SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

TEXAS MEMORY SYSTEMS, INC.
TEXAS MEMORY SYSTEMS RAMSAN-320 *(8 PORT)*

SPC-1 V1.8

Submitted for Review: April 5, 2004
Submission Identifier: A00028
Accepted: June 4, 2004

First Edition – April 2004

Trademarks

Notes

The following terms, used in this document, are defined as:

- Kilobyte (KB) is equal to 1,000 (10^3) bytes.
- Megabyte (MB) is equal to 1,000,000 (10^6) bytes.
- Gigabyte (GB) is equal to 1,000,000,000 (10^9) bytes.
- Terabyte (TB) is equal to 1,000,000,000,000 (10^{12}) bytes.

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AUDIT CERTIFICATION

William Hutsell
Texas Memory Systems, Inc.
11200 Westheimer Road
Suite 1000
Houston, TX 77042

March 2, 2004

The SPC Benchmark 1™ results listed below for the Texas Memory Systems RamSan-320 *(8 port)* were produced in compliance with the SPC Benchmark 1™ V1.8 Onsite Audit requirements.

SPC Benchmark 1™ V1.8 Results	
Tested Storage Configuration (TSC) Name: Texas Memory Systems RamSan-320 *(8 port)*	
Metric	**Reported Result**
SPC-1 IOPS™	112,491.34
SPC-1 Price-Performance	$1.50/SPC-1 IOPS™
Total ASU Capacity	68.719 GB
Data Protection Level	Other Protection Level
Total TSC Price (including three-year maintenance)	$168,776

The following SPC Benchmark 1™ Onsite Audit requirements were reviewed and found compliant with V1.8 of the SPC Benchmark 1™ specification:

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

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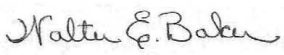
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters.
- Commands and parameters used to configure the SPC-1 Workload Generator.
- The following Host System requirements were verified by physical inspection and information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

Audit Notes:

There were no additional audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

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LETTER OF GOOD FAITH

TMS
TEXAS MEMORY SYSTEMS

11200 Westheimer Suite 1000, Houston,Texas 77042
Phone: 713-266-3200 Fax: 713-266-0332

Date:
March 15, 2004

From:
William Hutsell
Executive Vice President
Texas Memory Systems, Inc.
11200 Westheimer Rd, Suite 1000
Houston, TX 77042

To:
Walter Baker, SPC Auditor
Gradient Systems
643 Blair Island Rd., Suite 103
Redwood City, CA 94063

Subject:
SPC-1 Letter of Good Faith for Texas Memory Systems RamSan-320 (8 port)

Texas Memory Systems, Inc. is the 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 V1.8 of the SPC-1 benchmark specification.

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

Signed: **Date:**

William Hutsell
Executive Vice President

March 15, 2004
Date of Signature

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Texas Memory Systems, Inc. – www.texmemsys.com Aaron Martz – aaron.martz@texmemsys.com 11200 Westheimer Road, Suite 1000 Houston, TX 77042 Phone: (713) 266-3200 FAX: (713) 266-0332
Test Sponsor Alternate Contact	Texas Memory Systems, Inc. – www.texmemsys.com Michael Clonts – michael.clonts@texmemsys.com 11200 Westheimer Road, Suite 1000 Houston, TX 77042 Phone: (713) 266-3200 FAX: (713) 266-0332
Auditor	Storage Performance Council – 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	V1.8
SPC-1 Workload Generator revision number	V2.00.04a
Date Results were first used publicly	April 5, 2004
Date FDR was submitted to the SPC	April 5, 2004
Date the TSC is/was available for shipment to customers	July 1, 2003
Date the TSC completed audit certification	March 31, 2004

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: Texas Memory Systems RamSan-320 *(8-Node)*	
Metric	**Reported Result**
SPC-1 IOPS™	112,491.34
SPC-1 Price-Performance	$1.50/SPC-1 IOPS™
Total ASU Capacity	68.719 GB
Data Protection Level	Other Protection Level
Total TSC Price (including three-year maintenance)	$168,776

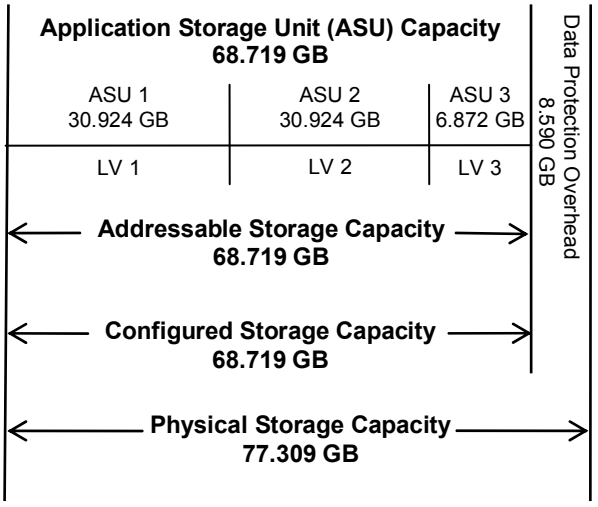
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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 Other Protection Level was used. Data protection was accomplished with the use of Error Correction Code (ECC). The ECC hardware stored an additional eight bits of parity data for every 64-bit word. During read requests the hardware uses the parity data to detect data corruption. Any single bit error is immediately corrected. Multiple bit errors are detected but not corrected. In both cases, the system provides notification of the error.

Storage Capacities and Relationships

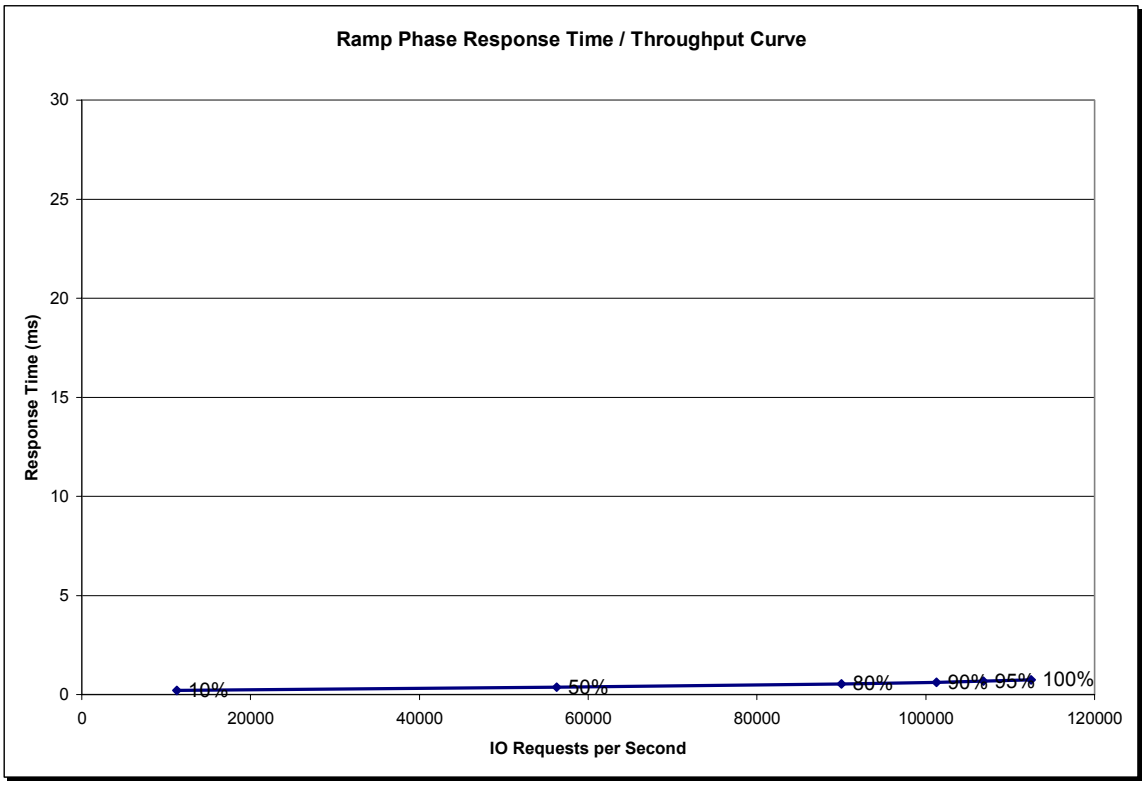
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



Response Time – Throughput Curve

The Response Time-Throughput Curve illustrates the Average Response Time (milliseconds) and I/O Request Throughput at 100%, 95%, 90%, 80%, 50%, and 10% of the workload level used to generate the SPC-1 IOPS™ metric.

The Average Response Time measured at any of the above load points cannot exceed 30 milliseconds or the benchmark measurement is invalid.



Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	11,254.35	56,244.55	90,019.90	101,247.09	106,836.96	112,491.34
Average Response Time (ms):						
All ASUs	0.20	0.37	0.54	0.62	0.67	0.73
ASU-1	0.18	0.34	0.50	0.58	0.62	0.68
ASU-2	0.19	0.36	0.52	0.60	0.65	0.71
ASU-3	0.24	0.43	0.62	0.71	0.77	0.84
Reads	0.18	0.34	0.48	0.55	0.60	0.65
Writes	0.21	0.39	0.57	0.66	0.71	0.78

Tested Storage Configuration Pricing *(Priced Storage Configuration)*

1 RamSan unit(s), 3 extra 16GB memory card(s), 3 extra Fibre Channel controller(s)

Hardware Pricing

Part	Qty.	Description	Price	Total
RamSan-320-16**	1	RamSan-320-16GB-1FC65*	$36,000	$36,000
Addt'l Memory	3	Additional 16GB Memory	$24,000	$72,000
Addt'l FC-65	3	Dual Ported Fibre Channel Controller	$4,000	$12,000
QLogic HBAs	4	SANblade 2342 2Gb PCI-X Dual Channel HBA	$1,781	$7,124
Emulex HBAs	4	LightPulse 10000DC 2Gb Dual Channel HBA	$1,952	$7,808
Fibre Channel Cables	8	LC-LC 1 and 2 meter 50/125 FC cables	$47	$376
Hardware List Price				$135,308
HARDWARE TOTAL				$135,308

Support Pricing

Part	Qty.	Description	Price	Total
24x7x4 Maintenance Year 1	1	Platinum Warranty 1st Year (6.3% of list)	$8,524	$8,524
24x7x4 Maintenance Year 2	1	Platinum Warranty 2nd Year (8.7% of list)	$11,772	$11,772
24x7x4 Maintenance Year 3	1	Platinum Warranty 3rd Year (8.7% of list)	$11,772	$11,772
Spares Kit-320	1	Spares Kit (per unit ordered)	$1,200	$1,200
Support List Price				$33,268
SUPPORT TOTAL				$33,268
Shipping	1	Shipping	$200	$200
		Total Purchase Price		**$168,776**

**Includes: 1 dual ported Fibre Channel controller, hot swappable power supplies, management contol port, rendudant batteries, hot swappable RAID-3 protected backup hard disk drives.

Third-party price quotations for the QLogic and Emulex Host Bus Adapters, including support for those adapters may be found on page 54, "Appendix C: Third-Party Price Quotations".

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

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

Benchmark Configuration/Tested Storage Configuration Diagram

Benchmark Configuration/Tested Storage Configuration Details

Host Systems:	Tested Storage Configuration (TSC):
HS-1/2/3/4: *SuperMicro AMD Opteron Servers*	4 – QLogic 2342 dual channel HBAs *(HS-1/2/3/4)*
2 – AMD 1.8 GHz Opteron CPUs per server	4 – Emulex LP10000DC-M2 dual channel HBAs *(HS-5/6/7/8)*
1024 KB L2 cache per CPU	**SC-1: *Texas Memory Systems RamSan 320*** *(8-Node)*
4 GB Main Memory per server	4 – FC65 dual port fibre channel controllers
Microsoft ® Windows ® 2000 Advanced Server with Service Pack 4	8 – 2 Gbs fibre channel ports
WG	77.309 GB of solid state storage
HS-5/6/7/8: *SuperMicro Intel Xeon Servers*	Hot swappable RAID-3 protected backup disks
2 – Intel 2.4 GHz Xeon CPUs per server	Fibre Channel
512 KB L2 cache per CPU	
3 GB Main Memory per server	
Microsoft ® Windows ® 2000 Advanced Server with Service Pack 4	
WG	

CONFIGURATION INFORMATION

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

Clause 9.2.4.4.1

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

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 13 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Storage Network Configuration

Clause 9.2.4.4.2

If a storage network is employed in the BC/TSC, the FDR shall contain a topology diagram… . This diagram should include, but is not limited to the following components:

1. *Storage Controller and Domain Controllers (see Clause 9.2.4.4.1)*
2. *Host Systems (see Clause 9.2.4.4.1)*
3. *Routers and Bridges*
4. *Hubs and Switches*
5. *HBAs to Host Systems and Front End Port to Storage Controllers*

Additionally the diagram shall:

- *Illustrate the physical connection between components.*
- *Describe the type of each physical connection.*
- *Describe the network protocol used over each physical connection.*
- *The maximum theoretical transfer rate of each class of interconnect used in the configuration.*
- *Correlate with the BC Configuration Diagram in Clause 9.2.4.4.1.*

The Test Sponsor shall additionally supply (referenced in an appendix) a wiring diagram of the physical connections and physical port assignments used in the storage network. The diagram should allow anyone to exactly replicate the physical configuration of the storage network.

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

Host System Configuration

Clause 9.2.4.4.3

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

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

The details of the Host System configuration may be found on page 13 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Customer Tuning Parameters and Options

Clause 9.2.4.5.1

All Benchmark Configuration (BC) components with customer tunable parameter and options that have been altered from their default values must be listed in the FDR. The FDR entry for each of those components must include both the name of the component and the altered value of the parameter or option.

There were no customer tunable parameters or options that were altered from their default values.

Tested Storage Configuration (TSC) Description

Clause 9.2.4.5.2

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

- *All physical components that comprise the TSC. Those components are also illustrated in the Benchmark Configuration (BC) diagram in Clause 9.2.4.4.1 and, if applicable, 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.*

In addition the FDR may include listings of scripts and/or commands used to configure the physical components that comprise the TSC.

"Appendix A: Tested Storage Configuration (TSC) Creation" on page 50 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.2.4.5.3

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

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in "Appendix B: SPC-1 Workload Generator Storage Commands and Parameters" on page 53.

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 ECC 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.

Storage Capacities and Relationships

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.

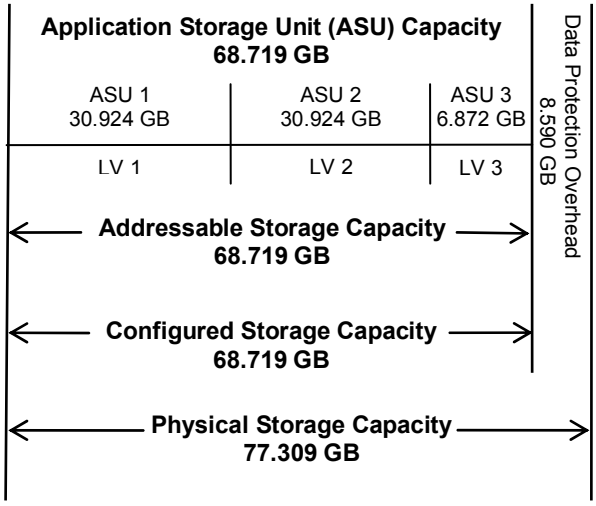
SPC-1 Storage Capacities

SPC-1 Storage Capacities		
Storage Hierarchy Component	**Units**	**Capacity**
Total ASU Capacity	Gigabytes (GB)	68.719
Addressable Storage Capacity	Gigabytes (GB)	68.719
Configured Storage Capacity	Gigabytes (GB)	68.719
Physical Storage Capacity	Gigabytes (GB)	77.309
Data Protection Overhead (ECC)	Gigabytes (GB)	8.590
Required Storage	Gigabytes (GB)	0.000
Global Storage Overhead	Gigabytes (GB)	0.000
Total Unused Storage	Gigabytes (GB)	0.000

The Physical Storage Capacity consisted of 77.309 GB of solid state storage.

SPC-1 Storage Capacities and Relationships Illustration

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



SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	100.00%	100.00%	88.89%
Required for Data Protection		12.50%	11.11%
Addressable Storage Capacity		100.00%	88.89%
Required Storage		0.00%	0.00%
Configured Storage Capacity			88.89%%
Global Storage Overhead			0.00%
Unused Storage	0.00%	0.00%	0.00%

Logical Volume Capacity and ASU Mapping

Clause 9.2.4.6.2

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

Logical Volume Capacity and Mapping		
ASU-1 (30.924 GB)	**ASU-2 (30.924 GB)**	**ASU-3 (6.872 GB)**
1 Logical Volume 30.924 GB per Logical Volume (30.924GB used/Logical Volume)	1 Logical Volume 30.924 GB per Logical Volume (30.924GB used/Logical Volume)	1 Logical Volume 6.872 GB per Logical Volume (6.872 GB used/Logical Volume)

The Data Protection Level used for all Logical Volumes was Mirroring as described on page 10. See "ASU Configuration" in the **IOPS Test Results File** for more detailed configuration information.

SPC-1 BENCHMARK EXECUTION RESULTS

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.*

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.*

Measurement Interval: *The finite and contiguous time period, after the Tested Storage Configuration (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.*

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. Comment: Steady Stated is achieved only after caches in the TSC have filled and as a result the I/O Request throughput of the TSC has stabilized.*

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

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.*

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 Figure 5-1 below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.*

Sustainability Test Phase

Clause 5.4.2.1

The Sustainability Test Phase consists of one Test Run at the 100% load point with a Measurement Interval of three (3) hours. The intent is to demonstrate a sustained maximum I/O Request Throughput as well as insuring the Tested Storage Configuration (TSC) has reached steady state prior to measuring the maximum I/O Request Throughput (SPC-1™ IOPS).

The reported I/O Request Throughput of the Sustainability Test Run must be within 5% of the reported SPC-1™ IOPS primary metric. The Average Response Time measured in Sustainability Test Run cannot exceed thirty (30) milliseconds.

Clause 9.2.4.7.1

For the Sustainability Test Phase the FDR shall contain:

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

SPC-1 Workload Generator Input Parameters

The following SPC-1 Workload Generator input parameters were used for the Sustainability, IOPS, and Response Time Ramp Test Runs :

java –Xmx512m –Xms512m –Xss128k metrics –b 2250 –s 300

Sustainability Test Results File

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

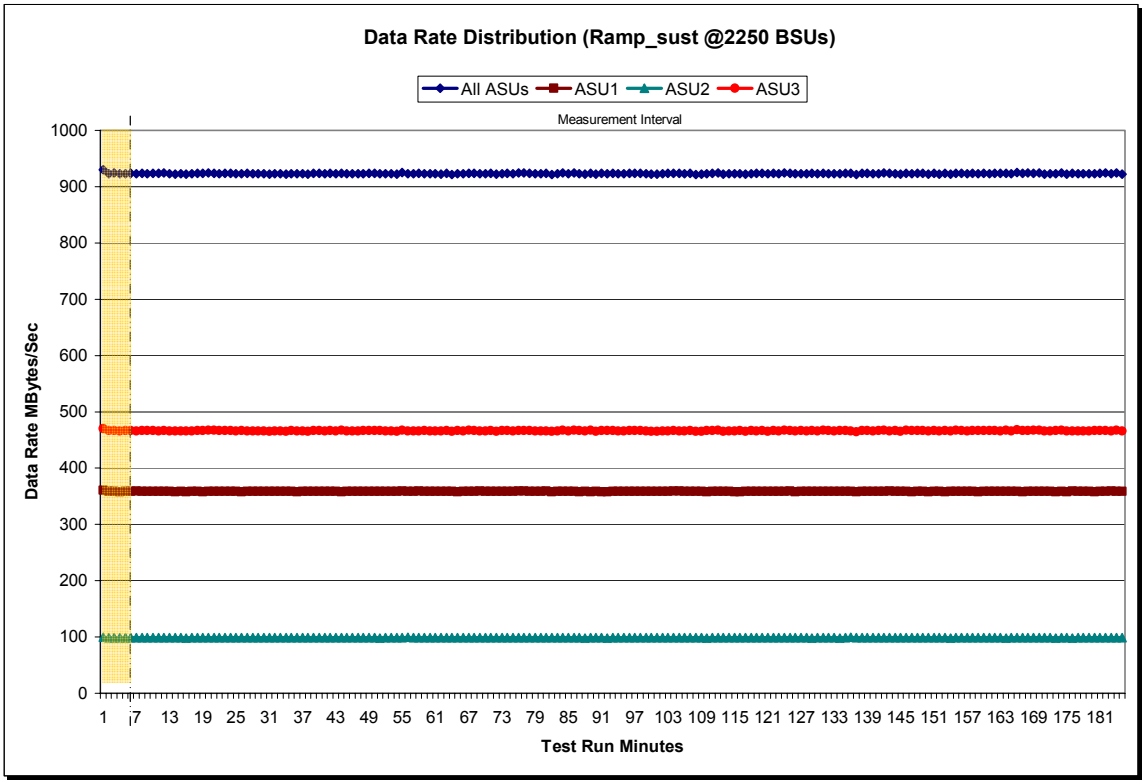
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	17:21:44	17:26:44	0-4	0:05:00
Measurement Interval	17:26:44	20:26:44	5-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	930.29	360.75	99.57	469.97	63	921.86	358.26	98.48	465.12	126	923.30	358.47	98.49	466.35
1	923.07	358.53	98.37	466.17	64	922.86	357.96	98.70	466.20	127	923.24	358.64	98.55	466.04
2	924.07	358.62	98.73	466.73	65	922.93	358.49	98.62	465.82	128	923.34	358.34	98.24	466.77
3	923.08	358.11	98.83	466.13	66	924.02	358.60	98.51	466.92	129	922.87	358.70	98.58	465.59
4	923.15	358.37	98.45	466.33	67	923.66	358.45	98.81	466.40	130	923.92	358.30	98.73	466.89
5	923.40	358.23	98.55	466.62	68	923.05	358.95	98.41	465.69	131	923.29	358.56	98.35	466.37
6	923.31	359.20	98.53	465.58	69	922.89	358.28	98.53	466.08	132	922.89	358.29	98.58	466.01
7	923.50	358.34	98.38	466.78	70	923.90	358.69	98.58	466.63	133	923.09	358.30	98.27	466.52
8	923.30	358.18	98.69	466.43	71	922.48	358.29	98.76	465.43	134	923.98	358.53	98.72	466.74
9	923.64	358.49	98.72	466.43	72	923.21	358.35	98.66	466.20	135	923.35	358.77	99.07	465.52
10	923.36	358.76	98.59	466.01	73	923.57	358.19	98.75	466.63	136	921.19	358.00	98.47	464.72
11	924.34	358.87	98.87	466.61	74	922.72	358.43	98.47	465.83	137	923.35	358.31	98.72	466.33
12	922.88	358.46	98.62	465.80	75	924.21	358.93	98.64	466.64	138	923.86	358.63	98.46	466.78
13	922.58	358.15	98.70	465.73	76	924.25	358.90	98.57	466.78	139	923.25	358.60	98.80	465.84
14	922.93	358.53	98.63	465.78	77	923.37	358.39	98.46	466.53	140	923.27	358.62	98.48	466.17
15	921.90	358.15	98.11	465.64	78	923.09	358.40	98.76	465.93	141	924.13	358.40	98.43	467.30
16	922.89	358.34	98.81	465.74	79	923.23	358.60	98.64	465.99	142	923.87	358.91	98.97	465.99
17	923.46	358.55	98.48	466.43	80	923.86	359.19	98.59	466.08	143	923.18	358.48	98.52	466.19
18	923.51	358.14	98.91	466.45	81	921.70	358.09	98.40	465.21	144	922.20	358.30	98.63	465.27
19	924.25	358.62	98.47	467.16	82	922.98	358.28	98.68	466.03	145	924.03	358.60	98.32	467.12
20	923.75	358.18	98.58	466.99	83	924.38	358.72	98.46	467.20	146	922.84	358.09	98.43	466.31
21	923.15	358.28	98.61	466.26	84	923.17	358.47	98.89	465.80	147	923.75	358.83	98.47	466.45
22	923.53	358.47	98.71	466.35	85	924.19	358.46	98.80	466.93	148	923.80	358.35	98.95	466.50
23	923.64	358.48	98.49	466.68	86	923.14	358.15	98.48	466.51	149	922.11	357.71	98.60	465.79
24	923.22	358.48	98.64	466.10	87	922.59	358.43	98.21	465.95	150	923.53	358.29	98.73	466.51
25	922.82	358.08	98.55	466.18	88	923.59	357.99	98.31	467.29	151	922.45	358.30	98.65	465.49
26	923.40	358.82	98.45	466.12	89	921.90	358.38	98.62	464.90	152	923.52	358.14	98.88	466.51
27	923.05	358.58	98.48	465.99	90	923.64	358.15	98.91	466.59	153	922.56	358.65	98.06	465.85
28	923.28	358.64	98.67	465.97	91	922.77	358.10	98.26	466.41	154	923.78	358.29	98.54	466.95
29	923.05	358.39	98.67	465.99	92	923.54	358.40	98.40	466.74	155	923.51	358.34	98.32	466.84
30	922.25	358.47	98.54	465.24	93	923.29	358.39	98.82	466.08	156	922.85	358.50	98.51	465.84
31	922.77	358.68	98.53	465.56	94	923.10	358.78	98.76	465.56	157	923.43	358.23	98.70	466.51
32	923.29	358.66	98.59	466.03	95	923.41	358.41	98.67	466.33	158	922.86	357.98	98.61	466.27
33	922.56	358.44	98.92	465.20	96	923.40	358.66	98.43	466.31	159	923.77	358.29	98.77	466.71
34	923.23	358.34	98.71	466.19	97	924.00	358.82	98.68	466.50	160	922.88	358.20	98.34	466.33
35	922.61	358.11	98.60	465.90	98	923.32	358.66	98.50	466.15	161	923.69	358.20	98.88	466.60
36	923.27	358.58	98.77	465.93	99	921.92	358.18	98.62	465.12	162	923.44	358.59	98.80	466.05
37	922.47	358.34	98.79	465.35	100	922.36	358.76	98.57	465.03	163	923.36	358.30	98.07	466.99
38	923.85	358.74	98.79	466.32	101	922.64	358.24	98.46	465.94	164	923.30	358.68	98.50	466.11
39	923.68	358.71	98.58	466.39	102	923.39	358.87	98.78	465.73	165	925.22	358.83	98.70	467.68
40	922.96	358.58	98.69	465.69	103	923.81	358.92	98.69	466.20	166	923.61	358.00	98.76	466.85
41	923.63	358.27	98.58	466.77	104	923.33	358.98	98.59	465.76	167	924.24	358.84	98.54	466.85
42	922.69	358.38	98.38	465.93	105	923.13	358.63	98.62	465.87	168	923.73	358.18	98.53	467.02
43	923.47	357.80	98.72	466.95	106	923.64	358.19	98.95	466.51	169	924.11	358.27	98.85	466.99
44	922.94	358.59	98.48	465.87	107	921.82	358.22	98.58	465.02	170	922.58	358.61	98.28	465.69
45	923.25	358.42	98.89	465.94	108	922.36	358.61	98.42	465.33	171	923.24	358.57	98.78	465.89
46	922.61	358.27	98.47	465.88	109	922.78	358.00	98.25	466.53	172	922.72	357.99	98.14	466.59
47	923.08	358.26	98.49	466.33	110	923.66	358.70	98.56	466.40	173	924.35	358.54	98.87	466.94
48	923.33	358.52	98.53	466.27	111	924.23	358.51	98.61	467.10	174	921.95	357.81	98.47	465.67
49	923.37	358.44	98.64	466.29	112	922.58	358.50	98.88	465.21	175	923.40	359.22	98.25	465.93
50	922.79	358.36	98.20	466.23	113	923.10	358.72	98.58	465.80	176	922.76	358.37	98.52	465.87
51	922.99	358.40	98.65	465.94	114	922.75	358.03	98.70	466.03	177	923.31	358.70	98.49	466.12
52	923.17	358.75	98.55	465.87	115	922.76	358.17	98.34	466.25	178	922.93	358.60	98.50	465.82
53	922.37	358.36	98.86	465.15	116	921.95	358.31	98.70	464.94	179	922.89	358.04	98.60	466.25
54	925.11	359.11	98.79	467.21	117	923.10	358.18	98.75	466.17	180	923.51	358.47	98.54	466.50
55	922.96	358.41	99.02	465.53	118	923.34	358.87	98.72	465.75	181	924.09	358.87	98.74	466.48
56	922.86	358.35	98.78	465.73	119	923.46	358.44	98.54	466.48	182	923.33	358.92	98.40	466.01
57	923.54	359.20	98.65	465.69	120	922.85	358.64	98.91	465.30	183	924.46	358.41	98.91	467.14
58	923.00	358.25	98.40	466.34	121	923.45	358.79	98.43	466.23	184	922.55	358.57	98.46	465.53
59	922.80	358.36	98.39	466.06	122	923.05	358.30	98.74	466.01					
60	923.02	358.61	98.68	465.73	123	924.28	358.38	98.88	467.02					
61	922.59	358.50	98.59	465.49	124	923.88	358.91	98.67	466.30					
62	923.84	358.71	98.59	466.54	125	922.80	358.10	98.80	465.90					

Sustainability – Data Rate Distribution Graph

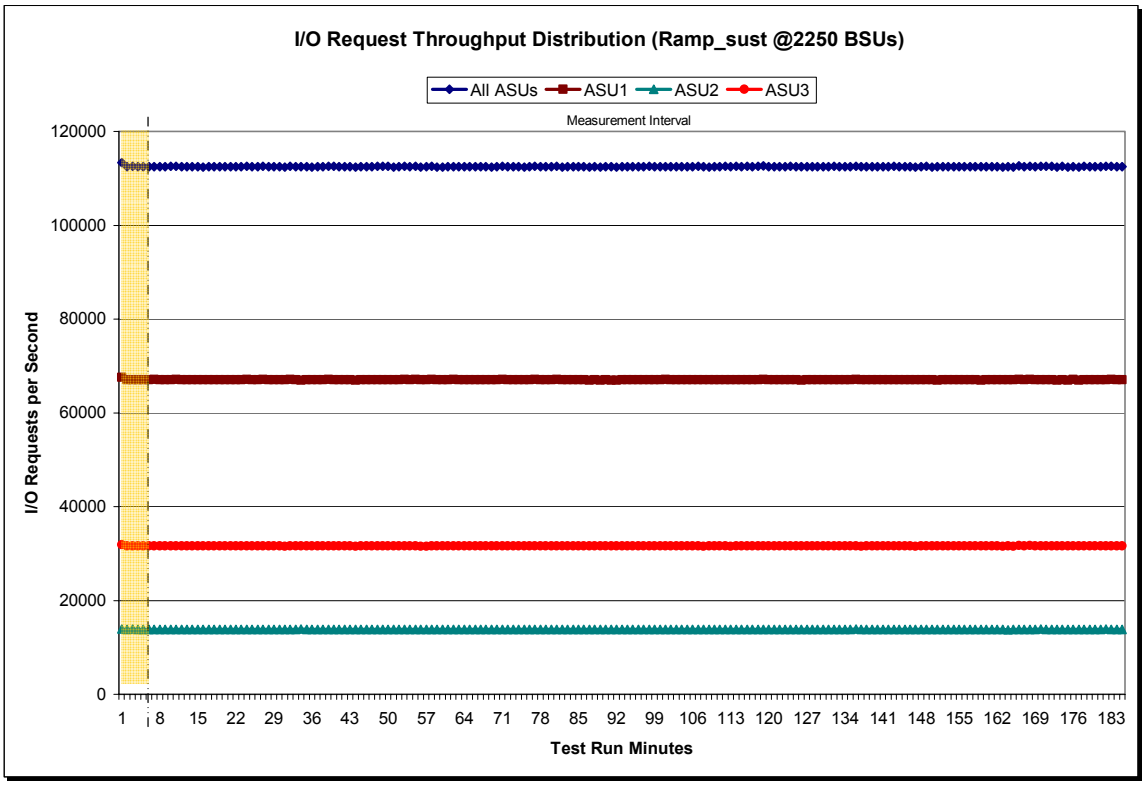


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	17:21:44	17:26:44	0-4	0:05:00
Measurement Interval	17:26:44	20:26:44	5-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	113,349.10	67,527.95	13,947.90	31,873.25	63	112,450.70	67,028.12	13,830.72	31,591.87	126	112,507.97	67,067.73	13,827.58	31,612.65
1	112,471.93	67,063.08	13,828.65	31,580.20	64	112,462.72	67,014.95	13,836.53	31,611.23	127	112,513.42	67,082.28	13,826.18	31,604.95
2	112,567.75	67,064.33	13,867.18	31,636.23	65	112,477.30	67,031.83	13,827.97	31,617.50	128	112,506.17	67,075.70	13,799.07	31,631.40
3	112,512.92	67,048.05	13,846.98	31,617.88	66	112,523.03	67,065.45	13,847.87	31,609.72	129	112,462.97	67,064.03	13,822.05	31,576.88
4	112,445.03	67,032.43	13,807.97	31,604.63	67	112,441.67	67,015.85	13,836.68	31,589.13	130	112,499.83	67,009.57	13,838.68	31,651.58
5	112,512.27	67,014.57	13,850.75	31,646.95	68	112,439.78	67,046.35	13,791.63	31,601.80	131	112,535.72	67,057.92	13,846.57	31,631.23
6	112,503.13	67,103.15	13,821.98	31,578.00	69	112,480.87	67,049.40	13,825.45	31,606.02	132	112,492.88	67,048.48	13,831.90	31,612.50
7	112,474.50	67,039.10	13,791.25	31,644.15	70	112,575.22	67,107.05	13,833.00	31,635.17	133	112,486.12	67,064.00	13,802.23	31,619.88
8	112,470.43	67,012.55	13,831.82	31,626.07	71	112,465.58	67,015.57	13,857.63	31,592.38	134	112,513.63	67,039.43	13,857.58	31,616.62
9	112,549.75	67,047.13	13,860.52	31,642.10	72	112,482.90	67,032.23	13,817.80	31,632.87	135	112,608.78	67,113.28	13,886.88	31,608.62
10	112,542.10	67,087.92	13,837.03	31,617.15	73	112,510.08	67,017.03	13,844.10	31,648.95	136	112,463.97	67,049.97	13,837.82	31,576.18
11	112,491.25	67,044.75	13,834.12	31,612.38	74	112,431.65	67,009.93	13,825.95	31,595.77	137	112,477.90	67,028.50	13,834.23	31,615.17
12	112,522.57	67,077.93	13,828.53	31,616.10	75	112,526.78	67,073.35	13,838.22	31,615.22	138	112,508.62	67,047.53	13,832.15	31,628.93
13	112,440.62	67,008.53	13,833.98	31,598.10	76	112,574.77	67,104.95	13,841.30	31,628.52	139	112,465.57	67,017.37	13,847.60	31,600.60
14	112,477.40	67,044.73	13,837.27	31,595.40	77	112,497.65	67,052.07	13,823.93	31,621.65	140	112,515.33	67,058.28	13,832.57	31,624.48
15	112,403.18	67,027.28	13,798.60	31,577.30	78	112,460.13	67,006.87	13,848.23	31,605.03	141	112,487.20	67,013.37	13,823.70	31,650.13
16	112,481.57	67,041.48	13,832.50	31,607.58	79	112,476.43	67,056.55	13,832.20	31,587.68	142	112,530.70	67,060.47	13,846.15	31,624.08
17	112,475.28	67,019.98	13,835.13	31,620.17	80	112,578.63	67,118.57	13,849.93	31,610.13	143	112,506.22	67,023.83	13,849.95	31,632.43
18	112,494.63	67,020.07	13,842.43	31,632.13	81	112,436.58	67,026.87	13,823.23	31,586.48	144	112,460.65	67,027.17	13,842.70	31,590.78
19	112,511.50	67,045.95	13,831.40	31,634.15	82	112,447.27	67,029.83	13,808.43	31,609.00	145	112,526.92	67,075.72	13,789.90	31,661.30
20	112,455.80	67,006.93	13,823.70	31,625.17	83	112,485.30	67,020.92	13,833.10	31,631.28	146	112,421.60	67,017.28	13,835.18	31,569.13
21	112,492.27	67,037.22	13,839.47	31,615.58	84	112,470.93	67,031.30	13,833.92	31,605.72	147	112,497.17	67,032.62	13,830.85	31,633.70
22	112,513.30	67,072.95	13,820.73	31,619.62	85	112,505.97	67,042.12	13,831.82	31,632.03	148	112,549.98	67,055.10	13,853.28	31,641.60
23	112,555.23	67,086.30	13,837.27	31,631.67	86	112,408.17	66,969.38	13,823.40	31,615.38	149	112,432.02	67,002.45	13,838.67	31,590.90
24	112,460.33	67,060.75	13,814.68	31,584.90	87	112,474.97	67,015.33	13,845.17	31,614.47	150	112,459.52	66,986.02	13,857.70	31,615.80
25	112,478.88	67,028.77	13,826.43	31,623.68	88	112,427.20	66,983.92	13,815.08	31,628.20	151	112,506.82	67,075.82	13,847.38	31,583.62
26	112,591.78	67,120.37	13,846.30	31,625.12	89	112,475.37	67,030.33	13,839.18	31,605.85	152	112,503.80	67,042.27	13,845.40	31,616.13
27	112,461.05	67,016.80	13,845.32	31,598.93	90	112,444.07	66,981.22	13,855.70	31,607.15	153	112,485.15	67,055.03	13,817.62	31,612.50
28	112,470.45	67,029.72	13,821.93	31,618.80	91	112,421.87	66,988.45	13,802.50	31,630.92	154	112,517.42	67,052.98	13,827.10	31,637.33
29	112,466.75	67,027.33	13,830.82	31,608.60	92	112,475.67	67,030.33	13,813.53	31,631.80	155	112,507.40	67,049.18	13,821.30	31,636.92
30	112,426.82	67,040.23	13,826.85	31,559.73	93	112,504.82	67,071.17	13,837.40	31,596.25	156	112,479.15	67,060.62	13,823.62	31,594.92
31	112,530.08	67,086.98	13,832.37	31,610.73	94	112,481.87	67,041.68	13,849.83	31,590.35	157	112,510.13	67,059.78	13,846.90	31,603.45
32	112,501.02	67,047.45	13,852.23	31,601.33	95	112,443.57	67,019.97	13,837.83	31,585.77	158	112,466.42	66,994.18	13,856.73	31,615.50
33	112,456.53	66,994.03	13,866.52	31,595.98	96	112,495.17	67,044.70	13,829.55	31,620.92	159	112,503.90	67,049.63	13,849.85	31,604.42
34	112,458.10	67,007.15	13,832.88	31,618.07	97	112,537.18	67,072.77	13,845.50	31,618.92	160	112,465.50	67,004.92	13,833.18	31,627.40
35	112,436.78	67,005.45	13,833.85	31,597.48	98	112,460.28	67,022.17	13,833.12	31,605.00	161	112,523.48	67,044.70	13,848.22	31,630.57
36	112,475.25	67,037.48	13,850.70	31,587.07	99	112,452.03	67,028.90	13,837.03	31,586.10	162	112,427.70	67,027.25	13,840.02	31,560.43
37	112,479.62	67,011.52	13,849.38	31,618.72	100	112,523.22	67,093.70	13,841.60	31,587.92	163	112,494.55	67,077.08	13,772.18	31,645.28
38	112,543.78	67,094.70	13,844.02	31,605.07	101	112,483.05	67,025.78	13,844.78	31,612.48	164	112,417.37	67,022.25	13,837.57	31,557.55
39	112,563.68	67,081.55	13,858.68	31,623.45	102	112,526.08	67,054.35	13,864.53	31,607.20	165	112,627.73	67,092.38	13,852.07	31,683.28
40	112,485.35	67,061.88	13,829.40	31,594.07	103	112,518.93	67,059.87	13,829.67	31,629.40	166	112,497.02	67,005.07	13,847.22	31,644.73
41	112,489.17	67,040.52	13,856.23	31,592.42	104	112,526.62	67,079.18	13,832.12	31,615.32	167	112,591.20	67,096.02	13,827.50	31,667.68
42	112,443.48	67,029.13	13,819.35	31,595.00	105	112,518.48	67,079.13	13,838.27	31,601.08	168	112,504.55	67,012.58	13,839.57	31,652.40
43	112,424.25	66,997.60	13,850.12	31,576.53	106	112,546.33	67,056.73	13,853.83	31,635.77	169	112,556.85	67,029.40	13,868.00	31,659.45
44	112,467.22	67,054.97	13,833.98	31,578.27	107	112,481.95	67,079.12	13,836.33	31,566.50	170	112,534.53	67,072.13	13,860.97	31,601.43
45	112,507.02	67,040.80	13,855.37	31,610.85	108	112,433.58	67,024.67	13,819.57	31,589.35	171	112,536.42	67,052.35	13,860.48	31,623.58
46	112,462.17	67,037.05	13,835.83	31,589.28	109	112,480.07	67,041.15	13,822.08	31,616.83	172	112,408.17	66,986.17	13,811.80	31,610.20
47	112,536.33	67,051.22	13,842.97	31,642.15	110	112,450.15	67,005.90	13,818.32	31,625.93	173	112,551.92	67,053.57	13,853.32	31,645.03
48	112,531.70	67,063.10	13,837.17	31,631.43	111	112,532.93	67,057.62	13,856.53	31,618.78	174	112,433.25	66,995.63	13,826.30	31,611.32
49	112,529.15	67,051.03	13,834.15	31,643.97	112	112,446.03	67,055.77	13,822.97	31,567.30	175	112,520.53	67,085.75	13,818.75	31,616.03
50	112,427.83	67,042.62	13,790.83	31,594.38	113	112,532.00	67,048.32	13,847.62	31,636.07	176	112,431.72	66,978.17	13,839.22	31,614.33
51	112,513.60	67,070.40	13,820.70	31,622.50	114	112,494.17	67,032.52	13,853.92	31,607.73	177	112,547.58	67,070.80	13,838.87	31,637.92
52	112,555.65	67,099.25	13,839.65	31,616.75	115	112,545.75	67,062.38	13,831.87	31,651.50	178	112,467.63	67,034.35	13,829.10	31,604.18
53	112,459.38	67,018.72	13,857.62	31,583.05	116	112,484.25	67,050.10	13,855.17	31,578.98	179	112,505.75	67,050.30	13,847.08	31,608.37
54	112,565.33	67,090.07	13,862.75	31,612.52	117	112,545.18	67,045.58	13,841.30	31,658.30	180	112,500.47	67,010.28	13,845.87	31,644.32
55	112,432.83	67,013.83	13,859.43	31,559.57	118	112,617.35	67,147.37	13,840.82	31,629.17	181	112,529.03	67,033.92	13,874.62	31,620.50
56	112,440.95	67,031.30	13,836.20	31,573.45	119	112,503.22	67,072.08	13,832.92	31,598.22	182	112,557.95	67,118.28	13,840.02	31,599.65
57	112,565.47	67,102.67	13,838.88	31,623.92	120	112,496.75	67,065.43	13,827.88	31,603.43	183	112,504.80	67,031.55	13,842.92	31,630.33
58	112,421.37	67,013.73	13,816.90	31,590.73	121	112,510.65	67,070.03	13,844.40	31,596.22	184	112,467.38	67,024.12	13,835.30	31,607.97
59	112,419.68	67,000.27	13,831.13	31,588.28	122	112,500.02	67,033.28	13,844.70	31,622.03	Average	112,492.89	67,043.69	13,836.51	31,612.69
60	112,473.02	67,013.48	13,853.37	31,606.17	123	112,554.30	67,044.47	13,861.88	31,647.95					
61	112,507.98	67,084.90	13,837.03	31,586.05	124	112,519.58	67,071.02	13,837.55	31,611.02					
62	112,447.28	67,015.43	13,824.02	31,607.83	125	112,457.63	66,992.53	13,864.33	31,600.77					

Sustainability – I/O Request Throughput Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

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

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.*

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%.*

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

IOPS Test Phase

Clause 5.4.2.2

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

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

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

Clause 9.2.4.7.2

For the IOPS Test Phase the FDR shall contain:

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, and Response Time Ramp Test Runs are listed below:

java –Xmx512m –Xms512m –Xss128k metrics –b 2250 –s 300

IOPS Test Results File

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

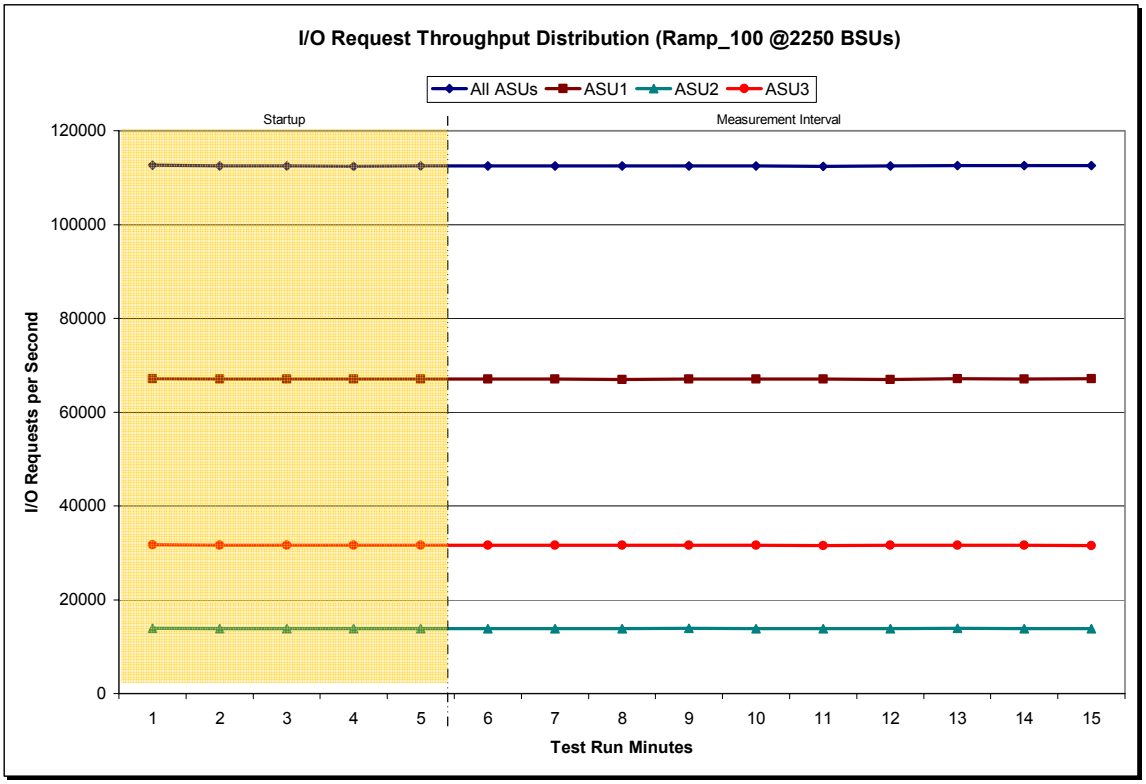
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

2250 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:27:45	20:32:46	0-4	0:05:01
Measurement Interval	20:32:46	20:42:46	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	112,695.07	67,162.17	13,868.93	31,663.97
1	112,477.02	67,049.18	13,802.95	31,624.88
2	112,451.62	67,044.03	13,827.02	31,580.57
3	112,437.22	67,001.17	13,820.42	31,615.63
4	112,469.60	67,024.02	13,850.60	31,594.98
5	112,463.88	67,027.63	13,829.13	31,607.12
6	112,442.83	67,017.20	13,822.27	31,603.37
7	112,462.93	66,993.63	13,830.80	31,638.50
8	112,502.18	67,045.35	13,868.90	31,587.93
9	112,509.12	67,025.65	13,855.22	31,628.25
10	112,399.70	67,011.03	13,821.62	31,567.05
11	112,452.93	66,990.98	13,854.00	31,607.95
12	112,602.30	67,099.33	13,867.23	31,635.73
13	112,544.45	67,075.35	13,831.95	31,637.15
14	112,533.08	67,108.22	13,856.52	31,568.35
Average	112,491.34	67,039.44	13,843.76	31,608.14

IOPS Test Run – I/O Request Throughput Distribution Graph

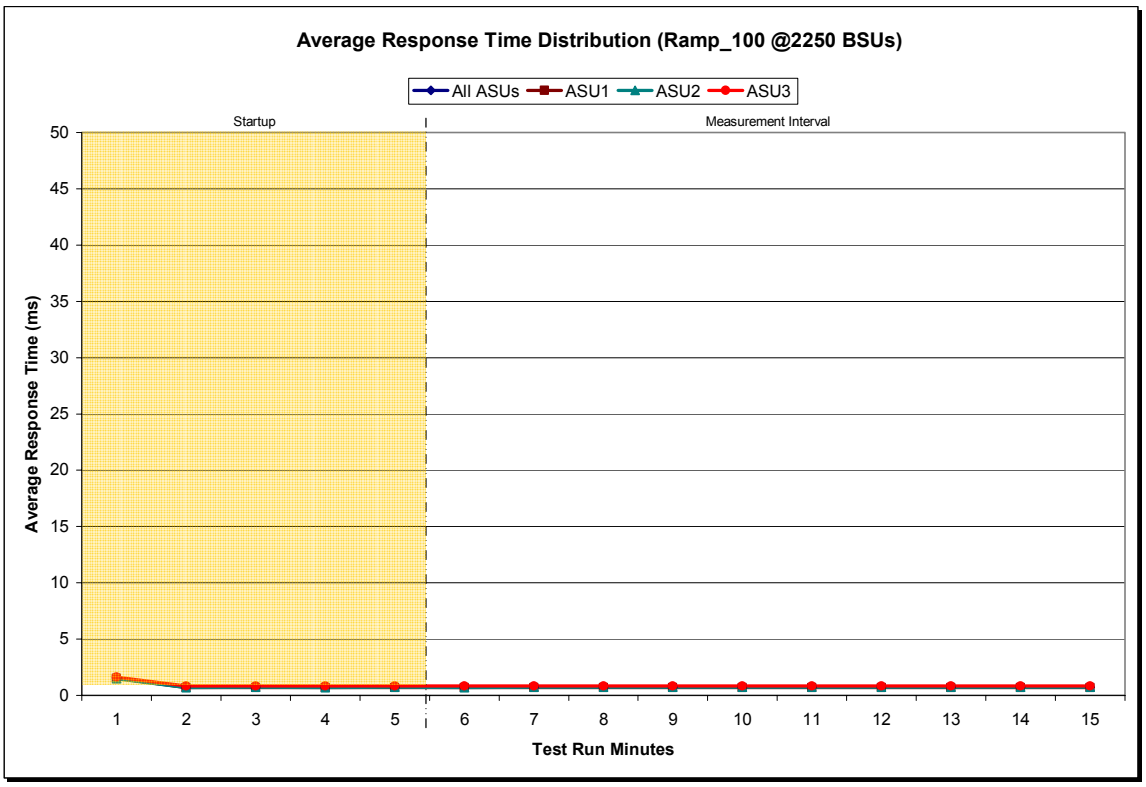


IOPS Test Run – Response Time Frequency Distribution Data

2250 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:27:45	20:32:46	0-4	0:05:01
Measurement Interval	20:32:46	20:42:46	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	1.54	1.52	1.47	1.62
1	0.71	0.67	0.69	0.82
2	0.73	0.68	0.70	0.84
3	0.72	0.68	0.70	0.83
4	0.73	0.68	0.70	0.83
5	0.72	0.67	0.70	0.82
6	0.73	0.68	0.71	0.84
7	0.73	0.69	0.71	0.84
8	0.73	0.68	0.71	0.84
9	0.72	0.68	0.70	0.83
10	0.73	0.68	0.71	0.84
11	0.74	0.69	0.71	0.84
12	0.73	0.68	0.70	0.83
13	0.72	0.68	0.70	0.83
14	0.73	0.68	0.71	0.84
Average	0.73	0.68	0.71	0.84

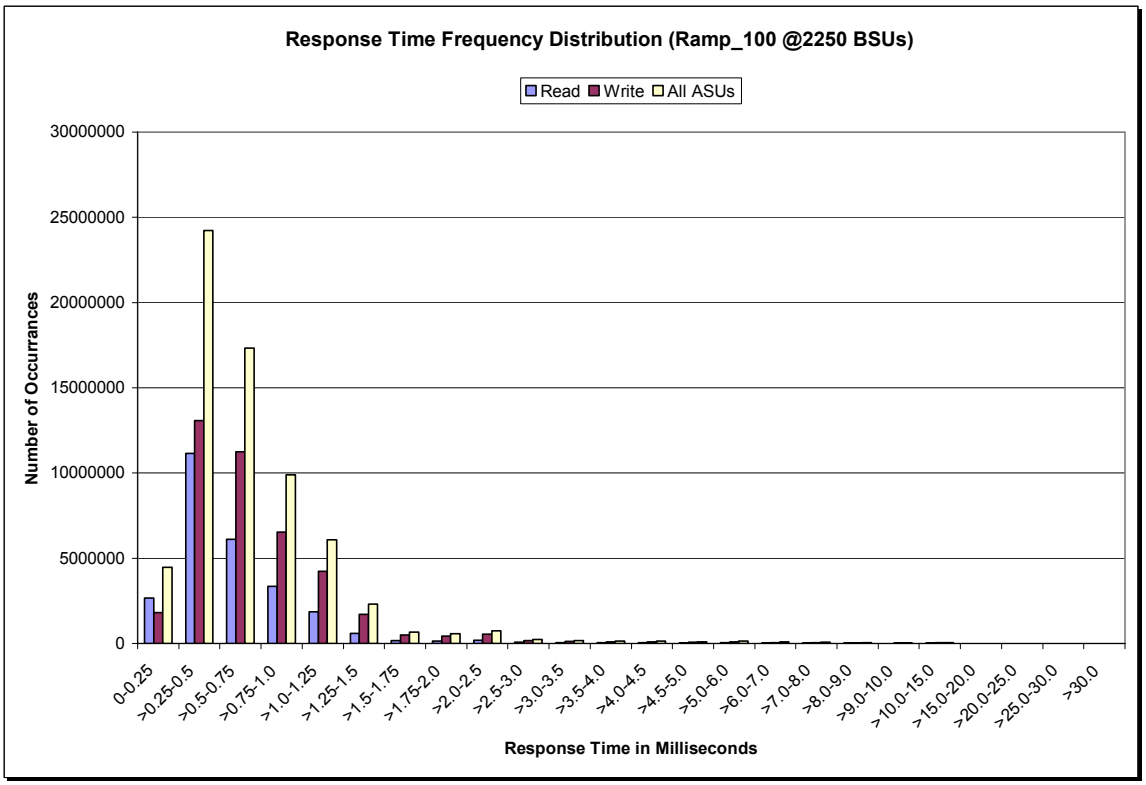
IOPS Test Run –Response Time Frequency Distribution Graph



IOPS Test Run – Average Response Time (ms) 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	2651629	11,151,566	6,097,509	3,363,222	1,850,211	592,950	162,949	144,202
Write	1815115	13,074,673	11,232,584	6,529,293	4,238,765	1,718,204	495,926	435,333
All ASUs	4466744	24,226,239	17,330,093	9,892,515	6,088,976	2,311,154	658,875	579,535
ASU1	3309046	16,009,689	9,908,831	5,380,803	3,031,073	1,041,834	279,469	255,813
ASU2	559831	3,106,491	2,131,212	1,183,976	711,472	261,623	72,163	63,015
ASU3	597867	5,110,059	5,290,050	3,327,736	2,346,431	1,007,697	307,243	260,707
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	194,709	73,023	52,062	46,620	46,591	32,181	47,761	33,063
Write	546,886	160,486	109,244	95,069	91,042	60,700	84,941	57,319
All ASUs	741,595	233,509	161,306	141,689	137,633	92,881	132,702	90,382
ASU1	331,647	119,270	85,831	78,140	78,602	53,967	79,165	54,554
ASU2	81,208	26,744	19,057	16,397	15,434	10,182	14,256	9,745
ASU3	328,740	87,495	56,418	47,152	43,597	28,732	39,281	26,083
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	22,069	15,328	10,584	21,775	4,206	2,245	562	478
Write	38,290	26,532	17,916	36,117	6,961	4,029	976	857
All ASUs	60,359	41,860	28,500	57,892	11,167	6,274	1,538	1,335
ASU1	36,505	25,432	17,262	34,767	6,634	3,684	856	761
ASU2	6,614	4,518	3,202	6,669	1,289	754	216	187
ASU3	17,240	11,910	8,036	16,456	3,244	1,836	466	387

IOPS Test Run – Average Response Time (ms) 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
67,494,753	67,493,418	1,335

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

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

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.*

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%.*

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

Response Time Ramp Test Phase

Clause 5.4.2.3

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

The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 11.

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

Clause 9.2.4.7.3

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

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, and Response Time Ramp Test Runs are listed below:

java –Xmx512m –Xms512m –Xss128k metrics –b 2250 –s 300

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 - 2250 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:27:45	20:32:46	0-4	0:05:01
Measurement Interval	20:32:46	20:42:46	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	112,695.07	67,162.17	13,868.93	31,663.97
1	112,477.02	67,049.18	13,802.95	31,624.88
2	112,451.62	67,044.03	13,827.02	31,580.57
3	112,437.22	67,001.17	13,820.42	31,615.63
4	112,469.60	67,024.02	13,850.60	31,594.98
5	112,463.88	67,027.63	13,829.13	31,607.12
6	112,442.83	67,017.20	13,822.27	31,603.37
7	112,462.93	66,993.63	13,830.80	31,638.50
8	112,502.18	67,045.35	13,868.90	31,587.93
9	112,509.12	67,025.65	13,855.22	31,628.25
10	112,399.70	67,011.03	13,821.62	31,567.05
11	112,452.93	66,990.98	13,854.00	31,607.95
12	112,602.30	67,099.33	13,867.23	31,635.73
13	112,544.45	67,075.35	13,831.95	31,637.15
14	112,533.08	67,108.22	13,856.52	31,568.35
Average	112,491.34	67,039.44	13,843.76	31,608.14

95% Load Level - 2137 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:43:33	20:48:34	0-4	0:05:01
Measurement Interval	20:48:34	20:58:34	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	107,047.22	63,795.63	13,159.83	30,091.75
1	106,813.83	63,654.72	13,119.95	30,039.17
2	106,861.85	63,709.97	13,141.80	30,010.08
3	106,814.33	63,624.02	13,153.93	30,036.38
4	106,836.07	63,655.48	13,125.93	30,054.65
5	106,832.70	63,630.68	13,149.37	30,052.65
6	106,821.98	63,652.37	13,132.02	30,037.60
7	106,919.78	63,705.03	13,149.73	30,065.02
8	106,852.25	63,672.20	13,143.50	30,036.55
9	106,778.62	63,626.48	13,127.58	30,024.55
10	106,797.48	63,659.48	13,142.83	29,995.17
11	106,792.40	63,658.93	13,120.92	30,012.55
12	106,829.78	63,648.02	13,169.67	30,012.10
13	106,866.65	63,668.98	13,187.55	30,010.12
14	106,877.92	63,710.32	13,122.48	30,045.12
Average	106,836.96	63,663.25	13,144.57	30,029.14

90% Load Level - 2025 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:59:16	21:04:17	0-4	0:05:01
Measurement Interval	21:04:17	21:14:17	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	101,445.73	60,457.52	12,490.87	28,497.35
1	101,286.13	60,362.00	12,446.78	28,477.35
2	101,241.73	60,344.45	12,445.62	28,451.67
3	101,276.72	60,360.73	12,453.67	28,462.32
4	101,165.12	60,271.88	12,448.90	28,444.33
5	101,282.65	60,377.07	12,460.02	28,445.57
6	101,237.10	60,310.25	12,438.03	28,488.82
7	101,258.02	60,354.18	12,469.87	28,433.97
8	101,212.45	60,326.08	12,451.47	28,434.90
9	101,288.92	60,370.97	12,443.50	28,474.45
10	101,294.12	60,358.40	12,461.60	28,474.12
11	101,248.40	60,342.98	12,458.53	28,446.88
12	101,213.28	60,293.17	12,460.07	28,460.05
13	101,185.43	60,349.20	12,433.47	28,402.77
14	101,250.55	60,381.32	12,460.22	28,409.02
Average	101,247.09	60,346.36	12,453.68	28,447.05

80% Load Level - 1800 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:14:51	21:19:52	0-4	0:05:01
Measurement Interval	21:19:52	21:29:52	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	90,110.65	53,686.35	11,092.35	25,331.95
1	89,972.00	53,633.77	11,062.97	25,275.27
2	89,992.60	53,621.35	11,058.67	25,312.58
3	90,079.88	53,689.25	11,091.73	25,298.90
4	90,032.37	53,666.32	11,076.75	25,289.30
5	89,966.17	53,620.72	11,064.92	25,280.53
6	90,008.83	53,671.22	11,061.20	25,276.42
7	90,007.35	53,629.70	11,070.43	25,307.22
8	90,044.63	53,685.10	11,063.50	25,296.03
9	90,083.87	53,681.03	11,079.27	25,323.57
10	89,967.55	53,609.87	11,071.42	25,286.27
11	90,013.65	53,642.57	11,070.50	25,300.58
12	90,094.65	53,706.83	11,071.95	25,315.87
13	89,967.40	53,624.72	11,061.08	25,281.60
14	90,044.85	53,644.63	11,068.55	25,331.67
Average	90,019.90	53,651.64	11,068.28	25,299.98

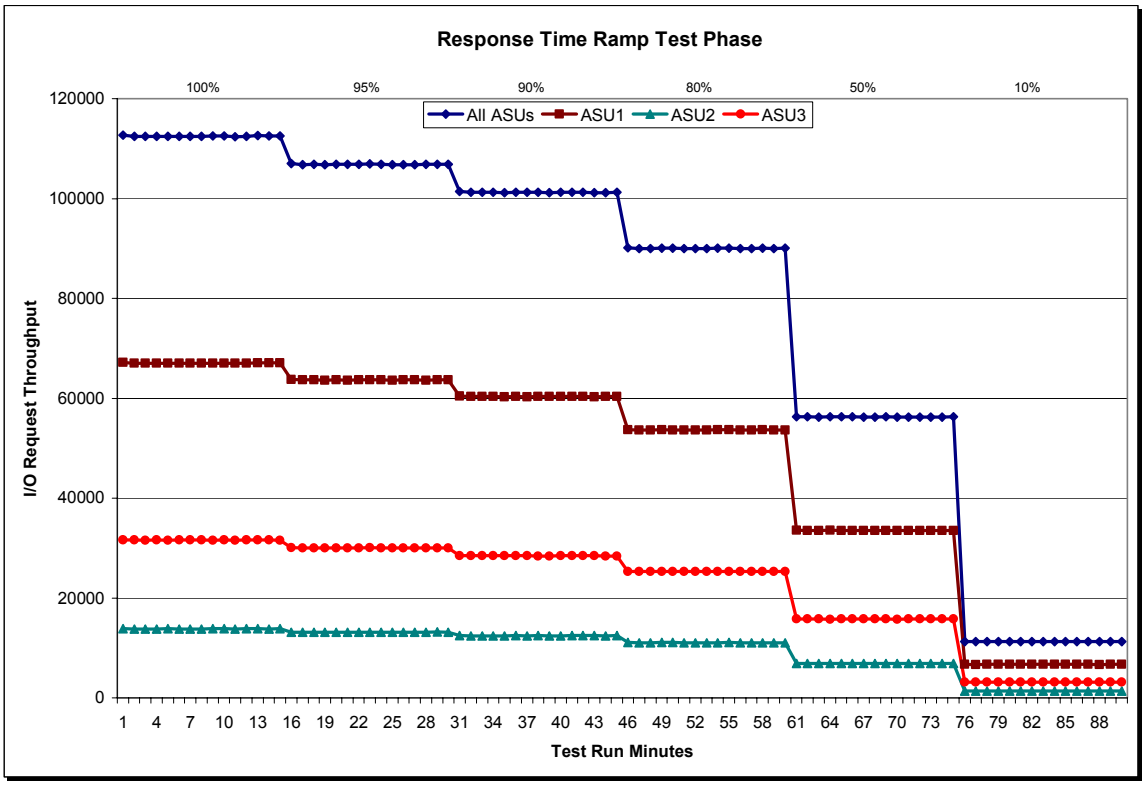
50% Load Level - 1125 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:30:10	21:35:11	0-4	0:05:01
Measurement Interval	21:35:11	21:45:11	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	56,308.58	33,565.47	6,913.43	15,829.68
1	56,276.78	33,545.98	6,916.92	15,813.88
2	56,219.88	33,509.88	6,914.97	15,795.03
3	56,268.97	33,571.40	6,922.72	15,774.85
4	56,273.05	33,549.23	6,906.87	15,816.95
5	56,277.38	33,506.58	6,934.30	15,836.50
6	56,218.78	33,501.28	6,920.02	15,797.48
7	56,250.47	33,521.83	6,929.73	15,798.90
8	56,274.37	33,536.45	6,929.68	15,808.23
9	56,190.97	33,499.08	6,913.07	15,778.82
10	56,233.72	33,489.33	6,916.75	15,827.63
11	56,241.15	33,520.85	6,913.13	15,807.17
12	56,249.87	33,538.60	6,918.88	15,792.38
13	56,223.40	33,504.60	6,906.18	15,812.62
14	56,285.42	33,532.82	6,920.38	15,832.22
Average	56,244.55	33,515.14	6,920.21	15,809.20

10% Load Level - 225 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:45:19	21:50:20	0-4	0:05:01
Measurement Interval	21:50:20	22:00:20	5-14	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	11,258.40	6,700.95	1,386.58	3,170.87
1	11,242.00	6,692.90	1,377.78	3,171.32
2	11,240.33	6,698.68	1,374.93	3,166.72
3	11,258.18	6,707.55	1,380.22	3,170.42
4	11,238.07	6,703.08	1,375.28	3,159.70
5	11,251.48	6,711.77	1,392.57	3,147.15
6	11,249.85	6,696.78	1,389.72	3,163.35
7	11,268.12	6,727.12	1,382.23	3,158.77
8	11,267.90	6,717.45	1,387.23	3,163.22
9	11,238.18	6,705.57	1,381.23	3,151.38
10	11,249.30	6,710.98	1,381.40	3,156.92
11	11,246.95	6,713.13	1,378.00	3,155.82
12	11,244.03	6,690.22	1,376.37	3,177.45
13	11,269.58	6,715.18	1,385.05	3,169.35
14	11,258.08	6,698.43	1,383.98	3,175.67
Average	11,254.35	6,708.66	1,383.78	3,161.91

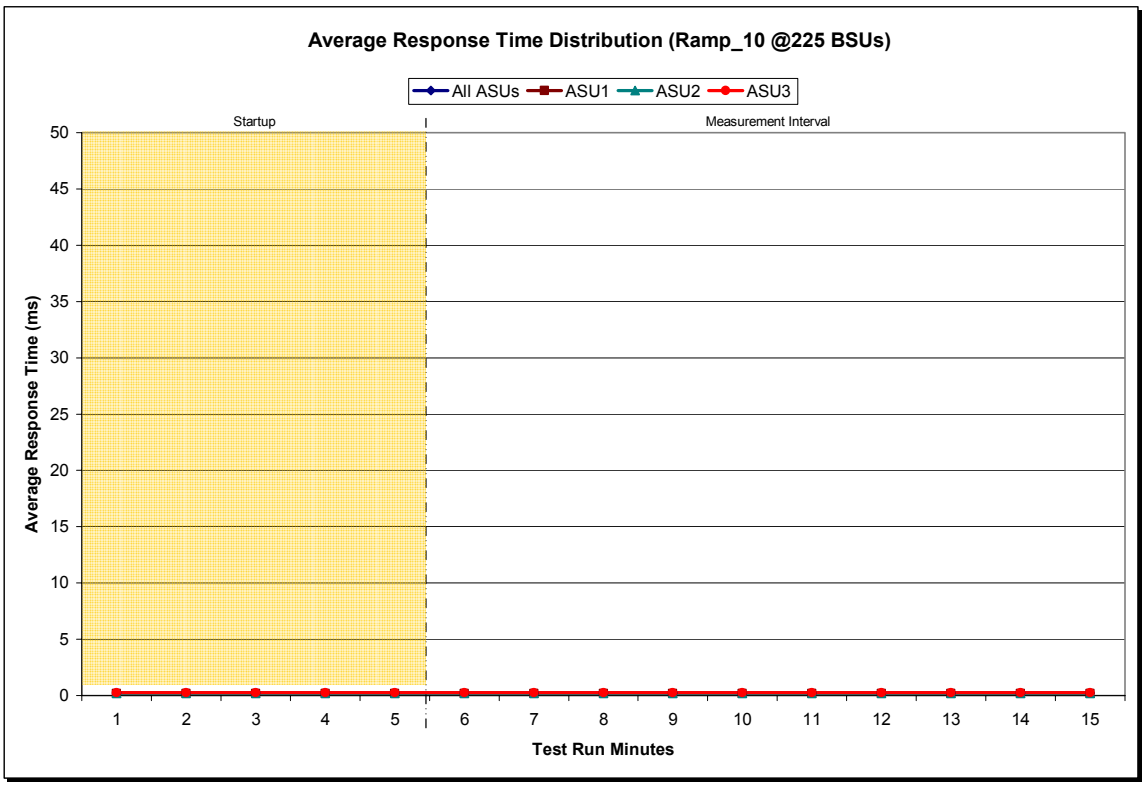
Response Time Ramp Distribution (IOPS) Graph



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

225 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:45:19	21:50:20	0-4	0:05:01
Measurement Interval	21:50:20	22:00:20	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.20	0.18	0.19	0.24
1	0.20	0.18	0.19	0.24
2	0.20	0.18	0.19	0.24
3	0.20	0.18	0.19	0.24
4	0.20	0.18	0.19	0.24
5	0.20	0.18	0.19	0.24
6	0.20	0.18	0.19	0.24
7	0.20	0.18	0.19	0.24
8	0.20	0.18	0.19	0.24
9	0.20	0.18	0.19	0.24
10	0.20	0.18	0.19	0.24
11	0.20	0.18	0.19	0.24
12	0.20	0.18	0.19	0.24
13	0.20	0.18	0.19	0.24
14	0.20	0.18	0.19	0.24
Average	0.20	0.18	0.19	0.24

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



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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0348	0.2810	0.0701	0.2101	0.0179	0.0700	0.0350	0.2809
COV	0.005	0.001	0.004	0.003	0.007	0.005	0.008	0.003

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.*

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%.*

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

Repeatability Test

Clause 5.4.3

The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ and SPC-1 LRT™ primary metrics 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™ primary metric. Each Average Response Time value must be less than the SPC-1 LRT™ primary metric plus 5%.

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

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

Clause 9.2.4.7.3

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 two Repeatability Test Phases. The content, appearance, and format of the table are specified in Table 9-11.*
2. *An I/O Request Throughput Distribution (data and graph).*
3. *An Average Response Time Distribution (data and graph).*
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 Repeatability Test Runs are listed below:

java –Xmx512m –Xms512m –Xss128k repeat1 –b 2250 –s 300

java –Xmx512m –Xms512m –Xss128k repeat1 –b 2250 –s 300

Repeatability Test Results File

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

	SPC-1 IOPS™	SPC-1 LRT™
Primary Metrics	*112,491.34*	*0.20*
Repeatability Test Phase 1	112,478.41	0.20
Repeatability Test Phase 2	112,488.92	0.20

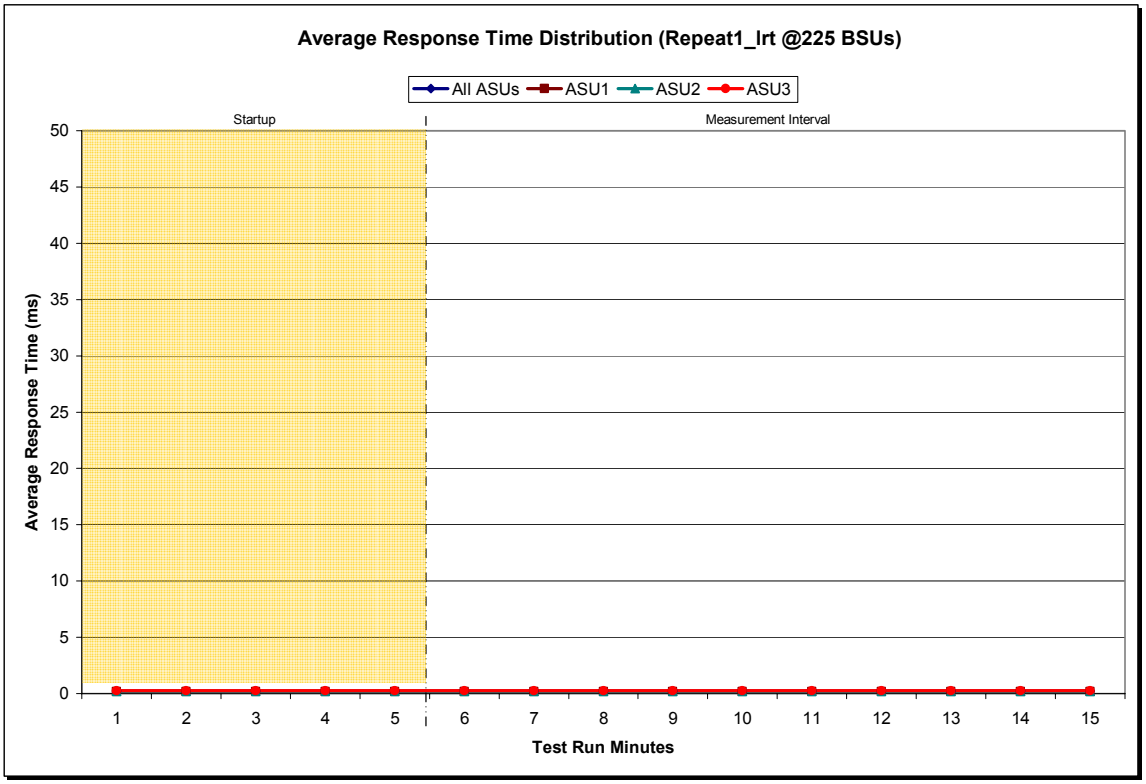
A link to the test result file generated from each Repeatability Test Run list is listed below.

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

Repeatability 1 LRT – I/O Request Throughput Distribution Data

225 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:02:29	9:07:29	0-4	0:05:00
Measurement Interval	9:07:29	9:17:29	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	11,253.15	6,709.87	1,375.92	3,167.37
1	11,235.67	6,702.72	1,375.57	3,157.38
2	11,254.83	6,694.45	1,387.72	3,172.67
3	11,257.85	6,713.73	1,377.18	3,166.93
4	11,247.47	6,701.68	1,370.82	3,174.97
5	11,237.80	6,702.45	1,381.63	3,153.72
6	11,239.53	6,698.12	1,380.48	3,160.93
7	11,254.88	6,702.40	1,382.75	3,169.73
8	11,268.08	6,708.63	1,387.38	3,172.07
9	11,260.53	6,714.60	1,392.53	3,153.40
10	11,236.52	6,702.10	1,381.05	3,153.37
11	11,249.85	6,701.98	1,390.15	3,157.72
12	11,257.07	6,707.00	1,398.45	3,151.62
13	11,237.83	6,702.88	1,380.97	3,153.98
14	11,243.83	6,701.08	1,390.53	3,152.22
Average	11,248.59	6,704.13	1,386.59	3,157.88

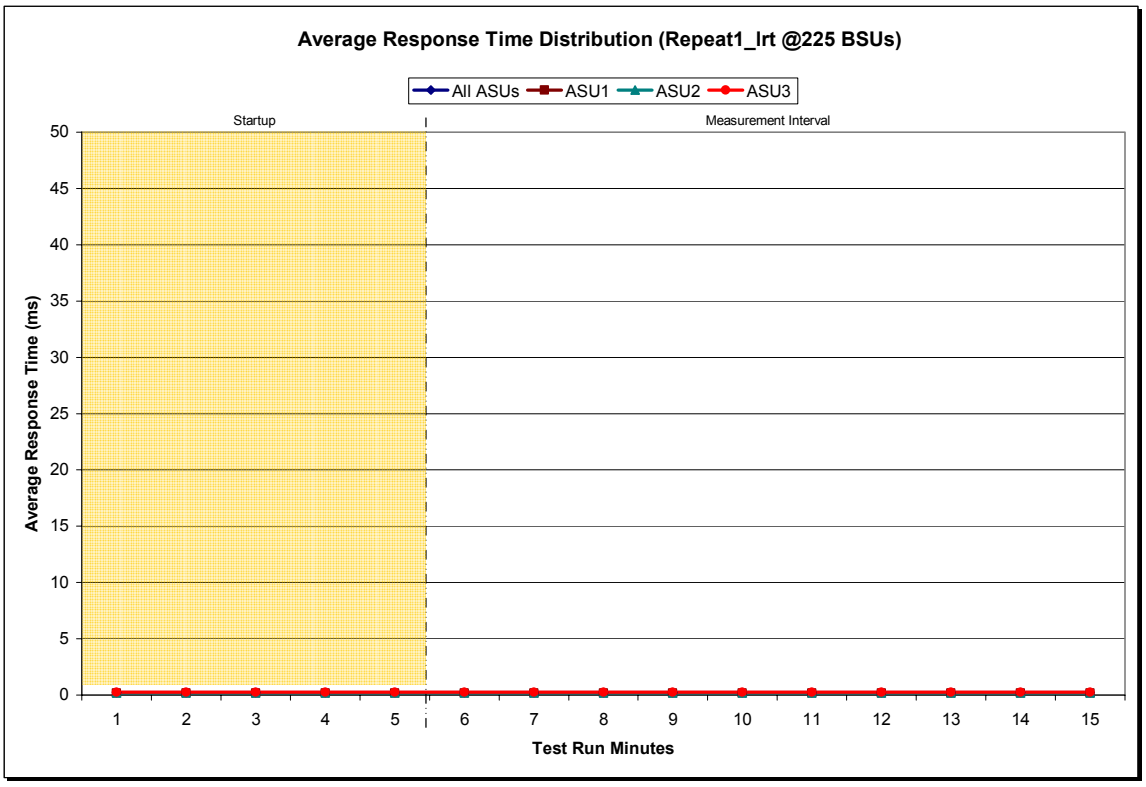
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

225 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:02:29	9:07:29	0-4	0:05:00
Measurement Interval	9:07:29	9:17:29	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.20	0.18	0.19	0.24
1	0.20	0.18	0.19	0.24
2	0.20	0.18	0.19	0.24
3	0.20	0.18	0.19	0.24
4	0.20	0.18	0.19	0.24
5	0.20	0.18	0.19	0.24
6	0.20	0.18	0.19	0.24
7	0.20	0.18	0.19	0.24
8	0.20	0.18	0.19	0.24
9	0.20	0.18	0.19	0.24
10	0.20	0.18	0.19	0.24
11	0.20	0.18	0.19	0.24
12	0.20	0.18	0.19	0.24
13	0.20	0.18	0.19	0.24
14	0.20	0.18	0.19	0.24
Average	0.20	0.18	0.19	0.24

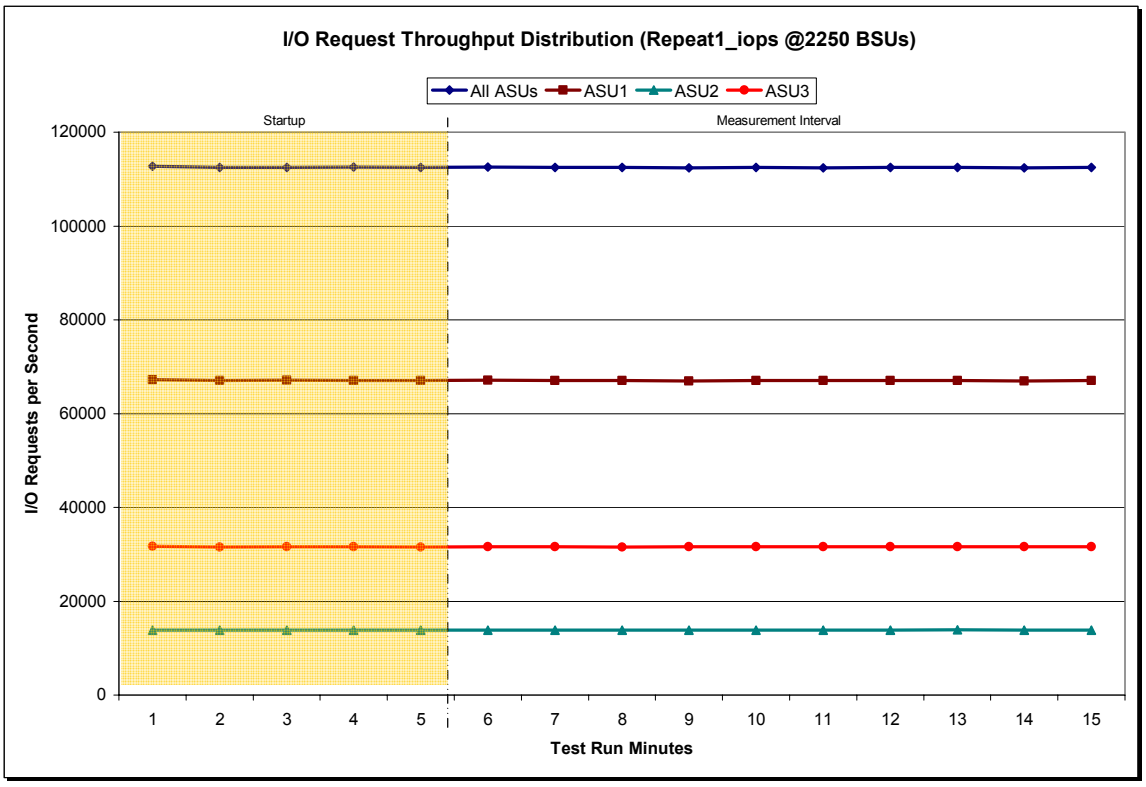
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

2250 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:18:19	9:23:20	0-4	0:05:01
Measurement Interval	9:23:20	9:33:20	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	112,709.18	67,174.95	13,834.28	31,699.95
1	112,456.48	67,054.62	13,828.97	31,572.90
2	112,520.87	67,088.53	13,849.02	31,583.32
3	112,563.60	67,083.12	13,831.10	31,649.38
4	112,491.88	67,069.30	13,850.30	31,572.28
5	112,553.73	67,100.15	13,845.10	31,608.48
6	112,523.27	67,037.03	13,859.07	31,627.17
7	112,477.68	67,077.92	13,831.35	31,568.42
8	112,415.85	66,989.43	13,835.27	31,591.15
9	112,504.15	67,043.72	13,823.28	31,637.15
10	112,438.03	67,020.37	13,821.60	31,596.07
11	112,445.38	67,031.38	13,816.42	31,597.58
12	112,515.32	67,043.47	13,866.45	31,605.40
13	112,432.37	66,988.80	13,842.92	31,600.65
14	112,478.32	67,054.62	13,829.13	31,594.57
Average	112,478.41	67,038.69	13,837.06	31,602.66

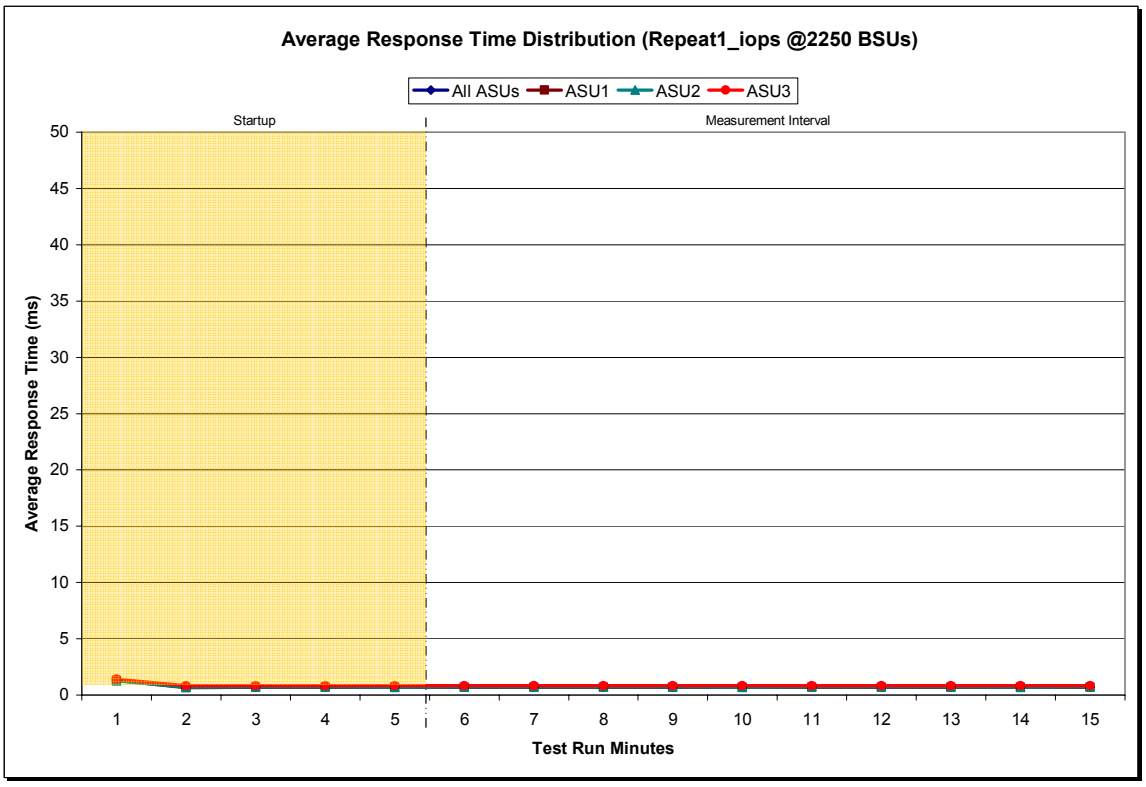
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

2250 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:18:19	9:23:20	0-4	0:05:01
Measurement Interval	9:23:20	9:33:20	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.32	1.30	1.26	1.39
1	0.71	0.66	0.69	0.82
2	0.73	0.68	0.71	0.84
3	0.73	0.68	0.71	0.84
4	0.72	0.67	0.70	0.83
5	0.72	0.68	0.70	0.83
6	0.73	0.68	0.71	0.84
7	0.73	0.68	0.71	0.84
8	0.73	0.68	0.70	0.83
9	0.72	0.67	0.70	0.83
10	0.73	0.68	0.71	0.84
11	0.72	0.68	0.70	0.83
12	0.73	0.68	0.71	0.84
13	0.72	0.67	0.70	0.83
14	0.73	0.68	0.70	0.84
Average	0.73	0.68	0.70	0.84

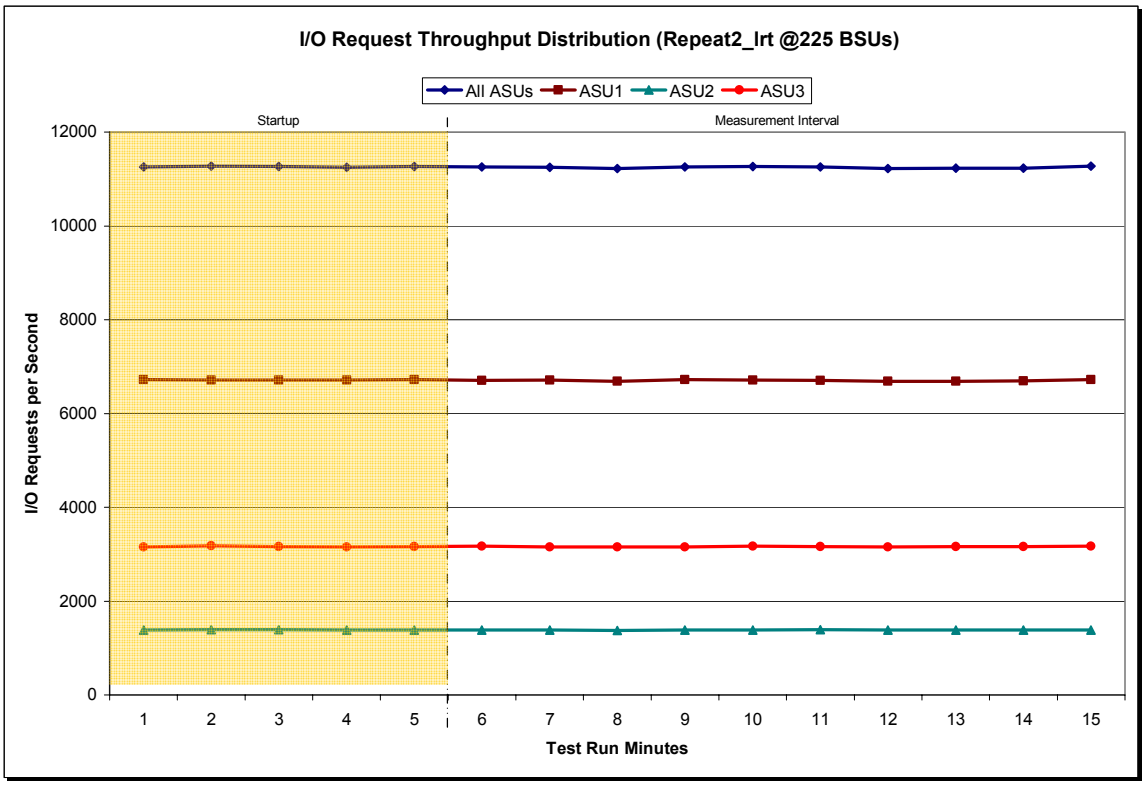
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

225 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:44:37	9:49:37	0-4	0:05:00
Measurement Interval	9:49:37	9:59:37	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	11,258.78	6,721.62	1,383.70	3,153.47
1	11,275.80	6,711.88	1,386.78	3,177.13
2	11,263.80	6,716.05	1,387.00	3,160.75
3	11,247.12	6,710.77	1,379.23	3,157.12
4	11,267.30	6,720.25	1,385.87	3,161.18
5	11,259.50	6,707.25	1,385.12	3,167.13
6	11,251.37	6,709.28	1,385.98	3,156.10
7	11,219.02	6,690.33	1,372.00	3,156.68
8	11,254.93	6,719.82	1,380.38	3,154.73
9	11,263.50	6,712.92	1,383.52	3,167.07
10	11,254.18	6,700.90	1,389.00	3,164.28
11	11,218.48	6,683.65	1,383.52	3,151.32
12	11,229.05	6,689.97	1,379.03	3,160.05
13	11,231.15	6,692.57	1,379.10	3,159.48
14	11,270.27	6,719.07	1,378.63	3,172.57
Average	11,245.15	6,702.58	1,381.63	3,160.94

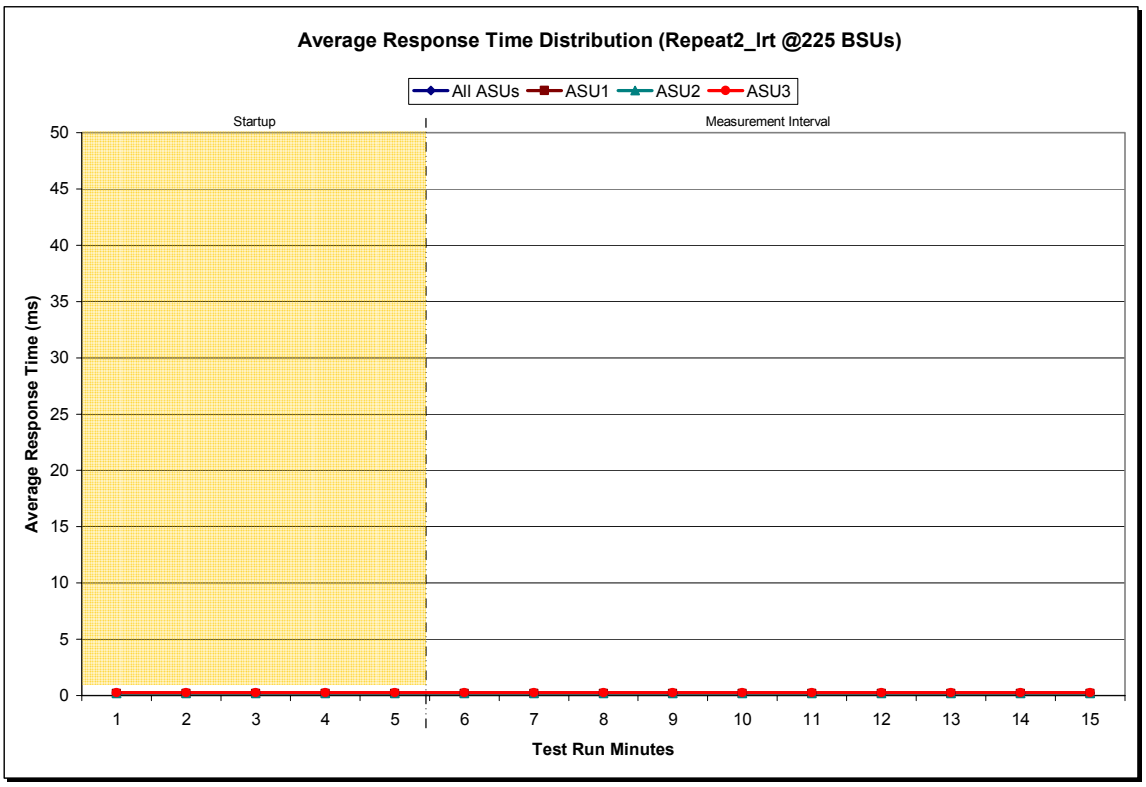
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

225 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	9:44:37	9:49:37	0-4	0:05:00
Measurement Interval	9:49:37	9:59:37	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.20	0.18	0.19	0.25
1	0.20	0.18	0.19	0.24
2	0.20	0.18	0.19	0.24
3	0.20	0.18	0.19	0.24
4	0.20	0.18	0.19	0.24
5	0.20	0.18	0.19	0.24
6	0.20	0.18	0.19	0.24
7	0.20	0.18	0.19	0.24
8	0.20	0.18	0.19	0.24
9	0.20	0.18	0.19	0.24
10	0.20	0.18	0.19	0.24
11	0.20	0.18	0.19	0.24
12	0.20	0.18	0.19	0.24
13	0.20	0.18	0.19	0.24
14	0.20	0.18	0.19	0.24
Average	0.20	0.18	0.19	0.24

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

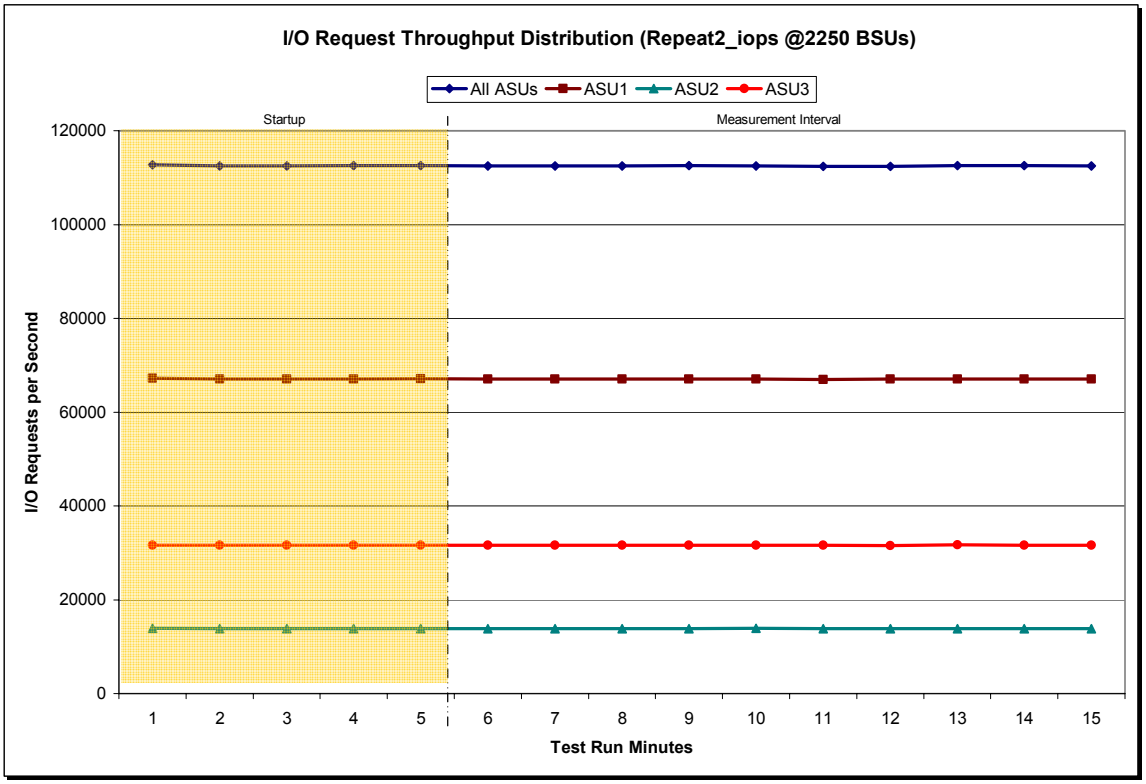


Repeatability 2 IOPS – I/O Request Throughput Distribution Data

2250 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:00:27	10:05:28	0-4	0:05:01
Measurement Interval	10:05:28	10:15:28	5-14	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	112,717.42	67,194.22	13,886.88	31,636.32
1	112,495.50	67,062.43	13,838.25	31,594.82
2	112,493.65	67,074.75	13,829.68	31,589.22
3	112,580.02	67,076.50	13,847.33	31,656.18
4	112,608.33	67,139.65	13,826.03	31,642.65
5	112,459.75	67,004.32	13,863.88	31,591.55
6	112,490.43	67,019.62	13,822.57	31,648.25
7	112,520.83	67,056.10	13,855.92	31,608.82
8	112,530.35	67,082.93	13,845.15	31,602.27
9	112,484.18	67,029.60	13,867.45	31,587.13
10	112,419.07	66,984.75	13,842.23	31,592.08
11	112,409.08	67,015.55	13,827.97	31,565.57
12	112,548.88	67,050.22	13,810.35	31,688.32
13	112,577.25	67,080.33	13,851.87	31,645.05
14	112,449.40	67,042.93	13,816.80	31,589.67
Average	112,488.92	67,036.64	13,840.42	31,611.87

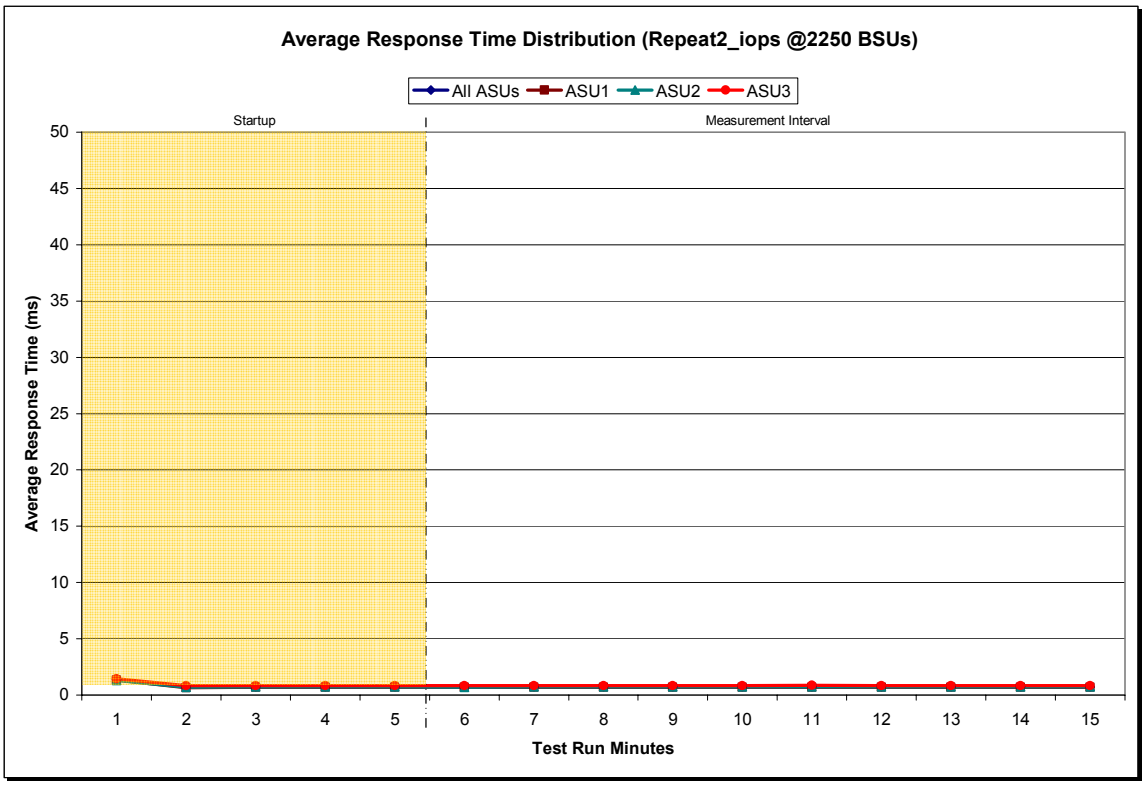
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

2250 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:00:27	10:05:28	0-4	0:05:01
Measurement Interval	10:05:28	10:15:28	5-14	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.35	1.33	1.28	1.44
1	0.71	0.67	0.69	0.82
2	0.73	0.68	0.71	0.84
3	0.73	0.68	0.71	0.84
4	0.73	0.68	0.71	0.84
5	0.72	0.68	0.70	0.83
6	0.73	0.68	0.70	0.83
7	0.73	0.68	0.71	0.84
8	0.73	0.68	0.71	0.84
9	0.72	0.67	0.70	0.83
10	0.74	0.69	0.71	0.85
11	0.73	0.68	0.71	0.84
12	0.73	0.68	0.71	0.83
13	0.73	0.68	0.71	0.83
14	0.73	0.68	0.71	0.84
Average	0.73	0.68	0.71	0.84

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



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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
	0.0349	0.2811	0.0701	0.2099	0.0180	0.0702	0.0350	0.2807
	0.004	0.002	0.006	0.002	0.006	0.005	0.007	0.002

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.*

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%.*

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

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0349	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.002	0.000	0.001	0.001	0.004	0.002	0.002	0.001

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0351	0.2812	0.0699	0.2099	0.0180	0.0700	0.0349	0.2811
COV	0.005	0.002	0.004	0.002	0.009	0.004	0.005	0.001

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0350	0.2809	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.002	0.000	0.001	0.001	0.002	0.002	0.002	0.001

Data Persistence Test

Clause 6

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

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

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

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

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

Clause 9.2.4.8

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

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Data Persistence Test are listed below:

java –Xmx512m –Xms512m –Xss128k persist1 –b 2250

java java –Xmx512m –Xms512m –Xss128k persist2

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	222,757,072
Total Number of Logical Blocks Verified	8,388,544
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks	10 minutes
Size in Bytes of each Logical Block	512
Number of Failed I/O Requests in the process of the Test	0

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

PRICED STORAGE CONFIGURATION AVAILABILITY DATE

Clause 9.2.4.9

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

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

The Texas Memory Systems RamSan-320, as documented in this Full Disclosure Report became available for customer purchase and shipment on July 1, 2003.

PRICING INFORMATION

Clause 9.2.4.11

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

Pricing information may found in the Tested Storage Configuration Pricing section on page 12.

ANOMALIES OR IRREGULARITIES

Clause 9.2.4.10

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

There were no anomalies or irregularities encountered during the SPC-1 Onsite Audit of the Texas Memory Systems RamSan-320.

APPENDIX A: TESTED STORAGE CONFIGURATION (TSC) CREATION

The logical Tested Storage Configuration (TSC) was created and configured from the 'LUN Config' page of the RamSan-320 Web-based management utility. The following screen shots and text descriptions document the steps required for that TSC creation and configuration.

Step 1:

ASU-1 (LUN 0) was created by selecting 'New LUN.' The size was set to 29,491 MB, the backup type to 'Data Sync,' and the LUN was linked to all fibre channel ports.

Step 2:

ASU-2 (LUN 1) was created by selecting 'New LUN.' The size was set to 29,491 MB, the backup type to 'Data Sync,' and the LUN was linked to all fibre channel ports.

Step 3:

ASU-3 (LUN 2) was created by selecting 'New LUN.' The size was set to 6,554 MB, the backup type to 'Data Sync,' and the LUN was linked to all fibre channel ports.

Step 4:

Selecting 'Save Table' completed the LUN configuration process.

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

Master configuration file ("SPC1.cfg"):

```
host=master
slaves=(slave4101,slave4102,slave4103,slave4104,slave4201,slave4202,slave4203,slave4204,s
lave4301,slave4302,slave4303,slave4304,slave4401,slave4402,slave4403,slave4404,slave3301
,slave3302,slave3303,slave3501,slave3502,slave3503,slave3601,slave3602,slave3603,slave370
1,slave3702,slave3703)
sd=asu1_1,lun=\\.\PhysicalDrive2
sd=asu2_1,lun=\\.\PhysicalDrive3
sd=asu3_1,lun=\\.\PhysicalDrive4
```

Slave configuration file ("slave*XXXX*.txt")**:**

```
master=192.94.232.38
host=slave3301
sd=asu1_1,lun=\\.\PhysicalDrive1
sd=asu2_1,lun=\\.\PhysicalDrive2
sd=asu3_1,lun=\\.\PhysicalDrive3
```

Each Slave Host System used a SPC-1 configuration file identical to the above sample with the exception of substituting the appropriate "host" command line.

APPENDIX C: THIRD-PARTY PRICE QUOTATIONS

QLogic and Emulex HBAs:

Info X
Technology Solutions

1 Veterans Place
Whippany, NJ 07981
(973) 386-1411, Fax: (973) 386-0783
(800) 463-9998
Toll Free: (800) 463-9998 - Evelyn Caruso Ext. 132

QUOTE

ORDER NUMBER: 0032367
ORDER DATE: 3/16/2004

CUSTOMER NO: TEXAS

SOLD TO:

Texas Memory Systems, Inc.
11200 Westheimer
Suite 1000
Houston, TX 77042US

SHIP TO:

Texas Memory Systems, Inc.
11200 Westheimer
Suite 1000
Houston, TX 77042US

CONFIRM TO: Aaron

CUSTOMER P.O.	SHIP VIA	F.O.B.	TERMS
			Pre-Paid

ITEM NUMBER	UNIT	ORDERED	SHIPPED	BACK ORDE	PRICE	AMOUNT
QLA2342-CK Qlogic 2Gb 133Mhz PCI-X Dual Qlogic Note - $100. instant rebate valid thru 3/31/04 has not been applied	EACH	4	0	0	1,781.00	7,124.00
LP10000DC-M2 Emulex 2Gb 133Mhz PCI-X Dual	EACH	4	0	0	1,952.00	7,808.00

Advanced Replacements on all defective HBA products.
24x7x365 Support from our Certified Fibre Channel Engineers.
3 Year Manufacturer Warranty on all Fibre Channel HBAs.

Net Order:	14,932.00
Less Discount:	0.00
Shipping & Handling:	0.00
Sales Tax:	0.00
Order Total:	**14,932.00**

EMULEX qlogic jni LSI LOGIC CambeX EMERSON Network Power

Call 1-800-463-9998 for all your Fibre Channel Needs

Important Notice: Customers purchasing EMC Certified HBAs must supply Info X with the following information: EMC Storage system (i.e. Symmetrix or CLARiiON) and the Operating System on the Host Server. Info X will not process orders without this information.

Terms and Conditions:
Shipping and Handling are not included on this Quote. Please ask your sales representative for a freight quote based on the desired shipping method.
Customer is responsible for all applicable taxes and duties.
Prices are in US currency and are subject to change without notice.
Returns will only be accepted after a valid RMA number has been issued. All non-defective returns must be completed within 30 days from the original purchase date. Open items will only be accepted on a case by case basis and are subject to a 15% restocking fee and are not allowed after 30 days from the original purchase date.
Customer is responsible for all freight costs associated with returns or exchanges.
Past Due invoices will incur a 1% monthly finance charge. In addition, any collection costs associated with past due invoices will be the responsibility of the customer.

Accepted

www.info-x.com

Date Accepted:_____