



**SPC BENCHMARK 1™
FULL DISCLOSURE REPORT**

**DataCore Software Corporation
SANsymphonyÔ Network Edition**

SPC-1 V1.7

Submitted for Review: August 08, 2003

Accepted: January 28, 2004



First Edition – August 2003

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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



DataCore Software Corporation
 Ziya Aral
 Chairman of the Board and Chief Technical Officer
 6300 NW 5th Way
 Fort Lauderdale, FL 33309

August 8, 2003

The SPC Benchmark 1™ results listed below for the DataCore SANsymphony™ Network Edition were produced in compliance with the SPC Benchmark 1™ v1.7 Onsite Audit requirements.

SPC Benchmark 1™ Results	
Tested Storage Configuration (TSC) Name: DataCore SANsymphony™ Network Edition	
Metric	Reported Result
SPC-1 IOPS™	50,003.55
SPC-1 Price-Performance	\$6.11/SPC-1 IOPS™
Total ASU Capacity	1,407.00 GB
Data Protection Level	Mirroring
SPC-1 LRT™	1.68 ms
Total TSC Price (including three-year maintenance)	\$305,608.00

The following SPC Benchmark 1™ Onsite Audit requirements were verified:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified by information supplied by the Test Sponsor as well as physical inspection:
 - ✓ 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.
- Appropriate diagrams of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC) and storage network configuration.

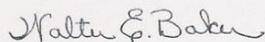
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 Redwood City, CA 94062
AuditService@storageperformance.org
 Phone: 650.556.9384
 FAX: 650.556.9385

- Physical verification of the components to match the above diagrams.
- 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 type of Host Systems 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 work presented to each Application Storage Unit (ASU) from each Host System preserved the required SPC-1 workload parameters.
- 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 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 benchmarked TSC and priced TSC are documented in the Full Disclosure Report. Those differences will have no impact on the reported SPC-1 performance.
- The final version of the pricing spreadsheet meets all of the requirements and constraints of Clause 8 of the SPC-1 Benchmark Specification.
- The Full Disclosure Report meets 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



Date: 7/18/2003

From: Ziya Aral, Chief Technology Officer, DataCore Software

To: Walter Baker, SPC Auditor, Gradient Systems

Subject: Letter of Good Faith for the SPC-1™ results published on the SANsymphony configuration.

This letter of Good Faith between DataCore Software Corporation (hereafter known as the "Test Sponsor") and the Storage Performance Council (hereafter known as the SPC) documents that:

1. Fidelity and candor has been and will be maintained in reporting any anomalies in the SPC Benchmark-1™, even if not explicitly required for disclosure in the SPC Benchmark-1 specification.
2. No attempt has been or will be made to deceive the SPC Audit Service, SPC, customers or the public regarding the authenticity or accuracy of the SPC Benchmark-1 results in the SANsymphony configuration. As such, the SPC-1 Full Disclosure Report that will document SPC Benchmark-1 results (per clause 10 of the SPC Benchmark-1 Benchmark Specification) on the SANsymphony configuration.
3. The SANsymphony configuration used for reporting the SPC Benchmark-1 results as documented in the full Disclosure Report (per clause 10 of SPC Benchmark-1 Benchmark Specification) has not been misrepresented to the SPC or SPC Audit Service in any way.
4. SPC Benchmark-1 results on the SANsymphony configuration are compliant with the spirit, intent and letter of the SPC Benchmark-1.
5. The SPC Benchmark-1 results do not represent a "Benchmark special" as documented in clause 0.2 of the SPC Benchmark-1 specification.

(Ziya Aral, Chief Technology Officer, DataCore Software)

Executive Summary

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
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Revision Information and Key Dates

Revision Information and Key Dates	
SPC-1 Specification revision number	V 1.7
SPC-1 Workload Generator revision number	V 2.1
Date Results were first used publicly	August 08 2003
Date FDR was submitted to the SPC	August 08 2003
Date the TSC is/was available for shipment to customers	August 01 2003
Date the TSC completed audit certification	August 08 2003

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name : DataCore SANsymphony Network Edition	
Metric Reported	Results
SPC-1 IOPs	50,003.55
SPC-1 Price-Performance	\$6.11/SPC-1 IOPS™
Total ASU Capacity	1,407GB
Data Protection Level	Mirroring
SPC-1 LRT	1.68 ms
Total TSC Price (including three-year maintenance)	\$305,608

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. The Addressable Storage Capacity, which contains the Total ASU Capacity, was 1,825.36 GB. The Total ASU Capacity utilized 77.08% of the Addressable Storage Capacity. The actual Configured Storage Capacity was 4,022.66 GB, which included the user data copy required by a Data Protection Level of Mirroring. The Configured Storage Capacity utilized 99.63% of the priced Physical Storage Capacity of 4,037.43 GB.

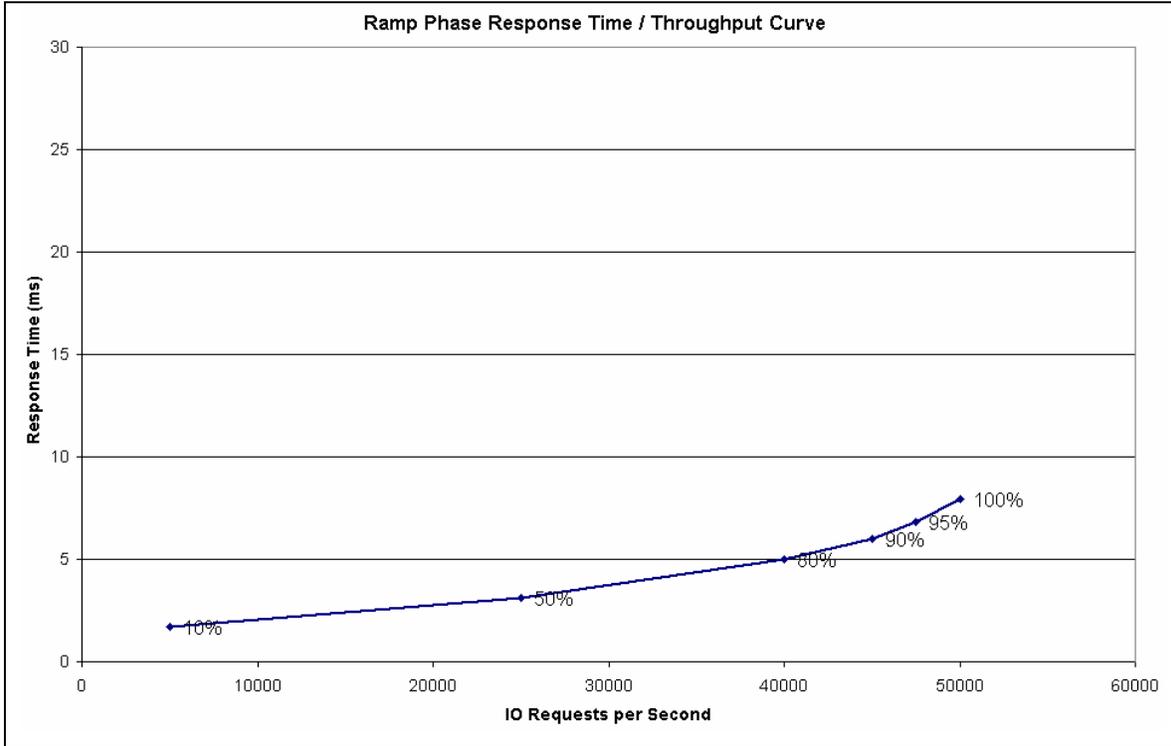
A Data Protection Level of Mirroring configures two or more identical copies of user data, maintained on separate disks.

The **SPC-1 LRT™** metric is the Average Response Time measured at the 10% load point, as illustrated on the next page. SPC-1 LRT™ represents the Average Response Time measured on a lightly loaded Tested Storage Configuration (TSC).

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 the 100% load point cannot exceed 30 milliseconds or the benchmark measurement is invalid.



Response Time – Throughput Data

Response Time - Throughput

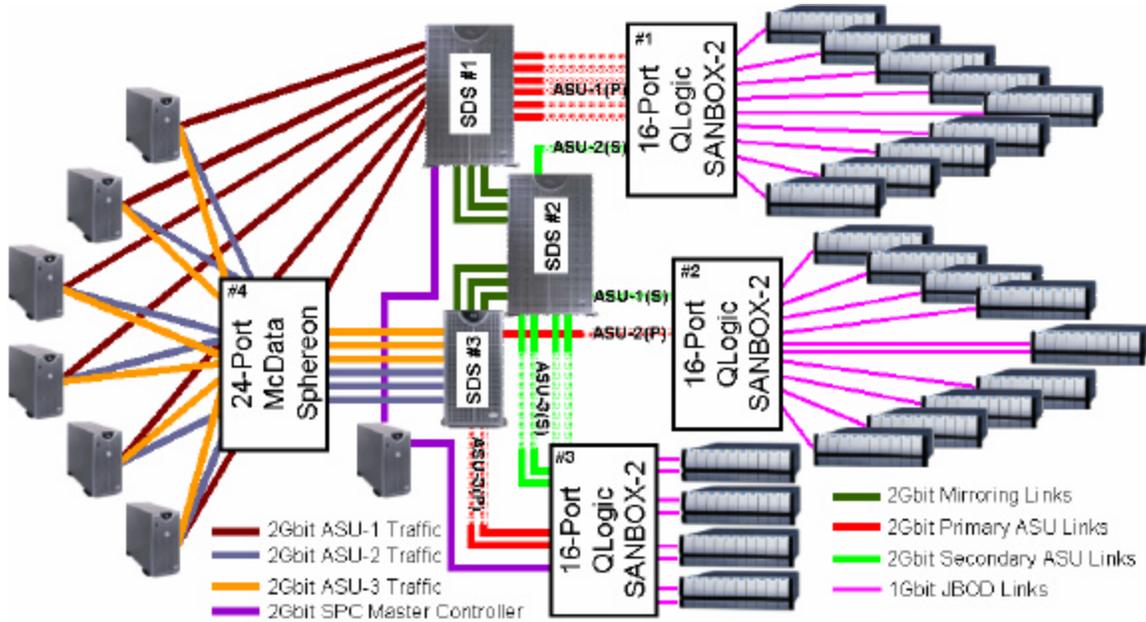
	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	4,997.33	25,002.16	40,008.03	45,016.78	47,495.03	50,003.55
Average Response Time (ms):						
All ASUs	1.68	3.13	5.00	6.03	6.80	7.97
ASU-1	2.04	4.19	6.85	8.21	9.19	10.14
ASU-2	2.01	2.80	3.94	4.59	5.08	5.84
ASU-3	0.78	1.03	1.53	2.04	2.50	4.30
Reads	3.19	6.57	10.70	12.73	14.18	15.44
Writes	0.70	0.89	1.28	1.66	2.00	3.11

Tested Storage Configuration Pricing

Part Number	Description	Units	Unit Cost	%age Discount	Final Price
JYD-EWV-501-BU1	DELL PE4600 2x3GHz 12GB DELL PE4600 2x2.8GHz 6GB DELL PE2600 2x3GHz 6GB 3 x Windows Server 2003 Enterprise Edition 22 x JMR Fortra 10-drive 1Gbit JBOD 220xSeagate 18GBx15K RPM FC Drive 22 x QLogic QL2310 (Single port HBA) 11 x QLogic QL2342 (Dual port HBA) 4 x QLogic QL2344 (Quad port HBA) 27 x Copper –Fibre MIA 3 x QLogic SANbox-2 16-port switch 1 x McData 4500 Sphereon 24-port switch 74 x 5M Fibre channel cables 2 x 72" Rack	1	\$170,637	No discount	\$170,637
JYD-EWV-GLD-BU1	24x7 4-hour response H/W maintenance (1 year)	3	\$14,096	No discount	\$42,288
HWI-MVV-520-BVS	Hardware Installation & Integration	1	\$11,500	No discount	\$11,500
Hardware + Installation + H/W Maintenance Subtotal					\$224,425
SSM-EWB-520-BM1	SANsymphony Network Edition + Network Mirroring Bundle	3	\$23,490	25%	\$52,853
SSM-EWB-GLD-BM1	SANsymphony Maintenance	3	\$4,698	No discount	\$14,094
NMV-EWB-520-FS1	Network Managed Volumes (NMV)	3	\$4,995	25%	\$11,239
NMV-EWB-520-FS1	NMV Maintenance	3	\$999	No discount	\$2,997
Software + Software Maintenance Subtotal					\$81,183
Hardware + Software + Installation + Maintenance					\$305,608

Benchmark Configuration/Tested Storage Configuration Diagram

The first figure illustrates the physical connections between the SANsymphony Storage Domain Servers (SDS nodes), the QLogic 2Gbit 16-port FC switches and the 22x10-drive 1Gbit JBODs and benchmark load generators.

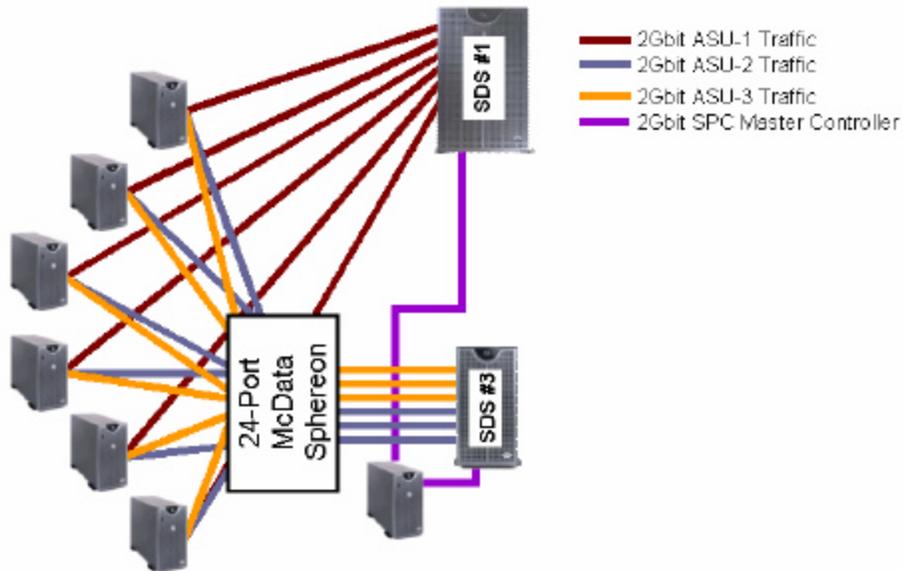


Tested Storage Configuration (physical)

It's easier to explain all the connections by looking at the configuration in two halves:

1. The front-end connections between the six slave Host Systems, the single master Host System and the SANsymphony nodes; SDS#1 and SDS#3.
2. The back-end connections between physical storage and the three SDS nodes.

The next figure shows the logical connections for the front-end configuration:



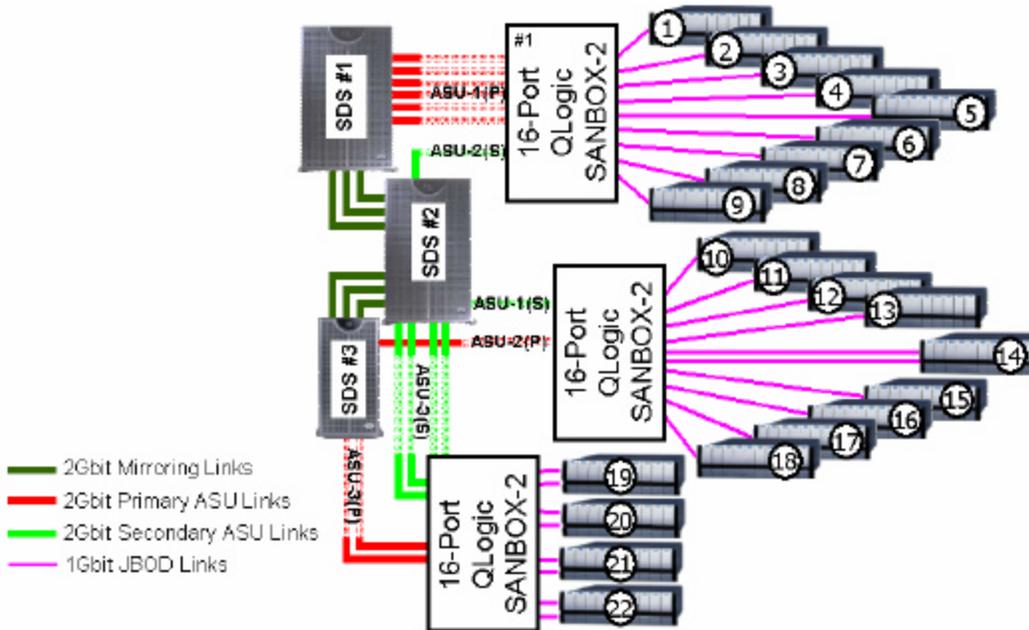
Front-end (Logical)

The configuration consists of:

1. Six slave Host Systems running the SPC-1 Workload Generator. Each slave Host System has three connections, one connection direct to SDS#1 for ASU-1 traffic, and two connections to the switch for ASU-2 and ASU-3 traffic.
2. One Host System runs the SPC-1 load generator as the “master” and doesn’t actually generate any work, but it does need to see the ASU-1, ASU-2 and ASU-3 devices presented by SDS#1 and SDS#3. In the diagram it’s shown as directly connected to both SDS#1 and SDS#3. Physically, the SDS#3 connection was via one of the 16-port switches used in the back-end.
3. SDS #1 has six point-to-point connections with the hosts and carries all the ASU-1 traffic.
4. SDS#3 has six connections to the switch; three of the connections carried ASU-2 traffic, while the other three connections carried ASU-3 traffic.

For the sake of simplicity, SDS #2 is not shown on the front-end diagram because it only provides mirror targets for SDS #1 and SDS #3 so has no direct connections to the hosts.

The second figure illustrates the back-end configuration (i.e. the collection of hardware that corresponds to a conventional storage array.)



Back-end Configuration

The drives are housed in standard 10-drive enclosures featuring a dual 1Gbit Fibre loop. Of the 22 enclosures in the configuration only enclosures 14,19,20,21 and 22 are dual connected with five drives on each loop. The other 17 enclosures each have 10 drives on a single loop.

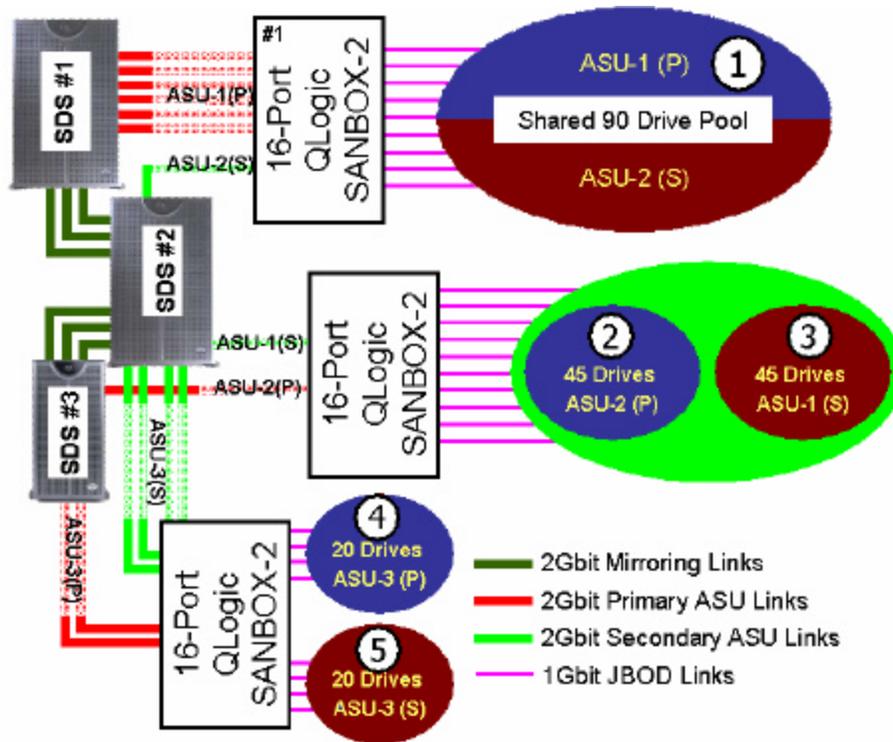
The following table illustrates the assignment of drives and enclosures to the SDS nodes.

	SDS#1	SDS#2	SDS#3
Enclosures 1-9	Shared	Shared	No access
Enclosures 10-13	No Access	No Access	Assigned
Drives 1-5 Enclosure 14	No Access	No Access	Assigned
Drives 6-10 Enclosure 14	No Access	Assigned	No Access
Enclosures 15-18	No Access	Assigned	No Access
Enclosures 19-20	No Access	Assigned	No Access
Enclosures 21-22	No Access	No Access	Assigned

The physical storage used in the benchmark was configured using SANsymphony Network Managed Volumes. The process is effectively a two-step process. First, physical resources (i.e. disks) are assigned to resource pools, and second, logical volumes are created from the resource pools. The following table illustrates the mappings:

Resource Pool	Physical mapping	Logical volumes
Network Volume Pool #1	90x 18.3GB Drives	ASU-1 ASU-2 (User Data Copy)
Network Volume Pool #2	45x 18.3GB Drives	ASU-2
Network Volume Pool #3	45x 18.3GB Drives	ASU-1 (User Data Copy)
Network Volume Pool #4	20x 18.3GB Drives	ASU-3
Network Volume Pool #5	20x 18.3GB Drives	ASU-3 (User Data Copy)

The next figure illustrates the way in which the physical drives are distributed and used for the various ASU volumes.



Storage Pool Configuration (logical)

The 220 drives used in the benchmark were split into five logical pools serving the primary and secondary ASU LUNs. The drives are allocated to Network Managed Volume (NMV) pools as follows:

1. Pool 1: Consists of 90 drives taken from 9x10-drive JBODs attached to switch #1. SDS #1 and SDS #2 share this pool. Using NMVs, ASU-1(P) and ASU-2(S) are striped across all 90 drives in 1MB chunks.

2. Pool 2: 45 drives taken from 4x10-drive JBODs and half of a fifth JBOD attached to switch #2. This pool is allocated exclusively to SDS#3 and contains the primary copy of ASU-2.
3. Pool 3: 45 drives taken from 4x10-drive JBODs and half of a fifth JBOD attached to switch #2. This pool is allocated exclusively to SDS#2 and contains the mirror of ASU-1.
4. Pool 4: 20 drives taken from dual-attached 2x10-drive JBODs attached to switch #3. This pool is allocated exclusively to SDS#3 and contains the primary copy of ASU-3.
5. Pool 5: Consists of 20 drives taken from dual-attached 2x10-drive JBODs attached to switch #3. This pool is allocated exclusively to SDS#2 and contains the mirror of ASU-3.

The ASU volumes are assigned as follows:

	SDS #1	SDS #2	SDS #3
ASU #1	Primary	Mirror	
ASU #2		Mirror	Primary
ASU #3		Mirror	Primary

Hardware Configuration Details

As seen in the previous diagrams, DataCore used three off-the-shelf Intel-based servers as Storage Domain Servers. The configurations for the three SDS nodes are as follows:

	SDS #1	SDS #2	SDS #3
Nodename	Charger	Super	Executor
Platform	Dell PowerEdge 4600	Dell PowerEdge 4600	Dell PowerEdge 2600
Processor	2x3.0GHz XEON	2x2.8GHz XEON	2x3.0GHz XEON
System RAM	12GB	6GB	6GB
QLogic 2310 HBA			Two (2x 2Gbit ports)
QLogic 2342 HBA	Four (8x 2Gbit ports)	Four (8x 2Gbit ports)	Three (6x 2Gbit ports)
QLogic 2344 HBA	Two (8x 2Gbit ports)	One (4x 2Gbit ports)	One (4x 2Gbit ports)
Software			
Operating System	Windows Server 2003 Enterprise Edition		
SANsymphony	Network Edition		
Network Mirroring	Yes		
Network Managed Volumes	Yes		

For SDS nodes, the system RAM is equivalent to cache on a conventional array, although some is required for the operating system and SANsymphony leaving approximately 21GB of memory available for caching.

SDS #1 has six 2Gbit connections to the workload generators, all dedicated to ASU-1 traffic as point-to-point links. SDS#3 has 6x2Gbit connections to the switch. Three of those connections carry ASU-2 traffic, while the other three connections carry ASU-3 traffic.

Storage

The storage consists of twenty-two identical 10-drive enclosures manufactured by JMR Corporation. These JBODs only support 1Gbit transfer rates, so all switch-JBOD connections are 1Gbit even though the switches support 2Gbit transfer rates. Each connection from a JBOD to a switch required a copper-Fibre Media Interface Adapter (MIA) for a total of 27 MIAs in the configuration.

Each JBOD is fully populated with Seagate Cheetah X15 15K RPM 18.3GB disk drives (Seagate P/N # ST318453FC.)

Switching Infrastructure

A total of four 2Gbit Fibre Channel switches were used. The three switches on the “back end” of the configuration were identical 16-port Qlogic SANbox-2 devices, while the “front-end” used to connect the host systems to ASU-2 and ASU-3 was a 24-port McData Sphereon 4500 device.

SPC-1 Host Systems

The hardware/software configuration of each of the six Host systems was identical:

Host system	
Platform	Dell PowerEdge 2300
Processor	2x1.2GHz Pentium III
Processor Cache	L1-32KB (16/16 I/D) L2-256KB (unified)
System RAM	1GB
QLogic 2310 HBA	Three (provides 3x2Gbit ports)
Software	
Operating System	Windows Server 2003 Standard Edition
SPC-1 Workload Generator	Version 2.1

Each of the Host systems uses a separate 2Gbit link for traffic to each ASU.

The seventh Host system which acted as the as the master, was identically configured with the exception of the number of QL2310 HBAs. Only two were required; one to access LUNs served by SDS#1 and one to access LUNs served by SDS#3.

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.

See the [“Benchmark Configuration/Tested Storage Configuration Diagram”](#) section starting on page 13 for a full description of the storage and network infrastructure used in the benchmark.

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 12 (Benchmark Configuration/Tested Storage Configuration Diagram).

See the [“SPC-1 Host Systems”](#) section starting on page 18 for a full description of the Host systems used in the benchmark.

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.

Windows Registry Changes on the SANsymphony Storage Domain Servers

On each SDS, various changes were made to three groups of registry entries that control caching, Fibre Channel I/O and device polling behavior for SANsymphony. The changes can be applied using the Windows 2003 Server Registry Editor.

Changes for Cache Behavior on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	IoQueueCount
Default	16
SPC-1	8192
Changes for Cache Behavior on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	IoQueueSize
Default	4096
SPC-1	2097152 (0x200000)
Changes for Cache Behavior on SDS#1 (Nodename: Charger)	

Changes for Cache Behavior on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	WriteSizeStop
Default	65536
SPC-1	40894464 (0x2700000)
Changes for Cache Behavior on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	AllowRewrite
Default	0 (Disabled)
SPC-1	1 (Enabled)
Changes for Cache Behavior on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	ReadAhead
Default	1 (Enabled)
SPC-1	0 (Disabled)

Changes for Polling Behavior on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsPoll\Parameters
Key	MaxPollers
Default	1
SPC-1	3
Changes for Polling Behavior on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsPoll\Parameters
Key	HighWaterMarkPercentage
Default	40
SPC-1	5
Changes for Polling Behavior on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsPoll\Parameters
Key	LowWaterMarkPercentage
Default	10
SPC-1	0

Changes for FC I/O on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsSp\Parameters
WWNs	210000E08B09CADC, 210100E08B29CADC, 210200E08B49CADC
Parameter	LunQueueDepth
Default	64
SPC-1	254 (0xFE)
Changes for FC I/O on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsSp\Parameters
WWNs	210000E08B09CADC, 210100E08B29CADC, 210200E08B49CADC
Parameter	IoDistribution
Default	0 (False)
SPC-1	1 (True)
Changes for FC I/O on SDS#1 (Nodename: Charger)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsSp\Parameters
WWNs	210000E08B09CADC, 210100E08B29CADC, 210200E08B49CADC
Parameter	LunDistribution
Default	0 (False)
SPC-1	1 (True)

Changes for Cache Behavior on SDS#2 (Nodename: Super)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	IoQueueCount
Default	16
SPC-1	48
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	IoQueueSize
Default	4096
SPC-1	819200 (0xC8000)
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	WriteSizeStop
Default	65536
SPC-1	10485760 (0xA00000)
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	AllowRewrite
Default Value	0 (Disabled)
SPC-1	1 (Enabled)
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	ReadAhead
Default Value	1 (Enabled)
SPC-1	0 (Disabled)

Changes for Polling Behavior on SDS#2 (Nodename: Super)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsPoll\Parameters
Key	MaxPollers
Default Value	1
SPC-1 Value	3
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsPoll\Parameters
Key	HighWaterMarkPercentage
Default Value	40
SPC-1 Value	5
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsPoll\Parameters
Key	LowWaterMarkPercentage
Default Value	10
SPC-1 Value	0

Changes for Cache Behavior on SDS#3 (Nodename: Executor)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	IoQueueCount
Default	16
SPC-1	96
Changes for Cache Behavior on SDS#3 (Nodename: Executor)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	IoQueueSize
Default	4096
SPC-1	8388608 (0x800000)
Changes for Cache Behavior on SDS#3 (Nodename: Executor)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	WriteSizeStop
Default	65536
SPC-1	18874368 (0x1200000)
Changes for Cache Behavior on SDS#3 (Nodename: Executor)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	AllowRewrite
Default Value	0 (Disabled)
SPC-1	1 (Enabled)
Changes for Cache Behavior on SDS#3 (Nodename: Executor)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsCache\Parameters
Key	ReadAhead
Default Value	1 (Enabled)
SPC-1	0 (Disabled)

Changes for Polling Behavior on SDS#3 (Nodename: Executor)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsPoll\Parameters
Key	MaxPollers
Default Value	1
SPC-1 Value	3
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsPoll\Parameters
Key	HighWaterMarkPercentage
Default Value	40
SPC-1 Value	5
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsPoll\Parameters
Key	LowWaterMarkPercentage
Default Value	10
SPC-1 Value	0

Changes for FC I/O on SDS#3 (Nodename: Executor)	
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsSp\Parameters
WWNs	210000E08B0B8CF9, 210100E08B2B8CF9, 210200E08B4B8CF9
Parameter	LunQueueDepth
Default	64
SPC-1	127 (0x7F)
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsSp\Parameters
WWNs	210000E08B07A0A7
Parameter	LunQueueDepth
Default	64
SPC-1	24 (0x18)
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsSp\Parameters
WWNs	210000E08B0B8CF9, 210100E08B2B8CF9, 210200E08B4B8CF9
Parameter	IoDistribution
Default	0 (False)
SPC-1	1 (True)
Path	HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\DcsSp\Parameters
WWNs	210000E08B0B8CF9, 210100E08B2B8CF9, 210200E08B4B8CF9
Parameter	LunDistribution
Default	0 (False)
SPC-1	1 (True)

Host Changes

On each of the six hosts running the SPC-1 Workload Generator, the following changes were made to the firmware settings on the Qlogic host bus adapters.

Qlogic “Outstanding Queue” Firmware setting	
ASU-1 HBA	96
ASU-2 HBA	32
ASU-3 HBA	8

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.

The physical components that comprise the TSC are illustrated on page 13 ([Benchmark Configuration/Tested Storage Configuration Diagram](#)).

The process of creating and assigning LUNs on SANsymphony takes place entirely through a graphical user interface (GUI) and has the following basic sequence:

1. Assign the physical drives to the NMV resource pools as defined on page 16-17, by dragging graphical representations of the physical devices into the appropriate NMV pools.
2. Create logical volumes of the required size from each pool as shown in the following table:

Logical Volume	Size	NMV Pool	SDS
ASU-1 Primary	821.4124 GB	Pool 1	SDS #1
ASU-1 Secondary	821.4124 GB	Pool 3	SDS #2
ASU-2 Primary	821.4124 GB	Pool 2	SDS #3
ASU-2 Secondary	821.4124 GB	Pool 1	SDS #2
ASU-3 Primary	182.5361 GB	Pool 4	SDS #3
ASU-3 Secondary	182.5361 GB	Pool 5	SDS #2

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DataCore Software Corporation

AUGUST 08 2003

SANsymphony Network Edition

3. When the NMV LUN is created, it is striped across all drives in the pool using 1MB chunks distributed using a round-robin algorithm. For example, ASU-1 Primary is striped across all 90 drives in NMV Pool 1.
4. Once the NMV LUN is created, the appropriate pairs are grouped together by dragging and dropping them into a Network Mirrored virtual volume.
5. The Network Mirrored virtual volume is served up to each Host by simply dragging it to the HBA on which the volume will appear on the host.

This completes the configuration process for creating and assigning the ASU volumes to the Hosts.

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.

Master	
Master (IP Address 172.20.17.171)	<pre> host=master slaves=(aphroditel,aphrodite2,athenael, athena2,demeter1,demeter2,eros1,eros2, hades1,hades2,kronos1,kronos2) # sd=asu1_1,lun=\\.PhysicalDrive1,size=633g sd=asu2_1,lun=\\.PhysicalDrive2,size=633g sd=asu3_1,lun=\\.PhysicalDrive3,size=141g </pre>

Slaves	
Host 1: aphrodite1 and 2	sd=asu1_1,lun=\\.\PhysicalDrive2,size=633g sd=asu2_1,lun=\\.\PhysicalDrive3,size=633g sd=asu3_1,lun=\\.\PhysicalDrive1,size=141g
Host 2: demeter1 and 2	sd=asu1_1,lun=\\.\PhysicalDrive2,size=633g sd=asu2_1,lun=\\.\PhysicalDrive3,size=633g sd=asu3_1,lun=\\.\PhysicalDrive1,size=141g
Host 3: athena1 and 2	sd=asu1_1,lun=\\.\PhysicalDrive2,size=633g sd=asu2_1,lun=\\.\PhysicalDrive3,size=633g sd=asu3_1,lun=\\.\PhysicalDrive1,size=141g
Host 4: eros1 and 2	sd=asu1_1,lun=\\.\PhysicalDrive2,size=633g sd=asu2_1,lun=\\.\PhysicalDrive3,size=633g sd=asu3_1,lun=\\.\PhysicalDrive1,size=141g
Host 5: kronos1 and 2	sd=asu1_1,lun=\\.\PhysicalDrive2,size=633g sd=asu2_1,lun=\\.\PhysicalDrive3,size=633g sd=asu3_1,lun=\\.\PhysicalDrive1,size=141g
Host 6: hades1 and 2	sd=asu1_1,lun=\\.\PhysicalDrive2,size=633g sd=asu2_1,lun=\\.\PhysicalDrive3,size=633g sd=asu3_1,lun=\\.\PhysicalDrive1,size=141g

Note: the ASU volumes don't appear as the same physical drive numbers on each host because the drive numbering is driven by the Windows Plug-n-Play functions. So the number assigned is based on the order that the HBAs and drives are seen when the particular host boots. However, Windows uses drive signatures to ensure that the right physical device is associated with the correct logical device at all times regardless of the order in which the devices appear at boot time.

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 Volumes.*

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).*

User Data Copy: *An identical copy of user data maintained on separate disks.*

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

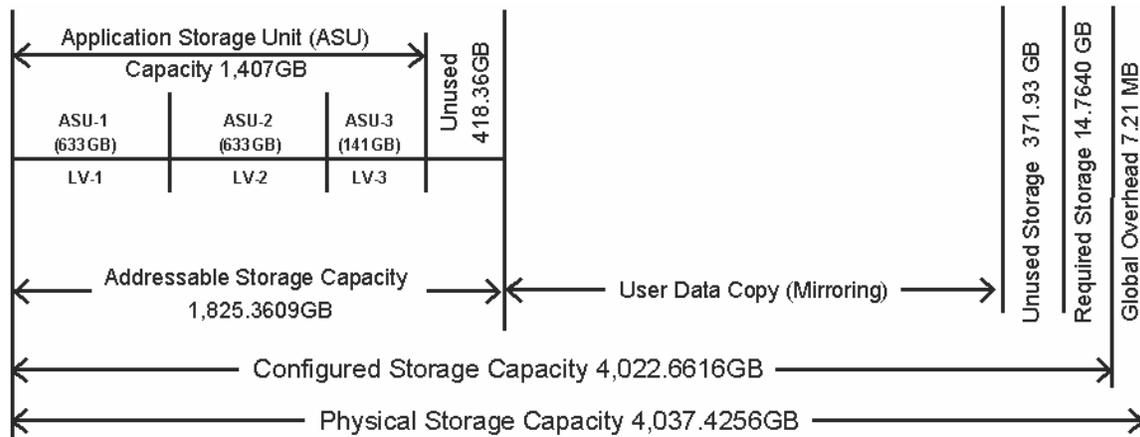
SPC-1 Storage Capacities

SPC-1 Storage Capacities		
Storage Hierarchy Component	Units	Capacity
Total ASU Capacity	Gigabytes (GB)	1,407.00
Addressable Storage Capacity	Gigabytes (GB)	1,825.36
Configured Storage Capacity	Gigabytes (GB)	4,022.66
Physical Storage Capacity	Gigabytes (GB)	4,037.43
User Data Copy (Mirroring)	Gigabytes (GB)	1,825.36
Required Storage (NMV metadata etc)	Gigabytes (GB)	14.76
Global Storage Overhead	Gigabytes (GB)	0.0072
Total Unused Storage	Gigabytes (GB)	1,208.66

The Required Storage consisted of 14.76 GB used for SANsymphony Network Managed Volume metadata, where each physical drive in configuration has 67.11MB of NMV metadata. No hot spares were used. The Physical Storage Capacity consisted of 220 disk drives, each with a formatted capacity of 18.35 GB. The Addressable Storage Capacity and its mirror each contained 418.36 GB of Unused Storage. The Configured Storage Capacity contained an additional 371.93 GB of unused storage, which resulted in 1,208.66 GB of unused storage. The Physical Storage Capacity contained 0.0072 GB of Global Storage Overhead, which consisted of Windows disk signatures.

SPC-1 Storage Capacities And Relationships Illustration

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



For a more detailed discussion of how the storage is allocated to the pools and storage domain servers, see the [“Benchmark Configuration/Tested Storage Configuration Diagram”](#) section starting on page 12. This includes a full description of the storage and network infrastructure used in the benchmark.

SPC-1 Storage Hierarchy Ratios			
	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	77.08%	34.98%	34.85%
User Data Copy (Mirror)		45.38%	45.21%
Addressable Storage Capacity		45.38%	45.21%
Required Storage (metadata)		0.37%	0.37%
Configured Storage Capacity			99.63%
Global Storage Overhead			0.0002%
Unused Storage	22.92%	30.05%	29.94%

The Addressable Storage Capacity contained 22.02% (418.36 GB) of Unused Storage.

The Configured Storage Capacity contained 30.05% ((418.36 GB *2)+371.9398 GB) of Unused Storage.

The Physical Storage Capacity contained 29.94% (1,208.66 GB unused) of Unused Storage.

Logical Volume Capacity & 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 (633GB)	ASU-2 (633GB)	ASU-3 (141GB)
Single logical volume	Single logical volume	Single logical volume
821.4124 GB	821.4124 GB	182.5361 GB
633 GB used	633 GB used	141 GB used

The Data Protection Level used for all Logical Volumes was Mirroring as described on page 9. 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 SPC-1 Workload Generator input parameters for the Sustainability, IOPS, and Response Time Ramp Test Runs are listed below.

```
java metrics -b 1000 -s 300
```

Sustainability Test Results File

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

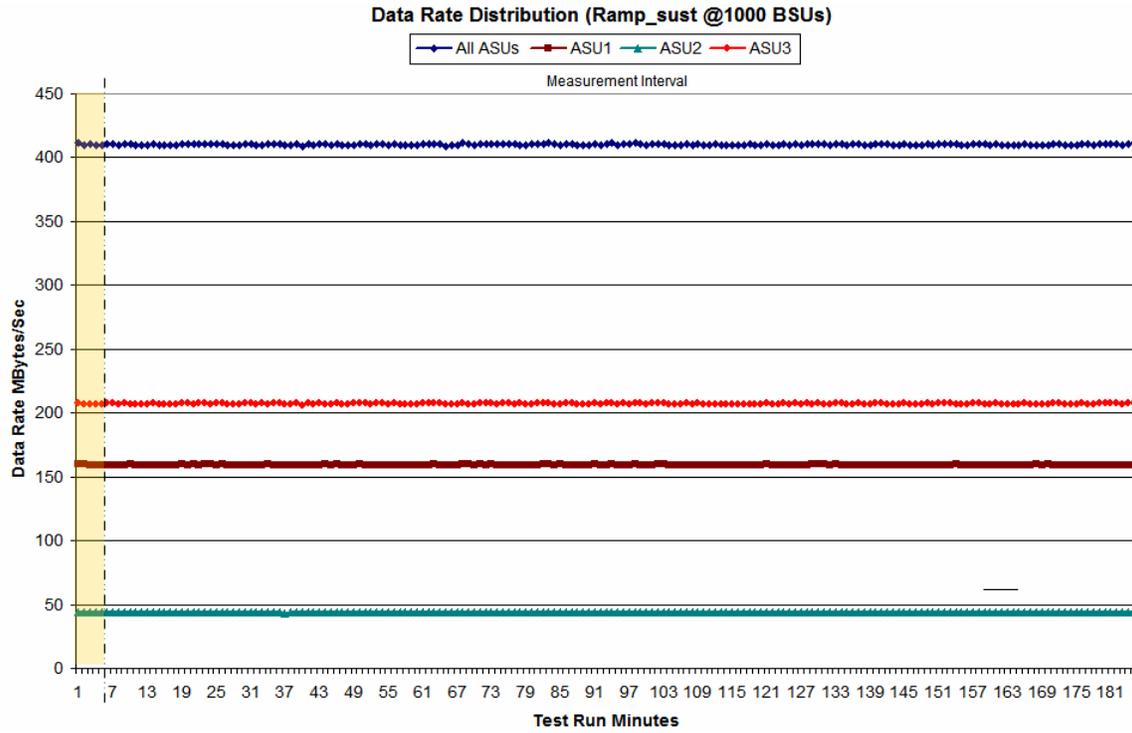
[Sustainability Test Results File](#)

Sustainability – Data Rate Distribution Data (MB/second)

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	11:29:58	11:34:58	0-4	0:05:00
Measurement Interval	11:34:58	14:34:58	4-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	412.01	160.06	44.11	207.84	62	410.72	159.52	43.67	207.53	124	410.07	159.20	43.86	207.00
1	410.17	159.51	43.81	206.84	63	410.29	159.21	43.84	207.25	125	410.53	159.23	43.79	207.51
2	410.26	159.41	43.80	207.05	64	409.18	159.15	43.61	206.42	126	410.17	159.47	43.89	206.81
3	409.67	159.08	43.70	206.89	65	409.76	159.12	43.95	206.69	127	410.69	159.31	43.79	207.59
4	410.01	159.31	43.79	206.91	66	409.85	159.09	44.05	206.71	128	410.45	159.72	43.75	206.87
5	410.49	159.19	43.82	207.47	67	411.28	159.53	43.87	207.87	129	410.89	159.60	43.81	207.48
6	410.60	159.39	43.69	207.53	68	410.61	159.78	43.87	206.95	130	410.52	159.54	44.14	206.84
7	409.90	159.33	43.68	206.90	69	409.98	159.31	43.96	206.71	131	410.14	159.14	43.87	207.13
8	410.26	158.93	43.83	207.51	70	410.43	159.54	43.53	207.37	132	410.68	159.55	43.65	207.48
9	410.55	159.53	43.89	207.12	71	410.62	159.38	43.89	207.35	133	410.32	159.02	43.77	207.53
10	409.70	159.37	43.72	206.61	72	410.85	159.51	43.82	207.52	134	409.56	158.96	43.83	206.77
11	410.13	159.39	43.81	206.93	73	410.45	159.33	43.99	207.13	135	410.34	159.28	43.88	207.18
12	410.05	159.40	44.00	206.65	74	410.48	159.06	43.74	207.68	136	410.67	159.33	44.04	207.31
13	410.49	159.34	43.85	207.30	75	410.62	159.36	43.78	207.47	137	409.90	159.22	43.81	206.87
14	410.03	159.42	43.80	206.81	76	410.30	159.33	43.88	207.09	138	410.20	159.47	43.81	206.91
15	409.97	159.41	44.02	206.54	77	410.11	159.07	43.59	207.45	139	410.49	159.19	43.99	207.31
16	409.58	159.05	43.60	206.93	78	409.72	159.15	43.86	206.72	140	410.63	159.32	44.01	207.30
17	409.98	159.39	43.93	206.66	79	410.37	159.45	43.88	207.04	141	410.44	159.31	43.93	207.21
18	410.59	159.56	43.78	207.25	80	410.51	159.41	43.83	207.27	142	410.16	159.36	43.79	207.02
19	410.58	159.38	43.86	207.34	81	410.87	159.67	43.92	207.27	143	410.07	159.33	43.80	206.94
20	410.44	159.55	43.83	207.07	82	411.23	159.66	43.93	207.64	144	410.36	159.11	43.79	207.46
21	410.34	159.21	43.82	207.31	83	410.28	159.26	43.94	207.08	145	410.23	159.18	43.84	207.22
22	411.06	159.64	44.03	207.39	84	410.21	159.60	43.67	206.94	146	410.01	159.13	43.74	207.13
23	410.65	159.66	43.79	207.20	85	410.46	159.25	43.69	207.52	147	410.19	159.24	43.82	207.13
24	410.40	159.47	43.68	207.25	86	410.58	159.43	43.90	207.25	148	411.03	159.50	44.04	207.49
25	411.03	159.59	43.70	207.74	87	409.71	158.96	43.69	207.06	149	409.75	159.39	43.65	206.72
26	410.19	159.43	43.77	206.98	88	410.10	159.46	43.61	207.03	150	410.80	159.47	43.70	207.63
27	409.67	159.18	43.80	206.69	89	409.88	159.00	43.79	207.10	151	410.44	159.18	43.89	207.38
28	410.10	159.21	43.89	207.00	90	411.16	159.58	43.90	207.69	152	410.80	159.29	43.94	207.57
29	410.41	159.24	43.80	207.37	91	410.24	159.34	43.88	207.01	153	410.57	159.53	43.98	207.07
30	410.31	159.09	43.85	207.38	92	410.30	159.30	43.68	207.32	154	410.09	159.28	43.70	207.12
31	409.93	159.43	43.78	206.72	93	411.26	159.54	44.21	207.51	155	410.06	159.04	43.89	207.13
32	409.99	158.98	43.68	207.33	94	410.16	159.51	43.97	206.68	156	410.87	159.31	43.82	207.74
33	410.27	159.55	43.79	206.92	95	410.90	159.51	44.02	207.38	157	410.72	159.41	43.84	207.48
34	411.10	159.30	44.03	207.77	96	410.27	159.28	43.81	207.18	158	410.58	159.45	43.95	207.19
35	410.63	159.31	43.93	207.39	97	411.37	159.68	43.89	207.80	159	409.57	159.36	43.72	206.50
36	409.62	159.15	43.50	206.98	98	410.95	159.50	44.07	207.38	160	410.44	159.05	43.67	207.72
37	409.33	159.19	43.56	206.58	99	409.51	158.88	43.88	206.76	161	410.11	159.41	43.89	206.82
38	410.92	159.33	43.97	207.62	100	410.46	159.32	43.90	207.25	162	409.97	159.27	43.80	206.91
39	409.06	159.27	43.79	206.00	101	411.06	159.52	44.04	207.49	163	409.84	159.34	43.79	206.72
40	410.27	159.11	43.88	207.27	102	410.76	159.60	43.88	207.29	164	409.91	159.26	43.71	206.94
41	409.72	159.08	43.84	206.80	103	409.68	159.29	43.68	206.71	165	410.28	159.08	43.84	207.36
42	410.28	159.19	43.51	207.59	104	410.02	159.29	43.71	207.01	166	409.91	159.20	43.87	206.84
43	410.45	159.58	43.80	207.08	105	410.05	159.17	44.05	206.83	167	409.97	159.64	43.79	206.54
44	410.14	159.49	43.76	206.89	106	410.57	159.22	43.86	207.49	168	409.94	159.51	43.80	206.64
45	410.67	159.60	43.78	207.29	107	409.98	159.29	43.71	206.97	169	410.15	159.59	43.87	206.69
46	410.18	159.29	43.77	207.12	108	411.09	159.08	43.91	208.10	170	410.86	159.28	43.81	207.77
47	410.08	159.39	43.84	206.84	109	409.54	159.17	43.83	206.54	171	410.38	159.03	43.89	207.47
48	410.15	159.16	43.74	207.25	110	409.88	159.11	43.86	206.91	172	409.36	159.23	43.59	206.54
49	410.93	159.55	43.93	207.44	111	410.45	159.32	43.98	207.15	173	410.01	159.36	43.69	206.96
50	410.61	159.42	43.95	207.24	112	410.19	159.32	43.72	207.14	174	409.99	159.41	43.72	206.86
51	410.11	159.30	43.64	207.17	113	409.67	159.20	43.86	206.60	175	410.32	159.22	43.81	207.29
52	410.52	159.32	43.93	207.27	114	410.08	159.28	43.67	207.13	176	410.27	159.39	43.82	207.06
53	410.58	159.12	43.80	207.67	115	409.64	159.13	43.92	206.59	177	410.02	159.37	43.72	206.93
54	409.77	159.15	43.66	206.97	116	409.82	159.45	43.61	206.76	178	410.37	159.28	43.71	207.38
55	411.05	159.45	43.86	207.74	117	410.29	159.46	43.91	206.93	179	410.80	159.50	43.76	207.55
56	410.23	159.33	43.84	207.06	118	409.82	159.26	43.82	206.74	180	410.59	159.35	43.67	207.56
57	409.82	159.23	43.75	206.84	119	410.06	159.22	43.90	206.95	181	410.55	159.50	43.77	207.28
58	410.04	159.09	43.79	207.17	120	410.52	159.58	43.72	207.23	182	410.10	159.26	43.83	207.01
59	409.61	159.19	43.99	206.43	121	410.07	159.33	43.83	206.91	183	410.49	159.33	43.69	207.46
60	410.36	159.26	43.87	207.24	122	410.12	159.25	43.93	206.93	184	411.26	159.35	43.96	207.94
61	410.64	158.97	43.98	207.69	123	410.52	159.35	43.87	207.30					

Sustainability – Data Rate Distribution Graph

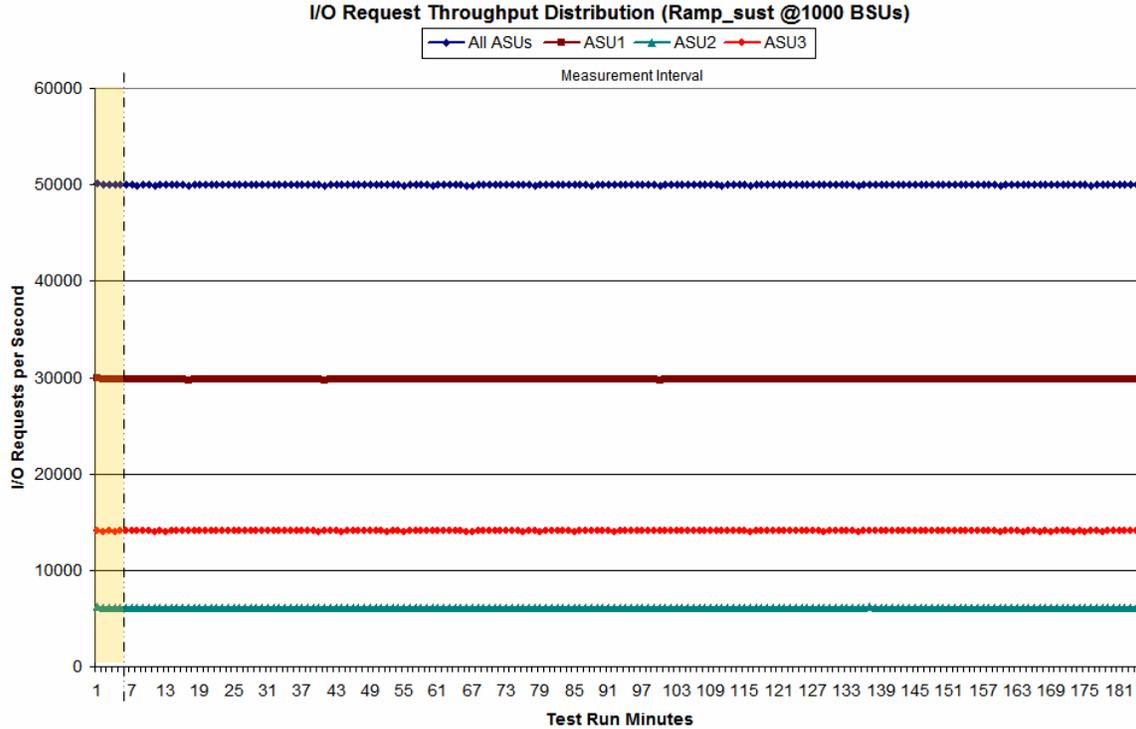


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	11:29:58	11:34:58	0-4	0:05:00
Measurement Interval	11:34:58	14:34:58	4-184	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	50,161.33	29,892.62	6,179.47	14,089.25	62	50,026.60	29,839.32	6,134.32	14,054.97	124	49,985.70	29,794.62	6,146.80	14,044.28
1	49,995.05	29,810.05	6,154.58	14,030.42	63	50,016.88	29,808.77	6,157.57	14,050.55	125	49,993.23	29,778.58	6,150.62	14,064.03
2	50,007.98	29,812.95	6,161.68	14,033.35	64	49,982.75	29,786.28	6,157.98	14,038.48	126	49,996.33	29,796.80	6,148.83	14,050.70
3	49,961.55	29,789.35	6,149.65	14,022.55	65	49,953.45	29,773.02	6,155.75	14,024.68	127	50,044.02	29,821.43	6,139.85	14,082.73
4	50,020.25	29,825.65	6,157.68	14,036.92	66	49,946.75	29,776.15	6,150.00	14,020.60	128	49,982.53	29,819.08	6,134.42	14,029.03
5	50,009.88	29,797.57	6,152.67	14,059.65	67	50,018.85	29,809.80	6,142.32	14,066.73	129	50,048.93	29,834.55	6,156.72	14,057.67
6	50,003.05	29,801.12	6,141.60	14,060.33	68	50,037.93	29,821.63	6,166.18	14,050.12	130	50,041.57	29,820.27	6,168.78	14,052.52
7	49,951.60	29,765.25	6,143.95	14,042.40	69	49,991.38	29,804.32	6,151.53	14,035.53	131	49,982.92	29,771.30	6,163.47	14,048.15
8	49,967.60	29,763.10	6,146.92	14,057.58	70	50,023.18	29,815.27	6,132.25	14,075.67	132	50,008.12	29,801.37	6,156.72	14,050.03
9	49,997.35	29,810.10	6,151.27	14,035.98	71	50,040.82	29,824.38	6,157.32	14,059.12	133	49,977.68	29,776.40	6,155.32	14,045.97
10	49,953.53	29,785.72	6,141.77	14,026.05	72	50,053.43	29,831.70	6,162.60	14,059.13	134	49,940.93	29,777.72	6,133.45	14,029.77
11	50,043.73	29,827.87	6,151.45	14,064.42	73	50,026.75	29,793.52	6,162.57	14,070.67	135	50,018.43	29,793.75	6,165.60	14,059.08
12	50,002.12	29,815.35	6,158.47	14,028.30	74	49,993.82	29,778.33	6,146.83	14,066.65	136	50,017.45	29,764.87	6,178.65	14,053.93
13	49,984.80	29,769.58	6,142.67	14,072.55	75	49,976.97	29,794.52	6,151.17	14,031.28	137	50,006.45	29,813.12	6,150.77	14,042.57
14	50,029.70	29,832.70	6,156.18	14,040.82	76	49,999.65	29,795.13	6,162.90	14,041.62	138	50,014.67	29,811.30	6,149.80	14,053.57
15	50,051.20	29,842.82	6,158.47	14,049.92	77	49,953.73	29,759.48	6,139.35	14,054.90	139	49,978.22	29,785.22	6,146.80	14,046.20
16	49,925.28	29,744.93	6,142.00	14,038.35	78	49,985.32	29,799.50	6,157.28	14,028.53	140	50,057.17	29,832.62	6,167.55	14,057.00
17	49,981.17	29,792.45	6,149.02	14,039.70	79	50,012.75	29,806.75	6,153.52	14,052.48	141	49,993.82	29,799.23	6,147.77	14,046.82
18	50,060.75	29,841.85	6,156.58	14,062.32	80	49,986.32	29,806.12	6,127.17	14,053.03	142	49,998.38	29,799.20	6,148.13	14,051.05
19	50,020.02	29,786.00	6,167.00	14,067.02	81	50,029.62	29,831.72	6,156.63	14,041.27	143	49,981.87	29,797.27	6,150.55	14,034.05
20	50,059.75	29,850.85	6,160.88	14,048.02	82	50,064.45	29,826.12	6,160.48	14,077.85	144	49,966.73	29,788.93	6,143.77	14,034.03
21	50,014.75	29,814.97	6,143.38	14,056.40	83	50,015.83	29,797.95	6,161.72	14,056.17	145	50,028.63	29,797.95	6,158.93	14,071.75
22	50,009.97	29,799.15	6,155.90	14,054.92	84	50,036.17	29,864.62	6,145.93	14,025.62	146	49,966.62	29,776.03	6,144.37	14,046.22
23	50,027.15	29,835.48	6,155.32	14,036.35	85	50,011.45	29,826.27	6,137.72	14,047.47	147	50,004.93	29,788.05	6,150.18	14,066.70
24	50,001.08	29,818.33	6,140.65	14,042.10	86	49,982.18	29,785.98	6,144.73	14,051.47	148	50,061.43	29,806.85	6,166.75	14,087.83
25	50,054.07	29,832.48	6,148.17	14,073.42	87	49,957.33	29,756.27	6,146.98	14,054.08	149	49,968.08	29,783.15	6,139.93	14,045.00
26	50,003.97	29,812.65	6,154.93	14,036.38	88	50,048.15	29,844.77	6,143.73	14,059.65	150	50,022.92	29,821.42	6,132.83	14,068.67
27	49,962.17	29,769.97	6,152.98	14,039.22	89	49,960.88	29,763.30	6,147.73	14,049.85	151	49,970.17	29,760.95	6,155.08	14,054.13
28	50,006.45	29,818.42	6,149.07	14,038.97	90	50,002.67	29,789.47	6,143.60	14,069.60	152	50,023.68	29,792.65	6,161.40	14,069.63
29	50,018.00	29,799.03	6,148.50	14,070.47	91	49,989.60	29,805.67	6,150.77	14,033.17	153	49,996.35	29,804.53	6,157.85	14,033.97
30	50,005.30	29,801.97	6,145.37	14,057.97	92	50,002.53	29,775.83	6,144.27	14,082.43	154	49,987.08	29,795.75	6,150.32	14,041.02
31	49,975.98	29,791.92	6,142.22	14,041.85	93	50,067.23	29,839.85	6,167.60	14,059.78	155	50,004.88	29,775.83	6,160.27	14,068.78
32	49,999.37	29,796.80	6,144.87	14,057.70	94	50,045.62	29,836.07	6,163.60	14,045.95	156	49,985.32	29,763.52	6,148.25	14,053.55
33	50,025.77	29,816.47	6,150.95	14,058.35	95	50,043.77	29,831.97	6,136.05	14,075.75	157	50,000.48	29,792.40	6,149.20	14,058.88
34	50,044.95	29,801.07	6,166.60	14,077.28	96	49,996.38	29,808.38	6,154.53	14,033.47	158	50,028.15	29,820.92	6,152.30	14,054.93
35	50,024.90	29,814.13	6,149.93	14,060.83	97	50,029.82	29,829.53	6,125.87	14,074.42	159	49,943.07	29,783.95	6,149.78	14,009.33
36	49,978.47	29,787.22	6,149.98	14,041.27	98	49,992.90	29,799.82	6,147.97	14,045.12	160	50,005.65	29,796.00	6,140.72	14,068.93
37	49,965.28	29,784.07	6,136.08	14,045.13	99	49,942.27	29,745.48	6,160.08	14,036.70	161	50,005.78	29,813.15	6,145.80	14,046.83
38	50,015.98	29,812.08	6,148.53	14,055.37	100	50,008.98	29,797.03	6,147.02	14,064.93	162	49,987.67	29,778.33	6,143.38	14,065.95
39	49,978.58	29,824.73	6,144.77	14,009.08	101	50,029.63	29,796.98	6,161.42	14,071.23	163	49,972.08	29,794.30	6,158.53	14,019.25
40	49,958.40	29,748.77	6,157.82	14,051.82	102	50,043.45	29,852.35	6,145.73	14,045.37	164	49,967.35	29,783.03	6,138.78	14,045.53
41	49,973.08	29,782.60	6,150.82	14,039.67	103	49,998.20	29,806.90	6,155.38	14,033.92	165	50,012.93	29,793.50	6,151.00	14,068.43
42	49,967.00	29,777.92	6,129.87	14,059.22	104	49,958.92	29,794.67	6,125.23	14,039.02	166	49,973.12	29,792.00	6,152.63	14,028.48
43	49,977.30	29,796.90	6,148.95	14,029.45	105	50,011.05	29,816.75	6,156.98	14,037.32	167	50,033.87	29,861.83	6,134.13	14,037.90
44	50,008.67	29,791.50	6,151.13	14,066.03	106	50,011.83	29,803.27	6,147.90	14,060.67	168	49,978.53	29,808.85	6,153.22	14,016.47
45	50,048.18	29,822.85	6,137.40	14,087.93	107	49,994.62	29,809.97	6,144.70	14,039.95	169	50,017.98	29,810.50	6,152.25	14,055.23
46	49,990.07	29,785.67	6,152.88	14,051.52	108	50,005.30	29,764.63	6,157.57	14,083.10	170	49,984.52	29,767.75	6,146.85	14,069.92
47	50,014.43	29,817.17	6,149.32	14,047.95	109	49,982.55	29,796.83	6,147.25	14,038.47	171	50,004.03	29,782.12	6,154.58	14,067.33
48	49,969.47	29,761.95	6,148.87	14,058.65	110	49,948.90	29,752.83	6,153.53	14,042.53	172	49,970.90	29,807.32	6,141.65	14,021.93
49	50,037.73	29,834.08	6,149.72	14,053.93	111	49,988.22	29,775.37	6,152.75	14,060.10	173	49,973.02	29,790.02	6,134.90	14,048.10
50	50,035.60	29,830.83	6,159.08	14,045.68	112	49,968.35	29,778.38	6,150.38	14,038.58	174	49,990.87	29,811.78	6,147.52	14,031.57
51	49,977.63	29,810.15	6,136.82	14,030.67	113	49,967.50	29,783.22	6,135.53	14,048.75	175	49,952.13	29,776.87	6,139.68	14,035.58
52	49,974.05	29,775.78	6,144.95	14,053.32	114	49,993.72	29,789.25	6,161.72	14,042.75	176	49,982.02	29,801.72	6,137.33	14,042.97
53	50,047.90	29,831.68	6,151.02	14,065.20	115	49,929.98	29,757.27	6,154.15	14,018.57	177	49,983.28	29,814.50	6,141.00	14,027.78
54	49,953.38	29,779.43	6,145.87	14,028.08	116	50,017.00	29,829.70	6,145.67	14,041.63	178	49,972.73	29,787.40	6,145.03	14,040.30
55	50,049.72	29,818.17	6,153.08	14,078.47	117	50,017.15	29,815.13	6,160.55	14,041.47	179	50,031.30	29,819.02	6,150.45	14,061.83
56	50,026.28	29,815.35	6,143.72	14,067.22	118	50,029.68	29,835.75	6,149.68	14,044.25	180	50,001.20	29,793.32	6,136.08	14,071.80
57	50,002.18	29,802.98	6,157.28	14,041.92	119	49,961.08	29,774.58	6,149.55	14,036.95	181	50,052.75	29,854.50	6,142.95	14,055.30
58	49,986.18	29,780.78	6,146.82	14,058.58	120	49,985.37	29,787.05	6,152.38	14,045.93	182	49,983.38	29,798.23	6,138.70	14,046.45
59	49,941.50	29,762.75	6,131.92	14,046.83	121	49,968.88	29,784.13	6,150.13	14,034.62	183	50,011.13	29,812.03	6,141.40	14,057.70
60	49,993.87	29,774.00	6,157.03	14,062.83	122	49,995.22	29,796.07	6,156.50	14,042.65	184	50,011.33	29,782.18	6,164.78	14,064.37
61	50,017.70	29,787.78	6,168.23	14,061.68	123	50,007.62	29,797.12							

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
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>MIM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>COV</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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

IOPS Test PhaseClause 5.4.2.2

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

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

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

Clause 9.2.4.7.2

For the IOPS Test Phase the FDR shall contain:

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

SPC-1 Workload Generator Input Parameters

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

```
java metrics -b 1000 -s 300
```

IOPS Test Results File

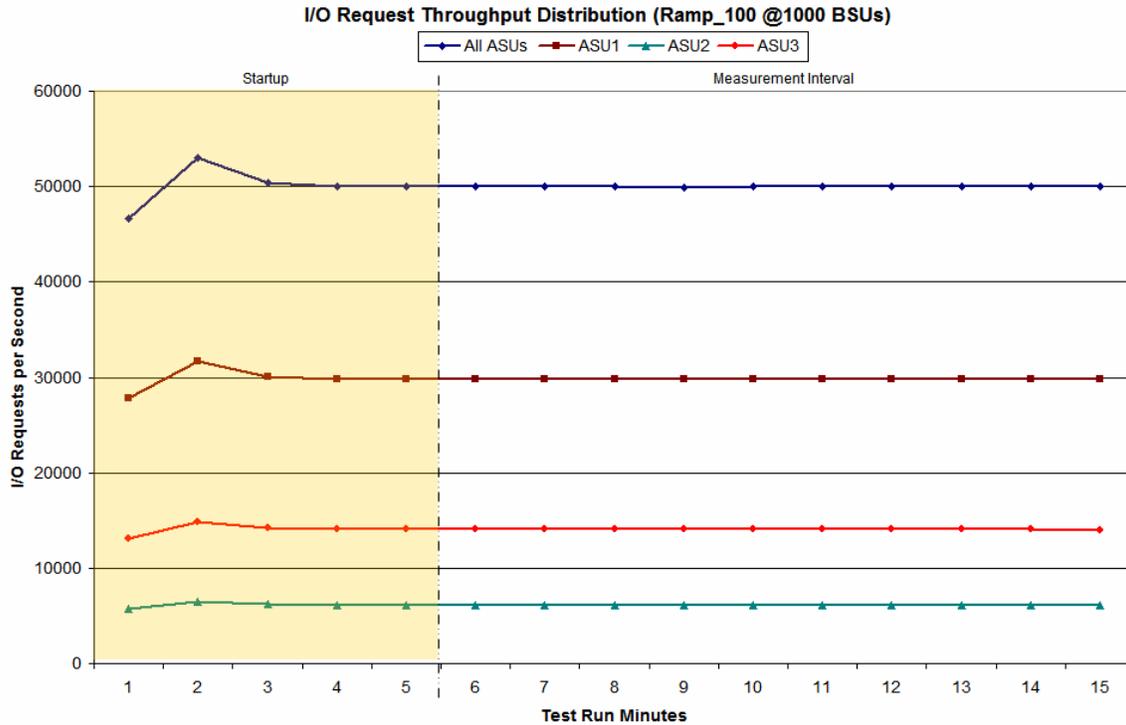
A link to the test results file generated from the IOPS Test Run is listed below.

[IOPS Test Results File](#)

IOPS Test Run – I/O Request Throughput Distribution Data

1,000 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	14:35:42	14:40:43	0-4	0:05:01
<i>Measurement Interval</i>	14:40:43	14:50:43	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	46,695.55	27,801.78	5,744.97	13,148.80
1	53,027.90	31,631.65	6,521.82	14,874.43
2	50,453.37	30,087.08	6,198.23	14,168.05
3	50,018.80	29,814.60	6,159.02	14,045.18
4	50,017.32	29,829.98	6,149.78	14,037.55
5	49,990.85	29,787.08	6,159.20	14,044.57
6	50,012.20	29,813.80	6,156.77	14,041.63
7	50,035.22	29,812.97	6,170.43	14,051.82
8	49,953.92	29,770.53	6,141.55	14,041.83
9	50,018.68	29,795.40	6,133.70	14,089.58
10	49,968.75	29,783.23	6,148.53	14,036.98
11	50,036.72	29,826.13	6,155.55	14,055.03
12	50,009.55	29,790.92	6,155.47	14,063.17
13	50,029.40	29,799.35	6,138.85	14,091.20
14	49,980.25	29,804.08	6,149.27	14,026.90
Average	50,003.55	29,798.35	6,150.93	14,054.27

IOPS Test Run – I/O Request Throughput Distribution Graph

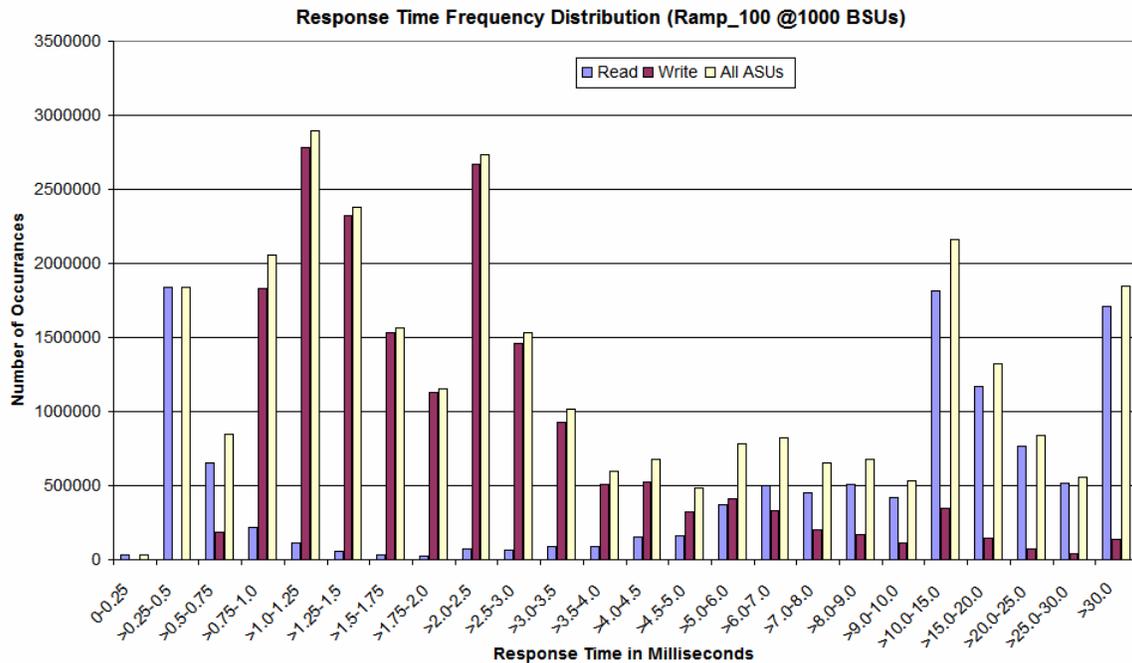


IOPS TEST PHASE

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	30895	1,837,973	657,162	219,065	116,386	59,506	33,393	27,370
Write	0	-	187,151	1,834,332	2,781,899	2,318,992	1,528,472	1,125,940
All ASUs	30895	1,837,973	844,313	2,053,397	2,898,285	2,378,498	1,561,865	1,153,310
ASU1	27659	1,698,224	777,779	1,658,612	2,020,842	1,388,640	727,508	479,793
ASU2	3236	139,749	54,530	185,628	290,736	262,088	190,724	143,280
ASU3	0	-	12,004	209,157	586,707	727,770	643,633	530,237
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	68,839	68,322	88,436	87,834	150,109	163,189	370,646	496,490
Write	2,667,705	1,462,721	928,700	509,278	526,031	323,677	410,003	329,227
All ASUs	2,736,544	1,531,043	1,017,136	597,112	676,140	486,866	780,649	825,717
ASU1	922,402	378,571	216,714	133,142	163,261	144,298	289,689	362,156
ASU2	324,303	176,368	125,101	83,028	108,793	93,068	177,337	211,377
ASU3	1,489,839	976,104	675,321	380,942	404,086	249,500	313,623	252,184
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	453,197	504,635	421,435	1,812,478	1,170,153	764,257	517,654	1,709,883
Write	200,715	172,337	113,729	350,445	149,069	76,513	41,701	133,825
All ASUs	653,912	676,972	535,164	2,162,923	1,319,222	840,770	559,355	1,843,708
ASU1	335,858	384,536	337,508	1,491,160	1,018,116	706,296	497,824	1,718,149
ASU2	166,278	160,429	110,694	388,930	170,038	66,305	25,858	32,653
ASU3	151,776	132,007	86,962	282,833	131,068	68,169	35,673	92,906

IOPS Test Run –Response Time Frequency Distribution Graph

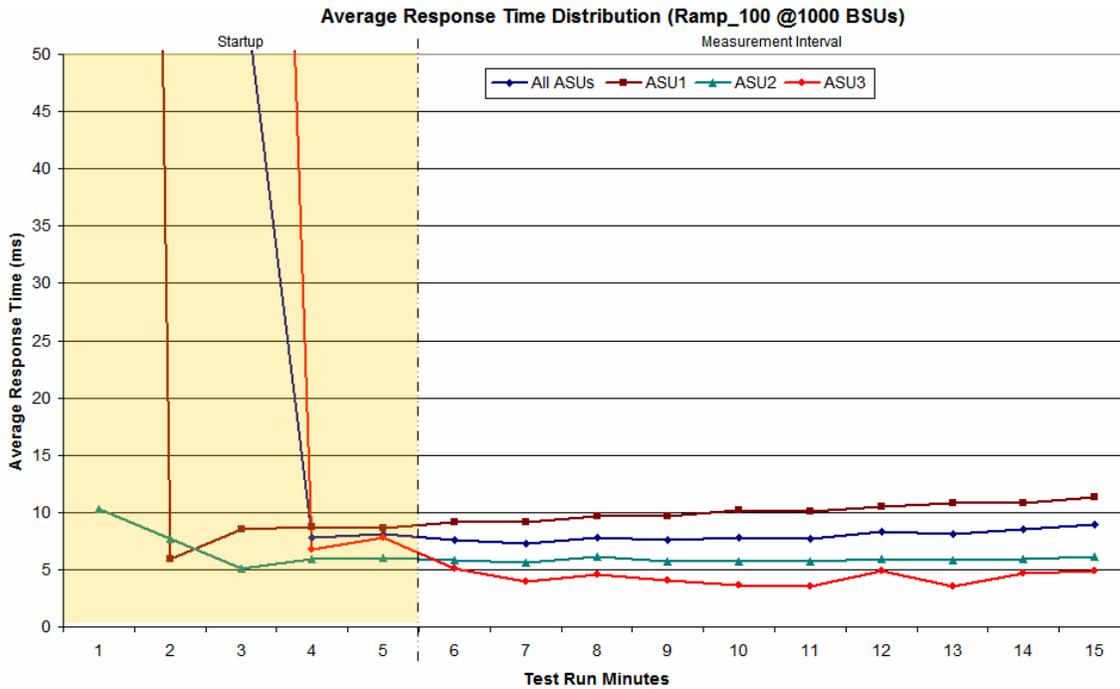


IOPS TEST PHASE

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

1,000 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:35:42	14:40:43	0-4	0:05:01
Measurement Interval	14:40:43	14:50:43	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	514.94	418.16	10.24	940.10
1	394.49	5.94	7.66	1,390.37
2	57.51	8.54	5.10	184.45
3	7.81	8.72	5.92	6.71
4	8.09	8.65	6.01	7.82
5	7.58	9.11	5.78	5.15
6	7.25	9.14	5.62	3.96
7	7.82	9.71	6.10	4.55
8	7.63	9.70	5.71	4.08
9	7.75	10.14	5.67	3.59
10	7.74	10.12	5.76	3.57
11	8.36	10.50	5.89	4.90
12	8.13	10.77	5.84	3.55
13	8.52	10.86	5.90	4.72
14	8.91	11.38	6.10	4.89
Average	7.97	10.14	5.84	4.30

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
30,001,769	28,158,061	1,843,708

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
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>MIM</i>	0.0350	0.2810	0.0700	0.2099	0.0180	0.0700	0.0350	0.2811
<i>COV</i>	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00

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, Response Time Ramp, and Repeatability Test Runs are listed below.

```
java metrics -b 1000 -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](#)

SPC BENCHMARK 1™ V1.7 FULL DISCLOSURE REPORT SUBMITTED FOR REVIEW

DataCore Software Corporation

AUGUST 08 2003

SANsymphony Network Edition

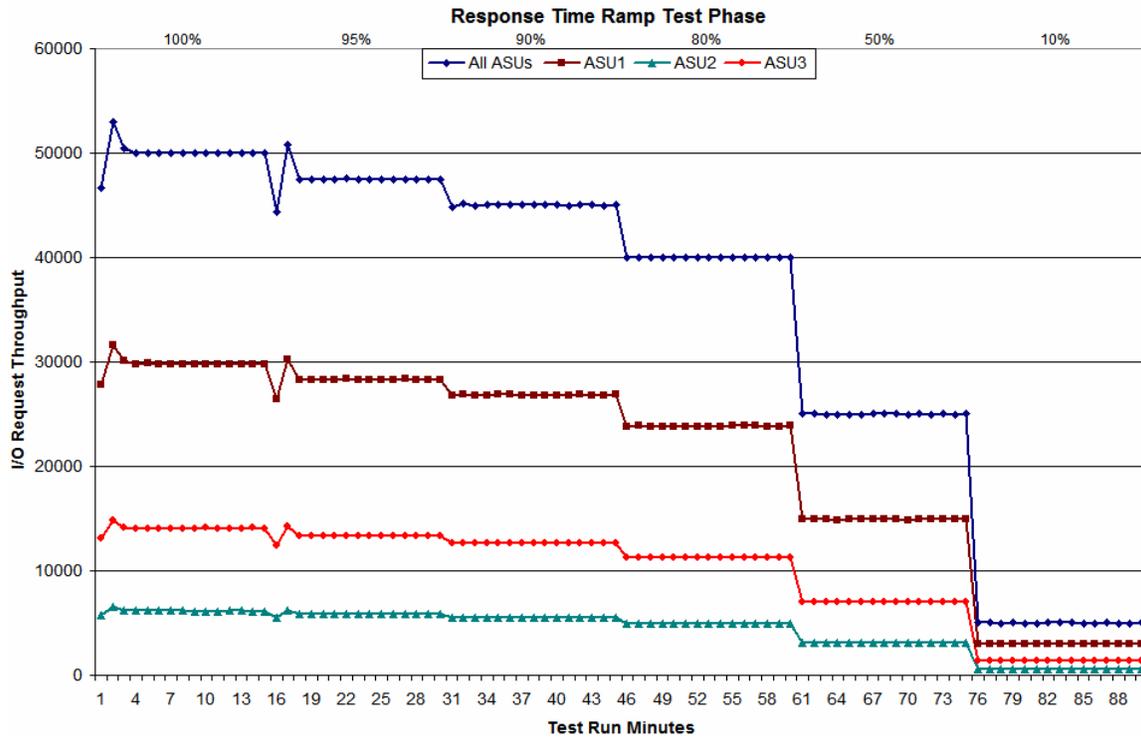
RESPONSE TIME RAMP TEST PHASE

Response Time Ramp Distribution (IOPS) Data

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

100% Load Level - 1,000 BSUs					95% Load Level - 950 BSUs				
Start-Up/Ramp-Up	Start	Stop	Interval	Duration	Start-Up/Ramp-Up	Start	Stop	Interval	Duration
Measurement Interval	14:35:42	14:40:43	0-4	0:05:01	Measurement Interval	14:51:13	14:56:14	0-4	0:05:01
(60 second intervals)	14:40:43	14:50:43	4-14	0:10:00	(60 second intervals)	14:56:14	15:06:14	4-14	0:10:00
	All ASUs	ASU-1	ASU-2	ASU-3		All ASUs	ASU-1	ASU-2	ASU-3
0	46,695.55	27,801.78	5,744.97	13,148.80	0	44,341.28	26,431.30	5,465.22	12,444.77
1	53,027.90	31,631.65	6,521.82	14,874.43	1	50,787.88	30,258.33	6,250.02	14,279.53
2	50,453.37	30,087.08	6,198.23	14,168.05	2	47,501.48	28,310.60	5,851.80	13,339.08
3	50,018.80	29,814.60	6,159.02	14,045.18	3	47,503.58	28,330.63	5,834.43	13,338.52
4	50,017.32	29,829.98	6,149.78	14,037.55	4	47,503.87	28,301.12	5,855.42	13,347.33
5	49,990.85	29,787.08	6,159.20	14,044.57	5	47,443.40	28,269.93	5,841.12	13,332.35
6	50,012.20	29,813.80	6,156.77	14,041.63	6	47,535.32	28,336.90	5,849.80	13,348.62
7	50,035.22	29,812.97	6,170.43	14,051.82	7	47,504.18	28,332.55	5,839.25	13,332.38
8	49,953.92	29,770.53	6,141.55	14,041.83	8	47,525.57	28,324.65	5,851.10	13,349.82
9	50,018.68	29,795.40	6,133.70	14,089.58	9	47,469.93	28,298.78	5,841.20	13,329.95
10	49,968.75	29,783.23	6,148.53	14,036.98	10	47,479.37	28,294.38	5,839.65	13,345.33
11	50,036.72	29,826.13	6,155.55	14,055.03	11	47,495.37	28,338.42	5,841.95	13,315.00
12	50,009.55	29,790.92	6,155.47	14,063.17	12	47,518.78	28,318.30	5,853.97	13,346.52
13	50,029.40	29,799.35	6,138.85	14,091.20	13	47,518.47	28,309.42	5,845.48	13,363.57
14	49,980.25	29,804.08	6,149.27	14,026.90	14	47,459.93	28,284.00	5,843.55	13,332.38
Average	50,003.55	29,798.35	6,150.93	14,054.27	Average	47,495.03	28,310.73	5,844.71	13,339.59
90% Load Level - 900 BSUs					80% Load Level - 800 BSUs				
Start-Up/Ramp-Up	Start	Stop	Interval	Duration	Start-Up/Ramp-Up	Start	Stop	Interval	Duration
Measurement Interval	15:11:43	15:21:43	4-14	0:10:00	Measurement Interval	15:22:10	15:27:11	0-4	0:05:01
(60 second intervals)	15:11:43	15:21:43	4-14	0:10:00	(60 second intervals)	15:27:11	15:37:11	4-14	0:10:00
	All ASUs	ASU-1	ASU-2	ASU-3		All ASUs	ASU-1	ASU-2	ASU-3
0	44,877.83	26,730.08	5,522.63	12,625.12	0	39,980.23	23,834.52	4,926.18	11,219.53
1	45,184.12	26,939.90	5,552.92	12,691.30	1	40,044.23	23,871.52	4,928.78	11,243.93
2	44,990.43	26,803.08	5,534.83	12,652.52	2	39,999.82	23,833.97	4,914.97	11,250.88
3	45,024.52	26,837.18	5,547.40	12,639.93	3	39,963.48	23,815.57	4,906.40	11,241.52
4	45,058.42	26,861.77	5,540.93	12,655.72	4	40,001.68	23,836.67	4,920.38	11,244.63
5	45,044.20	26,853.92	5,532.40	12,657.88	5	40,007.43	23,843.55	4,930.93	11,232.95
6	45,009.22	26,828.18	5,539.07	12,641.97	6	40,022.47	23,822.85	4,941.95	11,257.67
7	45,033.23	26,825.60	5,544.53	12,663.10	7	39,980.38	23,828.80	4,917.10	11,234.48
8	45,071.02	26,837.12	5,568.37	12,665.53	8	39,974.95	23,825.08	4,917.90	11,231.97
9	45,009.78	26,793.52	5,549.58	12,666.68	9	40,006.20	23,851.05	4,929.72	11,225.43
10	44,957.38	26,802.00	5,530.85	12,624.53	10	40,025.80	23,860.58	4,917.67	11,247.55
11	45,029.33	26,849.18	5,531.62	12,648.53	11	40,039.97	23,870.72	4,921.30	11,247.95
12	45,006.08	26,801.47	5,535.40	12,669.22	12	39,985.97	23,819.85	4,918.55	11,247.57
13	44,992.75	26,802.27	5,532.98	12,657.50	13	39,981.98	23,817.13	4,915.60	11,249.25
14	45,014.77	26,846.97	5,527.95	12,639.85	14	40,055.10	23,874.73	4,916.53	11,263.83
Average	45,016.78	26,824.02	5,539.28	12,653.48	Average	40,008.03	23,841.44	4,922.73	11,243.87
50% Load Level - 500 BSUs					10% Load Level - 100 BSUs				
Start-Up/Ramp-Up	Start	Stop	Interval	Duration	Start-Up/Ramp-Up	Start	Stop	Interval	Duration
Measurement Interval	15:42:35	15:52:35	4-14	0:10:00	Measurement Interval	15:52:53	15:57:54	0-4	0:05:01
(60 second intervals)	15:42:35	15:52:35	4-14	0:10:00	(60 second intervals)	15:57:54	16:07:54	4-14	0:10:00
	All ASUs	ASU-1	ASU-2	ASU-3		All ASUs	ASU-1	ASU-2	ASU-3
0	25,019.88	14,909.48	3,067.35	7,043.05	0	5,008.53	2,993.85	609.67	1,405.02
1	25,032.85	14,929.58	3,076.25	7,027.02	1	5,015.73	2,993.78	616.68	1,405.27
2	24,977.08	14,889.85	3,069.90	7,017.33	2	4,995.80	2,977.20	615.13	1,403.47
3	24,968.62	14,866.98	3,068.33	7,033.30	3	5,017.32	2,993.17	614.35	1,409.80
4	24,995.67	14,912.10	3,052.45	7,031.12	4	4,995.15	2,974.67	616.15	1,404.33
5	24,993.17	14,896.02	3,084.37	7,012.78	5	4,981.05	2,960.67	615.43	1,404.95
6	25,015.87	14,921.65	3,068.55	7,025.67	6	5,001.52	2,981.23	612.83	1,407.45
7	25,005.22	14,899.55	3,078.02	7,027.65	7	5,002.65	2,979.62	617.15	1,405.88
8	25,008.27	14,919.70	3,077.17	7,011.40	8	5,004.55	2,985.68	612.18	1,406.68
9	24,982.47	14,883.32	3,075.45	7,023.70	9	4,985.67	2,972.67	613.80	1,399.20
10	25,017.57	14,905.02	3,058.55	7,054.00	10	4,998.22	2,974.48	618.73	1,405.00
11	24,994.70	14,911.98	3,072.98	7,009.73	11	5,010.40	2,990.58	622.67	1,397.15
12	25,001.57	14,901.92	3,081.63	7,018.02	12	4,994.48	2,979.68	617.97	1,396.83
13	24,980.03	14,888.80	3,069.90	7,021.33	13	4,986.52	2,966.73	613.17	1,406.62
14	25,022.70	14,919.53	3,060.87	7,042.30	14	5,008.28	2,984.93	616.90	1,406.45
Average	25,002.16	14,904.75	3,072.75	7,024.66	Average	4,997.33	2,977.63	616.08	1,403.62

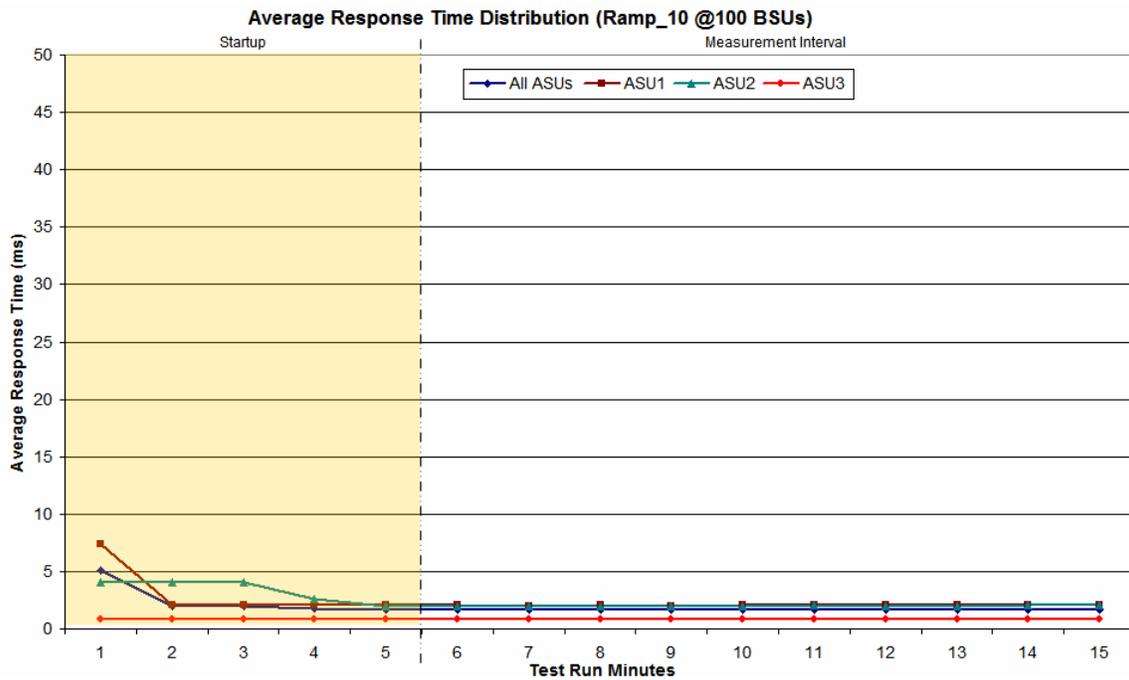
Response Time Ramp Distribution (IOPS) Graph



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

100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	16:08:19	16:13:19	0-4	0:05:00
Measurement Interval	16:13:19	16:23:19	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	4.00	5.93	2.00	0.79
1	1.63	1.95	2.00	0.78
2	1.62	1.94	2.02	0.78
3	1.63	1.95	1.99	0.78
4	1.63	1.96	1.99	0.78
5	1.63	1.95	2.02	0.78
6	1.64	1.97	2.00	0.78
7	1.64	1.96	2.03	0.78
8	1.64	1.97	2.00	0.78
9	1.64	1.95	2.04	0.78
10	1.63	1.96	1.99	0.78
11	1.63	1.95	2.01	0.78
12	1.64	1.97	2.03	0.78
13	1.64	1.97	2.00	0.78
14	1.65	1.98	2.00	0.78
Average	1.64	1.96	2.01	0.78

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
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0703	0.0350	0.2810
<i>MIM</i>	0.0351	0.2812	0.0699	0.2097	0.0180	0.0703	0.0350	0.2809
<i>COV</i>	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.00

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

Repeatability TestClause 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 repeat1 -b1000 -s300
```

```
java repeat2 -b1000 -s300
```

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-LRT™
Primary Metrics	50003.55	1.68ms
Repeatability Test Phase 1	49,985.33	1.64ms
Repeatability Test Phase 2	49,995.74	1.70ms

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 \(LRT\)](#)

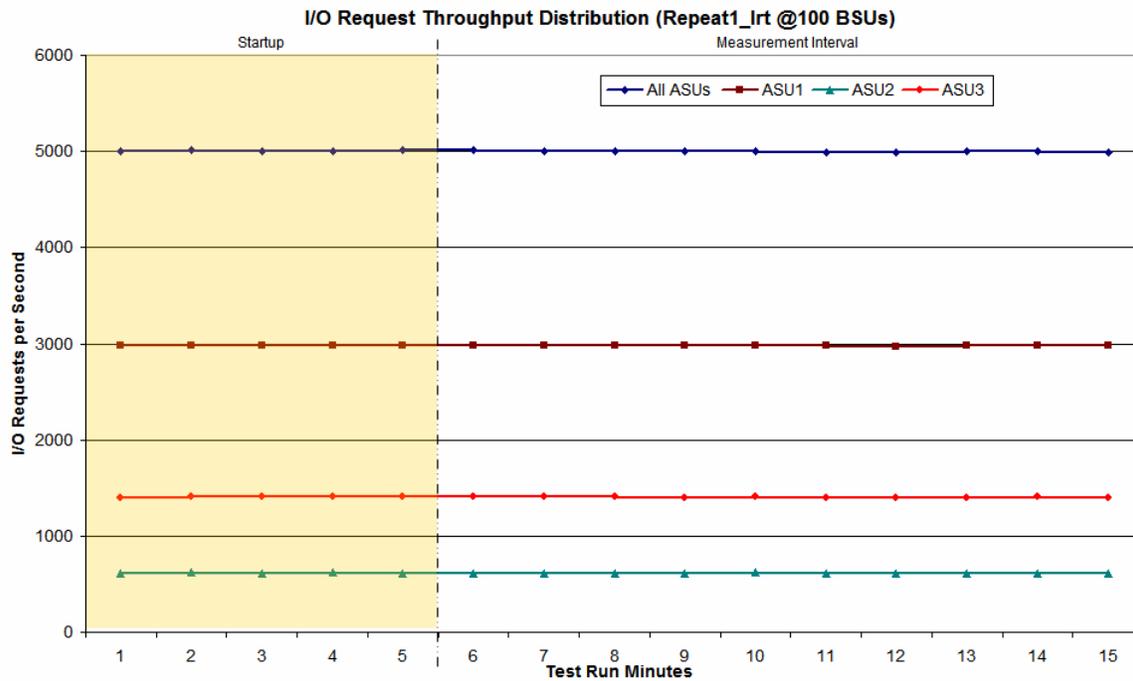
[Repeatability Test Phase 2, Test Run 2 \(IOPS\)](#)

REPEATABILITY TEST

Repeatability 1 LRT – I/O Request Throughput Distribution Data

100 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	16:08:19	16:13:19	0-4	0:05:00
Measurement Interval	16:13:19	16:23:19	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	4,998.13	2,978.10	617.38	1,402.65
1	5,009.13	2,984.17	618.20	1,406.77
2	5,001.95	2,979.20	612.62	1,410.13
3	5,006.93	2,984.47	618.92	1,403.55
4	5,013.45	2,987.25	615.07	1,411.13
5	5,009.58	2,987.37	614.15	1,408.07
6	4,998.20	2,977.48	610.80	1,409.92
7	5,008.12	2,983.63	614.50	1,409.98
8	5,003.10	2,986.98	614.68	1,401.43
9	5,006.78	2,982.52	618.47	1,405.80
10	4,993.85	2,976.75	617.02	1,400.08
11	4,991.18	2,972.78	615.30	1,403.10
12	4,996.05	2,980.32	612.93	1,402.80
13	5,001.88	2,979.10	613.85	1,408.93
14	4,991.28	2,976.17	615.13	1,399.98
Average	5,000.00	2,980.31	614.68	1,405.01

Repeatability 1 LRT – I/O Request Throughput Distribution Graph

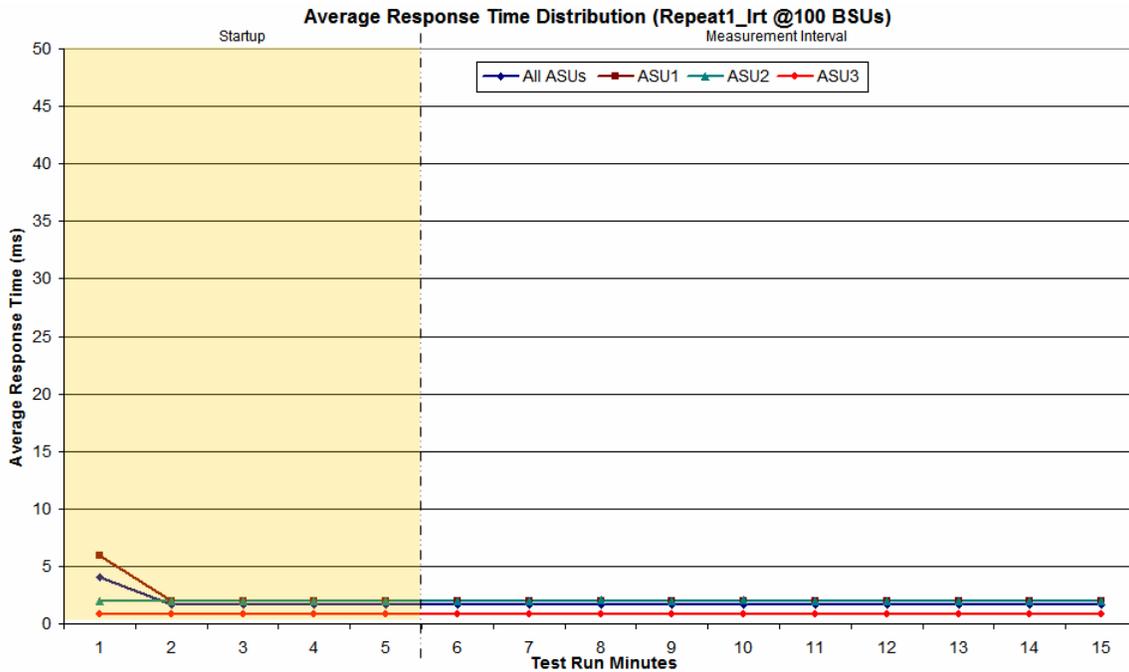


REPEATABILITY TEST

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

100 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	16:08:19	16:13:19	0-4	0:05:00
<i>Measurement Interval</i>	16:13:19	16:23:19	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	4.00	5.93	2.00	0.79
1	1.63	1.95	2.00	0.78
2	1.62	1.94	2.02	0.78
3	1.63	1.95	1.99	0.78
4	1.63	1.96	1.99	0.78
5	1.63	1.95	2.02	0.78
6	1.64	1.97	2.00	0.78
7	1.64	1.96	2.03	0.78
8	1.64	1.97	2.00	0.78
9	1.64	1.95	2.04	0.78
10	1.63	1.96	1.99	0.78
11	1.63	1.95	2.01	0.78
12	1.64	1.97	2.03	0.78
13	1.64	1.97	2.00	0.78
14	1.65	1.98	2.00	0.78
Average	1.64	1.96	2.01	0.78

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

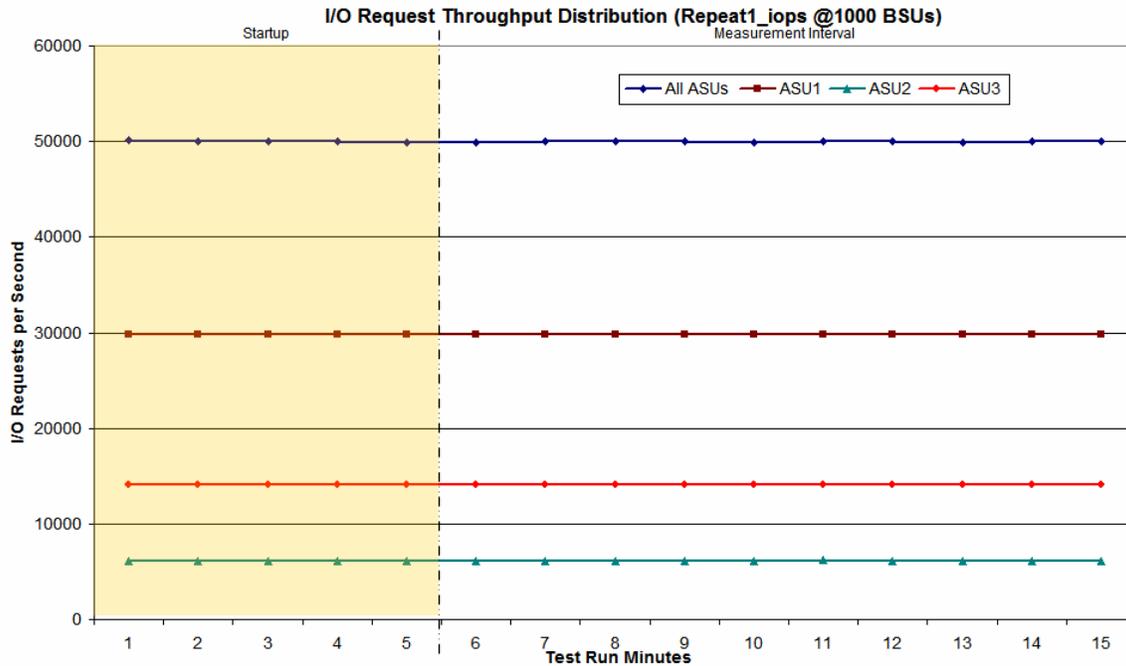


REPEATABILITY TEST

Repeatability 1 IOPS – I/O Request Throughput Distribution Data

1,000 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	16:23:48	16:28:49	0-4	0:05:01
<i>Measurement Interval</i>	16:28:49	16:38:49	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	50,087.45	29,863.05	6,142.48	14,081.92
1	49,989.08	29,768.98	6,157.83	14,062.27
2	49,994.30	29,819.22	6,126.98	14,048.10
3	50,001.82	29,791.33	6,161.08	14,049.40
4	49,956.37	29,762.13	6,152.53	14,041.70
5	49,948.75	29,757.28	6,145.57	14,045.90
6	49,975.97	29,776.00	6,147.12	14,052.85
7	49,971.17	29,782.62	6,139.50	14,049.05
8	50,000.63	29,792.08	6,174.57	14,033.98
9	49,936.70	29,754.53	6,134.78	14,047.38
10	50,030.77	29,807.02	6,179.40	14,044.35
11	50,006.55	29,806.30	6,143.27	14,056.98
12	49,953.62	29,758.30	6,160.13	14,035.18
13	50,016.88	29,795.08	6,147.12	14,074.68
14	50,012.22	29,844.35	6,124.83	14,043.03
Average	49,985.33	29,787.36	6,149.63	14,048.34

Repeatability 1 IOPS – I/O Request Throughput Distribution Graph

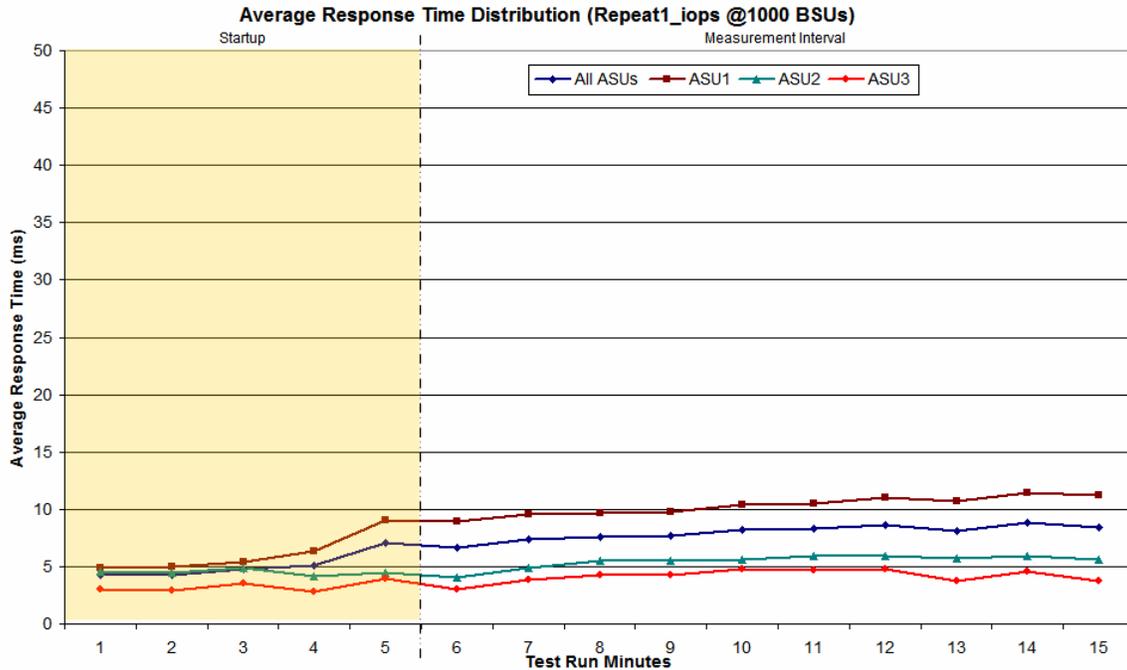


REPEATABILITY TEST

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

1,000 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	16:23:48	16:28:49	0-4	0:05:01
Measurement Interval	16:28:49	16:38:49	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	4.30	4.86	4.60	2.98
1	4.31	4.95	4.43	2.91
2	4.83	5.42	4.86	3.56
3	5.05	6.29	4.13	2.83
4	7.04	9.05	4.42	3.94
5	6.67	8.94	4.08	3.00
6	7.35	9.53	4.87	3.82
7	7.62	9.66	5.49	4.22
8	7.73	9.80	5.56	4.27
9	8.20	10.34	5.66	4.77
10	8.28	10.48	5.94	4.64
11	8.61	10.99	5.94	4.73
12	8.16	10.74	5.72	3.75
13	8.80	11.39	5.97	4.55
14	8.43	11.22	5.56	3.77
Average	7.98	10.31	5.48	4.15

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

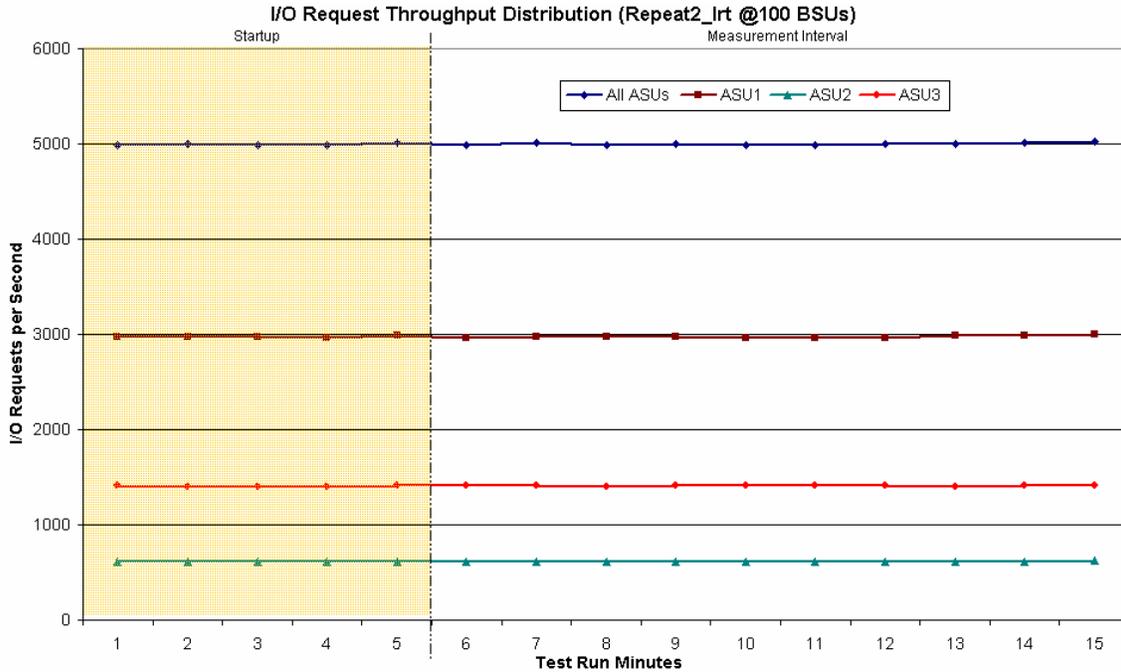


REPEATABILITY TEST

Repeatability 2 LRT – I/O Request Throughput Distribution Data

100 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	16:39:16	16:44:16	0-4	0:05:00
<i>Measurement Interval</i>	16:44:16	16:54:16	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	4,985.75	2,968.87	609.33	1,407.55
1	5,000.05	2,977.45	618.48	1,404.12
2	4,988.73	2,969.05	616.08	1,403.60
3	4,988.65	2,966.45	616.30	1,405.90
4	5,011.12	2,985.03	617.15	1,408.93
5	4,985.45	2,962.43	613.57	1,409.45
6	5,010.70	2,981.00	613.87	1,415.83
7	4,993.42	2,978.12	610.77	1,404.53
8	5,002.28	2,979.42	613.38	1,409.48
9	4,988.57	2,968.62	610.82	1,409.13
10	4,989.43	2,966.02	611.77	1,411.65
11	4,994.83	2,967.62	617.42	1,409.80
12	4,997.40	2,982.77	617.92	1,396.72
13	5,007.08	2,984.50	616.05	1,406.53
14	5,027.12	2,995.90	619.92	1,411.30
Average	4,999.63	2,976.64	614.55	1,408.44

Repeatability 2 LRT – I/O Request Throughput Distribution Graph

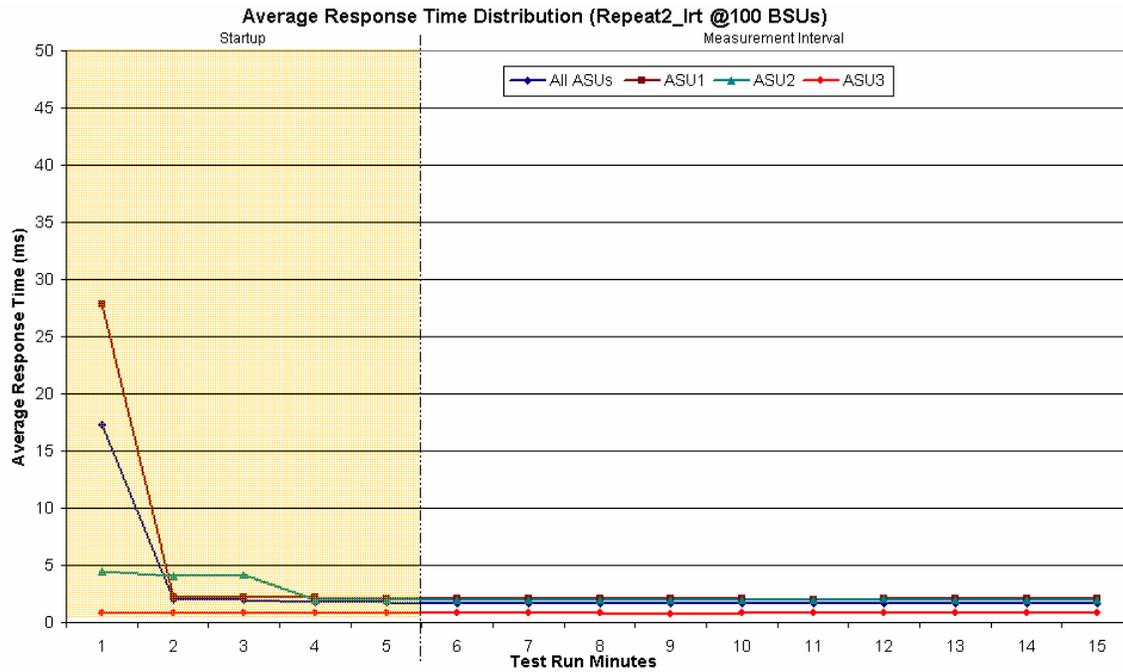


REPEATABILITY TEST

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

100 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	16:39:16	16:44:16	0-4	0:05:00
<i>Measurement Interval</i>	16:44:16	16:54:16	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	17.33	27.81	4.45	0.79
1	2.03	2.19	4.05	0.79
2	2.03	2.18	4.12	0.79
3	1.74	2.14	1.98	0.78
4	1.73	2.13	1.94	0.78
5	1.71	2.10	1.98	0.78
6	1.70	2.08	1.96	0.78
7	1.70	2.07	2.00	0.78
8	1.69	2.06	2.02	0.78
9	1.71	2.05	2.01	0.86
10	1.68	2.03	2.01	0.81
11	1.71	2.05	2.04	0.83
12	1.71	2.05	2.02	0.86
13	1.71	2.06	1.99	0.86
14	1.70	2.07	2.00	0.78
Average	1.70	2.06	2.00	0.81

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

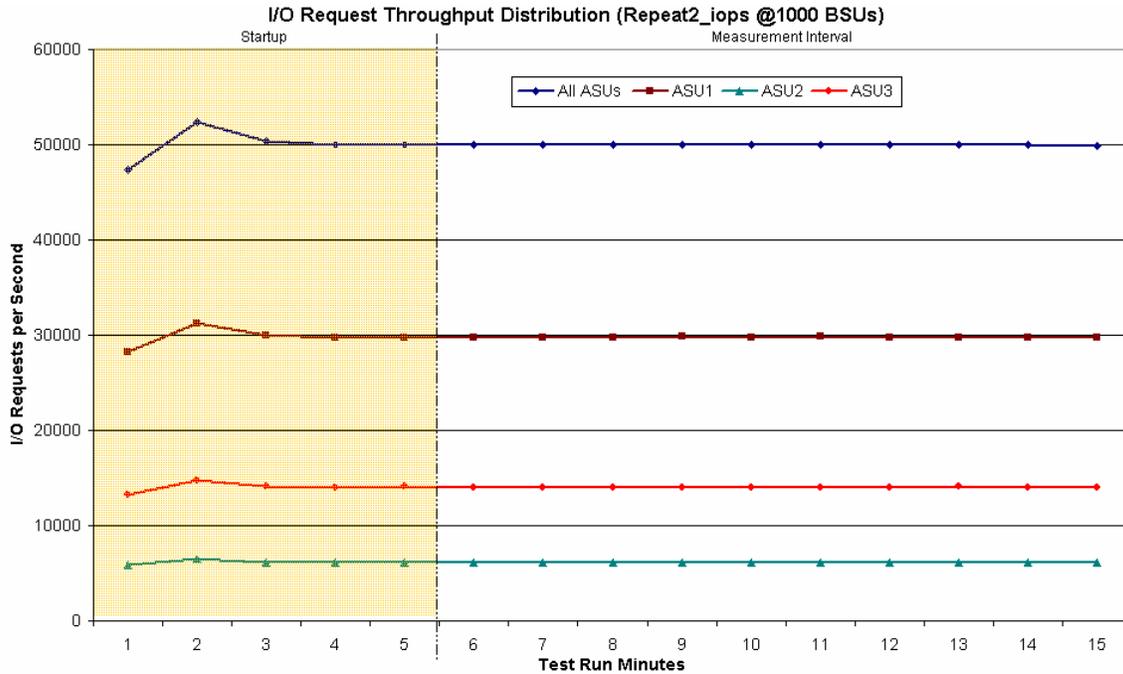


REPEATABILITY TEST

Repeatability 2 IOPS – I/O Request Throughput Distribution Data

1,000 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	16:54:45	16:59:46	0-4	0:05:01
<i>Measurement Interval</i>	16:59:46	17:09:46	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	47,359.75	28,222.77	5,839.05	13,297.93
1	52,390.03	31,207.68	6,439.68	14,742.67
2	50,329.20	29,991.58	6,173.92	14,163.70
3	49,983.35	29,774.15	6,166.35	14,042.85
4	50,004.50	29,780.70	6,144.20	14,079.60
5	50,000.43	29,788.37	6,163.20	14,048.87
6	49,986.45	29,775.72	6,158.43	14,052.30
7	50,010.78	29,801.45	6,157.30	14,052.03
8	50,036.23	29,830.95	6,152.37	14,052.92
9	50,011.40	29,808.00	6,149.33	14,054.07
10	50,021.50	29,816.22	6,157.22	14,048.07
11	49,964.57	29,787.43	6,138.48	14,038.65
12	50,001.50	29,775.07	6,153.15	14,073.28
13	49,988.65	29,790.90	6,156.40	14,041.35
14	49,935.85	29,757.95	6,135.55	14,042.35
Average	49,995.74	29,793.21	6,152.14	14,050.39

Repeatability 2 IOPS – I/O Request Throughput Distribution Graph

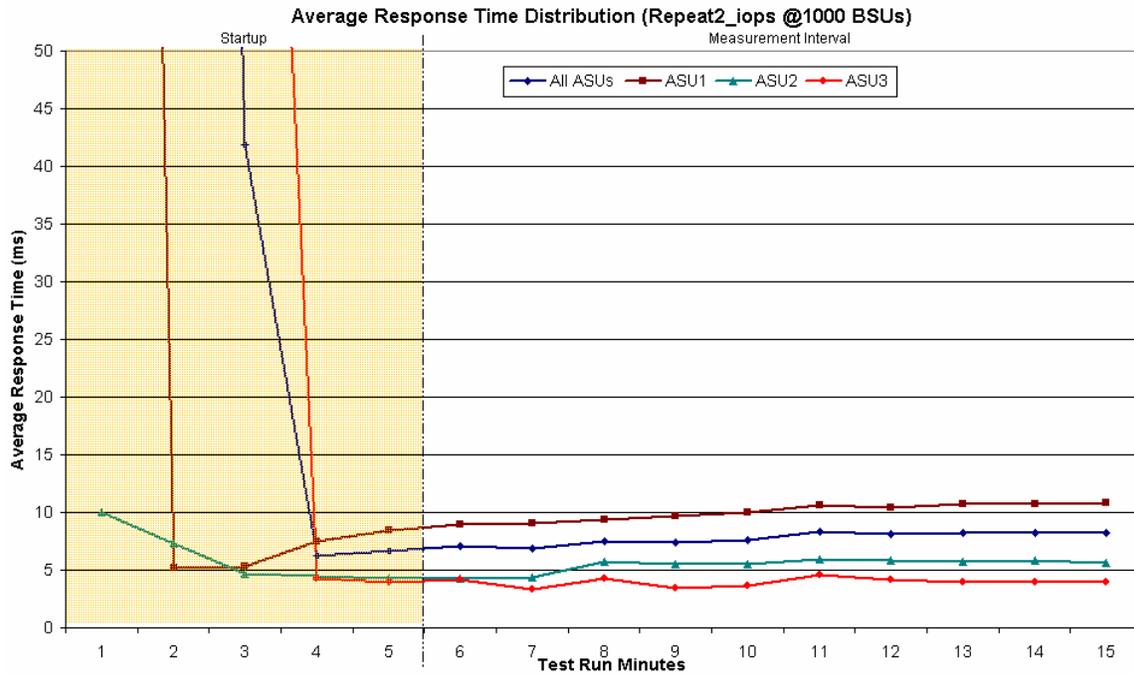


REPEATABILITY TEST

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

1,000 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	16:54:45	16:59:46	0-4	0:05:01
<i>Measurement Interval</i>	16:59:46	17:09:46	5-14	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	502.15	296.27	10.04	1,155.18
1	271.99	5.21	7.27	952.36
2	41.88	5.26	4.72	135.60
3	6.21	7.48	4.53	4.26
4	6.69	8.45	4.32	3.99
5	7.05	9.00	4.31	4.14
6	6.86	9.06	4.36	3.29
7	7.49	9.38	5.69	4.29
8	7.41	9.68	5.48	3.45
9	7.65	9.96	5.52	3.69
10	8.37	10.66	5.91	4.59
11	8.11	10.46	5.81	4.13
12	8.23	10.74	5.77	4.00
13	8.24	10.75	5.78	3.98
14	8.28	10.86	5.65	3.95
Average	7.77	10.05	5.43	3.95

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



REPEATABILITY TEST

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
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>MIM</i>	0.0350	0.2811	0.0702	0.2097	0.0179	0.0701	0.0349	0.2810
<i>COV</i>	0.01	0.00	0.01	0.00	0.02	0.01	0.01	0.00

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
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>MIM</i>	0.0350	0.2809	0.0701	0.2100	0.0180	0.0700	0.0350	0.2810
<i>COV</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>MIM</i>	0.0350	0.2813	0.0698	0.2093	0.0179	0.0700	0.0350	0.2817
<i>COV</i>	0.01	0.00	0.01	0.00	0.02	0.01	0.01	0.00

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
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>MIM</i>	0.0350	0.2810	0.0700	0.2099	0.0180	0.0700	0.0350	0.2810
<i>COV</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Data Persistence Test

Data Persistence TestClause 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:

A listing or screen image of all input parameters supplied to the Workload Generator.

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.

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 persist1 -b 1000
```

```
java -Xmx512m persist2 -b 1000
```

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

Data Persistence Test Results

Data Persistence Test Results	
Data Persistence Test Run Number: 1	
Total Number of Logical Blocks Written	106,853,856
Total Number of Logical Blocks Verified	77,718,128
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 bytes
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.

TESTED STORAGE CONFIGURATION (TSC) AVAILABILITY DATE

Clause 9.2.4.9

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

The DataCore SANsymphony configuration, as documented in this Full Disclosure Report became available for customer purchase and shipment on August 1st, 2003.

PRICING INFORMATION

Clause 9.2.4.1

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

Differences Between Benchmarked & Priced Configurations

The only difference is that the quoted configuration will contain 220 drives with identical Seagate Revision levels, the benchmarked configuration contained several different firmware revisions:

Revision level	Number of drives
2	7
3	122
5	76
F28F	15

This change will not impact either pricing or performance.

Pricing information may found in the Tested Storage Configuration Pricing section on page 11. The current pricing is effective as of August, 2003.

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 observed during the SPC-1 Onsite Audit of the DataCore SANsymphony Configuration.

SPC BENCHMARK 1™ V1.7 FULL DISCLOSURE REPORT SUBMITTED FOR REVIEW

DataCore Software Corporation

AUGUST 08 2003

SANsymphony Network Edition

