SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

FUJITSU LIMITED
FUJITSU STORAGE SYSTEMS ETERNUS3000 MODEL 600

SPC-1 V1.7

Submitted for Review: July 14, 2003
Submission Identifier: A00014

Accepted: September 12, 2003
Revised: August 9, 2004

First Edition – July 2003

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

Fujitsu Limited
Fujitsu Technology Solutions, Inc.
C. A. Wilson
1250 East Arques Ave.
P.O. Box 3470
Sunnyvale, CA 94088-3470

July 14, 2003

The SPC Benchmark 1™ results listed below for the Fujitsu Storage Systems ETERNUS3000 Model 600 were produced in compliance with the SPC Benchmark 1™ Remote Audit requirements.

SPC Benchmark 1™ Results	
Tested Storage Configuration (TSC) Name: Fujitsu Storage Systems ETERNUS3000 Model 600	
Metric	**Reported Result**
SPC-1 IOPS™	33,496.57
SPC-1 Price-Performance	$34.61/SPC-1 IOPS™
Total ASU Capacity	7,804.500 GB
Data Protection Level	Mirroring
SPC-1 LRT™	2.26 ms
Total TSC Price (including three-year maintenance)	$1,159,379.26

The following SPC Benchmark 1™ Remote 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:
  - ✓ 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).

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

- Listings and commands to configure the BC/TSC.
- The type of Host System including the number of processors and main memory.
- The presence and version number of the Workload Generator on the Host System.
- The TSC boundary within the Host System.
- The Test Results Files and resultant Summary Results Files received 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 benchmarked TSC and priced TSC.
- 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

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

LETTER OF GOOD FAITH

FUJITSU

FUJITSU LIMITED
1-1, Kamikodanaka 4-chome, Nakahara-ku, Kawasaki 211-8588 Japan
Telephone : 044-777-1111 Fax : 044-754-3643

Date: 2003/7/9

From: Yasuo Kurihara, Director, Enterprise System Group

To: Walter E. Baker, SPC Administrator and Auditor, Gradient Systems

Subject: Letter of Good Faith for the SPC Benchmark-1 results published on the Fujitsu Storage System ETERNUS3000 Model 600

This Letter of Good Faith between Fujitsu Limited ("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 results, even if not explicitly required for disclosure in the SPC Benchmark-1 specification.

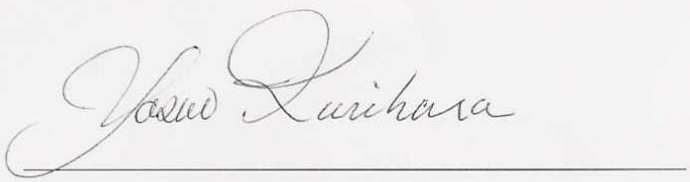
2. No attempt has been or will be made to deceive the SPC Audit Service, SPC, customers, or the public regarding the authenticity or accuracy of SPC Benchmark-1 results on the Fujitsu Storage System ETERNUS3000 Model 600. As such, the SPC-1 Full Disclosure Report that will document SPC Benchmark-1 results (per Clause 10 of the SPC Benchmark-1 Specification) on the Fujitsu Storage System ETERNUS3000 Model 600 is authentic and accurate.

3. The Fujitsu Storage System ETERNUS3000 Model 600 configuration used for reporting SPC Benchmark-1 results, as documented in the Full Disclosure Report (per Clause 10 of the SPC Benchmark-1 Specification), has not been misrepresented to the SPC or SPC Audit Service in any way.

4. SPC Benchmark-1 results on the Fujitsu Storage System ETERNUS3000 Model 600 are compliant with the spirit, intent, and letter of the SPC Benchmark-1.

5. That the SPC Benchmark-1 results do not represent a "Benchmark Special" as documented in Clause 0.2 of the SPC Benchmark-1 specification.

Signed:



Yasuo Kurihara, Director, Enterprise System Group

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Fujitsu Limited – http://www.fujitsu.com/services/computing/storage/ Fujitsu Computer Systems Corp. C.A. (Sandy) Wilson Sandy_Wilson@us.fujitsu.com 1250 East Arques Ave PO Box 3470 Sunnyvale, CA 94088-3470 Phone: (916) 434-8593
Test Sponsor Alternate Contact	Fujitsu Limited – http://www.fujitsu.com/services/computing/storage/ Fujitsu Computer Systems Corp. John Andoh John_Andoh@us.fujitsu.com Phone: (408) 746-6432 FAX: (408) 942-1725 Jim Repinski Jim_Repinski@us.fujitsu.com Phone: (408)992-2597 Noah Jergler Noah_Jergler@us.fujitsu.com Phone: (408)746-7690 Kun Katsumata Kun_Katsumata@us.fujitsu.com Phone (408) 746-6415 1250 East Arques Ave. PO Box 3470 Sunnyvale, CA 94088-3470
Test Sponsor Alternate Contact	Fujitsu Limited – http://www.fujitsu.com/services/computing/storage/ Norihiko Kondo kondo.n@jp.fujitsu.com Kanagawa-ken, Kanagawa-ken, Kawasaki-shi, Nakahara-ku, Kamikodanaka 4-1-1 Japan 211-8588 Phone: 044- 754-3605
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	V1.7
SPC-1 Workload Generator revision number	V2.1
Date Results were first used publicly	July 14, 2003
Date FDR was submitted to the SPC	July 14, 2003
Date revised FDR was submitted to the SPC Pricing and Price/Performance revised. **Revision History:** ***March 4, 2004:*** Company name change Email addresses changed resultant from above. Pricing and Price/Performance revised.	August 9, 2004
Date the TSC is/was available for shipment to customers	July 31, 2003
Date the TSC completed audit certification	July 14, 2003

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: Fujitsu Storage Systems ETERNUS3000 Model 600	
Metric	**Reported Result**
SPC-1 IOPS™	33,496.57
SPC-1 Price-Performance	$14.65/SPC-1 IOPS™
Total ASU Capacity	7,804.500 GB
Data Protection Level	Mirroring
SPC-1 LRT™	2.26 ms
Total TSC Price (including three-year maintenance)	$490,750

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 7,849.648 GB. The Total ASU Capacity utilized 99.42% of the Addressable Storage Capacity. The actual Configured Storage Capacity was 16,294.049 GB, which included the multiple copies of user data required by a Data Protection Level of Mirroring. The Configured Storage Capacity utilized 93.23% of the priced Physical Storage Capacity of 17,475.433 GB.

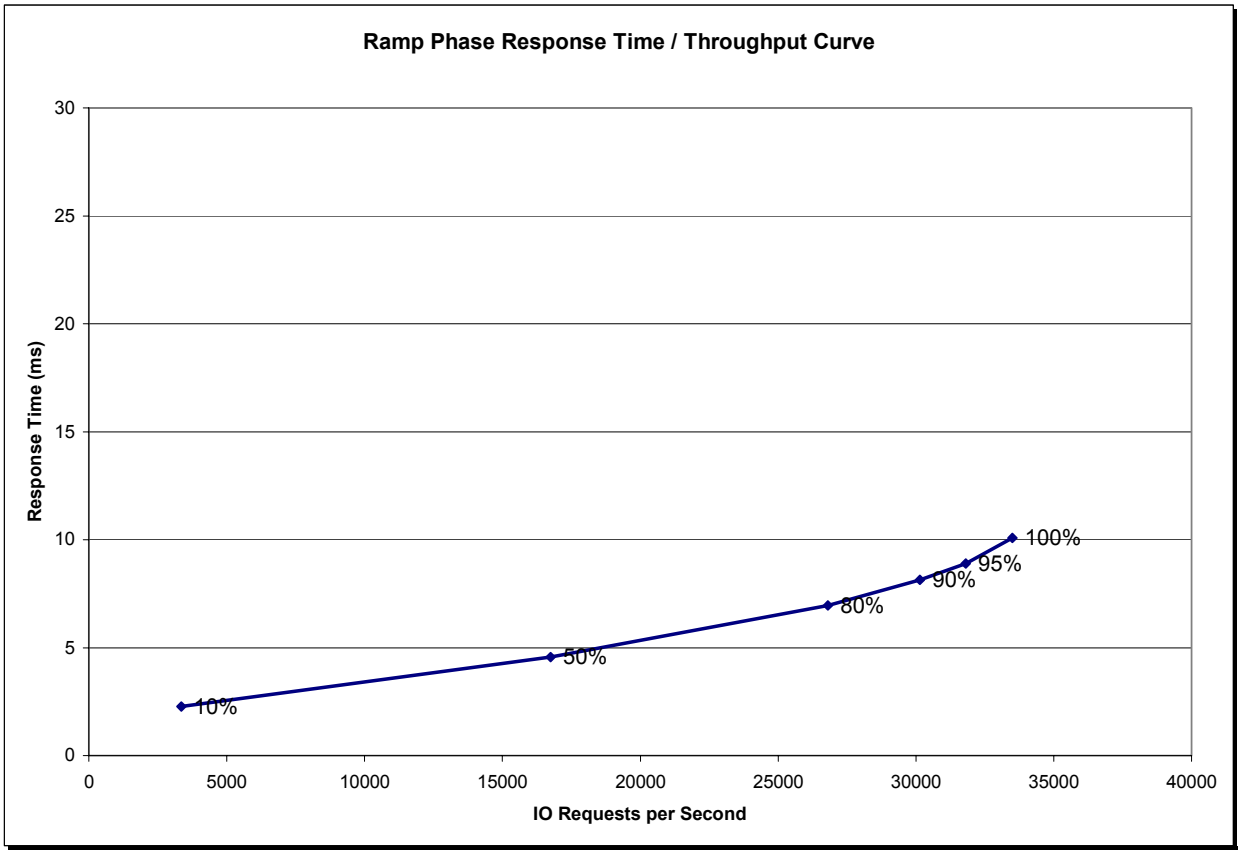
A **Data Protection Level** of Mirroring configures two or more identical copies of user data, maintained on separate disks.

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.



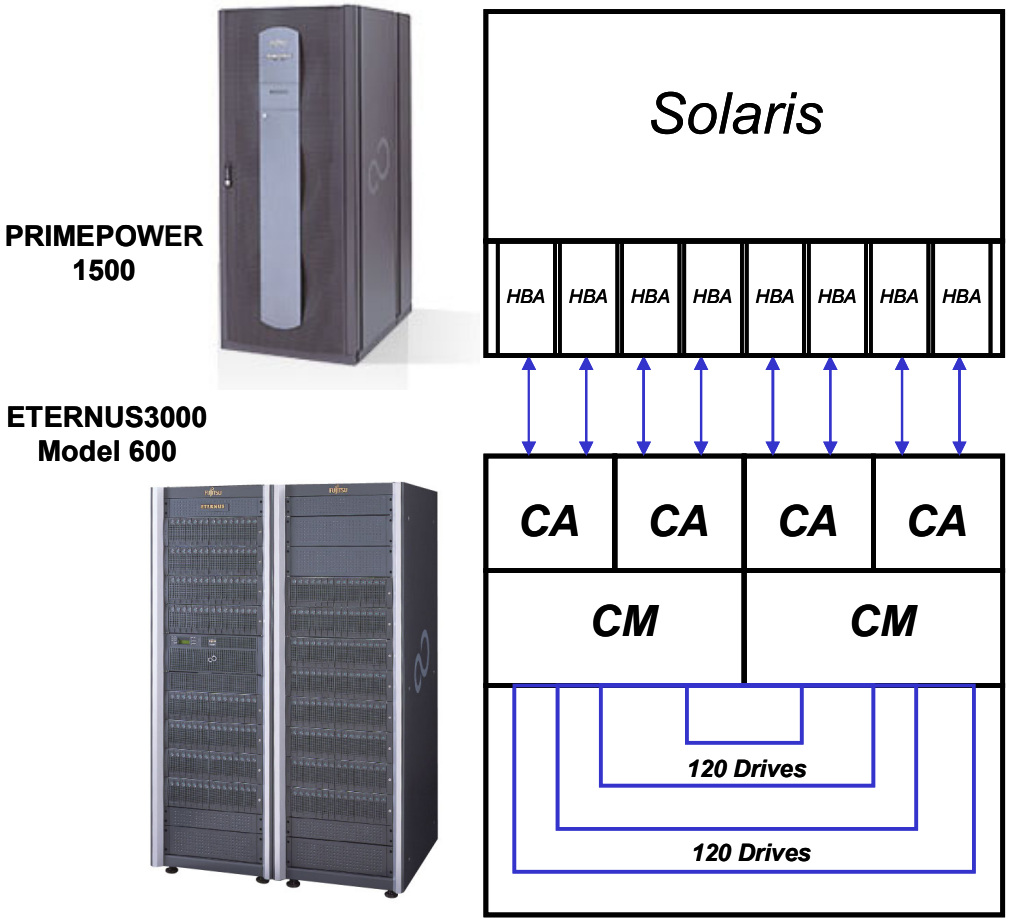
Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	3,348.87	16,748.05	26,802.92	30,147.87	31,805.13	33,496.57
Average Response Time (ms):						
All ASUs	2.26	4.57	6.96	8.13	8.90	10.09
ASU-1	2.77	5.45	8.31	9.73	10.66	12.06
ASU-2	2.96	6.18	9.49	11.22	12.39	14.15
ASU-3	0.88	2.00	2.99	3.38	3.63	4.14
Reads	4.53	8.75	13.40	15.83	17.44	19.80
Writes	0.79	1.85	2.76	3.11	3.33	3.77

Tested Storage Configuration Pricing

Item	Product Id	Description	Qty	Unit $	Extd $
1	E360S20AU	ETERNUS3000 Model 600 without Door including Controller Enclosure, 2x Controllers, each Controller with dual ports & 2GB Cache dual power supplies, dual battery units 2x drive enclosures, 2x 146GB disk drives 1800mm (36U) rack, 2x power distribution (200VAC) 4x FC cables (5m), 2x LAN cables (5m) rack mount kit, ETERNUSmgr & drivers slots for up to 30 disk drives	1	$560,000	$560,000
2	E340SR3	ETERNUS3000 Expansion rack without Door including Expansion 1800mm (36U) rack 2x drive enclosures, 2x 146GB disk drives 2x power distribution (200 VAC) slots for up to 30 disk drives	1		
3	E300CE2	Drive Enclosure pair - (rack mount 2x 3U) with slots for up to 30 disk drives	6		
4	E360CM4	Additional cache memory (2x 2GB)	1		
5	E300CHF4	Additional host interface (2x dual ports)	1		
6	E300CD7H	73GB/15krpm Disk Drives	236		
7	CBL-MLLB15	Fibre Channel Cable	8	$250	$2,000
8	LP9002L	Emulex LP9002 HBA	8	$2,795	$22,360
9	A08974-J00000	Veritas Volume Manager	1	$28,295	$28,295
10		Maintenance VxVM - 3 years 24x7	1	$15,279	$15,279
11		Enhanced Plus Model 600 - Phone 24x7, On-site 24x7, with 4 hour response - 3 year Warranty Uplift Base w/ 2 DEs	1	$14,256	$14,256
12		Enhanced Plus Model 600 - Phone 24x7, On-site 24x7, with 4 hour response - 3 year Warranty Uplift per DE pair	7	$13,464	$94,248
		Total Product List Price			$612,655
		Product Discount		30%	
		Net Product Price			$428,859
		Total Service List Price			$123,783
		Service Discount		50%	
		Net Service Price			$61,892
		Total Sell Price, including 3 years Service			$490,750

Benchmark Configuration/Tested Storage Configuration Diagram



Host System:	Storage System:
Fujitsu PRIMEPOWER 1500	Fujitsu ETERNUS3000 Model 600
UID=HS-1	UID=SC-1
32 SPARC64GP-V 1.35 GHz CPUs each with 128KB L1 Instruction Cache, 128KB L1 Data Cache, 2 MB L2 Cache	Dual Control Modules, each with: 2.8 GHz Xeon CPU 4 GB Cache 2 dual channel FC Host interfaces
64 GB Main Memory	8 – Front side Fibre Channels (2 Gbit each)
Solaris 8	4 – Drive side Fibre Channel Loops (2 Gbit each)
8 - Emulex LP9002L Fibre Channel Host Bus Adapters (2 Gbit)	16 Drive Enclosure Modules, each with dual FC-AL interfaces 15 Hot Swap drive slots
Veritas Volume Manager 3.5	236 – 73GB disks, 4 – 146GB disks
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 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.

Solaris Control File

The following settings were made in the Solaris "/etc/system" control file information for execution of the Workload Generator on the PRIMEPOWER 1500:

```
* Begin FJSVssf (do not edit)
set ftrace_atboot = 1
set kmem_flags = 0x100
set kmem_lite_maxalign = 8192
* End FJSVssf (do not edit)
* Begin FJSVpnl (do not edit)
forceload:drv/FJSVpanel
* End FJSVpnl (do not edit)
forceload:drv/se
forceload:drv/fjmse

* The forceload of drv/clone is required for successful
* IP operation of EMULEX fibre channel drivers lpfc / lpfs
* and for the diagnostics (dfc) interface.
forceload: drv/clone

* vxvm_START (do not remove)
forceload: drv/vxdmp
forceload: drv/vxio
forceload: drv/vxspec
* vxvm_END (do not remove)

* vxfs_START -- do not remove the following lines:
* VxFS requires a stack size greater than the default 8K.
* The following value allows the kernel stack size to be
* increased to 24K for Solaris 7, 8 and 9, and 16K for Solaris 2.6.
set lwp_default_stksize=0x6000
```

```
* vxfs_END


* vxfs_START -- do not remove the following lines:
* VxFS requires a stack size greater than the default 8K.
* The following value allows the kernel stack size to be
* increased to 24K for Solaris 7, 8 and 9, and 16K for Solaris 2.6.
set rpcmod:svc_default_stksize=0x6000
* vxfs_END
```

Emulex HBA Parameters

The following parameters, in "lpfc.conf", to control the operations of the Emulex Fibre Channel HBAs were changed from their default values:

```
*****************Set Bindings to Port WWNs*********************
  fcp-bind-WWPN="21ff00e000a8ffc4:lpfc0t0",
                "22ff00e000a8ffc4:lpfc1t0",
                "23ff00e000a8ffc4:lpfc2t0",
                "24ff00e000a8ffc4:lpfc3t0",
                "25ff00e000a8ffc4:lpfc4t0",
                "26ff00e000a8ffc4:lpfc5t0",
                "27ff00e000a8ffc4:lpfc6t0",
                "28ff00e000a8ffc4:lpfc7t0";
***********Set to recognize only devices with Binding*********
automap=0;

*************Set LUN Queue Depth******************
lun-queue-depth=128;

*************Set Target Queue Depth*************
tgt-queue-depth=128;

*************Set Loop scanning low to high ALPAs**********
scan-down=0;

********Set Topology 1) P to P (Fabric), 2) Loop
topology=6;
```

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 following entries in "sd.conf" were defined to enable the Emulex HBA for accessing LUNs defined in the ETERNUS3000:

```
name="sd" parent="lpfc" target=0 lun=0;
name="sd" parent="lpfc" target=0 lun=1;
name="sd" parent="lpfc" target=0 lun=2;
name="sd" parent="lpfc" target=0 lun=3;
name="sd" parent="lpfc" target=0 lun=4;
name="sd" parent="lpfc" target=0 lun=5;
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name="sd" parent="lpfc" target=0 lun=89;
name="sd" parent="lpfc" target=0 lun=90;
name="sd" parent="lpfc" target=0 lun=91;
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name="sd" parent="lpfc" target=0 lun=92;
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name="sd" parent="lpfc" target=0 lun=131;
name="sd" parent="lpfc" target=0 lun=132;
name="sd" parent="lpfc" target=0 lun=133;
name="sd" parent="lpfc" target=0 lun=134;
name="sd" parent="lpfc" target=0 lun=135;
name="sd" parent="lpfc" target=0 lun=136;
name="sd" parent="lpfc" target=0 lun=137;
name="sd" parent="lpfc" target=0 lun=138;
name="sd" parent="lpfc" target=0 lun=139;
name="sd" parent="lpfc" target=0 lun=140;
name="sd" parent="lpfc" target=0 lun=141;
name="sd" parent="lpfc" target=0 lun=142;
name="sd" parent="lpfc" target=0 lun=143;
name="sd" parent="lpfc" target=0 lun=144;
name="sd" parent="lpfc" target=0 lun=145;
name="sd" parent="lpfc" target=0 lun=146;
name="sd" parent="lpfc" target=0 lun=147;
```

```
name="sd" parent="lpfc" target=0 lun=148;
name="sd" parent="lpfc" target=0 lun=149;
```

The following scripts (**listdisks.sh, labeldisks.sh, fmtdisks.sh,** and **maxkevx**) and commands were used to create the logical representation of the TSC used in the benchmark measurement for the Eternus3000 Storage system.

listdisks.sh

The **listdisks.sh** script is used to create a list of disks to be partitioned into slices by the Solaris **format** command.

labeldisks.sh

The **labeldisks.sh** script calls the **fmtdisks.sh** script to format, partition, and label disks using a disk list, created by the **listdisk.sh** script, and a format command file.

fmtdisks.sh

The **fmtdisks.sh** script is used to format, partition, and label disks using a disk list, created by the **listdisk.sh** script, and a format command file.

labelcmd

The **labelcmd** file contains the list of commands used by the format command to label a disk.

makevx

The **makevx** script is used to create the VxVM logical volumes based on the configuration description file, **P1-a1.txt**.

P1-a1.txt

The **P1-a1.txt** file contains the list of raw disks that were used to create the VxVM logical volumes that comprised SPC-1 Application Storage Units: ASU-1, ASU-2, and ASU-3.

Listed below are the actual script contents and commands.

---

listdisks.sh

```
#!/bin/sh
#
#
# listdisks.sh
# A shell script to create a disk list for the labeldisks.sh script


#  Remove the old disk list files

rm -r /SPC1_E3000M600/SPC1SCRIPTS/c3.format.log
rm -r /SPC1_E3000M600/SPC1SCRIPTS/c4.format.log
rm -r /SPC1_E3000M600/SPC1SCRIPTS/c5.format.log
rm -r /SPC1_E3000M600/SPC1SCRIPTS/c6.format.log
rm -r /SPC1_E3000M600/SPC1SCRIPTS/c7.format.log
rm -r /SPC1_E3000M600/SPC1SCRIPTS/c8.format.log
rm -r /SPC1_E3000M600/SPC1SCRIPTS/c9.format.log
rm -r /SPC1_E3000M600/SPC1SCRIPTS/c10.format.log

rm /SPC1_E3000M600/SPC1SCRIPTS/formatok
rm /SPC1_E3000M600/SPC1SCRIPTS/formaterr


#  Create the new disk list file


ls /dev/rdsk/c3*s2 |sed 's/\/dev\/rdsk\///g'| sed
's/s2//g'>/SPC1_E3000M600/SPC1SCRIPTS/c3.disk.list

ls /dev/rdsk/c4*s2 |sed 's/\/dev\/rdsk\///g'| sed
's/s2//g'>/SPC1_E3000M600/SPC1SCRIPTS/c4.disk.list

ls /dev/rdsk/c5*s2 |sed 's/\/dev\/rdsk\///g'| sed
's/s2//g'>/SPC1_E3000M600/SPC1SCRIPTS/c5.disk.list

ls /dev/rdsk/c6*s2 |sed 's/\/dev\/rdsk\///g'| sed
's/s2//g'>/SPC1_E3000M600/SPC1SCRIPTS/c6.disk.list

ls /dev/rdsk/c7*s2 |sed 's/\/dev\/rdsk\///g'| sed
's/s2//g'>/SPC1_E3000M600/SPC1SCRIPTS/c7.disk.list

ls /dev/rdsk/c8*s2 |sed 's/\/dev\/rdsk\///g'| sed
's/s2//g'>/SPC1_E3000M600/SPC1SCRIPTS/c8.disk.list

ls /dev/rdsk/c9*s2 |sed 's/\/dev\/rdsk\///g'| sed
's/s2//g'>/SPC1_E3000M600/SPC1SCRIPTS/c9.disk.list

ls /dev/rdsk/c10*s2 |sed 's/\/dev\/rdsk\///g'| sed
's/s2//g'>/SPC1_E3000M600/SPC1SCRIPTS/c10.disk.list
```

---
labeldisks.sh

```
#!/bin/sh
#
# WARNING: This script will destroy all data on the disk.
# USE AT YOUR OWN RISK
#
# labeldisks.sh


./fmtdisks.sh /SPC1_E3000M600/SPC1SCRIPTS/c3.disk.list
/SPC1_E3000M600/SPC1SCRIPTS/c3.format.log
/SPC1_E3000M600/SPC1SCRIPTS/labelcmd

./fmtdisks.sh /SPC1_E3000M600/SPC1SCRIPTS/c4.disk.list
/SPC1_E3000M600/SPC1SCRIPTS/c4.format.log
/SPC1_E3000M600/SPC1SCRIPTS/labelcmd

./fmtdisks.sh /SPC1_E3000M600/SPC1SCRIPTS/c5.disk.list
/SPC1_E3000M600/SPC1SCRIPTS/c5.format.log
/SPC1_E3000M600/SPC1SCRIPTS/labelcmd

./fmtdisks.sh /SPC1_E3000M600/SPC1SCRIPTS/c6.disk.list
/SPC1_E3000M600/SPC1SCRIPTS/c6.format.log
/SPC1_E3000M600/SPC1SCRIPTS/labelcmd

./fmtdisks.sh /SPC1_E3000M600/SPC1SCRIPTS/c7.disk.list
/SPC1_E3000M600/SPC1SCRIPTS/c7.format.log
/SPC1_E3000M600/SPC1SCRIPTS/labelcmd

./fmtdisks.sh /SPC1_E3000M600/SPC1SCRIPTS/c8.disk.list
/SPC1_E3000M600/SPC1SCRIPTS/c8.format.log
/SPC1_E3000M600/SPC1SCRIPTS/labelcmd

./fmtdisks.sh /SPC1_E3000M600/SPC1SCRIPTS/c9.disk.list
/SPC1_E3000M600/SPC1SCRIPTS/c9.format.log
/SPC1_E3000M600/SPC1SCRIPTS/labelcmd

./fmtdisks.sh /SPC1_E3000M600/SPC1SCRIPTS/c10.disk.list
/SPC1_E3000M600/SPC1SCRIPTS/c10.format.log
/SPC1_E3000M600/SPC1SCRIPTS/labelcmd
```

---
fmtdisks.sh

```
#!/bin/sh
#
# WARNING: This script will destroy all data on the disk.
# USE AT YOUR OWN RISK
#
# fmtdisks.sh
# A shell script to format and label disks using a disk list and a format
# command file
```

```
   case $# in
   0) echo "Usage: $0 disklist log_directory commandfile" 1>&2; exit 2 ;;
   1) echo "Usage: $0 disklist log_directory commandfile" 1>&2; exit 2 ;;
   2) echo "Usage: $0 disklist log_directory commandfile" 1>&2; exit 2 ;;
   esac


   # Define the Disk List file
   DISK_LIST=$1
   # Define where the logfiles directory is
   LOG_DIR=$2
   # Define the location of the format command file
   FMT_CMD=$3

   #
   # Make the log directory
   mkdir -p $LOG_DIR
   #

   # Iterate through the disk list
   for DISKS in `cat $DISK_LIST`
   do

   # Run the format command and check the exit status
   # to see if it worked correctly

   format -f $FMT_CMD -l $LOG_DIR/format_log.$DISKS $DISKS
   if [ $? -gt 0 ]
   then
        echo "format of disk $DISKS failed" >>
   /SPC1_E3000M600/SPC1SCRIPTS/formaterr
   else
        echo "format of disk $DISKS completed" >>
   /SPC1_E3000M600/SPC1SCRIPTS/formatok
   fi
   done
```

---

makevx

```
   #!/bin/ksh
   # Usage: usage
   #
   usage()
   {
           echo "\nUsage: $0 configFile\n"
           exit 1
   }

   cleanVG()
   {
```

```
   dgNames=`vxdg list|nawk '{ if ( $1 ~ var ) print $1 }' var=$dgPrefix`
   for i in $dgNames
   do
#        volumes=`vxprint -g $i -v`
         test=`vxdg destroy $i`
                if [ $? != 0 ]
                then
                    echo "Failed to delete VG $vg"
                    exit 4
                fi

   done
}
checkDisk()
{

   checkName=`grep $diskName $vxdiskFile`
   if [ "$checkName" == "" ]
   then
         echo "disk $diskName from line $lineno of config file is not
listed in vxdisk listing"
         exit 4
   fi
   for disk in ${DISKS[$groups]}
   do
         if [ "$disk" == "$diskName" ]
         then
               echo "disk $diskName repeated at line $lineno"
               echo ${DISKS[$groups]}
               exit 4
         fi
   done
   disks=$disks+1
   DISKS[$groups]=${DISKS[$groups]}$diskName" "
   if [ "$getSize" == "yes" ]
   then
         diskTmp="/dev/rdsk/"$diskName"s2"
#        prtData=`prtvtoc $diskTmp`
                if [ $? != 0 ]
                then
                        echo "Failed to get disk size from prtvtoc
$diskTmp"
                        exit 4
                fi
      (( LVSIZE[$groups]=${LVSIZE[$groups]}+`prtvtoc $diskTmp|nawk '{if
($1 == 4) print $5}'` ))
   fi
}

addDisks()
{
   typeset -i diskNum=0
   typeset -i count=$name
```

```
      typeset -i jump=1
      diskNum=${label#*d}
      if (( $diskNum < 10 ))
      then
            diskPrefix=`echo $label|awk '{ print substr( $1, 0, length($1)-1
   ) }'`
      elif (( $diskNum < 100 ))
      then
            diskPrefix=`echo $label|awk '{ print substr( $1, 0, length($1)-2
   ) }'`
      else
            diskPrefix=`echo $label|awk '{ print substr( $1, 0, length($1)-3
   ) }'`
      fi
      if [ "$skip" != "" ]
      then
            jump=$skip
      fi
      count=$count-1
      while [ $count != 0 ]
      do
            count=$count-1
            diskNum=$diskNum+$jump
            diskName=$diskPrefix$diskNum
            checkDisk
      done

   }

   createVG()
   {
      typeset -i count=1
      typeset -i groupCount=1
      for vg in $VGNAME
      do
            for i in ${DISKS[$groupCount]}
            do
                  vgdisk=$vg"-"$count
                  lvdisk=$i"s2"
                  if [ $count == 1 ]
                  then
                        test=`vxdg init $vg $vgdisk=$lvdisk`
                        if [ $? != 0 ]
                        then
                              echo "Failed to make VG $vg with disk $lvdisk"
                              exit 4
                        fi
                  else
                        test=`vxdg -g $vg adddisk $vgdisk=$lvdisk`
                        if [ $? != 0 ]
                        then
                              echo "Failed to add disk $lvdisk to VG $vg"
                              exit 4
```

```
                        fi
                fi
                count=$count+1
        done
        vgname=$vg"data-01"
        (( lvsize=${LVSIZE[$groupCount]}-(16384*$count) ))
        count=$count-1
        test=`vxassist -g $vg make $vgname $lvsize layout=stripe
stripeunit=16m ncols=$count`
        if [ $? != 0 ]
        then
                echo "Failed to make LV $vgname for VG $vg"
                exit 4
        fi
        groupCount=$groupCount+1
        count=1
   done
}

checkConfig()
{
   typeset -i groups=0
   typeset -i disks=0
   typeset -i lineno=1
   invg="no"
   typeset -i adddisks=0
   while read -r label name skip
   do
        case $label in
        "VOLUME_GROUP:")
                VGNAME=$VGNAME$name" "
                invg="yes"
                groups=$groups+1
                getSize="yes"
                ;;
        "#")
                ;;
        "")
                ;;
        "END")
                invg="no"
                ;;
        *)
                if [ "$invg" != "yes" ]
                then
                        echo "invalid line in config file line=$lineno
data=\"$label $name\""
                        exit 4
                fi
                diskName=$label
                checkDisk
                if [ "$name" != "" ]
                then
```

```
                        addDisks
                fi
            esac
            lineno=$lineno+1
      done < $CONFIG
   }

   #  main()

   vxdiskFile=/tmp/garf
   dgPrefix="asu"
   case $# in
   1)
      CONFIG=$1
           echo "Doing vxvm config from $1"
           ;;
   *)
           usage
           ;;
   esac
      cleanVG
      test=`vxdisk list > $vxdiskFile`
      checkConfig
      createVG
```

This section contains the listings of the command files.

---

labelcmd

```
   par
   pr
   quit
   label
   quit
```

P1-a1.txt

```
   VOLUME_GROUP: asu1-1
   c16t0d7
   c16t0d16
   c16t0d25
   c16t0d34
   c20t0d7
   c20t0d16
   c20t0d25
   c18t0d7
   c18t0d16
   c18t0d25
   c22t0d7
```

```
c22t0d16
c22t0d25
c22t0d34
c18t0d34
c18t0d43
c18t0d52
c18t0d61
c22t0d43
c22t0d52
c22t0d61
c16t0d43
c16t0d52
c16t0d61
c20t0d34
c20t0d43
c20t0d52
c20t0d61
c16t0d70
c16t0d79
c16t0d88
c16t0d97
c20t0d70
c20t0d79
c20t0d88
c18t0d70
c18t0d79
c18t0d88
c22t0d70
c22t0d79
c22t0d88
c22t0d97
c18t0d97
c18t0d106
c18t0d115
c18t0d124
c22t0d106
c22t0d115
c22t0d124
c16t0d106
c16t0d115
c16t0d124
c20t0d97
c20t0d106
c20t0d115
c20t0d124
END
VOLUME_GROUP: asu1-2
c16t0d5
c16t0d14
c16t0d23
c16t0d32
c20t0d5
c20t0d14
c20t0d23
c18t0d5
c18t0d14
```

```
c18t0d23
c22t0d5
c22t0d14
c22t0d23
c22t0d32
c18t0d32
c18t0d41
c18t0d50
c18t0d59
c22t0d41
c22t0d50
c22t0d59
c16t0d41
c16t0d50
c16t0d59
c20t0d32
c20t0d41
c20t0d50
c20t0d59
c16t0d68
c16t0d77
c16t0d86
c16t0d95
c20t0d68
c20t0d77
c20t0d86
c18t0d68
c18t0d77
c18t0d86
c22t0d68
c22t0d77
c22t0d86
c22t0d95
c18t0d95
c18t0d104
c18t0d113
c18t0d122
c22t0d104
c22t0d113
c22t0d122
c16t0d104
c16t0d113
c16t0d122
c20t0d95
c20t0d104
c20t0d113
c20t0d122
END
VOLUME_GROUP: asu1-3
c16t0d6
c16t0d15
c16t0d24
c16t0d33
c20t0d6
c20t0d15
c20t0d24
```

```
c18t0d6
c18t0d15
c18t0d24
c22t0d6
c22t0d15
c22t0d24
c22t0d33
c18t0d33
c18t0d42
c18t0d51
c18t0d60
c22t0d42
c22t0d51
c22t0d60
c16t0d42
c16t0d51
c16t0d60
c20t0d33
c20t0d42
c20t0d51
c20t0d60
c16t0d69
c16t0d78
c16t0d87
c16t0d96
c20t0d69
c20t0d78
c20t0d87
c18t0d69
c18t0d78
c18t0d87
c22t0d69
c22t0d78
c22t0d87
c22t0d96
c18t0d96
c18t0d105
c18t0d114
c18t0d123
c22t0d105
c22t0d114
c22t0d123
c16t0d105
c16t0d114
c16t0d123
c20t0d96
c20t0d105
c20t0d114
c20t0d123
END
VOLUME_GROUP: asu1-4
c16t0d4
c16t0d13
c16t0d22
c16t0d31
c20t0d4
```

```
c20t0d13
c20t0d22
c18t0d4
c18t0d13
c18t0d22
c22t0d4
c22t0d13
c22t0d22
c22t0d31
c18t0d31
c18t0d40
c18t0d49
c18t0d58
c22t0d40
c22t0d49
c22t0d58
c16t0d40
c16t0d49
c16t0d58
c20t0d31
c20t0d40
c20t0d49
c20t0d58
c16t0d67
c16t0d76
c16t0d85
c16t0d94
c20t0d67
c20t0d76
c20t0d85
c18t0d67
c18t0d76
c18t0d85
c22t0d67
c22t0d76
c22t0d85
c22t0d94
c18t0d94
c18t0d103
c18t0d112
c18t0d121
c22t0d103
c22t0d112
c22t0d121
c16t0d103
c16t0d112
c16t0d121
c20t0d94
c20t0d103
c20t0d112
c20t0d121
END
VOLUME_GROUP: asu2-1
c16t0d0
c16t0d9
c16t0d18
```

```
c16t0d27
c20t0d0
c20t0d9
c20t0d18
c18t0d0
c18t0d9
c18t0d18
c22t0d0
c22t0d9
c22t0d18
c22t0d27
c18t0d27
c18t0d36
c18t0d45
c18t0d54
c22t0d36
c22t0d45
c22t0d54
c16t0d36
c16t0d45
c16t0d54
c20t0d27
c20t0d36
c20t0d45
c20t0d54
c16t0d63
c16t0d72
c16t0d81
c16t0d90
c20t0d63
c20t0d72
c20t0d81
c18t0d63
c18t0d72
c18t0d81
c22t0d63
c22t0d72
c22t0d81
c22t0d90
c18t0d90
c18t0d99
c18t0d108
c18t0d117
c22t0d99
c22t0d108
c22t0d117
c16t0d99
c16t0d108
c16t0d117
c20t0d90
c20t0d99
c20t0d108
c20t0d117
END
VOLUME_GROUP: asu2-2
c16t0d1
```

```
c16t0d10
c16t0d19
c16t0d28
c20t0d1
c20t0d10
c20t0d19
c18t0d1
c18t0d10
c18t0d19
c22t0d1
c22t0d10
c22t0d19
c22t0d28
c18t0d28
c18t0d37
c18t0d46
c18t0d55
c22t0d37
c22t0d46
c22t0d55
c16t0d37
c16t0d46
c16t0d55
c20t0d28
c20t0d37
c20t0d46
c20t0d55
c16t0d64
c16t0d73
c16t0d82
c16t0d91
c20t0d64
c20t0d73
c20t0d82
c18t0d64
c18t0d73
c18t0d82
c22t0d64
c22t0d73
c22t0d82
c22t0d91
c18t0d91
c18t0d100
c18t0d109
c18t0d118
c22t0d100
c22t0d109
c22t0d118
c16t0d100
c16t0d109
c16t0d118
c20t0d91
c20t0d100
c20t0d109
c20t0d118
END
```

```
VOLUME_GROUP: asu2-3
c16t0d2
c16t0d11
c16t0d20
c16t0d29
c20t0d2
c20t0d11
c20t0d20
c18t0d2
c18t0d11
c18t0d20
c22t0d2
c22t0d11
c22t0d20
c22t0d29
c18t0d29
c18t0d38
c18t0d47
c18t0d56
c22t0d38
c22t0d47
c22t0d56
c16t0d38
c16t0d47
c16t0d56
c20t0d29
c20t0d38
c20t0d47
c20t0d56
c16t0d65
c16t0d74
c16t0d83
c16t0d92
c20t0d65
c20t0d74
c20t0d83
c18t0d65
c18t0d74
c18t0d83
c22t0d65
c22t0d74
c22t0d83
c22t0d92
c18t0d92
c18t0d101
c18t0d110
c18t0d119
c22t0d101
c22t0d110
c22t0d119
c16t0d101
c16t0d110
c16t0d119
c20t0d92
c20t0d101
c20t0d110
```

```
c20t0d119
END
VOLUME_GROUP: asu2-4
c16t0d3
c16t0d12
c16t0d21
c16t0d30
c20t0d3
c20t0d12
c20t0d21
c18t0d3
c18t0d12
c18t0d21
c22t0d3
c22t0d12
c22t0d21
c22t0d30
c18t0d30
c18t0d39
c18t0d48
c18t0d57
c22t0d39
c22t0d48
c22t0d57
c16t0d39
c16t0d48
c16t0d57
c20t0d30
c20t0d39
c20t0d48
c20t0d57
c16t0d66
c16t0d75
c16t0d84
c16t0d93
c20t0d66
c20t0d75
c20t0d84
c18t0d66
c18t0d75
c18t0d84
c22t0d66
c22t0d75
c22t0d84
c22t0d93
c18t0d93
c18t0d102
c18t0d111
c18t0d120
c22t0d102
c22t0d111
c22t0d120
c16t0d102
c16t0d111
c16t0d120
c20t0d93
```

```
c20t0d102
c20t0d111
c20t0d120
END
VOLUME_GROUP: asu3-1
c16t0d8
c16t0d17
c16t0d26
c16t0d35
c20t0d8
c20t0d17
c20t0d26
c18t0d8
c18t0d17
c18t0d26
c22t0d8
c22t0d17
c22t0d26
c22t0d35
c18t0d35
c18t0d44
c18t0d53
c18t0d62
c22t0d44
c22t0d53
c22t0d62
c16t0d44
c16t0d53
c16t0d62
c20t0d35
c20t0d44
c20t0d53
c20t0d62
c16t0d71
c16t0d80
c16t0d89
c16t0d98
c20t0d71
c20t0d80
c20t0d89
c18t0d71
c18t0d80
c18t0d89
c22t0d71
c22t0d80
c22t0d89
c22t0d98
c18t0d98
c18t0d107
c18t0d116
c18t0d125
c22t0d107
c22t0d116
c22t0d125
c16t0d107
c16t0d116
```

```
c16t0d125
c20t0d98
c20t0d107
c20t0d116
c20t0d125
END
```

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 following SPC-1 Workload Generator storage configuration commands and parameters were used:

```
sd=asu1_1,lun=/dev/vx/rdsk/asu1-1/asu1-1data-01,size=878g
sd=asu1_2,lun=/dev/vx/rdsk/asu1-2/asu1-2data-01,size=878g
sd=asu1_3,lun=/dev/vx/rdsk/asu1-3/asu1-3data-01,size=878g
sd=asu1_4,lun=/dev/vx/rdsk/asu1-4/asu1-4data-01,size=878g
sd=asu2_1,lun=/dev/vx/rdsk/asu2-1/asu2-1data-01,size=878g
sd=asu2_2,lun=/dev/vx/rdsk/asu2-2/asu2-2data-01,size=878g
sd=asu2_3,lun=/dev/vx/rdsk/asu2-3/asu2-3data-01,size=878g
sd=asu2_4,lun=/dev/vx/rdsk/asu2-4/asu2-4data-01,size=878g
sd=asu3_1,lun=/dev/vx/rdsk/asu3-1/asu3-1data-01,size=780.5g
```

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).

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

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

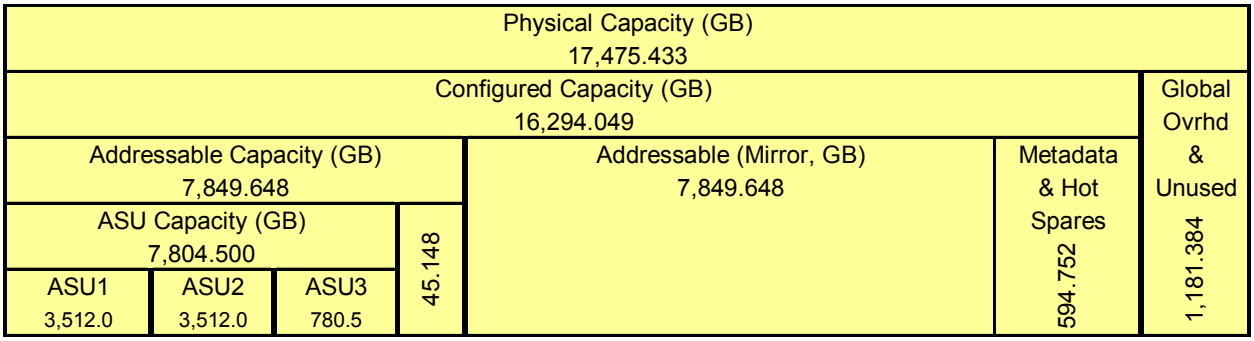
SPC-1 Storage Capacities		
Storage Hierarchy Component	**Units**	**Capacity**
Total ASU Capacity	Gigabytes (GB)	7,804.500
Addressable Storage Capacity	Gigabytes (GB)	7,849.408
Configured Storage Capacity	Gigabytes (GB)	16,294.648
Physical Storage Capacity	Gigabytes (GB)	17,475.433
User Data Copy (Mirroring)	Gigabytes (GB)	7,849.648
Required Storage (metadata) & Hot Spares	Gigabytes (GB)	594.752
Global Storage Overhead	Gigabytes (GB)	5.369
Total Unused Storage	Gigabytes (GB)	1,266.312

The Required Storage consisted of 33.974 GB used for VERITAS Volume Manager metadata. The Hot Spares consisted of four (4) disk devices with a formatted capacity of 140.195 GB per disk device for a total capacity of 560.778 GB. The Physical Storage Capacity consisted of 236 disk drives, each with a formatted capacity of 71.672 GB and 4 disk drives, each with a formatted capacity of 140.195 GB.

The Addressable Storage Capacity and its mirror each contained 45.148 GB of Unused Storage. The Physical Storage Capacity contained an additional 1,176.016 GB of Unused Storage, which resulted in 1,266.312 GB of Total Unused 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

SPC-1 Storage Hierarchy Ratios			
	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	99.43%	47.90%	44.66%
User Data Copy (Mirror)		48.17%	44.92%
Addressable Storage Capacity		48.17%	44.92%
Required Storage (metadata) & Hot Spares		3.65%	3.40%
Configured Storage Capacity			93.24%
Global Storage Overhead			0.03%
Unused Storage	0.58%	0.55%	7.25%

The Addressable Storage Capacity contained 0.58% (45.148 GB) of Unused Storage. The Configured Storage Capacity contained 0.55% (45.148 GB *2) of Unused Storage. The Physical Storage Capacity contained 7.25% (1,176.016 GB + 45.148 GB + 45.148 GB) of Unused Storage.

Logical Volume Capacity and ASU Mapping

Clause 9.2.4.6.2

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

Logical Volume Capacity and Mapping		
ASU-1 (3,512.000 GB)	**ASU-2 (3,512.000 GB)**	**ASU-3 (780.500 GB)**
4 Logical Volume 883.144 GB per Logical Volume (878.000 GB used/Logical Volume)	4 Logical Volume 883.144 GB per Logical Volume (878.000 GB used/Logical Volume)	1 Logical Volume 784.494 GB per Logical Volume (780.500 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.

Assignment of RAID Groups and LUNs

RAID Group Assignments are RAID0+1(2+2) sets, each divided into 9 Logical Volumes, for a total of 530 LVs. These are grouped into four separate sets of LUNs, using Host Affinity grouping, each with 126 LUNs. RAID Groups 38, 39, & 3A are not used in the tested configuration, but the drives are included in the configuration pricing.

Device Enclosure	Drive Slot:	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
	DE 00	RG 38 (56)	RG-0 (0)		RG-1 (1)		RG-2 (2)		RG-3 (3)		RG-4 (4)		RG-5 (5)		RG-6 (6)	
	DE 10															
	DE 01		RG-7 (7)		RG-8 (8)		RG-9 (9)		RG-A (10)		RG-B (11)		RG-C (12)		RG-D (13)	
	DE 11															
	DE 02	RG 39	RG-E (14)		RG-F (15)		RG-10 (16)		RG-11 (17)		RG-12 (18)		RG-13 (19)		RG-14 (20)	
	DE 12															
	DE 03	HS	RG-15 (21)		RG-16 (22)		RG-17 (23)		RG-18 (24)		RG-19 (25)		RG-1A (26)		RG-1B (27)	
	DE 13	HS														
	DE 04	(57)	RG-1C (28)		RG-1D (29)		RG-1E (30)		RG-1F (31)		RG-20 (32)		RG-21 (33)		RG-22 (34)	
	DE 14															
	DE 05	RG 3A (58)	RG-23 (35)		RG-24 (36)		RG-25 (37)		RG-26 (38)		RG-27 (39)		RG-28 (40)		RG-29 (41)	
	DE 15															
	DE 06		RG-2A (42)		RG-2B (43)		RG-2C (44)		RG-2D (45)		RG-2E (46)		RG-2F (47)		RG-30 (48)	
	DE 16															
	DE 07	HS	RG-31 (49)		RG-32 (50)		RG-33 (51)		RG-34 (52)		R-35 (53)		RG-36 (54)		RG-37 (55)	
	DE 17	HS														

The RAID Groups and LUN assignments are set up through a series of actions on the GUI Management Interface (GRMgr). The task of setting up the configuration for each customer is provided as part of the base system price by Fujitsu. Different techniques are applied, depending upon the needs of the customer. This configuration reflects the customary techniques that are applied when a high performance requirement dominates the customer environment. Other techniques are applied when the primary requirement is for maximum capacity. In the case of high performance, it is customary to define RAID Groups arranged in RAID0+1 configurations. In this configuration, all of the RAID Groups are 2+2 arrangements. One set of the drives, making up each RAID Group, is in one Drive Enclosure (DE), and the mating set is in another DE. A special case exists for the RAID Groups that include the drives (0-3) in DE0. These drives have reduced configurable capacity, due to reserved system space on each of these four drives. When these drives are mated with others in a RAID0+1 configuration, the other drives also have reduced space available. This results in RAID Groups 0 and 1 being somewhat smaller than the other groups. This loss of space, along with the reservation of four Hot Spare drives, accounts for the difference between the Configurable Capacity, and the Addressable Capacity shown in the Storage Capacity Diagram.

The LUNs, seen through the eight HBAs by Solaris, are then grouped into VxVM Volume Groups, and used with 16 MB stripe units across the sets. The LUNs assigned to each of the unused RAID Groups, are not included in the Veritas Logical Volumes used for the defined ASU storage volumes. Four Volume Groups, each with 56 LUNs are used for ASU1 and for ASU2, while one Volume Group, also with 56 LUNs is used for ASU3. This assignment of LUNs to Volume Groups ensures that no single storage unit presented to the SPC-1 Workload Generator is larger than 1 TB. The sizes are reflected in the ASU Logical Volume Mapping chart.

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 –Xmx512m metrics -b 670
```

Sustainability Test Results File

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

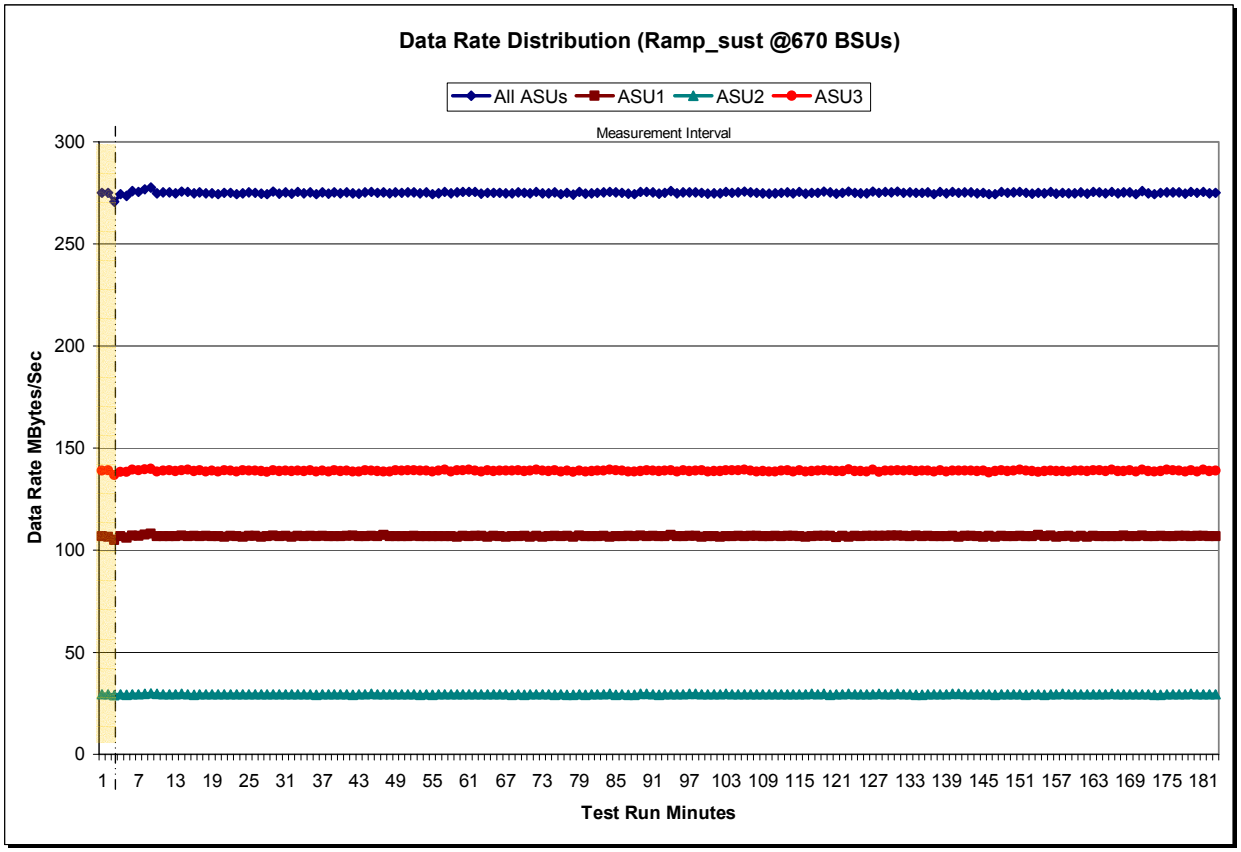
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	7:15:32	7:18:32	0-2	0:03:00
Measurement Interval	7:18:32	10:18:32	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	275.03	106.76	29.31	138.95	61	275.31	107.00	29.39	138.93	122	275.51	106.57	29.50	139.43
1	274.89	106.55	29.33	139.02	62	274.57	106.86	29.35	138.36	123	274.91	106.84	29.43	138.65
2	270.65	105.04	28.95	136.66	63	274.91	106.40	29.45	139.06	124	274.76	106.71	29.34	138.71
3	274.30	106.74	29.38	138.18	64	274.98	106.94	29.45	138.59	125	274.79	106.99	29.40	138.40
4	273.44	106.01	29.22	138.21	65	274.92	106.64	29.33	138.95	126	275.67	106.83	29.46	139.37
5	275.87	107.19	29.36	139.33	66	274.82	106.56	29.36	138.89	127	274.88	107.02	29.53	138.33
6	275.38	106.99	29.34	139.05	67	274.65	106.62	29.11	138.92	128	275.32	107.02	29.42	138.88
7	276.65	107.62	29.58	139.45	68	275.07	106.59	29.45	139.03	129	275.19	107.03	29.36	138.81
8	277.60	108.10	29.71	139.80	69	274.95	106.95	29.23	138.77	130	275.68	107.14	29.48	139.06
9	274.77	106.68	29.54	138.55	70	274.72	106.49	29.45	138.77	131	274.94	106.80	29.29	138.85
10	275.10	106.78	29.35	138.97	71	275.44	106.83	29.32	139.29	132	275.09	106.76	29.33	139.00
11	275.07	106.66	29.35	139.05	72	274.79	106.56	29.32	138.91	133	274.89	107.02	29.24	138.62
12	274.76	106.74	29.32	138.71	73	274.76	106.64	29.35	138.77	134	275.03	106.80	29.25	138.98
13	275.68	107.11	29.50	139.07	74	275.07	106.84	29.24	138.99	135	275.08	106.95	29.35	138.78
14	275.35	106.66	29.41	139.29	75	274.31	106.62	29.28	138.41	136	274.36	106.60	29.39	138.36
15	274.71	106.88	29.26	138.58	76	275.01	106.88	29.21	138.93	137	275.29	106.77	29.43	139.09
16	275.11	106.71	29.38	139.02	77	274.07	106.52	29.24	138.31	138	274.65	106.80	29.41	138.44
17	274.77	106.94	29.33	138.49	78	275.37	107.12	29.43	138.81	139	275.37	106.84	29.58	138.95
18	274.79	106.74	29.27	138.77	79	274.42	106.71	29.19	138.52	140	274.96	106.58	29.52	138.86
19	274.39	106.68	29.32	138.39	80	274.64	106.60	29.29	138.75	141	275.13	107.00	29.32	138.82
20	275.02	106.52	29.33	139.17	81	274.90	106.73	29.34	138.83	142	275.26	106.91	29.42	138.92
21	275.05	106.85	29.41	138.79	82	275.15	106.82	29.37	138.96	143	274.75	106.61	29.44	138.70
22	274.34	106.62	29.36	138.36	83	275.35	106.51	29.57	139.27	144	274.86	106.53	29.48	138.84
23	274.82	106.42	29.34	139.06	84	275.19	106.78	29.26	139.14	145	274.30	106.86	29.35	138.08
24	275.09	106.95	29.31	138.83	85	275.01	106.67	29.43	138.90	146	274.32	106.48	29.16	138.68
25	275.05	106.86	29.28	138.91	86	274.56	106.85	29.24	138.48	147	275.35	106.88	29.37	139.10
26	274.57	106.59	29.32	138.67	87	274.29	106.68	29.26	138.35	148	274.89	106.72	29.45	138.73
27	274.31	106.76	29.37	138.18	88	275.42	107.17	29.52	138.74	149	275.13	106.79	29.44	138.89
28	275.51	107.04	29.36	139.11	89	275.30	106.78	29.51	139.01	150	275.47	106.88	29.38	139.21
29	274.46	106.60	29.30	138.56	90	275.20	106.88	29.43	138.89	151	274.93	106.69	29.26	138.98
30	275.11	106.83	29.38	138.90	91	274.49	106.66	29.22	138.62	152	274.53	106.70	29.27	138.56
31	274.55	106.55	29.28	138.72	92	274.92	106.62	29.33	138.97	153	274.94	107.27	29.34	138.34
32	275.29	106.94	29.45	138.90	93	275.84	107.41	29.37	139.06	154	274.63	106.70	29.16	138.76
33	274.71	106.73	29.34	138.63	94	274.65	106.80	29.34	138.51	155	275.37	107.15	29.39	138.83
34	275.27	106.91	29.33	139.03	95	275.12	106.73	29.38	139.01	156	274.54	106.50	29.36	138.68
35	274.32	106.78	29.14	138.40	96	275.09	106.89	29.50	138.70	157	274.91	106.77	29.49	138.65
36	275.10	106.86	29.31	138.94	97	275.21	106.85	29.53	138.83	158	274.71	106.81	29.44	138.46
37	274.58	106.65	29.38	138.54	98	274.96	106.53	29.27	139.15	159	274.75	106.47	29.43	138.85
38	275.20	106.80	29.27	139.13	99	274.51	106.80	29.34	138.37	160	275.20	106.89	29.41	138.90
39	274.65	106.67	29.32	138.66	100	274.74	106.74	29.44	138.56	161	274.48	106.43	29.42	138.63
40	275.11	106.88	29.40	138.82	101	274.63	106.54	29.40	138.68	162	275.37	106.82	29.38	139.17
41	274.77	107.15	29.24	138.38	102	275.38	106.80	29.58	139.00	163	275.13	106.72	29.36	139.05
42	274.62	106.80	29.37	138.45	103	274.97	106.60	29.33	139.04	164	274.67	106.72	29.32	138.63
43	275.16	106.60	29.44	139.11	104	275.25	106.93	29.27	139.05	165	275.36	106.64	29.51	139.22
44	275.48	106.95	29.57	138.96	105	275.55	106.79	29.47	139.30	166	274.65	106.66	29.30	138.69
45	274.86	106.79	29.38	138.69	106	275.08	106.85	29.33	138.91	167	275.12	107.05	29.32	138.75
46	275.17	107.32	29.35	138.49	107	274.86	106.98	29.38	138.50	168	275.16	106.71	29.40	139.05
47	274.66	106.79	29.36	138.51	108	274.63	106.67	29.39	138.58	169	274.40	106.62	29.36	138.42
48	275.11	106.61	29.39	139.11	109	274.56	106.68	29.42	138.45	170	275.82	107.17	29.36	139.28
49	275.00	106.76	29.34	138.90	110	274.81	106.92	29.41	138.48	171	274.76	106.70	29.35	138.71
50	275.17	106.76	29.27	139.14	111	275.03	106.70	29.46	138.87	172	274.35	106.66	29.26	138.44
51	275.25	106.91	29.33	139.00	112	275.20	106.88	29.30	139.02	173	274.87	106.94	29.26	138.67
52	274.77	106.60	29.26	138.92	113	274.71	106.83	29.34	138.54	174	275.23	106.70	29.28	139.25
53	275.14	106.79	29.37	138.98	114	275.33	106.80	29.46	139.08	175	275.07	106.66	29.38	139.03
54	274.21	106.72	29.14	138.34	115	274.49	106.50	29.45	138.55	176	275.09	106.92	29.33	138.83
55	274.80	106.61	29.40	138.78	116	274.91	106.70	29.54	138.67	177	274.53	106.85	29.32	138.35
56	275.42	106.77	29.42	139.24	117	275.05	106.84	29.39	138.82	178	275.38	106.70	29.65	139.03
57	274.65	106.66	29.46	138.54	118	275.53	106.91	29.63	138.99	179	274.86	106.98	29.37	138.51
58	275.12	106.47	29.47	139.18	119	275.06	106.86	29.26	138.94	180	275.38	106.83	29.34	139.21
59	275.28	106.94	29.29	139.04	120	274.49	106.36	29.46	138.67	181	274.64	106.70	29.29	138.65
60	275.36	106.78	29.36	139.22	121	274.84	106.85	29.37	138.63	182	274.86	106.66	29.35	138.85

Sustainability – Data Rate Distribution Graph

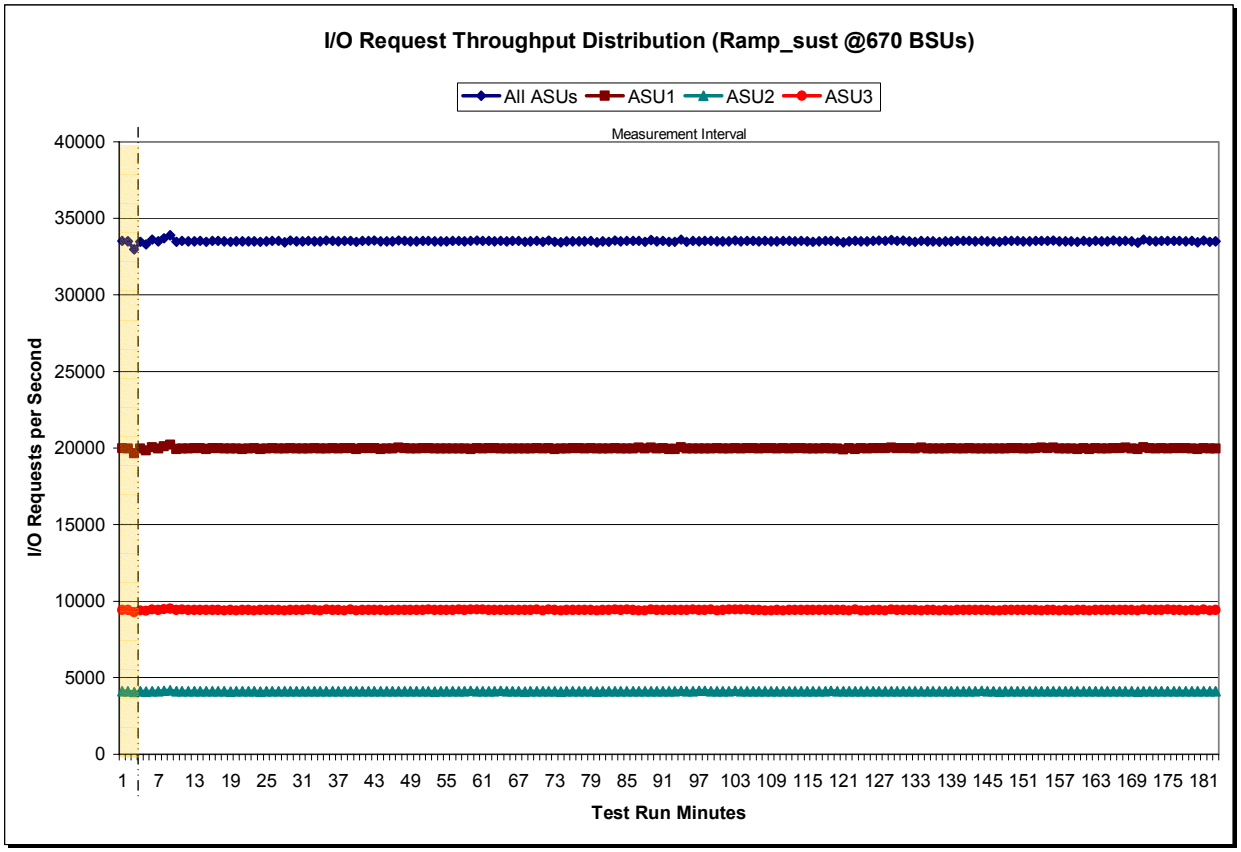


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	7:15:32	7:18:32	0-2	0:03:00
Measurement Interval	7:18:32	10:18:32	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	33,521.77	19,993.23	4,118.08	9,410.45	61	33,515.68	19,980.53	4,118.53	9,416.62	122	33,506.93	19,942.05	4,125.13	9,439.75
1	33,477.37	19,946.68	4,118.42	9,412.27	62	33,501.38	19,976.13	4,120.43	9,404.82	123	33,493.17	19,974.52	4,117.38	9,401.27
2	32,970.53	19,640.38	4,056.75	9,273.40	63	33,507.02	19,956.10	4,134.57	9,416.35	124	33,487.72	19,967.05	4,124.85	9,395.82
3	33,462.50	19,946.95	4,116.85	9,398.70	64	33,496.98	19,970.07	4,116.63	9,410.28	125	33,528.38	19,986.15	4,127.30	9,414.93
4	33,303.98	19,852.47	4,102.40	9,349.12	65	33,508.82	19,949.33	4,131.28	9,428.20	126	33,546.10	19,992.57	4,126.97	9,426.57
5	33,606.47	20,033.28	4,119.85	9,453.33	66	33,520.57	19,967.18	4,125.87	9,427.52	127	33,509.23	19,987.02	4,122.17	9,400.05
6	33,497.05	19,968.58	4,115.03	9,413.43	67	33,465.18	19,949.42	4,095.97	9,419.80	128	33,567.90	20,012.87	4,119.00	9,436.03
7	33,696.33	20,090.18	4,141.18	9,464.97	68	33,499.03	19,950.68	4,131.20	9,417.15	129	33,508.13	19,975.08	4,121.67	9,411.38
8	33,902.85	20,214.12	4,173.65	9,515.08	69	33,532.85	19,984.00	4,114.33	9,434.52	130	33,539.53	19,995.20	4,125.92	9,418.42
9	33,460.78	19,937.23	4,115.73	9,407.82	70	33,461.82	19,954.20	4,126.78	9,380.83	131	33,505.58	19,973.68	4,115.07	9,416.83
10	33,507.77	19,947.70	4,128.20	9,431.87	71	33,537.03	19,974.72	4,126.95	9,435.37	132	33,474.15	19,947.03	4,124.40	9,402.72
11	33,506.08	19,961.68	4,125.70	9,418.70	72	33,471.50	19,938.22	4,118.72	9,414.57	133	33,523.10	20,007.48	4,119.35	9,396.27
12	33,498.32	19,977.08	4,115.37	9,405.87	73	33,445.03	19,942.58	4,100.52	9,401.93	134	33,484.00	19,948.82	4,116.65	9,418.53
13	33,534.37	19,993.53	4,130.03	9,410.80	74	33,491.75	19,960.88	4,107.33	9,423.53	135	33,494.40	19,967.97	4,120.55	9,405.88
14	33,465.80	19,936.63	4,117.62	9,411.55	75	33,492.87	19,971.50	4,107.97	9,413.40	136	33,470.82	19,943.70	4,125.08	9,402.03
15	33,524.73	19,981.00	4,128.17	9,415.57	76	33,499.92	19,980.07	4,107.82	9,412.03	137	33,489.15	19,954.88	4,113.17	9,421.10
16	33,512.13	19,972.90	4,110.52	9,428.72	77	33,491.13	19,954.20	4,120.20	9,416.73	138	33,487.77	19,973.83	4,122.25	9,391.68
17	33,493.43	19,969.55	4,125.95	9,397.93	78	33,521.90	19,992.32	4,125.83	9,403.75	139	33,508.65	19,956.40	4,127.87	9,424.38
18	33,465.38	19,958.58	4,101.47	9,405.33	79	33,443.35	19,957.20	4,098.20	9,387.95	140	33,507.05	19,967.30	4,123.23	9,416.52
19	33,488.78	19,964.70	4,121.73	9,402.35	80	33,479.28	19,948.68	4,115.97	9,414.63	141	33,510.45	19,979.50	4,121.63	9,409.32
20	33,480.13	19,930.93	4,123.08	9,426.12	81	33,472.33	19,946.33	4,114.95	9,411.05	142	33,499.08	19,961.12	4,123.57	9,414.40
21	33,495.92	19,968.73	4,120.63	9,406.55	82	33,541.82	19,978.87	4,127.60	9,435.35	143	33,509.38	19,956.75	4,141.83	9,410.80
22	33,486.53	19,981.03	4,118.92	9,386.58	83	33,494.67	19,942.92	4,127.52	9,424.23	144	33,485.20	19,946.13	4,131.07	9,408.00
23	33,450.53	19,935.85	4,102.82	9,411.87	84	33,527.45	19,970.62	4,116.88	9,439.95	145	33,477.72	19,960.45	4,125.93	9,391.33
24	33,487.88	19,953.07	4,117.23	9,417.58	85	33,518.42	19,964.08	4,127.58	9,426.75	146	33,468.55	19,965.95	4,102.30	9,400.30
25	33,515.98	19,971.92	4,114.88	9,429.18	86	33,511.30	20,001.07	4,109.53	9,400.70	147	33,511.15	19,969.07	4,121.65	9,420.43
26	33,507.80	19,955.60	4,130.65	9,421.55	87	33,476.72	19,961.77	4,116.32	9,398.63	148	33,521.82	19,987.10	4,124.68	9,410.03
27	33,444.32	19,944.23	4,114.58	9,385.50	88	33,589.47	20,025.42	4,124.67	9,439.38	149	33,520.28	19,984.17	4,125.25	9,410.87
28	33,541.07	19,991.60	4,125.73	9,423.73	89	33,497.37	19,946.45	4,126.55	9,424.37	150	33,495.47	19,956.53	4,114.57	9,424.37
29	33,482.88	19,967.93	4,105.72	9,409.23	90	33,519.47	19,972.28	4,117.77	9,429.42	151	33,498.48	19,956.50	4,119.70	9,422.28
30	33,490.68	19,959.68	4,119.37	9,411.63	91	33,457.37	19,936.18	4,116.15	9,405.03	152	33,510.47	19,979.03	4,117.20	9,414.23
31	33,510.72	19,951.97	4,126.60	9,432.15	92	33,448.58	19,939.02	4,106.63	9,402.93	153	33,526.15	20,016.02	4,122.07	9,388.07
32	33,506.07	19,980.88	4,114.22	9,410.97	93	33,594.08	20,037.75	4,133.77	9,422.57	154	33,507.02	19,980.12	4,111.37	9,415.53
33	33,478.05	19,965.78	4,113.98	9,398.28	94	33,469.70	19,950.75	4,112.83	9,406.12	155	33,539.23	20,000.08	4,129.50	9,409.65
34	33,536.18	19,969.50	4,130.43	9,436.25	95	33,523.00	19,959.33	4,130.80	9,432.87	156	33,478.35	19,952.70	4,130.42	9,395.23
35	33,513.32	19,988.23	4,121.68	9,403.40	96	33,489.23	19,946.72	4,132.63	9,409.88	157	33,495.07	19,955.58	4,120.38	9,419.10
36	33,486.80	19,954.45	4,117.77	9,414.58	97	33,516.15	19,970.08	4,133.92	9,412.15	158	33,480.30	19,957.50	4,127.05	9,395.75
37	33,516.67	19,996.07	4,118.25	9,402.35	98	33,516.83	19,963.55	4,121.48	9,431.80	159	33,459.27	19,935.47	4,108.23	9,415.57
38	33,526.35	19,972.53	4,114.10	9,439.72	99	33,504.58	19,992.78	4,111.87	9,399.93	160	33,531.87	19,975.42	4,131.65	9,424.80
39	33,452.83	19,930.65	4,123.30	9,398.88	100	33,500.63	19,956.13	4,123.00	9,421.50	161	33,449.50	19,930.30	4,119.97	9,399.23
40	33,520.58	19,982.83	4,126.52	9,411.23	101	33,496.43	19,944.42	4,120.02	9,432.00	162	33,523.07	19,982.03	4,115.98	9,425.05
41	33,511.53	19,987.57	4,111.45	9,412.52	102	33,551.58	19,975.67	4,134.93	9,440.98	163	33,498.22	19,961.27	4,114.20	9,422.75
42	33,540.13	19,997.53	4,130.05	9,412.55	103	33,498.73	19,943.33	4,119.10	9,436.30	164	33,497.02	19,963.47	4,110.55	9,423.00
43	33,482.48	19,936.97	4,119.30	9,426.22	104	33,529.23	19,982.98	4,114.72	9,431.53	165	33,535.43	19,986.48	4,122.38	9,426.57
44	33,481.95	19,951.42	4,128.45	9,402.08	105	33,509.83	19,975.78	4,115.92	9,418.13	166	33,503.28	19,985.45	4,104.68	9,413.15
45	33,492.95	19,958.35	4,121.15	9,413.45	106	33,495.10	19,970.03	4,114.42	9,410.65	167	33,525.55	20,003.65	4,115.78	9,406.12
46	33,541.75	20,012.77	4,118.82	9,410.17	107	33,512.08	19,996.22	4,128.10	9,387.77	168	33,502.45	19,947.72	4,123.77	9,430.97
47	33,518.80	19,981.42	4,124.60	9,412.78	108	33,486.55	19,976.62	4,114.52	9,395.42	169	33,416.23	19,931.22	4,100.57	9,384.45
48	33,503.52	19,966.35	4,118.05	9,419.12	109	33,499.20	19,970.57	4,121.50	9,407.13	170	33,613.48	20,041.13	4,130.82	9,441.53
49	33,485.53	19,967.32	4,110.70	9,407.52	110	33,520.20	19,995.22	4,125.43	9,399.55	171	33,520.47	19,981.27	4,127.47	9,411.73
50	33,533.00	19,980.30	4,125.42	9,427.28	111	33,508.83	19,965.05	4,131.83	9,411.95	172	33,495.47	19,956.93	4,121.02	9,417.52
51	33,532.00	19,971.28	4,118.80	9,441.92	112	33,505.97	19,979.50	4,114.65	9,411.82	173	33,525.68	19,974.90	4,123.27	9,427.52
52	33,482.23	19,952.72	4,100.70	9,428.82	113	33,514.80	19,976.35	4,124.77	9,413.68	174	33,514.82	19,962.75	4,117.00	9,435.07
53	33,489.55	19,947.42	4,126.52	9,415.62	114	33,482.12	19,944.00	4,112.55	9,425.57	175	33,526.85	19,984.00	4,131.60	9,411.25
54	33,483.27	19,963.93	4,116.15	9,403.18	115	33,474.93	19,951.15	4,113.37	9,410.42	176	33,511.20	19,977.33	4,121.30	9,412.57
55	33,516.87	19,965.35	4,129.02	9,422.50	116	33,488.65	19,964.42	4,111.75	9,412.48	177	33,494.67	19,977.93	4,121.37	9,395.37
56	33,514.72	19,957.68	4,113.75	9,443.28	117	33,524.62	19,983.33	4,118.20	9,423.08	178	33,509.62	19,955.20	4,131.82	9,422.60
57	33,482.87	19,955.12	4,114.30	9,413.45	118	33,519.98	19,965.18	4,136.77	9,418.03	179	33,442.23	19,938.62	4,120.57	9,383.05
58	33,506.28	19,937.23	4,137.03	9,432.02	119	33,496.52	19,968.52	4,109.12	9,418.88	180	33,536.07	19,985.53	4,114.57	9,435.97
59	33,535.92	19,988.40	4,110.88	9,436.63	120	33,443.23	19,911.62	4,122.53	9,409.08	181	33,464.30	19,944.33	4,125.02	9,394.95
60	33,516.48	19,965.60	4,116.07	9,434.82	121	33,496.17	19,975.08	4,124.20	9,396.88	182	33,487.72	19,955.15	4,125.23	9,407.33
										Average	33,504.82	19,968.97	4,120.52	9,415.32

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	0.004	0.001	0.003	0.001	0.005	0.003	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.*

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 metrics -b 670
```

IOPS Test Results File

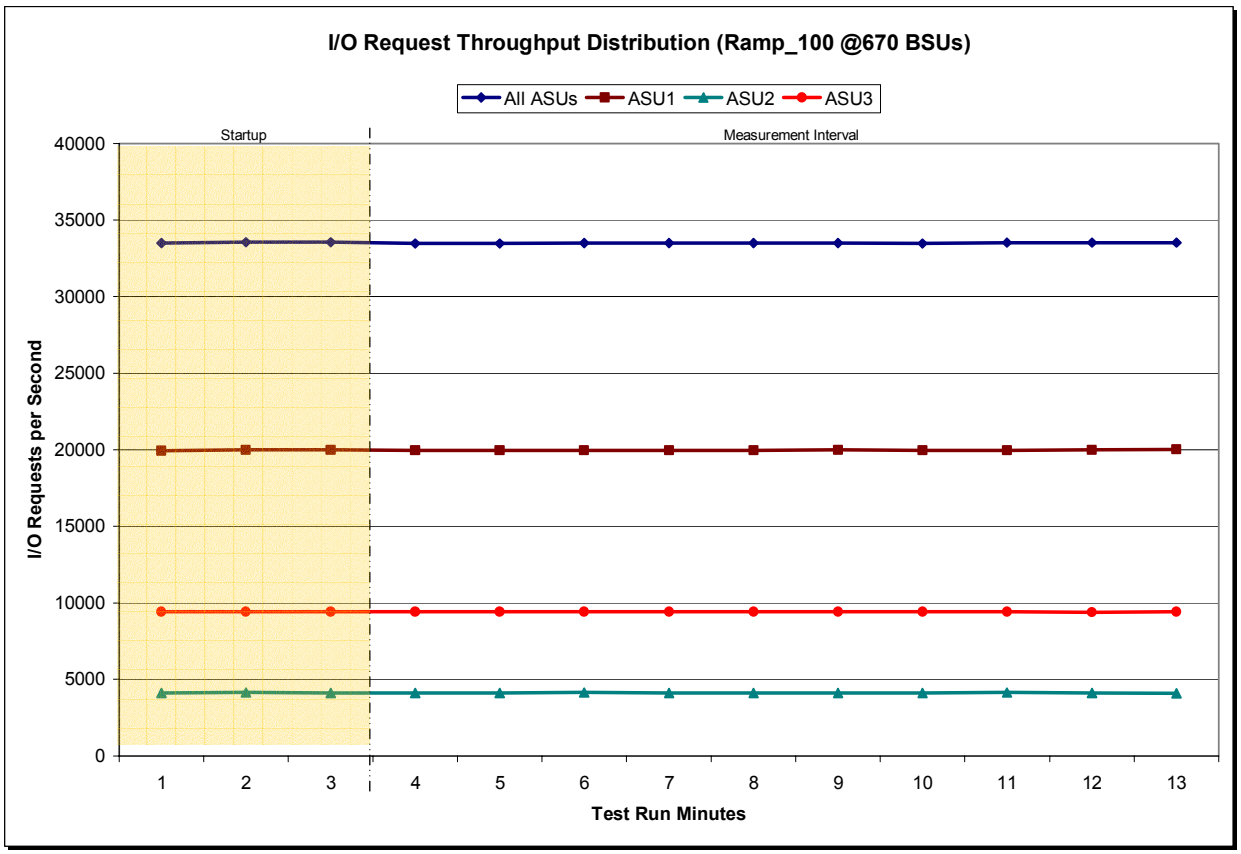
A link to the test results file generated from the IOPS Test Run is listed below.

IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

670 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:19:58	10:22:59	0-2	0:03:01
Measurement Interval	10:22:59	10:32:59	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	33,485.35	19,942.12	4,114.70	9,428.53
1	33,541.02	19,976.95	4,134.40	9,429.67
2	33,537.88	19,998.15	4,126.20	9,413.53
3	33,472.15	19,946.33	4,113.77	9,412.05
4	33,463.35	19,944.15	4,113.30	9,405.90
5	33,500.57	19,954.47	4,137.82	9,408.28
6	33,482.48	19,956.25	4,113.05	9,413.18
7	33,505.72	19,953.95	4,128.83	9,422.93
8	33,504.95	19,988.18	4,108.28	9,408.48
9	33,468.57	19,948.47	4,113.38	9,406.72
10	33,530.23	19,964.58	4,136.00	9,429.65
11	33,511.83	19,987.38	4,124.22	9,400.23
12	33,525.88	20,012.12	4,099.25	9,414.52
Average	33,496.57	19,965.59	4,118.79	9,412.20

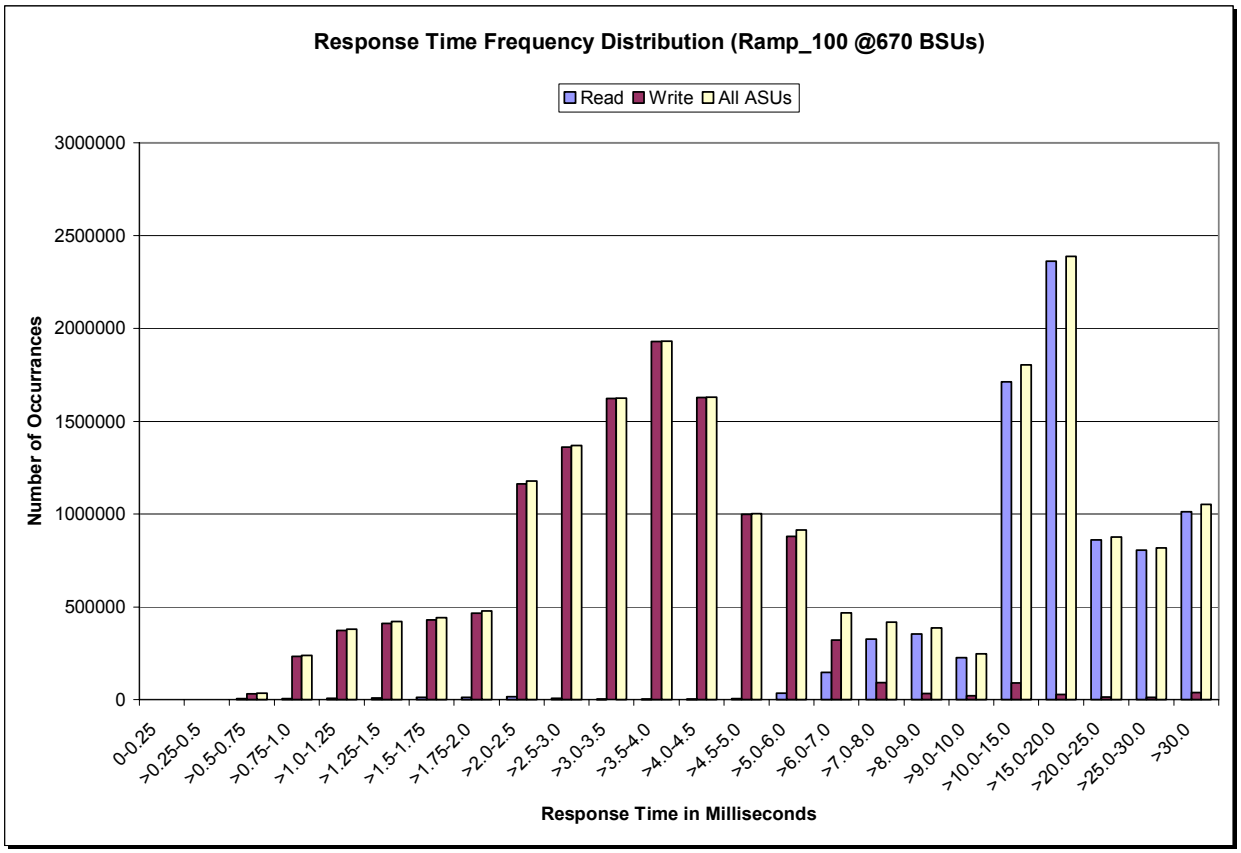
IOPS Test Run – I/O Request Throughput Distribution Graph



IOPS Test Run – Response Time Frequency Distribution Data

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	0	626	4,501	5,783	6,749	8,665	11,348	12,074
Write	0	107	31,709	231,663	373,323	411,300	430,364	465,277
All ASUs	0	733	36,210	237,446	380,072	419,965	441,712	477,351
ASU1	0	648	21,922	128,815	194,805	208,667	216,663	232,503
ASU2	0	54	4,060	28,319	44,342	47,205	48,901	52,205
ASU3	0	31	10,228	80,312	140,925	164,093	176,148	192,643
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	16,384	7,152	3,087	1,891	2,242	4,537	35,806	148,123
Write	1,161,609	1,361,155	1,621,918	1,929,674	1,627,752	997,188	878,327	320,360
All ASUs	1,177,993	1,368,307	1,625,005	1,931,565	1,629,994	1,001,725	914,133	468,483
ASU1	568,386	650,208	770,156	901,104	722,977	394,454	253,317	174,733
ASU2	130,788	151,153	180,156	211,742	170,534	92,915	54,584	19,315
ASU3	478,819	566,946	674,693	818,719	736,483	514,356	606,232	274,435
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	324,574	354,394	226,711	1,712,637	2,360,387	861,008	804,510	1,012,876
Write	93,402	32,937	20,637	89,576	27,633	14,969	11,640	39,096
All ASUs	417,976	387,331	247,348	1,802,213	2,388,020	875,977	816,150	1,051,972
ASU1	317,179	333,289	210,208	1,550,763	2,020,107	725,217	653,536	729,517
ASU2	27,247	33,499	25,931	207,215	350,513	141,252	153,823	295,468
ASU3	73,550	20,543	11,209	44,235	17,400	9,508	8,791	26,987

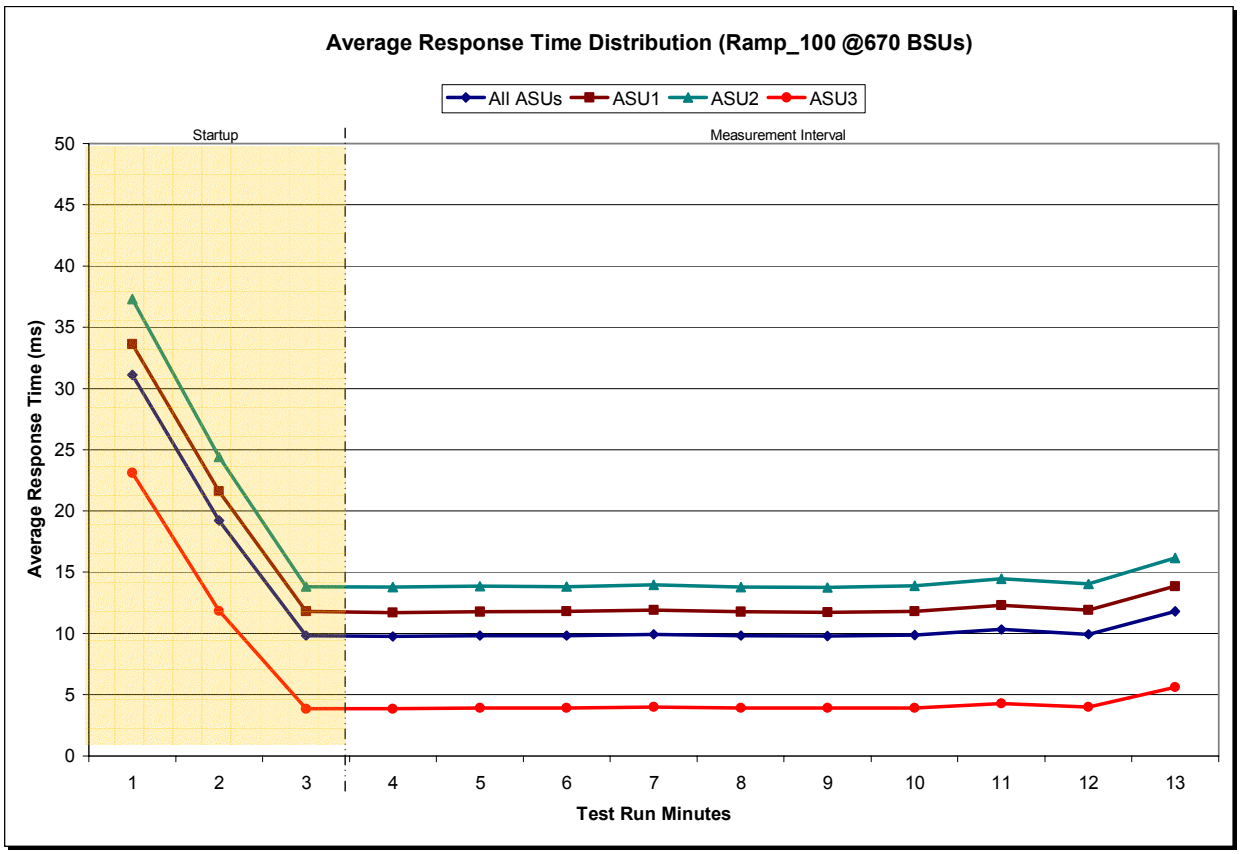
IOPS Test Run –Response Time Frequency Distribution Graph



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

670 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:19:58	10:22:59	0-2	0:03:01
Measurement Interval	10:22:59	10:32:59	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	31.12	33.64	37.28	23.11
1	19.21	21.62	24.42	11.83
2	9.82	11.80	13.82	3.86
3	9.76	11.71	13.78	3.87
4	9.83	11.78	13.85	3.92
5	9.84	11.80	13.83	3.91
6	9.94	11.92	13.95	3.99
7	9.81	11.76	13.79	3.93
8	9.79	11.75	13.74	3.91
9	9.86	11.81	13.91	3.94
10	10.32	12.31	14.48	4.30
11	9.95	11.91	14.03	3.99
12	11.82	13.85	16.16	5.60
Average	10.09	12.06	14.15	4.14

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
20,097,681	19,045,709	1,051,972

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	0.2101	0.0180	0.0700	0.0350	0.2810
COV	0.003	0.001	0.003	0.001	0.003	0.004	0.004	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 metrics -b 670

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 - 670 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:19:58	10:22:59	0-2	0:03:01
Measurement Interval	10:22:59	10:32:59	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	33,485.35	19,942.12	4,114.70	9,428.53
1	33,541.02	19,976.95	4,134.40	9,429.67
2	33,537.88	19,998.15	4,126.20	9,413.53
3	33,472.15	19,946.33	4,113.77	9,412.05
4	33,463.35	19,944.15	4,113.30	9,405.90
5	33,500.57	19,954.47	4,137.82	9,408.28
6	33,482.48	19,956.25	4,113.05	9,413.18
7	33,505.72	19,953.95	4,128.83	9,422.93
8	33,504.95	19,988.18	4,108.28	9,408.48
9	33,468.57	19,948.47	4,113.38	9,406.72
10	33,530.23	19,964.58	4,136.00	9,429.65
11	33,511.83	19,987.38	4,124.22	9,400.23
12	33,525.88	20,012.12	4,099.25	9,414.52
Average	33,496.57	19,965.59	4,118.79	9,412.20

95% Load Level - 636 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:33:28	10:36:29	0-2	0:03:01
Measurement Interval	10:36:29	10:46:29	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	31,822.02	18,999.32	3,910.67	8,912.03
1	31,777.05	18,947.60	3,912.55	8,916.90
2	31,815.78	18,967.57	3,925.25	8,922.97
3	31,802.57	18,965.80	3,907.95	8,928.82
4	31,828.70	18,978.25	3,918.27	8,932.18
5	31,808.98	18,962.77	3,921.45	8,924.77
6	31,801.38	18,949.00	3,903.22	8,949.17
7	31,832.25	18,992.40	3,906.75	8,933.10
8	31,817.15	18,986.25	3,920.60	8,910.30
9	31,782.13	18,959.65	3,900.50	8,921.98
10	31,788.72	18,934.00	3,918.95	8,935.77
11	31,805.98	18,946.27	3,913.20	8,946.52
12	31,783.40	18,958.70	3,902.03	8,922.67
Average	31,805.13	18,963.31	3,911.29	8,930.53

90% Load Level - 603 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:46:54	10:49:55	0-2	0:03:01
Measurement Interval	10:49:55	10:59:55	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	30,175.08	17,979.42	3,706.67	8,489.00
1	30,126.00	17,967.75	3,710.78	8,447.47
2	30,188.52	17,979.62	3,723.87	8,485.03
3	30,161.55	17,982.60	3,715.07	8,463.88
4	30,130.15	17,955.88	3,703.68	8,470.58
5	30,177.18	17,968.10	3,719.40	8,489.68
6	30,148.43	17,974.23	3,718.27	8,455.93
7	30,171.27	17,983.20	3,715.98	8,472.08
8	30,152.03	17,966.12	3,708.90	8,477.02
9	30,120.93	17,965.37	3,699.58	8,455.98
10	30,143.62	17,955.63	3,706.40	8,481.58
11	30,142.42	17,957.83	3,711.95	8,472.63
12	30,131.13	17,959.17	3,704.00	8,467.97
Average	30,147.87	17,966.81	3,710.32	8,470.74

80% Load Level - 536 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:00:19	11:03:20	0-2	0:03:01
Measurement Interval	11:03:20	11:13:20	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	26,810.98	15,976.37	3,287.35	7,547.27
1	26,812.75	15,965.40	3,306.03	7,541.32
2	26,810.28	15,977.15	3,289.25	7,543.88
3	26,780.38	15,958.55	3,300.12	7,521.72
4	26,783.43	15,966.08	3,297.45	7,519.90
5	26,800.97	15,987.90	3,301.42	7,511.65
6	26,840.55	15,987.87	3,312.38	7,540.30
7	26,786.80	15,968.00	3,291.43	7,527.37
8	26,823.95	15,988.67	3,307.35	7,527.93
9	26,791.82	15,954.22	3,301.87	7,535.73
10	26,792.27	15,968.35	3,304.90	7,519.02
11	26,801.78	15,986.93	3,293.07	7,521.78
12	26,827.20	15,985.62	3,302.60	7,538.98
Average	26,802.92	15,975.22	3,301.26	7,526.44

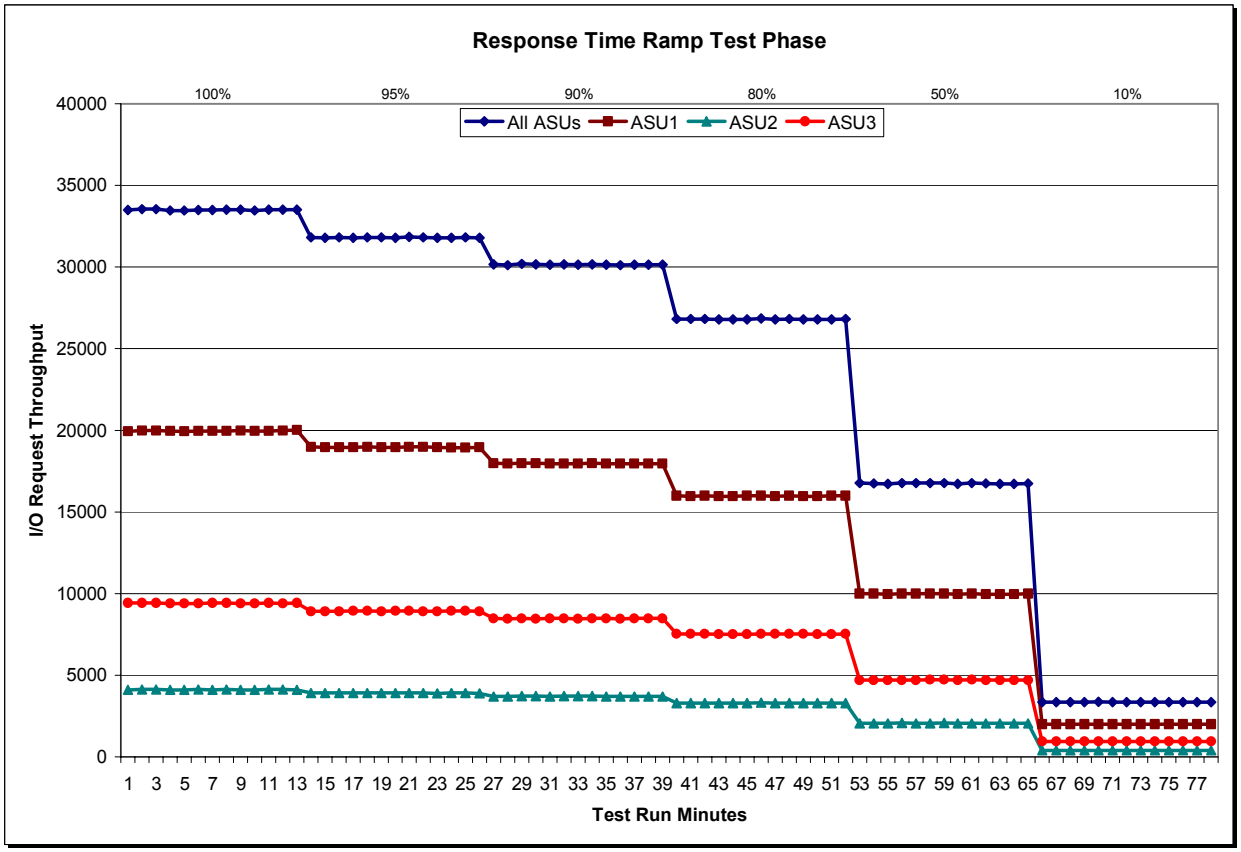
50% Load Level - 335 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:13:37	11:16:38	0-2	0:03:01
Measurement Interval	11:16:38	11:26:38	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	16,764.55	9,995.98	2,061.12	4,707.45
1	16,735.65	9,982.23	2,056.38	4,697.03
2	16,723.12	9,975.75	2,057.53	4,689.83
3	16,765.10	9,984.38	2,072.37	4,708.35
4	16,773.28	9,997.10	2,065.72	4,710.47
5	16,766.70	9,983.43	2,062.22	4,721.05
6	16,779.65	9,995.88	2,068.82	4,714.95
7	16,723.38	9,969.10	2,053.58	4,700.70
8	16,760.10	9,986.75	2,055.87	4,717.48
9	16,732.50	9,972.95	2,061.45	4,698.10
10	16,716.60	9,967.82	2,057.73	4,691.05
11	16,722.87	9,961.62	2,053.10	4,708.15
12	16,740.35	9,988.22	2,049.98	4,702.15
Average	16,748.05	9,980.73	2,060.08	4,707.25

10% Load Level - 67 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:26:51	11:29:52	0-2	0:03:01
Measurement Interval	11:29:52	11:39:52	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	3,341.73	1,987.33	413.35	941.05
1	3,346.68	1,996.85	410.60	939.23
2	3,354.88	2,001.33	413.08	940.47
3	3,354.30	2,003.32	412.75	938.23
4	3,367.03	2,001.37	415.85	949.82
5	3,342.23	1,993.92	415.70	932.62
6	3,354.22	1,998.07	411.82	944.33
7	3,352.67	2,003.55	410.35	938.77
8	3,354.08	2,005.22	409.85	939.02
9	3,338.63	1,987.38	410.87	940.38
10	3,344.50	1,999.17	408.73	936.60
11	3,342.07	1,998.45	410.23	933.38
12	3,338.97	1,988.65	413.23	937.08
Average	3,348.87	1,997.91	411.94	939.02

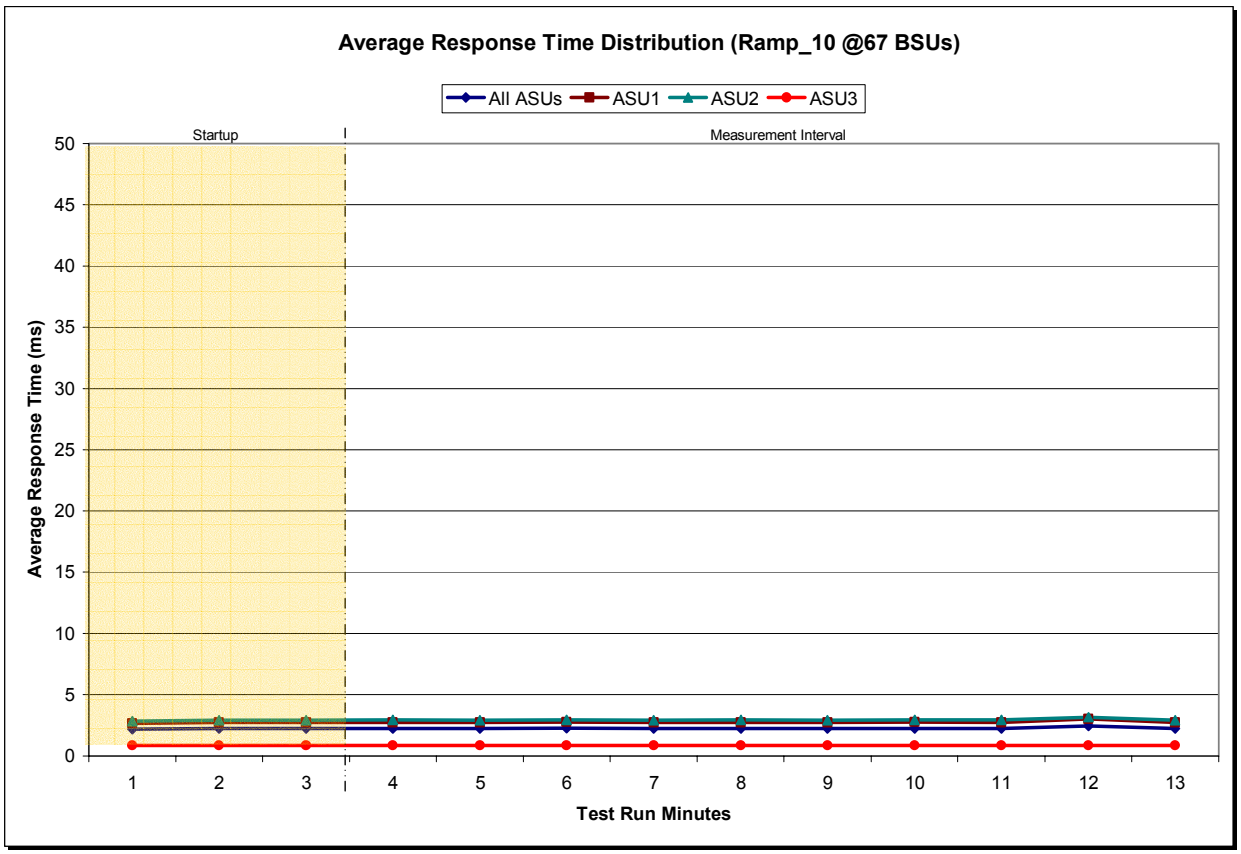
Response Time Ramp Distribution (IOPS) Graph



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

67 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:26:51	11:29:52	0-2	0:03:01
Measurement Interval	11:29:52	11:39:52	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.18	2.66	2.86	0.87
1	2.24	2.75	2.91	0.88
2	2.24	2.75	2.93	0.88
3	2.24	2.74	2.94	0.88
4	2.24	2.74	2.92	0.88
5	2.25	2.75	2.93	0.88
6	2.24	2.74	2.92	0.88
7	2.25	2.75	2.94	0.88
8	2.24	2.73	2.92	0.88
9	2.25	2.75	2.95	0.88
10	2.24	2.73	2.94	0.88
11	2.45	3.03	3.18	0.88
12	2.24	2.74	2.92	0.88
Average	2.26	2.77	2.96	0.88

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	0.0351	0.2813	0.0699	0.2103	0.0181	0.0699	0.0350	0.2804
COV	0.015	0.004	0.007	0.006	0.023	0.005	0.016	0.004

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 repeat1 -b 670

java –Xmx512m repeat2 -b 670

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	*33,496.57*	*2.26*
Repeatability Test Phase 1	33,514.62	2.23
Repeatability Test Phase 2	33,496.67	2.24

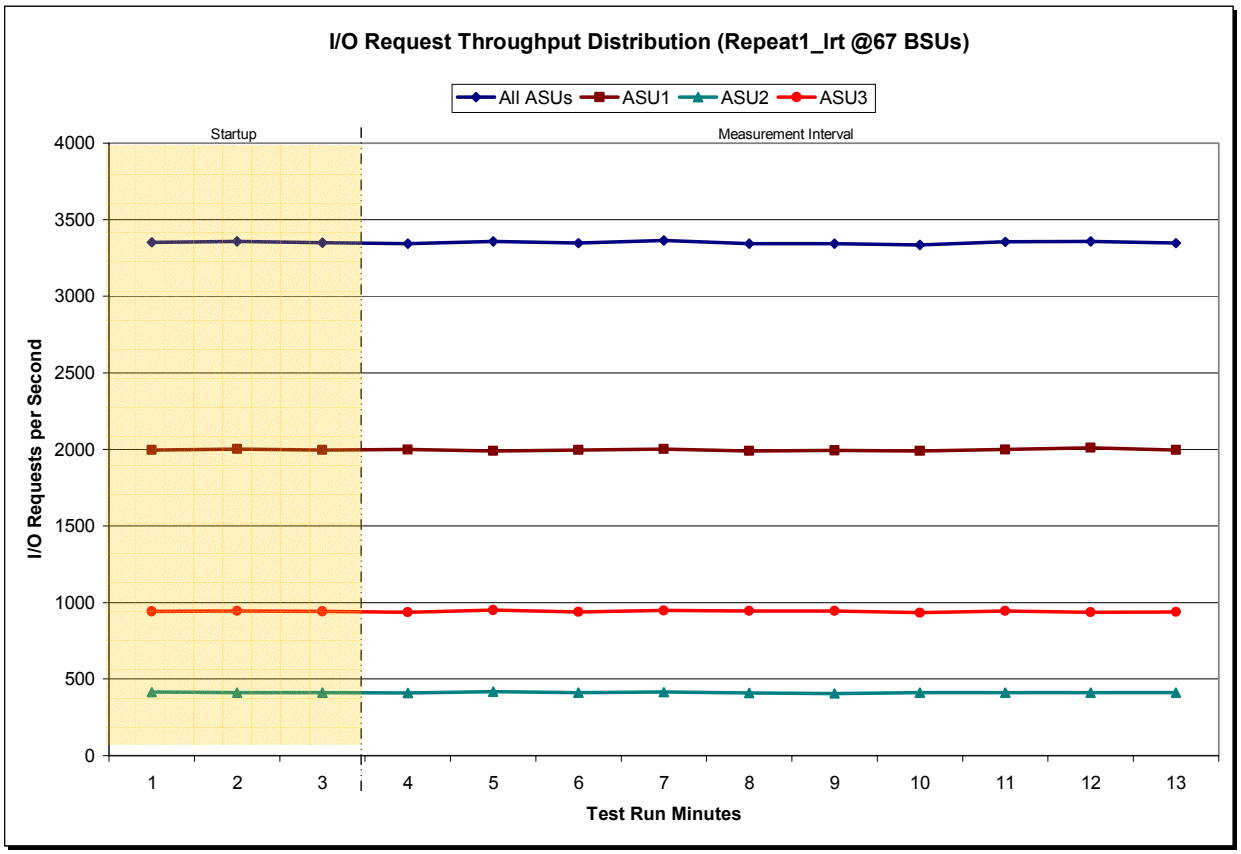
A link to the test result file generated from each Repeatability Test Run list is listed below.

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

67 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:40:15	11:43:15	0-2	0:03:00
Measurement Interval	11:43:15	11:53:15	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	3,350.77	1,994.70	415.63	940.43
1	3,356.62	2,000.32	411.43	944.87
2	3,348.75	1,995.23	411.05	942.47
3	3,342.55	1,999.05	408.12	935.38
4	3,358.60	1,990.97	418.43	949.20
5	3,345.82	1,996.05	410.43	939.33
6	3,362.80	2,001.07	414.07	947.67
7	3,344.38	1,990.05	409.85	944.48
8	3,342.90	1,992.27	407.28	943.35
9	3,334.87	1,989.68	411.20	933.98
10	3,353.53	1,997.20	413.07	943.27
11	3,357.70	2,009.00	411.68	937.02
12	3,347.25	1,997.03	412.82	937.40
Average	3,349.04	1,996.24	411.70	941.11

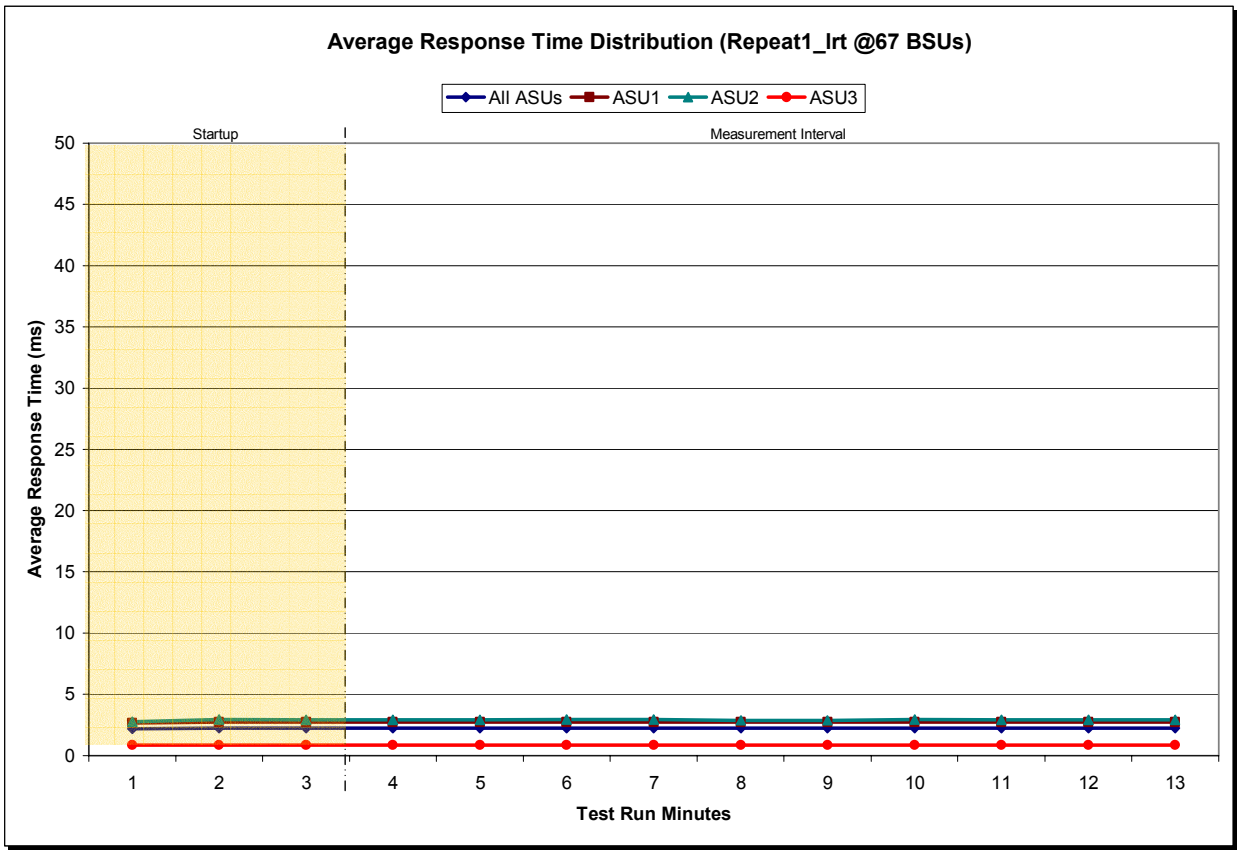
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

67 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:40:15	11:43:15	0-2	0:03:00
Measurement Interval	11:43:15	11:53:15	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.18	2.68	2.78	0.87
1	2.24	2.74	2.94	0.88
2	2.23	2.73	2.92	0.87
3	2.24	2.74	2.93	0.88
4	2.23	2.73	2.93	0.88
5	2.23	2.73	2.94	0.88
6	2.24	2.74	2.94	0.87
7	2.23	2.74	2.90	0.87
8	2.22	2.72	2.89	0.87
9	2.24	2.73	2.94	0.87
10	2.24	2.75	2.91	0.87
11	2.24	2.74	2.93	0.87
12	2.24	2.73	2.92	0.87
Average	2.23	2.73	2.92	0.87

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

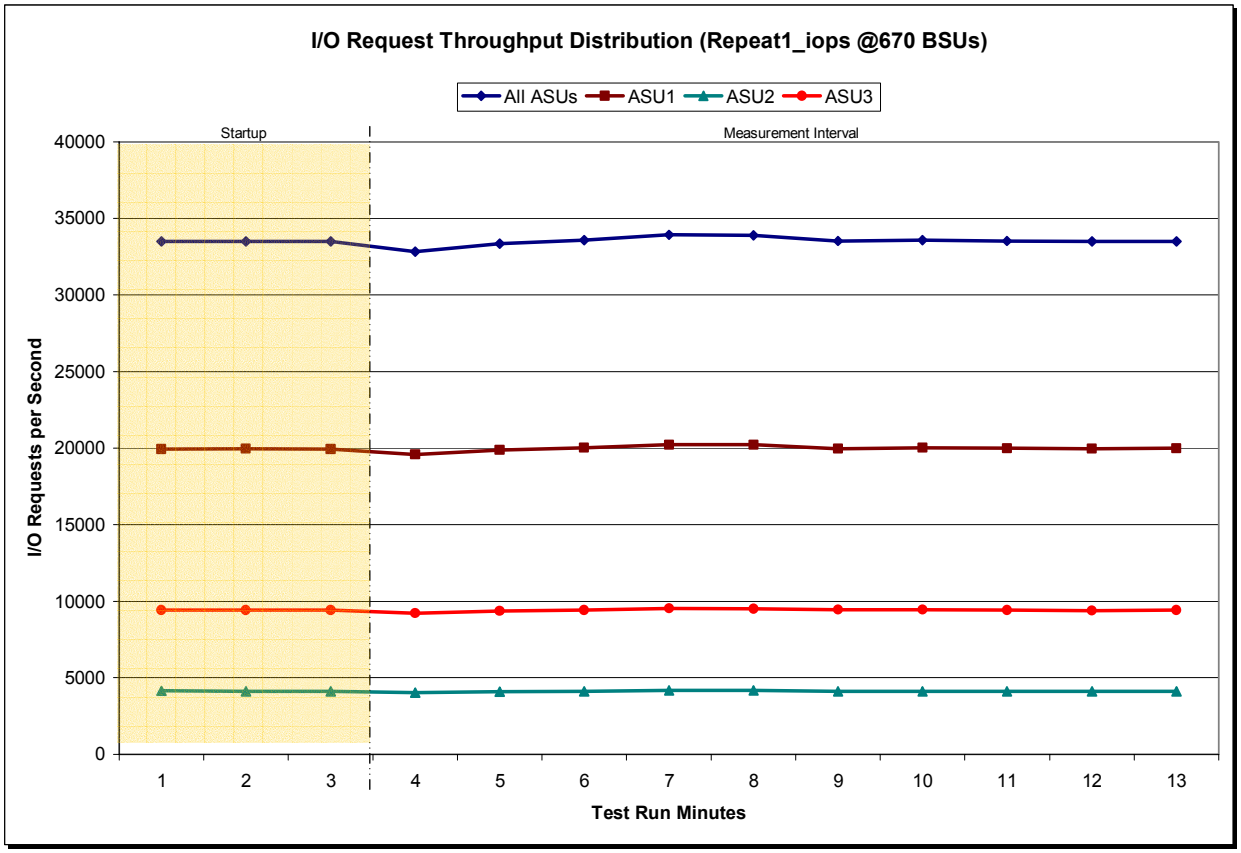


Repeatability 1 IOPS – I/O Request Throughput Distribution Data

670 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:53:45	11:56:46	0-2	0:03:01
Measurement Interval	11:56:46	12:06:46	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	33,486.70	19,935.12	4,132.78	9,418.80
1	33,498.93	19,953.83	4,126.23	9,418.87
2	33,481.35	19,937.47	4,125.90	9,417.98
3	32,826.50	19,575.57	4,037.23	9,213.70
4	33,343.27	19,869.12	4,100.62	9,373.53
5	33,564.30	20,019.20	4,120.60	9,424.50
6	33,927.45	20,211.62	4,172.98	9,542.85
7	33,902.62	20,219.83	4,178.63	9,504.15
8	33,510.22	19,960.58	4,116.88	9,432.75
9	33,569.40	20,020.52	4,117.52	9,431.37
10	33,518.77	19,979.77	4,119.23	9,419.77
11	33,477.77	19,954.62	4,120.90	9,402.25
12	33,505.87	19,973.27	4,118.25	9,414.35
Average	33,514.62	19,978.41	4,120.29	9,415.92

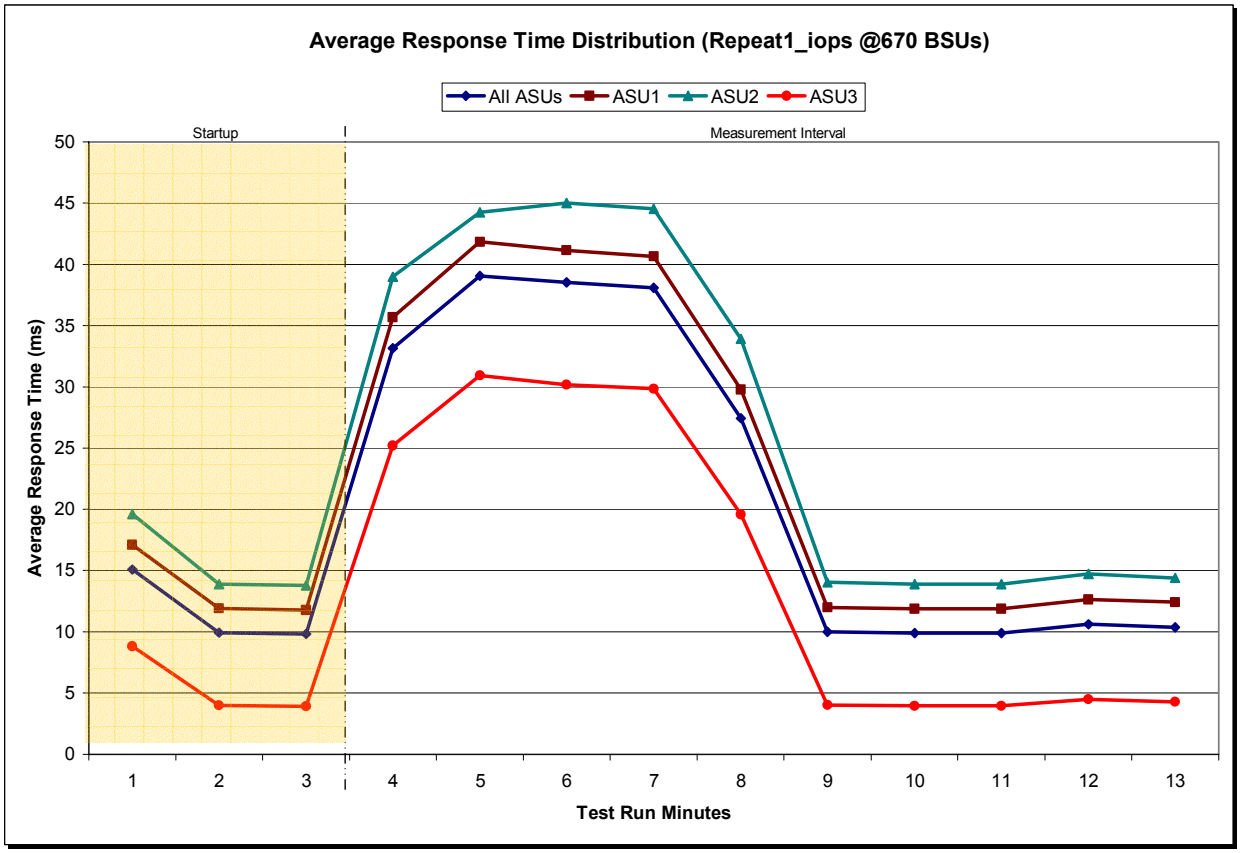
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

670 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:53:45	11:56:46	0-2	0:03:01
Measurement Interval	11:56:46	12:06:46	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	15.07	17.09	19.60	8.81
1	9.92	11.90	13.91	3.98
2	9.82	11.79	13.78	3.92
3	33.14	35.67	38.98	25.20
4	39.05	41.81	44.23	30.93
5	38.53	41.13	44.98	30.18
6	38.08	40.63	44.55	29.84
7	27.42	29.77	33.91	19.57
8	9.99	11.98	14.02	4.03
9	9.90	11.87	13.89	3.97
10	9.90	11.88	13.88	3.98
11	10.62	12.65	14.72	4.50
12	10.37	12.41	14.41	4.29
Average	22.70	24.98	27.76	15.65

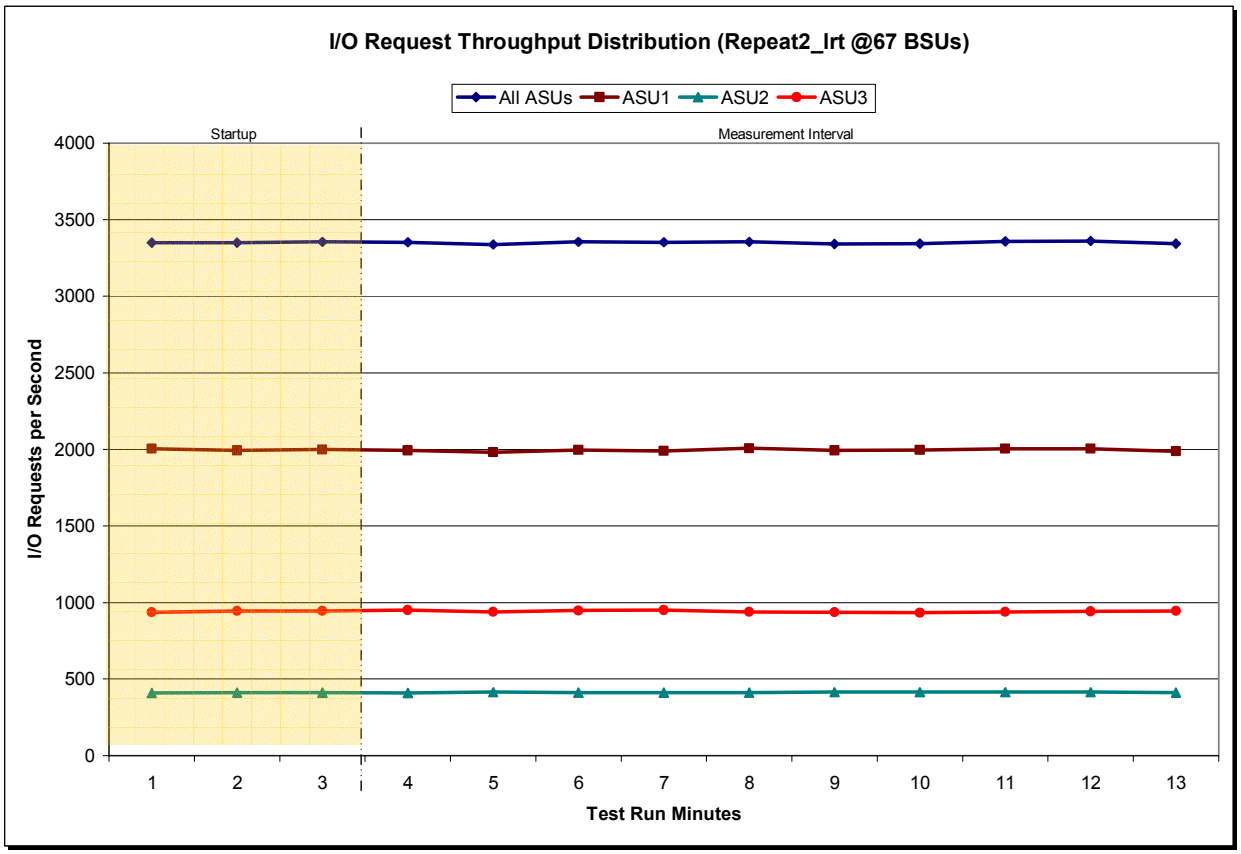
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

67 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:07:09	12:10:09	0-2	0:03:00
Measurement Interval	12:10:09	12:20:09	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	3,349.57	2,005.35	408.63	935.58
1	3,350.32	1,993.72	411.43	945.17
2	3,353.55	1,998.40	411.55	943.60
3	3,352.05	1,992.63	409.70	949.72
4	3,336.77	1,982.42	415.25	939.10
5	3,354.28	1,994.72	413.17	946.40
6	3,353.12	1,990.03	413.20	949.88
7	3,354.70	2,006.92	410.42	937.37
8	3,340.88	1,992.32	413.47	935.10
9	3,343.50	1,995.12	414.08	934.30
10	3,359.17	2,004.83	415.43	938.90
11	3,360.88	2,004.33	414.27	942.28
12	3,343.18	1,986.28	412.03	944.87
Average	3,349.85	1,994.96	413.10	941.79

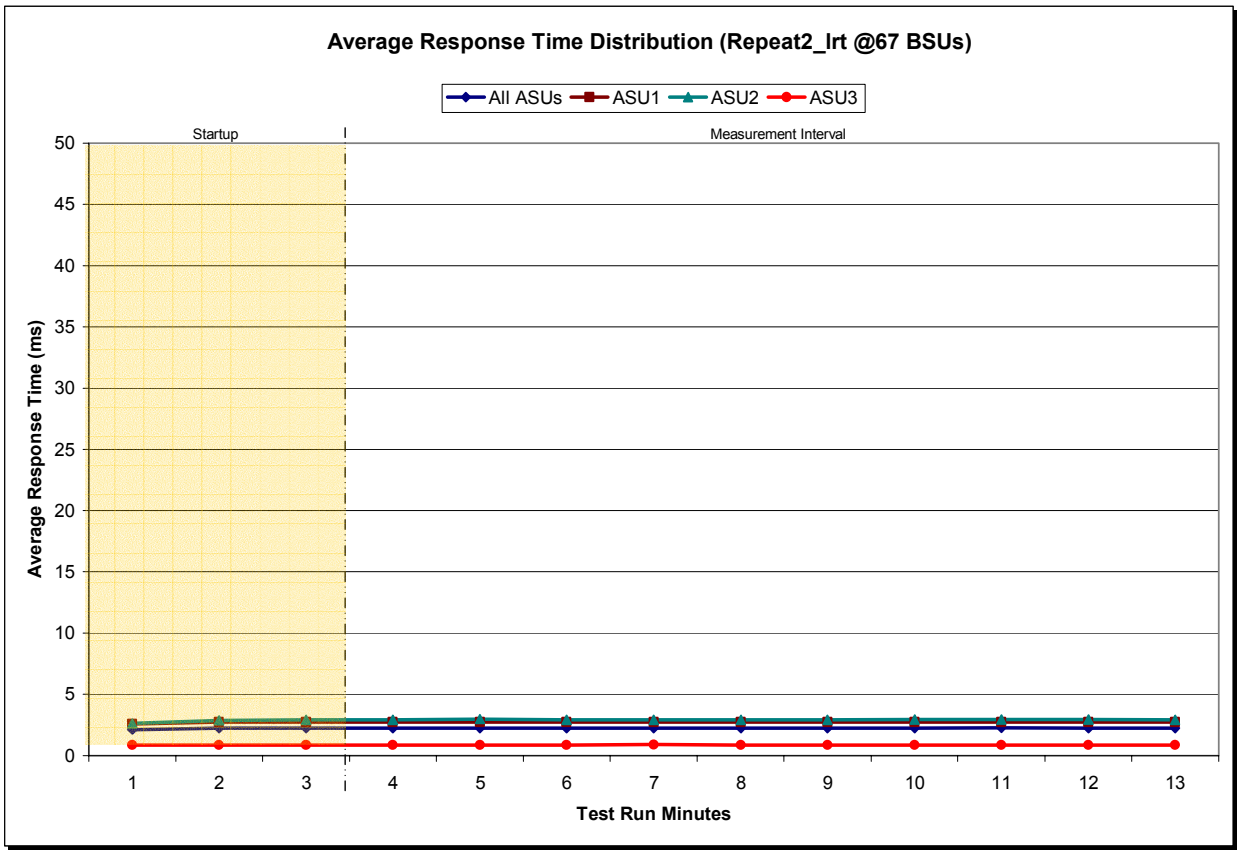
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

67 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:07:09	12:10:09	0-2	0:03:00
Measurement Interval	12:10:09	12:20:09	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.11	2.58	2.64	0.88
1	2.23	2.74	2.89	0.88
2	2.24	2.74	2.92	0.88
3	2.22	2.72	2.91	0.88
4	2.25	2.74	2.98	0.88
5	2.23	2.73	2.90	0.88
6	2.23	2.73	2.92	0.88
7	2.24	2.73	2.91	0.88
8	2.24	2.74	2.92	0.87
9	2.24	2.73	2.94	0.87
10	2.25	2.75	2.95	0.87
11	2.25	2.75	2.95	0.87
12	2.23	2.73	2.93	0.87
Average	2.24	2.74	2.93	0.88

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

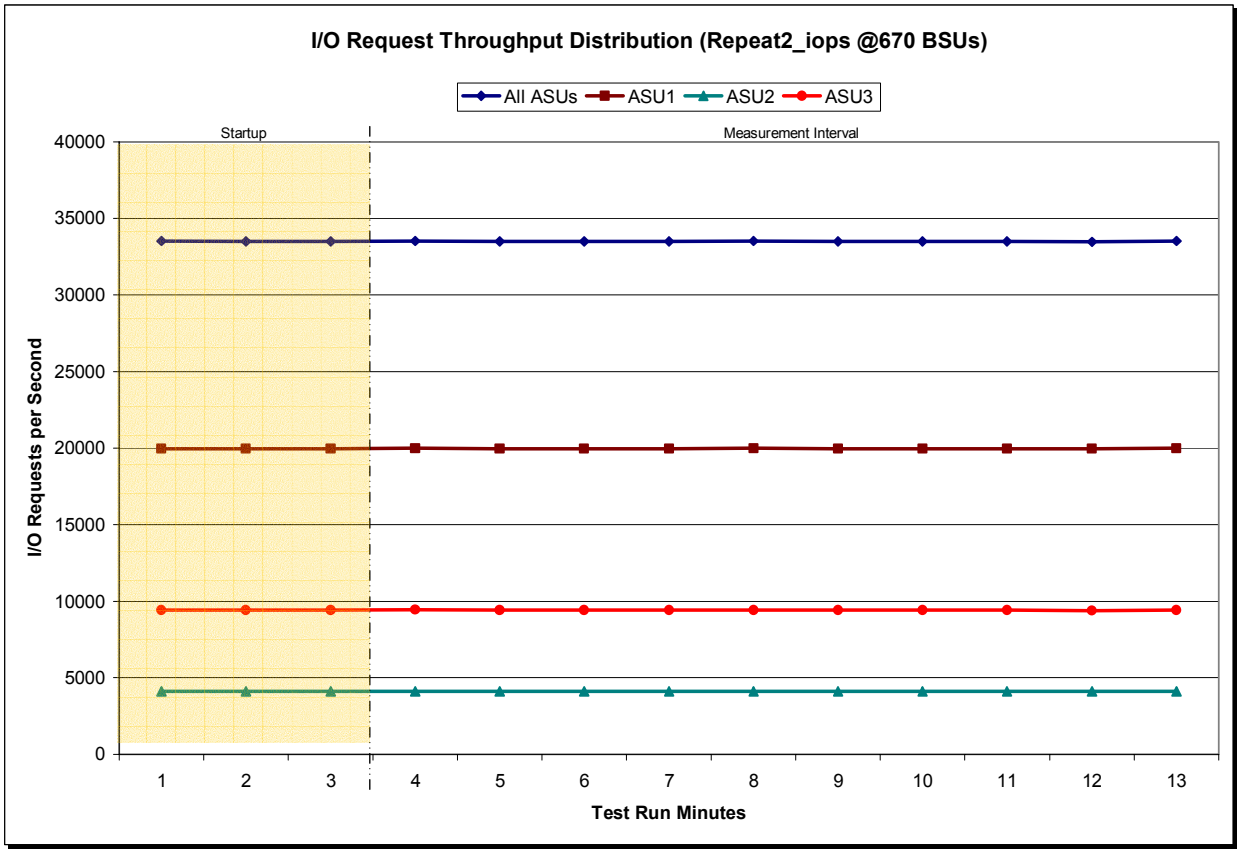


Repeatability 2 IOPS – I/O Request Throughput Distribution Data

670 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:20:39	12:23:40	0-2	0:03:01
Measurement Interval	12:23:40	12:33:40	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	33,515.07	19,958.05	4,130.57	9,426.45
1	33,477.38	19,948.82	4,106.77	9,421.80
2	33,485.87	19,951.52	4,128.13	9,406.22
3	33,530.25	19,981.70	4,115.25	9,433.30
4	33,483.65	19,956.33	4,115.55	9,411.77
5	33,496.82	19,966.00	4,117.80	9,413.02
6	33,481.47	19,960.82	4,112.23	9,408.42
7	33,533.07	19,979.88	4,124.32	9,428.87
8	33,491.92	19,960.32	4,116.67	9,414.93
9	33,488.83	19,955.70	4,114.62	9,418.52
10	33,479.82	19,944.75	4,125.85	9,409.22
11	33,460.15	19,951.03	4,109.13	9,399.98
12	33,520.73	19,982.27	4,128.77	9,409.70
Average	33,496.67	19,963.88	4,118.02	9,414.77

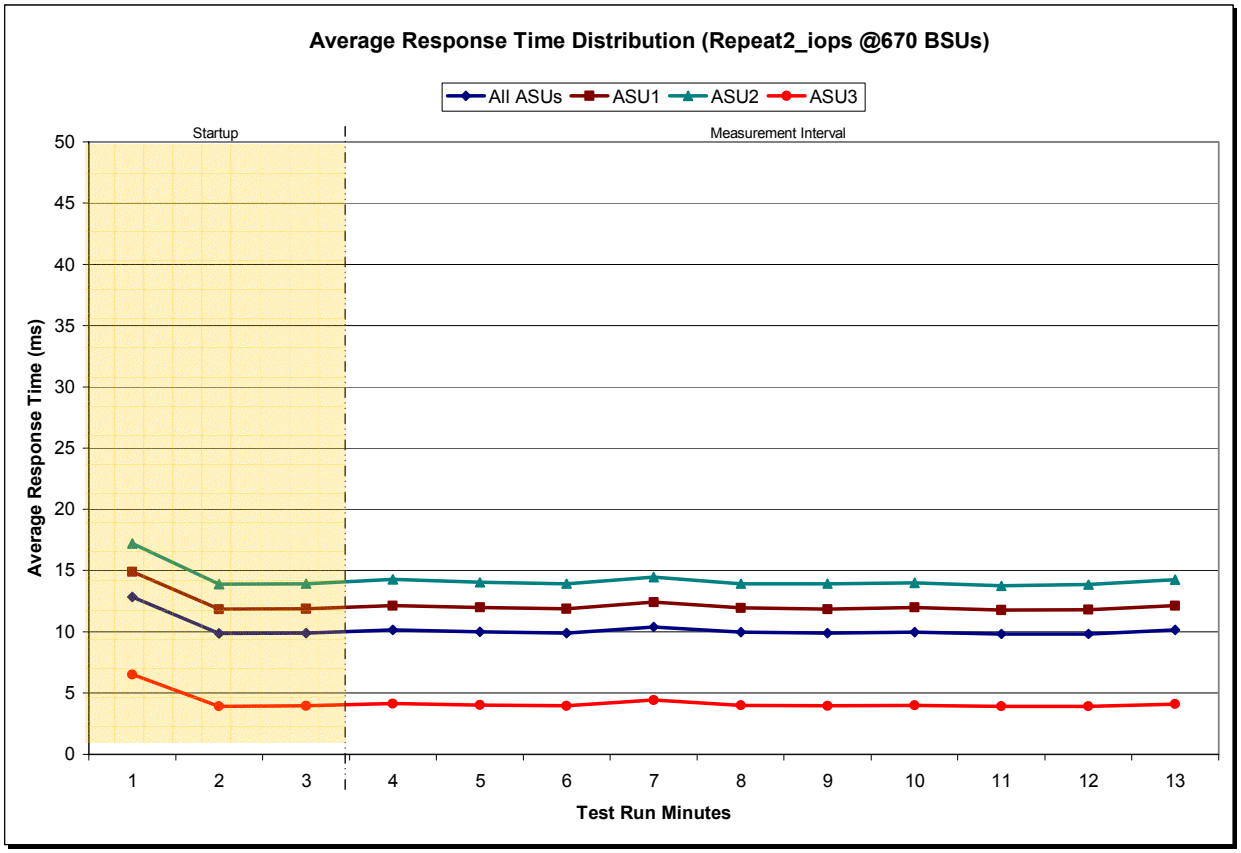
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

670 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:20:39	12:23:40	0-2	0:03:01
Measurement Interval	12:23:40	12:33:40	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	12.83	14.92	17.20	6.51
1	9.87	11.84	13.89	3.93
2	9.91	11.88	13.94	3.95
3	10.15	12.15	14.29	4.13
4	10.01	12.00	14.04	4.05
5	9.91	11.89	13.93	3.96
6	10.42	12.41	14.47	4.42
7	9.96	11.95	13.93	4.00
8	9.89	11.86	13.93	3.97
9	9.98	11.97	14.01	4.00
10	9.82	11.79	13.76	3.92
11	9.84	11.80	13.87	3.93
12	10.14	12.14	14.25	4.09
Average	10.01	11.99	14.05	4.05

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



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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0350	0.2808	0.0700	0.2102	0.0181	0.0701	0.0348	0.2810
COV	0.013	0.005	0.005	0.006	0.017	0.008	0.012	0.004

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	0.0350	0.2810	0.0700	0.2101	0.0180	0.0700	0.0350	0.2809
COV	0.003	0.001	0.002	0.001	0.004	0.002	0.005	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	0.0350	0.2808	0.0699	0.2099	0.0181	0.0701	0.0351	0.2811
COV	0.013	0.006	0.007	0.005	0.016	0.004	0.013	0.006

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	0.2101	0.0180	0.0700	0.0349	0.2811
COV	0.004	0.001	0.002	0.001	0.004	0.002	0.004	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 persist1 -b 670

java –Xmx512m 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	63,012,864
Total Number of Logical Blocks Verified	55,585,536
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.

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 Fujitsu Storage Systems ETERNUS3000 Model 600, as documented in this Full Disclosure Report will become available for customer purchase and shipment on July 31, 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 Remote Audit of the Fujitsu Storage Systems ETERNUS3000 Model 600.