56	22.68	28.17	9.16	142	19.76	22.72	28.01	9.85
9	21.31	24.67	30.77	10.04	76	20.49	23.54	29.04	10.27	143	19.76	22.72	27.85	9.94
10	20.98	24.31	30.21	9.87	77	19.70	22.79	28.22	9.39	144	19.88	22.81	28.01	10.10
11	22.03	25.42	31.29	10.77	78	18.49	21.67	27.38	7.85	145	19.97	22.90	27.98	10.28
12	20.70	24.06	30.00	9.51	79	19.84	22.93	28.46	9.47	146	18.61	21.58	26.88	8.68
13	22.06	25.33	31.45	11.01	80	20.28	23.32	28.93	10.03	147	19.26	22.23	27.35	9.38
14	19.69	23.13	29.47	8.11	81	19.05	22.17	27.78	8.60	148	18.34	21.39	26.70	8.23
15	21.20	24.54	30.23	10.15	82	19.82	22.93	28.46	9.43	149	19.29	22.26	27.40	9.43
16	21.40	24.67	30.66	10.41	83	20.00	23.05	28.70	9.74	150	19.15	22.11	27.49	9.19
17	20.96	24.27	30.11	9.96	84	19.45	22.62	28.20	8.88	151	18.65	21.66	26.86	8.67
18	20.12	23.47	29.62	8.86	85	18.96	22.15	27.51	8.47	152	18.99	21.98	27.08	9.07
19	21.83	25.09	30.98	10.91	86	20.44	23.52	28.81	10.24	153	19.24	22.18	27.38	9.47
20	21.41	24.67	30.55	10.51	87	20.52	23.57	29.08	10.29	154	18.81	21.86	27.07	8.74
21	20.98	24.33	29.91	9.98	88	20.22	23.31	28.63	10.02	155	18.79	21.80	26.98	8.84
22	20.76	24.06	29.96	9.74	89	20.09	23.18	28.49	9.85	156	19.91	22.85	28.08	10.10
23	19.82	23.12	29.20	8.72	90	18.42	21.60	27.27	7.82	157	18.25	21.28	26.50	8.22
24	20.32	23.57	29.46	9.40	91	19.00	22.09	27.61	8.67	158	19.57	22.53	27.66	9.77
25	20.55	23.82	29.77	9.59	92	20.77	23.77	29.29	10.66	159	19.49	22.46	27.58	9.67
26	21.45	24.66	30.67	10.63	93	19.96	23.03	28.20	9.85	160	18.47	21.49	26.61	8.51
27	21.01	24.31	30.02	10.10	94	19.46	22.56	27.88	9.19	161	19.70	22.63	27.80	9.95
28	20.52	23.76	29.91	9.53	95	19.43	22.51	28.11	9.10	162	18.81	21.87	27.01	8.76
29	20.71	23.94	29.78	9.88	96	19.23	22.34	27.73	8.91	163	18.29	21.34	26.50	8.21
30	21.11	24.33	30.07	10.33	97	19.25	22.33	27.67	9.02	164	18.71	21.75	26.80	8.72
31	20.96	24.18	29.93	10.19	98	20.03	23.20	28.46	9.63	165	19.81	22.71	27.92	10.12
32	20.20	23.40	29.32	9.44	99	20.27	23.31	28.78	10.12	166	19.10	22.09	27.20	9.24
33	19.36	22.64	28.46	8.39	100	19.41	22.51	27.88	9.11	167	20.29	23.19	28.23	10.65
34	21.61	24.85	30.51	10.85	101	19.52	22.62	27.96	9.25	168	19.70	22.61	27.94	9.95
35	20.04	23.29	29.09	9.19	102	18.86	21.97	27.49	8.51	169	19.68	22.61	27.74	9.93
36	20.83	24.02	29.79	10.14	103	18.55	21.66	27.27	8.15	170	18.61	21.57	26.75	8.75
37	21.17	24.29	30.24	10.55	104	19.86	22.87	28.22	9.82	171	19.03	21.97	27.06	9.25
38	20.59	23.85	29.53	9.78	105	19.92	22.98	28.21	9.79	172	18.50	21.48	26.75	8.56
39	20.19	23.41	29.23	9.42	106	20.44	23.42	28.61	10.52	173	19.06	21.98	27.18	9.30
40	20.51	23.71	29.49	9.76	107	18.74	21.81	27.27	8.48	174	19.50	22.41	27.67	9.76
41	19.32	22.59	28.46	8.38	108	19.19	22.25	27.68	8.97	175	19.21	22.11	27.37	9.46
42	20.79	23.96	29.67	10.16	109	18.82	21.87	27.32	8.65	176	19.85	22.78	27.80	10.15
43	21.08	24.24	29.89	10.51	110	20.20	23.21	28.52	10.15	177	19.48	22.39	27.63	9.74
44	20.67	23.85	29.63	10.00	111	18.87	21.99	27.26	8.56	178	19.86	22.74	28.04	10.16
45	19.79	23.07	28.73	8.95	112	19.74	22.77	28.09	9.65	179	17.60	20.68	25.93	7.42
46	20.01	23.27	28.93	9.18	113	20.27	23.26	28.51	10.30	180	18.83	21.79	27.14	8.95
47	19.83	23.07	28.85	9.02	114	19.24	22.30	27.92	8.96	181	19.83	22.79	27.98	9.99
48	20.69	23.85	29.37	10.19	115	20.80	24.06	28.77	10.39	182	19.99	22.96	28.00	10.22
49	20.51	23.65	29.35	9.97	116	19.33	22.37	27.78	9.21	183	19.86	22.77	27.94	10.15
50	19.77	22.97	28.56	9.12	117	18.83	21.89	27.09	8.73	184	18.70	21.66	26.75	8.89
51	21.07	24.25	29.90	10.48	118	19.18	22.18	27.64	9.12	185	18.27	21.25	26.47	8.33
52	19.18	22.39	28.13	8.46	119	19.52	22.58	27.77	9.42	186	18.48	21.44	26.74	8.59
53	21.24	24.35	29.89	10.82	120	19.80	22.80	28.06	9.84	187	18.89	21.90	27.00	8.94
54	20.49	23.68	29.38	9.88	121	19.66	22.70	27.83	9.64	188	19.36	22.27	27.43	9.66
55	19.61	22.80	28.61	8.91	122	18.86	21.91	27.15	8.75	189	18.45	21.43	26.57	8.58
56	19.83	23.02	28.79	9.15	123	18.29	21.36	26.63	8.14	190	18.36	21.30	26.33	8.61
57	20.77	23.94	29.52	10.23	124	18.50	21.57	26.86	8.35	191	19.16	22.05	27.14	9.52
58	20.71	23.83	29.51	10.24	125	19.47	22.50	27.81	9.40	192	17.54	20.61	25.92	7.35
59	18.84	22.08	27.93	7.97	126	18.82	21.81	27.20	8.81	193	19.37	22.27	27.33	9.74
60	20.55	23.65	29.24	10.17	127	18.89	21.93	27.12	8.82	194	19.39	22.30	27.34	9.72
61	20.51	23.60	29.18	10.16	128	19.56	22.56	27.98	9.48	195	18.97	21.92	26.94	9.23
62	19.63	22.78	28.42	9.08	129	18.14	21.28	26.49	7.83	196	18.91	21.87	27.04	9.05
63	19.45	22.62	28.28	8.88	130	20.22	23.17	28.58	10.30	197	18.91	21.91	27.20	8.91
64	19.38	22.54	28.29	8.76	131	19.09	22.24	27.28	8.82	198	18.71	21.65	26.84	8.88
65	20.51	23.64	29.14	10.10	132	18.67	21.72	26.96	8.57	199	19.52	22.41	27.49	9.91
66	20.07	23.27	28.56	9.57	133	19.39	22.34	27.79	9.46	Average	19.63	22.70	28.11	9.41

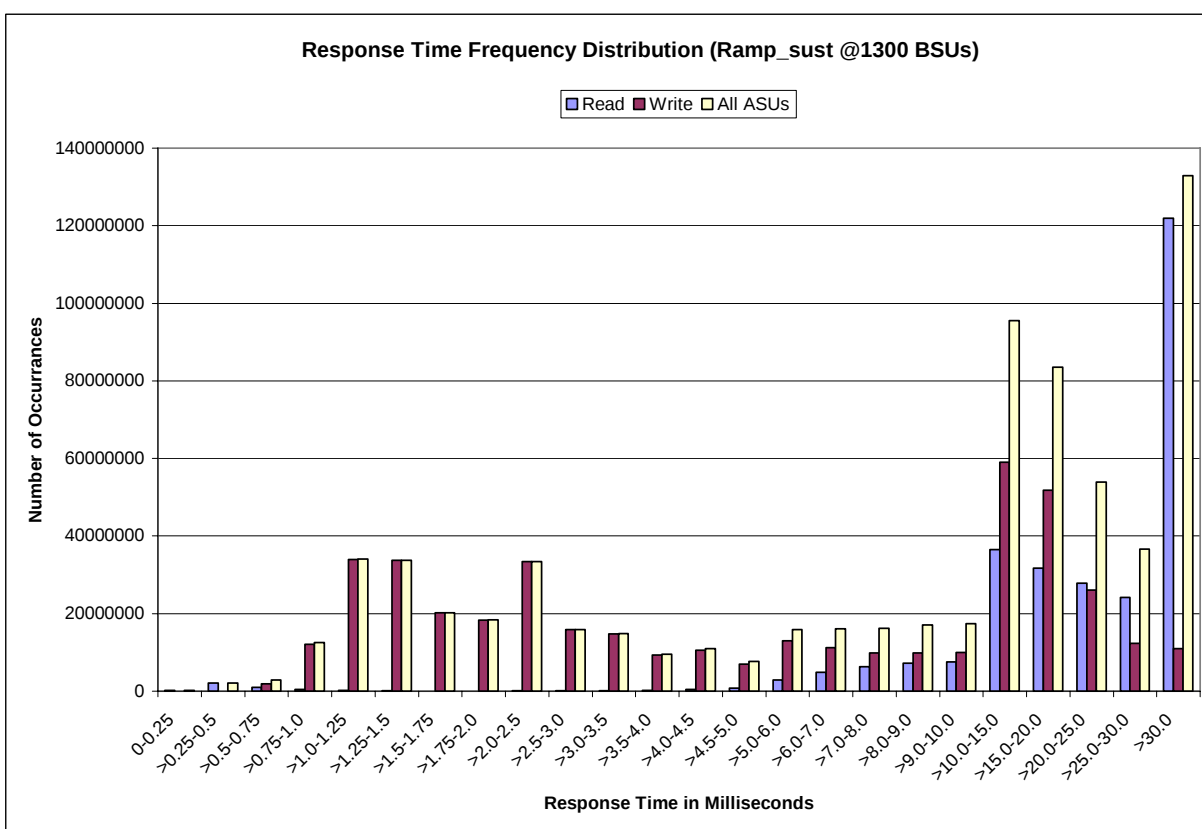
Sustainability – Average Response Time (ms) Distribution Graph



Sustainability – Response Time Frequency Distribution Data

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	173,568	2,147,297	1,023,444	389,962	177,290	85,464	46,380	39,726
Write	-	806	1,842,212	12,135,539	33,906,815	33,680,093	20,144,131	18,351,309
All ASUs	173,568	2,148,103	2,865,656	12,525,501	34,084,105	33,765,557	20,190,511	18,391,035
ASU1	162,408	2,003,503	1,804,880	6,103,175	16,016,969	15,245,479	8,794,972	7,929,285
ASU2	11,160	144,146	279,555	1,497,321	4,012,321	3,754,270	2,130,107	1,898,680
ASU3	-	454	781,221	4,925,005	14,054,815	14,765,808	9,265,432	8,563,070
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	81,735	58,182	110,910	205,568	495,287	721,346	2,875,140	4,880,643
Write	33,337,860	15,818,272	14,801,352	9,299,147	10,486,910	6,981,173	12,962,611	11,180,833
All ASUs	33,419,595	15,876,454	14,912,262	9,504,715	10,982,197	7,702,519	15,837,751	16,061,476
ASU1	14,375,419	6,848,779	6,479,693	4,200,464	4,996,893	3,683,929	8,254,828	9,247,632
ASU2	3,431,334	1,653,480	1,540,493	973,395	1,112,311	779,557	1,626,761	1,712,299
ASU3	15,612,842	7,374,195	6,892,076	4,330,856	4,872,993	3,239,033	5,956,162	5,101,545
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	6,320,375	7,212,755	7,529,894	36,498,028	31,737,863	27,790,114	24,233,917	121,894,529
Write	9,890,404	9,901,893	9,934,375	59,052,865	51,779,905	26,089,029	12,325,410	11,013,617
All ASUs	16,210,779	17,114,648	17,464,269	95,550,893	83,517,768	53,879,143	36,559,327	132,908,146
ASU1	9,916,820	10,653,592	10,904,916	57,264,825	50,134,258	35,162,526	25,647,220	102,342,041
ASU2	1,784,604	1,932,142	1,987,483	10,685,897	8,999,005	6,043,898	4,335,146	23,987,345
ASU3	4,509,355	4,528,914	4,571,870	27,600,171	24,384,505	12,672,719	6,576,961	6,578,760

Sustainability – Response Time Frequency Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	.003	0.001	0.002	0.001	0.004	0.002	0.003	0.001

Primary Metrics Test – IOPS Test Phase

Clause 5.4.2.2

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

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

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

Clause 9.2.4.7.2

For the IOPS Test Phase the FDR shall contain:

- 1. I/O Request Throughput Distribution (data and graph).*
- 2. A Response Time Frequency Distribution.*
- 3. An Average Response Time Distribution.*
- 4. The human readable Test Run Results File produced by the Workload Generator.*
- 5. A listing or screen image of all input parameters supplied to 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 66.

IOPS Test Results File

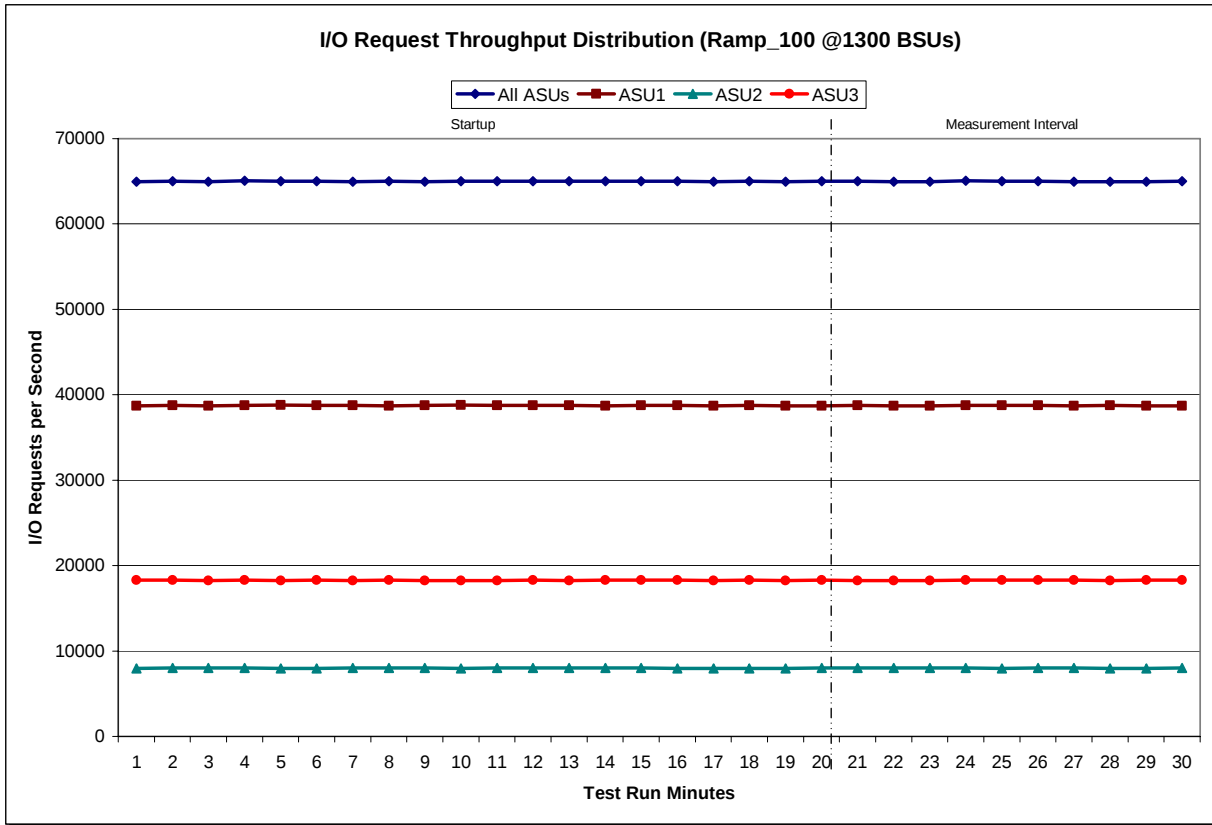
A link to the test results file generated from the IOPS Test Run is listed below.

[IOPS Test Results File](#)

IOPS Test Run – I/O Request Throughput Distribution Data

1300 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	18:38:50	18:58:51	0-19	0:20:01
<i>Measurement Interval</i>	18:58:51	19:08:51	20-29	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	64,978.25	38,720.48	7,987.75	18,270.02
1	65,006.15	38,735.73	7,999.52	18,270.90
2	64,951.85	38,723.75	7,995.05	18,233.05
3	65,079.97	38,775.82	8,022.68	18,281.47
4	65,035.12	38,786.50	7,987.65	18,260.97
5	65,003.88	38,749.33	7,973.05	18,281.50
6	64,961.50	38,748.68	7,989.32	18,223.50
7	64,998.95	38,708.87	7,991.97	18,298.12
8	64,975.60	38,732.23	7,991.03	18,252.33
9	65,019.10	38,779.88	7,973.72	18,265.50
10	65,025.37	38,771.28	8,008.25	18,245.83
11	65,020.13	38,748.58	8,000.40	18,271.15
12	65,003.72	38,731.00	8,013.22	18,259.50
13	65,010.42	38,716.05	8,012.70	18,281.67
14	65,007.50	38,734.62	7,997.72	18,275.17
15	65,009.82	38,750.75	7,979.18	18,279.88
16	64,959.50	38,722.83	7,979.22	18,257.45
17	65,000.10	38,745.57	7,977.57	18,276.97
18	64,954.82	38,711.07	7,983.90	18,259.85
19	65,008.77	38,723.95	8,013.27	18,271.55
20	64,992.12	38,735.23	8,008.27	18,248.62
21	64,954.20	38,690.47	8,001.17	18,262.57
22	64,973.60	38,722.30	7,995.02	18,256.28
23	65,038.33	38,745.42	7,997.93	18,294.98
24	65,005.42	38,752.08	7,984.08	18,269.25
25	65,030.80	38,745.47	7,995.60	18,289.73
26	64,976.03	38,696.93	8,005.22	18,273.88
27	64,980.67	38,746.95	7,966.57	18,267.15
28	64,983.68	38,725.87	7,983.02	18,274.80
29	64,992.82	38,707.77	8,016.05	18,269.00
Average	64,992.77	38,726.85	7,995.29	18,270.63

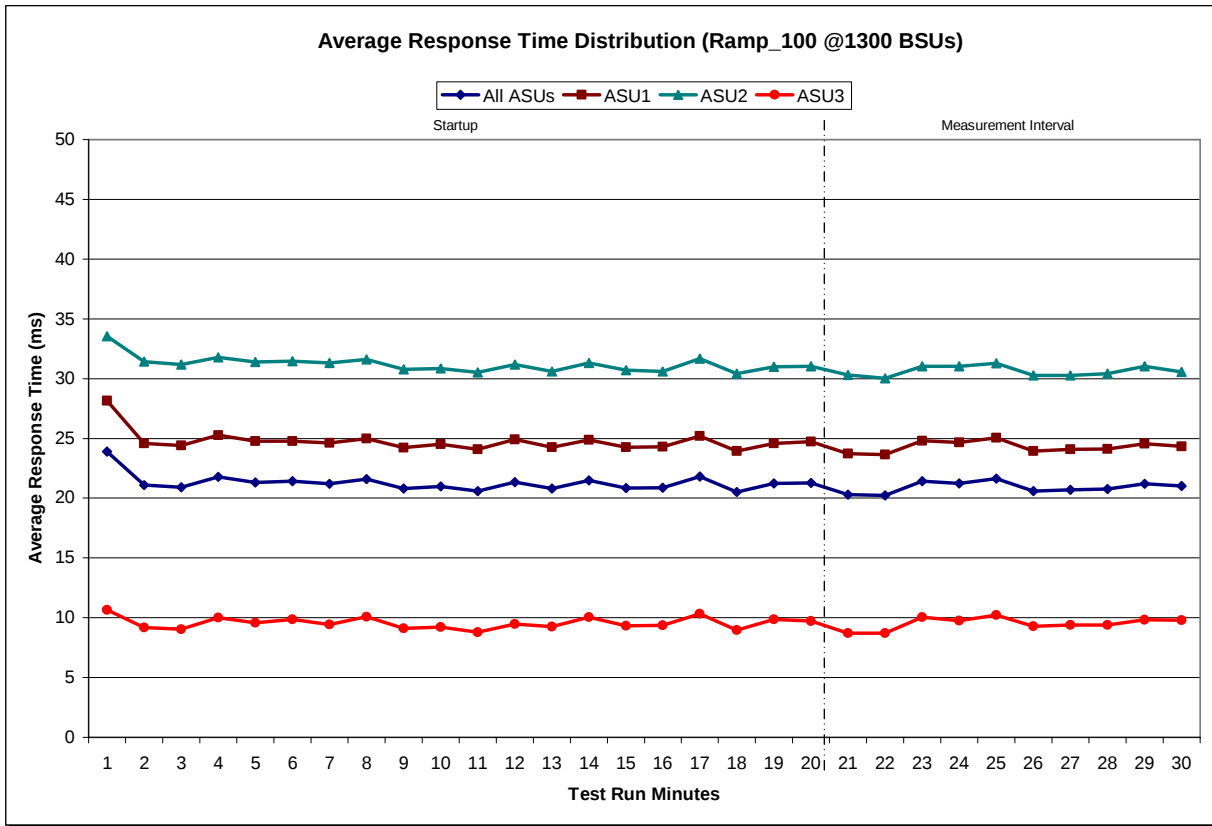
IOPS Test Run – I/O Request Throughput Distribution Graph



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

1300 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	18:38:50	18:58:51	0-19	0:20:01
<i>Measurement Interval</i>	18:58:51	19:08:51	20-29	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	23.90	28.16	33.56	10.64
1	21.10	24.59	31.43	9.18
2	20.93	24.42	31.16	9.02
3	21.78	25.26	31.77	10.01
4	21.31	24.76	31.40	9.58
5	21.40	24.78	31.45	9.85
6	21.19	24.63	31.31	9.44
7	21.59	24.96	31.61	10.07
8	20.79	24.24	30.78	9.11
9	20.99	24.52	30.84	9.21
10	20.57	24.07	30.53	8.78
11	21.34	24.90	31.16	9.48
12	20.82	24.25	30.61	9.26
13	21.49	24.87	31.32	10.03
14	20.85	24.25	30.72	9.33
15	20.87	24.30	30.61	9.35
16	21.83	25.21	31.67	10.35
17	20.54	23.96	30.41	8.97
18	21.24	24.59	30.99	9.86
19	21.28	24.72	31.03	9.71
20	20.32	23.72	30.32	8.70
21	20.24	23.66	30.02	8.71
22	21.41	24.79	31.02	10.05
23	21.24	24.65	31.04	9.75
24	21.64	25.04	31.28	10.21
25	20.60	23.94	30.29	9.29
26	20.70	24.07	30.26	9.39
27	20.76	24.13	30.42	9.41
28	21.21	24.56	31.04	9.83
29	21.02	24.34	30.56	9.79
Average	20.92	24.29	30.63	9.51

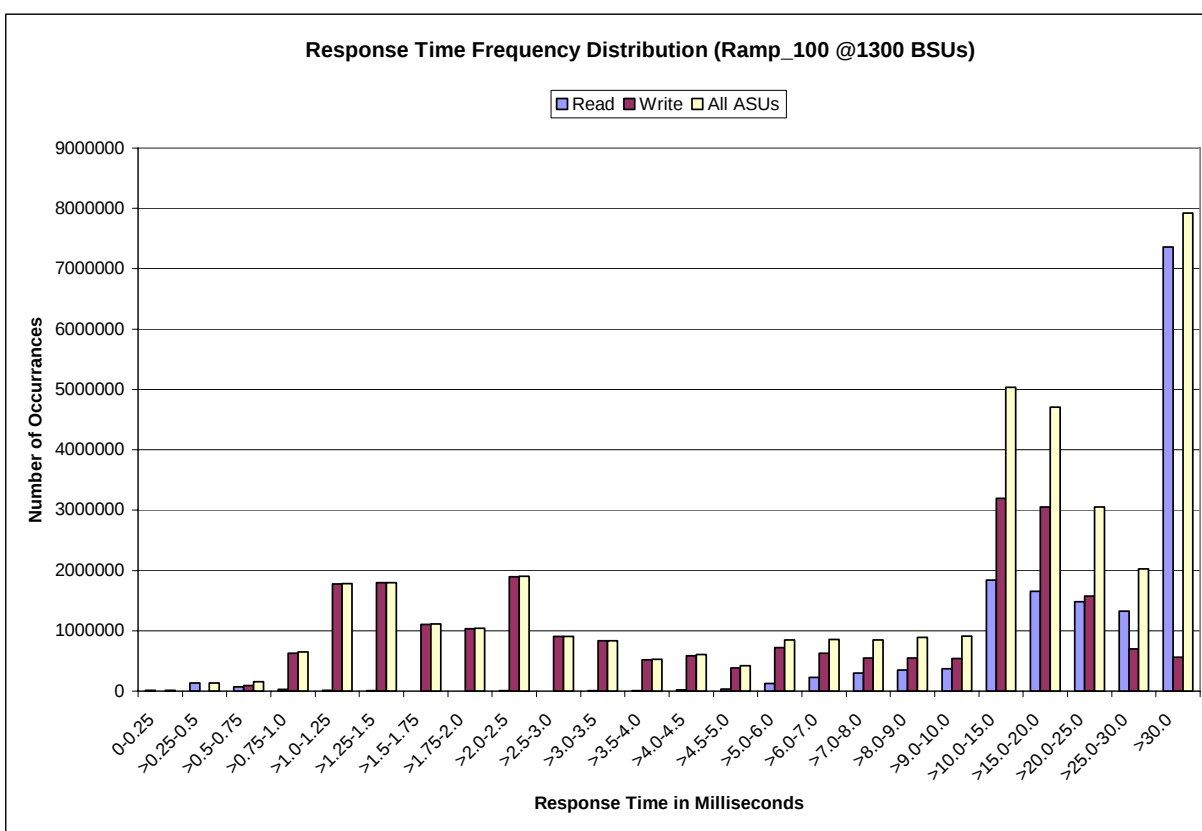
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	11359	138,133	69,007	27,037	12,639	5,921	3,128	2,530
Write	0	54	91,447	624,607	1,773,029	1,794,412	1,106,904	1,036,908
All ASUs	11359	138,187	160,454	651,644	1,785,668	1,800,333	1,110,032	1,039,438
ASU1	10713	129,846	106,885	319,529	838,091	813,958	483,473	449,302
ASU2	646	8,313	14,559	77,590	210,647	201,381	117,936	108,064
ASU3	0	28	39,010	254,525	736,930	784,994	508,623	482,072
Response Time (ms)	>2.0-2.5	>2.5-3.0	>3.0-3.5	>3.5-4.0	>4.0-4.5	>4.5-5.0	>5.0-6.0	>6.0-7.0
Read	5,059	3,288	5,354	9,163	21,664	32,268	130,325	226,346
Write	1,896,401	902,996	832,308	521,154	584,014	387,683	719,383	626,156
All ASUs	1,901,460	906,284	837,662	530,317	605,678	419,951	849,708	852,502
ASU1	820,413	391,396	364,317	233,364	272,958	197,287	431,868	477,688
ASU2	195,564	94,672	86,609	54,496	61,442	42,715	87,429	91,053
ASU3	885,483	420,216	386,736	242,457	271,278	179,949	330,411	283,761
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	297,620	345,919	367,793	1,836,894	1,652,676	1,481,094	1,326,965	7,360,501
Write	550,512	547,393	542,502	3,195,204	3,052,656	1,573,368	697,372	564,968
All ASUs	848,132	893,312	910,295	5,032,098	4,705,332	3,054,462	2,024,337	7,925,469
ASU1	503,879	542,751	557,285	2,972,996	2,761,847	1,965,467	1,420,770	6,168,980
ASU2	93,385	100,769	103,264	562,782	498,986	334,202	234,202	1,416,200
ASU3	250,868	249,792	249,746	1,496,320	1,444,499	754,793	369,365	340,289

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
38,994,114	31,068,645	7,92,469

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
MIM	0.0350	0.2809	0.0700	0.2100	0.0180	0.0700	0.0350	0.2811
COV	0.002	0.001	0.003	0.001	0.004	0.002	0.002	0.001

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.2.3

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

The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 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 66.

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](#)

PRIMARY METRICS TEST – RESPONSE TIME RAMP TEST PHASE TEST PHASE

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.

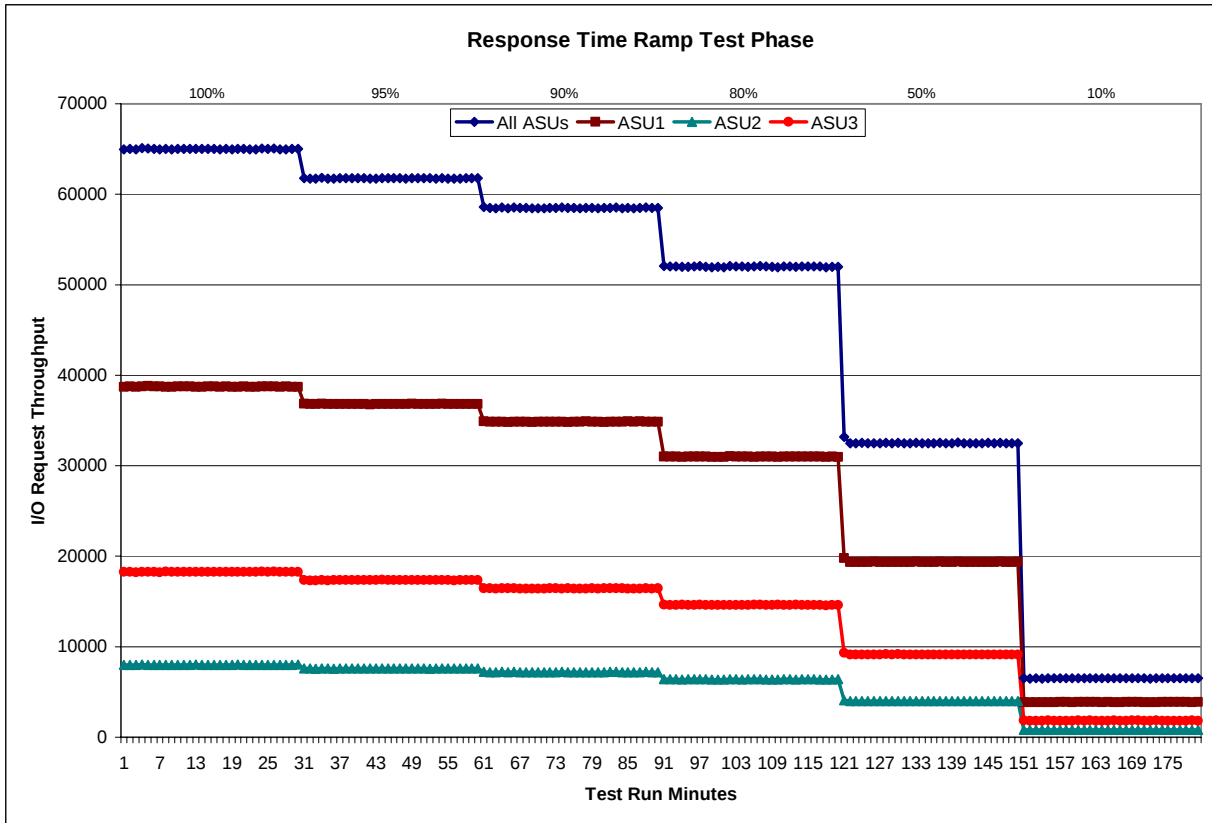
100% Load Level - 1300 BSUs					95% Load Level - 1235 BSUs				
Start-Up/Ramp-Up	Start	Stop	Interval	Duration	Start-Up/Ramp-Up	Start	Stop	Interval	Duration
Measurement Interval	18:38:50	18:58:51	0-19	0:20:01	Measurement Interval	19:09:02	19:29:03	0-19	0:20:01
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3	(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	64,978.25	38,720.48	7,987.75	18,270.02	0	61,790.07	36,843.93	7,598.05	17,348.08
1	65,006.15	38,735.73	7,999.52	18,270.90	1	61,731.98	36,798.43	7,620.95	17,312.60
2	64,951.85	38,723.75	7,995.05	18,233.05	2	61,716.80	36,819.10	7,575.35	17,322.35
3	65,079.97	38,775.82	8,022.68	18,281.47	3	61,799.95	36,843.13	7,611.63	17,345.18
4	65,035.12	38,786.50	7,987.65	18,260.97	4	61,736.48	36,817.27	7,589.37	17,329.85
5	65,003.88	38,749.33	7,973.05	18,281.50	5	61,737.02	36,806.73	7,574.18	17,356.10
6	64,961.50	38,748.68	7,989.32	18,223.50	6	61,751.63	36,817.68	7,595.47	17,338.48
7	64,998.95	38,708.87	7,991.97	18,298.12	7	61,764.22	36,806.65	7,586.30	17,371.27
8	64,975.60	38,732.23	7,991.03	18,252.33	8	61,761.08	36,799.63	7,589.85	17,371.60
9	65,019.10	38,779.88	7,973.72	18,265.50	9	61,771.93	36,817.68	7,613.60	17,340.65
10	65,025.37	38,771.28	8,008.25	18,245.83	10	61,777.00	36,807.78	7,610.92	17,358.30
11	65,020.13	38,748.58	8,000.40	18,271.15	11	61,738.93	36,771.60	7,589.45	17,377.88
12	65,003.72	38,731.00	8,013.22	18,259.50	12	61,746.70	36,784.37	7,618.47	17,343.87
13	65,010.42	38,716.05	8,012.70	18,281.67	13	61,792.77	36,797.67	7,600.90	17,394.20
14	65,007.50	38,734.62	7,997.72	18,275.17	14	61,749.53	36,812.80	7,592.75	17,343.98
15	65,009.82	38,750.75	7,979.18	18,279.88	15	61,772.67	36,803.93	7,626.67	17,342.07
16	64,959.50	38,722.83	7,979.22	18,257.45	16	61,763.97	36,822.37	7,600.73	17,340.87
17	65,000.10	38,745.57	7,977.57	18,276.97	17	61,745.50	36,807.75	7,603.20	17,334.55
18	64,954.82	38,711.07	7,983.90	18,259.85	18	61,790.50	36,840.25	7,605.03	17,345.22
19	65,008.77	38,723.95	8,013.27	18,271.55	19	61,758.55	36,827.48	7,590.32	17,340.75
20	64,992.12	38,735.23	8,008.27	18,248.62	20	61,767.80	36,822.08	7,605.15	17,340.57
21	64,954.20	38,690.47	8,001.17	18,262.57	21	61,758.97	36,801.57	7,582.62	17,374.78
22	64,973.60	38,722.30	7,995.02	18,256.28	22	61,735.85	36,793.47	7,598.35	17,344.03
23	65,038.33	38,745.42	7,997.93	18,294.98	23	61,789.73	36,831.02	7,590.18	17,368.53
24	65,005.42	38,752.08	7,984.08	18,269.25	24	61,741.98	36,796.23	7,591.37	17,354.38
25	65,030.80	38,745.47	7,995.60	18,289.73	25	61,735.82	36,792.92	7,613.38	17,329.52
26	64,976.03	38,696.93	8,005.22	18,273.88	26	61,720.07	36,786.87	7,588.52	17,344.68
27	64,980.67	38,746.95	7,966.57	18,267.15	27	61,760.00	36,810.25	7,586.97	17,362.78
28	64,983.68	38,725.87	7,983.02	18,274.80	28	61,788.25	36,811.12	7,614.73	17,362.40
29	64,992.82	38,707.77	8,016.05	18,269.00	29	61,763.33	36,819.55	7,598.28	17,345.50
Average	64,992.77	38,726.85	7,995.29	18,270.63	Average	61,756.18	36,806.51	7,596.96	17,352.72

90% Load Level - 1170 BSUs					80% Load Level - 1040 BSUs				
Start-Up/Ramp-Up	Start	Stop	Interval	Duration	Start-Up/Ramp-Up	Start	Stop	Interval	Duration
Measurement Interval	19:39:11	19:59:12	0-19	0:20:01	Measurement Interval	20:09:25	20:29:26	0-19	0:20:01
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3	(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	58,573.02	34,892.28	7,207.97	16,472.77	0	52,078.58	31,010.88	6,404.35	14,663.35
1	58,488.42	34,860.80	7,192.50	16,435.12	1	52,002.22	30,995.35	6,401.78	14,605.08
2	58,467.55	34,851.83	7,200.52	16,415.20	2	52,010.07	31,001.32	6,401.92	14,606.83
3	58,529.65	34,870.32	7,206.87	16,452.47	3	51,995.87	30,956.10	6,393.27	14,646.50
4	58,451.20	34,830.42	7,177.07	16,443.72	4	51,997.45	30,989.93	6,398.57	14,608.95
5	58,528.40	34,866.35	7,223.45	16,438.60	5	52,030.43	31,001.37	6,407.60	14,621.47
6	58,473.47	34,859.55	7,199.68	16,414.23	6	52,059.52	31,022.32	6,402.77	14,634.43
7	58,477.37	34,867.85	7,189.12	16,420.40	7	51,994.43	30,997.80	6,398.25	14,598.38
8	58,424.22	34,820.40	7,175.33	16,428.48	8	51,951.92	30,975.62	6,390.25	14,586.05
9	58,455.28	34,857.93	7,182.92	16,414.43	9	51,960.62	30,979.30	6,387.75	14,593.57
10	58,449.97	34,851.38	7,178.45	16,420.13	10	51,938.53	30,954.08	6,377.73	14,606.72
11	58,497.92	34,858.72	7,191.33	16,447.87	11	52,062.73	31,045.50	6,413.12	14,604.12
12	58,511.23	34,867.82	7,199.87	16,443.55	12	52,020.05	31,008.62	6,404.60	14,606.83
13	58,526.32	34,877.87	7,219.65	16,428.80	13	52,003.43	30,988.80	6,392.18	14,622.45
14	58,492.82	34,823.42	7,198.48	16,470.92	14	51,997.97	30,994.83	6,398.60	14,604.53
15	58,479.02	34,864.97	7,191.57	16,422.48	15	52,015.50	30,977.20	6,397.65	14,640.65
16	58,424.25	34,838.25	7,173.60	16,412.40	16	52,074.33	31,026.30	6,410.02	14,638.02
17	58,486.55	34,890.63	7,186.33	16,409.58	17	52,025.35	31,018.77	6,387.15	14,619.43
18	58,479.28	34,856.65	7,190.10	16,432.53	18	51,982.98	30,987.07	6,389.47	14,606.45
19	58,446.77	34,867.67	7,191.02	16,388.08	19	51,945.57	30,943.17	6,379.20	14,623.20
20	58,473.82	34,824.72	7,201.03	16,448.07	20	52,021.02	30,998.50	6,404.87	14,617.65
21	58,481.75	34,839.82	7,204.58	16,437.35	21	52,045.10	31,026.67	6,397.38	14,621.05
22	58,518.63	34,873.42	7,208.85	16,436.37	22	51,993.38	30,991.48	6,377.45	14,624.45
23	58,462.88	34,837.05	7,182.08	16,443.75	23	52,009.63	30,993.55	6,400.37	14,615.72
24	58,509.05	34,902.92	7,191.93	16,414.20	24	52,025.92	31,022.53	6,400.00	14,603.38
25	58,452.93	34,865.27	7,174.78	16,412.88	25	52,005.98	30,987.78	6,404.98	14,613.22
26	58,508.43	34,895.50	7,203.03	16,409.90	26	52,004.35	31,020.18	6,384.68	14,599.48
27	58,536.93	34,871.33	7,212.45	16,453.15	27	51,934.27	30,972.50	6,392.80	14,568.97
28	58,485.15	34,872.17	7,190.60	16,422.38	28	51,995.65	31,002.68	6,390.45	14,602.52
29	58,506.73	34,871.70	7,197.63	16,437.40	29	51,976.47	30,981.52	6,413.78	14,581.17
Average	58,493.63	34,865.39	7,196.70	16,431.55	Average	52,001.18	30,999.74	6,396.68	14,604.76

Response Time Ramp Distribution (IOPS) Data (cont)

50% Load Level - 650 BSUs					10% Load Level - 130 BSUs				
Start	Stop	Interval	Duration		Start	Stop	Interval	Duration	
20:44:18	21:04:19	0-19	0:20:01		21:18:40	21:38:41	0-19	0:20:01	
Start-Up/Ramp-Up					Start-Up/Ramp-Up				
Measurement Interval					Measurement Interval				
(60 second intervals)					(60 second intervals)				
All ASUs	ASU-1	ASU-2	ASU-3		All ASUs	ASU-1	ASU-2	ASU-3	
0	33,187.92	19,762.32	4,100.63	9,324.97	0	6,497.77	3,864.63	798.77	1,834.37
1	32,497.23	19,367.55	3,994.35	9,135.33	1	6,484.82	3,865.55	795.73	1,823.53
2	32,488.62	19,365.20	3,999.00	9,124.42	2	6,498.40	3,874.10	794.95	1,829.35
3	32,512.08	19,367.58	4,016.97	9,127.53	3	6,488.15	3,863.20	800.12	1,824.83
4	32,482.97	19,368.73	4,000.67	9,113.57	4	6,503.75	3,868.83	800.95	1,833.97
5	32,496.85	19,379.50	4,010.35	9,107.00	5	6,493.78	3,862.07	803.17	1,828.55
6	32,470.92	19,348.05	3,994.35	9,128.52	6	6,501.17	3,882.20	798.20	1,820.77
7	32,520.55	19,364.82	3,995.33	9,160.40	7	6,510.97	3,881.95	800.07	1,828.95
8	32,466.48	19,349.57	3,982.68	9,134.23	8	6,497.22	3,872.90	808.13	1,816.18
9	32,534.18	19,368.42	4,006.22	9,159.55	9	6,508.00	3,878.58	796.50	1,832.92
10	32,462.77	19,349.72	3,984.62	9,128.43	10	6,501.10	3,878.38	798.18	1,824.53
11	32,481.68	19,365.60	3,993.78	9,122.30	11	6,518.90	3,879.07	803.20	1,836.63
12	32,514.80	19,391.83	3,998.53	9,124.43	12	6,492.68	3,877.63	796.18	1,818.87
13	32,485.43	19,360.37	4,003.78	9,121.28	13	6,495.57	3,874.22	801.83	1,819.52
14	32,497.55	19,369.65	3,993.98	9,133.92	14	6,504.87	3,880.55	801.08	1,823.23
15	32,497.00	19,373.30	4,010.57	9,113.13	15	6,515.28	3,874.68	803.10	1,837.50
16	32,528.95	19,415.65	3,989.63	9,123.67	16	6,501.03	3,874.33	802.17	1,824.53
17	32,457.77	19,347.65	3,993.62	9,116.50	17	6,510.78	3,883.67	798.20	1,828.92
18	32,502.23	19,370.27	4,008.43	9,123.53	18	6,507.08	3,876.27	797.15	1,833.67
19	32,554.40	19,410.02	3,996.08	9,148.30	19	6,511.22	3,877.68	798.40	1,835.13
20	32,489.70	19,368.22	3,993.23	9,128.25	20	6,491.57	3,865.43	800.42	1,825.72
21	32,462.28	19,358.92	3,987.92	9,115.45	21	6,482.37	3,866.92	799.07	1,816.38
22	32,482.07	19,358.27	3,993.07	9,130.73	22	6,503.30	3,866.67	796.20	1,840.43
23	32,495.77	19,376.27	4,004.80	9,114.70	23	6,503.25	3,879.15	795.07	1,829.03
24	32,503.60	19,367.25	4,004.75	9,131.60	24	6,504.75	3,882.23	799.45	1,823.07
25	32,495.78	19,347.90	3,999.78	9,148.10	25	6,496.83	3,875.88	795.62	1,825.33
26	32,514.93	19,382.62	3,991.58	9,140.73	26	6,498.50	3,878.12	796.87	1,823.52
27	32,481.72	19,359.80	3,984.93	9,136.98	27	6,505.95	3,883.10	793.85	1,829.00
28	32,486.05	19,343.72	4,000.43	9,141.90	28	6,511.82	3,872.07	804.37	1,835.38
29	32,490.42	19,378.48	3,978.83	9,133.10	29	6,512.10	3,892.37	796.60	1,823.13
Average	32,490.23	19,364.14	3,993.93	9,132.16	Average	6,501.04	3,876.19	797.75	1,827.10

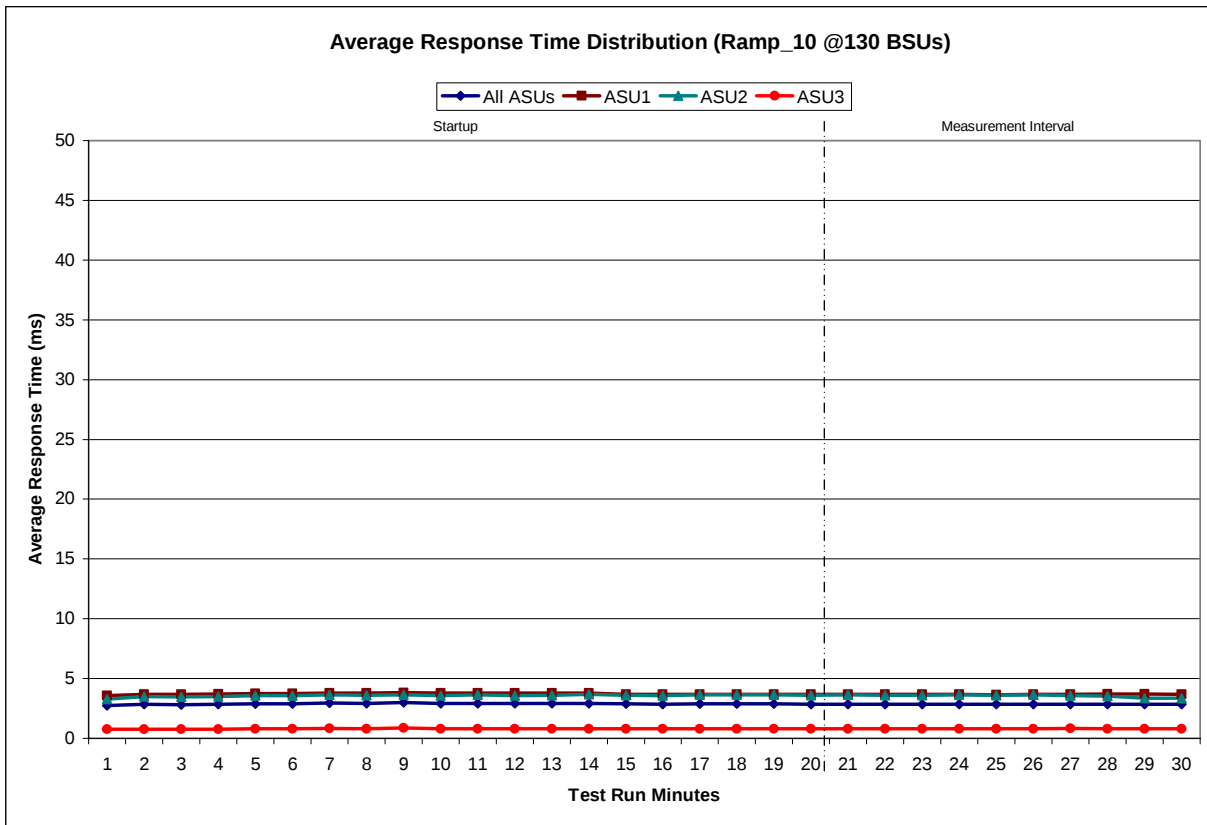
Response Time Ramp Distribution (IOPS) Graph



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

130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:18:40	21:38:41	0-19	0:20:01
Measurement Interval	21:38:41	21:48:41	20-29	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	2.73	3.56	3.27	0.75
1	2.83	3.68	3.48	0.76
2	2.82	3.66	3.46	0.76
3	2.85	3.69	3.48	0.77
4	2.88	3.74	3.57	0.78
5	2.89	3.74	3.56	0.78
6	2.94	3.79	3.62	0.84
7	2.91	3.77	3.60	0.79
8	2.98	3.83	3.64	0.87
9	2.91	3.77	3.56	0.79
10	2.92	3.78	3.62	0.80
11	2.90	3.77	3.57	0.79
12	2.93	3.79	3.62	0.79
13	2.92	3.77	3.66	0.79
14	2.86	3.69	3.59	0.79
15	2.84	3.67	3.57	0.79
16	2.87	3.69	3.63	0.79
17	2.87	3.69	3.65	0.79
18	2.87	3.68	3.63	0.81
19	2.84	3.66	3.59	0.78
20	2.85	3.67	3.62	0.79
21	2.85	3.66	3.59	0.79
22	2.84	3.66	3.60	0.79
23	2.85	3.66	3.63	0.79
24	2.84	3.65	3.59	0.79
25	2.86	3.67	3.62	0.81
26	2.85	3.66	3.57	0.81
27	2.86	3.69	3.52	0.79
28	2.84	3.70	3.36	0.79
29	2.83	3.68	3.34	0.79
Average	2.85	3.67	3.55	0.79

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



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

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
MIM	0.0349	0.2812	0.0699	0.2103	0.0179	0.0699	0.0349	0.2810
COV	0.011	0.003	0.006	0.003	0.015	0.006	0.006	0.003

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 66.

Repeatability Test Results File

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

	SPC-1 IOPS™
Primary Metrics	64,992.77
Repeatability Test Phase 1	65,003.24
Repeatability Test Phase 2	64,998.66

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

	SPC-1 LRT™
Primary Metrics	2.85 ms
Repeatability Test Phase 1	2.88 ms
Repeatability Test Phase 2	2.86 ms

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

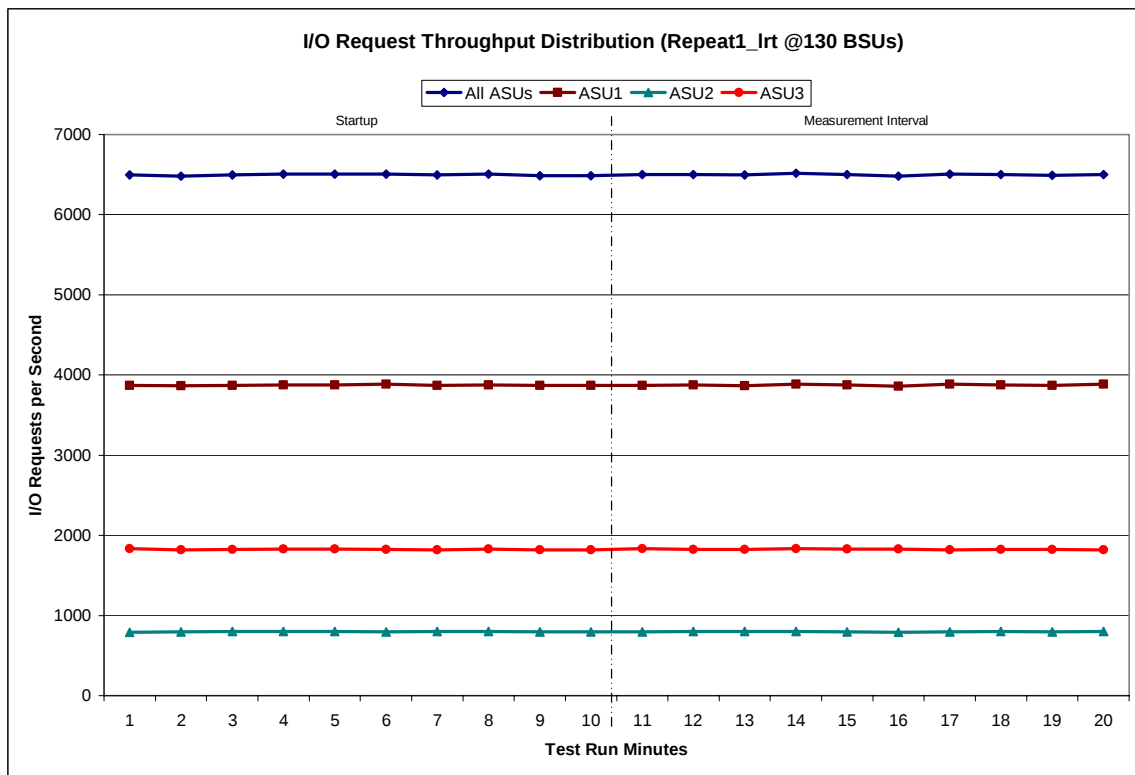
A link to the test result file generated from each Repeatability Test Run is listed below.

[Repeatability Test Phase 1, Test Run 1 \(LRT\)](#)
[Repeatability Test Phase 1, Test Run 2 \(IOPS\)](#)
[Repeatability Test Phase 2, Test Run 1 \(LRT\)](#)
[Repeatability Test Phase 2, Test Run 2 \(IOPS\)](#)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:48:59	21:58:59	0-9	0:10:00
Measurement Interval	21:58:59	22:08:59	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	6,497.73	3,870.48	793.03	1,834.22
1	6,481.98	3,864.70	798.15	1,819.13
2	6,494.90	3,871.55	799.67	1,823.68
3	6,507.82	3,875.12	801.63	1,831.07
4	6,505.85	3,874.70	802.50	1,828.65
5	6,507.67	3,887.77	795.60	1,824.30
6	6,494.78	3,869.95	803.60	1,821.23
7	6,504.25	3,875.58	798.98	1,829.68
8	6,486.78	3,870.67	795.33	1,820.78
9	6,487.60	3,868.55	798.25	1,820.80
10	6,498.63	3,868.02	798.60	1,832.02
11	6,499.25	3,875.02	802.37	1,821.87
12	6,494.65	3,867.83	801.37	1,825.45
13	6,517.30	3,883.02	799.13	1,835.15
14	6,498.62	3,876.10	794.30	1,828.22
15	6,482.35	3,862.15	791.28	1,828.92
16	6,505.12	3,886.00	797.63	1,821.48
17	6,500.03	3,873.67	803.43	1,822.93
18	6,488.95	3,869.57	794.25	1,825.13
19	6,503.30	3,886.47	799.62	1,817.22
Average	6,498.82	3,874.78	798.20	1,825.84

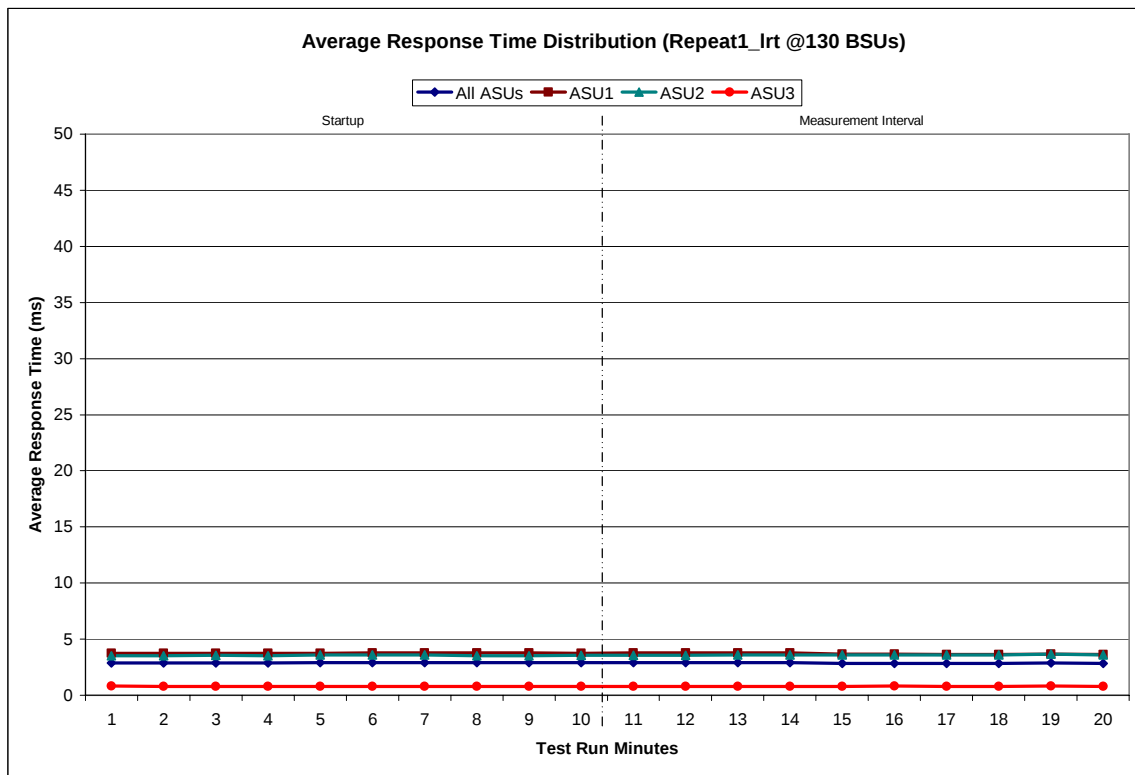
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:48:59	21:58:59	0-9	0:10:00
Measurement Interval	21:58:59	22:08:59	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	2.90	3.76	3.53	0.81
1	2.88	3.75	3.51	0.78
2	2.90	3.75	3.57	0.78
3	2.89	3.76	3.54	0.78
4	2.90	3.76	3.59	0.79
5	2.91	3.76	3.60	0.79
6	2.93	3.79	3.58	0.81
7	2.90	3.77	3.53	0.79
8	2.91	3.78	3.53	0.79
9	2.90	3.76	3.55	0.78
10	2.91	3.78	3.56	0.79
11	2.91	3.77	3.55	0.79
12	2.93	3.79	3.59	0.80
13	2.91	3.77	3.59	0.79
14	2.85	3.67	3.60	0.79
15	2.86	3.68	3.61	0.81
16	2.84	3.64	3.60	0.79
17	2.84	3.64	3.58	0.79
18	2.88	3.68	3.67	0.84
19	2.85	3.65	3.60	0.79
Average	2.88	3.71	3.60	0.80

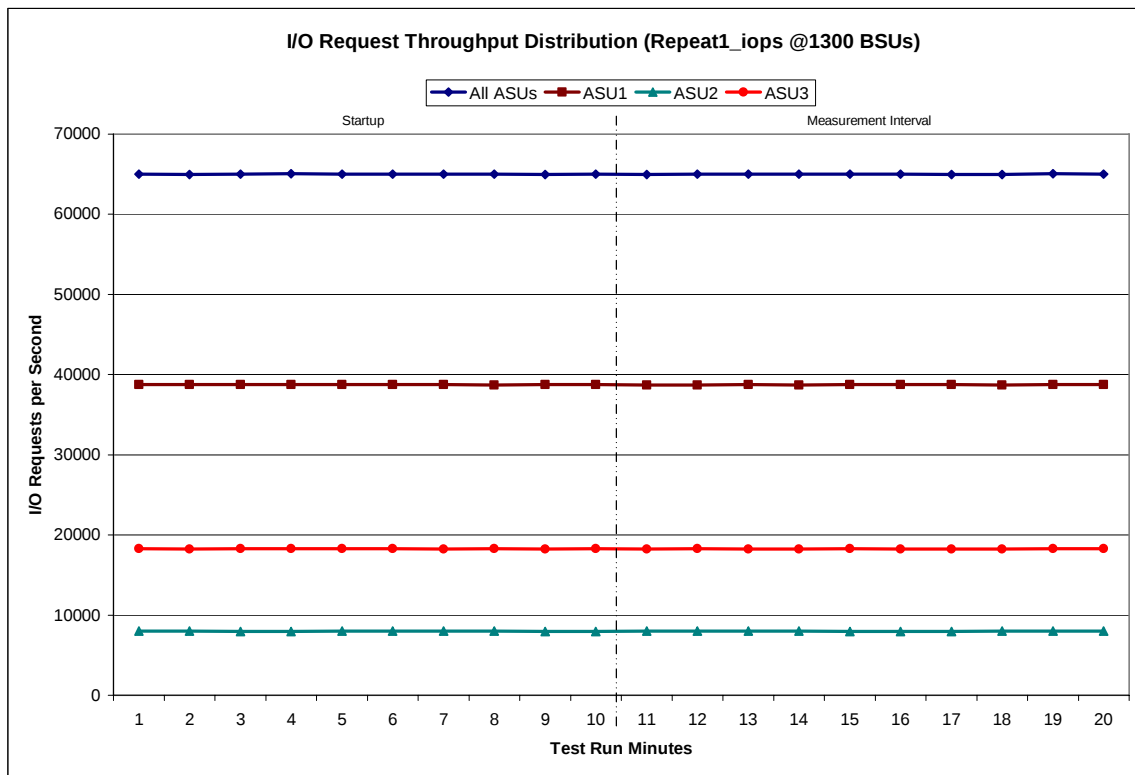
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

1300 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:09:07	22:19:08	0-9	0:10:01
Measurement Interval	22:19:08	22:29:08	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	65,015.88	38,742.52	8,000.37	18,273.00
1	64,967.17	38,735.00	7,991.55	18,240.62
2	65,033.37	38,763.87	7,986.15	18,283.35
3	65,042.30	38,768.10	7,987.60	18,286.60
4	64,997.35	38,729.53	7,992.35	18,275.47
5	65,006.92	38,736.23	7,991.83	18,278.85
6	64,995.67	38,762.38	7,993.68	18,239.60
7	65,002.90	38,720.85	8,000.95	18,281.10
8	64,958.68	38,742.80	7,969.00	18,246.88
9	64,987.83	38,732.10	7,978.83	18,276.90
10	64,963.45	38,711.97	7,998.38	18,253.10
11	65,002.17	38,728.82	8,004.50	18,268.85
12	65,010.08	38,767.68	7,988.95	18,253.45
13	64,989.02	38,725.45	7,996.18	18,267.38
14	65,032.70	38,764.90	7,983.98	18,283.82
15	65,007.57	38,775.87	7,975.62	18,256.08
16	64,982.88	38,740.68	7,977.70	18,264.50
17	64,976.35	38,716.67	7,991.50	18,268.18
18	65,054.30	38,771.93	8,012.28	18,270.08
19	65,013.90	38,730.87	8,000.02	18,283.02
Average	65,003.24	38,743.48	7,992.91	18,266.85

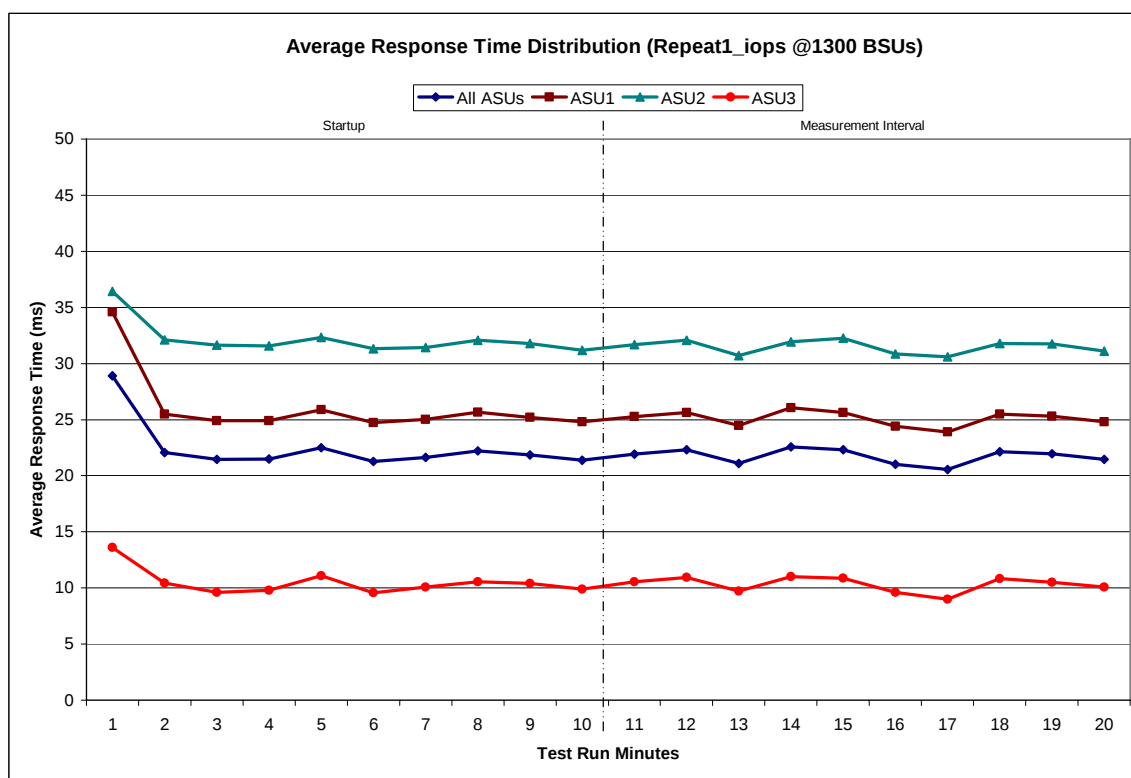
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

1300 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:09:07	22:19:08	0-9	0:10:01
Measurement Interval	22:19:08	22:29:08	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	28.92	34.59	36.41	13.60
1	22.08	25.49	32.10	10.44
2	21.44	24.92	31.63	9.63
3	21.48	24.91	31.57	9.80
4	22.50	25.87	32.33	11.07
5	21.27	24.73	31.32	9.56
6	21.62	25.03	31.42	10.08
7	22.21	25.66	32.07	10.56
8	21.86	25.20	31.79	10.41
9	21.40	24.80	31.18	9.92
10	21.92	25.27	31.68	10.55
11	22.31	25.65	32.07	10.96
12	21.10	24.48	30.72	9.71
13	22.55	26.05	31.95	11.03
14	22.30	25.64	32.25	10.88
15	21.03	24.39	30.86	9.61
16	20.54	23.91	30.61	9.01
17	22.14	25.47	31.78	10.85
18	21.95	25.32	31.74	10.51
19	21.44	24.79	31.12	10.09
Average	21.73	25.10	31.48	10.32

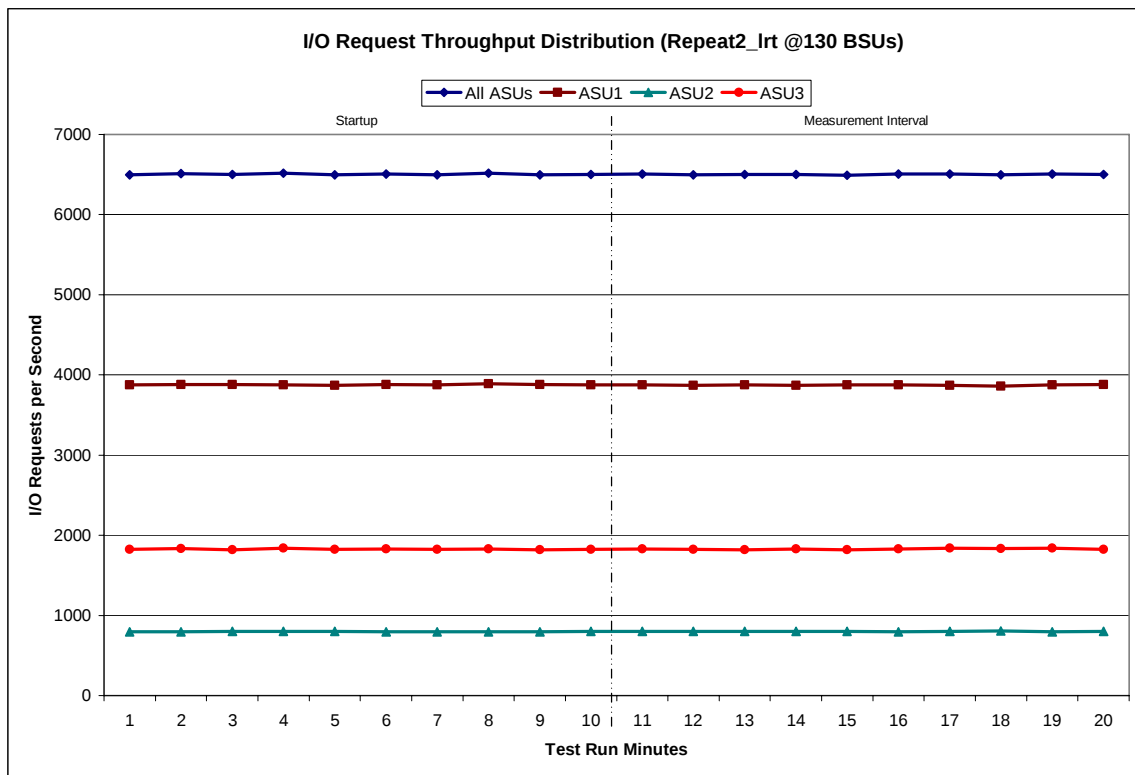
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:29:18	22:39:18	0-9	0:10:00
Measurement Interval	22:39:18	22:49:18	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	6,495.90	3,873.25	796.30	1,826.35
1	6,513.38	3,882.02	797.68	1,833.68
2	6,499.42	3,880.93	799.92	1,818.57
3	6,513.77	3,877.45	799.10	1,837.22
4	6,496.15	3,872.02	799.70	1,824.43
5	6,506.82	3,882.88	797.07	1,826.87
6	6,497.07	3,875.10	795.67	1,826.30
7	6,518.62	3,888.73	798.10	1,831.78
8	6,498.22	3,881.52	796.03	1,820.67
9	6,500.12	3,873.20	800.67	1,826.25
10	6,506.28	3,876.52	802.47	1,827.30
11	6,496.63	3,869.65	801.20	1,825.78
12	6,499.32	3,877.78	800.47	1,821.07
13	6,500.68	3,868.78	801.20	1,830.70
14	6,492.17	3,873.68	801.70	1,816.78
15	6,505.57	3,876.23	798.35	1,830.98
16	6,508.27	3,868.60	800.58	1,839.08
17	6,497.38	3,860.50	804.58	1,832.30
18	6,507.65	3,874.27	794.23	1,839.15
19	6,500.85	3,879.50	798.85	1,822.50
Average	6,501.48	3,872.55	800.36	1,828.57

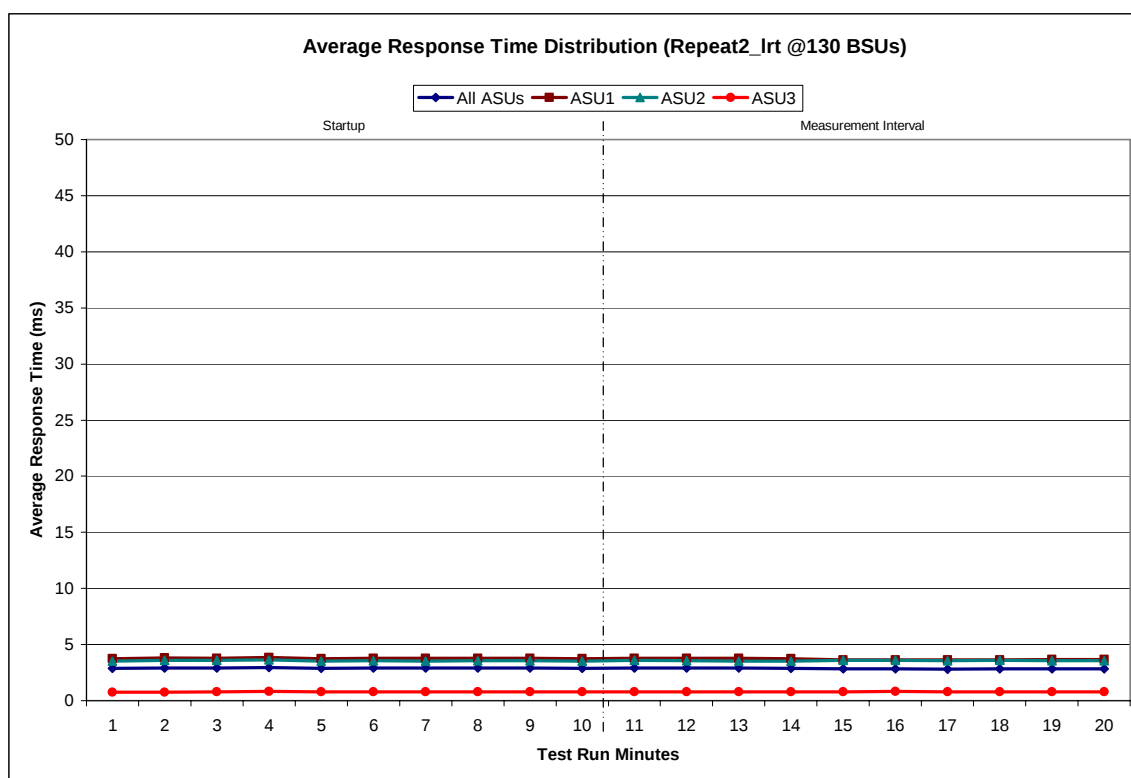
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

130 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:29:18	22:39:18	0-9	0:10:00
Measurement Interval	22:39:18	22:49:18	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	2.86	3.73	3.52	0.75
1	2.92	3.80	3.60	0.76
2	2.91	3.76	3.60	0.77
3	2.97	3.85	3.64	0.82
4	2.89	3.76	3.54	0.78
5	2.91	3.77	3.56	0.79
6	2.91	3.79	3.53	0.79
7	2.91	3.77	3.56	0.79
8	2.92	3.78	3.58	0.79
9	2.89	3.75	3.54	0.79
10	2.91	3.77	3.58	0.79
11	2.91	3.77	3.56	0.80
12	2.91	3.77	3.53	0.79
13	2.89	3.75	3.54	0.79
14	2.84	3.65	3.59	0.79
15	2.84	3.64	3.61	0.81
16	2.82	3.63	3.58	0.79
17	2.83	3.64	3.60	0.79
18	2.83	3.66	3.55	0.79
19	2.84	3.65	3.57	0.79
Average	2.86	3.69	3.57	0.79

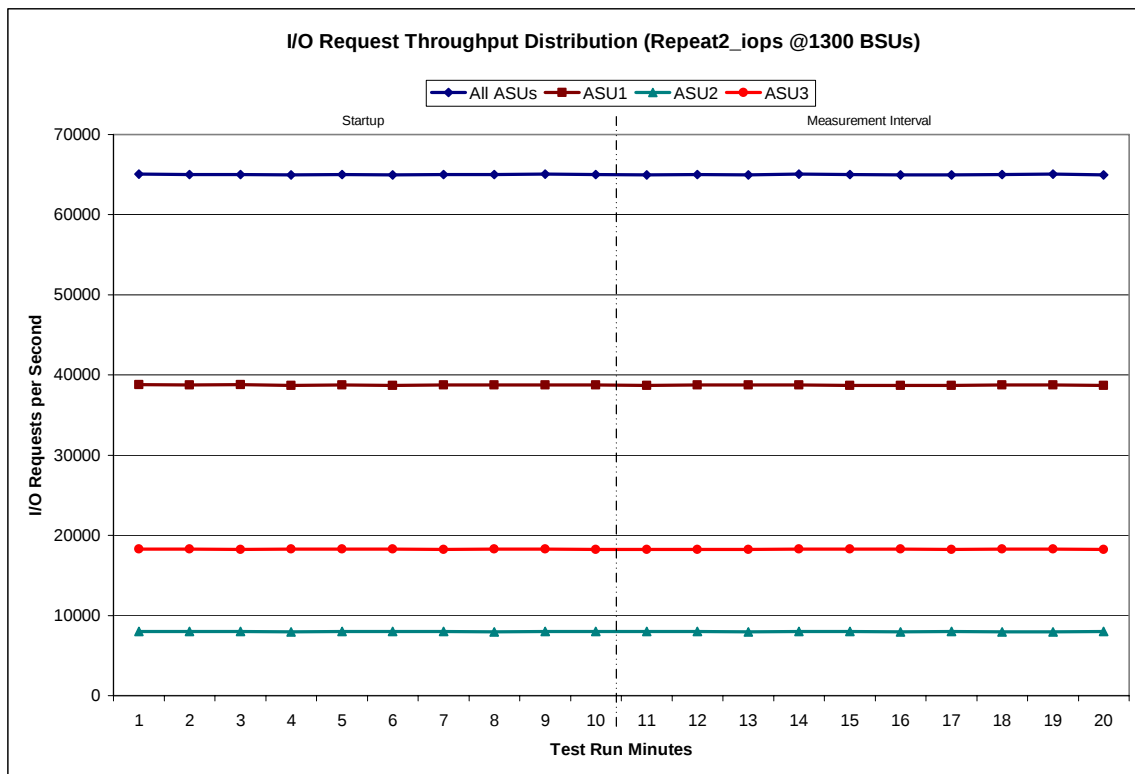
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

1300 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:49:26	22:59:27	0-9	0:10:01
Measurement Interval	22:59:27	23:09:27	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	65,077.22	38,811.95	7,994.67	18,270.60
1	64,999.15	38,737.35	7,992.58	18,269.22
2	65,034.28	38,789.22	7,994.77	18,250.30
3	64,973.72	38,726.83	7,976.70	18,270.18
4	64,997.12	38,729.67	7,991.43	18,276.02
5	64,968.88	38,689.32	7,994.20	18,285.37
6	65,003.73	38,751.15	7,998.32	18,254.27
7	65,025.97	38,763.33	7,982.02	18,280.62
8	65,056.00	38,764.95	8,010.58	18,280.47
9	65,000.63	38,766.43	7,989.63	18,244.57
10	64,968.20	38,703.60	7,998.57	18,266.03
11	65,008.18	38,757.48	7,992.35	18,258.35
12	64,978.72	38,738.90	7,985.28	18,254.53
13	65,054.20	38,764.70	8,011.47	18,278.03
14	65,007.45	38,711.28	8,020.12	18,276.05
15	64,974.35	38,709.65	7,983.05	18,281.65
16	64,965.40	38,701.03	7,996.63	18,267.73
17	65,007.15	38,736.68	7,987.22	18,283.25
18	65,046.40	38,769.53	7,985.78	18,291.08
19	64,976.50	38,711.27	8,000.97	18,264.27
Average	64,998.66	38,730.41	7,996.14	18,272.10

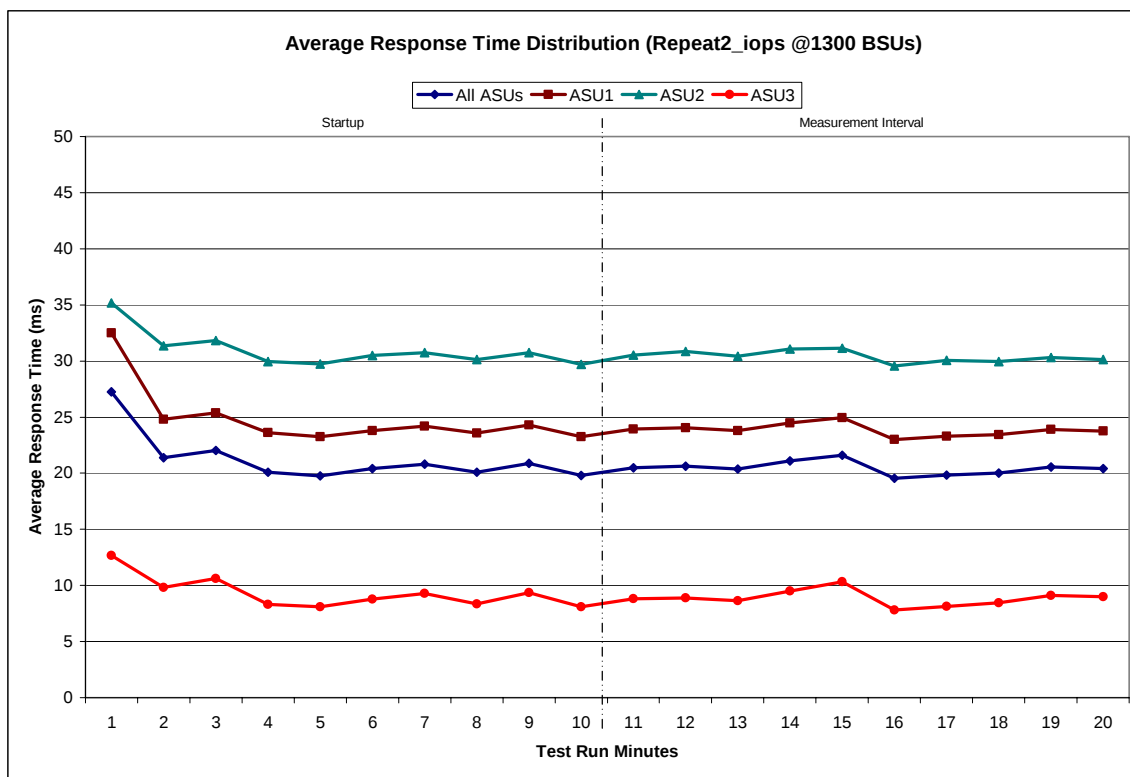
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

1300 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:49:26	22:59:27	0-9	0:10:01
Measurement Interval	22:59:27	23:09:27	10-19	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	27.25	32.49	35.15	12.66
1	21.40	24.80	31.37	9.81
2	22.03	25.39	31.84	10.61
3	20.08	23.60	29.94	8.33
4	19.78	23.24	29.74	8.09
5	20.40	23.81	30.47	8.80
6	20.80	24.18	30.74	9.27
7	20.10	23.57	30.15	8.35
8	20.89	24.29	30.75	9.38
9	19.80	23.27	29.70	8.08
10	20.50	23.93	30.53	8.82
11	20.62	24.04	30.86	8.88
12	20.36	23.81	30.41	8.64
13	21.08	24.47	31.07	9.52
14	21.59	24.94	31.12	10.32
15	19.53	22.99	29.55	7.82
16	19.85	23.28	30.05	8.12
17	20.02	23.43	29.94	8.46
18	20.54	23.92	30.33	9.11
19	20.40	23.75	30.14	9.01
Average	20.45	23.86	30.40	8.87

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



Repeatability 1 (LRT)

Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
MIM	0.0349	0.2814	0.0700	0.2100				
COV	0.007	0.002	0.006	0.002				

Repeatability 1 (IOPS)

Measured Intensity Multiplier and Coefficient of Variation

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

Repeatability 2 (LRT)

Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
MIM	0.0349	0.2809	0.0699	0.2099	0.0181	0.0701	0.0349	0.2813
COV	0.008	0.001	0.008	0.004	0.006	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	0.2809	0.0700	0.2100	0.0180	0.0700	0.0350	0.2811
COV	0.001	0.001	0.001	0.001	0.004	0.002	0.003	0.001

Data Persistence Test

Clause 6

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

- *Is capable of maintaining 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 66.

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	138,649,360
Total Number of Logical Blocks Verified	65,500,304
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 Pillar Axiom 600 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 Pillar Axiom 600.

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 gibibyte (GiB) is equal to 1,073,741,824 (2^{30}) bytes.
- A tebibyte (TiB) is equal to 1,099,511,627,776 (2^{40}) bytes.
- A pebibyte (PiB) is equal to 1,125,899,906,842,624 (2^{50}) bytes.
- An exbibyte (EiB) is equal to 1,152,921,504,606,846,967 (2^{60}) bytes.

SPC-1 Data Repository Definitions

Total ASU Capacity: The total storage capacity read and written in the course of executing the SPC-1 benchmark.

Application Storage Unit (ASU): The logical interface between the storage and SPC-1 Workload Generator. The three ASUs (Data, User, and Log) are typically implemented on one or more Logical Volume.

Logical Volume: The division of Addressable Storage Capacity into individually addressable logical units of storage used in the SPC-1 benchmark. Each Logical Volume is implemented as a single, contiguous address space.

Addressable Storage Capacity: The total storage (sum of Logical Volumes) that can be read and written by application programs such as the SPC-1 Workload Generator.

Configured Storage Capacity: This capacity includes the Addressable Storage Capacity and any other storage (parity disks, hot spares, etc.) necessary to implement the Addressable Storage Capacity.

Physical Storage Capacity: The formatted capacity of all storage devices physically present in the Tested Storage Configuration (TSC).

Data Protection Overhead: The storage capacity required to implement the selected level of data protection.

Required Storage: The amount of Configured Storage Capacity required to implement the Addressable Storage Configuration, excluding the storage required for the three ASUs.

Global Storage Overhead: The amount of Physical Storage Capacity that is required for storage subsystem use and unavailable for use by application programs.

Total Unused Storage: The amount of storage capacity available for use by application programs but not included in the Total ASU Capacity.

SPC-1 Data Protection Levels

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

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

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

Unprotected: There is no data protection provided.

SPC-1 Test Execution Definitions

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

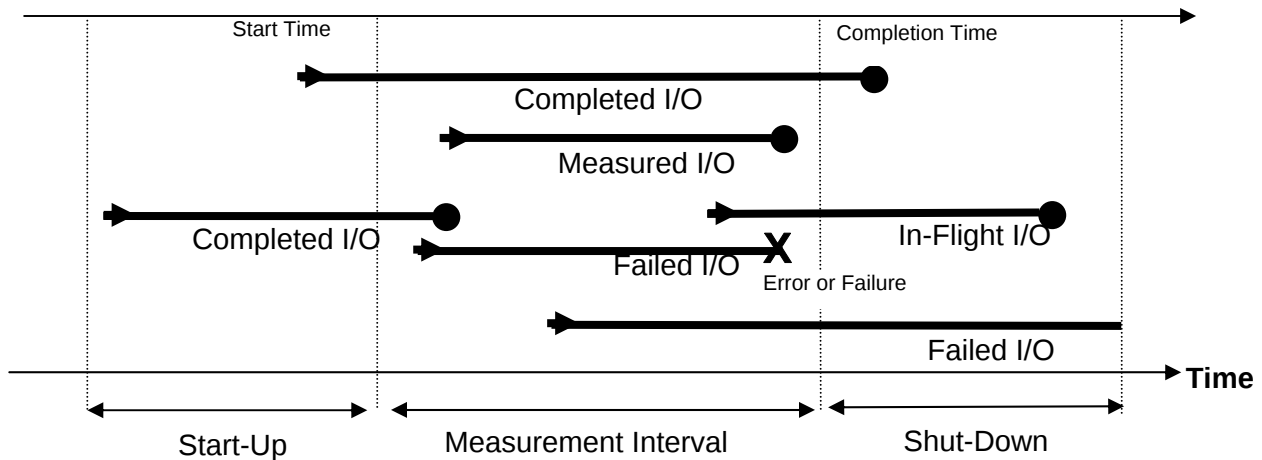
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

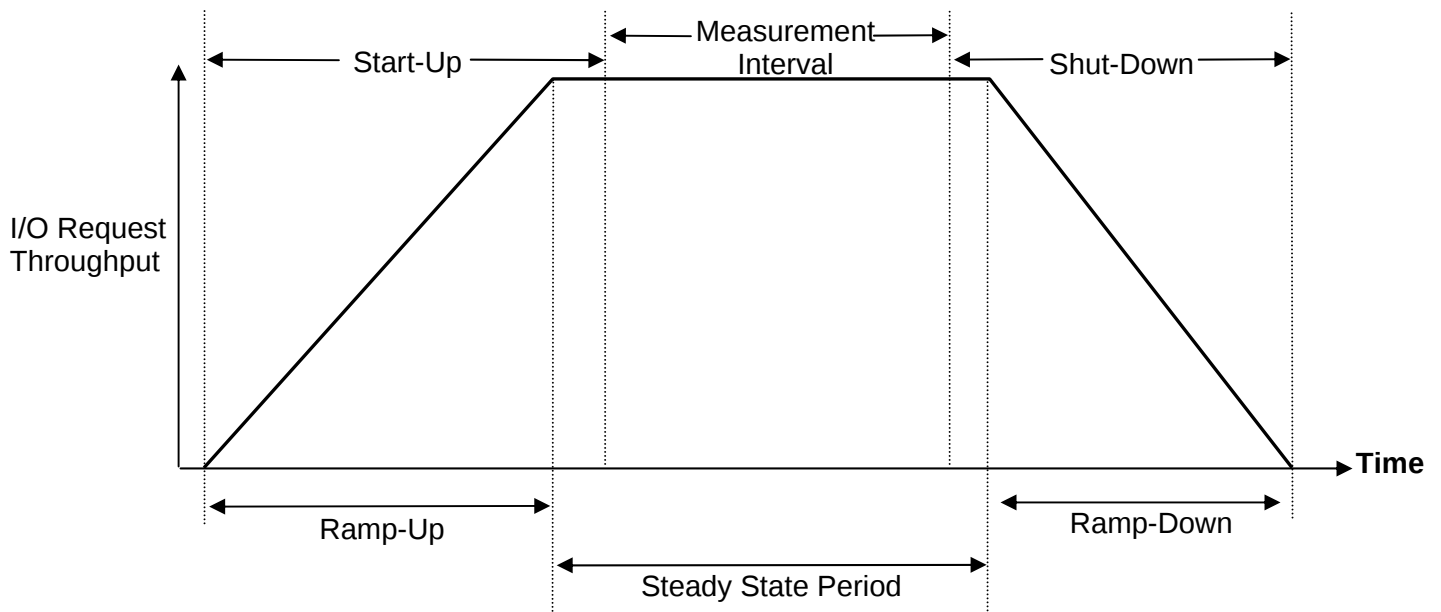
period, Shut-Down period, and Ramp-Down period as illustrated in the “SPC-1 Test Run Components” below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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

I/O Completion Types



SPC-1 Test Run Components



APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

The following parameters were changed from their default values during the execution of the script documented in Appendix C: Tested Storage Configuration (TSC) Creation:

AccessBias=Random

IOBias=Write

The above two parameter values result in a RAID-10 configuration

Profile=HighThroughput

This parameter stripes the LUNs over all the arrays

RelativePriority=Premium

Specifies allocation on fibre channel enclosures

Redundancy=Standard

No additional mirroring other than that provided by RAID-10

CloneStorage.MaximumCapacity=0

No space set aside for block-level snapshots on the LUN

Axiom Path Manager load balancing set to **Round Robin** for all LUNs

Specifies that accesses to the LUNs alternate between the two host HBA ports

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

Create RAID-10 Volumes

The **pdsccli** utility submits configuration commands to the Axiom system. Commands of the following form were issued from a script to configure a total of 60 LUNs, 20 used for each ASU.

The ASU-1 and ASU-2 LUNs were created using the following commands:

```
pdsccli sub -H zing -u administrator -p password \  
CreateLUN VolumeGroup=/ \  
EnableiSCSIAccess=0 EnableFibreChannelAccess=1 \  
Name=L_0 Profile=HighThroughput Capacity=225 \  
RelativePriority=Premium AccessBias=Random \  
IOBias=Write Redundancy=Standard Mapped=0 \  
CloneStorage.MaximumCapacity=0 LUNNumber=1
```

The LUN **Name** and **LUNNumber** values were unique for each LUN created, but the remainder of the parameters were the same. A total of 40 LUNs were created with these parameters.

The ASU-3 LUNs were created with similar commands that substitute a smaller **Capacity** value:

```
pdsccli sub -H zing -u administrator -p password \  
CreateLUN VolumeGroup=/ \  
EnableiSCSIAccess=0 EnableFibreChannelAccess=1 \  
Name=L_0 Profile=HighThroughput Capacity=50 \  
RelativePriority=Premium AccessBias=Random \  
IOBias=Write Redundancy=Standard Mapped=0 \  
CloneStorage.MaximumCapacity=0 LUNNumber=1
```

A total of 20 LUNs were created with these parameters.

Configure ASU-1, ASU-2, and ASU-3 from the RAID-10 Volumes

A Windows striped volume was create for ASU-1, ASU-2, and ASU-3 with the following steps:

Initialize the LUNs and convert them to dynamic disks

- Start the Windows Computer Manager and select **Disk Management**.
- Right-click on Disk 1 and select **Initialize**.
- Right-click on Disk 1 and select **Convert to Dynamic Disk**. Select all 60 of the new LUNs for conversion.

Configure ASU-1

- Right click on Disk 1 and select **New Volume**
- In the New Volume Wizard, select **Next**

- Select Volume to create: **Striped**, then **Next**
- Add disks 2-10 and 31-40 then select **Next**
- Assign Drive Letter **F** then **Next**
- Select **Do not format this volume**, then **Next**
- Select **Finish**

Configure ASU-2

- Right click on Disk 11 and select **New Volume**
- In the New Volume Wizard, select **Next**
- Select Volume to create: **Striped**, then **Next**
- Add disks 12-20 and 41-50 then select **Next**
- Assign Drive Letter **E** then **Next**
- Select **Do not format this volume**, then **Next**
- Select **Finish**

Configure ASU-3

- Right click on Disk 21 and select **New Volume**
- In the New Volume Wizard, select **Next**
- Select Volume to create: **Striped**, then **Next**
- Add disks 22-30 and 51-60 then select **Next**
- Assign Drive Letter **G** then **Next**
- Select **Do not format this volume**, then **Next**
- Select **Finish**

Set Axiom Path Manager scheduling to “Round Robin”

- On the GUI, select **Storage > Host**
- Click the check box next to the test host and select **Modify host settings** from the drop-down menu
- Click on the **Settings** tab
- Click Select **All** to select all LUNs
- Select **Round Robin** from the Load Balancing drop-down menu
- Click on the **Update Settings** button
- Click on the **OK** button

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

The content of SPC-1 Workload Generator command and parameter file, used in this benchmark to execute the Primary Metrics, Repeatability, Persistence Tests, is listed below.

```
javaparms="-Xmx512m"  
sd=asu1_1,lun=\\.\F:,size=4500g  
sd=asu2_1,lun=\\.\E:,size=4500g  
sd=asu3_1,lun=\\.\G:,size=1000g
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

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

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

```
cd c:\spc-2003\SPC1
java -Xmx512m metrics -b 1300 -s 1200
java -Xmx512m repeat1 -b 1300 -s 600
java -Xmx512m repeat2 -b 1300 -s 600
java -Xmx512m persist1 -b 1300
```

Persistence Test Run 2

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

```
cd c:\spc-2003\SPC1
java -Xmx512m persist2
```