



THE POSSIBILITIES ARE INFINITE

**SPC BENCHMARK 1™  
FULL DISCLOSURE REPORT**

**FUJITSU LIMITED  
FUJITSU STORAGE SYSTEMS  
ETERNUS3000 MODEL 600M**

**SPC-1 V1.7**

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**First Edition – August 2003**

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**Notes**

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

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

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## AUDIT CERTIFICATION



Fujitsu Limited  
 Fujitsu Technology Solutions, Inc.  
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 P.O. Box 3470  
 Sunnyvale, CA 94088-3470

August 11, 2003

The SPC Benchmark 1™ results listed below for the Fujitsu Storage Systems ETERNUS3000 Model 600M were produced in compliance with the SPC Benchmark 1™ V1.7 Remote Audit requirements.

SPC Benchmark 1™ V1.7 Results	
Tested Storage Configuration (TSC) Name: Fujitsu Storage Systems ETERNUS3000 Model 600M	
Metric	Reported Result
SPC-1 IOPS™	64,249.77
SPC-1 Price-Performance	\$32.72/SPC-1 IOPS™
Total ASU Capacity	15,609.000 GB
Data Protection Level	Mirroring
SPC-1 LRT™	2.31 ms
Total TSC Price (including three-year maintenance)	\$2,102,146.54

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).

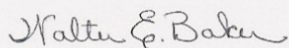
Storage Performance Council  
 643 Bair Island Road, Suite 103  
 Redwood City, CA 94062  
[AuditService@storageperformance.org](mailto:AuditService@storageperformance.org)  
 650.556.9384

- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, included customer tunable parameters.
- Commands and parameters used to configure the SPC-1 Workload Generator.
- 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  
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Redwood City, CA 94062  
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## LETTER OF GOOD FAITH



FUJITSU LIMITED  
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**Date:** 2003/7/14

**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 600M

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 600M. 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 600M is authentic and accurate.
3. The Fujitsu Storage System ETERNUS3000 Model 600M 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 600M 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	
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<b>Auditor</b>	Storage Performance Council – <a href="http://www.storageperformance.org">www.storageperformance.org</a> Walter E. Baker <a href="mailto:AuditService@storageperformance.org">AuditService@storageperformance.org</a> 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	
<b>SPC-1 Specification revision number</b>	V1.7
<b>SPC-1 Workload Generator revision number</b>	V2.0.1
<b>Date Results were first used publicly</b>	August 11, 2003
<b>Date FDR was submitted to the SPC</b>	August 11, 2003
<b>Date revised FDR was submitted to the SPC</b> Pricing and Price/Performance revised. <b>Revision History:</b> <b>March 4, 2004:</b> Company name change Email addresses changed resultant from above. Pricing and Price/Performance revised.	August 9, 2004
<b>Date the TSC is/was available for shipment to customers</b>	July 31, 2003
<b>Date the TSC completed audit certification</b>	August 11, 2003

## Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: Fujitsu Storage Systems ETERNUS3000 Model 600M	
Metric	Reported Result
SPC-1 IOPS™	64,249.77
SPC-1 Price-Performance	\$13.86/SPC-1 IOPS™
Total ASU Capacity	15,609.00 GB
Data Protection Level	Mirroring
SPC-1 LRT™	2.31 ms
Total TSC Price (including three-year maintenance)	\$890,497.00

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

**Total ASU (Application Storage Unit) Capacity** represents the total storage capacity read and written in the course of executing the SPC-1 benchmark. The Addressable Storage Capacity, which contains the Total ASU Capacity, was 15,697.569 GB. The Total ASU Capacity utilized 99.44% of the Addressable Storage Capacity. The actual Configured Storage Capacity was 32,588.098 GB, which included the multiple copies of user data required by a Data Protection Level of Mirroring. The Configured Storage Capacity utilized 93.24% of the priced Physical Storage Capacity of 34,950.867 GB.

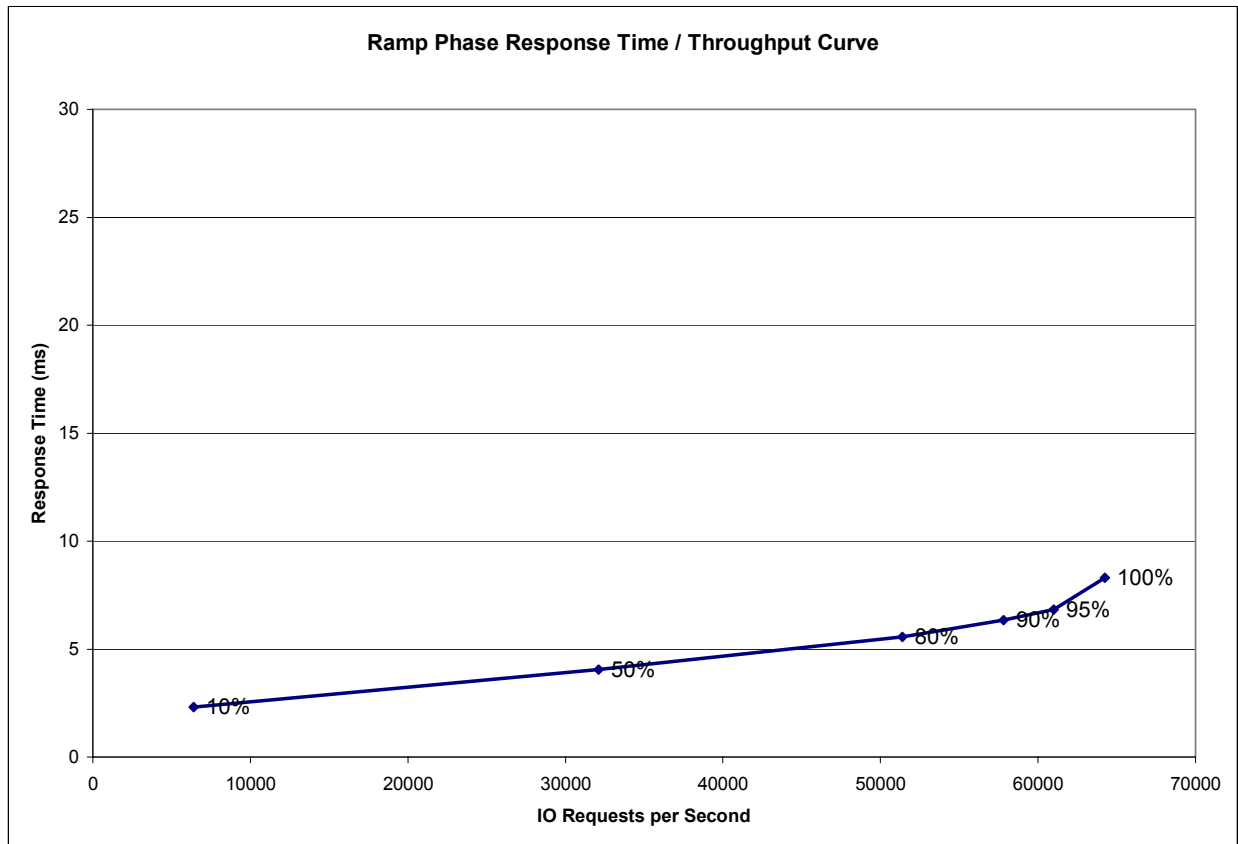
A **Data Protection Level** of Mirroring configures two or more identical copies of user data, maintained on separate disks.

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.



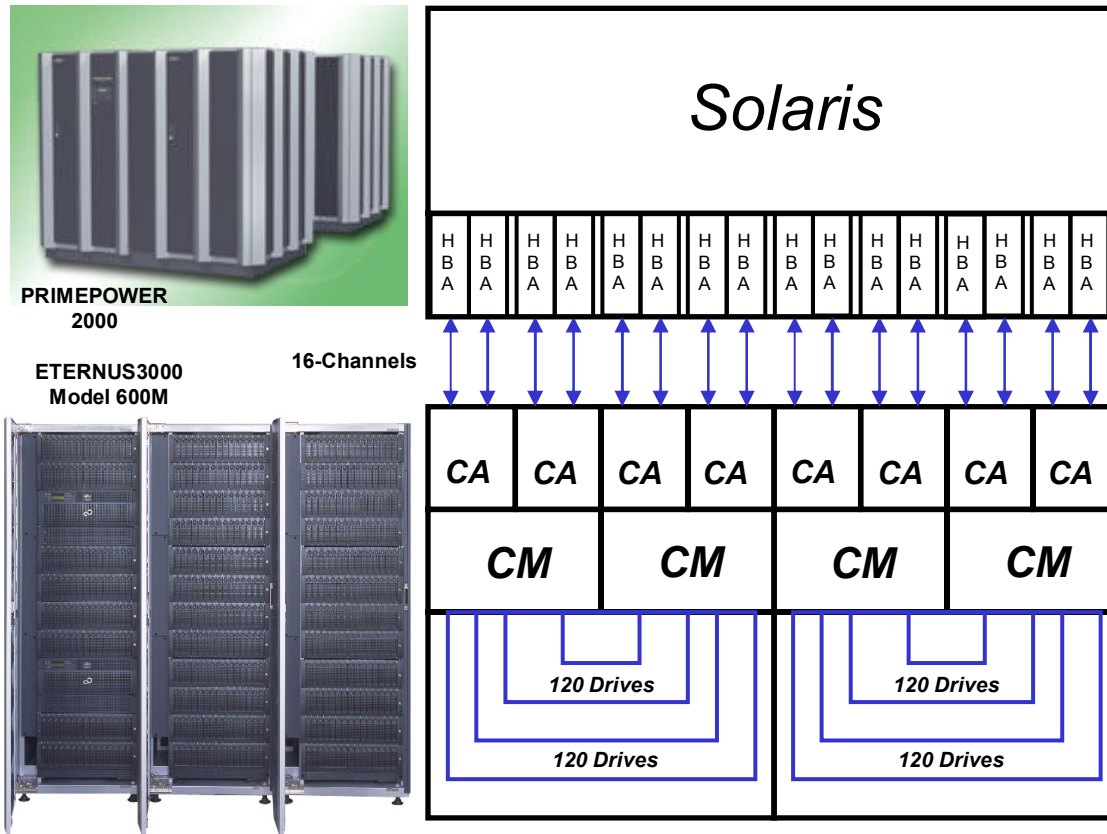
### Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
<b>I/O Request Throughput</b>	6,401.54	32,096.60	51,392.49	57,808.57	60,997.27	64,249.77
<b>Average Response Time (ms):</b>						
<b>All ASUs</b>	2.31	4.05	5.57	6.34	6.83	8.31
<b>ASU-1</b>	2.79	4.90	6.81	7.78	8.40	10.08
<b>ASU-2</b>	2.91	5.27	7.36	8.48	9.15	11.04
<b>ASU-3</b>	1.03	1.73	2.15	2.36	2.50	3.38
<b>Reads</b>	4.45	7.81	11.05	12.73	13.81	16.34
<b>Writes</b>	0.92	1.60	2.00	2.18	2.29	3.08

## Tested Storage Configuration Pricing

Item	Product Id	Description	Qty	Unit \$	Extd \$
1	E360S21A	ETERNUS3000 Model 600M without Door including 2x Controller Enclosures, 4x Controllers, each Controller with dual ports & 2GB Cache dual power supplies, dual battery units 4x drive enclosures, 4x 146GB disk drives 1800mm (36U) rack, 2x power distribution (200VAC) 8x FC cables (5m), 4x LAN cables (5m) rack mount kit, ETERNUSmgr & drivers slots for up to 60 disk drives	1	\$985,000	\$985,000
2	E300MR4	ETERNUS3000 Expansion rack without Door including 2x Expansion 1800mm (36U) rack 4x drive enclosures, 4x 146GB disk drives 4x power distribution (200 VAC) slots for up to 60 disk drives	1		
3	E300ME2	Drive Enclosure set of 4 - (rack mount 4x 3U) with slots for up to 60 disk drives	6		
4	E360MM8	Additional cache memory (4x 2GB)	1		
5	E360MHP8	Additional host interface (4x dual ports)	1		
6	E300MA7H	2x 73GB/15krpm Disk Drives	236		
7	CBL-MLLB15	Fibre Channel Cable	16	\$250	\$4,000
8	LP9002L	Emulex LP9002 HBA	16	\$2,795	\$44,720
9	A08974-M00000	Veritas Volume Manager	1	\$60,195	\$60,195
10		Maintenance VxVM - 3 years 24x7	1	\$32,505	\$32,505
11		Enhanced Plus Model 600M - Phone 24x7, On-site 24x7, with 4 hour response - 3 year Warranty Uplift Base w/ 4 DEs	1	\$28,512	\$28,512
12		Enhanced Plus Model 600M - Phone 24x7, On-site 24x7, with 4 hour response - 3 year Warranty Uplift per DE set (4)	7	\$26,928	\$188,496
<b>Total Product List Price</b>					<b>\$1,093,915</b>
				<b>Product Discount</b>	<b>30%</b>
<b>Net Product Price</b>					<b>\$765,741</b>
<b>Total Service List Price</b>					<b>\$249,513</b>
				<b>Service Discount</b>	<b>50%</b>
<b>Net Service Price</b>					<b>\$124,757</b>
<b>Total Sell Price, including 3 years Service</b>					<b>\$890,497</b>

**Benchmark Configuration/Tested Storage Configuration Diagram**



Host System:	Storage System:
Fujitsu PRIMEPOWER 2000	Fujitsu ETERNUS3000 Model 600M
UID=HS-1	UID=SC-1
64 SPARC64GP 675 MHz CPUs each with 128KB L1 Instruction Cache, 128KB L1 Data Cache, 8 MB L2 Cache	2 – Dual Control Modules, each with: 2.8 GHz Xeon CPU 4 GB Cache 2 dual channel FC Host interfaces
110 GB Main Memory	16 – Front side Fibre Channels (2 Gbit each)
Solaris 9	8 – Drive side Fibre Channel Loops (2 Gbit each)
16 - Emulex LP9002L Fibre Channel Host Bus Adapters (2 Gbit)	32 Drive Enclosure Modules, each with dual FC-AL interfaces 15 Hot Swap drive slots
Veritas Volume Manager 3.5	472 – 73GB disks, 8 – 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 2000:

```

***** START JCA *****
*
*
* IPC shared memory
*
*
set shmsys:shminfo_shmmax=0xffffffffffffffff
set shmsys:shminfo_shmmni=128
set shmsys:shminfo_shmseg=128

*
* IPC semaphores
*

set semsys:seminfo_semmap=4096
set semsys:seminfo_semmni=4096
set semsys:seminfo_semmns=4096
set semsys:seminfo_semmnu=4096
set semsys:seminfo_semume=64
set semsys:seminfo_semmsl=256

*
* IPC Messages
*

set msgsys:msginfo_msgmap=4096
set msgsys:msginfo_msgmni=4096
set msgsys:msginfo_msgssz=64
set msgsys:msginfo_msgtql=40000

*
* increase soft limit of the file descriptors from 256 to 1024

```

```

* hard limit now is 65536
set rlim_fd_cur = 1024

* buffer high water mark: limits the amount of RAM devoted to headers cache.

set bufhwm = 8000

* increase capability r
* do 4Mb IOs to *raw* devices, 32MB max.
set maxphys = 4194304

* Memory allocation parameters
set vxio:voliomem_chunk_size = 1048576

* I/O related parameters
set vxio:vol_default_iodelay = 10
set vxio:vol_maxkiocount = 32768
set vxio:vol_maxioctl = 131072
set vxio:vol_maxio = 8192
set vxio:vol_maxspecialio = 10240

*
* VxVM related
*
set maxpgio = 65536
set fastscan = 65536

*
* UFS related
* filesystem write throttling high/low watermark
*
set ufs:ufs_HW = 20971520
set ufs:ufs_LW = 15728640

* cool fsflushr on big memory machines
set autoup = 1024
set tune_t_fsflushr = 1

**** END JCA ****

```

## 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",
              "21ff00e000a8ffc5:lpfc9t0",
              "22ff00e000a8ffc5:lpfc10t0",
              "23ff00e000a8ffc5:lpfc11t0",
              "24ff00e000a8ffc5:lpfc12t0",
              "25ff00e000a8ffc5:lpfc13t0",
              "26ff00e000a8ffc5:lpfc14t0",
              "27ff00e000a8ffc5:lpfc15t0",
              "28ff00e000a8ffc5:lpfc19t0";

```



```
*****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 Transmit Queue Size*****
xmt-que-size=256;

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

*****Set number of IOCB buffers*****
num-iocbs=1024;

*****Set number of ELS buffers*****
num-bufs=1024;

*****Set Topology Loop Mode*****
topology=4;
```

## 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.

Entries in “sd.conf” were defined to enable the Emulex HBA for accessing LUNs defined in the ETERNUS3000. A list of those entries is located on Page 55, Appendix A: Emulex HBA “sd.conf” Entries.

The following scripts (**listdisks.sh**, **labeldisks.sh**, **fmtdisks.sh**, and **makevx2vi**) 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.

### **makevx2vi**

The **makevx2vi** script is used to create the VxVM logical volumes based on the configuration description file, **Q6-a1.txt**.

### **Q6-a1.txt**

The **Q6-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.

The actual script contents and commands are located on Page 58, Appendix B: TSC Creation/Configuration Scripts and Commands.

## **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:

```
javaparms="-Xmx3072m"  
sd=asu1_1,lun=/dev/vx/rdisk/asu1-1/asu1-1data-01,size=878g  
sd=asu1_2,lun=/dev/vx/rdisk/asu1-1/asu1-1data-01b,size=878g  
sd=asu1_3,lun=/dev/vx/rdisk/asu1-2/asu1-2data-01,size=878g  
sd=asu1_4,lun=/dev/vx/rdisk/asu1-2/asu1-2data-01b,size=878g  
sd=asu1_5,lun=/dev/vx/rdisk/asu1-3/asu1-3data-01,size=878g  
sd=asu1_6,lun=/dev/vx/rdisk/asu1-3/asu1-3data-01b,size=878g  
sd=asu1_7,lun=/dev/vx/rdisk/asu1-4/asu1-4data-01,size=878g  
sd=asu1_8,lun=/dev/vx/rdisk/asu1-4/asu1-4data-01b,size=878g  
sd=asu2_1,lun=/dev/vx/rdisk/asu2-1/asu2-1data-01,size=878g  
sd=asu2_2,lun=/dev/vx/rdisk/asu2-1/asu2-1data-01b,size=878g  
sd=asu2_3,lun=/dev/vx/rdisk/asu2-2/asu2-2data-01,size=878g  
sd=asu2_4,lun=/dev/vx/rdisk/asu2-2/asu2-2data-01b,size=878g  
sd=asu2_5,lun=/dev/vx/rdisk/asu2-3/asu2-3data-01,size=878g  
sd=asu2_6,lun=/dev/vx/rdisk/asu2-3/asu2-3data-01b,size=878g  
sd=asu2_7,lun=/dev/vx/rdisk/asu2-4/asu2-4data-01,size=878g  
sd=asu2_8,lun=/dev/vx/rdisk/asu2-4/asu2-4data-01b,size=878g  
sd=asu3_1,lun=/dev/vx/rdisk/asu3-1/asu3-1data-01,size=780.5g  
sd=asu3_2,lun=/dev/vx/rdisk/asu3-1/asu3-1data-01b,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)	15,609.000
Addressable Storage Capacity	Gigabytes (GB)	15,697.569
Configured Storage Capacity	Gigabytes (GB)	32,588.098
Physical Storage Capacity	Gigabytes (GB)	34,950.867
User Data Copy (Mirroring)	Gigabytes (GB)	15,697.569
Required Storage (metadata) & Hot Spares	Gigabytes (GB)	1,192.961
Global Storage Overhead	Gigabytes (GB)	10.737
Total Unused Storage	Gigabytes (GB)	2,529.169

The Required Storage consisted of 71.404 GB used for VERITAS Volume Manager metadata. The Hot Spares consisted of eight (8) disk devices with a formatted capacity of 140.195 GB per disk device for a total capacity of 1,121.557 GB. The Physical Storage Capacity consisted of 472 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 88.569 GB of Unused Storage. The Physical Storage Capacity contained an additional 2,352.031 GB of Unused Storage, which resulted in 2,529.169 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).

Physical Capacity (GB)							
34,950.867							
Configured Capacity (GB)							
32,588.098							
Addressable Capacity (GB)			Addressable (Mirror, GB)			Metadata & Hot Spares	Global Ovhd
15,697.569			15,697.569				
ASU Capacity (GB)			ASU (Mirror, GB)			1,192.961	2,352.031
15,609.000			15,609.000				
ASU1	ASU2	ASU3	unused 88.6				
7,024.0	7,024.0	1,561.0	unused 88.6			10.737	

**SPC-1 Storage Hierarchy Ratios**

SPC-1 Storage Hierarchy Ratios			
	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	99.44%	47.90%	44.66%
User Data Copy (Mirror)		48.17%	44.91%
Addressable Storage Capacity		48.17%	44.91%
Required Storage (metadata) & Hot Spares		3.66%	3.41%
Configured Storage Capacity			93.24%
Global Storage Overhead			0.03%
Unused Storage	0.56%	0.54%	7.24%

The Addressable Storage Capacity contained 0.56% (88.569 GB) of Unused Storage. The Configured Storage Capacity contained 0.54% (88.569 GB \*2) of Unused Storage. The Physical Storage Capacity contained 7.24% (2,351.031 GB + 88.569 GB + 88.569 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 (7,024.000 GB)	ASU-2 (7,024.000 GB)	ASU-3 (1,561.500 GB)
8 Logical Volume 883.144 GB per Logical Volume (878.000 GB used/Logical Volume)	8 Logical Volume 883.144 GB per Logical Volume (878.000 GB used/Logical Volume)	2 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

The ETERNUS3000 Model 600M consists of two sections, each with two Controllers and with 240 disk drives. For purposes of this discussion, they are designated Control Sections A & B.

RAID Group Assignments are RAID0+1(2+2) sets, each divided into 9 Logical Volumes, for a total of 1062 LVs. These are grouped into eight separate sets of LUNs, using Host Affinity grouping, two with 126 LUNs and six with 135 LUNs

**Control Section A RAID Group Assignments**

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

**Control Section B RAID Group Assignments**

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

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 DE00 & DE20. 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 in each Control Section 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.

RAID Groups 38, 39, & 3A in each Control Section are not used in the tested configuration, but the drives are included in the configuration pricing. 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. A total of 126 LUNs are used in each of the eight Host Affinity groups to form the VxVM Volume Groups.

The LUNs, seen through the sixteen HBAs by Solaris, are grouped into VxVM Volume Groups, with each broken into two VxVM Logical Volumes, and used with 16 MB stripe units across the sets. Eight Logical Volumes, each with 112 LUNs are used for ASU1 and another eight for ASU2, while two Volumes, also each with 112 LUNs are 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 1285
```

### **Sustainability Test Results File**

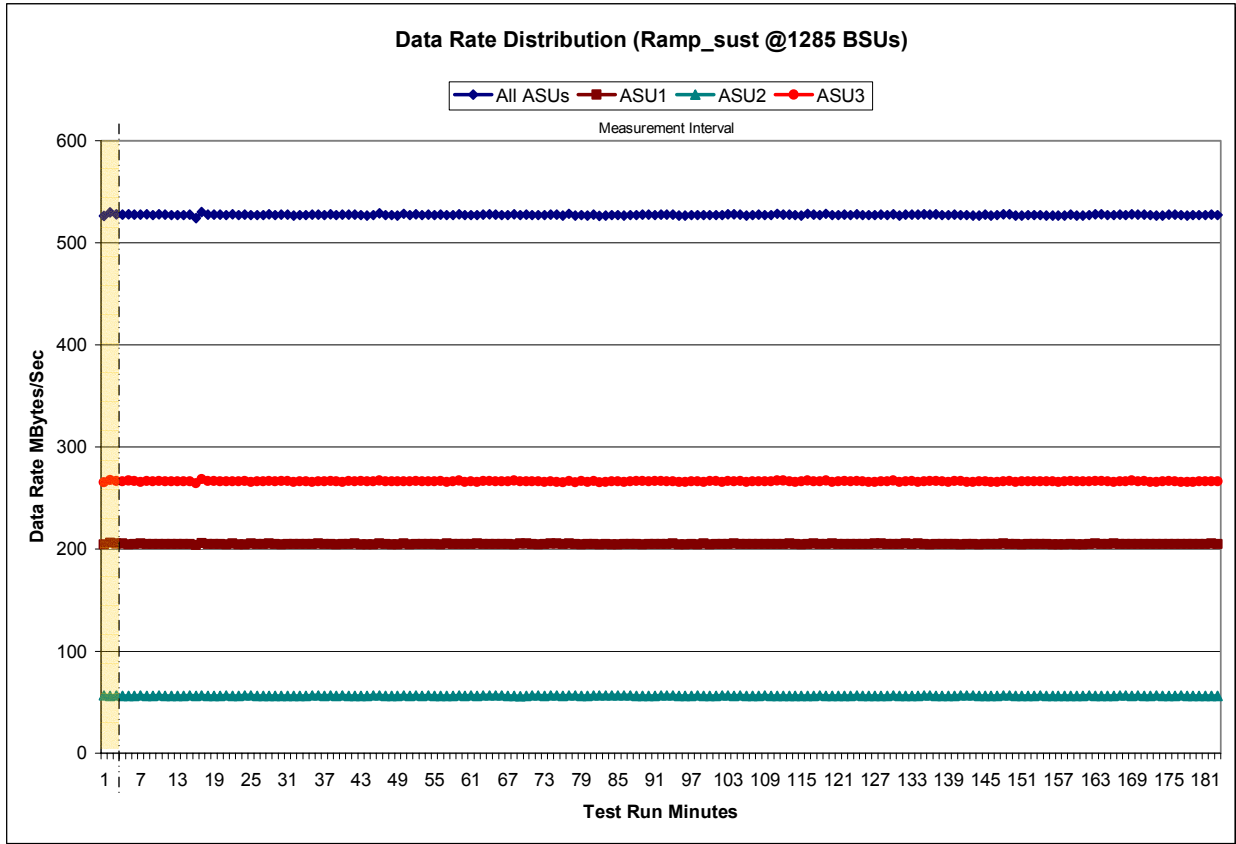
A link to the test results file generated from the Sustainability Test Run is listed below.

[Sustainability Test Results File](#)

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

Ramp-Up/Start-Up		Start	Stop	Interval	Duration										
Measurement Interval		21:40:23	21:43:23	0-2	0:03:00										
		21:43:23	0:43:23	3-182	3:00:00										
Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	
0	526.29	204.48	56.43	265.38	61	527.04	205.16	56.09	265.79	122	527.09	204.74	56.34	266.01	
1	529.48	206.02	56.24	267.22	62	527.54	204.70	56.38	266.47	123	527.94	204.80	56.42	266.71	
2	528.06	204.98	56.47	266.61	63	527.77	204.74	56.47	266.56	124	527.20	204.64	56.31	266.25	
3	527.22	205.04	56.27	265.90	64	527.54	204.83	56.48	266.23	125	527.04	204.93	56.24	265.87	
4	527.67	204.53	56.23	266.91	65	527.16	204.63	56.49	266.05	126	527.01	204.99	56.26	265.76	
5	527.43	204.83	56.04	266.56	66	527.01	204.79	56.31	265.91	127	527.32	205.14	56.29	265.89	
6	527.30	205.00	56.46	265.84	67	527.79	204.47	56.36	266.96	128	526.91	204.63	56.06	266.22	
7	527.71	204.72	56.36	266.64	68	527.12	205.11	55.92	266.09	129	528.05	204.89	56.38	266.78	
8	526.88	204.57	56.33	265.97	69	527.46	205.05	56.31	266.10	130	526.60	204.74	56.11	265.75	
9	527.71	204.57	56.59	266.55	70	527.08	204.64	56.55	265.89	131	527.54	205.01	56.36	266.17	
10	527.27	204.74	56.35	266.18	71	526.87	204.34	56.39	266.13	132	527.24	204.65	56.19	266.40	
11	527.01	204.68	56.21	266.12	72	526.88	204.86	56.29	265.73	133	527.38	205.27	56.29	265.82	
12	526.90	204.63	56.29	265.98	73	527.55	205.17	56.42	265.96	134	527.67	204.86	56.58	266.23	
13	527.20	204.75	56.31	266.15	74	527.28	205.09	56.45	265.74	135	527.63	204.51	56.46	266.65	
14	527.37	204.90	56.58	265.89	75	526.41	204.71	56.35	265.36	136	527.66	204.79	56.31	266.56	
15	524.18	203.84	56.02	264.32	76	528.14	204.99	56.51	266.64	137	527.19	204.77	56.33	266.09	
16	530.23	205.66	56.50	268.07	77	526.49	204.75	56.45	265.30	138	526.86	204.65	56.34	265.87	
17	527.59	204.60	56.27	266.72	78	527.12	204.44	56.08	266.59	139	527.31	204.70	56.28	266.34	
18	527.34	204.86	56.07	266.41	79	526.75	204.83	56.10	265.82	140	527.17	204.38	56.47	266.32	
19	527.28	204.90	56.28	266.10	80	527.42	204.60	56.40	266.42	141	527.09	204.71	56.56	265.82	
20	527.05	204.53	56.47	266.05	81	526.23	204.39	56.43	265.41	142	526.74	204.65	56.60	265.49	
21	527.77	205.32	56.29	266.16	82	526.68	204.70	56.49	265.48	143	526.70	204.49	56.18	266.03	
22	527.02	204.40	56.34	266.28	83	527.01	204.45	56.40	266.16	144	527.27	204.88	56.13	266.26	
23	527.50	204.52	56.41	266.58	84	526.79	204.38	56.47	265.94	145	526.44	204.70	56.16	265.57	
24	527.02	205.01	56.40	265.61	85	526.62	204.79	56.39	265.44	146	526.79	204.57	56.37	265.85	
25	526.83	204.57	56.13	266.13	86	527.16	204.77	56.41	265.98	147	527.72	205.17	56.48	266.62	
26	526.94	204.80	56.10	266.04	87	527.11	204.69	56.09	266.33	148	527.66	204.69	56.46	266.50	
27	527.90	205.00	56.31	266.59	88	527.32	204.49	56.24	266.59	149	526.70	204.61	56.36	265.73	
28	526.82	204.82	56.08	265.92	89	527.38	204.90	56.36	266.13	150	526.65	204.32	56.31	266.02	
29	527.24	204.49	56.36	266.39	90	527.06	204.61	56.05	266.40	151	526.99	204.66	56.24	266.10	
30	527.58	204.95	56.06	266.57	91	527.48	204.56	56.53	266.38	152	526.80	204.63	56.12	266.05	
31	526.75	204.60	56.37	265.78	92	527.48	204.85	56.42	266.21	153	527.13	204.63	56.41	266.08	
32	527.12	204.78	56.25	266.10	93	527.57	205.01	56.53	266.04	154	526.74	204.77	56.03	265.94	
33	527.20	204.89	56.10	266.21	94	526.50	204.39	56.31	265.79	155	526.78	204.42	56.25	266.11	
34	527.23	204.79	56.62	265.83	95	526.51	204.34	56.32	265.85	156	526.46	204.44	56.33	265.69	
35	527.41	205.01	56.48	265.92	96	527.16	204.91	56.24	266.01	157	526.53	204.42	55.96	266.16	
36	526.80	204.56	56.14	266.10	97	527.21	204.48	56.61	266.13	158	527.59	204.61	56.33	266.64	
37	527.81	204.81	56.53	266.47	98	526.98	204.98	56.28	265.72	159	526.75	204.37	56.12	266.26	
38	526.87	204.49	56.24	266.13	99	527.06	204.37	56.31	266.38	160	526.53	204.29	56.14	266.10	
39	527.24	204.90	56.51	265.83	100	526.97	204.55	56.06	266.36	161	527.04	204.54	56.43	266.07	
40	527.22	204.63	56.28	266.31	101	526.91	204.66	56.50	265.75	162	527.77	205.15	56.26	266.36	
41	527.22	205.12	56.13	265.98	102	527.68	204.66	56.38	266.63	163	527.66	204.94	55.99	266.73	
42	526.98	204.30	56.35	266.33	103	527.73	205.15	56.29	266.29	164	526.98	204.83	56.13	266.03	
43	526.70	204.26	56.35	266.09	104	527.60	204.83	56.46	266.32	165	526.96	205.05	56.33	265.58	
44	526.91	204.40	56.46	266.06	105	526.61	204.61	56.24	265.76	166	527.24	204.54	56.44	266.26	
45	528.61	205.27	56.46	266.88	106	526.98	204.68	56.24	266.06	167	527.06	204.74	56.37	265.95	
46	527.08	204.76	56.04	266.28	107	527.32	204.83	56.30	266.20	168	527.71	204.64	56.29	266.78	
47	526.78	204.41	56.30	266.07	108	527.19	204.83	56.41	265.96	169	527.47	204.95	56.37	266.15	
48	526.76	204.52	56.36	265.88	109	527.02	204.80	56.06	266.17	170	527.25	204.63	56.20	266.41	
49	528.24	205.28	56.69	266.28	110	528.14	204.80	56.29	267.05	171	526.79	204.73	56.34	265.73	
50	526.80	204.43	56.26	266.11	111	527.45	204.60	56.05	266.79	172	526.54	204.62	56.46	265.46	
51	527.74	204.83	56.38	266.53	112	527.64	205.02	56.35	266.27	173	526.77	204.77	56.12	265.88	
52	526.89	204.71	56.29	265.90	113	526.88	204.81	56.37	265.71	174	527.39	204.78	56.30	266.31	
53	527.58	204.83	56.69	266.06	114	526.55	204.50	56.14	265.91	175	527.42	204.82	56.34	266.26	
54	527.12	204.82	56.25	266.05	115	528.29	204.91	56.32	267.06	176	527.05	204.70	56.62	265.73	
55	527.22	204.44	56.36	266.42	116	527.58	205.05	56.24	266.29	177	526.42	204.68	56.16	265.58	
56	526.98	205.11	56.34	265.53	117	527.20	204.60	56.40	266.20	178	526.82	204.76	56.25	265.81	
57	527.05	204.88	55.96	266.21	118	528.15	204.82	56.32	267.01	179	527.16	204.90	56.16	266.10	
58	527.92	204.71	56.44	266.77	119	527.05	205.20	56.14	265.71	180	527.19	204.67	56.25	266.28	
59	526.99	204.84	56.32	265.83	120	527.18	204.81	56.31	266.05	181	527.54	205.07	56.18	266.30	
60	527.13	204.83	56.38	265.92	121	527.47	204.57	56.19	266.71	182	527.00	204.83	56.23	265.94	

### Sustainability - Data Rate Distribution Graph

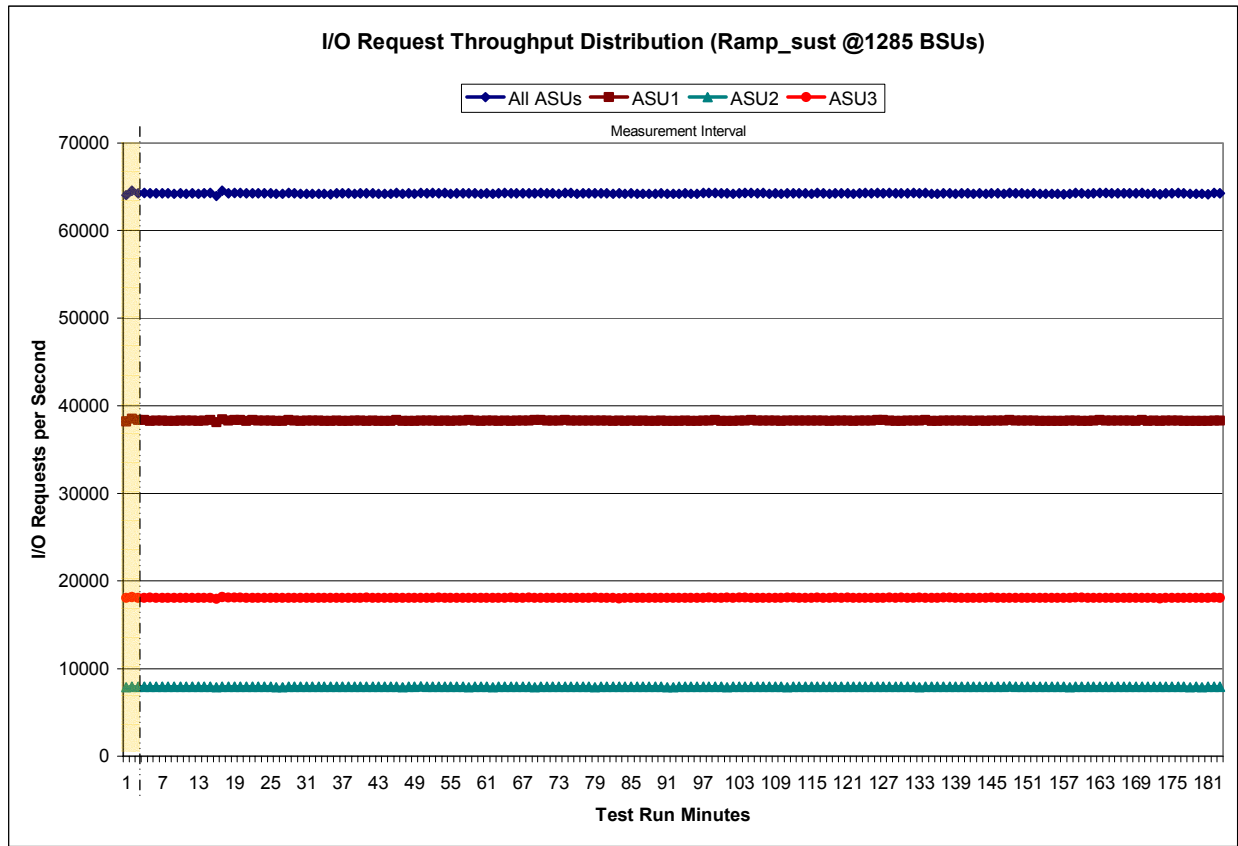


Sustainability – I/O Request Throughput Distribution Data

Ramp-Up/Start-Up Start Stop Interval Duration  
Measurement Interval 21:40:23 21:43:23 0-2 0:03:00  
21:43:23 0:43:23 3-182 3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	
0	64,066.08	38,175.93	7,869.28	18,020.87	61	64,216.48	38,316.70	7,880.87	18,018.92	122	64,257.02	38,291.58	7,913.40	18,052.03	
1	64,552.88	38,507.50	7,920.70	18,124.68	62	64,251.37	38,270.98	7,916.55	18,063.83	123	64,294.53	38,324.00	7,911.20	18,059.33	
2	64,267.58	38,329.43	7,914.37	18,023.78	63	64,289.48	38,323.83	7,900.78	18,064.87	124	64,246.38	38,286.60	7,894.92	18,064.87	
3	64,288.80	38,346.93	7,891.13	18,050.73	64	64,254.67	38,266.05	7,915.90	18,072.72	125	64,283.55	38,333.20	7,900.85	18,049.50	
4	64,236.68	38,255.40	7,906.22	18,075.07	65	64,264.58	38,294.68	7,918.62	18,051.28	126	64,254.97	38,330.72	7,894.85	18,029.40	
5	64,256.75	38,304.27	7,892.88	18,059.60	66	64,252.65	38,288.97	7,906.83	18,056.85	127	64,295.28	38,308.62	7,912.15	18,074.52	
6	64,260.72	38,305.00	7,910.00	18,045.72	67	64,274.85	38,290.08	7,900.80	18,083.97	128	64,230.15	38,273.92	7,906.70	18,049.53	
7	64,249.17	38,273.47	7,912.83	18,062.87	68	64,255.65	38,330.33	7,874.85	18,050.47	129	64,250.77	38,274.00	7,898.57	18,078.20	
8	64,219.42	38,274.80	7,912.70	18,031.92	69	64,282.43	38,331.98	7,910.43	18,040.02	130	64,246.27	38,301.08	7,908.05	18,037.13	
9	64,263.98	38,275.93	7,925.40	18,062.65	70	64,249.05	38,285.03	7,908.95	18,055.07	131	64,294.23	38,326.13	7,905.08	18,063.02	
10	64,227.02	38,287.13	7,893.83	18,046.05	71	64,246.90	38,291.70	7,910.72	18,044.48	132	64,240.77	38,293.35	7,877.73	18,069.68	
11	64,248.00	38,297.13	7,894.07	18,056.80	72	64,201.03	38,280.30	7,892.23	18,028.50	133	64,308.52	38,351.52	7,907.98	18,049.02	
12	64,222.40	38,275.17	7,891.23	18,056.00	73	64,322.03	38,346.23	7,922.75	18,053.05	134	64,228.58	38,265.90	7,922.30	18,040.38	
13	64,257.92	38,307.88	7,893.68	18,056.35	74	64,297.48	38,311.80	7,923.92	18,061.77	135	64,224.42	38,265.78	7,894.27	18,064.37	
14	64,295.43	38,337.43	7,914.83	18,043.17	75	64,219.02	38,291.42	7,910.45	18,017.15	136	64,269.73	38,291.63	7,911.08	18,067.02	
15	63,938.73	38,117.62	7,875.28	17,945.83	76	64,270.25	38,303.83	7,906.72	18,059.70	137	64,273.53	38,299.02	7,905.32	18,069.20	
16	64,543.40	38,456.82	7,922.77	18,163.82	77	64,230.67	38,282.60	7,923.30	18,024.77	138	64,200.05	38,281.62	7,893.02	18,025.42	
17	64,257.77	38,276.58	7,904.60	18,076.58	78	64,257.28	38,303.87	7,883.52	18,069.90	139	64,270.45	38,314.83	7,897.88	18,057.73	
18	64,311.23	38,335.62	7,892.83	18,082.78	79	64,257.77	38,315.10	7,906.78	18,035.88	140	64,239.37	38,286.52	7,908.87	18,043.98	
19	64,295.20	38,329.55	7,895.48	18,070.17	80	64,251.75	38,277.00	7,917.22	18,057.53	141	64,190.65	38,255.07	7,898.47	18,037.12	
20	64,245.53	38,257.95	7,924.23	18,063.35	81	64,189.67	38,249.93	7,903.57	18,036.17	142	64,238.60	38,290.88	7,908.47	18,039.25	
21	64,270.05	38,329.80	7,894.17	18,046.08	82	64,241.65	38,309.57	7,919.17	18,012.92	143	64,226.53	38,259.68	7,902.60	18,064.25	
22	64,252.03	38,289.57	7,900.15	18,062.32	83	64,218.62	38,285.53	7,898.35	18,054.73	144	64,274.10	38,306.68	7,896.20	18,071.22	
23	64,266.20	38,292.68	7,906.93	18,066.58	84	64,267.90	38,294.75	7,907.02	18,066.13	145	64,249.57	38,295.60	7,908.05	18,045.92	
24	64,237.98	38,307.77	7,907.73	18,022.48	85	64,181.70	38,265.52	7,894.67	18,021.52	146	64,228.60	38,304.00	7,891.45	18,033.15	
25	64,184.43	38,244.78	7,886.67	18,052.98	86	64,222.78	38,306.78	7,892.70	18,023.30	147	64,312.97	38,329.32	7,947.40	18,036.25	
26	64,197.33	38,269.13	7,886.45	18,041.75	87	64,211.67	38,258.93	7,889.15	18,063.58	148	64,273.55	38,301.18	7,915.75	18,056.62	
27	64,321.35	38,345.37	7,912.35	18,063.63	88	64,197.17	38,229.42	7,904.87	18,062.88	149	64,243.65	38,306.22	7,907.85	18,029.58	
28	64,246.63	38,309.08	7,900.75	18,036.80	89	64,235.52	38,285.53	7,896.42	18,053.57	150	64,223.65	38,277.63	7,899.58	18,046.43	
29	64,228.70	38,270.93	7,912.65	18,045.12	90	64,214.77	38,270.55	7,884.48	18,059.73	151	64,238.95	38,278.58	7,897.17	18,063.20	
30	64,225.87	38,287.13	7,895.80	18,042.93	91	64,200.77	38,264.40	7,886.60	18,049.77	152	64,201.13	38,272.60	7,888.58	18,039.95	
31	64,215.67	38,286.70	7,910.23	18,018.73	92	64,227.58	38,271.47	7,911.70	18,044.42	153	64,224.43	38,275.57	7,913.40	18,035.47	
32	64,211.52	38,286.43	7,892.35	18,032.73	93	64,247.80	38,288.60	7,911.52	18,047.68	154	64,221.20	38,274.57	7,912.42	18,034.22	
33	64,197.93	38,272.45	7,892.15	18,033.33	94	64,220.13	38,270.80	7,905.87	18,043.47	155	64,225.18	38,270.35	7,903.52	18,051.32	
34	64,173.37	38,257.92	7,893.50	18,021.95	95	64,219.47	38,269.27	7,909.22	18,040.98	156	64,177.40	38,263.08	7,888.78	18,025.53	
35	64,273.03	38,317.90	7,899.88	18,055.25	96	64,303.30	38,319.63	7,926.42	18,057.25	157	64,221.67	38,288.70	7,877.77	18,055.20	
36	64,231.90	38,273.65	7,897.62	18,060.63	97	64,280.98	38,290.73	7,921.75	18,068.50	158	64,290.90	38,296.77	7,903.05	18,091.08	
37	64,253.42	38,275.48	7,911.57	18,066.37	98	64,315.53	38,339.45	7,916.83	18,059.25	159	64,245.32	38,267.92	7,906.33	18,071.07	
38	64,213.87	38,281.07	7,893.38	18,039.42	99	64,233.73	38,264.90	7,901.92	18,066.92	160	64,202.87	38,253.73	7,888.00	18,061.13	
39	64,235.87	38,280.68	7,910.75	18,044.43	100	64,237.55	38,268.13	7,885.37	18,084.05	161	64,255.87	38,287.80	7,909.22	18,058.85	
40	64,268.50	38,272.83	7,914.53	18,081.13	101	64,216.78	38,271.80	7,904.93	18,040.05	162	64,306.63	38,331.07	7,910.67	18,064.90	
41	64,275.02	38,324.58	7,893.00	18,057.43	102	64,277.20	38,294.52	7,913.98	18,068.70	163	64,280.38	38,323.85	7,892.23	18,064.30	
42	64,220.32	38,264.75	7,914.28	18,041.28	103	64,291.90	38,319.57	7,901.27	18,071.07	164	64,247.03	38,294.98	7,900.37	18,051.68	
43	64,205.83	38,260.27	7,896.17	18,049.40	104	64,298.97	38,335.48	7,906.68	18,056.80	165	64,233.23	38,283.67	7,903.20	18,046.37	
44	64,223.13	38,264.02	7,907.53	18,051.58	105	64,235.02	38,286.48	7,911.37	18,037.17	166	64,240.75	38,281.83	7,913.15	18,045.77	
45	64,283.78	38,335.78	7,906.15	18,041.85	106	64,280.85	38,306.05	7,911.38	18,063.42	167	64,232.83	38,285.13	7,908.72	18,038.98	
46	64,181.27	38,245.10	7,884.67	18,051.50	107	64,203.97	38,289.17	7,889.35	18,025.45	168	64,261.40	38,274.27	7,922.68	18,064.45	
47	64,231.58	38,268.95	7,903.15	18,059.48	108	64,241.92	38,296.27	7,899.58	18,046.07	169	64,301.35	38,331.10	7,908.30	18,061.95	
48	64,202.50	38,261.48	7,909.48	18,031.53	109	64,223.22	38,273.78	7,893.68	18,055.75	170	64,223.93	38,268.57	7,903.45	18,051.92	
49	64,295.70	38,305.82	7,941.05	18,048.83	110	64,256.48	38,303.50	7,885.88	18,067.10	171	64,268.40	38,302.38	7,903.07	18,062.95	
50	64,234.67	38,289.43	7,903.35	18,041.88	111	64,247.80	38,279.22	7,892.78	18,075.80	172	64,143.58	38,229.55	7,912.88	18,001.15	
51	64,305.70	38,321.57	7,917.85	18,066.28	112	64,255.97	38,280.78	7,922.83	18,052.35	173	64,238.08	38,288.72	7,890.18	18,059.18	
52	64,234.15	38,259.42	7,900.18	18,074.55	113	64,272.08	38,308.28	7,914.90	18,048.90	174	64,252.25	38,285.85	7,907.85	18,058.55	
53	64,300.28	38,313.52	7,928.97	18,057.80	114	64,208.58	38,279.58	7,904.03	18,024.97	175	64,281.17	38,305.25	7,922.93	18,052.98	
54	64,223.77	38,269.57	7,900.52	18,053.68	115	64,292.03	38,311.65	7,900.22	18,080.17	176	64,232.77	38,274.75	7,920.28	18,037.73	
55	64,252.85	38,292.25	7,897.40	18,063.20	116	64,260.75	38,304.63	7,900.12	18,056.00	177	64,188.05	38,275.37	7,885.68	18,027.00	
56	64,242.52	38,307.05	7,891.93	18,043.53	117	64,203.70	38,263.30	7,894.80	18,045.60	178	64,213.63	38,269.90	7,895.32	18,048.42	
57	64,249.93	38,332.12	7,876.67	18,041.15	118	64,255.65	38,283.32	7,904.42	18,067.92	179	64,180.38	38,245.67	7,886.35	18,048.37	
58	64,249.73	38,277.18	7,906.45	18,066.10	119	64,254.35	38,317.58	7,895.93	18,040.83	180	64,167.58	38,246.88	7,887.10	18,033.60	
59	64,193.33	38,274.50	7,895.28	18,023.55	120	64,270.68	38,298.98	7,896.33	18,075.37	181	64,285.38	38,306.45	7,899.47	18,079.47	
60	64,253.72	38,308.38	7,897.98	18,047.35	121	64,225.45	38,262.20	7,902.85	18,060.40	182	64,238.00	38,300.87	7,903.67	18,033.47	
											Average	64,245.35	38,290.31	7,903.33	18,051.71

### 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	0.003	0.001	0.002	0.001	0.003	0.002	0.003	0.001

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

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

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

## **IOPS Test Phase**

### Clause 5.4.2.2

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

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

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

### Clause 9.2.4.7.2

*For the IOPS Test Phase the FDR shall contain:*

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

## **SPC-1 Workload Generator Input Parameters**

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

```
java Xmx512m metrics -b 1285
```

## **IOPS Test Results File**

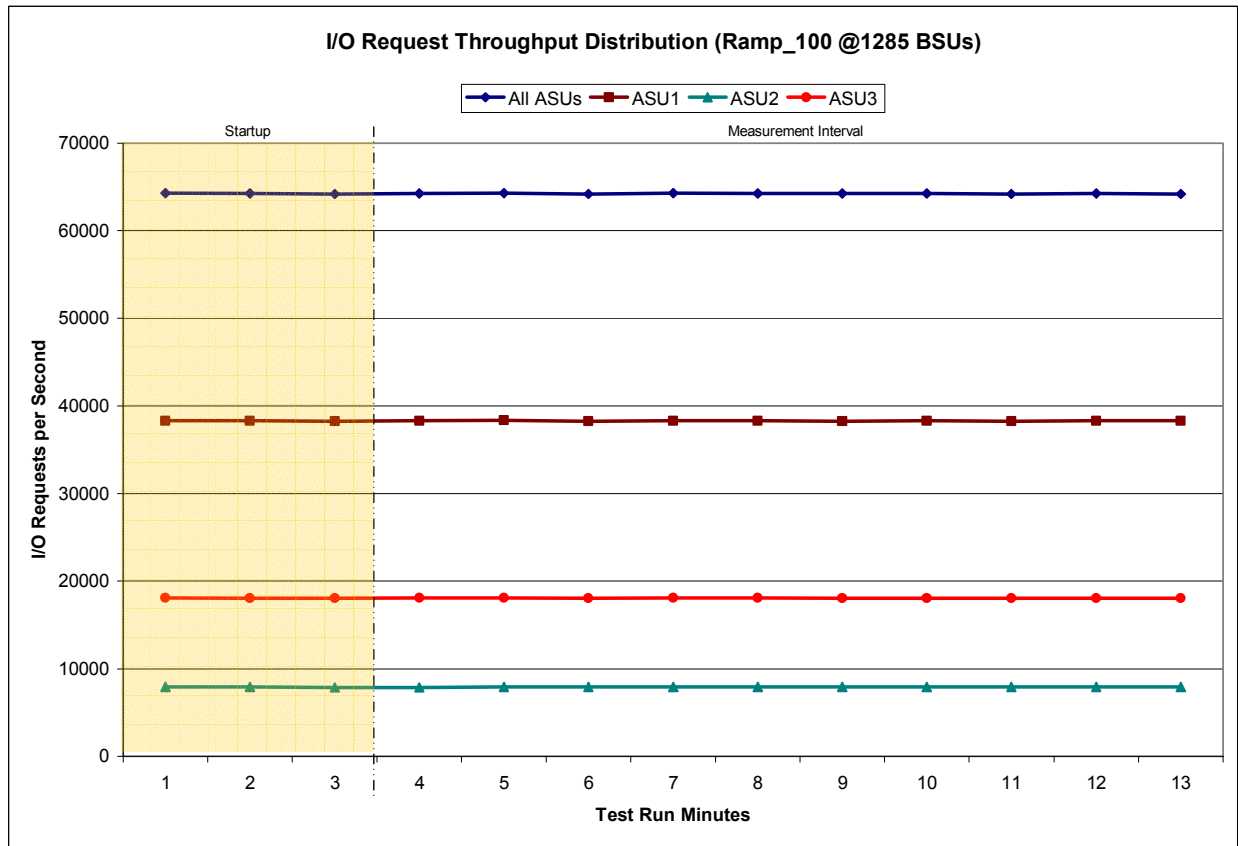
A link to the test results file generated from the IOPS Test Run is listed below.

[IOPS Test Results File](#)

**IOPS Test Run - I/O Request Throughput Distribution Data**

1,285 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	0:44:53	0:47:54	0-2	0:03:01
<i>Measurement Interval</i>	0:47:54	0:57:54	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	64,303.55	38,312.25	7,905.73	18,085.57
1	64,251.65	38,295.78	7,891.97	18,063.90
2	64,205.17	38,257.18	7,885.28	18,062.70
3	64,246.58	38,282.92	7,885.93	18,077.73
4	64,303.98	38,326.92	7,900.10	18,076.97
5	64,229.48	38,264.58	7,929.03	18,035.87
6	64,292.52	38,308.25	7,907.40	18,076.87
7	64,276.78	38,280.42	7,915.65	18,080.72
8	64,235.08	38,264.27	7,908.15	18,062.67
9	64,244.65	38,300.20	7,887.95	18,056.50
10	64,193.27	38,230.75	7,906.37	18,056.15
11	64,255.97	38,315.07	7,901.87	18,039.03
12	64,219.33	38,276.17	7,899.12	18,044.05
<b>Average</b>	64,249.77	38,284.95	7,904.16	18,060.66

**IOPS Test Run - I/O Request Throughput Distribution Graph**

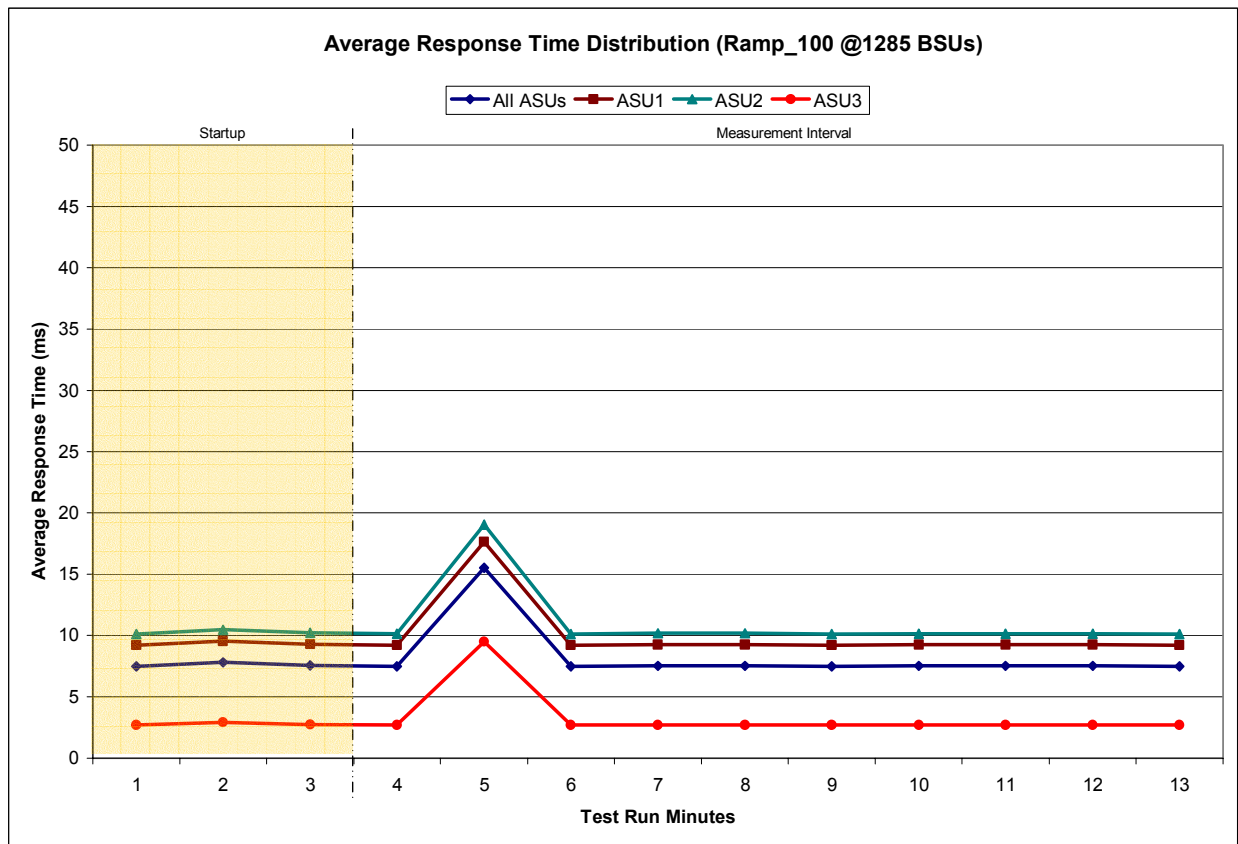




**IOPS Test Run - Response Time Frequency Distribution Data**

1,285 BSUs Start-Up/Ramp-Up Measurement Interval	Start	Stop	Interval	Duration
	0:44:53	0:47:54	0-2	0:03:01
	0:47:54	0:57:54	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	7.49	9.20	10.10	2.71
1	7.80	9.55	10.48	2.92
2	7.55	9.28	10.21	2.73
3	7.50	9.22	10.15	2.69
4	15.53	17.64	19.05	9.51
5	7.49	9.21	10.13	2.70
6	7.53	9.25	10.19	2.70
7	7.53	9.26	10.20	2.71
8	7.49	9.22	10.12	2.68
9	7.51	9.24	10.15	2.69
10	7.51	9.24	10.15	2.70
11	7.53	9.26	10.15	2.71
12	7.50	9.23	10.12	2.69
<b>Average</b>	8.31	10.08	11.04	3.38

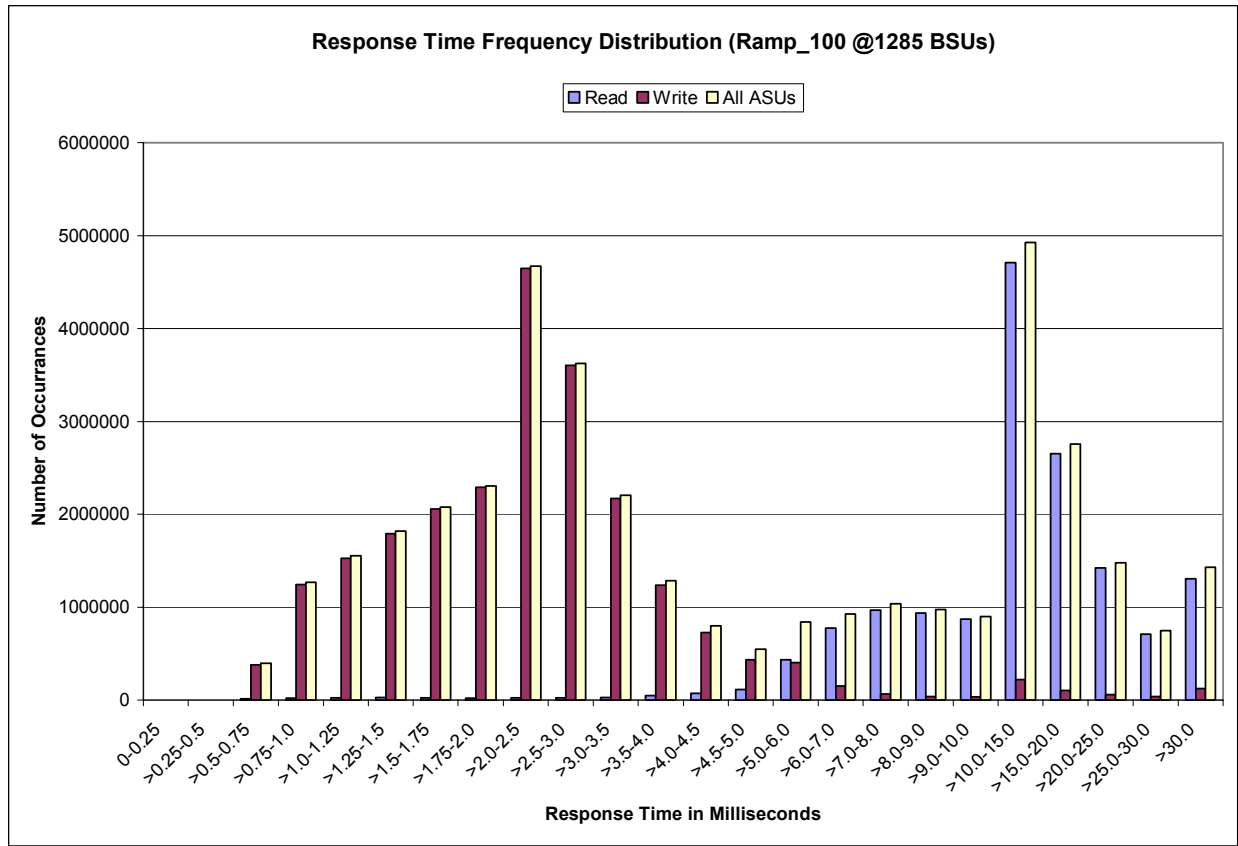
**IOPS Test Run -Response Time Frequency Distribution Graph**



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

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	0	1,094	13,376	20,947	26,029	26,787	22,684	16,663
Write	0	39	382,230	1,246,531	1,526,930	1,790,536	2,054,883	2,288,182
All ASUs	0	1,133	395,606	1,267,478	1,552,959	1,817,323	2,077,567	2,304,845
ASU1	0	1,046	225,907	652,542	760,097	875,770	989,723	1,082,140
ASU2	0	72	49,881	150,727	175,667	203,112	230,763	253,222
ASU3	0	15	119,818	464,209	617,195	738,441	857,081	969,483
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	24,558	23,715	30,356	46,016	72,229	113,780	433,052	773,085
Write	4,645,712	3,600,170	2,172,125	1,234,328	726,864	432,845	406,113	153,418
All ASUs	4,670,270	3,623,885	2,202,481	1,280,344	799,093	546,625	839,165	926,503
ASU1	2,131,681	1,562,575	864,523	455,658	281,367	225,935	516,062	749,167
ASU2	499,548	363,946	198,632	99,117	53,962	34,740	56,776	82,191
ASU3	2,039,041	1,697,364	1,139,326	725,569	463,764	285,950	266,327	95,145
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	967,937	933,878	867,271	4,707,215	2,650,418	1,420,688	709,171	1,306,684
Write	68,785	39,110	32,305	217,883	106,886	57,581	36,311	122,044
All ASUs	1,036,722	972,988	899,576	4,925,098	2,757,304	1,478,269	745,482	1,428,728
ASU1	880,905	826,990	762,833	4,112,228	2,255,725	1,173,477	567,929	1,016,392
ASU2	115,788	125,004	120,909	718,509	447,916	269,555	154,733	337,644
ASU3	40,029	20,994	15,834	94,361	53,663	35,237	22,820	74,692

**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
38,549,444	37,120,716	1,428,728

**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	0.0701	0.2099	0.0180	0.0700	0.0350	0.2811
COV	0.003	0.001	0.002	0.001	0.003	0.002	0.003	0.001

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

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

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

## Response Time Ramp Test Phase

### Clause 5.4.2.3

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

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

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

### Clause 9.2.4.7.3

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

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

## SPC-1 Workload Generator Input Parameters

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

```
java Xmx512m metrics -b 1285
```

## 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](#)

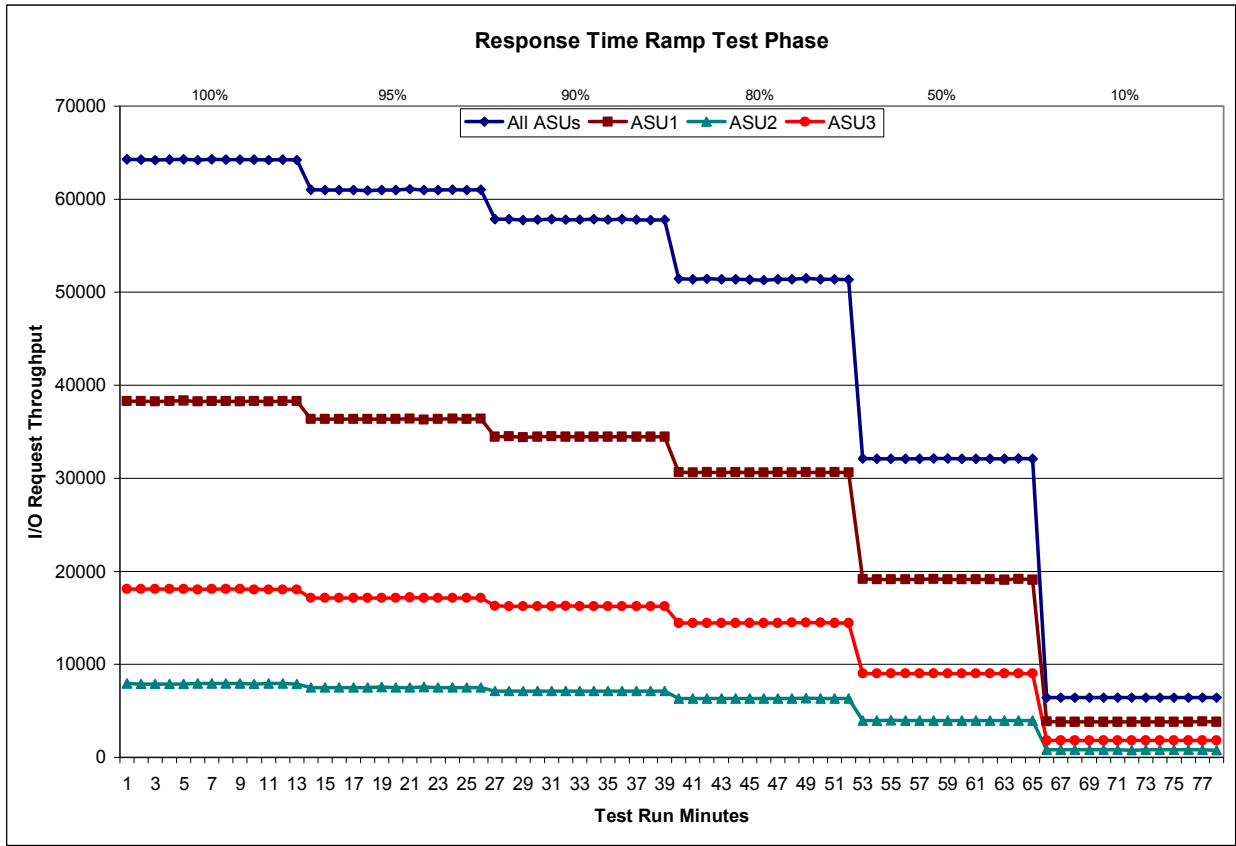
[10% Load Level](#)

**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 - 1,285 BSUs					95% Load Level - 1,220 BSUs				
	Start	Stop	Interval	Duration		Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:44:53	0:47:54	0-2	0:03:01	Start-Up/Ramp-Up	0:59:01	1:02:02	0-2	0:03:01
Measurement Interval	0:47:54	0:57:54	3-12	0:10:00	Measurement Interval	1:02:02	1:12:02	3-12	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3	(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	64,303.55	38,312.25	7,905.73	18,085.57	0	61,012.53	36,364.87	7,502.72	17,144.95
1	64,251.65	38,295.78	7,891.97	18,063.90	1	60,969.93	36,343.87	7,493.75	17,132.32
2	64,205.17	38,257.18	7,885.28	18,062.70	2	60,987.80	36,355.48	7,488.82	17,143.50
3	64,246.58	38,282.92	7,885.93	18,077.73	3	60,980.38	36,364.43	7,493.02	17,122.93
4	64,303.98	38,326.92	7,900.10	18,076.97	4	60,946.37	36,329.40	7,491.48	17,125.48
5	64,229.48	38,264.58	7,929.03	18,035.87	5	60,996.90	36,345.50	7,531.05	17,120.35
6	64,292.52	38,308.25	7,907.40	18,076.87	6	60,992.72	36,364.57	7,492.08	17,136.07
7	64,276.78	38,280.42	7,915.65	18,080.72	7	61,060.92	36,381.15	7,510.03	17,169.73
8	64,235.08	38,264.27	7,908.15	18,062.67	8	60,967.63	36,293.45	7,525.47	17,148.72
9	64,244.65	38,300.20	7,887.95	18,056.50	9	60,981.92	36,338.43	7,521.22	17,122.27
10	64,193.27	38,230.75	7,906.37	18,056.15	10	61,026.72	36,379.30	7,498.35	17,149.07
11	64,255.97	38,315.07	7,901.87	18,039.03	11	60,991.93	36,334.87	7,505.33	17,151.73
12	64,219.33	38,276.17	7,899.12	18,044.05	12	61,027.25	36,386.48	7,498.42	17,142.35
Average	64,249.77	38,284.95	7,904.16	18,060.66	Average	60,997.27	36,351.76	7,506.65	17,138.87
90% Load Level - 1,156 BSUs					80% Load Level - 1,028 BSUs				
	Start	Stop	Interval	Duration		Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:13:12	1:16:13	0-2	0:03:01	Start-Up/Ramp-Up	1:27:24	1:30:25	0-2	0:03:01
Measurement Interval	1:16:13	1:26:13	3-12	0:10:00	Measurement Interval	1:30:25	1:40:25	3-12	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3	(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	57,838.65	34,442.70	7,113.17	16,282.78	0	51,426.90	30,649.07	6,335.20	14,442.63
1	57,847.33	34,480.52	7,112.70	16,254.12	1	51,377.72	30,622.83	6,324.42	14,430.47
2	57,774.23	34,430.18	7,095.80	16,248.25	2	51,421.77	30,657.63	6,317.95	14,446.18
3	57,782.60	34,440.85	7,100.98	16,240.77	3	51,387.40	30,626.20	6,318.70	14,442.50
4	57,839.40	34,487.53	7,108.28	16,243.58	4	51,411.80	30,640.53	6,329.77	14,441.50
5	57,805.90	34,432.37	7,109.15	16,264.38	5	51,346.40	30,601.95	6,309.48	14,434.97
6	57,819.63	34,477.35	7,108.77	16,233.52	6	51,324.33	30,606.73	6,293.08	14,424.52
7	57,835.60	34,464.15	7,128.08	16,243.37	7	51,399.72	30,657.40	6,329.63	14,412.68
8	57,809.98	34,474.43	7,101.70	16,233.85	8	51,419.75	30,630.83	6,322.07	14,466.85
9	57,829.20	34,462.78	7,129.95	16,236.47	9	51,472.77	30,662.75	6,336.75	14,473.27
10	57,802.80	34,437.95	7,112.67	16,252.18	10	51,391.15	30,624.17	6,310.83	14,456.15
11	57,766.43	34,444.97	7,103.17	16,218.30	11	51,400.55	30,639.57	6,324.15	14,436.83
12	57,794.17	34,435.23	7,108.68	16,250.25	12	51,371.02	30,625.28	6,308.30	14,437.43
Average	57,808.57	34,455.76	7,111.14	16,241.67	Average	51,392.49	30,631.54	6,318.28	14,442.67
50% Load Level - 642 BSUs					10% Load Level - 128 BSUs				
	Start	Stop	Interval	Duration		Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:41:12	1:44:13	0-2	0:03:01	Start-Up/Ramp-Up	1:54:52	1:57:53	0-2	0:03:01
Measurement Interval	1:44:13	1:54:13	3-12	0:10:00	Measurement Interval	1:57:53	2:07:53	3-12	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3	(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	32,119.83	19,156.00	3,943.83	9,020.00	0	6,419.13	3,829.10	789.52	1,800.52
1	32,092.12	19,128.02	3,925.15	9,038.95	1	6,396.68	3,812.87	789.88	1,793.93
2	32,102.52	19,115.70	3,966.07	9,020.75	2	6,409.73	3,817.92	792.72	1,799.10
3	32,084.18	19,112.67	3,947.87	9,023.65	3	6,400.77	3,808.30	787.02	1,805.45
4	32,088.52	19,109.43	3,941.25	9,037.83	4	6,398.35	3,813.52	789.92	1,794.92
5	32,122.62	19,149.75	3,949.98	9,022.88	5	6,395.70	3,802.63	794.78	1,798.28
6	32,126.22	19,143.75	3,953.43	9,029.03	6	6,396.15	3,814.65	782.63	1,798.87
7	32,105.00	19,127.62	3,949.90	9,027.48	7	6,393.83	3,805.78	786.82	1,801.23
8	32,084.17	19,120.58	3,955.22	9,008.37	8	6,399.40	3,814.90	784.92	1,799.58
9	32,072.52	19,113.87	3,940.72	9,017.93	9	6,413.57	3,813.88	789.62	1,810.07
10	32,076.32	19,095.37	3,958.77	9,022.18	10	6,409.13	3,816.22	793.30	1,799.62
11	32,120.95	19,155.60	3,948.98	9,016.37	11	6,403.55	3,822.27	787.80	1,793.48
12	32,085.50	19,100.75	3,957.72	9,027.03	12	6,404.97	3,819.07	782.13	1,803.77
Average	32,096.60	19,122.94	3,950.38	9,023.28	Average	6,401.54	3,813.12	787.89	1,800.53

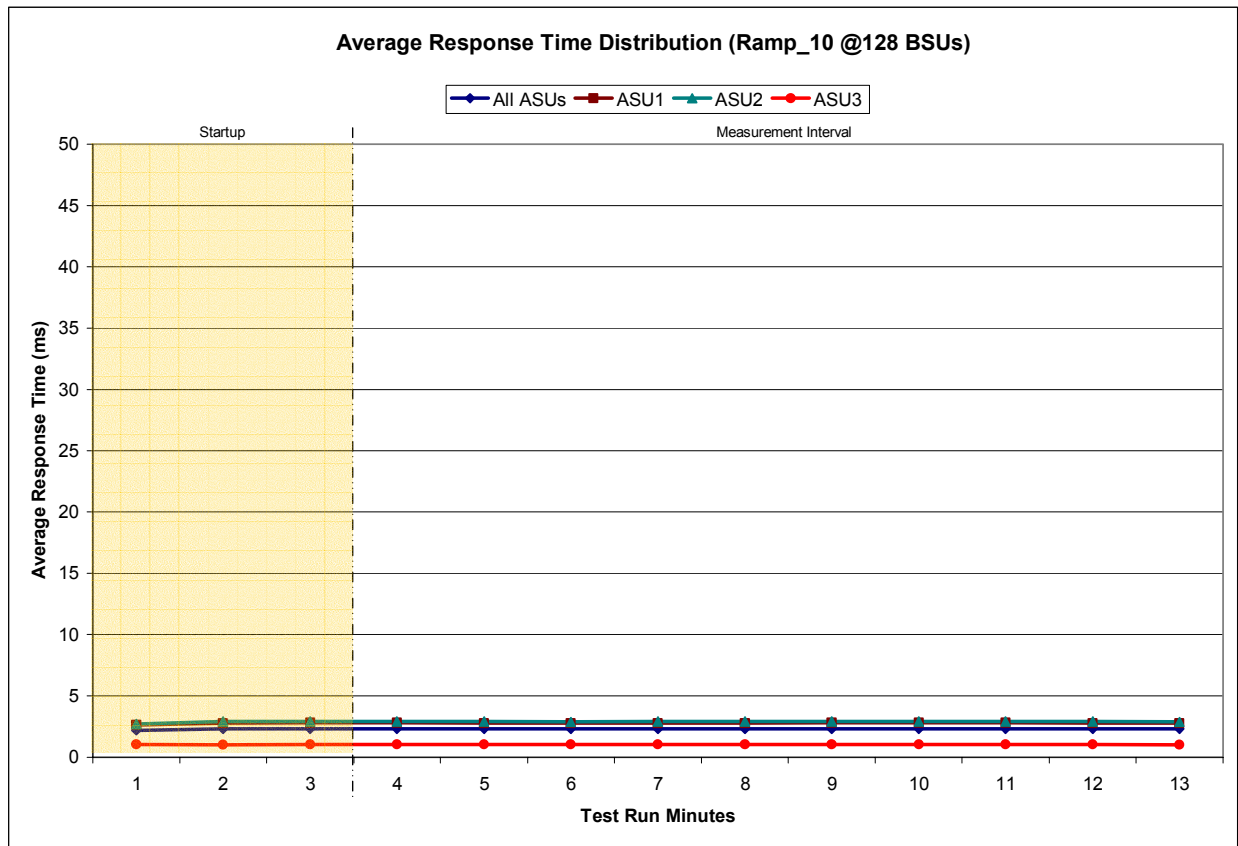
### Response Time Ramp Distribution (IOPS) Graph



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

128 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	1:54:52	1:57:53	0-2	0:03:01
<i>Measurement Interval</i>	1:57:53	2:07:53	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	2.20	2.64	2.70	1.03
1	2.31	2.78	2.91	1.03
2	2.31	2.80	2.92	1.03
3	2.31	2.79	2.90	1.03
4	2.31	2.79	2.92	1.03
5	2.31	2.79	2.89	1.03
6	2.31	2.79	2.90	1.03
7	2.31	2.79	2.90	1.03
8	2.31	2.80	2.90	1.03
9	2.31	2.79	2.91	1.03
10	2.32	2.80	2.91	1.03
11	2.31	2.79	2.92	1.03
12	2.30	2.78	2.90	1.03
<b>Average</b>	2.31	2.79	2.91	1.03

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



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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
<i>IM</i>	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
<i>MIM</i>	0.0351	0.2808	0.0700	0.2097	0.0180	0.0700	0.0350	0.2813
<i>COV</i>	0.007	0.003	0.004	0.003	0.008	0.004	0.009	0.002

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

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

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



## Repeatability 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 1285`

`java Xmx512m repeat2 -b 1285`

## 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™
<b>Primary Metrics</b>	64,249.77	2.31
<b>Repeatability Test Phase 1</b>	64,261.33	2.31
<b>Repeatability Test Phase 2</b>	64,259.28	2.32

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 \(IOPS\)](#)

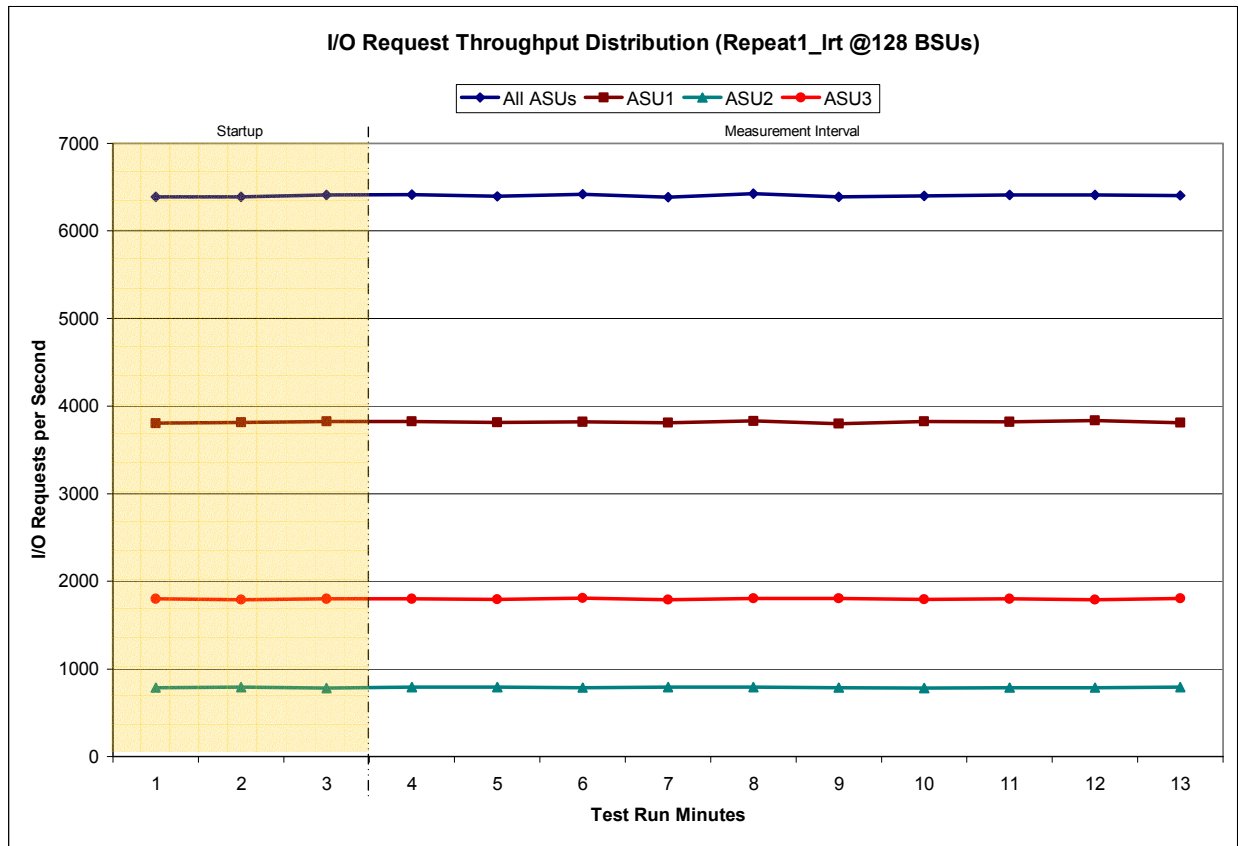
[Repeatability Test Phase 2, Test Run 1 \(LRT\)](#)

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

**Repeatability 1 LRT - I/O Request Throughput Distribution Data**

128 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	2:08:45	2:11:45	0-2	0:03:00
<i>Measurement Interval</i>	2:11:45	2:21:45	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	6,392.13	3,807.22	787.28	1,797.63
1	6,392.17	3,813.32	790.20	1,788.65
2	6,408.50	3,825.62	783.20	1,799.68
3	6,417.13	3,825.72	791.02	1,800.40
4	6,396.02	3,812.95	789.20	1,793.87
5	6,420.77	3,821.40	788.37	1,811.00
6	6,384.83	3,809.23	788.78	1,786.82
7	6,423.72	3,829.78	789.18	1,804.75
8	6,391.78	3,801.58	786.13	1,804.07
9	6,398.75	3,822.78	782.77	1,793.20
10	6,408.80	3,822.00	786.20	1,800.60
11	6,412.55	3,832.98	788.08	1,791.48
12	6,403.08	3,809.97	789.90	1,803.22
<b>Average</b>	6,405.74	3,818.84	787.96	1,798.94

**Repeatability 1 LRT - I/O Request Throughput Distribution Graph**



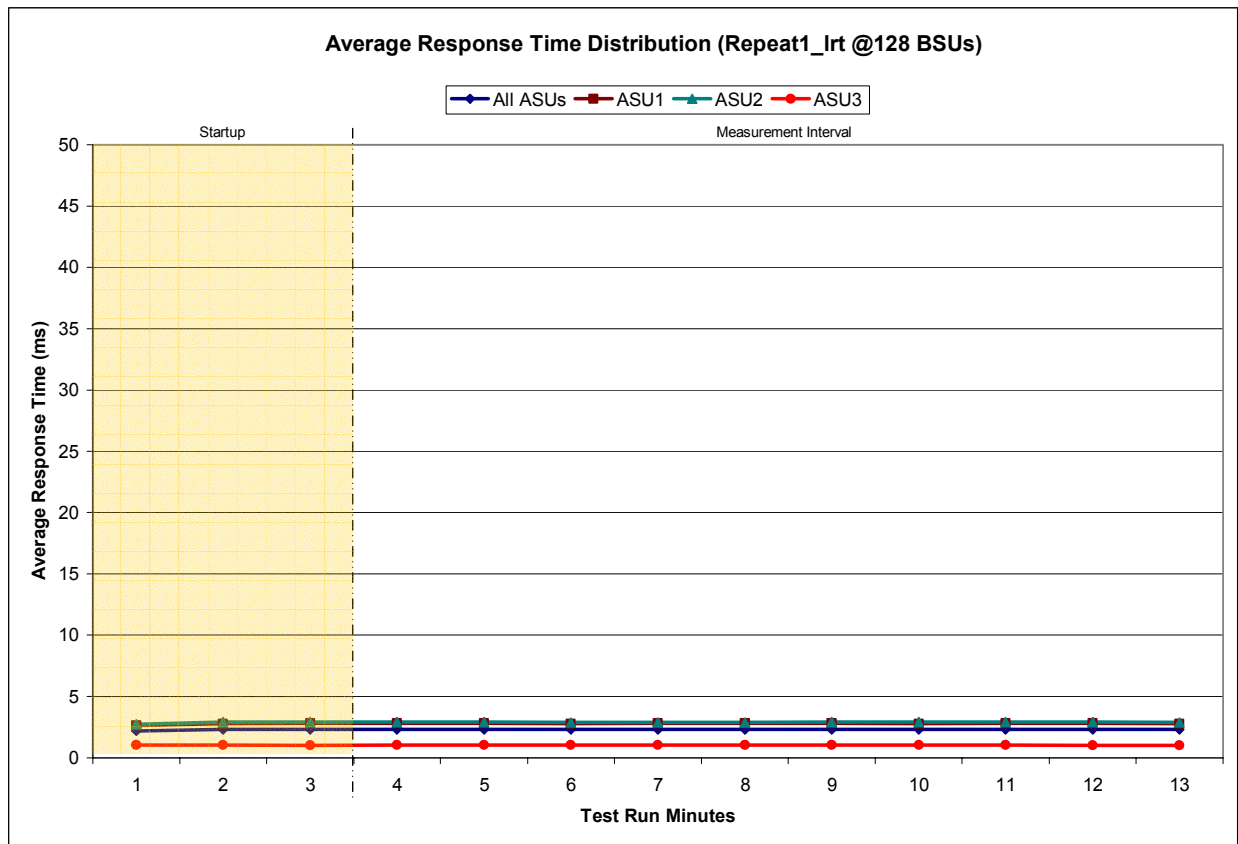
**Repeatability 1 LRT –Average Response Time (ms) Distribution Data**

128 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	2:08:45	2:11:45	0-2	0:03:00
Measurement Interval	2:11:45	2:21:45	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	2.20	2.64	2.72	1.04
1	2.31	2.79	2.90	1.03
2	2.31	2.79	2.90	1.03
3	2.31	2.79	2.90	1.03
4	2.32	2.80	2.91	1.03
5	2.30	2.79	2.89	1.03
6	2.31	2.79	2.89	1.03
7	2.32	2.81	2.90	1.03
8	2.31	2.80	2.93	1.03
9	2.31	2.79	2.91	1.03
10	2.31	2.79	2.91	1.03
11	2.32	2.80	2.92	1.02
12	2.30	2.79	2.87	1.02
Average	2.31	2.79	2.90	1.03

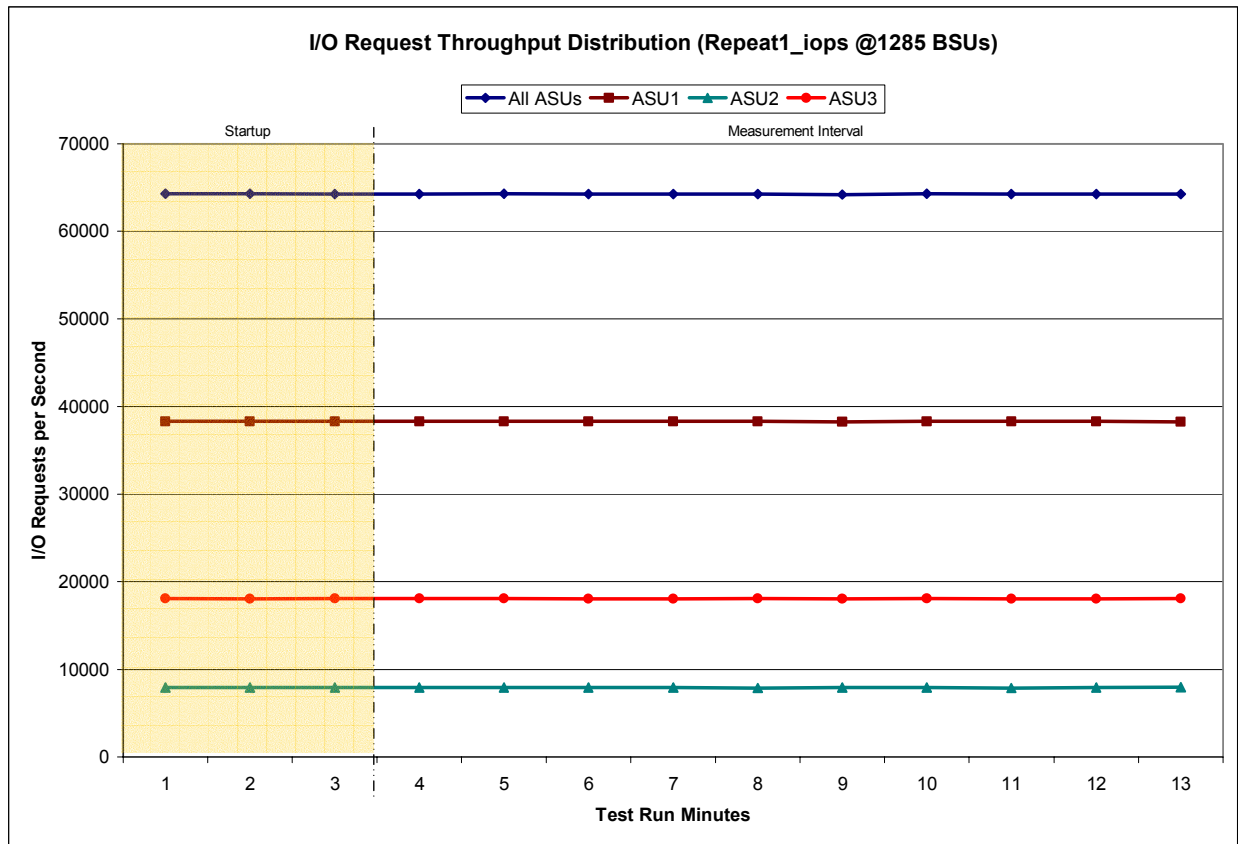
**Repeatability 1 LRT –Average Response Time (ms) Distribution Graph**



**Repeatability 1 IOPS - I/O Request Throughput Distribution Data**

1,285 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	2:22:40	2:25:41	0-2	0:03:01
Measurement Interval	2:25:41	2:35:41	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	64,303.38	38,301.58	7,927.73	18,074.07
1	64,289.12	38,316.72	7,912.90	18,059.50
2	64,260.38	38,294.33	7,894.88	18,071.17
3	64,269.17	38,308.28	7,887.02	18,073.87
4	64,280.88	38,306.80	7,904.25	18,069.83
5	64,276.48	38,314.90	7,899.57	18,062.02
6	64,236.35	38,293.23	7,898.33	18,044.78
7	64,267.92	38,303.52	7,886.57	18,077.83
8	64,215.27	38,262.47	7,907.47	18,045.33
9	64,291.95	38,305.53	7,901.18	18,085.23
10	64,240.77	38,305.58	7,884.25	18,050.93
11	64,256.40	38,297.32	7,914.83	18,044.25
12	64,278.10	38,259.75	7,941.37	18,076.98
<b>Average</b>	<b>64,261.33</b>	<b>38,295.74</b>	<b>7,902.48</b>	<b>18,063.11</b>

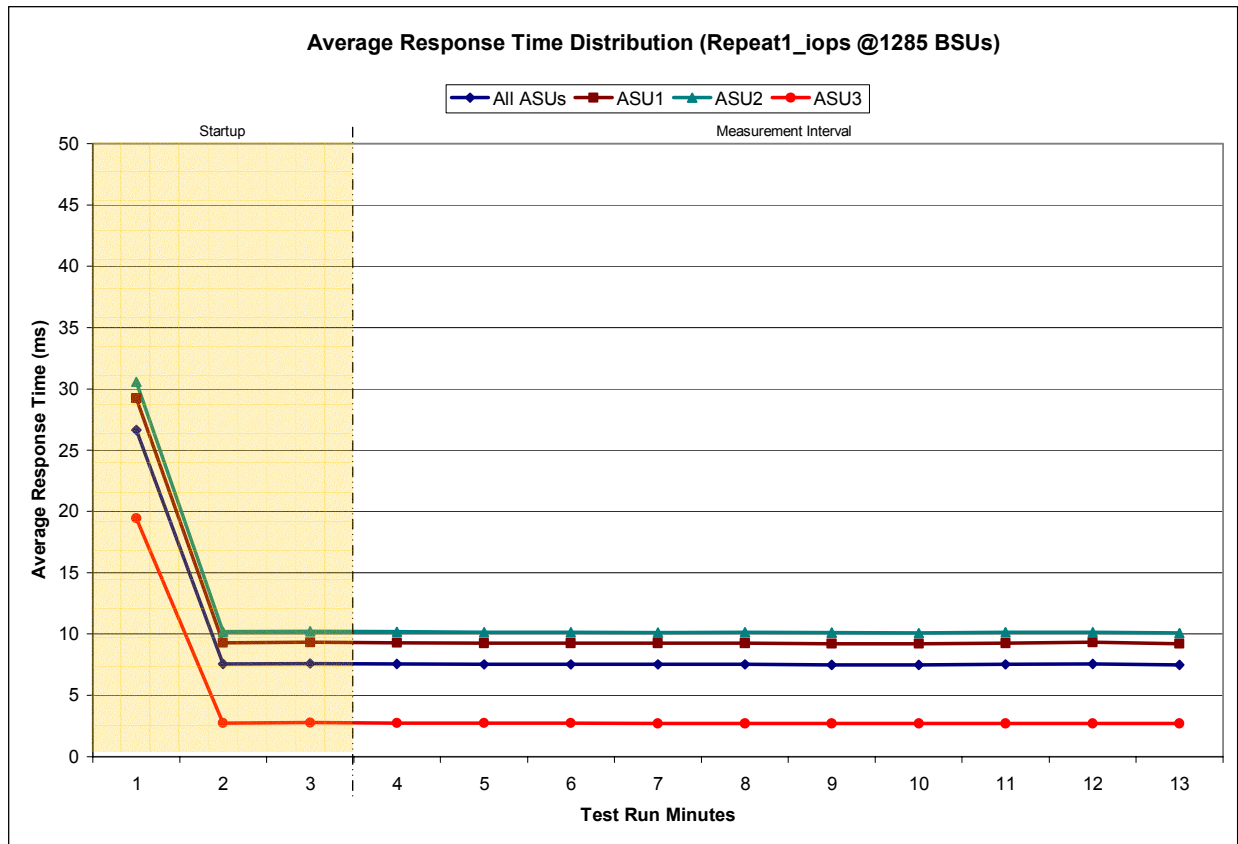
**Repeatability 1 IOPS - I/O Request Throughput Distribution Graph**



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

1,285 BSUs Start-Up/Ramp-Up Measurement Interval	Start	Stop	Interval	Duration
	2:22:40	2:25:41	0-2	0:03:01
	2:25:41	2:35:41	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	26.65	29.24	30.55	19.44
1	7.55	9.28	10.19	2.73
2	7.61	9.34	10.23	2.79
3	7.57	9.30	10.19	2.75
4	7.54	9.27	10.16	2.73
5	7.52	9.24	10.14	2.72
6	7.52	9.24	10.13	2.71
7	7.53	9.26	10.16	2.71
8	7.49	9.21	10.11	2.70
9	7.48	9.20	10.10	2.69
10	7.52	9.24	10.13	2.72
11	7.56	9.31	10.17	2.71
12	7.49	9.22	10.09	2.69
<b>Average</b>	<b>7.52</b>	<b>9.25</b>	<b>10.14</b>	<b>2.71</b>

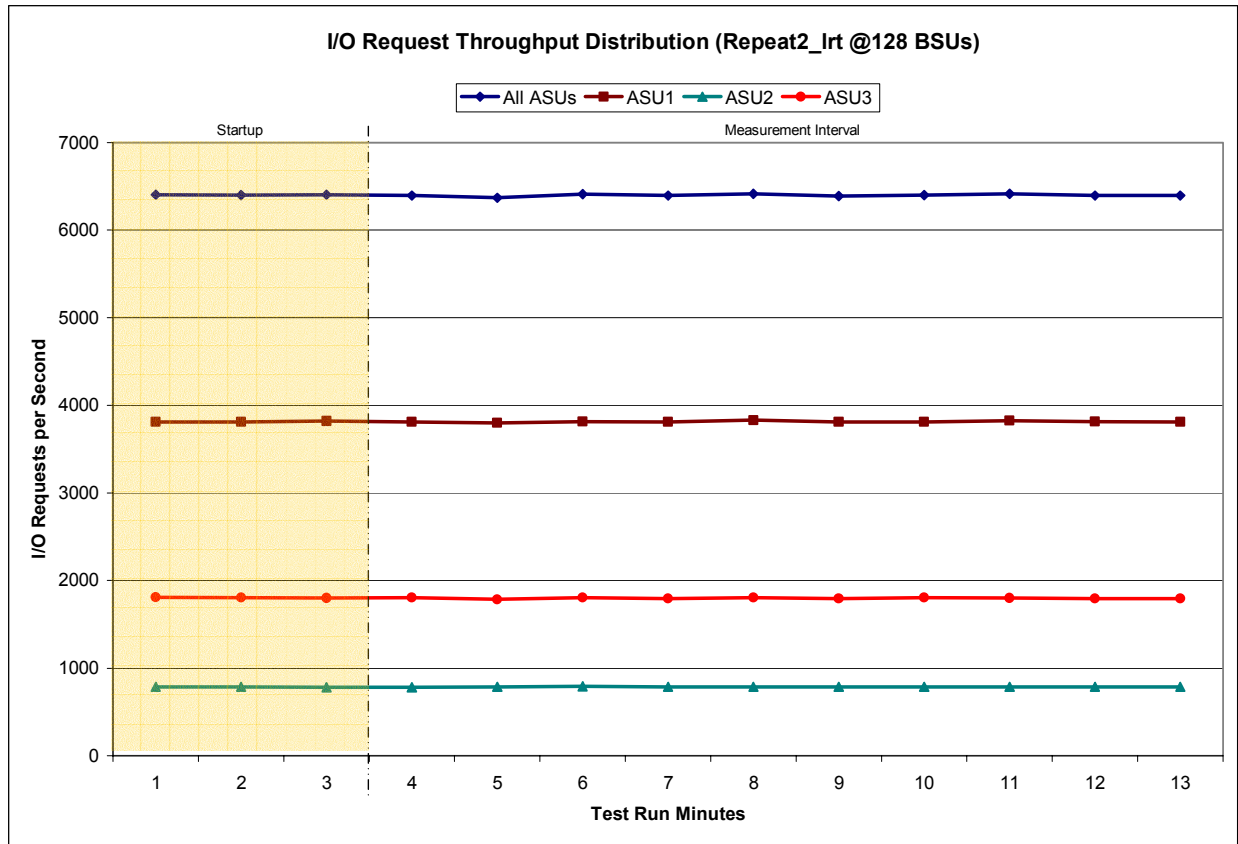
**Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph**



**Repeatability 2 LRT - I/O Request Throughput Distribution Data**

128 BSUs	Start	Stop	Interval	Duration
<i>Start-Up/Ramp-Up</i>	2:36:34	2:39:34	0-2	0:03:00
<i>Measurement Interval</i>	2:39:34	2:49:34	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	6,403.70	3,809.05	787.63	1,807.02
1	6,399.85	3,808.63	788.58	1,802.63
2	6,402.82	3,820.02	783.33	1,799.47
3	6,395.80	3,810.38	783.08	1,802.33
4	6,369.57	3,801.57	785.30	1,782.70
5	6,409.80	3,815.52	791.37	1,802.92
6	6,393.22	3,811.33	786.98	1,794.90
7	6,417.77	3,827.68	787.70	1,802.38
8	6,389.83	3,808.60	785.32	1,795.92
9	6,398.35	3,809.05	786.03	1,803.27
10	6,413.87	3,826.55	787.02	1,800.30
11	6,393.53	3,812.90	786.98	1,793.65
12	6,394.08	3,809.42	788.33	1,796.33
<b>Average</b>	<b>6,397.58</b>	<b>3,813.30</b>	<b>786.81</b>	<b>1,797.47</b>

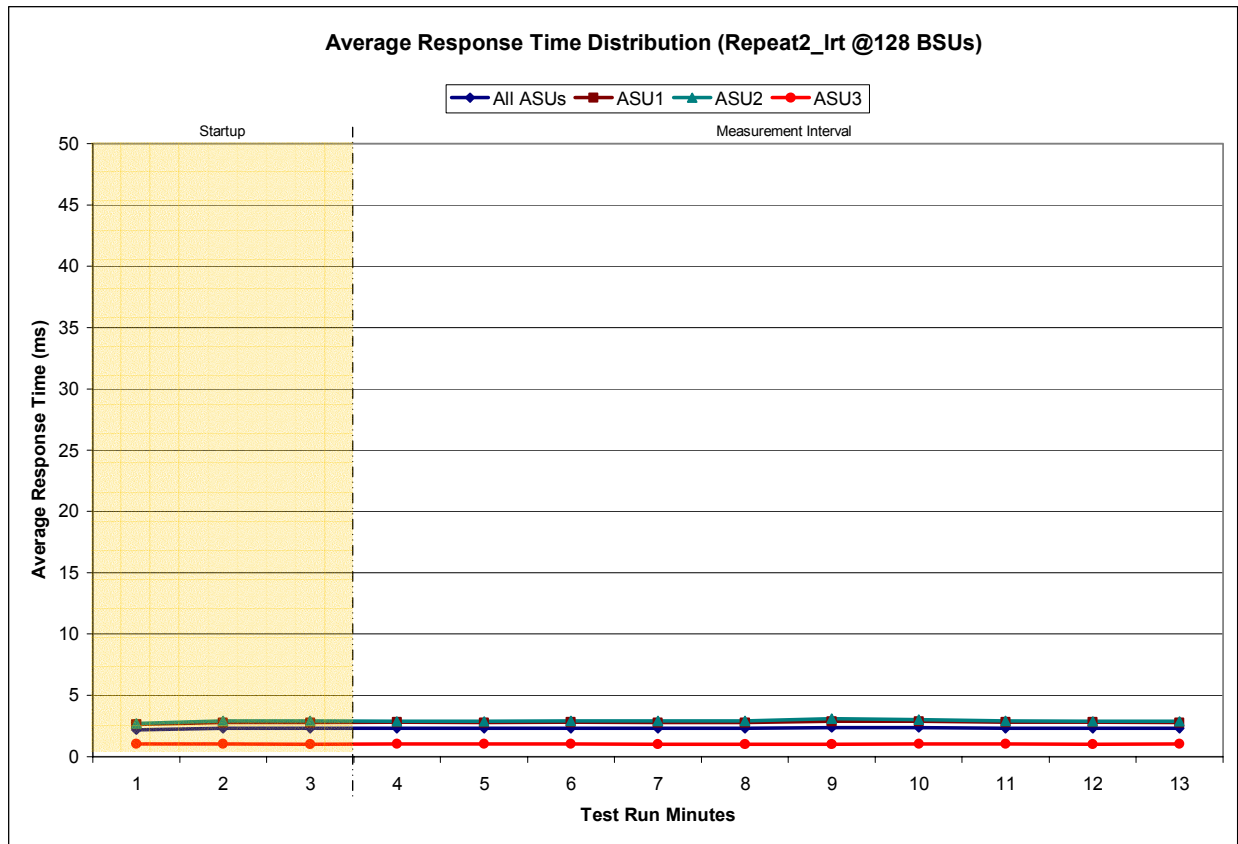
**Repeatability 2 LRT - I/O Request Throughput Distribution Graph**



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

128 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	2:36:34	2:39:34	0-2	0:03:00
Measurement Interval	2:39:34	2:49:34	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	2.19	2.63	2.71	1.04
1	2.30	2.78	2.92	1.03
2	2.30	2.78	2.90	1.02
3	2.31	2.79	2.89	1.03
4	2.30	2.78	2.89	1.03
5	2.31	2.79	2.92	1.03
6	2.30	2.78	2.91	1.02
7	2.31	2.79	2.90	1.02
8	2.37	2.87	3.08	1.02
9	2.37	2.87	3.03	1.03
10	2.31	2.79	2.90	1.03
11	2.31	2.79	2.89	1.02
12	2.30	2.79	2.88	1.03
Average	2.32	2.80	2.93	1.03

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

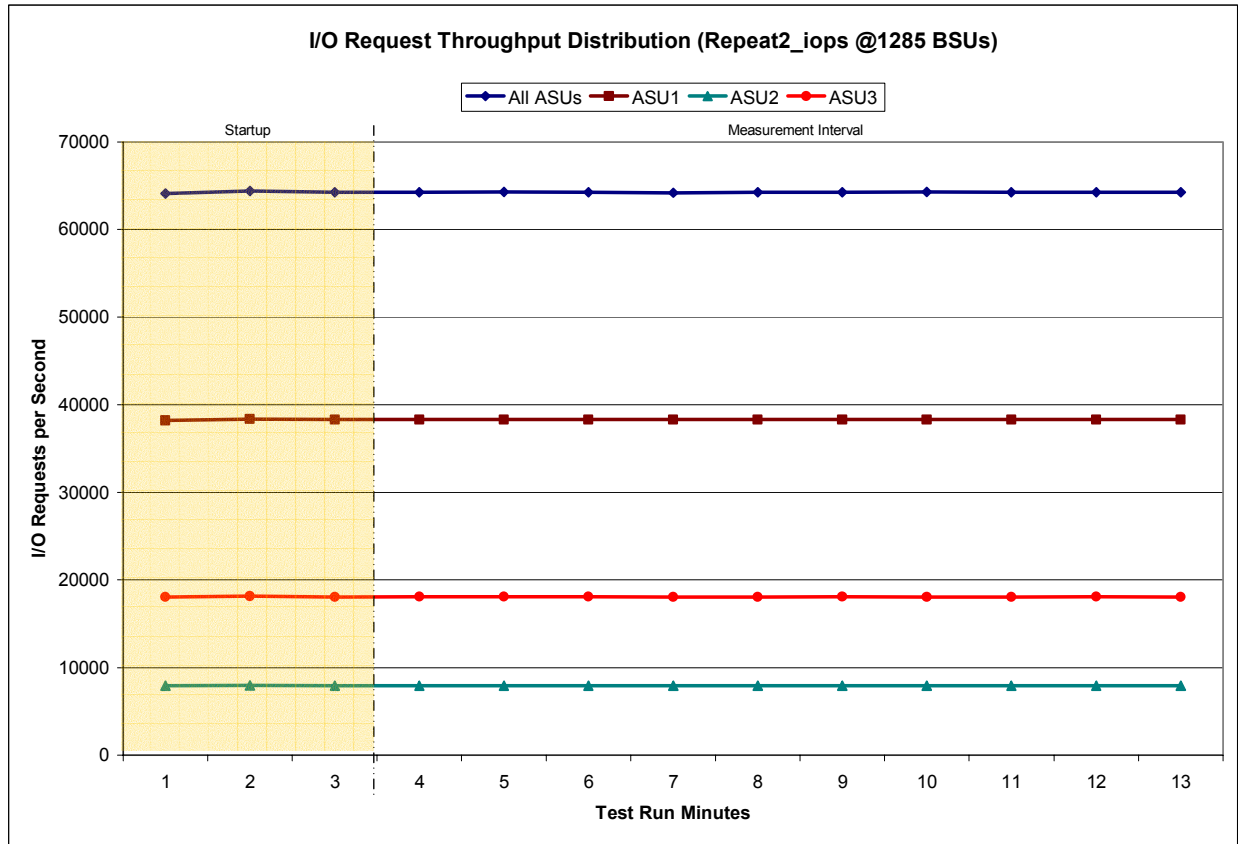




**Repeatability 2 IOPS - I/O Request Throughput Distribution Data**

1,285 BSUs Start-Up/Ramp-Up Measurement Interval	Start	Stop	Interval	Duration
	2:50:30	2:53:31	0-2	0:03:01
	2:53:31	3:03:31	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	64,125.88	38,203.67	7,903.43	18,018.78
1	64,428.03	38,363.98	7,943.72	18,120.33
2	64,234.68	38,279.73	7,916.63	18,038.32
3	64,261.10	38,285.48	7,906.85	18,068.77
4	64,295.77	38,324.22	7,899.68	18,071.87
5	64,269.98	38,296.50	7,898.62	18,074.87
6	64,223.33	38,289.83	7,898.57	18,034.93
7	64,240.20	38,312.73	7,895.92	18,031.55
8	64,271.65	38,275.83	7,907.43	18,088.38
9	64,280.87	38,310.58	7,904.87	18,065.42
10	64,254.28	38,307.65	7,899.65	18,046.98
11	64,256.18	38,288.45	7,899.38	18,068.35
12	64,239.38	38,292.77	7,894.48	18,052.13
<b>Average</b>	<b>64,259.28</b>	<b>38,298.41</b>	<b>7,900.55</b>	<b>18,060.33</b>

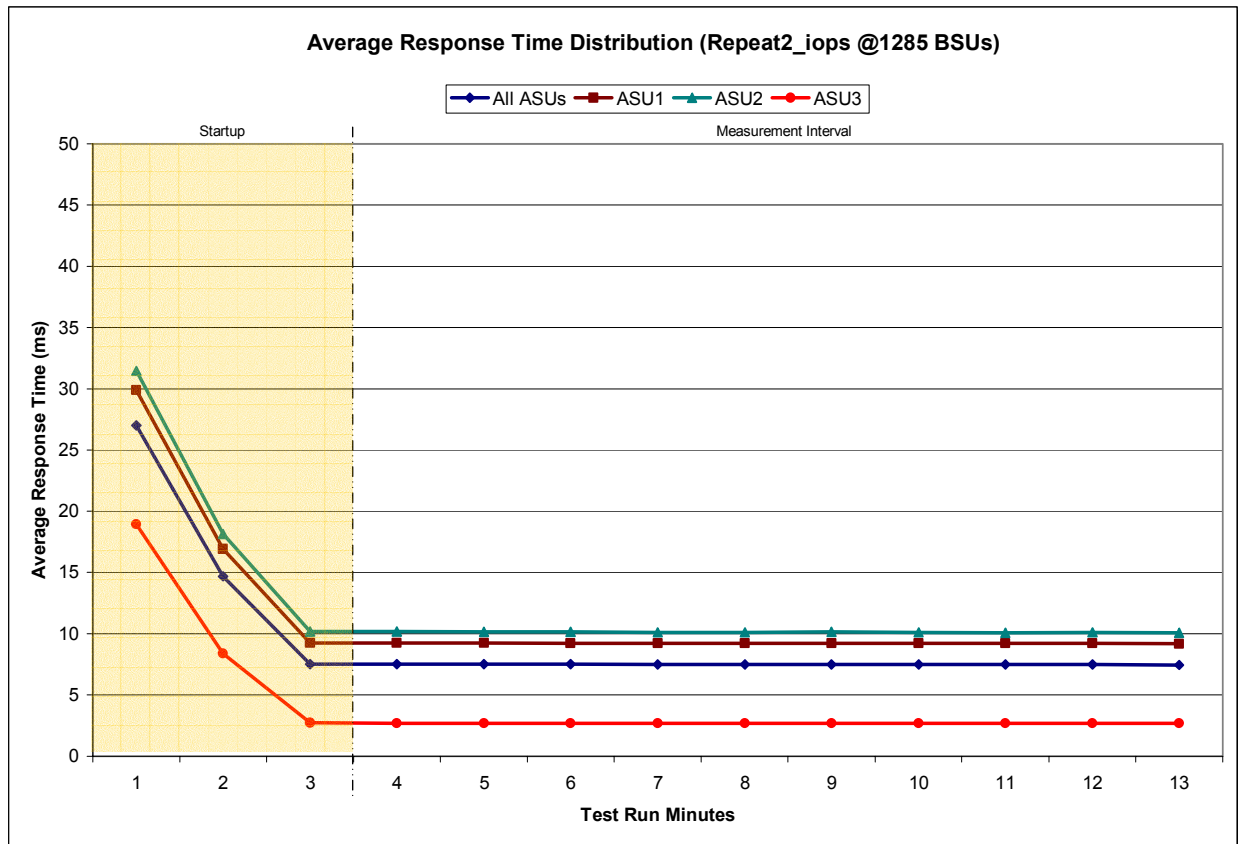
**Repeatability 2 IOPS - I/O Request Throughput Distribution Graph**



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

1,285 BSUs Start-Up/Ramp-Up Measurement Interval	Start	Stop	Interval	Duration
	2:50:30	2:53:31	0-2	0:03:01
	2:53:31	3:03:31	3-12	0:10:00
60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	26.99	29.86	31.45	18.94
1	14.68	16.93	18.13	8.40
2	7.53	9.25	10.18	2.73
3	7.52	9.25	10.17	2.70
4	7.53	9.26	10.16	2.70
5	7.51	9.23	10.16	2.70
6	7.49	9.21	10.12	2.69
7	7.49	9.20	10.12	2.69
8	7.49	9.21	10.14	2.69
9	7.49	9.21	10.10	2.69
10	7.49	9.22	10.09	2.69
11	7.49	9.22	10.10	2.69
12	7.47	9.18	10.08	2.69
<b>Average</b>	<b>7.50</b>	<b>9.22</b>	<b>10.12</b>	<b>2.69</b>

**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	0.0351	0.2813	0.0700	0.2099	0.0181	0.0699	0.0351	0.2808
COV	0.012	0.004	0.006	0.003	0.010	0.005	0.008	0.003

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

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

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

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
MIM	0.0350	0.2811	0.0700	0.2099	0.0180	0.0700	0.0350	0.2811
COV	0.004	0.000	0.002	0.001	0.004	0.002	0.003	0.001

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
MIM	0.0350	0.2813	0.0699	0.2099	0.0180	0.0699	0.0350	0.2810
COV	0.009	0.002	0.008	0.003	0.012	0.005	0.007	0.002

**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	0.2811	0.0700	0.2099	0.0180	0.0700	0.0350	0.2811
COV	0.003	0.000	0.002	0.001	0.004	0.002	0.003	0.001

## Data Persistence Test

### Clause 6

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

- *Is capable of 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 1285
```

```
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

<b>Data Persistence Test Results</b>	
Data Persistence Test Run Number: 1	
Total Number of Logical Blocks Written	74,775,344
Total Number of Logical Blocks Verified	64,478,336
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 600M, 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 600M.

**APPENDIX A: EMULEX HBA "SD.CONF" ENTRIES**

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name="sd" parent="lpfc" target=0 lun=103;  
name="sd" parent="lpfc" target=0 lun=104;  
name="sd" parent="lpfc" target=0 lun=105;  
name="sd" parent="lpfc" target=0 lun=106;  
name="sd" parent="lpfc" target=0 lun=107;  
name="sd" parent="lpfc" target=0 lun=108;  
name="sd" parent="lpfc" target=0 lun=109;  
name="sd" parent="lpfc" target=0 lun=110;  
name="sd" parent="lpfc" target=0 lun=111;  
name="sd" parent="lpfc" target=0 lun=112;  
name="sd" parent="lpfc" target=0 lun=113;  
name="sd" parent="lpfc" target=0 lun=114;  
name="sd" parent="lpfc" target=0 lun=115;  
name="sd" parent="lpfc" target=0 lun=116;  
name="sd" parent="lpfc" target=0 lun=117;  
name="sd" parent="lpfc" target=0 lun=118;  
name="sd" parent="lpfc" target=0 lun=119;  
name="sd" parent="lpfc" target=0 lun=120;



name="sd" parent="lpfc" target=0 lun=121;  
name="sd" parent="lpfc" target=0 lun=122;  
name="sd" parent="lpfc" target=0 lun=123;  
name="sd" parent="lpfc" target=0 lun=124;  
name="sd" parent="lpfc" target=0 lun=125;  
name="sd" parent="lpfc" target=0 lun=126;  
name="sd" parent="lpfc" target=0 lun=127;  
name="sd" parent="lpfc" target=0 lun=128;  
name="sd" parent="lpfc" target=0 lun=129;  
name="sd" parent="lpfc" target=0 lun=130;  
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;

## **APPENDIX B: TSC CREATION/CONFIGURATION SCRIPTS AND COMMANDS**

### **listdisks.sh**

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

# Remove the old list files

rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c8.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c9.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c10.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c11.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c12.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c13.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c14.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c15.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c16.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c17.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c18.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c19.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c20.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c21.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c23.format.log
rm -r /SPC1_E3000M600M/SPC1SCRIPTS/c24.format.log

rm /SPC1_E3000M600M/SPC1SCRIPTS/formatok
rm /SPC1_E3000M600M/SPC1SCRIPTS/formaterr

# Create the list file

ls /dev/rdisk/c8*s2 |sed 's/\dev\rdsk\//g' | sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c8.disk.list
ls /dev/rdisk/c9*s2 |sed 's/\dev\rdsk\//g' | sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c9.disk.list
ls /dev/rdisk/c10*s2 |sed 's/\dev\rdsk\//g' | sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c10.disk.list
ls /dev/rdisk/c11*s2 |sed 's/\dev\rdsk\//g' | sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c11.disk.list
ls /dev/rdisk/c12*s2 |sed 's/\dev\rdsk\//g' | sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c12.disk.list
ls /dev/rdisk/c13*s2 |sed 's/\dev\rdsk\//g' | sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c13.disk.list
ls /dev/rdisk/c14*s2 |sed 's/\dev\rdsk\//g' | sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c14.disk.list
ls /dev/rdisk/c15*s2 |sed 's/\dev\rdsk\//g' | sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c15.disk.list
ls /dev/rdisk/c16*s2 |sed 's/\dev\rdsk\//g' | sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c16.disk.list
ls /dev/rdisk/c17*s2 |sed 's/\dev\rdsk\//g' | sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c17.disk.list
```

```
ls /dev/rdisk/c18*s2 |sed 's/\devVrdskV//g'| sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c18.disk.list
ls /dev/rdisk/c19*s2 |sed 's/\devVrdskV//g'| sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c19.disk.list
ls /dev/rdisk/c20*s2 |sed 's/\devVrdskV//g'| sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c20.disk.list
ls /dev/rdisk/c21*s2 |sed 's/\devVrdskV//g'| sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c21.disk.list
ls /dev/rdisk/c23*s2 |sed 's/\devVrdskV//g'| sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c23.disk.list
ls /dev/rdisk/c24*s2 |sed 's/\devVrdskV//g'| sed 's/s2//g'>/SPC1_E3000M600M/SPC1SCRIPTS/c24.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_E3000M600M/SPC1SCRIPTS/c8.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c8.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c9.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c9.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c10.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c10.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c11.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c11.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c12.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c12.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c13.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c13.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c14.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c14.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c15.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c15.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c16.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c16.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c17.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c17.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c18.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c18.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c19.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c19.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c20.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c20.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c21.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c21.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c23.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c23.format.log
/SPC1_E3000M600M/SPC1SCRIPTS/labelcmd
```

```
./fmtdisks.sh /SPC1_E3000M600M/SPC1SCRIPTS/c24.disk.list /SPC1_E3000M600M/SPC1SCRIPTS/c24.format.log  
/SPC1_E3000M600M/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_E3000M600M/SPC1SCRIPTS/formaterr  
else  
    echo "format of disk $DISKS completed" >> /SPC1_E3000M600M/SPC1SCRIPTS/formatok  
fi  
done
```

---

## makevx2vi

```

-----

#!/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`
        testi=`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/rdisk/"$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"
                fi
            fi
        done
    done
}

```

```

                                exit 4
                                fi
                                fi
                                count=$((count+1))
                                done
                                vgname="$vg"data-01"
                                count=$((count-1))
                                test=`vxassist -g $vg maxsize layout=stripe stripeunit=16m ncols=$count|nawk '{if ($1 == "Maximum") print $4}'`
                                if [ "$test" == "" ]
                                then
                                echo "Cannot determine size for logical volume"
                                exit 4
                                fi
                                (( lvsizel=(test/2/16/1024/2/count)*(16*1024*2*count) ))
                                test=`vxassist -g $vg make $vgname $lvsizel layout=stripe stripeunit=16m ncols=$count`
                                if [ $? != 0 ]
                                then
                                echo "Failed to make LV $vgname for VG $vg"
                                exit 4
                                fi
                                test=`vxassist -g $vg make $vgname"b" $lvsizel layout=stripe stripeunit=16m ncols=$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

```

-----  
**Q6-a1.txt**  
-----

```

VOLUME_GROUP: asu1-1
c8t0d7
c8t0d16
c8t0d25

```



c8t0d34  
c12t0d7  
c12t0d16  
c12t0d25  
c10t0d7  
c10t0d16  
c10t0d25  
c14t0d7  
c14t0d16  
c14t0d25  
c14t0d34  
c10t0d34  
c10t0d43  
c10t0d52  
c10t0d61  
c14t0d43  
c14t0d52  
c14t0d61  
c8t0d43  
c8t0d52  
c8t0d61  
c12t0d34  
c12t0d43  
c12t0d52  
c12t0d61  
c8t0d70  
c8t0d79  
c8t0d88  
c8t0d97  
c12t0d70  
c12t0d79  
c12t0d88  
c10t0d70  
c10t0d79  
c10t0d88  
c14t0d70  
c14t0d79  
c14t0d88  
c14t0d97  
c10t0d97  
c10t0d106  
c10t0d115  
c10t0d124  
c14t0d106  
c14t0d115  
c14t0d124  
c8t0d106  
c8t0d115  
c8t0d124  
c12t0d97  
c12t0d106  
c12t0d115  
c12t0d124  
c16t0d7  
c16t0d16  
c16t0d25

c16t0d34  
c19t0d7  
c19t0d16  
c19t0d25  
c17t0d7  
c17t0d16  
c17t0d25  
c21t0d7  
c21t0d16  
c21t0d25  
c21t0d34  
c17t0d34  
c17t0d43  
c17t0d52  
c17t0d61  
c21t0d43  
c21t0d52  
c21t0d61  
c16t0d43  
c16t0d52  
c16t0d61  
c19t0d34  
c19t0d43  
c19t0d52  
c19t0d61  
c16t0d70  
c16t0d79  
c16t0d88  
c16t0d97  
c19t0d70  
c19t0d79  
c19t0d88  
c17t0d70  
c17t0d79  
c17t0d88  
c21t0d70  
c21t0d79  
c21t0d88  
c21t0d97  
c17t0d97  
c17t0d106  
c17t0d115  
c17t0d124  
c21t0d106  
c21t0d115  
c21t0d124  
c16t0d106  
c16t0d115  
c16t0d124  
c19t0d97  
c19t0d106  
c19t0d115  
c19t0d124  
END  
VOLUME\_GROUP: asu1-2  
c8t0d4

c8t0d13  
c8t0d22  
c8t0d31  
c12t0d4  
c12t0d13  
c12t0d22  
c10t0d4  
c10t0d13  
c10t0d22  
c14t0d4  
c14t0d13  
c14t0d22  
c14t0d31  
c10t0d31  
c10t0d40  
c10t0d49  
c10t0d58  
c14t0d40  
c14t0d49  
c14t0d58  
c8t0d40  
c8t0d49  
c8t0d58  
c12t0d31  
c12t0d40  
c12t0d49  
c12t0d58  
c8t0d67  
c8t0d76  
c8t0d85  
c8t0d94  
c12t0d67  
c12t0d76  
c12t0d85  
c10t0d67  
c10t0d76  
c10t0d85  
c14t0d67  
c14t0d76  
c14t0d85  
c14t0d94  
c10t0d94  
c10t0d103  
c10t0d112  
c10t0d121  
c14t0d103  
c14t0d112  
c14t0d121  
c8t0d103  
c8t0d112  
c8t0d121  
c12t0d94  
c12t0d103  
c12t0d112  
c12t0d121  
c16t0d4

c16t0d13  
c16t0d22  
c16t0d31  
c19t0d4  
c19t0d13  
c19t0d22  
c17t0d4  
c17t0d13  
c17t0d22  
c21t0d4  
c21t0d13  
c21t0d22  
c21t0d31  
c17t0d31  
c17t0d40  
c17t0d49  
c17t0d58  
c21t0d40  
c21t0d49  
c21t0d58  
c16t0d40  
c16t0d49  
c16t0d58  
c19t0d31  
c19t0d40  
c19t0d49  
c19t0d58  
c16t0d67  
c16t0d76  
c16t0d85  
c16t0d94  
c19t0d67  
c19t0d76  
c19t0d85  
c17t0d67  
c17t0d76  
c17t0d85  
c21t0d67  
c21t0d76  
c21t0d85  
c21t0d94  
c17t0d94  
c17t0d103  
c17t0d112  
c17t0d121  
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