SPC BENCHMARK 1™

FULL DISCLOSURE REPORT

XIOTECH CORPORATION

XIOTECH EMPRISE™ 5000
(ISE 9.6 TB/10.2 DATAPAC)

SPC-1 V1.12

Submitted for Review: September 20, 2010

Submission Identifier: A00095

First Edition – September 2010

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AUDIT CERTIFICATION

Ken Bates
Xiotech Corporation
9950 Federal Drive, Suite 100
Colorado Spring, CO 80921

September 17, 2010

The SPC Benchmark 1™ Reported Data listed below for the Xiotech Emprise™ 5000 *(ISE 9.6 TB/10.2 DataPac)* were produced in compliance with the SPC Benchmark 1™ 1.12 Remote Audit requirements.

SPC Benchmark 1™ 1.12 Results	
Tested Storage Configuration (TSC) Name:	
Xiotech Emprise™ 5000 *(ISE 9.6 TB/10.2 DataPac)*	
Metric	**Reported Result**
SPC-1 IOPS™	12,603.65
SPC-1 Price-Performance	$6.70/SPC-1 IOPS™
Total ASU Capacity	9,277.129 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$84,479.00

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with 1.12 of the SPC Benchmark 1™ specification:

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

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

AUDIT CERTIFICATION *(CONT.)*
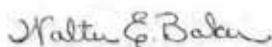
- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.

- The following Host System requirements, based on information supplied by Xiotech Corporation:

  ✓ The type of Host System including the number of processors and main memory.
  ✓ The presence and version number of the SPC-1 Workload Generator on each Host System.
  ✓ The TSC boundary within each Host System.

- The Test Results Files and resultant Summary Results Files received from Xiotech Corporation for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:

  ✓ Data Persistence Test
  ✓ Sustainability Test Phase
  ✓ IOPS Test Phase
  ✓ Response Time Ramp Test Phase
  ✓ Repeatability Test

- The differences between the Tested Storage Configuration (TSC) used for the benchmark and Priced Storage Configuration were documented and, if applied to the TSC, would not have an impact on the reported SPC-1 performance.

- The submitted pricing information met all of the requirements and constraints of Clause 8 of the SPC-1 Benchmark Specification.

- The Full Disclosure Report (FDR) met all of the requirements in Clause 9 of the SPC-1 Benchmark Specification.

- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

Audit Notes:

There were no audit notes or exceptions.

Respectfully,

Walter E. Baker

Walter E. Baker
SPC Auditor

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

LETTER OF GOOD FAITH

xiotech

26-Jul-2010

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

Subject: SPC-1 Letter of Good Faith for the Xiotech Emprise 5000 Virtual Storage System (ISE 9.6 TB / 10.2 DataPac)

Xiotech 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 V1.12 of the SPC-1 benchmark specification.

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

Sincerely,

David Gustavsson
Vice President, Engineering
Xiotech

Xiotech Corporation | 9950 Federal Drive | Suite 100 | Colorado Springs, 80921
Toll-Free: 866.472.6764 www.xiotech.com

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
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Test Sponsor Alternate Contact	Xiotech Corporation – http://www.xiotech.com Dave Gustavsson – dave.gustavsson@xiotech.com 9950 Federal Drive, Suite 100 Colorado Springs, CO 80921 Phone: (719) 388-5533 FAX: (719) 388-3300
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	V1.12
SPC-1 Workload Generator revision number	V2.1.0
Date Results were first used publicly	September 20, 2010
Date the FDR was submitted to the SPC	September 20, 2010
Date the priced storage configuration is available for shipment to customers	currently available
Date the TSC completed audit certification	September 17, 2010

Tested Storage Product (TSP) Description

Xiotech's Emprise 5000 system is a revolutionary concept in data storage. It is built on patented Intelligent Storage Element (ISE™) technology—a perfectly balanced building block of performance, reliability, and scalability.

Typical SAN systems come with high-level functionality you may not need, and all that functionality adds to the price tag. It also consumes performance and introduces a lot of complexity, which often requires high-priced administrators.

Emprise 5000, on the other hand, is a flexible, foundational building block of storage. It is a complete, self-enclosed virtualized storage solution that you can configure to meet your unique needs or optimize for a specific application.

Typical SAN performance is limited by bottlenecks in the system—from SAN controllers that slow data movement to back-end switches that add another point of contact. Scalability also is restricted by how many drives you can effectively put behind a set of controllers.

Emprise 5000 changes this paradigm. It eliminates the storage controllers on the front end and switches on the back, so data is free to flow at screaming speeds. And because storage is decoupled from the servers, you can add servers solely for processing power.

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: Xiotech Emprise™ 5000 *(ISE 9.6 TB/10.2 DataPac)*	
Metric	**Reported Result**
SPC-1 IOPS™	12,603.65
SPC-1 Price-Performance	$6.70/SPC-1 IOPS™
Total ASU Capacity	9,277.129 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$84,479.00

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 **Protected** using ***Mirroring*** configures two or more identical copies of user data.

Storage Capacities, Relationships, and Utilization

The following diagram and table document the various storage capacities, used in this benchmark, and their relationships, as well as the storage utilization values required to be reported.
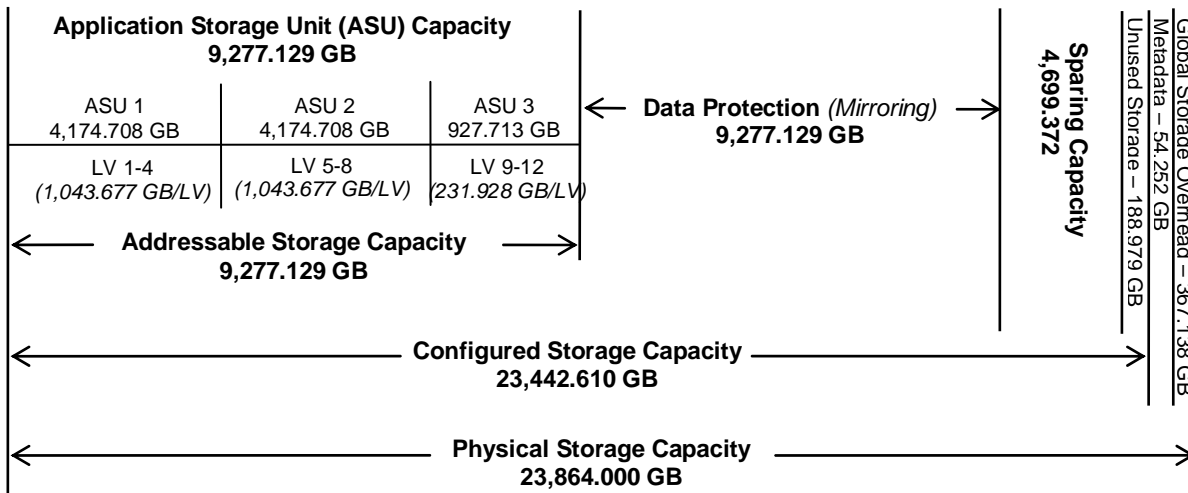
SPC-1 Storage Capacity Utilization	
Application Utilization	38.87%
Protected Application Utilization	77.75%
Unused Storage Ratio	0.79%

Application Utilization: Total ASU Capacity *(9,277.129 GB)* divided by Physical Storage Capacity *(23,864.000 GB)*.

Protected Application Utilization: Total ASU Capacity *(9,277.129 GB)* plus total Data Protection Capacity *(9,277.129 GB)* minus unused Data Protection Capacity *(0.000 GB)* divided by Physical Storage Capacity *(23,864.000 GB)*.

Unused Storage Ratio: Total unused capacity *(188.979 GB)* divided by Physical Storage Capacity *(23,864.000 GB)*. The Unused Storage Ratio cannot exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 18-19 in the Full Disclosure Report.

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.
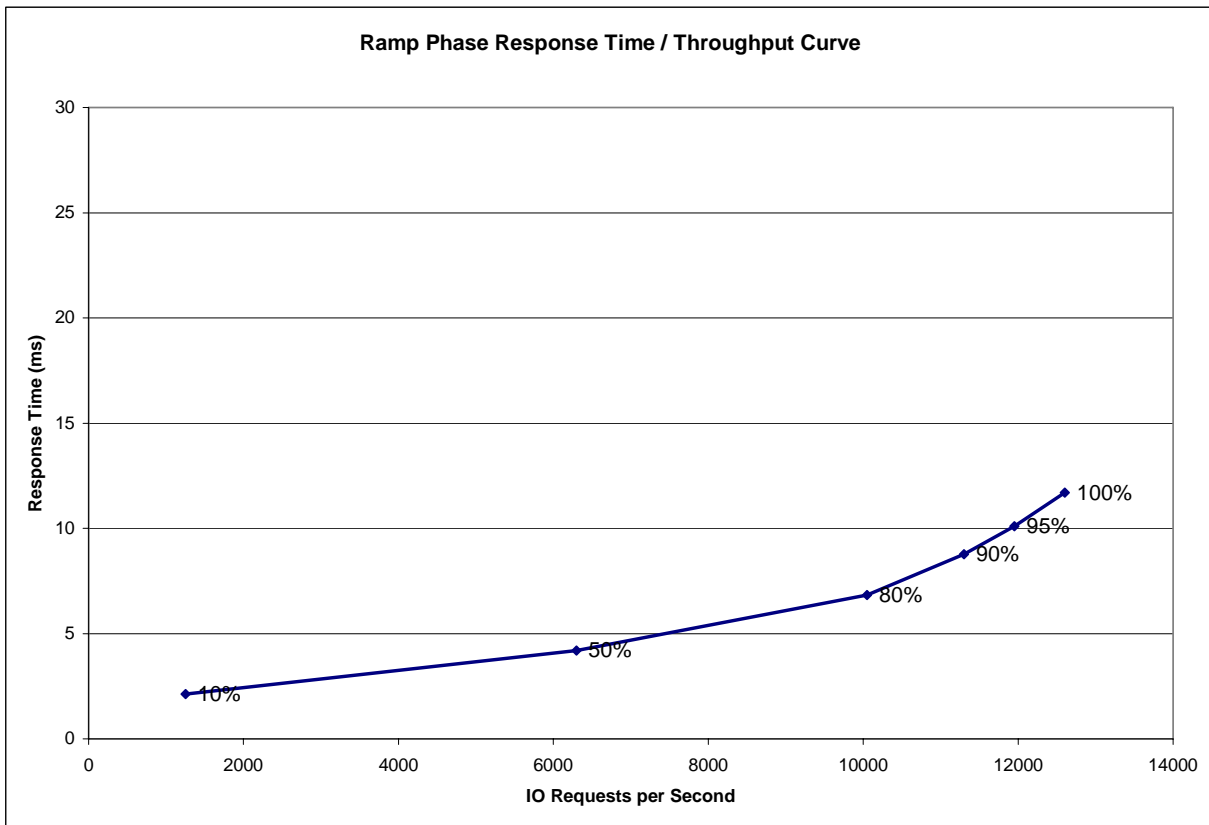
Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	1,249.25	6,300.47	10,046.69	11,300.94	11,953.52	12,603.65
Average Response Time (ms):						
All ASUs	2.12	4.19	6.82	8.77	10.10	11.71
ASU-1	3.01	5.67	8.38	10.16	11.32	12.79
ASU-2	2.24	6.09	14.21	21.32	26.46	32.45
ASU-3	0.18	0.24	0.29	0.33	0.33	0.35
Reads	5.12	10.29	16.88	21.73	25.06	29.06
Writes	0.17	0.22	0.28	0.33	0.35	0.40

Priced Storage Configuration Pricing

Qty	Name	Part Number	List Price	Discount	Unit Price	Extended Price
1	Emprise 5000 Virtual Storage System (Base Unit) Emprise 5000 Virtual Storage System (Base Unit) includes 1 Intelligent Storage Element (ISE) chassis for Emprise 5000 with 2 Fibre Channel host ports, power cords, bezel, rail kit, and accessory kit. Holds up to 2 DataPacs.	800864-000	$12,500.00	30%	$8,750.00	$8,750.00
2	Cable - 5m LC Duplex/LC Duplex Fiber Optic Patch Cord Cable - 5m LC Duplex/LC Duplex Fiber Optic Patch Cord	840056-000	$108.00	40%	$65.00	$130.00
1	QLogic - QLA2462 4Gb 64-bit 266MHz PCI-X 2.0 dual port Sever HBA	770814-000	$2,100.00	29%	$1,499.00	$1,499.00
2	ISE 9.6 TB/10.2 DataPac	800972-000	$50,000.00	30%	$35,000.00	$70,000.00
1	Emprise 5000 - Installation	000229-000	$4,083.33	40%	$2,450.00	$2,450.00
1	Emprise 5000 - 5 Year Hardware Warranty Emprise 5000 5 Year Hardware Warranty	020171-001	$0.00	-	$0.00	$0.00
1	Emprise 5000 - Software Warranty (90 Days) Emprise 5000 Software Warranty for 90 Days	020171-004	$0.00	-	$0.00	$0.00
1	Emprise 5000 - Software Maintenance - remainder of 1st year Emprise 5000 Software Maintenance Extension - Remainder of 1st Year. Extends initial Emprise 5000 Software warranty to 12 months.	020171-005	$749.97	40%	$450.00	$450.00
24	Emprise 5000 - Software Maintenance - 1 month Emprise 5000 Software 1 month	020171-006	$83.33	40%	$50.00	$1,200.00
					Total:	$84,479.00

The above pricing includes hardware maintenance and software support for a minimum of three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- Acknowledgement of new and existing problems with four (4) hours.

- Onsite present of a qualified maintenance engineer or provision of a customer replaceable part within four (4) hours of the above acknowledgement for any hardware failure that results in an inoperative Price Storage Configuration that can be remedied by the repair or replacement of a Priced Storage Configuration component.

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

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

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

Dell PowerEdge 2850 Server

Qlogic QLA2462
dual port 4 Gb HBA

Xiotech Emprise 5000 Virtual Storage System

2 – ISE 9.6 TB/10.2 DataPacs
(20 disk drives per DataPac)

40 – 600 GB 10K RPM disk drives
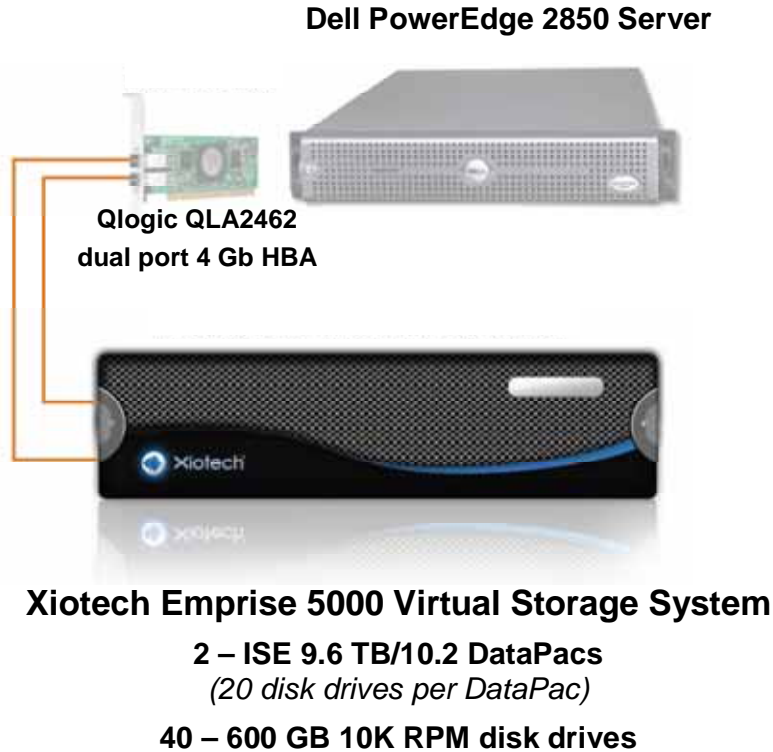
Benchmark Configuration (BC)/Tested Storage Configuration (TSC)/ Priced Storage Configuration Components

Host System:	Tested Storage Configuration (TSC)/ Priced Storage Configuration:
Dell PowerEdge 2850 Server	1 – dual-ported, 4Gb Qlogic 2462 HBA
2 – 3.6 GHz Xeon CPUs with 2 MB L2 cache per CPU	**Xiotech Emprise 5000 Virtual Storage System** 2 – dual-active controllers each with:
2 GB main memory	512 MB cache *(1 GB total)*
Windows Server 2003 Standard Edition with SP2	1 – 4 Gb Fibre Channel front-end host port *(2 total, 2 used)*
Xiotech MPIO driver	no backend connections due to the sealed DataPacs
PCI-X	
	2 – ISE 9.6 TB/10.2 DataPacs *(20 disk drives per DataPac)*
	40 – 600 GB 10K RPM disk drives

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

CONFIGURATION INFORMATION

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

Clause 9.4.3.4.1

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

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

Storage Network Configuration

Clause 9.4.3.4.1

…

> 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 9.4.3.4.2.*

Clause 9.4.3.4.2

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.4.3.4.1 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 Tested Storage Configuration did not utilize network storage.

Host System and Tested Storage Configuration (TSC) Table of Components

Clause 9.4.3.4.3

The FDR will contain a table that lists the major components of each Host System and the Tested Storage Configuration (TSC). Table 9-10 specifies the content, format, and appearance of the table.

The Host System and Tested Storage Configuration (TSC) table of components appears on page 15 *(Benchmark Configuration (BC)/Tested Storage Configuration (TSC)/ Priced Storage Configuration Components).*

Customer Tunable Parameters and Options

Clause 9.4.3.5.1

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

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

Tested Storage Configuration (TSC) Description

Clause 9.4.3.5.2

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

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

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

SPC-1 Workload Generator Storage Configuration

Clause 9.4.3.5.3

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 62.

SPC-1 DATA REPOSITORY

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

Storage Capacities and Relationships

Clause 9.4.3.6.1

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

SPC-1 Storage Capacities

SPC-1 Storage Capacities		
Storage Hierarchy Component	**Units**	**Capacity**
Total ASU Capacity	Gigabytes (GB)	9,277.129
Addressable Storage Capacity	Gigabytes (GB)	9,277.129
Configured Storage Capacity	Gigabytes (GB)	23,442.610
Physical Storage Capacity	Gigabytes (GB)	23,864.000
Data Protection *(Mirroring)*	Gigabytes (GB)	9,277.129
Required Storage *(metadata, sparing)*	Gigabytes (GB)	4,753.624
Global Storage Overhead	Gigabytes (GB)	367.138
Total Unused Storage	Gigabytes (GB)	188.979

SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	100.00%	39.57%	38.87%
Required for Data Protection *(Mirrored)*		39.57%	38.87%
Addressable Storage Capacity		39.57%	38.87%
Required Storage *(metadata, sparing)*		20.28%	19.92%
Configured Storage Capacity			98.23%
Global Storage Overhead			1.54%
Unused Storage:			
Addressable	0.00%		
Configured		0.81%	
Physical			0.00%

The Physical Storage Capacity consisted of 23.864.000 GB distributed over 40 disk drives each with a formatted capacity of 587.422 GB. There was GB (%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 0.000 GB (0.00%) of Physical Storage Capacity. There was 188.979 GB (0.81%) of Unused Storage within the Configured Storage Capacity, including. The Total ASU Capacity utilized 100.00% of the Addressable Storage Capacity resulting in 0.000 GB (0.00%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(mirroring)* capacity was 9,277.129 GB of which 9,277.129 GB was utilized. The total Unused Storage was 188.979 GB.

SPC-1 Storage Capacities and Relationships Illustration

The various storage capacities configured in the benchmark result are illustrated below (not to scale).
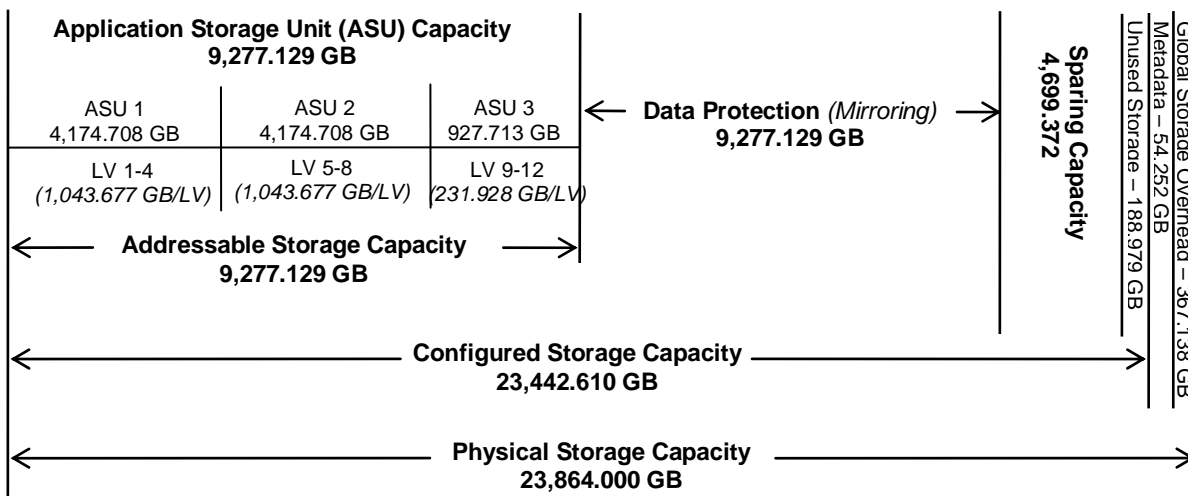
Logical Volume Capacity and ASU Mapping

Clause 9.4.3.6.3

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 (4,174.708 GB)	ASU-2 (4,174.708 GB)	ASU-3 (927.713 GB)
4 Logical Volumes 1,043.677 GB per Logical Volume (1,043.677 GB used per Logical Volume)	4 Logical Volumes 1,043.677 GB per Logical Volume (1,043.677 GB used per Logical Volume)	4 Logical Volumes 231.928 GB per Logical Volume (231.928 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.

Storage Capacity Utilization

Clause 9.4.3.6.2

The FDR will include a table illustrating the storage capacity utilization values defined for Application Utilization (Clause 2.8.1), Protected Application Utilization (Clause 2.8.2), and Unused Storage Ratio (Clause 2.8.3).

Clause 2,8.1

Application Utilization is defined as Total ASU Capacity divided by Physical Storage Capacity.

Clause 2,8.2

Protected Application Utilization is defined as (Total ASU Capacity plus total Data Protection Capacity minus unused Data Protection Capacity) divided by Physical Storage Capacity.

Clause 2,8.3

Unused Storage Ratio is defined as Total Unused Capacity divided by Physical Storage Capacity and may not exceed 45%.

SPC-1 Storage Capacity Utilization	
Application Utilization	38.87%
Protected Application Utilization	77.75%
Unused Storage Ratio	0.79%

SPC-1 BENCHMARK EXECUTION RESULTS

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

Clause 5.4.3

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

SPC-1 Tests, Test Phases, and Test Runs

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

- **Primary Metrics Test**
  - ➢ Sustainability Test Phase and Test Run
  - ➢ IOPS Test Phase and Test Run
  - ➢ Response Time Ramp Test Phase
    - ○ 95% of IOPS Test Run
    - ○ 90% of IOPS Test Run
    - ○ 80% of IOPS Test Run
    - ○ 50% of IOPS Test Run
    - ○ 10% of IOPS Test Run (LRT)

- **Repeatability Test**
  - ➢ Repeatability Test Phase 1
    - ○ 10% of IOPS Test Run (LRT)
    - ○ IOPS Test Run
  - ➢ Repeatability Test Phase 2
    - ○ 10% of IOPS Test Run (LRT)
    - ○ IOPS Test Run

- **Data Persistence Test**
  - ➢ Data Persistence Test Run 1
  - ➢ Data Persistence Test Run 2

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

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

Primary Metrics Test – Sustainability Test Phase

Clause 5.4.4.1.1

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

Clause 5.4.4.1.2

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

Clause 5.4.4.1.4

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

Clause 9.4.3.7.1

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 63.

Sustainability Test Results File

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

Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	10:41:18	10:46:18	0-4	0:05:00
Measurement Interval	10:46:18	13:46:18	4-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	103.59	40.15	11.02	52.42	63	103.65	40.40	10.96	52.29	126	103.17	40.12	10.98	52.06
1	103.24	40.05	10.95	52.24	64	103.67	40.21	11.08	52.39	127	103.65	40.17	11.03	52.45
2	103.15	39.91	11.12	52.12	65	103.43	40.02	11.08	52.33	128	103.28	40.09	11.04	52.15
3	103.26	40.14	11.08	52.04	66	103.15	40.26	11.07	51.83	129	103.12	40.15	11.12	51.85
4	103.57	40.19	11.06	52.33	67	103.62	40.26	11.02	52.35	130	102.98	40.01	10.99	51.98
5	103.61	40.26	11.12	52.23	68	103.26	40.03	11.10	52.12	131	103.22	40.02	11.08	52.12
6	103.54	40.12	11.02	52.40	69	103.48	40.18	11.10	52.21	132	103.43	40.04	11.05	52.35
7	103.40	40.14	11.13	52.13	70	103.46	40.32	11.06	52.09	133	103.40	40.13	11.17	52.10
8	103.53	40.07	11.07	52.39	71	103.15	40.03	10.99	52.13	134	103.39	40.09	11.05	52.24
9	103.22	40.16	11.05	52.02	72	103.52	40.21	10.93	52.39	135	103.39	40.11	11.02	52.25
10	103.54	39.97	11.12	52.45	73	103.24	40.06	10.99	52.18	136	103.50	40.16	11.09	52.25
11	103.34	40.01	10.99	52.35	74	103.49	40.10	11.13	52.26	137	103.56	40.16	11.15	52.25
12	103.54	40.08	10.99	52.47	75	103.33	40.11	10.93	52.29	138	103.23	40.26	10.88	52.10
13	103.47	40.13	11.05	52.29	76	103.42	40.31	11.00	52.11	139	103.39	40.24	11.08	52.07
14	103.53	40.13	11.06	52.35	77	103.38	40.15	11.06	52.17	140	103.56	40.13	11.01	52.42
15	103.52	40.18	11.05	52.29	78	103.59	40.31	11.10	52.18	141	103.48	40.06	11.07	52.34
16	103.32	40.19	11.00	52.13	79	103.13	40.17	11.03	51.94	142	103.44	40.16	11.07	52.21
17	103.52	40.13	11.04	52.35	80	103.48	40.07	10.96	52.45	143	103.06	40.20	11.01	51.85
18	103.50	40.25	11.14	52.11	81	103.43	40.15	11.06	52.22	144	103.35	40.12	11.03	52.20
19	103.13	39.99	11.00	52.15	82	103.60	40.25	11.04	52.31	145	103.33	40.26	11.06	52.02
20	103.17	40.06	10.96	52.15	83	103.12	40.01	11.00	52.12	146	103.37	40.04	11.06	52.27
21	102.88	40.07	11.03	51.79	84	103.35	40.11	10.93	52.30	147	102.90	39.97	11.00	51.93
22	103.48	40.06	11.15	52.27	85	103.23	40.32	11.00	51.91	148	103.03	40.15	11.05	51.83
23	103.52	40.34	10.99	52.18	86	103.12	40.12	11.05	51.95	149	103.65	40.38	11.13	52.14
24	103.28	40.12	11.05	52.11	87	103.70	40.12	11.15	52.43	150	103.56	40.21	11.10	52.25
25	103.66	40.25	11.04	52.38	88	103.54	40.11	11.05	52.38	151	103.09	40.09	11.13	51.87
26	103.52	40.22	11.09	52.20	89	103.57	40.19	11.11	52.27	152	103.13	40.07	11.09	51.97
27	103.53	40.19	11.07	52.26	90	103.51	40.06	11.05	52.40	153	103.14	40.10	10.96	52.08
28	103.35	40.23	11.02	52.10	91	103.32	40.19	11.08	52.06	154	103.23	39.98	11.01	52.24
29	103.33	40.39	11.01	51.93	92	103.37	40.09	11.04	52.24	155	103.61	40.37	11.00	52.23
30	103.41	40.28	10.95	52.18	93	103.32	40.05	11.05	52.15	156	103.57	40.13	10.99	52.46
31	103.29	40.15	11.14	52.00	94	103.23	40.05	11.13	52.05	157	103.48	40.30	11.03	52.16
32	103.21	40.22	11.08	51.91	95	102.97	40.02	11.05	51.91	158	103.45	40.21	11.04	52.21
33	103.56	40.33	11.01	52.22	96	103.70	40.26	11.03	52.42	159	103.50	40.24	11.07	52.18
34	103.40	40.11	11.01	52.28	97	103.43	40.22	11.04	52.16	160	103.44	40.29	11.00	52.14
35	103.37	40.17	11.10	52.09	98	103.49	40.13	11.10	52.27	161	102.92	40.16	10.97	51.79
36	103.42	40.23	10.97	52.22	99	103.27	39.97	11.01	52.29	162	103.37	40.14	10.97	52.26
37	103.52	40.20	11.09	52.23	100	103.40	40.09	10.98	52.33	163	103.25	39.96	11.18	52.11
38	103.66	40.33	11.05	52.28	101	103.42	40.15	11.00	52.28	164	103.18	40.16	11.01	52.01
39	103.19	40.11	11.06	52.02	102	103.48	40.29	11.16	52.04	165	103.56	40.16	10.98	52.43
40	103.31	40.08	11.04	52.19	103	103.52	40.40	11.04	52.07	166	102.94	40.06	11.03	51.86
41	103.70	40.14	11.12	52.43	104	103.46	39.96	11.01	52.49	167	103.41	40.26	11.02	52.14
42	103.13	40.32	10.98	51.83	105	103.55	40.21	10.94	52.40	168	103.66	40.14	11.06	52.46
43	103.58	40.13	11.17	52.28	106	103.38	40.17	11.07	52.14	169	103.07	40.08	10.91	52.07
44	103.59	40.32	11.14	52.13	107	103.61	40.23	11.03	52.36	170	103.62	40.19	11.00	52.43
45	103.36	40.14	11.00	52.22	108	103.63	40.27	11.11	52.26	171	103.36	40.22	11.12	52.02
46	103.58	40.07	11.06	52.45	109	103.54	40.22	11.07	52.26	172	103.46	40.13	11.03	52.30
47	103.41	40.25	10.92	52.25	110	103.20	40.00	10.91	52.29	173	103.61	40.19	11.01	52.41
48	103.95	40.31	10.98	52.66	111	103.52	40.06	10.96	52.51	174	103.64	40.14	11.10	52.40
49	103.30	40.01	10.97	52.31	112	103.39	40.15	11.10	52.14	175	103.34	40.23	10.99	52.11
50	103.40	39.93	11.06	52.41	113	103.33	40.19	11.17	51.97	176	103.30	40.12	11.07	52.12
51	103.75	40.26	10.99	52.50	114	103.50	40.15	11.06	52.30	177	103.53	40.07	10.98	52.48
52	103.23	40.22	11.13	51.89	115	103.59	40.13	11.09	52.37	178	103.80	40.18	11.12	52.50
53	103.02	40.03	11.03	51.95	116	103.18	40.11	10.93	52.15	179	103.27	40.24	10.95	52.08
54	103.36	40.21	11.02	52.13	117	103.63	40.19	11.18	52.27	180	103.39	40.14	11.05	52.20
55	103.61	40.31	11.01	52.29	118	103.19	40.01	11.01	51.92	181	103.50	40.02	11.06	52.42
56	103.50	40.35	10.91	52.24	119	102.96	39.93	11.08	51.95	182	103.43	40.12	11.05	52.26
57	103.25	40.03	10.98	52.23	120	103.36	40.27	11.08	52.02	183	103.44	40.13	11.02	52.30
58	103.41	40.03	11.06	52.32	121	103.53	40.12	11.07	52.35	184	92.25	35.86	9.84	46.55
59	103.57	40.22	11.07	52.28	122	103.17	40.08	10.99	52.10					
60	103.54	40.12	11.04	52.38	123	103.24	40.16	11.03	52.06					
61	103.27	40.34	11.03	51.90	124	103.17	40.08	11.05	52.04					
62	103.39	40.23	11.10	52.06	125	103.31	40.17	11.02	52.12					

Sustainability – Data Rate Distribution Graph
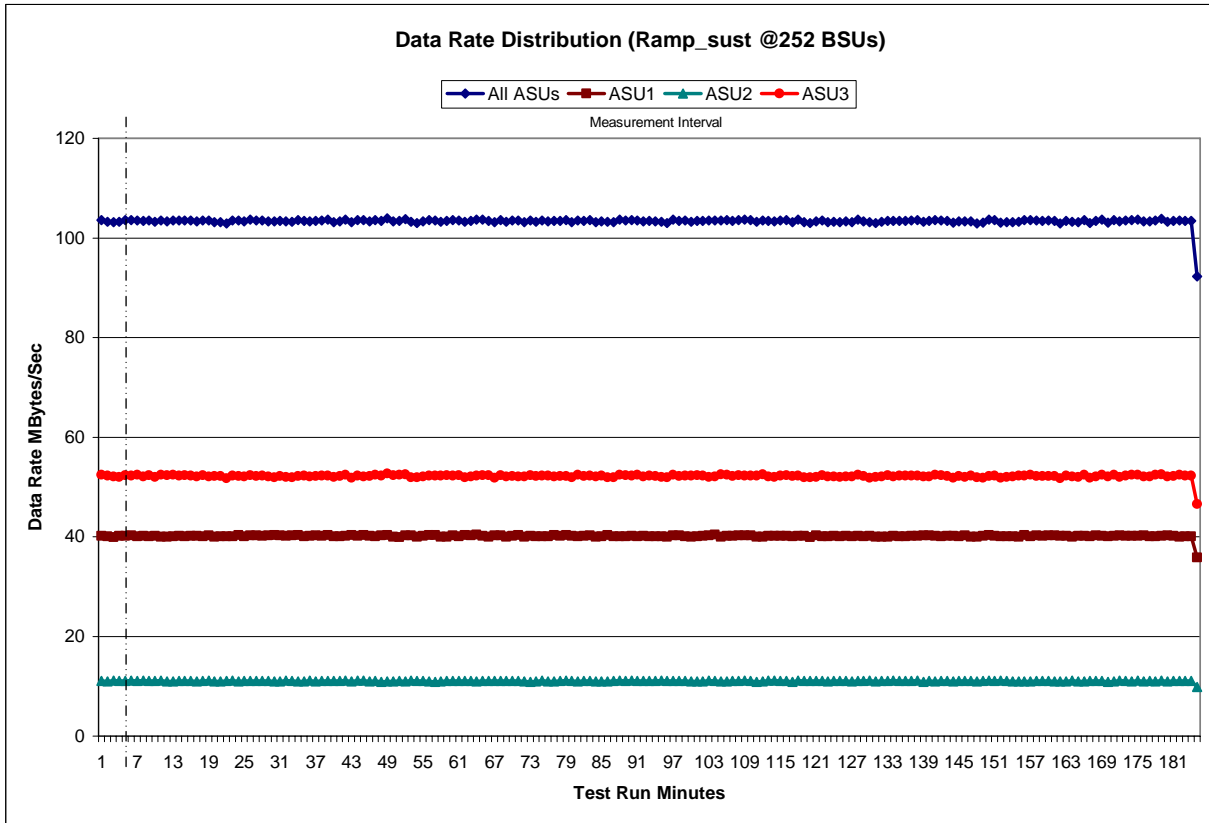
Data Rate Distribution (Ramp_sust @252 BSUs)

Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	10:41:18	10:46:18	0-4	0:05:00
Measurement Interval	10:46:18	13:46:18	5-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	12,589.40	7,507.93	1,539.13	3,542.33	63	12,612.20	7,520.92	1,549.33	3,541.95	126	12,602.65	7,514.10	1,547.87	3,540.68
1	12,587.67	7,494.82	1,543.98	3,548.87	64	12,612.57	7,514.67	1,548.08	3,549.82	127	12,618.73	7,509.78	1,545.83	3,563.12
2	12,580.30	7,488.22	1,554.17	3,537.92	65	12,596.02	7,507.95	1,554.82	3,533.25	128	12,602.50	7,510.47	1,548.43	3,543.60
3	12,593.75	7,508.10	1,552.10	3,533.55	66	12,589.22	7,505.17	1,544.83	3,539.22	129	12,598.58	7,511.15	1,553.23	3,534.20
4	12,595.57	7,514.88	1,547.60	3,533.08	67	12,591.07	7,510.92	1,538.43	3,541.72	130	12,586.87	7,501.72	1,548.17	3,536.98
5	12,618.58	7,518.17	1,553.43	3,546.98	68	12,601.02	7,502.77	1,557.92	3,540.33	131	12,566.18	7,489.77	1,545.08	3,531.33
6	12,606.85	7,516.20	1,541.95	3,548.70	69	12,594.37	7,511.35	1,548.12	3,534.90	132	12,596.53	7,503.47	1,552.22	3,540.85
7	12,596.45	7,504.65	1,546.37	3,545.43	70	12,599.13	7,523.50	1,549.28	3,526.35	133	12,605.97	7,510.65	1,560.15	3,535.17
8	12,600.07	7,510.73	1,549.50	3,539.83	71	12,598.27	7,509.12	1,553.57	3,535.58	134	12,605.98	7,513.03	1,548.07	3,544.88
9	12,577.65	7,500.57	1,545.73	3,531.35	72	12,615.42	7,517.43	1,547.03	3,550.95	135	12,575.62	7,491.48	1,548.03	3,536.10
10	12,579.02	7,485.95	1,554.12	3,538.95	73	12,587.80	7,496.47	1,546.37	3,544.97	136	12,609.10	7,515.58	1,549.53	3,543.98
11	12,598.88	7,499.30	1,552.45	3,547.13	74	12,622.27	7,525.78	1,556.18	3,540.30	137	12,594.18	7,491.35	1,557.72	3,545.12
12	12,607.42	7,505.53	1,555.42	3,546.47	75	12,612.17	7,516.25	1,551.33	3,544.58	138	12,597.28	7,511.57	1,542.72	3,543.00
13	12,594.68	7,502.98	1,544.32	3,547.38	76	12,602.78	7,526.55	1,542.67	3,533.57	139	12,584.65	7,505.38	1,547.50	3,531.77
14	12,604.43	7,515.47	1,556.10	3,532.87	77	12,601.57	7,512.95	1,554.88	3,533.73	140	12,592.77	7,500.68	1,545.60	3,546.48
15	12,623.88	7,521.97	1,550.63	3,551.28	78	12,630.55	7,533.58	1,550.43	3,546.53	141	12,607.73	7,510.20	1,554.32	3,543.22
16	12,607.15	7,517.40	1,546.77	3,542.98	79	12,599.80	7,511.63	1,557.70	3,530.47	142	12,607.05	7,514.97	1,551.23	3,540.85
17	12,596.70	7,513.13	1,545.00	3,538.57	80	12,599.95	7,498.35	1,548.30	3,553.30	143	12,582.82	7,498.72	1,548.38	3,535.72
18	12,612.60	7,522.20	1,552.87	3,537.53	81	12,601.57	7,503.92	1,555.18	3,542.47	144	12,598.07	7,502.48	1,550.33	3,545.25
19	12,581.23	7,500.13	1,548.43	3,532.67	82	12,606.18	7,517.50	1,550.00	3,538.68	145	12,601.60	7,521.65	1,548.82	3,531.13
20	12,576.95	7,501.85	1,537.80	3,537.30	83	12,561.77	7,496.97	1,537.77	3,527.03	146	12,592.12	7,499.47	1,546.72	3,545.93
21	12,579.65	7,501.20	1,551.22	3,527.23	84	12,593.88	7,505.65	1,540.05	3,548.18	147	12,565.22	7,497.58	1,547.02	3,520.62
22	12,601.23	7,505.83	1,543.60	3,551.80	85	12,617.97	7,533.88	1,552.65	3,531.43	148	12,585.10	7,507.20	1,552.58	3,525.32
23	12,623.32	7,537.10	1,544.23	3,541.98	86	12,584.52	7,500.75	1,550.37	3,533.40	149	12,614.82	7,519.45	1,555.27	3,540.10
24	12,580.97	7,500.25	1,547.80	3,532.92	87	12,627.33	7,520.72	1,554.55	3,552.07	150	12,619.83	7,528.90	1,546.90	3,544.03
25	12,609.28	7,510.67	1,551.47	3,547.15	88	12,618.50	7,526.33	1,549.95	3,542.22	151	12,588.32	7,508.52	1,549.28	3,530.52
26	12,600.55	7,509.90	1,552.83	3,537.82	89	12,599.10	7,513.48	1,547.55	3,538.07	152	12,598.20	7,510.05	1,552.52	3,535.63
27	12,584.95	7,494.63	1,554.58	3,535.73	90	12,604.38	7,508.87	1,552.72	3,542.80	153	12,581.08	7,502.63	1,545.48	3,532.97
28	12,598.60	7,514.62	1,548.40	3,535.58	91	12,602.42	7,516.05	1,552.90	3,533.47	154	12,599.08	7,507.52	1,553.88	3,537.68
29	12,593.22	7,520.88	1,540.12	3,532.22	92	12,589.22	7,508.28	1,544.43	3,536.50	155	12,592.88	7,518.15	1,543.67	3,531.07
30	12,603.77	7,518.72	1,547.57	3,537.48	93	12,600.90	7,517.50	1,545.73	3,536.77	156	12,611.62	7,507.10	1,548.40	3,556.12
31	12,589.95	7,492.80	1,561.67	3,535.48	94	12,582.32	7,490.43	1,557.57	3,534.32	157	12,601.08	7,512.37	1,550.18	3,538.53
32	12,618.77	7,517.92	1,552.80	3,548.05	95	12,577.27	7,496.95	1,557.20	3,523.12	158	12,616.52	7,512.33	1,553.98	3,550.20
33	12,601.32	7,519.52	1,541.30	3,540.50	96	12,629.42	7,536.13	1,547.15	3,546.13	159	12,603.27	7,513.72	1,551.42	3,538.13
34	12,607.17	7,510.80	1,548.70	3,547.67	97	12,600.62	7,512.88	1,545.68	3,542.05	160	12,623.98	7,526.73	1,545.35	3,551.90
35	12,568.25	7,489.97	1,553.07	3,525.22	98	12,585.50	7,492.67	1,549.35	3,543.48	161	12,562.55	7,497.68	1,546.33	3,518.53
36	12,595.93	7,507.73	1,546.75	3,541.45	99	12,596.75	7,498.28	1,545.13	3,553.33	162	12,600.63	7,507.60	1,548.35	3,544.68
37	12,606.60	7,509.55	1,549.67	3,547.38	100	12,600.17	7,510.65	1,542.15	3,547.17	163	12,587.80	7,497.20	1,558.07	3,532.53
38	12,620.17	7,528.88	1,554.58	3,536.70	101	12,583.10	7,499.83	1,540.47	3,542.80	164	12,589.72	7,509.60	1,543.32	3,536.80
39	12,582.80	7,492.02	1,548.22	3,542.57	102	12,605.32	7,521.20	1,552.18	3,531.93	165	12,593.20	7,498.70	1,542.63	3,551.87
40	12,595.50	7,507.42	1,550.07	3,538.02	103	12,627.70	7,532.22	1,554.12	3,541.37	166	12,579.13	7,495.92	1,546.75	3,536.47
41	12,603.35	7,507.62	1,547.30	3,548.43	104	12,583.83	7,488.90	1,548.65	3,546.28	167	12,591.12	7,512.00	1,550.95	3,528.17
42	12,592.67	7,520.40	1,545.50	3,526.77	105	12,605.08	7,512.40	1,550.12	3,542.57	168	12,610.93	7,524.33	1,548.85	3,537.75
43	12,615.63	7,513.47	1,560.70	3,541.47	106	12,603.48	7,512.90	1,550.77	3,539.82	169	12,578.77	7,495.83	1,543.57	3,539.37
44	12,598.52	7,503.53	1,553.00	3,541.98	107	12,603.57	7,507.93	1,547.43	3,548.20	170	12,608.45	7,521.32	1,540.02	3,547.12
45	12,593.67	7,510.07	1,544.88	3,538.72	108	12,609.88	7,522.50	1,549.12	3,538.27	171	12,584.28	7,515.32	1,552.15	3,516.82
46	12,594.83	7,507.03	1,547.87	3,539.93	109	12,606.73	7,506.20	1,553.93	3,546.60	172	12,592.78	7,495.87	1,553.30	3,543.62
47	12,605.48	7,515.78	1,542.47	3,547.23	110	12,567.77	7,494.10	1,541.50	3,532.17	173	12,622.52	7,524.05	1,550.60	3,547.87
48	12,593.93	7,505.37	1,544.65	3,543.92	111	12,584.73	7,502.45	1,544.75	3,537.53	174	12,617.70	7,505.50	1,558.13	3,554.07
49	12,586.63	7,497.88	1,554.52	3,534.23	112	12,609.02	7,515.27	1,547.88	3,545.87	175	12,603.70	7,506.83	1,553.05	3,543.82
50	12,592.40	7,495.65	1,543.80	3,552.95	113	12,584.47	7,508.97	1,549.78	3,525.72	176	12,581.02	7,502.17	1,544.72	3,534.13
51	12,617.28	7,524.05	1,542.60	3,550.63	114	12,599.52	7,516.50	1,545.62	3,537.40	177	12,597.85	7,500.70	1,551.42	3,545.73
52	12,605.68	7,514.20	1,554.95	3,536.53	115	12,621.60	7,518.42	1,554.32	3,548.87	178	12,608.42	7,504.18	1,549.45	3,554.78
53	12,576.00	7,487.50	1,554.47	3,534.03	116	12,597.45	7,508.82	1,546.95	3,541.68	179	12,595.93	7,510.27	1,544.33	3,541.33
54	12,599.58	7,508.33	1,552.92	3,538.33	117	12,602.63	7,513.83	1,548.85	3,539.95	180	12,585.08	7,489.88	1,551.52	3,543.68
55	12,626.00	7,526.65	1,548.40	3,550.95	118	12,600.15	7,513.15	1,558.03	3,528.97	181	12,601.37	7,511.05	1,551.90	3,538.42
56	12,603.73	7,508.93	1,549.02	3,545.78	119	12,571.18	7,490.80	1,549.48	3,530.90	182	12,593.97	7,495.30	1,549.80	3,548.87
57	12,582.43	7,490.20	1,542.25	3,549.98	120	12,612.73	7,518.48	1,550.58	3,543.67	183	12,598.43	7,511.67	1,547.77	3,539.00
58	12,584.65	7,494.65	1,556.18	3,533.82	121	12,590.02	7,512.43	1,545.98	3,531.60	184	11,264.67	6,710.42	1,386.67	3,167.58
59	12,607.90	7,519.37	1,544.78	3,543.75	122	12,608.27	7,512.93	1,543.47	3,551.87	*Average*	*12,591.20*	*7,505.06*	*1,548.28*	*3,537.87*
60	12,604.97	7,505.25	1,550.33	3,549.38	123	12,598.85	7,522.82	1,545.80	3,530.23					
61	12,598.15	7,527.30	1,551.52	3,519.33	124	12,583.23	7,505.27	1,543.27	3,534.70					
62	12,604.58	7,520.18	1,550.52	3,533.88	125	12,600.03	7,524.12	1,547.90	3,528.02					

Sustainability – I/O Request Throughput Distribution Graph

Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	10:41:18	10:46:18	0-4	0:05:00
Measurement Interval	10:46:18	13:46:18	4-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	10.64	11.73	28.81	0.43	63	11.69	12.74	32.53	0.33	126	11.79	12.81	32.94	0.39
1	12.11	13.17	34.06	0.33	64	11.64	12.74	32.19	0.34	127	11.23	12.36	30.73	0.38
2	11.46	12.48	31.90	0.34	65	11.46	12.46	31.96	0.33	128	11.50	12.57	31.82	0.36
3	11.52	12.64	31.60	0.32	66	11.46	12.45	32.14	0.34	129	11.58	12.57	32.36	0.34
4	11.93	12.98	33.33	0.33	67	11.51	12.49	32.43	0.33	130	11.29	12.36	31.03	0.37
5	11.58	12.63	32.21	0.32	68	11.65	12.63	32.69	0.32	131	11.40	12.39	31.76	0.37
6	11.49	12.63	31.64	0.32	69	11.67	12.69	32.63	0.32	132	11.63	12.63	32.40	0.40
7	11.43	12.40	32.18	0.34	70	11.58	12.60	32.23	0.34	133	11.62	12.71	31.91	0.37
8	11.35	12.33	31.70	0.35	71	11.68	12.89	31.62	0.34	134	11.57	12.68	31.79	0.36
9	11.34	12.40	31.35	0.33	72	11.64	12.78	32.01	0.35	135	11.51	12.58	31.69	0.39
10	11.27	12.26	31.43	0.33	73	11.36	12.39	31.64	0.32	136	11.42	12.31	32.26	0.42
11	11.41	12.52	31.34	0.34	74	11.65	12.64	32.58	0.34	137	11.61	12.76	31.60	0.38
12	11.51	12.63	31.53	0.34	75	11.62	12.66	32.42	0.31	138	11.55	12.67	31.79	0.39
13	11.37	12.35	31.98	0.32	76	11.48	12.42	32.41	0.33	139	11.76	12.55	33.90	0.37
14	11.37	12.44	31.31	0.33	77	11.58	12.60	32.25	0.33	140	11.70	12.81	32.25	0.39
15	11.33	12.43	31.22	0.33	78	11.43	12.46	31.83	0.34	141	11.78	12.83	32.68	0.38
16	11.31	12.33	31.50	0.35	79	11.45	12.51	31.59	0.32	142	11.49	12.62	31.40	0.37
17	11.29	12.31	31.43	0.33	80	11.51	12.58	31.94	0.34	143	11.70	12.67	32.88	0.37
18	11.28	12.26	31.44	0.34	81	11.54	12.62	31.88	0.32	144	11.67	12.88	31.57	0.41
19	11.36	12.39	31.56	0.32	82	11.48	12.55	31.75	0.32	145	11.63	12.76	31.78	0.37
20	11.63	12.69	32.45	0.34	83	11.58	12.55	32.66	0.32	146	11.61	12.65	32.41	0.35
21	11.49	12.47	32.14	0.33	84	11.44	12.47	32.00	0.33	147	11.50	12.56	31.82	0.32
22	11.30	12.32	31.58	0.33	85	11.61	12.65	32.24	0.31	148	11.51	12.55	31.77	0.37
23	11.35	12.30	32.00	0.33	86	11.54	12.54	32.24	0.35	149	11.74	12.82	32.46	0.35
24	11.38	12.32	32.09	0.33	87	11.72	12.90	32.01	0.34	150	11.42	12.45	31.73	0.37
25	11.33	12.50	30.84	0.33	88	11.75	12.74	33.07	0.32	151	11.41	12.48	31.38	0.35
26	11.53	12.68	31.48	0.33	89	11.73	12.71	33.05	0.32	152	11.57	12.59	32.22	0.35
27	11.37	12.39	31.59	0.32	90	11.59	12.58	32.45	0.35	153	11.65	12.75	32.08	0.38
28	11.34	12.42	31.20	0.35	91	11.29	12.34	31.18	0.32	154	11.44	12.51	31.46	0.37
29	11.68	12.72	32.60	0.32	92	11.69	12.61	33.26	0.32	155	11.64	12.69	32.24	0.39
30	11.41	12.43	31.79	0.33	93	11.29	12.25	31.76	0.32	156	11.46	12.62	31.35	0.37
31	11.10	12.31	29.64	0.34	94	11.30	12.33	31.20	0.33	157	11.53	12.60	31.90	0.35
32	11.40	12.42	31.79	0.33	95	11.46	12.37	32.29	0.33	158	11.79	12.89	32.62	0.37
33	11.49	12.48	32.28	0.32	96	11.77	12.86	32.70	0.32	159	11.71	12.70	32.77	0.39
34	11.31	12.39	31.23	0.34	97	11.68	12.69	32.78	0.33	160	11.62	12.74	31.91	0.41
35	11.40	12.36	31.92	0.33	98	11.64	12.75	32.11	0.34	161	11.53	12.53	32.04	0.38
36	11.27	12.26	31.52	0.33	99	11.37	12.46	31.51	0.33	162	11.79	12.76	33.22	0.38
37	11.37	12.40	31.67	0.33	100	11.68	12.66	33.00	0.33	163	11.45	12.45	31.70	0.39
38	11.56	12.56	32.26	0.33	101	11.70	12.63	33.34	0.32	164	11.57	12.57	32.37	0.36
39	11.29	12.25	31.72	0.34	102	11.64	12.69	32.32	0.33	165	11.73	12.89	32.35	0.33
40	11.26	12.30	31.17	0.33	103	11.47	12.53	31.74	0.32	166	11.64	12.67	32.37	0.38
41	11.43	12.35	32.43	0.33	104	11.43	12.38	32.22	0.35	167	11.78	12.96	31.97	0.40
42	11.60	12.55	32.71	0.32	105	11.54	12.60	32.03	0.33	168	11.91	12.90	33.41	0.37
43	11.49	12.53	31.78	0.32	106	11.54	12.54	31.86	0.32	169	11.62	12.72	32.12	0.35
44	11.52	12.57	32.02	0.32	107	11.71	12.80	32.52	0.33	170	11.84	12.96	32.82	0.38
45	11.42	12.43	31.91	0.34	108	11.25	12.21	31.50	0.33	171	11.95	13.13	32.47	0.35
46	11.46	12.60	31.45	0.32	109	11.51	12.55	32.01	0.34	172	11.76	12.74	32.95	0.39
47	11.34	12.35	31.77	0.32	110	11.31	12.29	31.70	0.33	173	11.86	12.86	33.20	0.42
48	11.41	12.47	31.70	0.33	111	11.56	12.55	32.50	0.33	174	11.76	13.06	31.44	0.39
49	11.47	12.52	31.68	0.33	112	11.46	12.42	32.28	0.33	175	11.79	12.88	32.61	0.36
50	11.12	12.21	30.62	0.35	113	11.29	12.21	31.79	0.32	176	11.65	12.73	32.22	0.37
51	11.28	12.28	31.56	0.33	114	11.15	12.15	31.03	0.34	177	11.62	12.70	32.13	0.37
52	11.29	12.35	31.10	0.33	115	11.53	12.52	32.29	0.35	178	11.58	12.49	32.89	0.36
53	11.37	12.36	31.68	0.32	116	11.59	12.64	32.21	0.35	179	11.81	12.96	32.52	0.36
54	11.60	12.66	32.14	0.33	117	11.75	12.81	32.66	0.35	180	11.75	12.84	32.43	0.40
55	11.54	12.58	32.27	0.31	118	11.39	12.42	31.43	0.34	181	11.94	13.06	32.88	0.37
56	11.39	12.45	31.59	0.33	119	11.29	12.31	31.33	0.34	182	11.64	12.78	31.94	0.36
57	11.47	12.59	31.67	0.33	120	11.62	12.62	32.45	0.36	183	11.51	12.60	31.71	0.37
58	11.38	12.48	31.11	0.36	121	11.40	12.45	31.52	0.36	184	12.12	13.10	34.13	0.40
59	11.30	12.40	31.13	0.32	122	11.40	12.37	32.06	0.38	*Average*	*11.53*	*12.57*	*32.01*	*0.35*
60	11.50	12.58	31.87	0.33	123	11.57	12.74	31.52	0.34					
61	11.58	12.64	31.95	0.33	124	11.45	12.55	31.55	0.34					
62	11.67	12.79	32.05	0.32	125	11.76	12.82	32.65	0.34					

Sustainability – Average Response Time (ms) Distribution Graph
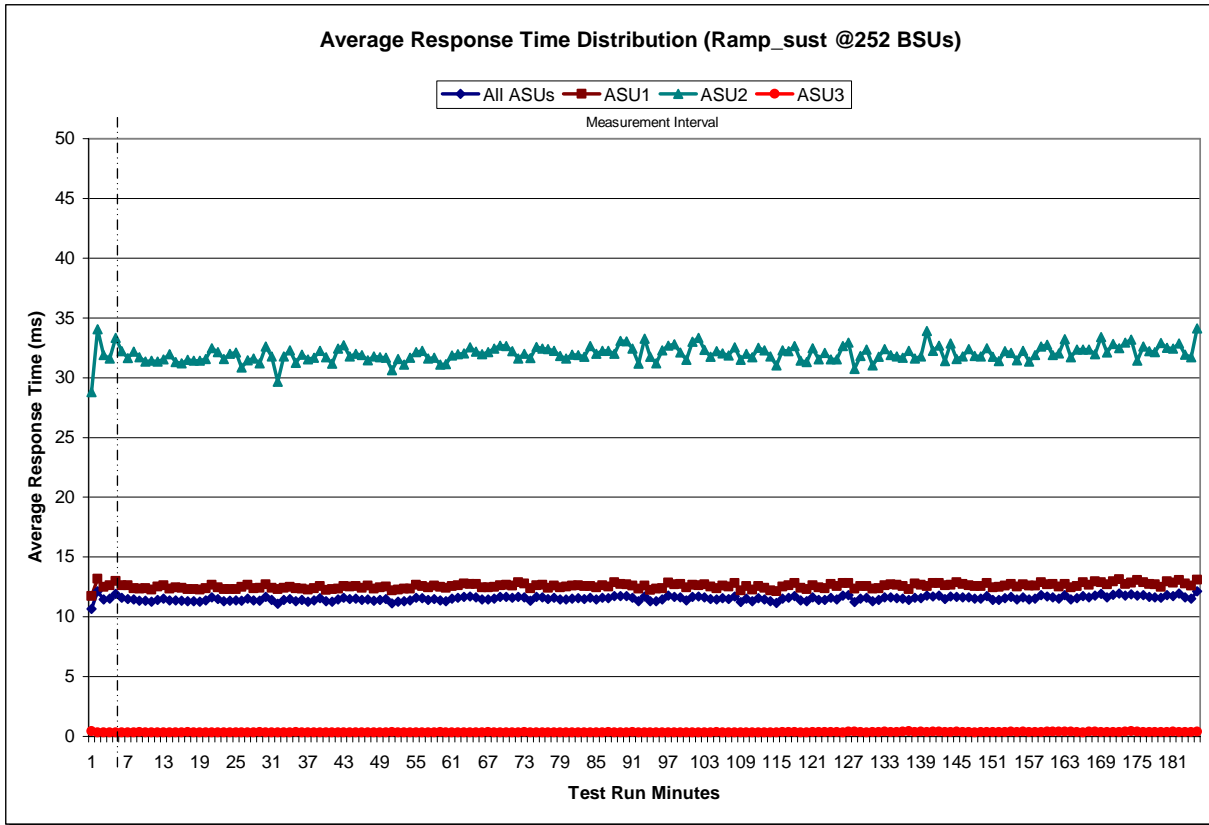
Sustainability – Response Time Frequency Distribution Data

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	6,052,217	3,786,834	592,290	206,928	115,386	75,553	53,164	45,450
Write	39,436,473	33,466,369	5,429,582	1,402,094	725,612	465,625	290,663	168,301
All ASUs	45,488,690	37,253,203	6,021,872	1,609,022	840,998	541,178	343,827	213,751
ASU1	22,475,395	16,615,255	2,101,586	683,859	398,490	269,841	185,321	128,353
ASU2	6,105,355	4,441,592	528,251	162,514	94,980	59,803	34,573	18,351
ASU3	16,907,940	16,196,356	3,392,035	762,649	347,528	211,534	123,933	67,047

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	196,459	417,565	608,462	673,000	829,846	887,695	1,906,725	2,139,814
Write	202,709	144,431	99,456	76,408	58,196	54,082	73,322	50,468
All ASUs	399,168	561,996	707,918	749,408	888,042	941,777	1,980,047	2,190,282
ASU1	307,150	507,172	665,505	714,562	852,636	906,799	1,905,569	2,103,234
ASU2	22,513	18,337	18,606	18,998	22,886	26,089	63,304	80,810
ASU3	69,505	36,487	23,807	15,848	12,520	8,889	11,174	6,238

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	2,139,946	2,006,667	1,548,504	6,154,227	4,142,030	3,047,184	2,320,653	13,689,626
Write	35,656	27,992	21,742	59,565	27,518	11,383	6,456	14,659
All ASUs	2,175,602	2,034,659	1,570,246	6,213,792	4,169,548	3,058,567	2,327,109	13,704,285
ASU1	2,086,175	1,942,343	1,488,791	5,877,119	3,900,764	2,826,437	2,123,192	9,989,051
ASU2	85,976	89,850	79,369	331,964	266,213	232,015	203,915	3,715,130
ASU3	3,451	2,466	2,086	4,709	2,571	115	2	104

Sustainability – Response Time Frequency Distribution Graph
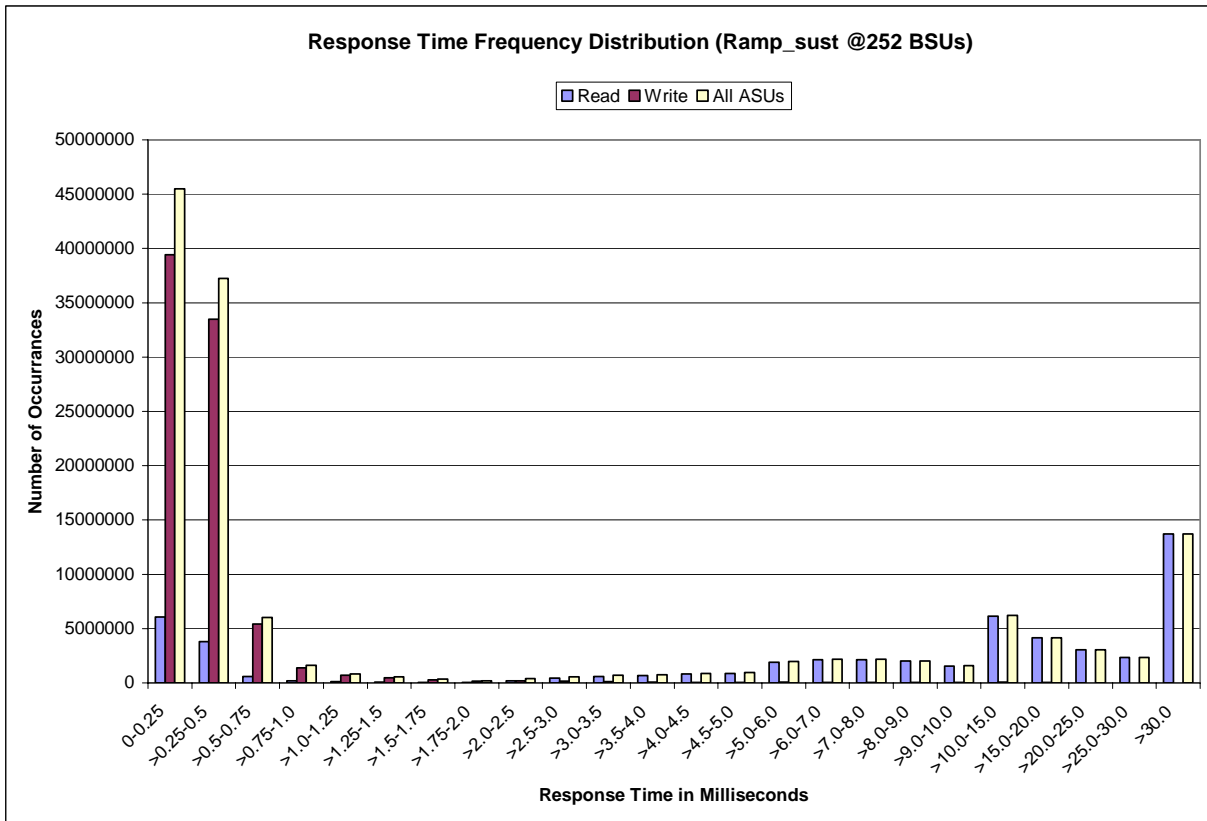
Sustainability – Measured Intensity Multiplier and Coefficient of Variation

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 5.1.10 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	0.28.10	0.0700	0.2101	0.0180	0.0700	0.0350	0.2810
COV	0.006	0.002	0.004	0.002	0.009	0.004	0.006	0.002

Primary Metrics Test – IOPS Test Phase

Clause 5.4.4.2

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 9.4.3.7.2

For the IOPS Test Phase the FDR shall contain:

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 63.

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

252 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:47:22	13:52:23	0-4	0:05:01
Measurement Interval	13:52:23	14:02:23	3-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	12,591.35	7,499.25	1,554.58	3,537.52
1	12,589.30	7,498.52	1,547.45	3,543.33
2	12,599.63	7,521.87	1,544.43	3,533.33
3	12,578.00	7,503.67	1,545.47	3,528.87
4	12,634.73	7,525.32	1,549.30	3,560.12
5	12,586.90	7,510.10	1,545.97	3,530.83
6	12,621.88	7,514.65	1,560.40	3,546.83
7	12,612.78	7,511.38	1,549.62	3,551.78
8	12,586.38	7,500.90	1,547.38	3,538.10
9	12,613.72	7,513.37	1,547.97	3,552.38
10	12,583.27	7,505.42	1,544.55	3,533.30
11	12,608.82	7,510.30	1,556.08	3,542.43
12	12,602.03	7,503.17	1,547.67	3,551.20
13	12,623.60	7,535.78	1,547.30	3,540.52
14	12,597.10	7,496.93	1,547.77	3,552.40
Average	*12,603.65*	*7,510.20*	*1,549.47*	*3,543.98*

IOPS Test Run – I/O Request Throughput Distribution Graph

SPC BENCHMARK 1™ V1.12   FULL DISCLOSURE REPORT   **Submission Identifier: A00095**
Xiotech Corporation   **Submitted for Review: SEPTEMBER 20, 2010**
Xiotech Emprise™ 5000 *(ISE 9.6 TB/10.2 DataPac)*

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

252 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:47:22	13:52:23	0-4	0:05:01
Measurement Interval	13:52:23	14:02:23	3-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	12.23	13.32	34.04	0.33
1	11.91	12.94	33.36	0.35
2	11.90	12.94	33.24	0.34
3	11.78	12.89	32.50	0.37
4	11.64	12.78	32.03	0.35
5	11.69	12.83	32.02	0.35
6	11.77	12.74	33.06	0.35
7	11.76	12.82	32.73	0.38
8	11.67	12.70	32.52	0.35
9	11.81	13.03	32.21	0.35
10	11.58	12.70	31.88	0.34
11	11.70	12.79	32.32	0.35
12	11.57	12.61	32.34	0.34
13	11.83	12.80	33.36	0.36
14	11.67	12.84	32.00	0.35
Average	*11.71*	*12.79*	*32.45*	*0.35*

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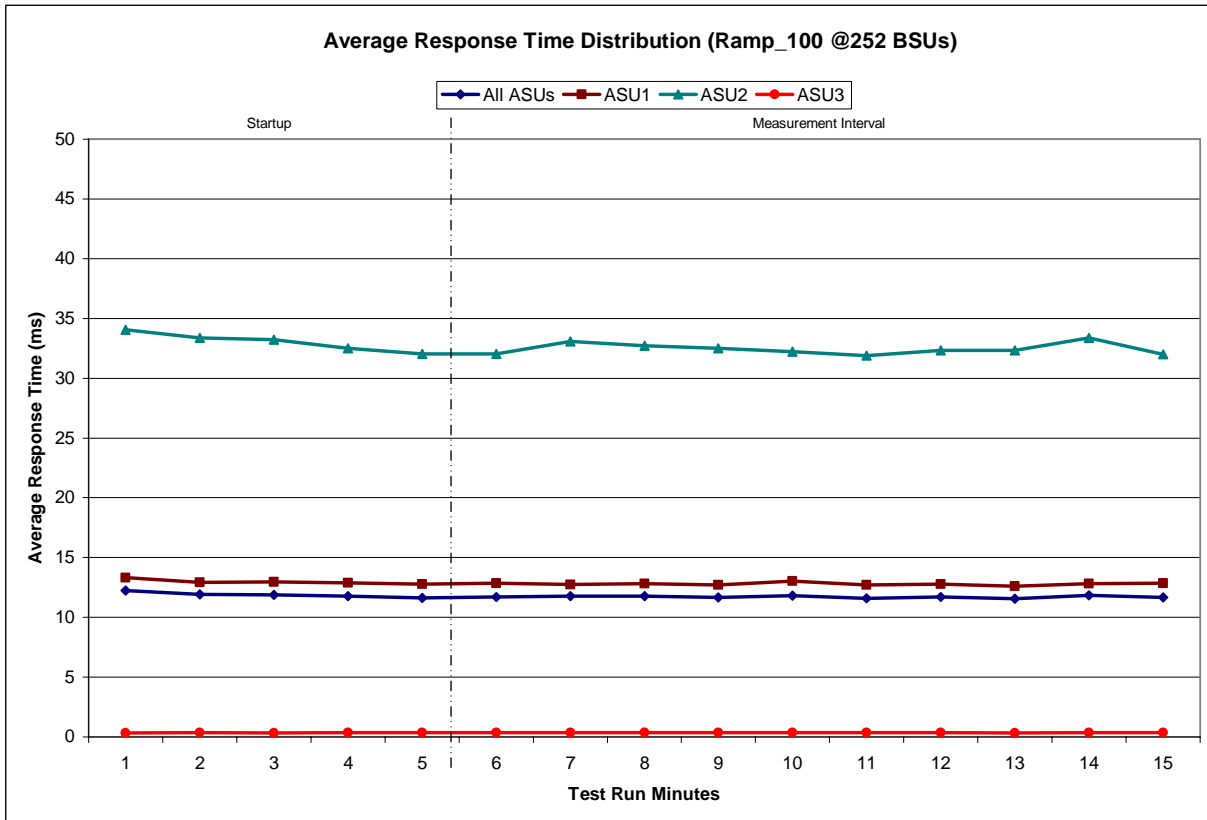
IOPS Test Run – Response Time Frequency Distribution Data

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	367088	231,177	36,718	13,455	7,725	5,328	3,679	3,035
Write	2388275	2,034,072	336,096	91,878	49,793	32,958	20,951	12,084
All ASUs	2755363	2,265,249	372,814	105,333	57,518	38,286	24,630	15,119
ASU1	1356538	1,006,475	131,152	45,280	27,501	19,270	13,419	9,067
ASU2	368091	272,646	33,382	10,754	6,659	4,359	2,458	1,352
ASU3	1030734	986,128	208,280	49,299	23,358	14,657	8,753	4,700

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	12,131	25,461	37,526	40,588	51,338	54,139	116,475	130,548
Write	14,562	10,571	7,338	5,660	4,359	3,787	5,595	3,719
All ASUs	26,693	36,032	44,864	46,248	55,697	57,926	122,070	134,267
ASU1	20,342	32,493	42,096	44,052	53,568	55,852	117,422	128,925
ASU2	1,551	1,112	1,240	1,156	1,310	1,567	3,883	4,947
ASU3	4,800	2,427	1,528	1,040	819	507	765	395

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	129,966	121,680	94,363	372,509	253,115	186,458	143,173	843,085
Write	2,729	2,083	1,644	4,621	2,013	912	543	1,048
All ASUs	132,695	123,763	96,007	377,130	255,128	187,370	143,716	844,133
ASU1	127,318	118,258	90,930	356,733	238,615	173,126	131,172	616,888
ASU2	5,210	5,372	4,962	20,057	16,363	14,235	12,544	227,245
ASU3	167	133	115	340	150	9	-	-

IOPS Test Run –Response Time Frequency Distribution Graph
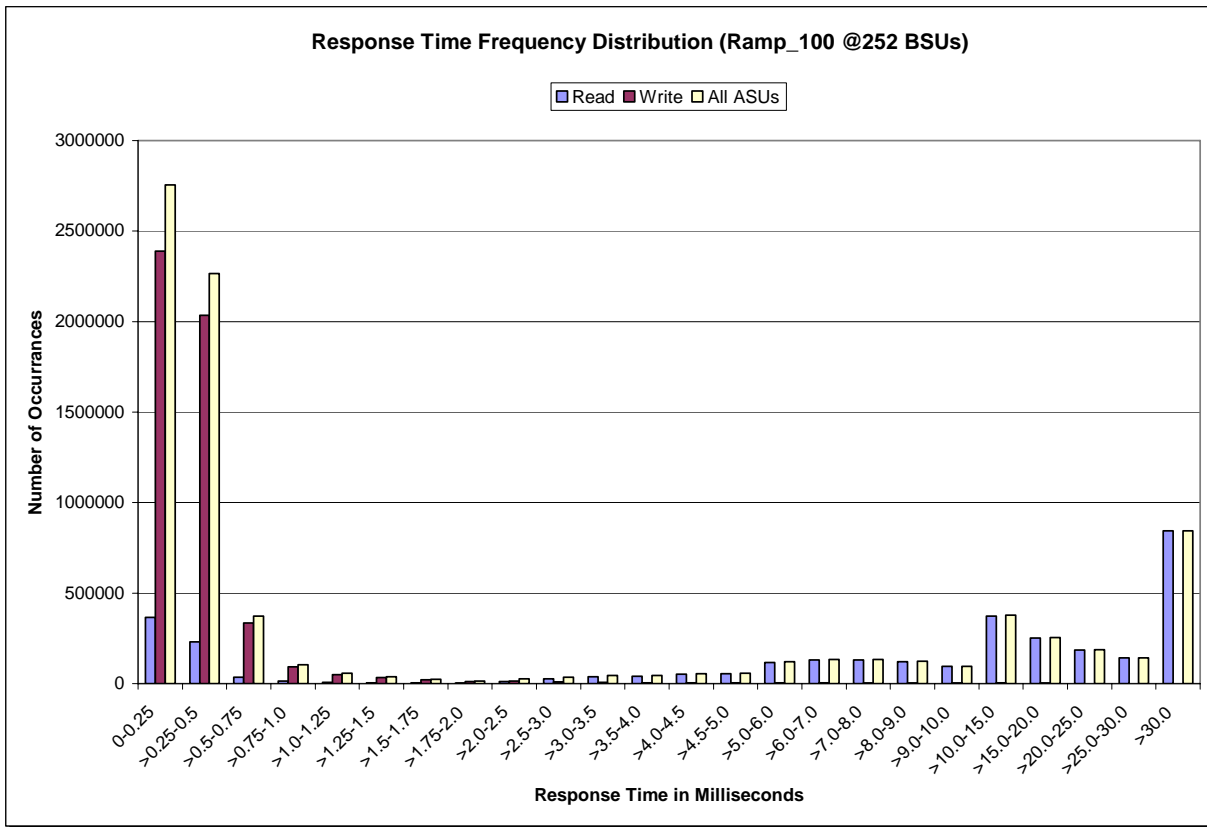
IOPS Test Run – I/O Request Information

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
8,318,051	7,473,918	844,133

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 5.1.10 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	0.2807	0.0700	0.2102	0.0180	0.0699	0.0350	0.2812
COV	0.006	0.002	0.004	0.002	0.008	0.003	0.004	0.002

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.4.3

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

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

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

Clause 9.4.3.7.3

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 63.

Response Time Ramp Test Results File

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

95% Load Level

**90% Load Level**

80% Load Level

50% Load Level

10% Load Level

Response Time Ramp Distribution (IOPS) Data

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

100% Load Level - 252 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:47:22	13:52:23	0-4	0:05:01
Measurement Interval	13:52:23	14:02:23	5-14	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	12,591.35	7,499.25	1,554.58	3,537.52
1	12,589.30	7,498.52	1,547.45	3,543.33
2	12,599.63	7,521.87	1,544.43	3,533.33
3	12,578.00	7,503.67	1,545.47	3,528.87
4	12,634.73	7,525.32	1,549.30	3,560.12
5	12,586.90	7,510.10	1,545.97	3,530.83
6	12,621.88	7,514.65	1,560.40	3,546.83
7	12,612.78	7,511.38	1,549.62	3,551.78
8	12,586.38	7,500.90	1,547.38	3,538.10
9	12,613.72	7,513.37	1,547.97	3,552.38
10	12,583.27	7,505.42	1,544.55	3,533.30
11	12,608.82	7,510.30	1,556.08	3,542.43
12	12,602.03	7,503.17	1,547.67	3,551.20
13	12,623.60	7,535.78	1,547.30	3,540.52
14	12,597.10	7,496.93	1,547.77	3,552.40
Average	12,603.65	7,510.20	1,549.47	3,543.98

95% Load Level - 239 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:03:26	14:08:27	0-4	0:05:01
Measurement Interval	14:08:27	14:18:27	5-14	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	11,963.22	7,140.65	1,461.92	3,360.65
1	11,978.22	7,132.88	1,474.35	3,370.98
2	11,967.50	7,148.32	1,462.43	3,356.75
3	11,969.93	7,145.85	1,465.03	3,359.05
4	11,934.77	7,106.03	1,476.47	3,352.27
5	11,922.80	7,107.00	1,468.58	3,347.22
6	11,934.85	7,113.95	1,466.90	3,354.00
7	11,937.33	7,128.00	1,462.42	3,346.92
8	11,966.08	7,141.70	1,475.80	3,348.58
9	11,945.10	7,122.12	1,467.25	3,355.73
10	11,981.72	7,131.33	1,483.03	3,367.35
11	11,981.07	7,146.75	1,478.13	3,356.18
12	11,940.22	7,108.57	1,469.12	3,362.53
13	11,973.17	7,146.18	1,469.25	3,357.73
14	11,952.87	7,119.67	1,473.60	3,359.60
Average	11,953.52	7,126.53	1,471.41	3,355.59

90% Load Level - 226 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:19:30	14:24:31	0-4	0:05:01
Measurement Interval	14:24:31	14:34:31	5-14	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	11,305.13	6,747.20	1,390.35	3,167.58
1	11,287.43	6,721.78	1,391.22	3,174.43
2	11,293.90	6,734.63	1,388.52	3,170.75
3	11,311.97	6,741.43	1,388.77	3,181.77
4	11,313.37	6,744.27	1,393.05	3,176.05
5	11,311.43	6,741.60	1,400.17	3,169.67
6	11,308.48	6,736.50	1,395.25	3,176.73
7	11,307.78	6,725.67	1,396.35	3,185.77
8	11,302.50	6,727.55	1,398.28	3,176.67
9	11,312.62	6,739.52	1,387.13	3,185.97
10	11,311.12	6,741.63	1,391.32	3,178.17
11	11,261.52	6,706.33	1,390.10	3,165.08
12	11,306.20	6,737.83	1,401.77	3,166.60
13	11,291.45	6,719.37	1,396.35	3,175.73
14	11,296.33	6,739.20	1,392.47	3,164.67
Average	11,300.94	6,731.52	1,394.92	3,174.51

80% Load Level - 201 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:35:34	14:40:35	0-4	0:05:01
Measurement Interval	14:40:35	14:50:35	5-14	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	10,058.70	6,008.28	1,228.80	2,821.62
1	10,040.90	5,983.13	1,243.63	2,814.13
2	10,061.78	5,981.93	1,241.50	2,838.35
3	10,049.08	5,975.52	1,241.05	2,832.52
4	10,048.13	5,991.62	1,241.12	2,815.40
5	10,039.70	5,981.53	1,238.08	2,820.08
6	10,043.07	5,991.57	1,233.65	2,817.85
7	10,042.67	5,985.50	1,224.53	2,832.63
8	10,039.47	5,982.33	1,231.80	2,825.33
9	10,058.53	5,992.28	1,231.85	2,834.40
10	10,060.47	6,007.98	1,227.50	2,824.98
11	10,047.97	5,979.53	1,246.72	2,821.72
12	10,042.83	5,985.92	1,236.50	2,820.42
13	10,051.32	5,991.95	1,235.35	2,824.02
14	10,040.90	5,972.38	1,235.62	2,832.90
Average	10,046.69	5,987.10	1,234.16	2,825.43

50% Load Level - 126 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:51:38	14:56:39	0-4	0:05:01
Measurement Interval	14:56:39	15:06:39	5-14	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	6,310.07	3,756.57	780.00	1,773.50
1	6,288.77	3,738.13	782.93	1,767.70
2	6,302.37	3,757.42	769.55	1,775.40
3	6,297.82	3,749.47	775.25	1,773.10
4	6,299.20	3,758.58	771.73	1,768.88
5	6,297.63	3,746.68	776.18	1,774.77
6	6,301.32	3,753.22	775.47	1,772.63
7	6,302.22	3,755.20	777.87	1,769.15
8	6,311.97	3,769.12	773.15	1,769.70
9	6,300.60	3,749.17	775.72	1,775.72
10	6,296.85	3,751.33	774.08	1,771.43
11	6,289.53	3,752.68	770.40	1,766.45
12	6,304.23	3,753.38	777.62	1,773.23
13	6,292.47	3,758.37	771.50	1,762.60
14	6,307.90	3,746.00	778.28	1,783.62
Average	6,300.47	3,753.52	775.03	1,771.93

| 10% Load Level - 25 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:07:42	15:12:43	0-4	0:05:01
Measurement Interval	15:12:43	15:22:43	5-14	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	1,244.80	740.87	151.82	352.12
1	1,252.05	745.50	153.73	352.82
2	1,245.68	744.58	153.38	347.72
3	1,251.35	743.33	153.95	354.07
4	1,250.07	745.72	154.53	349.82
5	1,247.67	746.27	153.82	347.58
6	1,255.98	748.37	153.32	354.30
7	1,241.63	741.32	150.05	350.27
8	1,252.30	746.67	153.67	351.97
9	1,253.70	746.23	154.08	353.38
10	1,248.57	742.52	154.77	351.28
11	1,248.63	747.02	154.65	346.97
12	1,250.45	742.45	154.90	353.10
13	1,250.32	747.03	154.87	348.42
14	1,243.23	741.63	153.60	348.00
Average	1,249.25	744.95	153.77	350.53

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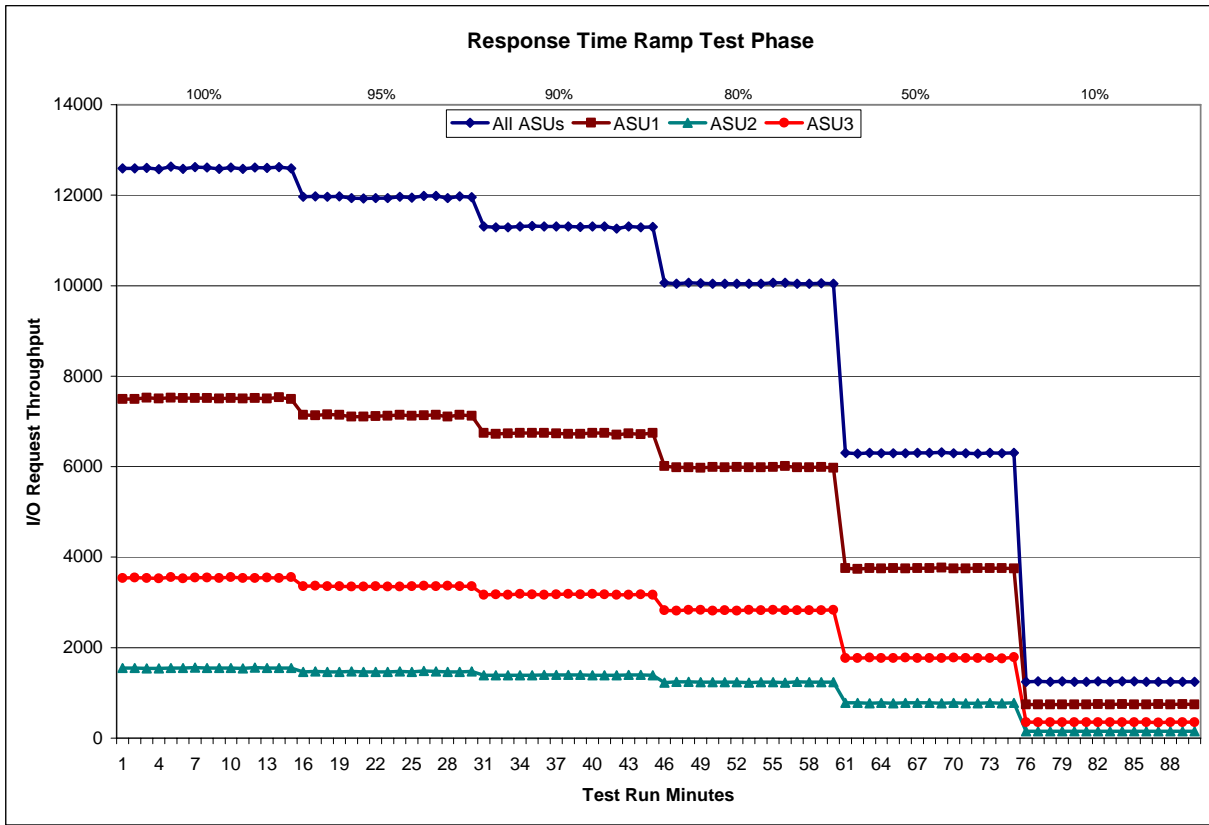
SPC-1 LRT™ Average Response Time (ms) Distribution Data

25 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:07:42	15:12:43	0-4	0:05:01
Measurement Interval	15:12:43	15:22:43	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	3.21	4.57	3.63	0.18
1	2.54	3.63	2.66	0.18
2	2.44	3.45	2.63	0.19
3	2.20	3.14	2.34	0.18
4	2.14	3.03	2.31	0.18
5	2.17	3.09	2.21	0.18
6	2.15	3.04	2.34	0.19
7	2.11	2.99	2.26	0.18
8	2.15	3.05	2.29	0.18
9	2.15	3.06	2.27	0.18
10	2.15	3.05	2.30	0.19
11	2.09	2.96	2.17	0.18
12	2.10	2.98	2.23	0.19
13	2.06	2.91	2.20	0.18
14	2.08	2.96	2.12	0.18
Average	*2.12*	*3.01*	*2.24*	*0.18*

SPC-1 LRT™ Average Response Time (ms) Distribution Graph
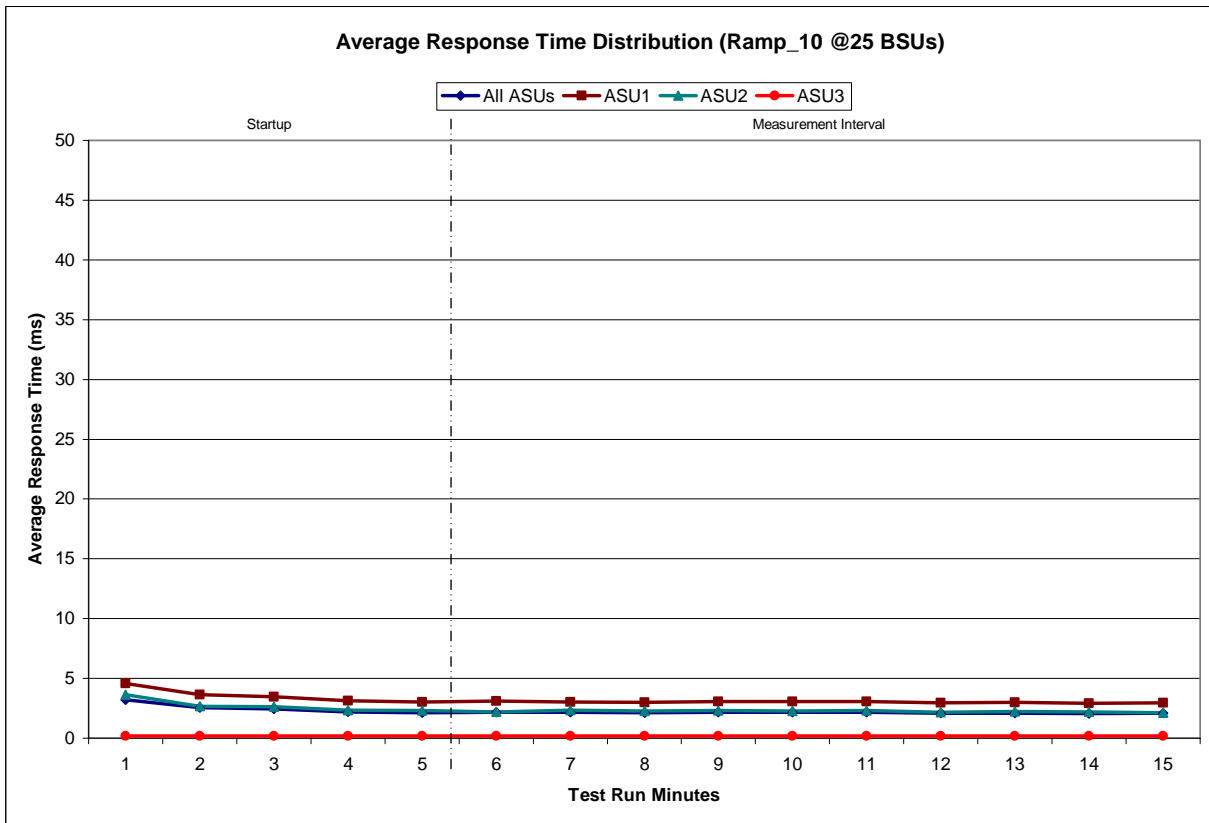
SPC-1 LRT™ (10%) – Measured Intensity Multiplier and Coefficient of Variation

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 5.1.10 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	0.0351	0.2812	0.0704	0.2096	0.0179	0.0703	0.0350	0.2806
COV	0.021	0.007	0.012	0.007	0.040	0.013	0.022	0.006

Repeatability Test

<u>Clause 5.4.5</u>

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% or less than the SPC-1 LRT™ metric plus one (1) millisecond (ms).

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.

<u>Clause 9.4.3.7.4</u>

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 63.

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	*12,603.65*
Repeatability Test Phase 1	12,606.94
Repeatability Test Phase 2	12,601.53

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

	SPC-1 LRT™
Primary Metrics	*2.12 ms*
Repeatability Test Phase 1	2.07 ms
Repeatability Test Phase 2	2.05 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 or less than the reported SPC-1 LRT™ Primary Metric minus one (1) millisecond (ms)..

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

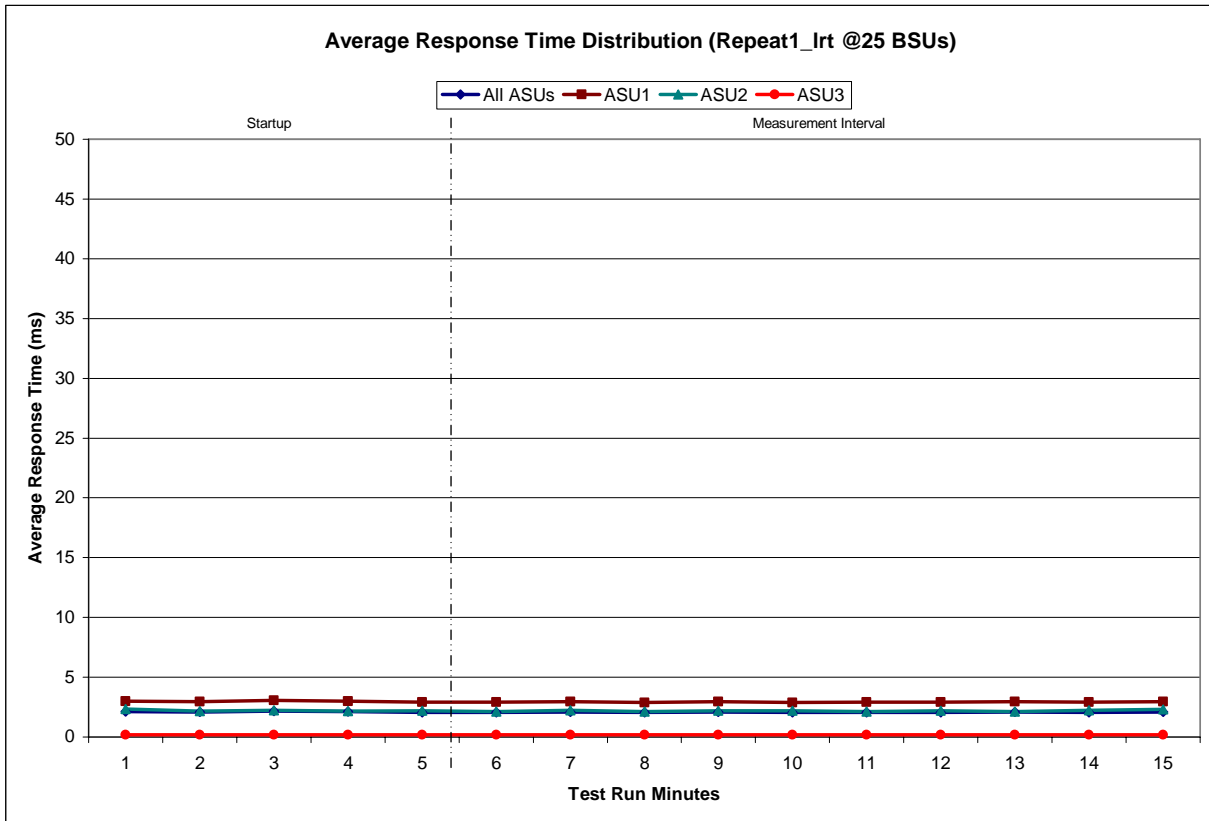| 25 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:23:48	15:28:48	0-4	0:05:00
Measurement Interval	15:28:48	15:38:48	3-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1,259.25	751.52	154.70	353.03
1	1,245.77	747.82	151.28	346.67
2	1,250.35	744.65	157.70	348.00
3	1,250.90	750.23	153.35	347.32
4	1,248.25	742.47	154.82	350.97
5	1,249.07	746.80	152.87	349.40
6	1,249.03	744.20	154.82	350.02
7	1,251.70	749.50	154.18	348.02
8	1,242.57	740.50	151.62	350.45
9	1,245.32	744.20	152.78	348.33
10	1,252.53	749.82	152.15	350.57
11	1,251.93	746.32	154.38	351.23
12	1,247.63	744.22	152.88	350.53
13	1,249.15	741.17	154.00	353.98
14	1,249.90	738.95	158.63	352.32
Average	*1,248.88*	*744.57*	*153.83*	*350.49*

Repeatability 1 LRT – I/O Request Throughput Distribution Graph
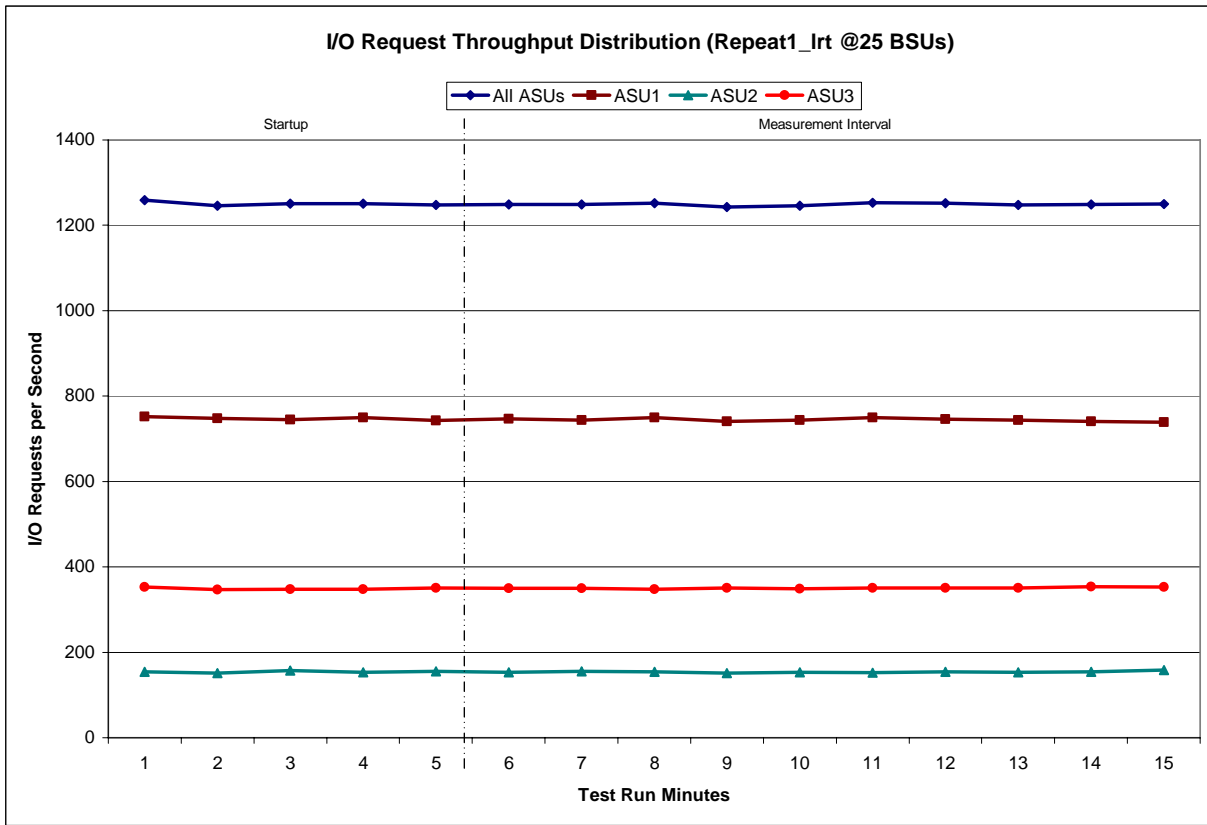
Repeatability 1 LRT –Average Response Time (ms) Distribution Data

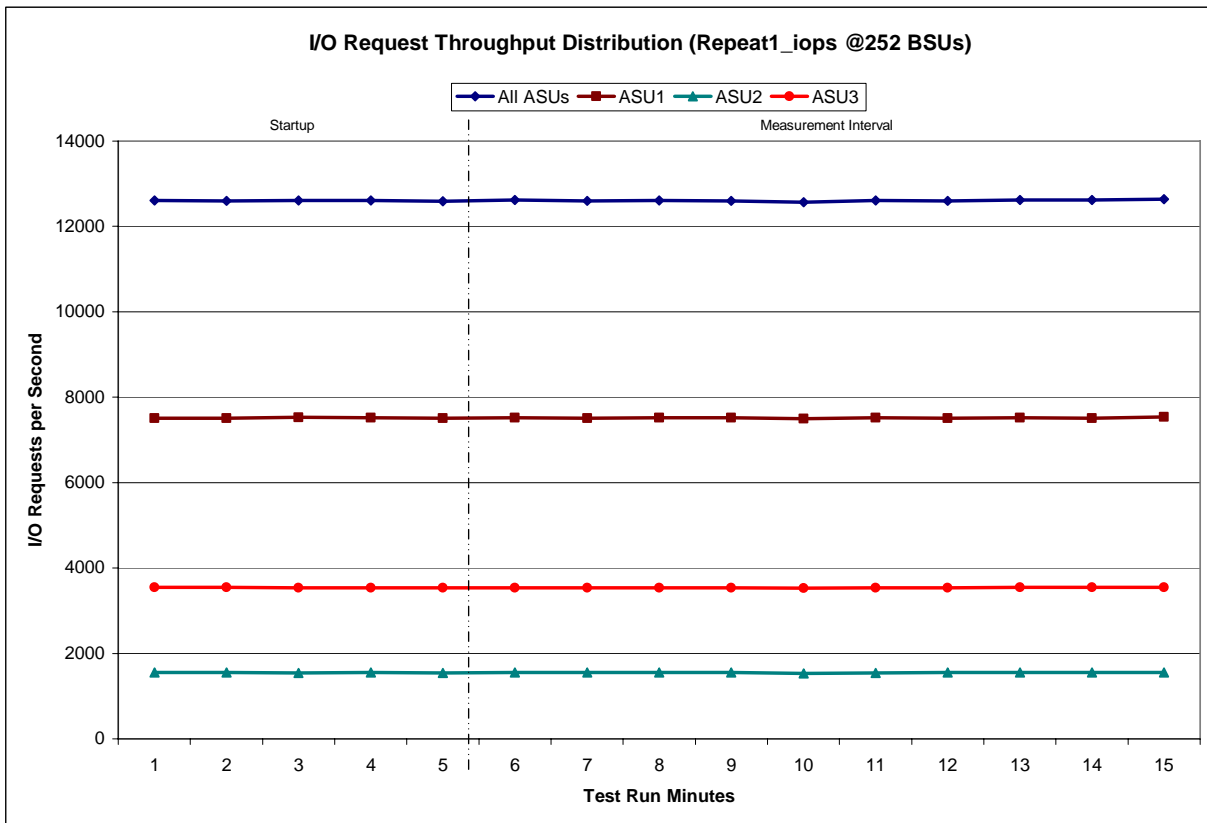| 25 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:23:48	15:28:48	0-4	0:05:00
Measurement Interval	15:28:48	15:38:48	3-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.13	3.00	2.34	0.18
1	2.08	2.94	2.17	0.18
2	2.15	3.06	2.22	0.18
3	2.12	3.00	2.17	0.19
4	2.06	2.93	2.20	0.18
5	2.06	2.91	2.14	0.19
6	2.09	2.96	2.22	0.18
7	2.04	2.88	2.11	0.19
8	2.08	2.95	2.18	0.18
9	2.05	2.89	2.18	0.18
10	2.07	2.93	2.13	0.18
11	2.06	2.92	2.18	0.19
12	2.08	2.96	2.12	0.18
13	2.06	2.92	2.23	0.18
14	2.08	2.94	2.29	0.18
Average	*2.07*	*2.93*	*2.18*	*0.18*

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

Repeatability 1 IOPS – I/O Request Throughput Distribution Data

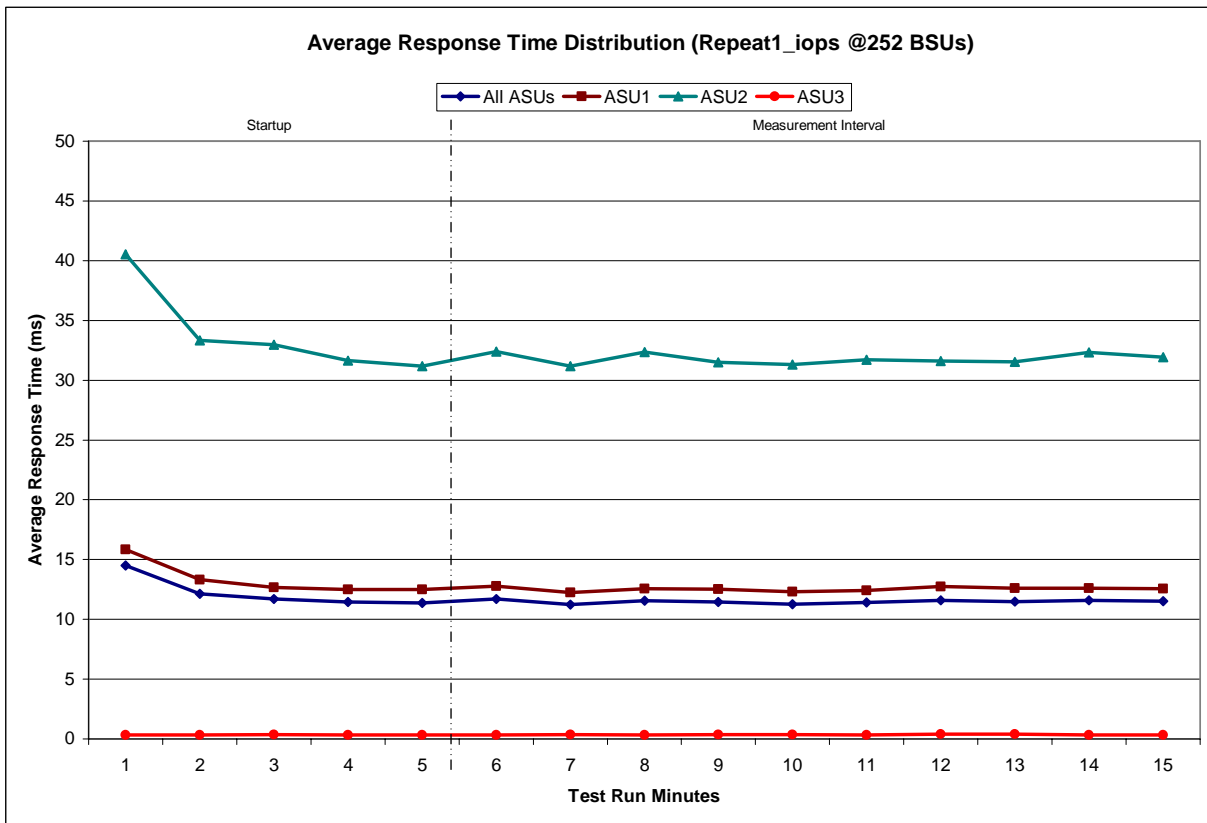| 252 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:39:51	15:44:52	0-4	0:05:01
Measurement Interval	15:44:52	15:54:52	3-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	12,604.07	7,510.55	1,550.57	3,542.95
1	12,601.20	7,507.03	1,551.07	3,543.10
2	12,606.33	7,526.80	1,542.80	3,536.73
3	12,605.22	7,516.32	1,554.12	3,534.78
4	12,590.92	7,508.93	1,544.07	3,537.92
5	12,616.07	7,522.95	1,550.82	3,542.30
6	12,597.37	7,511.02	1,551.90	3,534.45
7	12,606.48	7,520.83	1,547.33	3,538.32
8	12,603.87	7,514.15	1,553.27	3,536.45
9	12,565.95	7,502.97	1,533.00	3,529.98
10	12,604.33	7,521.90	1,546.63	3,535.80
11	12,602.90	7,507.63	1,557.17	3,538.10
12	12,619.83	7,519.02	1,550.42	3,550.40
13	12,616.95	7,513.95	1,552.65	3,550.35
14	12,635.68	7,534.87	1,549.45	3,551.37
Average	*12,606.94*	*7,516.93*	*1,549.26*	*3,540.75*

Repeatability 1 IOPS – I/O Request Throughput Distribution Graph

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

252 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:39:51	15:44:52	0-4	0:05:01
Measurement Interval	15:44:52	15:54:52	3-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	14.51	15.82	40.52	0.34
1	12.14	13.34	33.32	0.34
2	11.70	12.67	32.98	0.34
3	11.45	12.50	31.64	0.33
4	11.37	12.49	31.19	0.34
5	11.70	12.78	32.41	0.34
6	11.25	12.25	31.19	0.35
7	11.56	12.56	32.38	0.34
8	11.45	12.53	31.49	0.36
9	11.28	12.32	31.31	0.36
10	11.40	12.42	31.72	0.34
11	11.60	12.74	31.61	0.38
12	11.49	12.61	31.52	0.38
13	11.58	12.60	32.33	0.33
14	11.50	12.57	31.92	0.33
Average	*11.48*	*12.54*	*31.79*	*0.35*

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

Average Response Time Distribution (Repeat1_iops @252 BSUs)

Repeatability 2 LRT – I/O Request Throughput Distribution Data

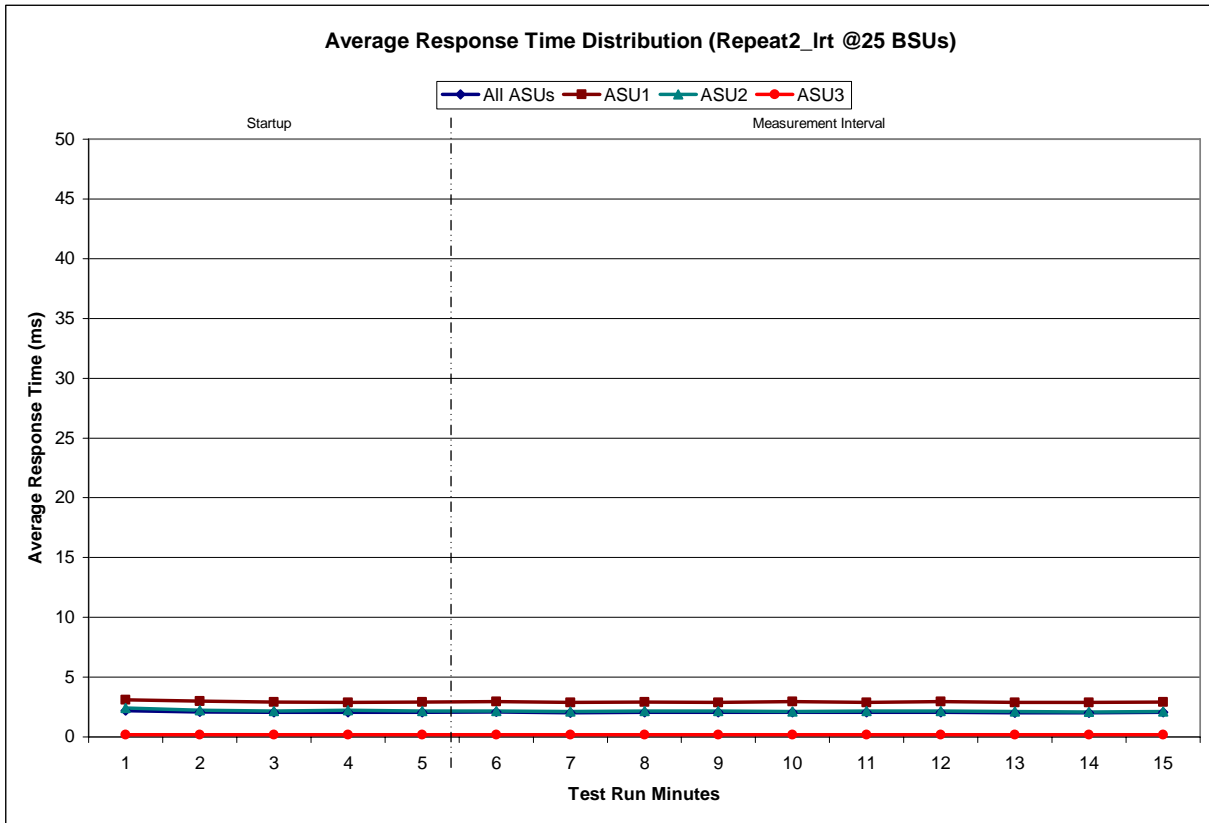| 25 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:55:58	16:00:58	0-4	0:05:00
Measurement Interval	16:00:58	16:10:58	3-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1,244.07	744.22	149.48	350.37
1	1,253.02	743.98	153.13	355.90
2	1,244.10	740.70	153.97	349.43
3	1,250.92	744.08	155.33	351.50
4	1,251.22	744.53	153.43	353.25
5	1,247.40	745.08	152.50	349.82
6	1,244.00	737.83	153.80	352.37
7	1,247.80	741.90	155.33	350.57
8	1,246.85	746.87	152.80	347.18
9	1,238.38	737.00	152.23	349.15
10	1,247.93	746.03	151.28	350.62
11	1,252.53	747.33	153.47	351.73
12	1,244.87	737.38	152.57	354.92
13	1,246.60	742.48	154.87	349.25
14	1,249.58	745.45	155.68	348.45
Average	*1,246.60*	*742.74*	*153.45*	*350.41*

Repeatability 2 LRT – I/O Request Throughput Distribution Graph

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

25 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:55:58	16:00:58	0-4	0:05:00
Measurement Interval	16:00:58	16:10:58	3-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.20	3.10	2.41	0.19
1	2.09	2.97	2.23	0.18
2	2.04	2.90	2.15	0.18
3	2.05	2.89	2.21	0.18
4	2.04	2.91	2.15	0.18
5	2.08	2.96	2.16	0.18
6	2.02	2.87	2.12	0.18
7	2.05	2.91	2.15	0.18
8	2.05	2.90	2.15	0.18
9	2.06	2.94	2.11	0.19
10	2.04	2.89	2.17	0.18
11	2.07	2.94	2.17	0.18
12	2.03	2.90	2.13	0.18
13	2.03	2.89	2.10	0.18
14	2.05	2.92	2.11	0.18
Average	*2.05*	*2.91*	*2.14*	*0.18*

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

Repeatability 2 IOPS – I/O Request Throughput Distribution Data

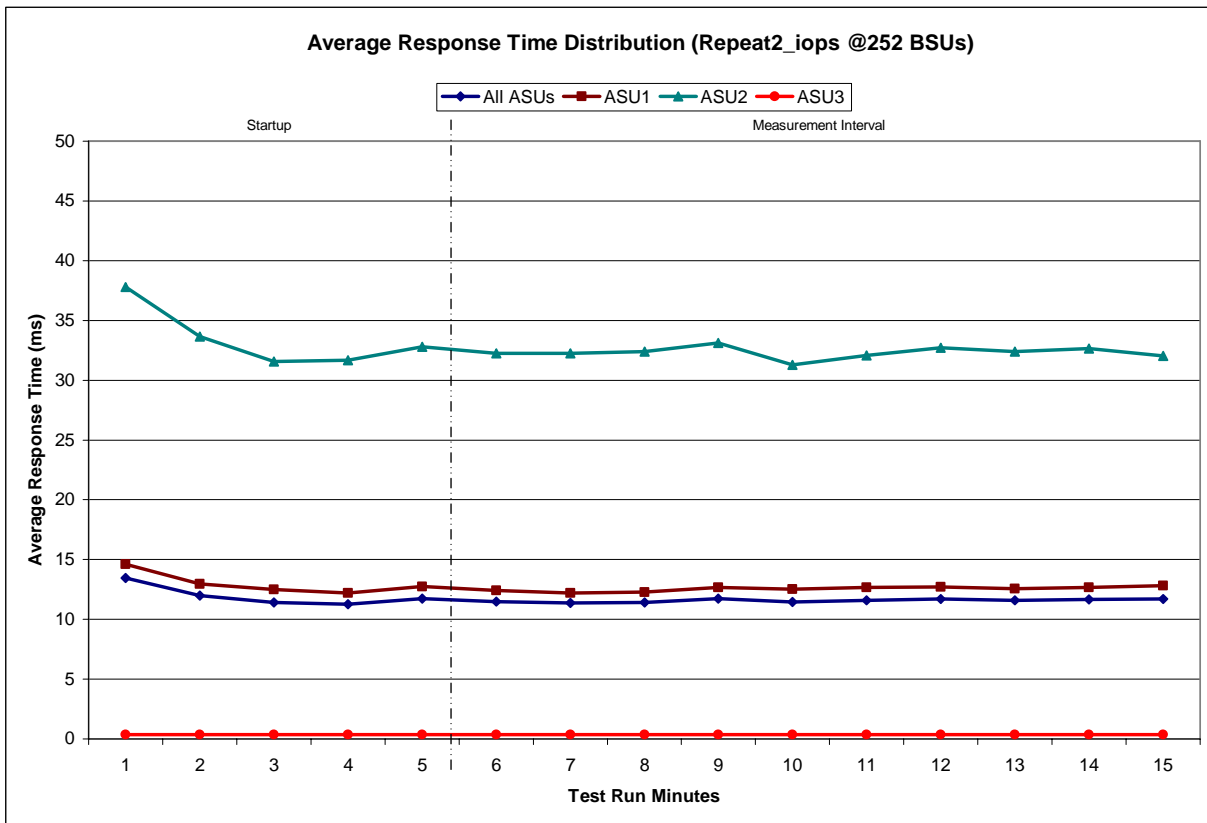| 252 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	16:12:01	16:17:02	0-4	0:05:01
Measurement Interval	16:17:02	16:27:02	3-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	12,585.42	7,499.75	1,547.68	3,537.98
1	12,590.12	7,500.13	1,551.93	3,538.05
2	12,611.72	7,509.23	1,553.43	3,549.05
3	12,596.97	7,502.03	1,544.13	3,550.80
4	12,613.28	7,517.77	1,550.53	3,544.98
5	12,604.62	7,503.67	1,551.37	3,549.58
6	12,585.27	7,512.77	1,550.90	3,521.60
7	12,614.02	7,513.83	1,549.93	3,550.25
8	12,614.48	7,514.43	1,549.85	3,550.20
9	12,591.75	7,497.33	1,560.75	3,533.67
10	12,594.27	7,507.10	1,549.43	3,537.73
11	12,596.82	7,507.63	1,552.53	3,536.65
12	12,592.20	7,502.33	1,549.37	3,540.50
13	12,614.62	7,519.20	1,555.30	3,540.12
14	12,607.22	7,518.08	1,558.63	3,530.50
Average	*12,601.53*	*7,509.64*	*1,552.81*	*3,539.08*

Repeatability 2 IOPS – I/O Request Throughput Distribution Graph
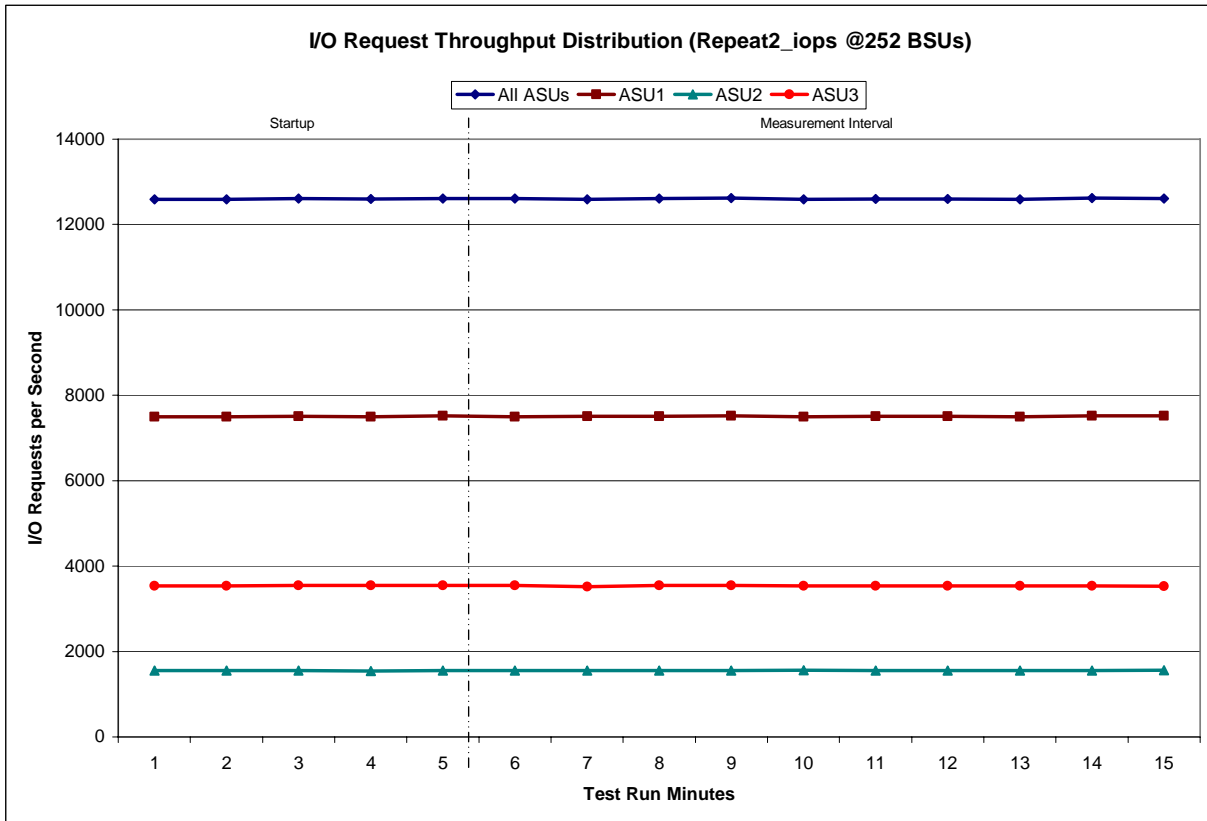
Repeatability 2 IOPS –Average Response Time (ms) Distribution Data

252 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	16:12:01	16:17:02	0-4	0:05:01
Measurement Interval	16:17:02	16:27:02	3-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	13.47	14.63	37.80	0.36
1	11.98	12.97	33.67	0.35
2	11.42	12.48	31.58	0.36
3	11.26	12.22	31.69	0.37
4	11.73	12.74	32.79	0.35
5	11.47	12.42	32.26	0.38
6	11.36	12.21	32.25	0.34
7	11.40	12.29	32.41	0.36
8	11.73	12.68	33.13	0.38
9	11.44	12.52	31.30	0.37
10	11.59	12.67	32.07	0.35
11	11.70	12.69	32.71	0.37
12	11.57	12.57	32.41	0.35
13	11.67	12.66	32.65	0.36
14	11.71	12.83	32.04	0.36
Average	*11.57*	*12.55*	*32.32*	*0.36*

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

SPC BENCHMARK 1™ V1.12   FULL DISCLOSURE REPORT   Submission Identifier: A00095
Xiotech Corporation   Submitted for Review: SEPTEMBER 20, 2010
Xiotech Emprise™ 5000 *(ISE 9.6 TB/10.2 DataPac)*

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 5.1.10 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	0.0701	0.2103	0.0182	0.0700	0.0350	0.2806
COV	0.015	0.007	0.010	0.007	0.023	0.018	0.021	0.005

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	0.0351	0.2813	0.0700	0.2099	0.0179	0.0699	0.0351	0.2809
COV	0.008	0.003	0.004	0.004	0.010	0.003	0.006	0.001

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0351	0.2808	0.0698	0.2101	0.0181	0.0699	0.0351	0.2811
COV	0.020	0.006	0.014	0.007	0.026	0.012	0.017	0.007

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0350	0.2810	0.0699	0.2100	0.0180	0.0702	0.0350	0.2808
COV	0.005	0.001	0.005	0.002	0.008	0.003	0.005	0.002

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.*

Execution of Persistence Test Run 1 will cause the SPC-1 Workload Generator to write a specific pattern at randomly selected locations throughout the Total ASU Capacity. The SPC-1 Workload Generator will retain the information necessary to later validate the pattern written at each location

The Tested Storage Configuration (TSC) 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. If the TSC includes the Host System(s), the Host System(s) must also be shutdown and restarted using a power off/power on cycle.

Persistence Test Run 2, executed after the TSC has been restarted, will utilize the retained data from Persistence Test Run 1 to validate the patterns written at each location during Persistence Test Run 1.

Clause 9.4.3.8

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 (may optionally be referenced in an appendix).*

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 9-16. 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 63.

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	29,857,216
Total Number of Logical Blocks Verified	28,185,104
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 for the Priced Storage Configuration must be the date at which all components are committed to be available.

The Xiotech Emprise™ 5000 *(ISE 9.6 TB/10.2 DataPac)* **as documented in this Full Disclosure Report is currently available for customer purchase and shipment.**

PRICING INFORMATION

Clause 9.4.3.3.6

The Executive Summary shall contain a pricing spreadsheet as documented in Clause 8.3.1.

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

TESTED STORAGE CONFIGURATION (TSC) AND PRICED STORAGE CONFIGURATION DIFFERENCES

Clause 9.4.3.3.7

The Executive Summary shall contain a pricing a list of all differenced between the Tested Storage Configuration (TSC) and the Priced Storage Configuration.

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

ANOMALIES OR IRREGULARITIES

Clause 9.4.3.10

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

There were no anomalies or irregularities encountered during the SPC-1 Remote Audit of the Xiotech Emprise™ 5000 *(ISE 9.6 TB/10.2 DataPac).*

APPENDIX A: SPC-1 GLOSSARY

"Decimal" *(powers of ten)* Measurement Units

In the storage industry, the terms "kilo", "mega", "giga", "tera", "peta", and "exa" are commonly used prefixes for computing performance and capacity. For the purposes of the SPC workload definitions, all of the following terms are defined in "powers of ten" measurement units.

A kilobyte (KB) is equal to 1,000 (10^3) bytes.

A megabyte (MB) is equal to 1,000,000 (10^6) bytes.

A gigabyte (GB) is equal to 1,000,000,000 (10^9) bytes.

A terabyte (TB) is equal to 1,000,000,000,000 (10^{12}) bytes.

A petabyte (PB) is equal to 1,000,000,000,000,000 (10^{15}) bytes

An exabyte (EB) is equal to 1,000,000,000,000,000,000 (10^{18}) bytes

"Binary" *(powers of two)* Measurement Units

The sizes reported by many operating system components use "powers of two" measurement units rather than "power of ten" units. The following standardized definitions and terms are also valid and may be used in this document.

A kibibyte (KiB) is equal to 1,024 (2^{10}) bytes.

A mebibyte (MiB) is equal to 1,048,576 (2^{20}) bytes.

A gigibyte (GiB) is equal to 1,073,741,824 (2^{30}) bytes.

A tebibyte (TiB) is equal to 1,099,511,627,776 (2^{40}) bytes.

A pebibyte (PiB) is equal to 1,125,899,906,842,624 (2^{50}) bytes.

An exbibyte (EiB) is equal to 1,152,921,504,606,846,967 (2^{60}) bytes.

SPC-1 Data Repository Definitions

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

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

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

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

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

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

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

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

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

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

SPC-1 Data Protection Levels

Protected: This level will ensure data protection in the event of a single point of failure of any configured storage device. A brief description of the data protection utilized is included in the Executive Summary.

Unprotected: No claim of data protection is asserted in the event of a single point of failure.

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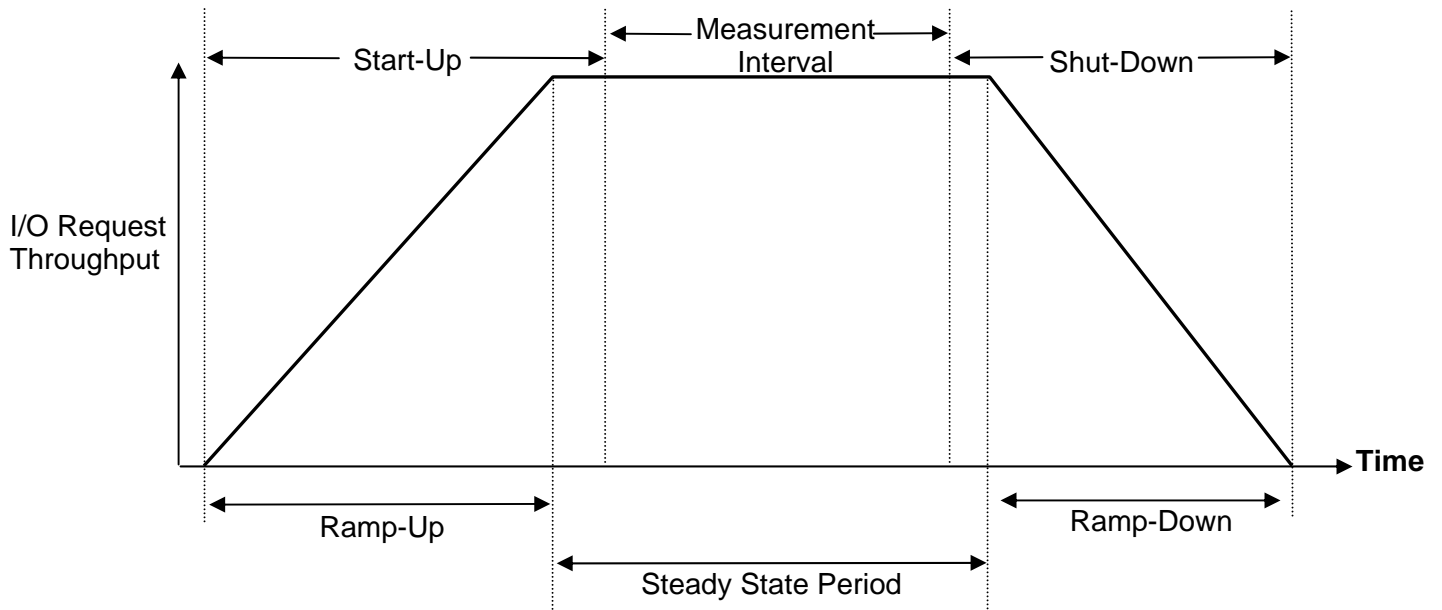
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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
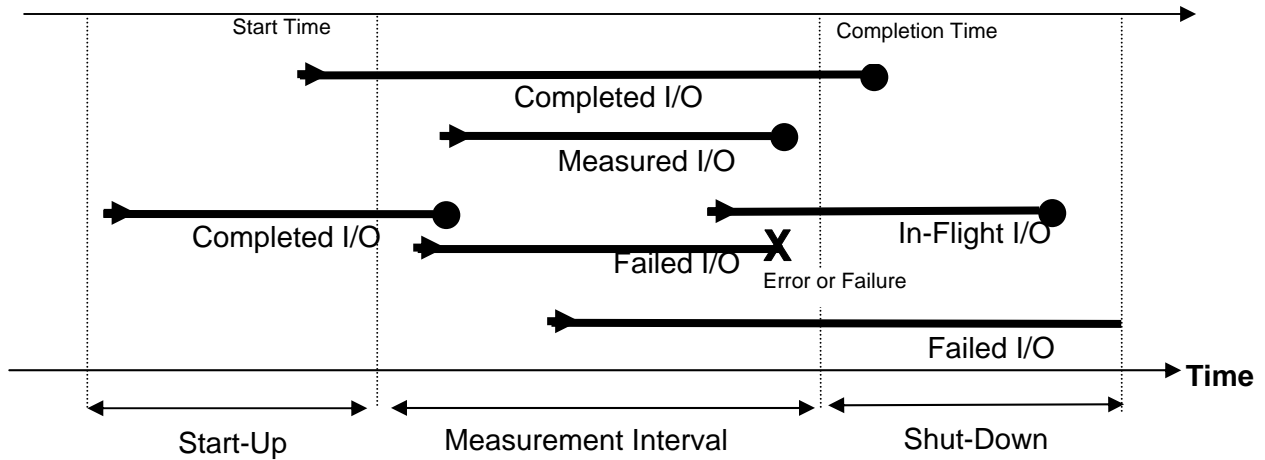
SPC-1 Test Run Components

APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

The Qlogic HBA EXECUTION THROTTLE parameter was set to 4,096 for both HBA ports.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

The following script, **FIRESTORM R1.SH**, is executed from a command window on the Host System and creates the twelve SPC-1 Logical Volumes as follows:

- The Emprise 5000 is first initialized with a spare level of 20% of the storage capacity available for application use.

- UPS mode is set to maintain write-back caching in the event of battery failure

- The twelve RAID-1 volumes are then created, four with a capacity of 216 GiB and the remaining eight with a capacity of 972 GiB. The DataPacs (pools) on which the volumes reside are alternated between DataPac 1 and DataPac 2.

- Next, the two Qlogic HBA ports are initialized and named.

- Finally, the twelve volumes are presented to both Qlogic HBA ports

After the script completes its execution, the Qlogic HBA is configured for the benchmark measurements by changing the **EXECUTION THROTTLE** parameter to a value of 4,096 for both HBA ports.

Firestorm R1.sh

```
#
#     Initialize brick
#
/bin/nseash -c "initialize --sparelevel=20"
/bin/nseash -c "configure --upsmode=enable"
#
#     Create Raid-1 volumes for SPC-1 testing on 600 GB DataPacs at 99.8% utilization
#
/bin/nseash -c "create --volume=L1 --size=216 --raid1 --pool1 --write-back"
/bin/nseash -c "create --volume=L2 --size=216 --raid1 --pool2 --write-back"
/bin/nseash -c "create --volume=L3 --size=216 --raid1 --pool1 --write-back"
/bin/nseash -c "create --volume=L4 --size=216 --raid1 --pool2 --write-back"
/bin/nseash -c "create --volume=L5 --size=972 --raid1 --pool1 --write-back"
/bin/nseash -c "create --volume=L6 --size=972 --raid1 --pool2 --write-back"
/bin/nseash -c "create --volume=L7 --size=972 --raid1 --pool1 --write-back"
/bin/nseash -c "create --volume=L8 --size=972 --raid1 --pool2 --write-back"
/bin/nseash -c "create --volume=L9 --size=972 --raid1 --pool1 --write-back"
/bin/nseash -c "create --volume=L10 --size=972 --raid1 --pool2 --write-back"
/bin/nseash -c "create --volume=L11 --size=972 --raid1 --pool1 --write-back"
/bin/nseash -c "create --volume=L12 --size=972 --raid1 --pool2 --write-back"
sleep 10
#
#     Create the QLogic hosts
#
/bin/nseash -c "create --host=\"Dell_2 P0\" --windows 210000E08B8E9064"
/bin/nseash -c "create --host=\"Dell_2 P1\" --windows 210100E08BAE9064"
#
#     Present the SPC-1 LUNs to the Dell HBAs
#
/bin/nseash -c "present --host=\"Dell_2 P0\" L1:0 L2:1 L3:2 L4:3 L5:4 L6:5 L7:6 L8:7
L9:8 L10:9 L11:10 L12:11"
/bin/nseash -c "present --host=\"Dell_2 P1\" L1:0 L2:1 L3:2 L4:3 L5:4 L6:5 L7:6 L8:7
L9:8 L10:9 L11:10 L12:11"
```

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

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

```
javaparms="-Xmx512m"
*
* Raw storage
*
sd=asu1_1,lun=\\.\PhysicalDrive6
sd=asu1_2,lun=\\.\PhysicalDrive5
sd=asu1_3,lun=\\.\PhysicalDrive7
sd=asu1_4,lun=\\.\PhysicalDrive8
*
sd=asu2_1,lun=\\.\PhysicalDrive9
sd=asu2_2,lun=\\.\PhysicalDrive10
sd=asu2_3,lun=\\.\PhysicalDrive11
sd=asu2_4,lun=\\.\PhysicalDrive12
*
sd=asu3_1,lun=\\.\PhysicalDrive1
sd=asu3_2,lun=\\.\PhysicalDrive2
sd=asu3_3,lun=\\.\PhysicalDrive3
sd=asu3_4,lun=\\.\PhysicalDrive4
*
* Formatted storage
*
*sd=asu1_1,lun=z$,size=450g
*sd=asu2_1,lun=y$,size=450g
*sd=asu3_1,lun=x$,size=100g
```

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.

```
@echo off
::
::   SPC-1 batch execution file
::
set /a BSU = 252
::
:: Run the "standard" SPC-1 run up to persistence phase 1
::
echo Executing SPC-1 metrics, repeatability, and persistence phase 1...
java -Xmx640m -Xms640m metrics -b %BSU% -s 300 -t 10860 -r 600
java -Xmx640m -Xms640m repeat1 -b %BSU% -s 300 -t 660
java -Xmx640m -Xms640m repeat2 -b %BSU% -s 300 -t 660
java -Xmx640m -Xms640m persist1 -b %BSU%

:: Manual intervention: Shut down all systems, then power back on
echo Shutdown all systems in preparation for persistence phase 2!
echo Run persistance test part 2: java -Xmx640m -Xms640m persist2
```

Persistence Test Run 2

The following CLI command was used to execute Persistence Test Run 2.

```
java -Xmx640m -Xms640m persist2
```