SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

FUJITSU LIMITED
FUJITSU STORAGE SYSTEMS
ETERNUS2000 MODEL 200

SPC-1 V1.10.1

Submitted for Review: October 13, 2008
Submission Identifier: A00071

First Edition – October 2008

Trademarks

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AUDIT CERTIFICATION

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October 10, 2008

The SPC Benchmark 1™ results listed below for the Fujitsu Storage Systems ETERNUS2000 Model 200 were produced in compliance with the SPC Benchmark 1™ V1.10.1 Remote Audit requirements.

SPC Benchmark 1™ V1.10.1 Results	
Tested Storage Configuration (TSC) Name: Fujitsu Storage Systems ETERNUS2000 Model 200	
Metric	**Reported Result**
SPC-1 IOPS™	13,250.44
SPC-1 Price-Performance	$3.40/SPC-1 IOPS™
Total ASU Capacity	1,923.000 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$45,049

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with V1.10.1 of the SPC Benchmark 1™ specification:

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

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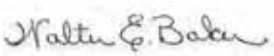
AUDIT CERTIFICATION *(CONT.)*

- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.
- The following Host System requirements, based on information supplied by Fujitsu Limited:
  - ✓ The type of Host System including the number of processors and main memory.
  - ✓ The presence and version number of the SPC-1 Workload Generator on the Host System.
  - ✓ The TSC boundary within the Host System.
- The Test Results Files and resultant Summary Results Files received from Fujitsu Limited for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability Test
- There were no differences between the Tested Storage Configuration (TSC) used for the benchmark and Priced Storage Configuration.
- The submitted pricing information met all of the requirements and constraints of Clause 8 of the SPC-1 Benchmark Specification.
- The Full Disclosure Report (FDR) met all of the requirements in Clause 9 of the SPC-1 Benchmark Specification.
- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

Audit Notes:

There were no audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

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LETTER OF GOOD FAITH

FUJITSU

FUJITSU LIMITED
Kanagawa-ken, Kawasaki-shi, Nakahara-ku, Kamikodanaka,4-1-1,JAPAN 211-8588
TEL: 044-754-3240, FAX: 044-754-3719

Date: Sept. 10, 2008

From: Fujitsu Limited, Test Sponsor

Submitted by: Tetsuro Kudo ,
General Manager, Storage Systems Division
Kanagawa-ken,Kawasaki-shi,Nakahara-ku,Kamikodanaka4-1-1
Japan211-8588

Contact Information: Carrel A. (Sandy) Wilson
Fujitsu Computer Systems Corp.
1250 East Arques Ave. PO Box 3470
Sunnyvale, CA 94088, U.S.A.

To: Walter E. Baker, SPC Auditor
Gradient Systems, Inc.
643 Bair Island Road, Suite 103
Redwood City, CA 94063-2755. U.S.A.

Subject: SPC-1 Letter of Good Faith for the ETERNUS2000 Model 200

Fujitsu Limited is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with V1.10.1 of the SPC-1 benchmark specification.

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

Signed: Tetsuro Kudo Date: 9/10/2008

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Fujitsu Limited – http://www.fujitsu.com/services/computing/storage/ Fujitsu Computer Systems Corp. C.A. (Sandy) Wilson Sandy_Wilson@us.fujitsu.com 1250 East Arques Ave PO Box 3470 Sunnyvale, CA 94088-3470 Phone: (916) 434-8593
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Test Sponsor Alternate Contact	Fujitsu Limited – http://www.fujitsu.com/services/computing/storage/ Tetsuro Kudo – kudo@jp.fujitsu.com Kanagawa-ken, Kawasaki-shi, Nakahara-ku, Kamikodanaka 4-1-1 Japan 211-8588 Phone: 044- 754-3240 FAX: 044-754-3719
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Revision Information and Key Dates

Revision Information and Key Dates	
SPC-1 Specification revision number	V1.10.1
SPC-1 Workload Generator revision number	V2.00.04a
Date Results were first used publicly	October 13, 2008
Date the FDR was submitted to the SPC	October 13, 2008
Date the TSC is available for shipment to customers	currently available
Date the TSC completed audit certification	October 10, 2008

Tested Storage Product (TSP) Description

The Fujitsu ETERNUS2000 Model 200 is a flexible, highly reliable storage array, equipped with redundant components to provide uncompromised availability to the small and mid market requirements. A mixture of 146GB and 300GB 15krpm SAS drives, as well as 500GB, 750GB, and 1TB Nearline SAS drives may be used, up to a maximum of 72 drives. The drives may be arranged in a variety of RAID groups, including RAID1, RAID1+0(10), RAID5, and RAID6. The product is offered with Fibre Channel (as tested), iSCSI, and SAS host connection versions, with 4 channels offered (2 channels per controller) in each version. In addition, a number of different snapshot and replication facilities, native disk data encryption, and MAID capabilities are available.

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: Fujitsu Storage Systems ETERNUS2000 Model 200	
Metric	**Reported Result**
SPC-1 IOPS™	13,250.44
SPC-1 Price-Performance	$3.40/SPC-1 IOPS™
Total ASU Capacity	1,923.000 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$45,049

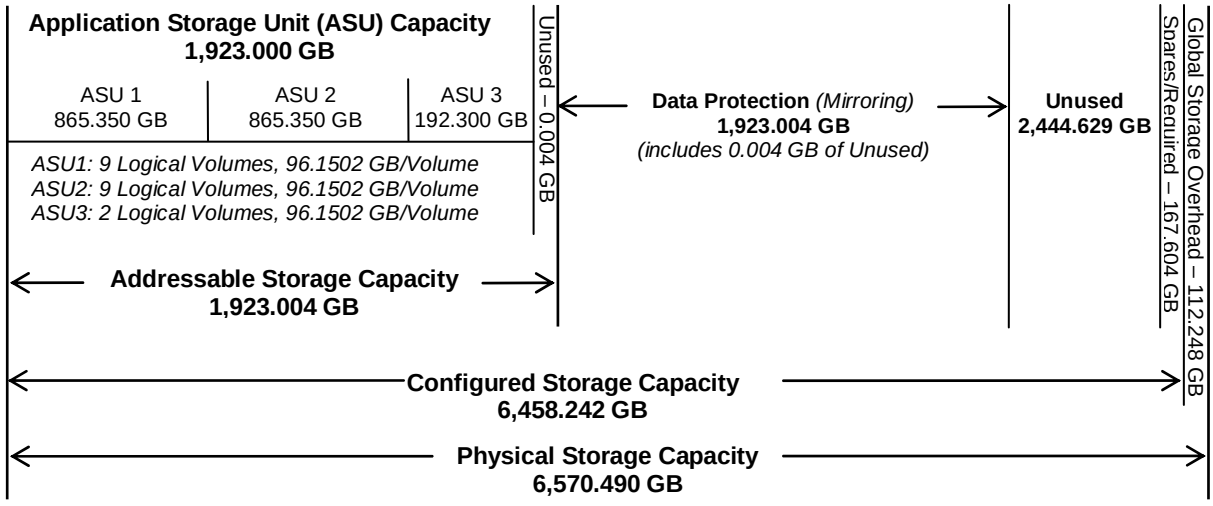
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

Total ASU (Application Storage Unit) **Capacity** represents the total storage capacity read and written in the course of executing the SPC-1 benchmark.

A **Data Protection Level** of "Mirroring" configures two or more identical copies of user data.

Storage Capacities and Relationships

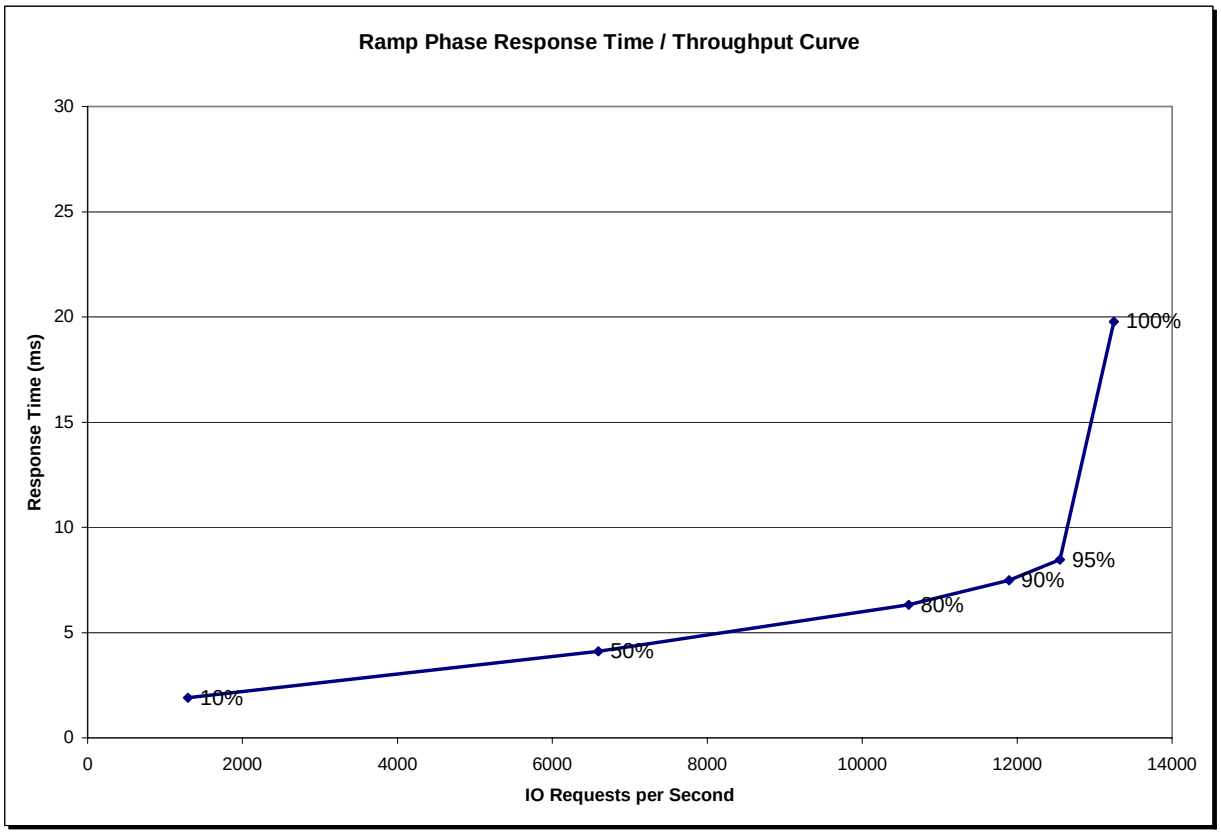
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



Response Time – Throughput Curve

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

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



Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	1,298.87	6,593.38	10,601.46	11,896.17	12,553.85	13,250.44
Average Response Time (ms):						
All ASUs	1.91	4.10	6.31	7.49	8.46	19.77
ASU-1	2.46	4.87	7.26	8.53	9.56	20.19
ASU-2	1.76	4.11	6.90	8.65	10.08	21.49
ASU-3	0.82	2.48	4.05	4.76	5.43	18.10
Reads	3.64	6.69	10.01	12.03	13.67	24.27
Writes	0.78	2.42	3.91	4.52	5.08	16.83

Tested Storage Configuration Pricing *(Priced Storage Configuration)*

Product name	Qty	Unit LP	Extended LP	Discount %	Discounted Price
ETERNUS2000 model 200 Base unit (FC 4 ports)	1	$13,000.00	$13,000.00	30%	$9,100.00
146GB/15Krpm (SAS) disk drive (set of 2) RAID1 E2K	22	$1,200.00	$26,400.00	30%	$18,480.00
146GB/15Krpm (SAS) disk drive (single) E2K	1	$600.00	$600.00	30%	$420.00
Additional drive enclosure (1xDE) E2K M200	3	$3,000.00	$9,000.00	30%	$6,300.00
Power distribution unit (1U) for E2K	2	$532.00	$1,064.00	30%	$744.80
Emulex 4Gb PCIe 2.5GGhz Dual Channel Fibre Channel HBA	2	$2,565.00	$5,130.00	40%	$3,078.00
24 x 7 Phone Support; 24 x 7, 4-hour On-Site Resp.(Sev-1), 36 Months, Prepaid billing			$10,656.00	35%	$6,926.40
			Total		**$45,049.20**

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

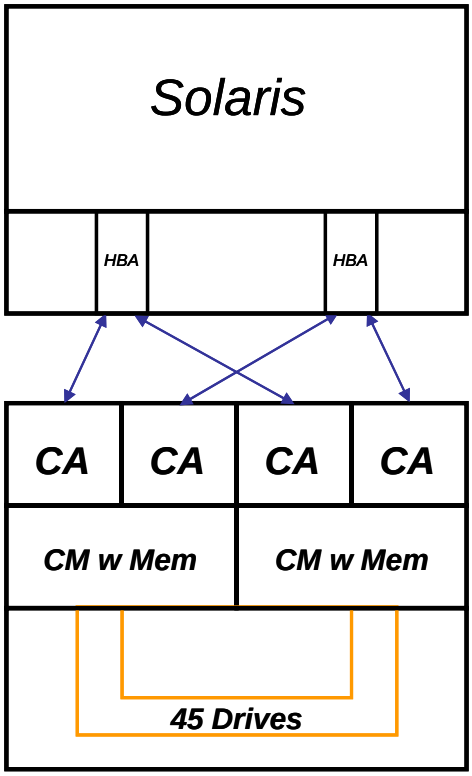
There were no differences between the Tested Storage Configuration and the Priced Storage Configuration.

Benchmark Configuration/Tested Storage Configuration Diagram

SPARC Enterprise M8000

ETERNUS2000 Model 200

CA – Channel Adapter
CM – Control Module
Mem – Cache Memory
HBA – Host Bus Adapter



Benchmark Configuration/Tested Storage Configuration Components

Host Systems:	Tested Storage Configuration (TSC):
UID=HS-1	2 – Emulex LPe11002 Fibre Channel HBAs
Fujitsu SPARC Enterprise M8000	***UID=SC-1:*** Fujitsu ETERNUS2000 Model 2000 2 – Controller Modules, each with: 2 GB cache 2 – Channel Adapter Modules 4 Fibre Channel ports each 2 – SAS Expander Drive Interfaces
16 – SPCAR64 VI chips, each with: 128 KB L1 data cache, 6 MB L2 cach3	
512 GB main memory	
Solaris 10	
PCIe	4 – Front side Fibre Channels *(set to 4 Gbit each)*
WG	2 – Back side SAS Channels
	4 – Drive Enclosure Modules, each with: dual SAS interfaces 12 – Hot Swap drive slots
	45 – 146 GB, 15K RPM disk drives *(44 drives in 22 RAID Groups plus 1 Hot Spare)*

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

CONFIGURATION INFORMATION

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

Clause 9.2.4.4.1

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 14 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Storage Network Configuration

Clause 9.2.4.4.1

…

5. *If the TSC contains network storage, the diagram will include the network configuration. If a single diagram is not sufficient to illustrate both the Benchmark Configuration and network configuration in sufficient detail, the Benchmark Configuration diagram will include a high-level network illustration as shown in Figure 9-8. In that case, a separate, detailed network configuration diagram will also be included as described in Clause 9.2.4.4.2.*

Clause 9.2.4.4.2

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.2.4.4.1 contains a high-level illustration of the network configuration, the Executive Summary will contain a one page topology diagram of the storage network as illustrated in Figure 9-9.

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC), including the network configuration, is illustrated on page 14 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Host System Configuration

Clause 9.2.4.4.3

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

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

The details of the Host System configuration may be found on page 14 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Customer Tunable 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. If the parameter name is not self-explanatory to a knowledgeable practitioner, a brief description of the parameter's use must also be included in the FDR entry.

"Appendix B: Customer Tunable Parameters and Options" on page 59 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Description

Clause 9.2.4.5.2

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 BC Configuration Diagram in Clause 9.2.4.4.1 and/or the Storage Network Configuration Diagram in Clause 9.2.4.4.2.*
  - *The logical representation of the TSC, configured from the above components that will be presented to the Workload Generator.*
- *Listings of scripts used to create the logical representation of the TSC.*
- *If scripts were not used, a description of the process used with sufficient detail to recreate the logical representation of the TSC.*

"Appendix C: Tested Storage Configuration (TSC) Creation" on page 69 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.2.4.5.3

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

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in "Appendix D: SPC-1 Workload Generator Storage Commands and Parameters" on page 87.

SPC-1 DATA REPOSITORY

This portion of the Full Disclosure Report presents the detailed information that fully documents the various SPC-1 storage capacities and mappings used in the Tested Storage Configuration. "SPC-1 Data Repository Definitions" on page 55 contains definitions of terms specific to the SPC-1 Data Repository.

Storage Capacities and Relationships

Clause 9.2.4.6.1

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

SPC-1 Storage Capacities

SPC-1 Storage Capacities		
Storage Hierarchy Component	**Units**	**Capacity**
Total ASU Capacity	Gigabytes (GB)	1,923.000
Addressable Storage Capacity	Gigabytes (GB)	1,923.004
Configured Storage Capacity	Gigabytes (GB)	6,458.242
Physical Storage Capacity	Gigabytes (GB)	6,570.490
Data Protection *(Mirroring)*	Gigabytes (GB)	1,923.004
Required Storage *(spares/overhead)*	Gigabytes (GB)	167.604
Global Storage Overhead	Gigabytes (GB)	112.248
Total Unused Storage	Gigabytes (GB)	2,444.638

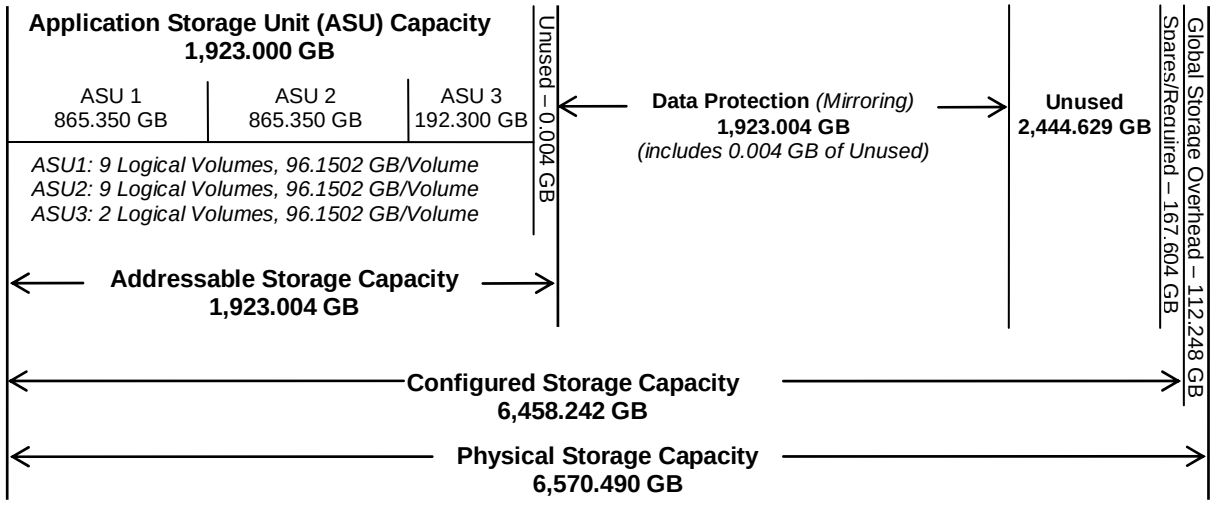
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	99.9998%	29.78%	29.27%
Required for Data Protection *(Mirroring)*		29.78%	29.27%
Addressable Storage Capacity		29.78%	29.27%
Required Storage (spares, overhead)		2.60%	2.55%
Configured Storage Capacity			98.29%
Global Storage Overhead			1.71%
Unused Storage:			
Addressable	0.0002%		
Configured		37.85%	
Physical			0.00%

The Physical Storage Capacity consisted of 6,570.490 GB distributed over 45 disk drives each with a formatted capacity of 146.011 GB. There was 0.000 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 112.248 GB (1.71%) of Physical Storage Capacity. There was 2,444.629 GB (37.85%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 99.9998% of the Addressable Storage Capacity resulting in 0.004 GB (0.0002%) of Unused Storage within the Addressable Storage Capacity.

SPC-1 Storage Capacities and Relationships Illustration

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



Logical Volume Capacity and ASU Mapping

Clause 9.2.4.6.2

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 (865.3500 GB)	**ASU-2 (865.3500 GB)**	**ASU-3 (192.3000 GB)**
9 Logical Volumes 96.1502 GB per Logical Volume (96.1500 GB used per Logical Volume)	9 Logical Volumes 96.1502 GB per Logical Volume (96.1500 GB used per Logical Volume)	2 Logical Volumes 96.1502 GB per Logical Volume (96.1500 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was "Mirrored" as described on page 11. See "ASU Configuration" in the **IOPS Test Results File** for more detailed configuration information.

Assignment of RAID Groups and LUNs

The 22 RAID Group Assignments are RAID1(1+1) sets, each divided into 20 Logical Volumes, for a total of 440 LVs.

The RAID Group assignments to drives in the array are illustrated by the following chart.

Drive:	11	10	9	8	7	6	5	4	3	2	1	0
CE-00	RG-5		RG-4		RG-3		RG-2		RG-1		RG-0	
DE-01	RG-B		RG-A		RG-9		RG-8		RG-7		RG-6	
DE-02	RG-11		RG-10		RG-F		RG-E		RG-D		RG-C	
DE-03				HS	RG-15		RG-14		RG-13		RG-12	

The RAID Groups and LUN assignments are set up through a series of actions on the GUI Management Interface (ETERNUS Administrator). 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 RAID1 configurations. In this configuration, all of the RAID Groups are 1+1 arrangements. Please see “Appendix C: Tested Storage Configuration (TSC) Creation” on page 69 for further details on preparing the configuration.

There is One (1) Hot Spare drive that has been included in the configuration. There are three (3) empty drive slots in this configuration, as well.

The 440 Logical Volumes are grouped into four separate sets of LUNs, using Host Affinity grouping, each with 110 LUNs. These are connected to the logical host server through the 4 CA ports and directly connected HBA ports. The LUNs, seen through the four HBA ports by Solaris, are grouped into Solaris Volume Groups, and used with 8 MB stripe unit depths across the sets. Nine Logical Volumes, each with 22 LUNs are used for ASU1 and another nine for ASU2, while two Volumes, also each with 22 LUNs are used for ASU3. The sizes are reflected in the ASU Logical Volume Mapping chart.

Two optional facilities in the ETERNUS2000 (GRPM and Trace), which are used for collection information during operation, were turned off during this benchmark run. They are normally not enabled during operations. Two secondary enhanced reliability features (Patrol and sampled Read after Write compare), which may be optionally enabled by a customer, were turned off during this benchmark run. The optional encryption feature was turned off during this benchmark, as well. Due to the transaction nature of the workload, as is customary for such workloads, the write sequential feature was turned off.

SPC-1 BENCHMARK EXECUTION RESULTS

This portion of the Full Disclosure Report documents the results of the various SPC-1 Tests, Test Phases, and Test Runs. "SPC-1 Test Execution Definitions" on page 56 contains definitions of terms specific to the SPC-1 Tests, Test Phases, and Test Runs.

Clause 5.4.3

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

SPC-1 Tests, Test Phases, and Test Runs

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

- **Primary Metrics Test**
  - Sustainability Test Phase and Test Run
  - IOPS Test Phase and Test Run
  - Response Time Ramp Test Phase
    - 95% of IOPS Test Run
    - 90% of IOPS Test Run
    - 80% of IOPS Test Run
    - 50% of IOPS Test Run
    - 10% of IOPS Test Run (LRT)
- **Repeatability Test**
  - Repeatability Test Phase 1
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run
  - Repeatability Test Phase 2
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run
- **Data Persistence Test**
  - Data Persistence Test Run 1
  - Data Persistence Test Run 2

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

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

Primary Metrics Test – Sustainability Test Phase

Clause 5.4.4.1.1

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

Clause 5.4.4.1.2

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

Clause 5.4.4.1.4

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

Clause 9.2.4.7.1

For the Sustainability Test Phase the FDR shall contain:

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 88.

Sustainability Test Results File

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

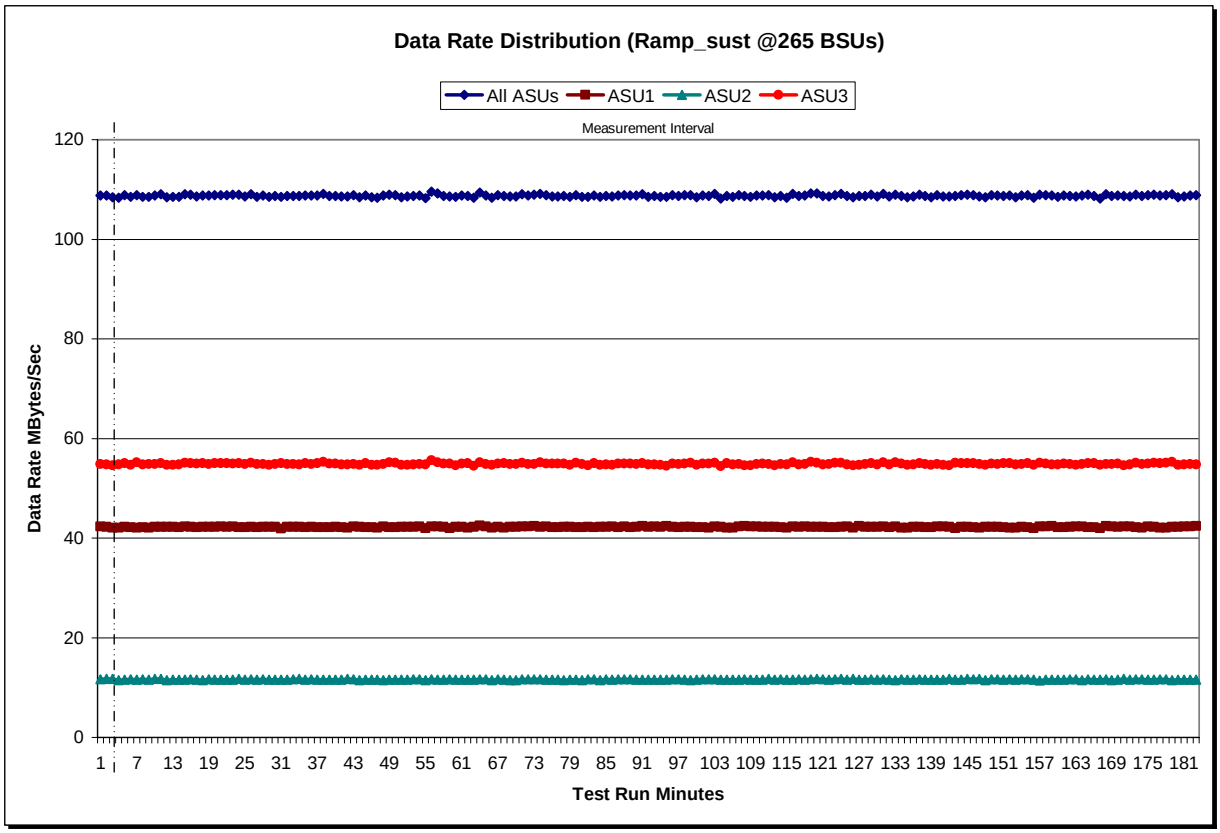
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	15:29:50	15:32:50	0-2	0:03:00
Measurement Interval	15:32:50	18:32:50	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	108.79	42.29	11.68	54.82	63	109.38	42.51	11.68	55.19	126	108.70	42.42	11.55	54.73
1	108.78	42.20	11.77	54.80	64	108.77	42.30	11.66	54.82	127	108.68	42.25	11.58	54.85
2	108.42	42.04	11.76	54.63	65	108.34	42.08	11.53	54.73	128	108.92	42.22	11.68	55.03
3	108.35	42.06	11.51	54.78	66	108.84	42.24	11.64	54.96	129	108.59	42.22	11.62	54.75
4	108.89	42.28	11.56	55.05	67	108.71	42.04	11.61	55.07	130	109.13	42.29	11.67	55.17
5	108.55	42.17	11.65	54.73	68	108.61	42.21	11.50	54.90	131	108.58	42.17	11.61	54.80
6	108.86	42.09	11.59	55.18	69	108.56	42.22	11.48	54.86	132	108.98	42.30	11.51	55.17
7	108.53	42.14	11.65	54.74	70	109.04	42.34	11.63	55.08	133	108.70	42.11	11.67	54.92
8	108.49	42.03	11.58	54.87	71	108.78	42.34	11.63	54.82	134	108.41	42.08	11.61	54.72
9	108.80	42.22	11.74	54.83	72	108.94	42.39	11.65	54.90	135	108.60	42.22	11.61	54.78
10	109.00	42.24	11.71	55.05	73	109.07	42.21	11.70	55.17	136	108.93	42.23	11.64	55.06
11	108.42	42.23	11.52	54.67	74	108.88	42.30	11.60	54.99	137	108.64	42.20	11.61	54.83
12	108.52	42.25	11.56	54.71	75	108.59	42.14	11.53	54.91	138	108.39	42.13	11.57	54.69
13	108.52	42.19	11.57	54.75	76	108.62	42.12	11.56	54.94	139	108.83	42.35	11.61	54.87
14	109.05	42.29	11.62	55.14	77	108.72	42.20	11.53	54.99	140	108.63	42.35	11.60	54.68
15	108.94	42.22	11.67	55.05	78	108.53	42.23	11.61	54.69	141	108.64	42.29	11.72	54.63
16	108.63	42.14	11.54	54.95	79	108.82	42.14	11.56	55.12	142	108.72	42.02	11.62	55.08
17	108.78	42.24	11.50	55.04	80	108.55	42.16	11.52	54.87	143	108.87	42.27	11.60	55.00
18	108.73	42.22	11.63	54.87	81	108.51	42.25	11.65	54.61	144	108.97	42.23	11.72	55.03
19	108.86	42.26	11.60	55.00	82	108.79	42.17	11.62	55.00	145	108.84	42.16	11.63	55.05
20	108.90	42.30	11.59	55.01	83	108.49	42.26	11.53	54.71	146	108.61	42.07	11.72	54.82
21	108.83	42.23	11.59	55.02	84	108.65	42.24	11.65	54.75	147	108.42	42.27	11.47	54.68
22	108.92	42.37	11.58	54.97	85	108.61	42.29	11.60	54.71	148	108.87	42.25	11.64	54.98
23	108.93	42.14	11.74	55.05	86	108.77	42.14	11.65	54.97	149	108.77	42.23	11.65	54.89
24	108.59	42.14	11.57	54.87	87	108.90	42.29	11.69	54.91	150	108.71	42.12	11.56	55.03
25	109.02	42.24	11.67	55.10	88	108.78	42.17	11.65	54.96	151	108.75	42.09	11.63	55.03
26	108.48	42.12	11.54	54.82	89	108.73	42.28	11.55	54.90	152	108.40	42.05	11.59	54.76
27	108.74	42.26	11.64	54.85	90	109.01	42.40	11.60	55.01	153	108.73	42.20	11.63	54.90
28	108.49	42.24	11.56	54.69	91	108.53	42.21	11.55	54.77	154	108.85	42.20	11.64	55.01
29	108.68	42.23	11.59	54.87	92	108.71	42.36	11.60	54.75	155	108.31	42.01	11.59	54.71
30	108.53	41.91	11.60	55.02	93	108.55	42.28	11.59	54.68	156	108.90	42.32	11.44	55.14
31	108.68	42.23	11.56	54.89	94	108.53	42.46	11.60	54.48	157	108.88	42.37	11.58	54.92
32	108.72	42.28	11.62	54.82	95	108.82	42.22	11.65	54.95	158	108.81	42.40	11.61	54.80
33	108.71	42.24	11.74	54.73	96	108.72	42.19	11.65	54.88	159	108.55	42.19	11.57	54.79
34	108.75	42.18	11.57	54.99	97	108.86	42.29	11.61	54.96	160	108.78	42.20	11.60	54.99
35	108.77	42.25	11.69	54.83	98	108.87	42.29	11.50	55.08	161	108.72	42.20	11.67	54.85
36	108.79	42.20	11.55	55.05	99	108.46	42.19	11.59	54.69	162	108.62	42.31	11.66	54.65
37	109.08	42.20	11.57	55.30	100	108.80	42.18	11.64	54.98	163	108.73	42.33	11.53	54.88
38	108.70	42.16	11.60	54.94	101	108.66	42.09	11.66	54.91	164	108.91	42.19	11.66	55.07
39	108.68	42.22	11.55	54.90	102	109.07	42.32	11.64	55.11	165	108.72	42.17	11.54	55.01
40	108.56	42.17	11.59	54.81	103	108.17	42.23	11.54	54.40	166	108.20	41.96	11.59	54.65
41	108.60	42.10	11.72	54.78	104	108.72	42.07	11.59	55.06	167	109.00	42.43	11.69	54.88
42	108.83	42.31	11.69	54.84	105	108.47	42.08	11.60	54.79	168	108.68	42.30	11.49	54.90
43	108.40	42.21	11.51	54.68	106	108.82	42.36	11.61	54.85	169	108.80	42.28	11.60	54.92
44	108.81	42.15	11.62	55.04	107	108.66	42.45	11.64	54.58	170	108.70	42.31	11.78	54.61
45	108.41	42.12	11.58	54.71	108	108.50	42.34	11.59	54.57	171	108.60	42.30	11.54	54.76
46	108.34	42.11	11.59	54.65	109	108.78	42.34	11.59	54.85	172	108.96	42.19	11.63	55.13
47	108.73	42.36	11.52	54.84	110	108.74	42.23	11.57	54.94	173	108.65	42.10	11.67	54.88
48	108.92	42.14	11.61	55.16	111	108.90	42.26	11.78	54.86	174	108.86	42.32	11.62	54.92
49	108.88	42.15	11.60	55.12	112	108.40	42.21	11.62	54.57	175	108.91	42.23	11.54	55.15
50	108.45	42.21	11.57	54.67	113	108.69	42.16	11.68	54.85	176	108.73	42.06	11.65	55.02
51	108.55	42.25	11.59	54.72	114	108.36	42.07	11.55	54.74	177	108.82	42.09	11.66	55.08
52	108.66	42.27	11.64	54.75	115	109.09	42.30	11.59	55.20	178	109.04	42.22	11.53	55.30
53	108.80	42.31	11.64	54.85	116	108.70	42.29	11.62	54.79	179	108.46	42.22	11.54	54.69
54	108.29	42.02	11.52	54.75	117	108.79	42.33	11.58	54.89	180	108.63	42.31	11.56	54.77
55	109.56	42.30	11.65	55.61	118	109.20	42.27	11.67	55.25	181	108.79	42.32	11.60	54.87
56	109.19	42.37	11.58	55.25	119	109.17	42.28	11.73	55.16	182	108.82	42.42	11.61	54.79
57	108.72	42.25	11.53	54.93	120	108.70	42.26	11.66	54.79					
58	108.62	42.00	11.63	54.99	121	108.58	42.12	11.61	54.84					
59	108.50	42.25	11.61	54.64	122	108.86	42.14	11.63	55.08					
60	108.75	42.21	11.59	54.95	123	109.14	42.24	11.75	55.15					
61	108.71	42.06	11.60	55.05	124	108.67	42.35	11.56	54.76					
62	108.33	42.24	11.56	54.54	125	108.42	42.07	11.73	54.62					

Sustainability – Data Rate Distribution Graph

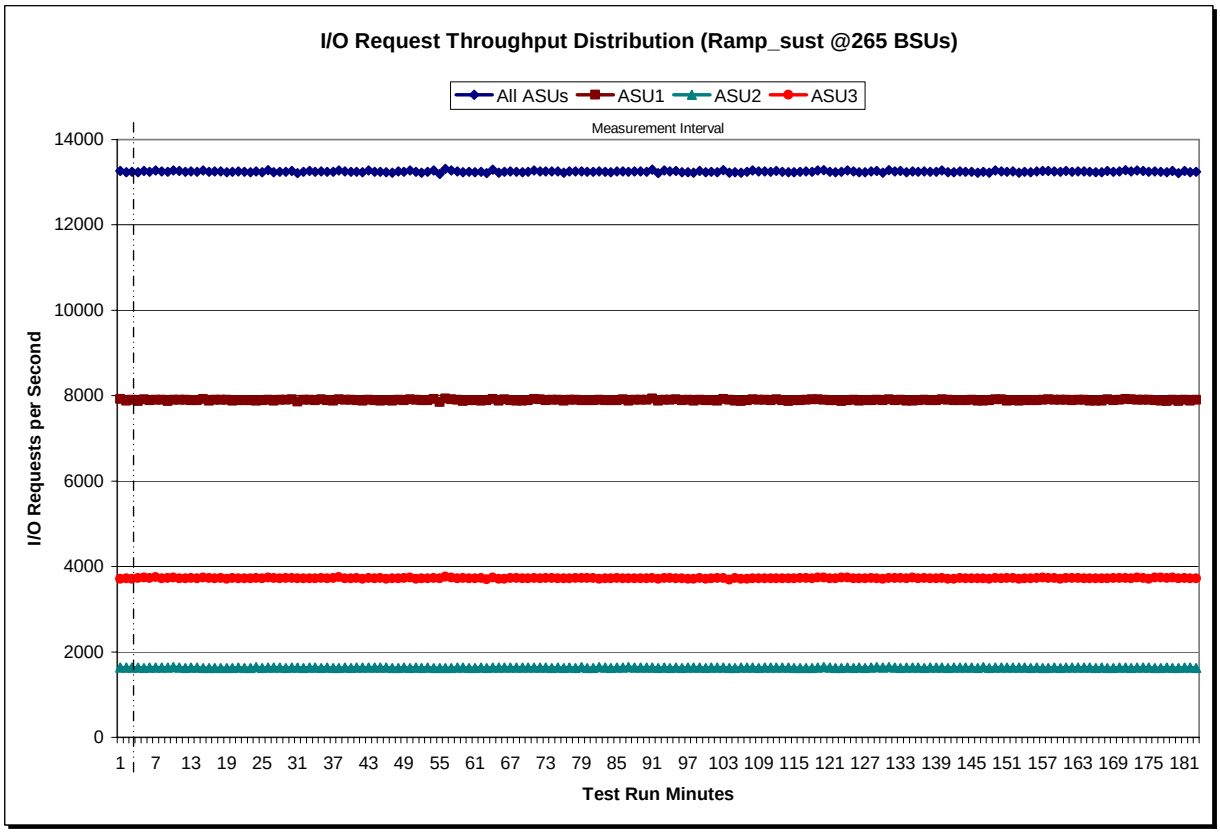


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	15:29:50	15:32:50	0-2	0:03:00
Measurement Interval	15:32:50	18:32:50	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	13,266.02	7,921.63	1,634.37	3,710.02	63	13,296.38	7,927.28	1,632.30	3,736.80	126	13,235.92	7,889.92	1,621.75	3,724.25
1	13,232.15	7,886.08	1,631.63	3,714.43	64	13,228.38	7,883.80	1,632.40	3,712.18	127	13,255.33	7,894.92	1,630.10	3,730.32
2	13,247.07	7,902.78	1,633.78	3,710.50	65	13,248.17	7,910.40	1,629.92	3,707.85	128	13,265.55	7,903.95	1,637.88	3,723.72
3	13,237.00	7,876.38	1,628.45	3,732.17	66	13,251.75	7,893.82	1,629.45	3,728.48	129	13,227.60	7,887.53	1,628.05	3,712.02
4	13,262.88	7,907.75	1,620.37	3,734.77	67	13,240.25	7,884.15	1,631.20	3,724.90	130	13,284.15	7,914.62	1,638.78	3,730.75
5	13,248.35	7,895.28	1,628.42	3,724.65	68	13,230.95	7,882.15	1,629.62	3,719.18	131	13,252.70	7,890.02	1,628.60	3,734.08
6	13,278.73	7,903.10	1,630.83	3,744.80	69	13,242.28	7,891.67	1,628.18	3,722.43	132	13,261.22	7,903.58	1,627.50	3,730.13
7	13,253.93	7,903.55	1,632.97	3,717.42	70	13,275.28	7,917.25	1,628.73	3,729.30	133	13,236.50	7,884.30	1,628.15	3,724.05
8	13,239.30	7,876.88	1,634.87	3,727.55	71	13,258.35	7,912.70	1,630.10	3,715.55	134	13,252.58	7,886.58	1,630.18	3,735.82
9	13,270.90	7,897.78	1,638.73	3,734.38	72	13,255.72	7,895.47	1,635.12	3,725.13	135	13,239.17	7,892.92	1,630.27	3,715.98
10	13,259.48	7,902.77	1,634.87	3,721.85	73	13,256.10	7,898.33	1,627.62	3,730.15	136	13,255.50	7,900.32	1,623.65	3,731.53
11	13,239.08	7,898.17	1,623.92	3,717.00	74	13,254.95	7,903.27	1,628.07	3,723.62	137	13,241.68	7,888.77	1,632.70	3,720.22
12	13,256.67	7,896.85	1,633.98	3,725.83	75	13,224.90	7,880.58	1,625.58	3,718.73	138	13,245.62	7,896.72	1,629.45	3,719.45
13	13,246.33	7,896.58	1,629.38	3,720.37	76	13,253.55	7,901.08	1,629.93	3,722.53	139	13,272.00	7,913.83	1,632.12	3,726.05
14	13,275.98	7,918.80	1,620.85	3,736.33	77	13,254.72	7,900.77	1,626.28	3,727.67	140	13,238.97	7,902.67	1,622.65	3,713.65
15	13,242.73	7,885.82	1,627.20	3,729.72	78	13,255.27	7,892.47	1,638.15	3,724.65	141	13,238.03	7,892.40	1,632.22	3,713.42
16	13,250.10	7,904.13	1,627.72	3,718.25	79	13,243.70	7,887.77	1,624.55	3,731.38	142	13,256.73	7,889.70	1,633.73	3,733.30
17	13,255.23	7,901.63	1,627.00	3,726.60	80	13,243.15	7,890.67	1,626.48	3,726.00	143	13,245.30	7,890.78	1,633.58	3,720.93
18	13,237.93	7,900.98	1,627.75	3,709.20	81	13,253.50	7,897.63	1,642.55	3,713.32	144	13,242.50	7,898.80	1,629.28	3,714.42
19	13,243.85	7,885.92	1,627.25	3,730.68	82	13,247.77	7,893.08	1,630.90	3,723.78	145	13,228.32	7,886.08	1,621.92	3,720.32
20	13,249.27	7,894.53	1,634.15	3,720.58	83	13,236.15	7,892.72	1,627.13	3,716.30	146	13,245.95	7,882.45	1,641.93	3,721.57
21	13,242.20	7,895.92	1,626.45	3,719.83	84	13,250.80	7,891.68	1,633.98	3,725.13	147	13,225.15	7,892.97	1,620.42	3,711.77
22	13,235.98	7,893.70	1,626.68	3,715.60	85	13,256.83	7,907.80	1,631.13	3,717.90	148	13,271.83	7,915.60	1,631.73	3,724.50
23	13,256.97	7,884.92	1,638.75	3,733.30	86	13,246.83	7,885.58	1,638.07	3,723.18	149	13,258.45	7,912.83	1,631.13	3,714.48
24	13,237.97	7,891.00	1,626.40	3,720.57	87	13,254.87	7,899.85	1,632.57	3,722.45	150	13,245.77	7,884.73	1,629.77	3,731.27
25	13,279.90	7,906.97	1,632.72	3,740.22	88	13,251.87	7,903.07	1,633.08	3,715.72	151	13,254.63	7,889.47	1,636.95	3,728.22
26	13,238.78	7,878.05	1,629.32	3,731.42	89	13,244.22	7,897.70	1,631.07	3,715.45	152	13,228.48	7,885.20	1,629.60	3,713.68
27	13,241.58	7,898.53	1,628.45	3,714.60	90	13,290.15	7,928.57	1,629.92	3,731.67	153	13,240.68	7,888.00	1,633.18	3,719.50
28	13,248.32	7,899.60	1,617.92	3,730.80	91	13,212.53	7,882.38	1,619.85	3,710.30	154	13,238.18	7,895.38	1,620.92	3,721.88
29	13,264.93	7,908.23	1,630.22	3,726.48	92	13,270.32	7,902.05	1,637.77	3,730.50	155	13,250.73	7,890.10	1,630.53	3,730.10
30	13,213.15	7,860.03	1,631.45	3,721.67	93	13,249.25	7,900.57	1,623.85	3,724.83	156	13,259.92	7,900.75	1,623.67	3,735.50
31	13,244.88	7,899.77	1,622.80	3,722.32	94	13,263.53	7,916.55	1,631.10	3,715.88	157	13,269.05	7,909.10	1,627.47	3,732.48
32	13,266.98	7,906.23	1,636.75	3,724.00	95	13,235.78	7,894.18	1,625.18	3,716.42	158	13,258.93	7,900.33	1,633.37	3,725.23
33	13,243.78	7,890.32	1,637.07	3,716.40	96	13,238.72	7,898.08	1,628.43	3,712.20	159	13,245.52	7,906.98	1,624.67	3,713.87
34	13,255.83	7,907.55	1,618.42	3,729.87	97	13,225.33	7,883.48	1,632.37	3,709.48	160	13,264.98	7,898.97	1,634.33	3,731.68
35	13,242.90	7,888.68	1,633.23	3,720.98	98	13,266.98	7,906.08	1,630.47	3,730.43	161	13,248.80	7,891.53	1,632.33	3,724.93
36	13,239.23	7,882.92	1,622.30	3,734.02	99	13,235.28	7,895.88	1,627.08	3,712.32	162	13,256.92	7,899.35	1,632.55	3,725.02
37	13,275.92	7,909.60	1,621.68	3,744.63	100	13,246.33	7,892.33	1,634.20	3,719.80	163	13,253.47	7,904.27	1,628.13	3,721.07
38	13,249.37	7,898.78	1,628.80	3,721.78	101	13,238.20	7,881.08	1,631.45	3,725.67	164	13,239.28	7,882.37	1,635.02	3,721.90
39	13,248.87	7,901.97	1,627.50	3,719.40	102	13,282.10	7,918.03	1,632.92	3,731.15	165	13,230.43	7,884.83	1,626.47	3,719.13
40	13,248.17	7,889.63	1,633.58	3,724.95	103	13,221.07	7,907.00	1,622.15	3,691.92	166	13,234.07	7,882.83	1,633.78	3,717.45
41	13,236.83	7,885.97	1,637.67	3,713.20	104	13,236.95	7,879.80	1,624.35	3,732.80	167	13,260.93	7,912.23	1,625.85	3,722.85
42	13,271.12	7,903.32	1,637.33	3,730.47	105	13,218.92	7,873.78	1,636.07	3,709.07	168	13,244.70	7,891.83	1,627.27	3,725.60
43	13,242.83	7,887.72	1,634.92	3,720.20	106	13,242.25	7,896.40	1,633.30	3,712.55	169	13,254.60	7,899.63	1,629.82	3,725.15
44	13,245.42	7,884.37	1,633.25	3,727.80	107	13,269.57	7,917.13	1,634.43	3,718.00	170	13,280.05	7,919.92	1,635.83	3,724.30
45	13,229.12	7,888.67	1,630.13	3,710.32	108	13,250.45	7,903.53	1,626.13	3,720.78	171	13,253.47	7,911.70	1,621.77	3,720.00
46	13,224.82	7,878.58	1,626.17	3,720.07	109	13,249.48	7,904.48	1,630.57	3,714.43	172	13,270.22	7,899.10	1,633.38	3,737.73
47	13,255.27	7,905.00	1,626.65	3,723.62	110	13,242.57	7,892.32	1,627.95	3,722.30	173	13,262.80	7,898.00	1,631.88	3,732.92
48	13,248.03	7,890.57	1,633.00	3,724.47	111	13,265.62	7,910.48	1,637.42	3,717.72	174	13,245.98	7,901.40	1,631.02	3,713.57
49	13,271.52	7,908.77	1,626.68	3,736.07	112	13,247.90	7,896.87	1,631.58	3,719.45	175	13,258.13	7,888.33	1,627.17	3,742.63
50	13,242.40	7,897.78	1,632.78	3,711.83	113	13,236.80	7,875.67	1,637.60	3,723.53	176	13,244.13	7,879.70	1,625.02	3,739.42
51	13,226.95	7,892.27	1,618.65	3,716.03	114	13,233.03	7,887.52	1,621.83	3,723.68	177	13,234.73	7,874.93	1,632.18	3,727.62
52	13,247.80	7,894.30	1,630.83	3,722.67	115	13,248.47	7,896.55	1,618.83	3,733.08	178	13,262.73	7,901.08	1,623.85	3,737.80
53	13,274.38	7,922.25	1,626.17	3,725.97	116	13,255.10	7,903.03	1,625.53	3,726.53	179	13,216.22	7,870.47	1,621.63	3,724.12
54	13,192.40	7,851.28	1,624.82	3,716.30	117	13,248.47	7,910.00	1,621.32	3,717.15	180	13,262.63	7,906.42	1,630.48	3,725.73
55	13,313.82	7,931.63	1,625.55	3,756.63	118	13,275.38	7,910.78	1,629.47	3,735.13	181	13,229.78	7,885.47	1,627.90	3,716.42
56	13,276.50	7,912.67	1,627.57	3,736.27	119	13,281.38	7,906.33	1,640.68	3,734.37	182	13,239.20	7,902.78	1,621.87	3,714.55
57	13,253.42	7,899.82	1,630.52	3,723.08	120	13,240.05	7,894.25	1,631.35	3,714.45	Average	13,249.30	7,896.11	1,629.47	3,723.73
58	13,232.77	7,874.05	1,629.43	3,729.28	121	13,231.08	7,888.75	1,624.78	3,717.55					
59	13,245.00	7,895.35	1,625.75	3,723.90	122	13,244.47	7,874.60	1,625.53	3,744.33					
60	13,237.92	7,896.05	1,619.18	3,722.68	123	13,269.82	7,896.98	1,634.77	3,738.07					
61	13,244.72	7,878.32	1,637.30	3,729.10	124	13,255.68	7,905.97	1,626.35	3,723.37					
62	13,211.55	7,891.92	1,619.18	3,700.45	125	13,233.92	7,885.50	1,633.63	3,714.78					

Sustainability – I/O Request Throughput Distribution Graph

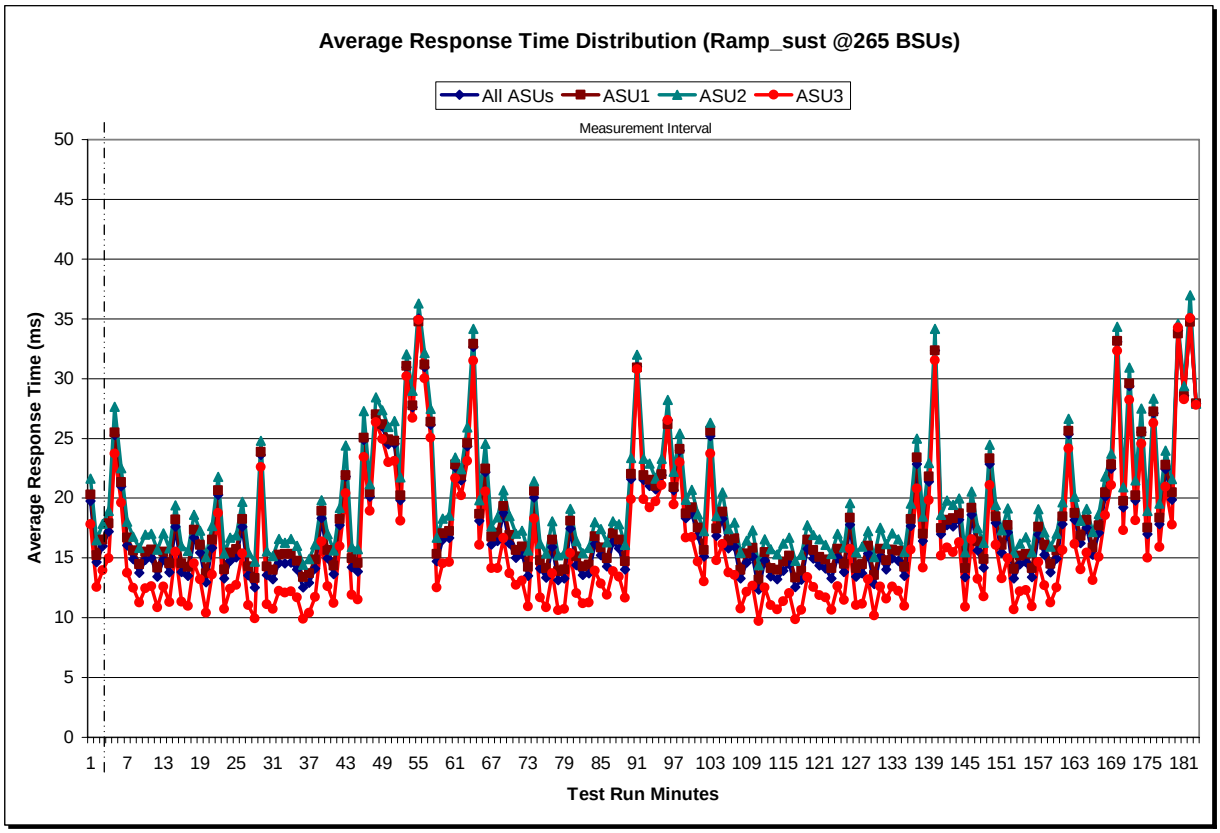


Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	15:29:50	15:32:50	0-2	0:03:00
Measurement Interval	15:32:50	18:32:50	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	19.77	20.30	21.62	17.82	63	32.67	32.91	34.17	31.50	126	13.44	14.14	15.50	11.07
1	14.64	15.24	16.50	12.56	64	18.10	18.69	19.85	16.08	127	13.71	14.46	15.93	11.15
2	15.97	16.52	17.87	13.96	65	22.18	22.45	24.55	20.56	128	15.38	16.02	17.23	13.19
3	17.20	17.90	18.94	14.97	66	16.14	16.77	17.63	14.14	129	12.80	13.57	15.06	10.17
4	25.25	25.49	27.65	23.72	67	16.42	17.09	18.39	14.14	130	15.10	15.78	17.53	12.59
5	21.00	21.34	22.49	19.63	68	18.75	19.33	20.67	16.67	131	14.05	14.78	16.16	11.58
6	16.04	16.71	18.03	13.76	69	16.20	16.91	18.49	13.70	132	14.98	15.69	17.06	12.59
7	14.90	15.64	16.78	12.50	70	14.99	15.64	17.03	12.73	133	14.77	15.60	16.55	12.26
8	13.74	14.47	15.83	11.26	71	15.32	15.96	17.28	13.10	134	13.50	14.27	15.53	10.98
9	14.83	15.50	16.96	12.47	72	13.49	14.25	15.63	10.95	135	17.69	18.25	19.54	15.69
10	15.01	15.71	17.01	12.64	73	20.05	20.60	21.43	18.29	136	22.86	23.38	25.00	20.82
11	13.43	14.17	15.70	10.88	74	14.10	14.81	16.21	11.69	137	16.40	17.01	18.47	14.20
12	14.88	15.50	17.05	12.62	75	13.37	14.14	15.36	10.87	138	21.39	21.80	22.92	19.85
13	13.78	14.53	15.80	11.30	76	15.92	16.52	18.08	13.71	139	32.35	32.37	34.15	31.53
14	17.60	18.22	19.40	15.51	77	13.14	13.90	15.23	10.63	140	16.98	17.48	18.60	15.19
15	13.83	14.55	16.00	11.35	78	13.28	14.05	15.38	10.73	141	17.74	18.18	19.81	15.89
16	13.49	14.24	15.59	10.97	79	17.47	18.10	19.13	15.40	142	17.65	18.32	19.43	15.47
17	16.72	17.36	18.61	14.54	80	14.41	15.10	16.42	12.07	143	18.20	18.72	19.96	16.31
18	15.43	16.10	17.28	13.20	81	13.56	14.30	15.41	11.19	144	13.39	14.13	15.48	10.90
19	12.96	13.73	15.10	10.40	82	13.70	14.42	15.82	11.26	145	18.60	19.17	20.55	16.54
20	15.84	16.51	17.69	13.61	83	16.15	16.82	18.00	13.93	146	15.64	16.39	17.48	13.23
21	20.27	20.66	21.76	18.77	84	15.21	15.87	17.44	12.85	147	14.20	14.92	16.26	11.76
22	13.28	14.05	15.35	10.73	85	14.28	14.97	16.32	11.91	148	22.86	23.34	24.50	21.11
23	14.74	15.44	16.71	12.41	86	16.31	17.08	18.05	13.90	149	17.92	18.47	19.45	16.09
24	15.04	15.73	16.88	12.76	87	15.82	16.52	17.83	13.44	150	15.44	16.08	17.30	13.27
25	17.62	18.25	19.68	15.37	88	14.04	14.73	16.11	11.66	151	17.14	17.75	19.15	14.98
26	13.53	14.29	15.48	11.06	89	21.59	22.02	23.35	19.90	152	13.30	14.09	15.43	10.68
27	12.53	13.30	14.69	9.93	90	31.00	30.91	31.99	30.77	153	14.47	15.18	16.20	12.21
28	23.61	23.85	24.79	22.60	91	21.53	21.92	23.28	19.91	154	14.65	15.33	16.74	12.31
29	13.56	14.29	15.57	11.13	92	21.04	21.51	22.89	19.23	155	13.40	14.13	15.47	10.94
30	13.22	13.99	15.17	10.74	93	20.73	21.02	21.64	19.73	156	16.96	17.61	19.07	14.66
31	14.58	15.27	16.59	12.23	94	21.91	22.00	23.31	21.09	157	15.27	16.09	17.13	12.72
32	14.54	15.34	16.28	12.09	95	26.53	26.18	28.23	26.53	158	13.79	14.52	15.96	11.27
33	14.61	15.34	16.60	12.20	96	20.66	20.90	22.21	19.48	159	14.93	15.62	17.02	12.52
34	14.05	14.75	16.01	11.71	97	23.98	24.13	25.41	23.02	160	17.82	18.46	19.66	15.67
35	12.54	13.38	14.44	9.90	98	18.31	18.74	19.87	16.71	161	25.35	25.64	26.65	24.17
36	12.93	13.72	14.90	10.42	99	18.71	19.24	20.68	16.72	162	18.19	18.74	20.12	16.16
37	14.13	14.85	16.13	11.73	100	16.87	17.53	18.65	14.69	163	16.22	16.86	18.10	14.02
38	18.32	18.92	19.84	16.37	101	15.12	15.67	17.24	13.02	164	17.52	18.19	19.10	15.43
39	14.97	15.66	16.99	12.64	102	25.18	25.63	26.30	23.74	165	15.26	15.87	17.18	13.12
40	13.64	14.35	15.62	11.25	103	16.84	17.45	18.49	14.79	166	17.09	17.70	18.68	15.09
41	17.73	18.25	19.19	15.99	104	18.30	18.87	20.48	16.15	167	20.11	20.48	21.82	18.58
42	21.80	21.92	24.42	20.40	105	15.81	16.44	17.41	13.78	168	22.45	22.83	23.71	21.10
43	14.23	14.97	15.91	11.91	106	15.95	16.64	17.98	13.59	169	33.07	33.16	34.35	32.31
44	13.86	14.56	15.74	11.53	107	13.28	14.01	15.45	10.76	170	19.23	19.77	20.92	17.32
45	24.89	25.07	27.29	23.45	108	14.60	15.36	16.45	12.17	171	29.38	29.59	30.93	28.24
46	20.13	20.48	21.16	18.95	109	15.13	15.83	17.30	12.68	172	19.79	20.23	21.48	18.13
47	27.00	27.01	28.42	26.34	110	12.34	13.16	14.40	9.70	173	25.51	25.56	27.50	24.54
48	25.98	26.19	27.37	24.94	111	14.78	15.47	16.56	12.52	174	17.00	17.54	18.95	14.99
49	24.50	24.91	25.94	23.02	112	13.47	14.15	15.73	11.04	175	27.11	27.25	28.33	26.28
50	24.54	24.81	26.46	23.13	113	13.22	13.99	15.31	10.69	176	17.80	18.35	19.53	15.90
51	19.82	20.24	21.74	18.12	114	13.93	14.67	16.21	11.38	177	22.42	22.80	23.96	20.93
52	30.95	31.08	32.04	30.19	115	14.49	15.19	16.70	12.05	178	19.85	20.47	21.59	17.79
53	27.62	27.76	28.99	26.71	116	12.56	13.37	14.75	9.88	179	34.01	33.76	34.61	34.28
54	35.01	34.78	36.27	34.93	117	13.18	13.94	15.25	10.66	180	28.57	28.54	29.39	28.27
55	30.96	31.16	32.15	30.01	118	15.78	16.51	17.74	13.38	181	35.10	34.74	36.95	35.05
56	26.14	26.38	27.46	25.04	119	14.95	15.67	16.93	12.57	182	27.89	27.93	27.88	27.80
57	14.73	15.35	16.71	12.53	120	14.37	15.10	16.56	11.87	Average	18.01	18.56	19.84	16.04
58	16.51	17.07	18.29	14.55	121	14.12	14.85	16.11	11.69					
59	16.67	17.23	18.55	14.66	122	13.30	14.13	15.32	10.67					
60	22.56	22.81	23.40	21.67	123	15.04	15.77	17.03	12.63					
61	21.49	21.88	22.42	20.25	124	13.83	14.52	15.87	11.47					
62	24.35	24.61	25.90	23.11	125	17.78	18.35	19.57	15.78					

Sustainability – Average Response Time (ms) Distribution Graph



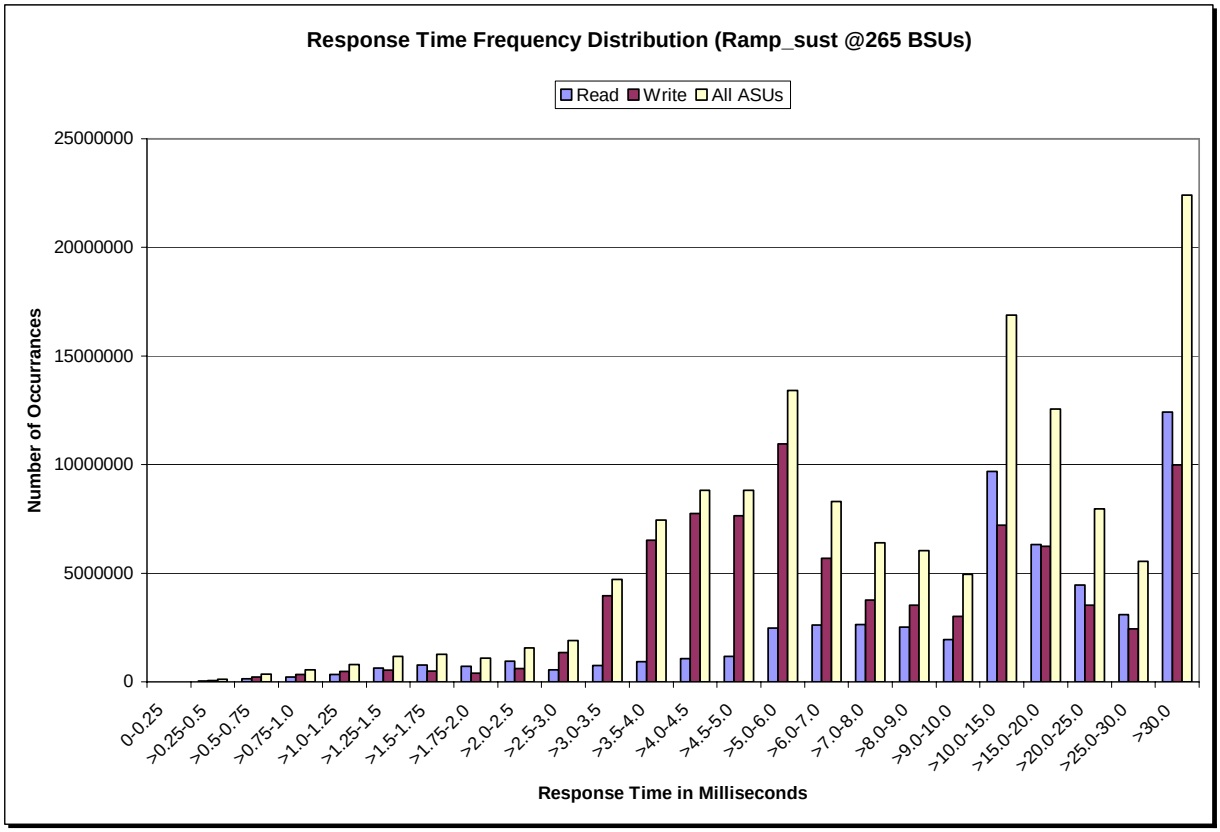
Sustainability – Response Time Frequency Distribution Data

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	2,145	44,958	143,228	221,189	333,107	640,535	779,715	703,555
Write	-	68,224	210,425	337,619	468,024	526,405	485,986	388,452
All ASUs	2,145	113,182	353,653	558,808	801,131	1,166,940	1,265,701	1,092,007
ASU1	1,774	70,927	216,561	337,519	488,579	763,231	853,430	742,041
ASU2	371	16,134	51,275	80,541	116,278	179,018	200,171	176,670
ASU3	-	26,121	85,817	140,748	196,274	224,691	212,100	173,296

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	952,101	550,359	752,011	933,060	1,063,381	1,162,212	2,472,367	2,615,938
Write	614,655	1,353,772	3,958,502	6,518,361	7,749,590	7,649,079	10,947,108	5,678,452
All ASUs	1,566,756	1,904,131	4,710,513	7,451,421	8,812,971	8,811,291	13,419,475	8,294,390
ASU1	1,034,440	1,037,492	2,372,052	3,704,228	4,384,956	4,398,127	6,768,392	4,490,223
ASU2	256,054	289,550	663,457	980,374	1,118,451	1,080,626	1,512,328	852,949
ASU3	276,262	577,089	1,675,004	2,766,819	3,309,564	3,332,538	5,138,755	2,951,218

Response Time (ms)	>7.0-8.0	>8.0-9.0	>9.0-10.0	>10.0-15.0	>15.0-20.0	>20.0-25.0	>25.0-30.0	>30.0
Read	2,637,960	2,520,518	1,944,363	9,678,453	6,312,122	4,450,100	3,098,699	12,411,330
Write	3,765,039	3,524,859	3,016,621	7,204,728	6,245,702	3,520,283	2,445,410	9,991,544
All ASUs	6,402,999	6,045,377	4,960,984	16,883,181	12,557,824	7,970,383	5,544,109	22,402,874
ASU1	3,852,192	3,743,028	3,033,149	11,757,949	8,255,198	5,343,637	3,609,908	14,018,779
ASU2	673,537	647,695	534,440	1,872,033	1,471,413	930,919	678,913	3,215,044
ASU3	1,877,270	1,654,654	1,393,395	3,253,199	2,831,213	1,695,827	1,255,288	5,169,051

Sustainability – Response Time Frequency Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2099	0.0180	0.0700	0.0350	0.2811
COV	0.006	0.002	0.004	0.002	0.009	0.004	0.006	0.002

Primary Metrics Test – IOPS Test Phase

Clause 5.4.2.2

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

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

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

Clause 9.2.4.7.2

For the IOPS Test Phase the FDR shall contain:

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 88.

IOPS Test Results File

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

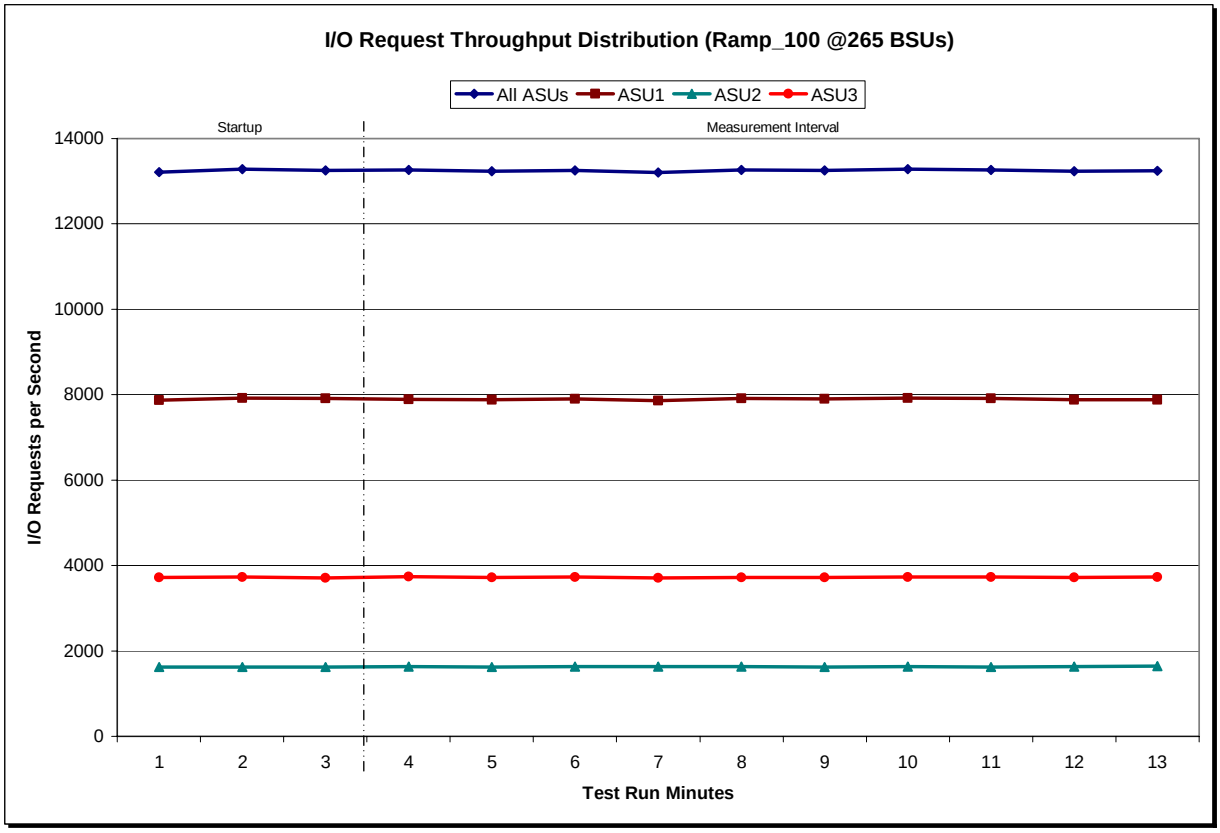
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

265 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:32:56	18:35:57	0-2	0:03:01
Measurement Interval	18:35:57	18:45:57	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	13,211.45	7,869.22	1,622.30	3,719.93
1	13,283.68	7,925.02	1,625.30	3,733.37
2	13,249.75	7,912.73	1,624.25	3,712.77
3	13,263.60	7,894.52	1,630.40	3,738.68
4	13,230.45	7,882.80	1,627.57	3,720.08
5	13,258.48	7,901.27	1,631.68	3,725.53
6	13,207.88	7,865.38	1,637.82	3,704.68
7	13,261.67	7,909.03	1,630.27	3,722.37
8	13,249.23	7,905.52	1,624.45	3,719.27
9	13,286.67	7,922.07	1,635.80	3,728.80
10	13,264.90	7,912.92	1,626.30	3,725.68
11	13,232.67	7,881.57	1,630.78	3,720.32
12	13,248.82	7,877.85	1,638.77	3,732.20
Average	13,250.44	7,895.29	1,631.38	3,723.76

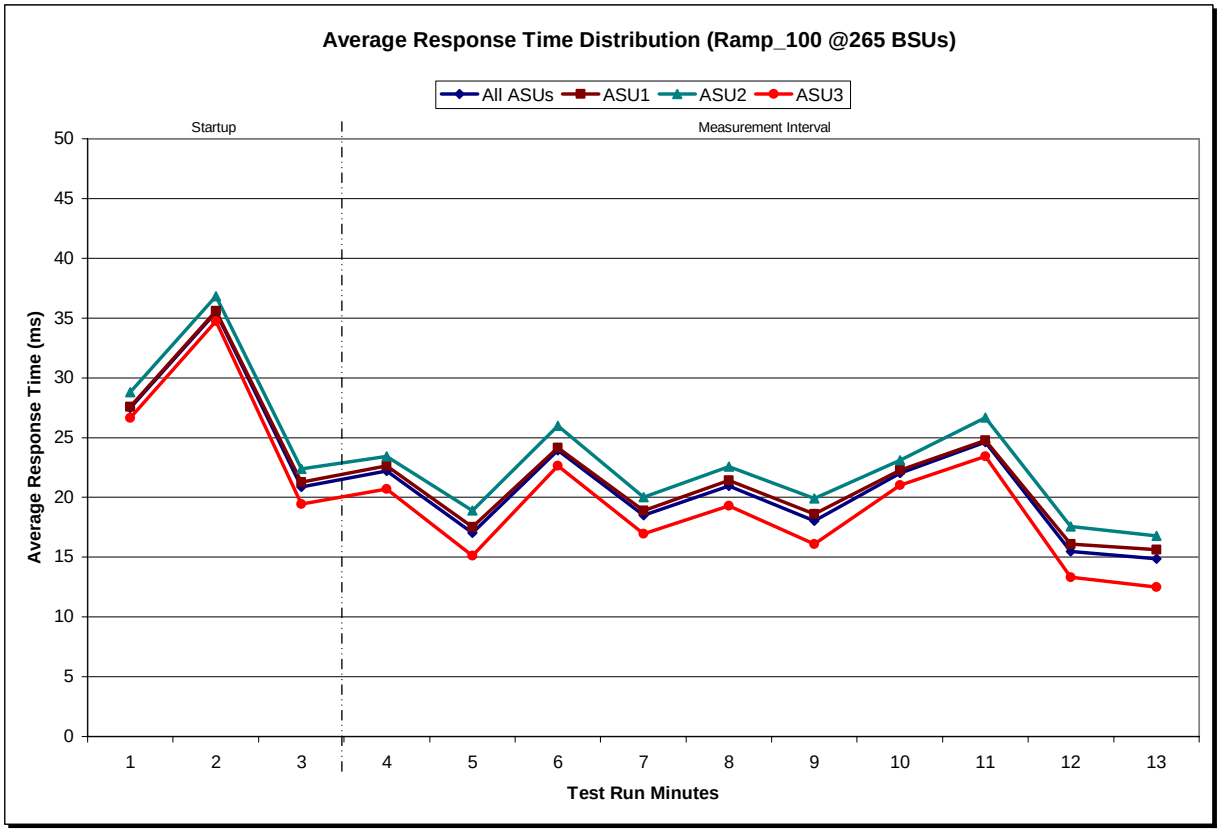
IOPS Test Run – I/O Request Throughput Distribution Graph



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

265 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:32:56	18:35:57	0-2	0:03:01
Measurement Interval	18:35:57	18:45:57	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	27.46	27.58	28.79	26.63
1	35.51	35.60	36.84	34.75
2	20.89	21.27	22.40	19.44
3	22.19	22.65	23.45	20.69
4	17.02	17.54	18.91	15.10
5	23.95	24.14	25.99	22.63
6	18.49	18.89	20.02	16.96
7	20.96	21.41	22.57	19.31
8	18.05	18.59	19.90	16.08
9	22.02	22.27	23.10	21.01
10	24.62	24.76	26.69	23.42
11	15.49	16.08	17.55	13.32
12	14.88	15.62	16.76	12.50
Average	19.77	20.19	21.49	18.10

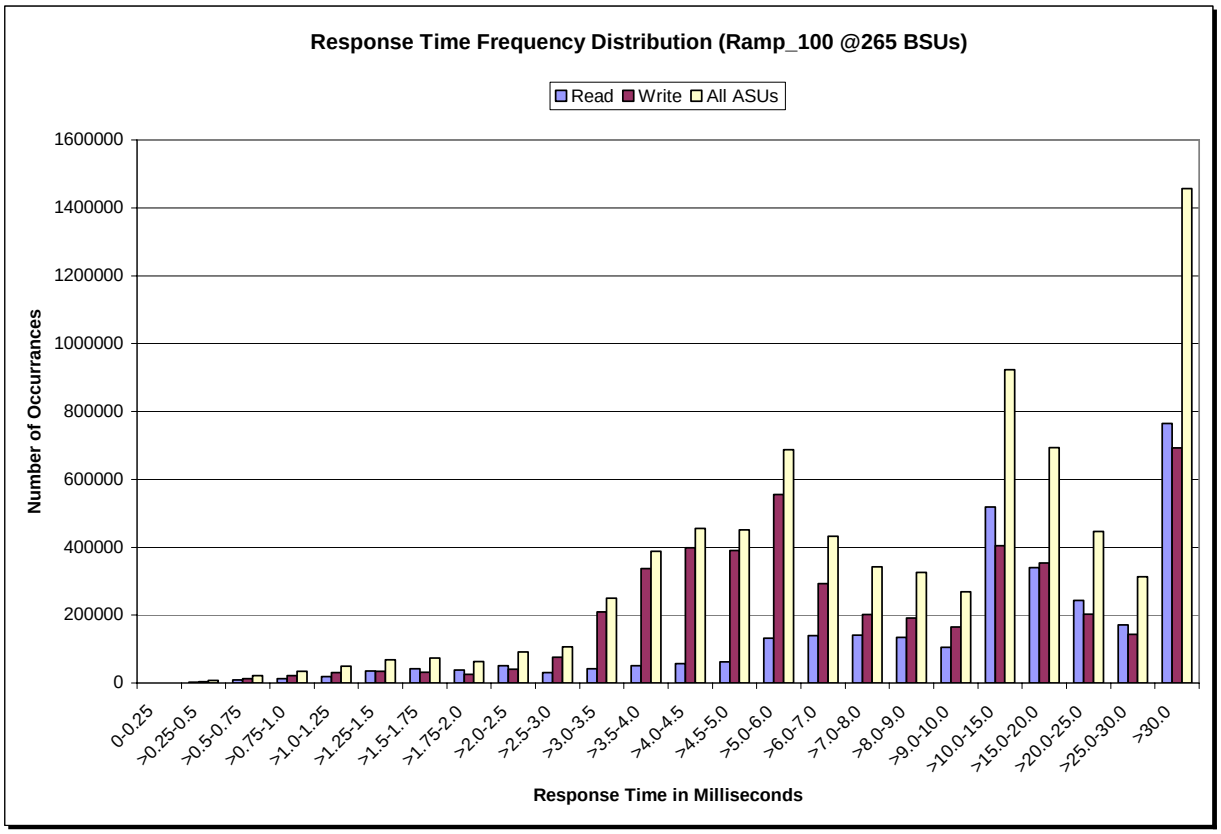
IOPS Test Run – Average Response Time (ms) Distribution Graph



IOPS Test Run – Response Time Frequency Distribution Data

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	135	2,878	8,684	12,914	18,983	34,916	41,624	37,785
Write	0	4,317	13,120	21,327	30,707	34,036	31,422	25,591
All ASUs	135	7,195	21,804	34,241	49,690	68,952	73,046	63,376
ASU1	114	4,570	13,451	20,694	30,068	44,543	48,466	42,244
ASU2	21	1,007	2,923	4,608	6,817	9,918	10,830	9,760
ASU3	0	1,618	5,430	8,939	12,805	14,491	13,750	11,372
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	50,781	30,067	41,327	50,554	56,636	61,991	131,591	138,958
Write	40,417	76,584	208,926	337,220	398,293	389,933	555,397	293,007
All ASUs	91,198	106,651	250,253	387,774	454,929	451,924	686,988	431,965
ASU1	58,928	57,463	126,588	193,784	227,193	226,829	348,489	235,728
ASU2	14,217	16,257	35,873	51,323	58,555	55,427	78,385	44,760
ASU3	18,053	32,931	87,792	142,667	169,181	169,668	260,114	151,477
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	140,604	134,372	104,702	518,343	339,859	242,836	170,902	764,781
Write	201,950	190,834	164,612	404,352	353,592	203,140	142,728	692,224
All ASUs	342,554	325,206	269,314	922,695	693,451	445,976	313,630	1,457,005
ASU1	206,780	200,741	164,045	637,998	451,604	296,175	201,756	898,730
ASU2	36,007	35,136	29,270	102,570	81,445	51,992	38,640	203,056
ASU3	99,767	89,329	75,999	182,127	160,402	97,809	73,234	355,219

IOPS Test Run –Response Time Frequency Distribution Graph



IOPS Test Run – I/O Request Information

I/O Requests Completed in the Measurement Interval	I/O Requests Completed with Response Time = or < 30 ms	I/O Requests Completed with Response Time > 30 ms
7,949,952	6,492,947	1,457,005

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0351	0.2809	0.0700	0.2099	0.0180	0.0701	0.0350	0.2810
COV	0.007	0.002	0.004	0.002	0.008	0.005	0.007	0.002

Primary Metrics Test – 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 12.

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

Clause 9.2.4.7.3

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

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 88.

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 - 265 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:32:56	18:35:57	0-2	0:03:01
Measurement Interval	18:35:57	18:45:57	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	13,211.45	7,869.22	1,622.30	3,719.93
1	13,283.68	7,925.02	1,625.30	3,733.37
2	13,249.75	7,912.73	1,624.25	3,712.77
3	13,263.60	7,894.52	1,630.40	3,738.68
4	13,230.45	7,882.80	1,627.57	3,720.08
5	13,258.48	7,901.27	1,631.68	3,725.53
6	13,207.88	7,865.38	1,637.82	3,704.68
7	13,261.67	7,909.03	1,630.27	3,722.37
8	13,249.23	7,905.52	1,624.45	3,719.27
9	13,286.67	7,922.07	1,635.80	3,728.80
10	13,264.90	7,912.92	1,626.30	3,725.68
11	13,232.67	7,881.57	1,630.78	3,720.32
12	13,248.82	7,877.85	1,638.77	3,732.20
Average	13,250.44	7,895.29	1,631.38	3,723.76

95% Load Level - 251 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:46:02	18:49:03	0-2	0:03:01
Measurement Interval	18:49:03	18:59:03	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	12,549.23	7,478.85	1,542.25	3,528.13
1	12,530.40	7,471.20	1,537.37	3,521.83
2	12,528.75	7,461.57	1,547.33	3,519.85
3	12,541.90	7,475.73	1,542.43	3,523.73
4	12,555.40	7,472.62	1,555.93	3,526.85
5	12,574.40	7,496.47	1,556.17	3,521.77
6	12,538.62	7,466.45	1,537.60	3,534.57
7	12,549.73	7,474.20	1,546.03	3,529.50
8	12,542.00	7,465.83	1,548.02	3,528.15
9	12,548.12	7,471.70	1,544.45	3,531.97
10	12,552.92	7,487.73	1,542.35	3,522.83
11	12,574.12	7,482.97	1,553.27	3,537.88
12	12,561.25	7,481.45	1,548.55	3,531.25
Average	12,553.85	7,477.52	1,547.48	3,528.85

90% Load Level - 238 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	18:59:08	19:02:09	0-2	0:03:01
Measurement Interval	19:02:09	19:12:09	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	11,899.73	7,093.27	1,466.50	3,339.97
1	11,908.57	7,095.20	1,465.75	3,347.62
2	11,898.58	7,075.12	1,472.70	3,350.77
3	11,878.63	7,091.88	1,453.92	3,332.83
4	11,881.50	7,094.20	1,447.87	3,339.43
5	11,886.35	7,072.10	1,464.30	3,349.95
6	11,867.53	7,074.38	1,456.88	3,336.27
7	11,901.13	7,102.03	1,465.47	3,333.63
8	11,898.68	7,095.38	1,469.43	3,333.87
9	11,899.67	7,070.80	1,477.72	3,351.15
10	11,908.23	7,103.05	1,462.60	3,342.58
11	11,926.02	7,107.02	1,465.68	3,353.32
12	11,913.97	7,107.33	1,467.78	3,338.85
Average	11,896.17	7,091.82	1,463.17	3,341.19

80% Load Level - 212 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:12:14	19:15:15	0-2	0:03:01
Measurement Interval	19:15:15	19:25:15	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	10,608.08	6,328.68	1,295.60	2,983.80
1	10,587.65	6,302.75	1,305.60	2,979.30
2	10,604.30	6,318.23	1,302.78	2,983.28
3	10,605.92	6,331.67	1,300.02	2,974.23
4	10,618.87	6,316.48	1,312.83	2,989.55
5	10,600.00	6,311.05	1,305.88	2,983.07
6	10,599.55	6,324.85	1,308.65	2,966.05
7	10,594.52	6,310.28	1,301.70	2,982.53
8	10,584.17	6,310.85	1,298.77	2,974.55
9	10,603.75	6,315.23	1,307.08	2,981.43
10	10,598.15	6,308.15	1,308.17	2,981.83
11	10,614.08	6,330.73	1,299.48	2,983.87
12	10,595.63	6,314.70	1,305.93	2,975.00
Average	10,601.46	6,317.40	1,304.85	2,979.21

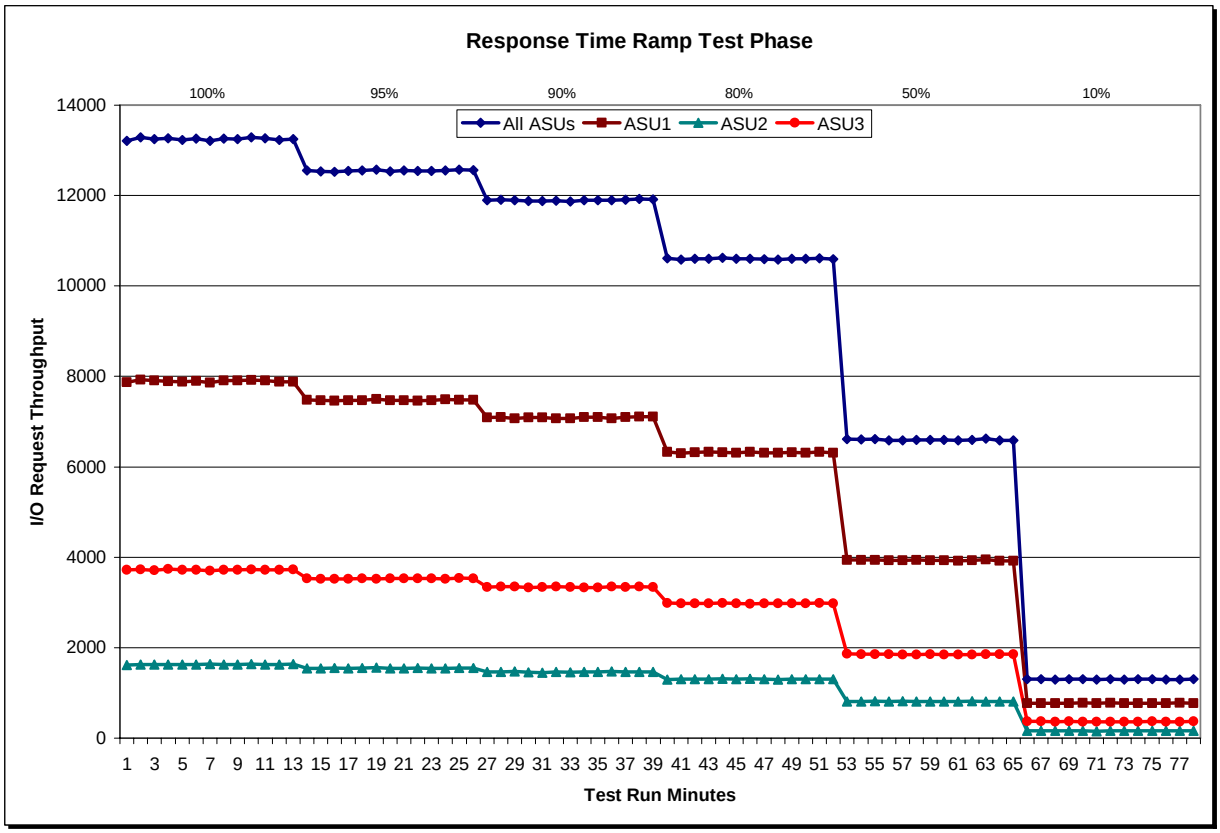
50% Load Level - 132 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:25:19	19:28:20	0-2	0:03:01
Measurement Interval	19:28:20	19:38:20	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	6,611.60	3,939.68	808.00	1,863.92
1	6,606.92	3,939.25	811.82	1,855.85
2	6,611.87	3,936.17	816.77	1,858.93
3	6,590.25	3,926.92	806.02	1,857.32
4	6,588.28	3,926.17	814.73	1,847.38
5	6,595.17	3,939.65	806.53	1,848.98
6	6,597.65	3,933.62	808.35	1,855.68
7	6,593.18	3,933.50	813.40	1,846.28
8	6,583.30	3,925.63	811.70	1,845.97
9	6,592.47	3,926.63	817.42	1,848.42
10	6,619.85	3,952.68	808.65	1,858.52
11	6,586.20	3,925.48	805.85	1,854.87
12	6,587.43	3,923.28	812.67	1,851.48
Average	6,593.38	3,931.36	810.53	1,851.49

10% Load Level - 26 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:38:24	19:41:25	0-2	0:03:01
Measurement Interval	19:41:25	19:51:25	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	1,304.37	775.50	159.60	369.27
1	1,300.58	774.22	159.67	366.70
2	1,299.03	772.55	160.47	366.02
3	1,300.32	769.38	159.85	371.08
4	1,302.60	777.05	161.33	364.22
5	1,296.92	773.75	156.95	366.22
6	1,299.40	776.32	158.80	364.28
7	1,292.82	767.97	162.77	362.08
8	1,301.65	775.58	163.40	362.67
9	1,304.75	773.08	162.13	369.53
10	1,290.88	771.93	157.78	361.17
11	1,297.72	777.18	157.60	362.93
12	1,301.63	772.90	160.48	368.25
Average	1,298.87	773.52	160.11	365.24

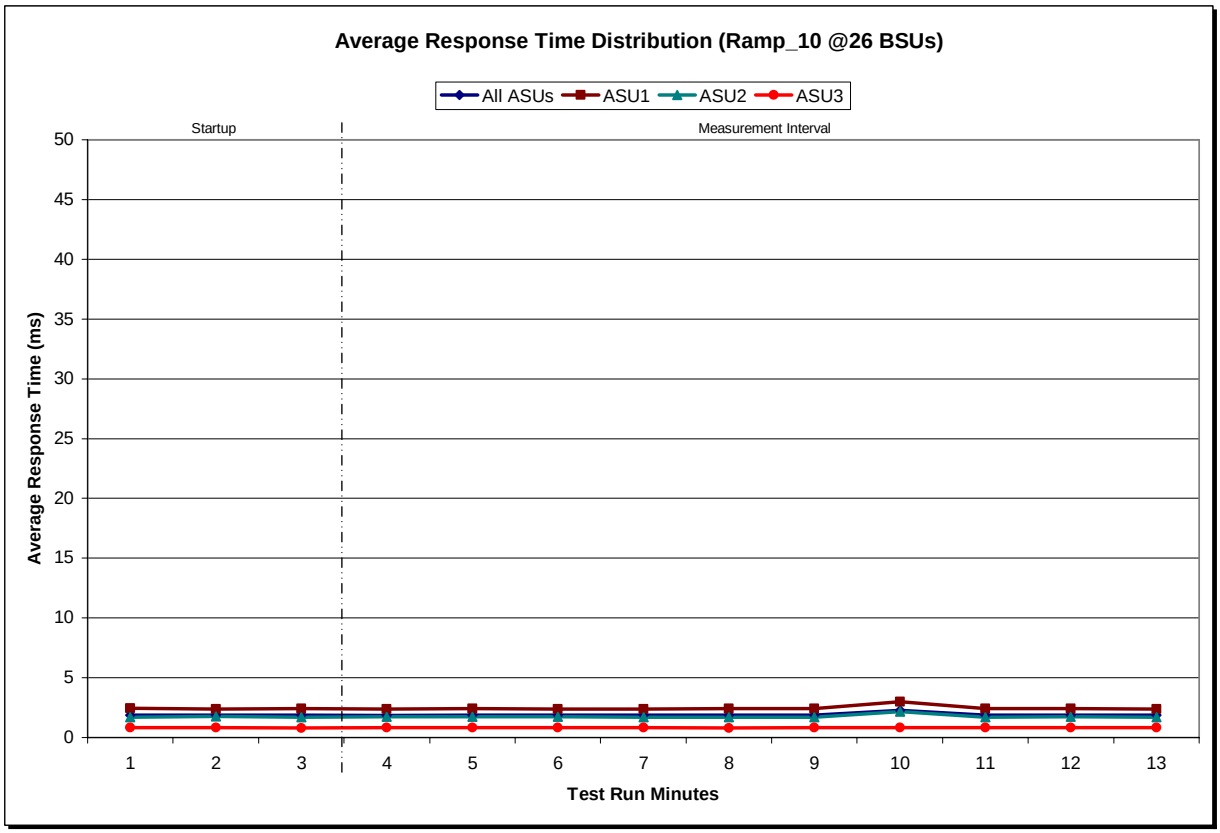
Response Time Ramp Distribution (IOPS) Graph



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

26 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:38:24	19:41:25	0-2	0:03:01
Measurement Interval	19:41:25	19:51:25	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.89	2.44	1.70	0.82
1	1.86	2.37	1.75	0.81
2	1.87	2.40	1.71	0.81
3	1.85	2.38	1.72	0.82
4	1.88	2.40	1.74	0.82
5	1.87	2.39	1.72	0.82
6	1.86	2.38	1.70	0.82
7	1.86	2.40	1.70	0.81
8	1.88	2.42	1.70	0.81
9	2.28	3.00	2.17	0.82
10	1.89	2.43	1.70	0.82
11	1.87	2.40	1.72	0.82
12	1.86	2.38	1.70	0.82
Average	1.91	2.46	1.76	0.82

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



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

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0349	0.2807	0.0698	0.2101	0.0178	0.0701	0.0353	0.2812
COV	0.016	0.009	0.016	0.004	0.025	0.021	0.011	0.008

Repeatability Test

Clause 5.4.5

The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ primary metric and SPC-1 LRT™ metric generated in earlier Test Runs.

There are two identical Repeatability Test Phases. Each Test Phase contains two Test Runs. Each of the Test Runs will have a Measurement Interval of no less than ten (10) minutes. The two Test Runs in each Test Phase will be executed without interruption or any type of manual intervention.

The first Test Run in each Test Phase is executed at the 10% load point. The Average Response Time from each of the Test Runs is compared to the SPC-1 LRT™ metric. Each Average Response Time value must be less than the SPC-1 LRT™ metric plus 5%.

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 9.2.4.7.4

The following content shall appear in the FDR for each Test Run in the two Repeatability Test Phases:

1. *A table containing the results of the Repeatability Test.*
2. *An I/O Request Throughput Distribution graph and table.*
3. *An Average Response Time Distribution graph and table.*
4. *The human readable Test Run Results File produced by the Workload Generator.*
5. *A listing or screen image of all input parameters supplied to the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 88.

Repeatability Test Results File

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

	SPC-1 IOPS™
Primary Metrics	***13,250.44***
Repeatability Test Phase 1	13,248.95
Repeatability Test Phase 2	13,248.84

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

	SPC-1 LRT™
Primary Metrics	***1.91 ms***
Repeatability Test Phase 1	1.90 ms
Repeatability Test Phase 2	1.89 ms

The average response time values in the SPC-1 LRT™ column were generated using 10% of the specified Business Scaling Unit (BSU) load level. Each of the Repeatability Test Phase values for SPC-1 LRT™ must be less than 105% of the reported SPC-1 LRT™ Primary Metric.

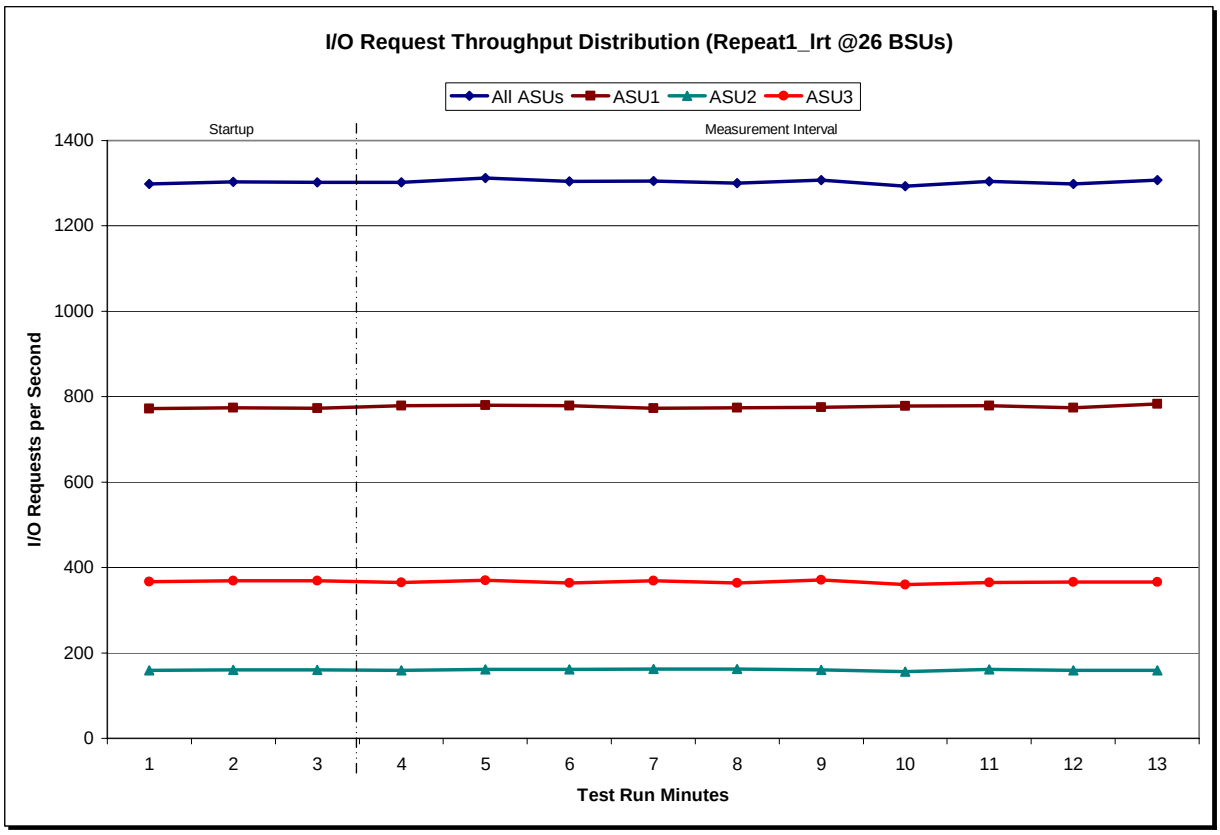
A link to the test result file generated from each Repeatability Test Run is listed below.

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

Repeatability 1 LRT – I/O Request Throughput Distribution Data

26 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:51:36	19:54:36	0-2	0:03:00
Measurement Interval	19:54:36	20:04:36	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1,298.35	771.83	159.53	366.98
1	1,303.28	774.28	160.50	368.50
2	1,302.13	773.28	159.80	369.05
3	1,302.45	778.92	158.80	364.73
4	1,311.87	780.42	161.57	369.88
5	1,304.68	779.07	161.35	364.27
6	1,304.92	772.93	162.68	369.30
7	1,300.12	773.75	162.62	363.75
8	1,307.42	775.50	160.73	371.18
9	1,293.60	777.85	156.15	359.60
10	1,304.60	778.88	161.18	364.53
11	1,298.05	773.78	158.83	365.43
12	1,307.53	782.90	158.92	365.72
Average	1,303.52	777.40	160.28	365.84

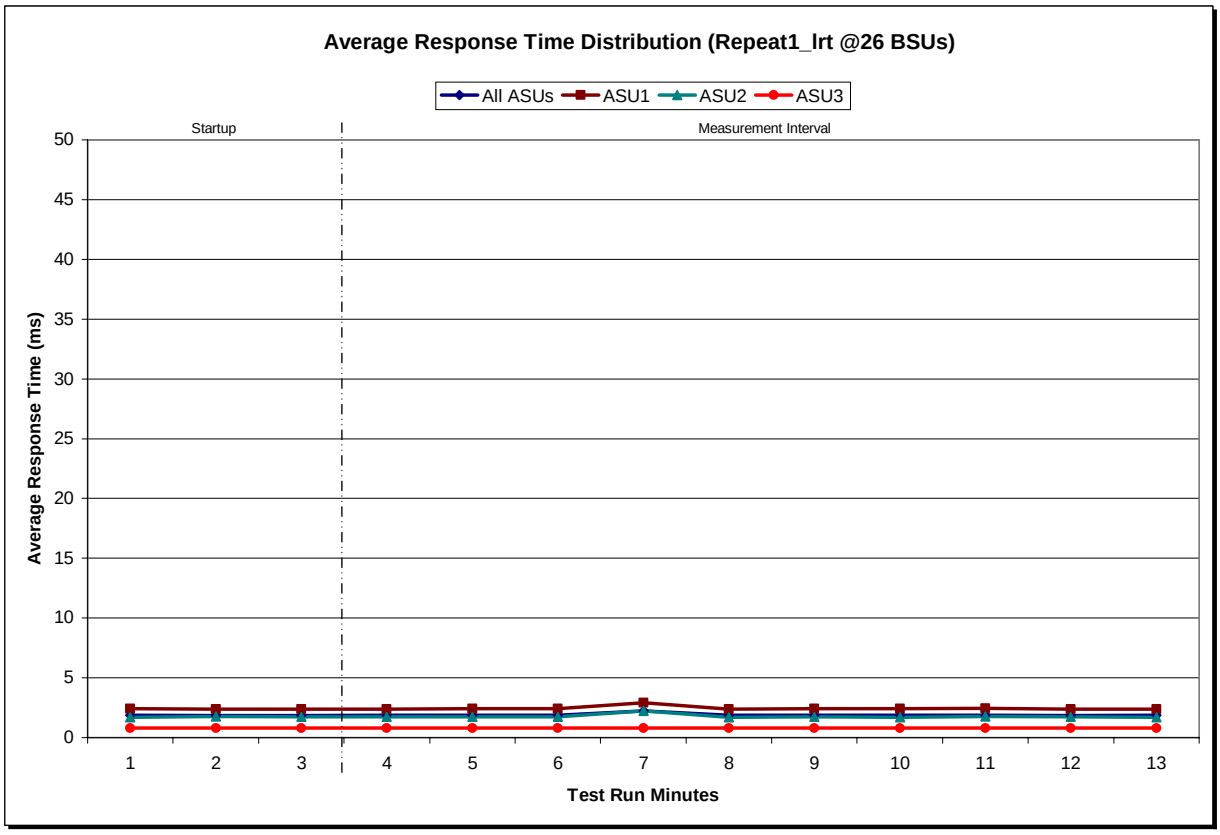
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

26 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:51:36	19:54:36	0-2	0:03:00
Measurement Interval	19:54:36	20:04:36	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.86	2.40	1.70	0.79
1	1.85	2.37	1.75	0.79
2	1.85	2.38	1.72	0.79
3	1.86	2.39	1.72	0.79
4	1.86	2.40	1.74	0.79
5	1.88	2.42	1.71	0.79
6	2.22	2.91	2.22	0.79
7	1.86	2.39	1.70	0.79
8	1.87	2.41	1.73	0.80
9	1.88	2.42	1.70	0.80
10	1.89	2.43	1.75	0.79
11	1.85	2.38	1.74	0.79
12	1.86	2.39	1.70	0.79
Average	1.90	2.45	1.77	0.79

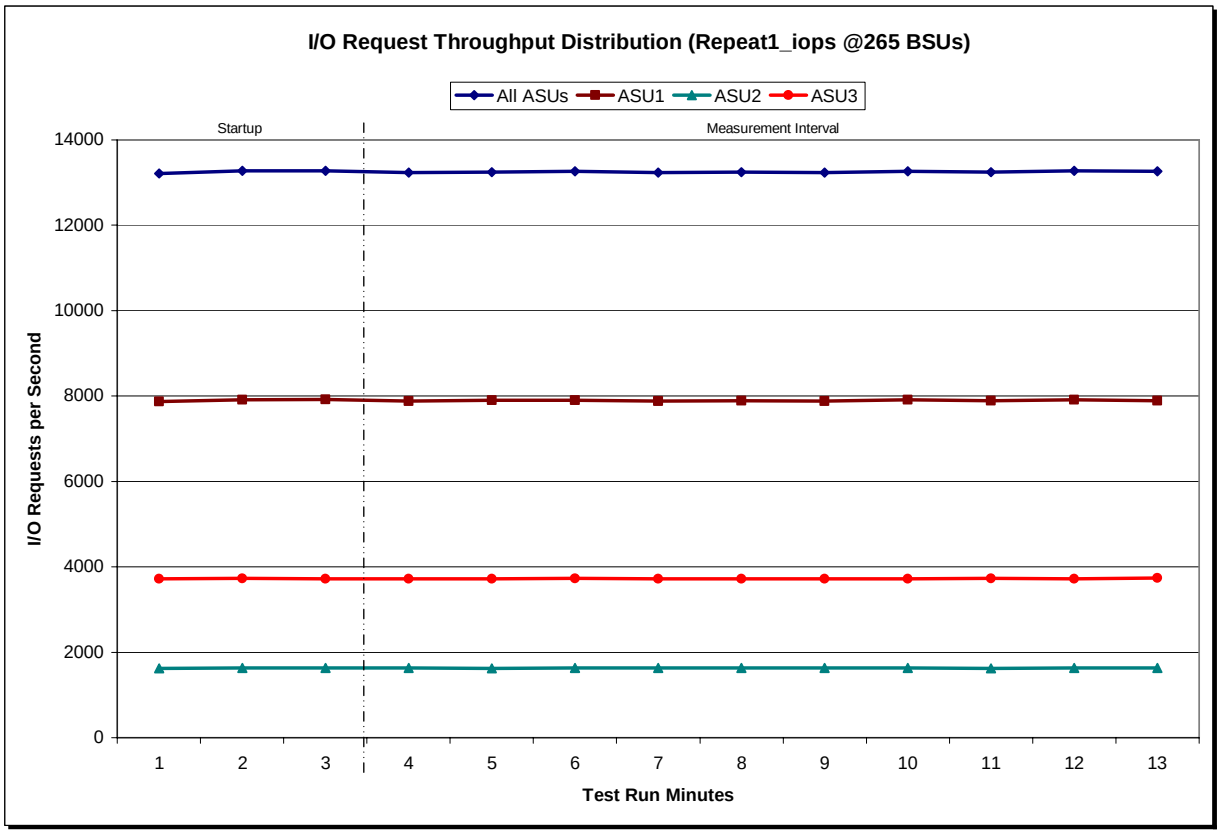
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

265 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:04:41	20:07:42	0-2	0:03:01
Measurement Interval	20:07:42	20:17:42	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	13,212.53	7,871.63	1,622.70	3,718.20
1	13,278.73	7,912.17	1,634.88	3,731.68
2	13,270.47	7,922.75	1,633.53	3,714.18
3	13,231.18	7,885.80	1,627.83	3,717.55
4	13,241.00	7,902.12	1,623.95	3,714.93
5	13,259.18	7,900.68	1,632.30	3,726.20
6	13,236.68	7,883.38	1,635.80	3,717.50
7	13,246.88	7,894.97	1,629.95	3,721.97
8	13,232.20	7,878.28	1,633.73	3,720.18
9	13,261.27	7,908.30	1,631.22	3,721.75
10	13,243.28	7,894.23	1,624.42	3,724.63
11	13,270.67	7,916.40	1,632.43	3,721.83
12	13,267.13	7,896.15	1,633.53	3,737.45
Average	13,248.95	7,896.03	1,630.52	3,722.40

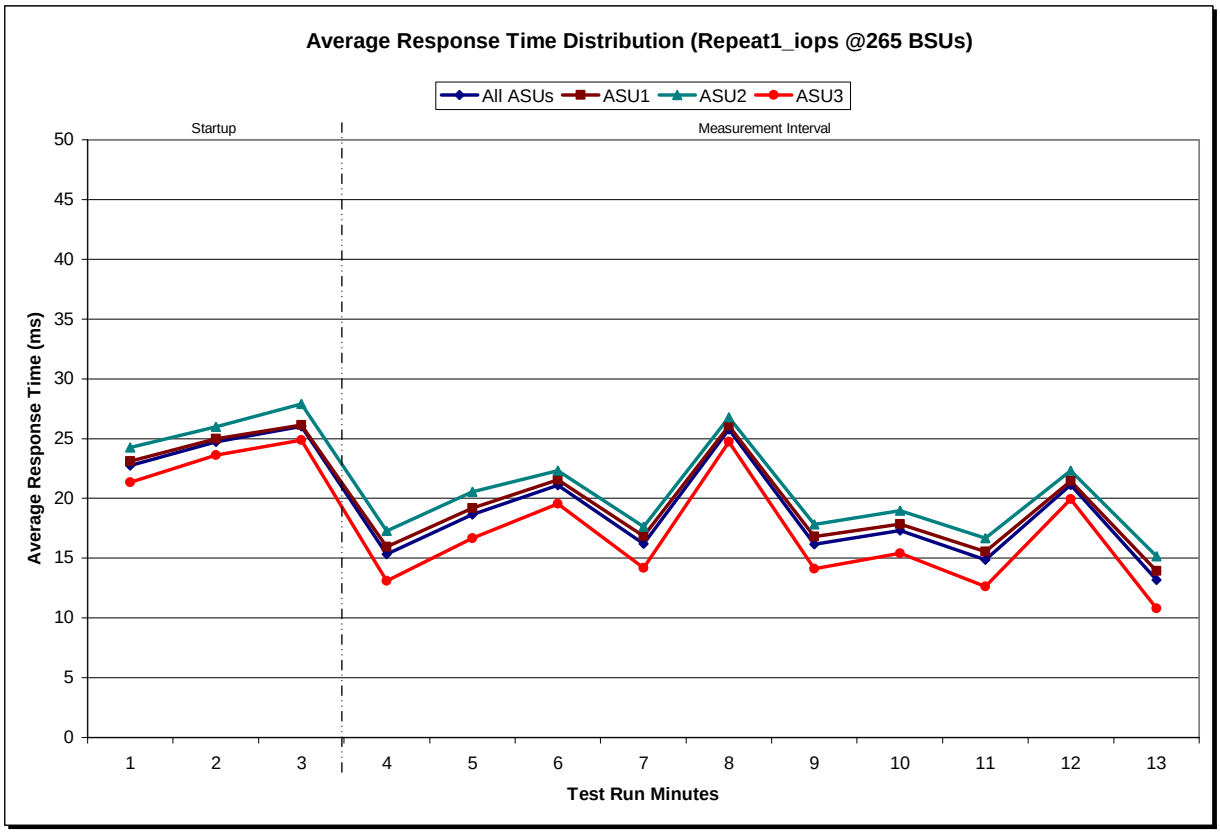
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

265 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:04:41	20:07:42	0-2	0:03:01
Measurement Interval	20:07:42	20:17:42	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	22.76	23.12	24.27	21.34
1	24.73	24.99	25.98	23.62
2	26.01	26.15	27.88	24.89
3	15.32	15.96	17.26	13.10
4	18.66	19.20	20.57	16.68
5	21.08	21.55	22.30	19.55
6	16.18	16.83	17.62	14.17
7	25.78	26.05	26.80	24.74
8	16.17	16.81	17.80	14.11
9	17.30	17.84	18.98	15.41
10	14.85	15.53	16.67	12.62
11	21.13	21.45	22.33	19.93
12	13.19	13.91	15.16	10.81
Average	17.97	18.52	19.55	16.11

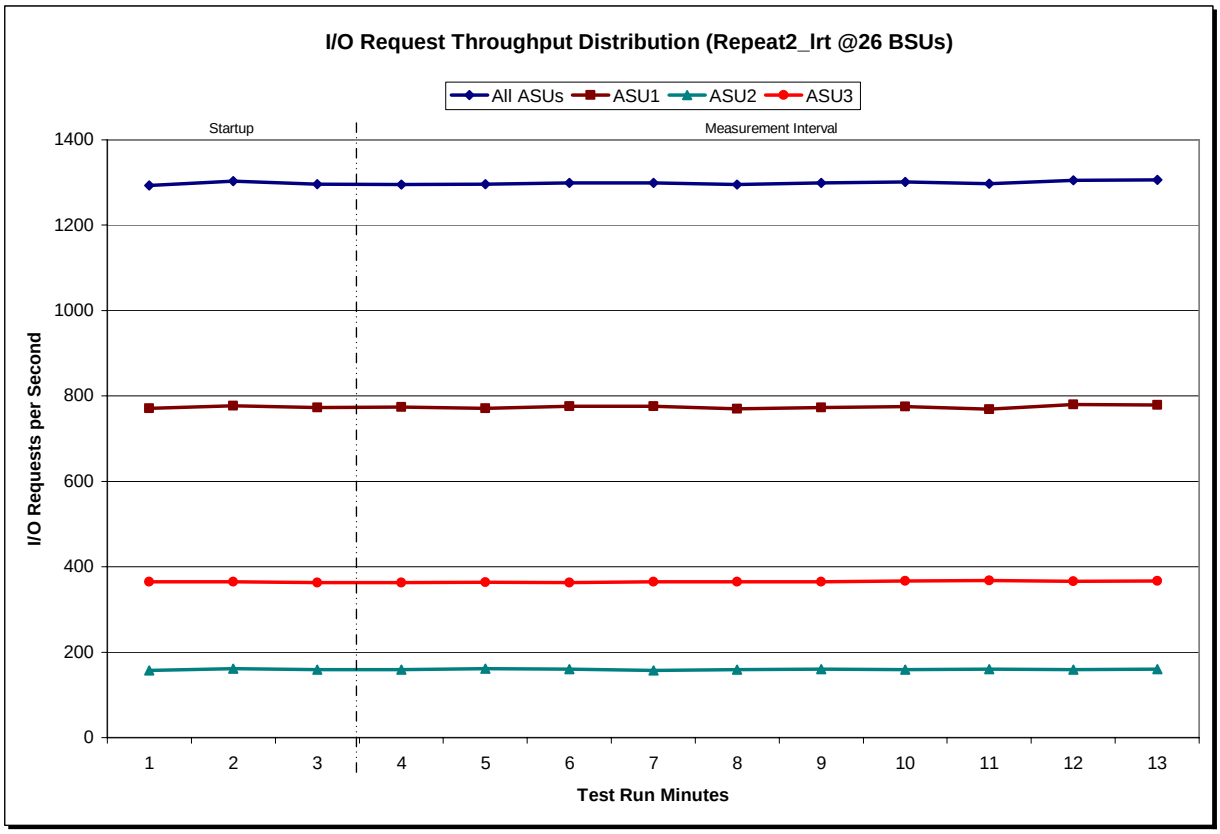
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

26 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:17:53	20:20:53	0-2	0:03:00
Measurement Interval	20:20:53	20:30:53	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1,292.68	770.67	157.12	364.90
1	1,302.98	776.77	160.92	365.30
2	1,296.25	773.50	159.43	363.32
3	1,295.17	773.65	158.95	362.57
4	1,296.68	771.27	161.40	364.02
5	1,299.48	775.82	160.53	363.13
6	1,298.93	776.12	157.72	365.10
7	1,294.72	770.40	159.43	364.88
8	1,299.27	773.43	160.47	365.37
9	1,300.85	774.87	159.00	366.98
10	1,297.63	769.10	160.57	367.97
11	1,305.05	779.72	159.40	365.93
12	1,306.25	779.08	159.80	367.37
Average	1,299.40	774.35	159.73	365.33

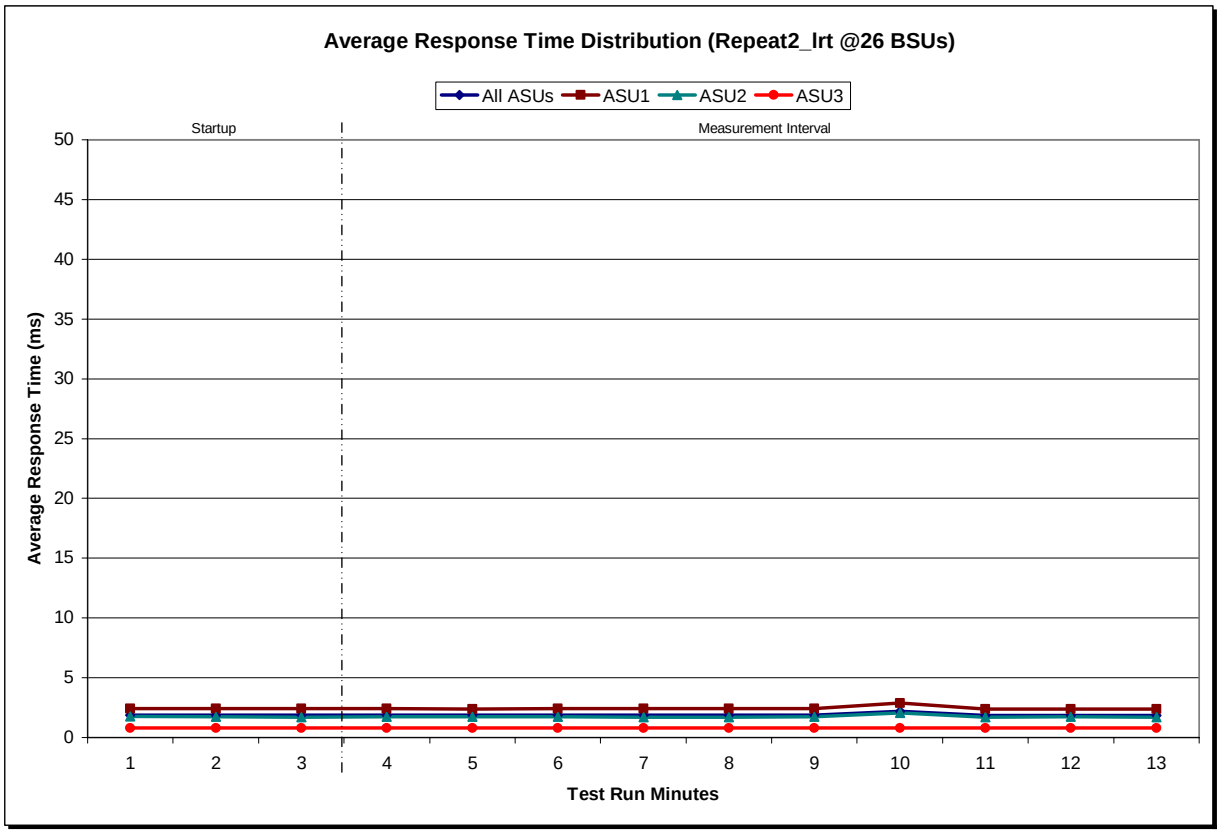
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

26 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:17:53	20:20:53	0-2	0:03:00
Measurement Interval	20:20:53	20:30:53	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.87	2.41	1.75	0.79
1	1.87	2.40	1.73	0.80
2	1.86	2.40	1.70	0.79
3	1.86	2.39	1.72	0.79
4	1.86	2.39	1.71	0.79
5	1.87	2.40	1.74	0.80
6	1.86	2.40	1.71	0.80
7	1.87	2.41	1.70	0.80
8	1.87	2.40	1.74	0.80
9	2.19	2.88	2.07	0.79
10	1.84	2.38	1.69	0.79
11	1.85	2.38	1.72	0.79
12	1.85	2.38	1.70	0.79
Average	1.89	2.44	1.75	0.79

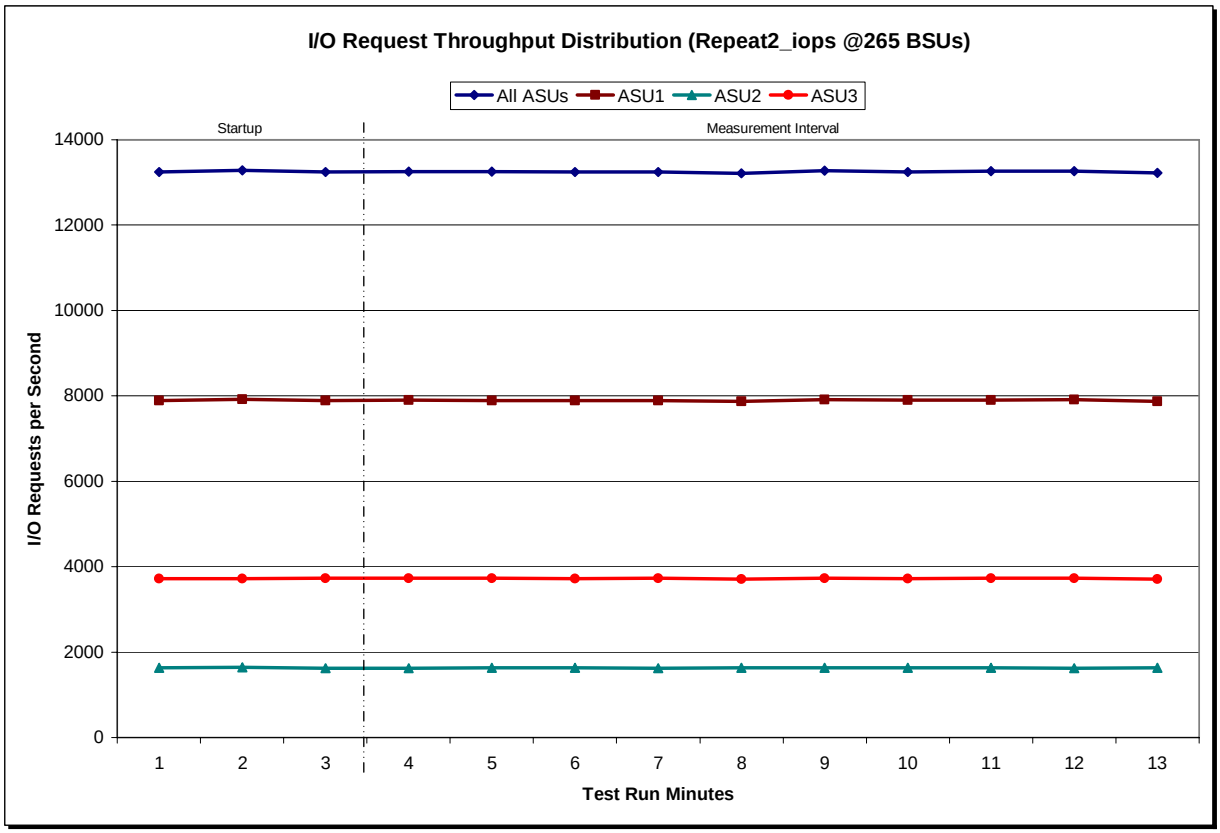
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

265 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:30:58	20:33:59	0-2	0:03:01
Measurement Interval	20:33:59	20:43:59	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	13,242.45	7,889.88	1,631.37	3,721.20
1	13,287.08	7,925.72	1,640.87	3,720.50
2	13,243.90	7,894.42	1,622.63	3,726.85
3	13,254.92	7,905.28	1,623.63	3,726.00
4	13,259.07	7,894.82	1,636.07	3,728.18
5	13,247.68	7,894.18	1,633.35	3,720.15
6	13,243.60	7,888.43	1,627.05	3,728.12
7	13,215.20	7,874.92	1,627.80	3,712.48
8	13,271.50	7,910.52	1,629.03	3,731.95
9	13,245.60	7,900.88	1,628.87	3,715.85
10	13,261.75	7,901.62	1,633.50	3,726.63
11	13,267.92	7,914.05	1,627.23	3,726.63
12	13,221.15	7,875.30	1,634.13	3,711.72
Average	13,248.84	7,896.00	1,630.07	3,722.77

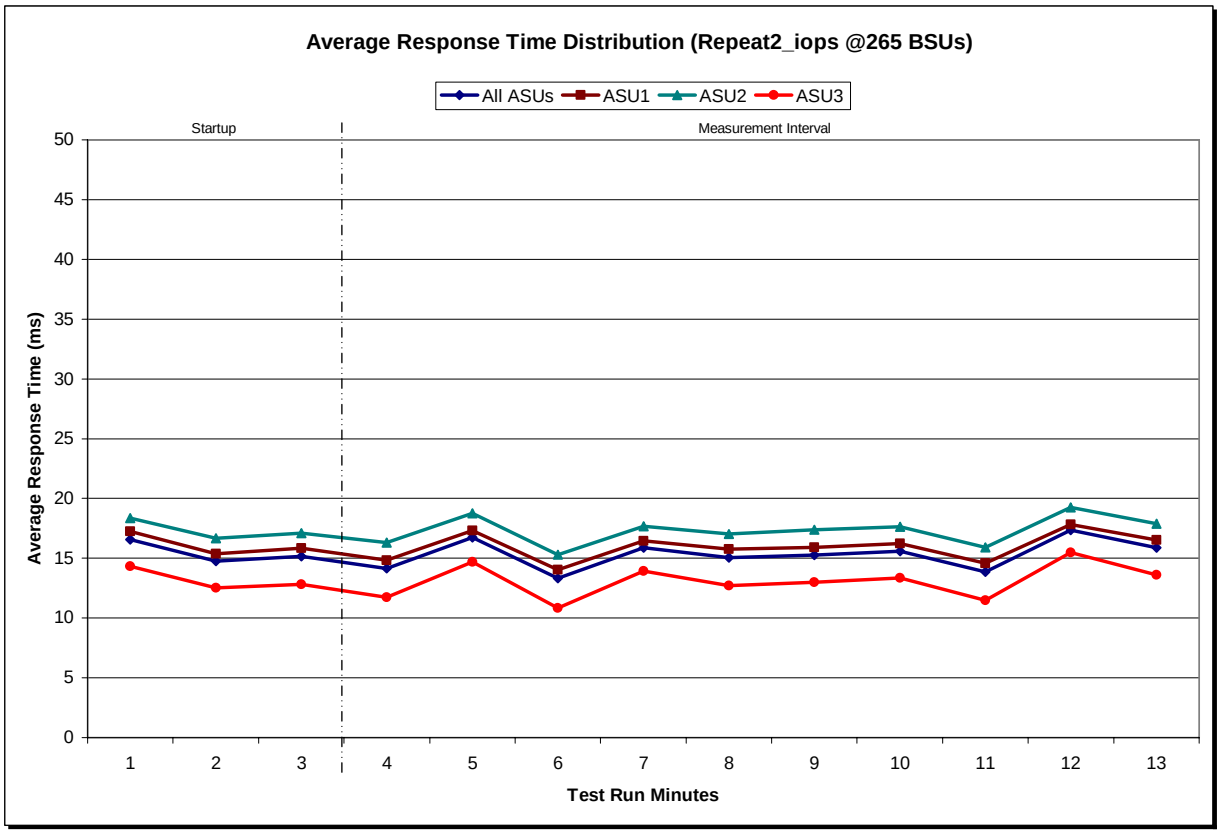
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

265 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:30:58	20:33:59	0-2	0:03:01
Measurement Interval	20:33:59	20:43:59	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	16.56	17.24	18.36	14.34
1	14.75	15.39	16.67	12.54
2	15.14	15.83	17.09	12.82
3	14.14	14.83	16.29	11.74
4	16.75	17.31	18.75	14.70
5	13.31	14.05	15.31	10.84
6	15.89	16.44	17.69	13.92
7	15.05	15.75	17.02	12.71
8	15.26	15.90	17.38	13.00
9	15.59	16.22	17.63	13.36
10	13.87	14.58	15.91	11.48
11	17.35	17.83	19.28	15.48
12	15.86	16.50	17.88	13.61
Average	15.31	15.94	17.31	13.08

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



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

Clause 3.4.3

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

Clauses 5.1.0 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0347	0.2814	0.0701	0.2102	0.0180	0.0698	0.0352	0.2807
COV	0.016	0.004	0.017	0.009	0.011	0.013	0.023	0.007

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0349	0.2811	0.0701	0.2098	0.0180	0.0702	0.0349	0.2810
COV	0.005	0.002	0.002	0.002	0.008	0.004	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	0.2816	0.0699	0.2095	0.0181	0.0698	0.0350	0.2812
COV	0.022	0.007	0.015	0.004	0.036	0.012	0.016	0.004

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2809	0.0700	0.2101	0.0180	0.0700	0.0350	0.2810
COV	0.005	0.002	0.004	0.001	0.007	0.003	0.007	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, a table 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 Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 88.

Data Persistence Test Results File

A link to each test result file generated from each Data Persistence Test is listed below.

Persistence 1 Test Results File

Persistence 2 Test Results File

Data Persistence Test Results

Data Persistence Test Results	
Data Persistence Test Run Number: 1	
Total Number of Logical Blocks Written	31,695,584
Total Number of Logical Blocks Verified	29,489,088
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks	10 minutes
Size in Bytes of each Logical Block	512
Number of Failed I/O Requests in the process of the Test	0

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

PRICED STORAGE CONFIGURATION AVAILABILITY DATE

Clause 9.2.4.9

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

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

The Fujitsu Storage Systems ETERNUS2000 Model 200 as documented in this Full Disclosure Report is currently available for customer purchase and shipment.

PRICING INFORMATION

Clause 9.2.4.11

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

Clause 9.2.4.11.3

A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration must be included.

Pricing information may found in the Tested Storage Configuration Pricing section on page 13. A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration may be found in the Executive Summary portion of this document on page 13.

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 ETERNUS2000 Model 200.

APPENDIX A: SPC-1 GLOSSARY

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

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

- A kilobyte (KB) is equal to 1,000 (10^3) bytes.
- A megabyte (MB) is equal to 1,000,000 (10^6) bytes.
- A gigabyte (GB) is equal to 1,000,000,000 (10^9) bytes.
- A terabyte (TB) is equal to 1,000,000,000,000 (10^{12}) bytes.
- A petabyte (PB) is equal to 1,000,000,000,000,000 (10^{15}) bytes
- An exabyte (EB) is equal to 1,000,000,000,000,000,000 (10^{18}) bytes

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

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

- A kibibyte (KiB) is equal to 1,024 (2^{10}) bytes.
- A mebibyte (MiB) is equal to 1,048,576 (2^{20}) bytes.
- A gigibyte (GiB) is equal to 1,073,741,824 (2^{30}) bytes.
- A tebibyte (TiB) is equal to 1,099,511,627,776 (2^{40}) bytes.
- A pebibyte (PiB) is equal to 1,125,899,906,842,624 (2^{50}) bytes.
- An exbibyte (EiB) is equal to 1,152,921,504,606,846,967 (2^{60}) bytes.

SPC-1 Data Repository Definitions

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

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

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

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

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

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

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

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

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

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

SPC-1 Data Protection Levels

RAID5: User data is distributed across the disks in the array. Check data corresponding to user data is distributed across multiple disks in the form of bit-by-bit parity.

Mirroring: Two or more identical copies of user data are maintained on separate disks.

Other Protection Level: Any data protection other than **RAID5** or **Mirroring**.

Unprotected: There is no data protection provided.

SPC-1 Test Execution Definitions

Average Response Time: The sum of the Response Times for all Measured I/O Requests divided by the total number of Measured I/O Requests.

Completed I/O Request: An I/O Request with a Start Time and a Completion Time (see "I/O Completion Types" below).

Completion Time: The time recorded by the Workload Generator when an I/O Request is satisfied by the TSC as signaled by System Software.

Data Rate: The data transferred in all Measured I/O Requests in an SPC-1 Test Run divided by the length of the Test Run in seconds.

Expected I/O Count: For any given I/O Stream and Test Phase, the product of 50 times the BSU level, the duration of the Test Phase in seconds, and the Intensity Multiplier for that I/O Stream.

Failed I/O Request: Any I/O Request issued by the Workload Generator that could not be completed or was signaled as failed by System Software. A Failed I/O Request has no Completion Time (see "I/O Completion Types" below).

I/O Request Throughput: The total number of Measured I/O requests in an SPC-1 Test Run divided by the duration of the Measurement Interval in seconds.

In-Flight I/O Request: An I/O Request issued by the I/O Command Generator to the TSC that has a recorded Start Time, but does not complete within the Measurement Interval (see "I/O Completion Types" below).

Measured I/O Request: A Completed I/O Request with a Completion Time occurring within the Measurement Interval (see "I/O Completion Types" below).

Measured Intensity Multiplier: The percentage of all Measured I/O Requests that were issued by a given I/O Stream.

Measurement Interval: The finite and contiguous time period, after the TSC has reached Steady State, when data is collected by a Test Sponsor to generate an SPC-1 test result or support an SPC-1 test result.

Ramp-Up: The time required for the Benchmark Configuration (BC) to produce Steady State throughput after the Workload Generator begins submitting I/O Requests to the TSC for execution.

Ramp-Down: The time required for the BC to complete all I/O Requests issued by the Workload Generator. The Ramp-Down period begins when the Workload Generator ceases to issue new I/O Requests to the TSC.

Response Time: The Response Time of a Measured I/O Request is its Completion Time minus its Start Time.

Start Time: The time recorded by the Workload Generator when an I/O Request is submitted, by the Workload Generator, to the System Software for execution on the Tested Storage Configuration (TSC).

Start-Up: The period that begins after the Workload Generator starts to submit I/O requests to the TSC and ends at the beginning of the Measurement Interval.

Shut-Down: The period between the end of the Measurement Interval and the time when all I/O Requests issued by the Workload Generator have completed or failed.

Steady State: The consistent and sustainable throughput of the TSC. During this period the load presented to the TSC by the Workload Generator is constant.

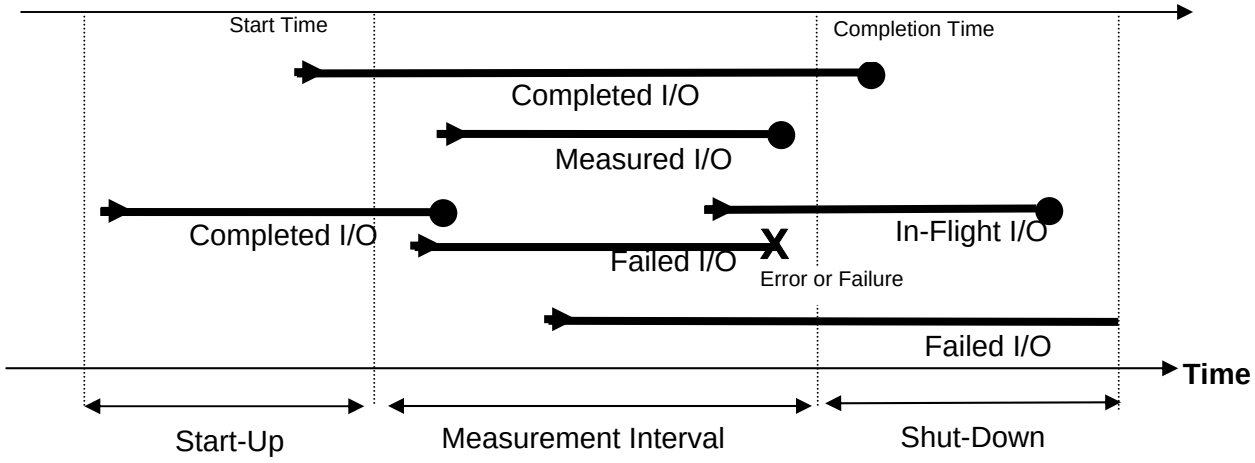
Test: A collection of Test Phases and or Test Runs sharing a common objective.

Test Run: The execution of SPC-1 for the purpose of producing or supporting an SPC-1 test result. SPC-1 Test Runs may have a finite and measured Ramp-Up period, Start-Up

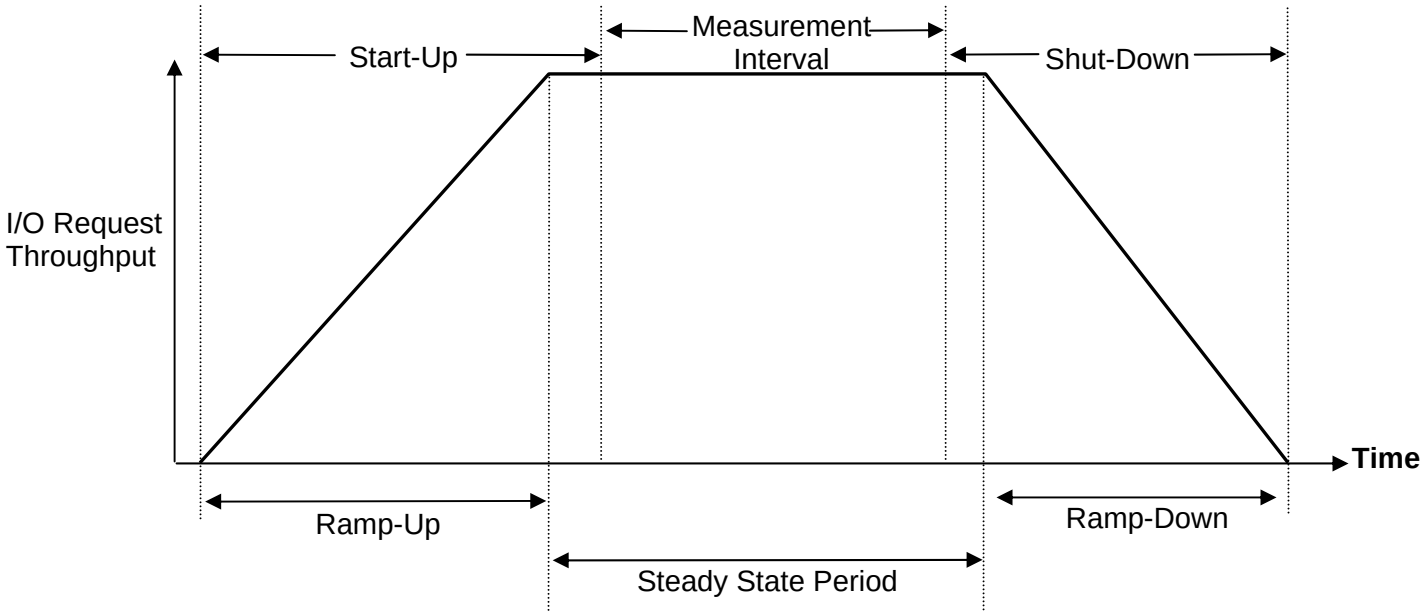
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

Test Phase: A collection of one or more SPC-1 Test Runs sharing a common objective and intended to be run in a specific sequence.

I/O Completion Types



SPC-1 Test Run Components



APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

Solaris Parameter Adjustments

The following settings were made the Solaris **/etc/system** control file information for execution of the SPC-1 Workload Generator on the SPARC Enterprise M8000.

```
*ident      "@(#)system  1.18   97/06/27 SMI" /* SVR4 1.5 */
*
* SYSTEM SPECIFICATION FILE
*

* moddir:
*
*    Set the search path for modules.  This has a format similar to the
*    csh path variable. If the module isn't found in the first directory
*    it tries the second and so on. The default is /kernel /usr/kernel
*
*    Example:
*           moddir: /kernel /usr/kernel /other/modules



* root device and root filesystem configuration:
*
*    The following may be used to override the defaults provided by
*    the boot program:
*
*    rootfs:             Set the filesystem type of the root.
*
*    rootdev:      Set the root device.  This should be a fully
*                  expanded physical pathname.  The default is the
*                  physical pathname of the device where the boot
*                  program resides.  The physical pathname is
*                  highly platform and configuration dependent.
*
*    Example:
*           rootfs:ufs
*           rootdev:/sbus@1,f8000000/esp@0,800000/sd@3,0:a
*
*    (Swap device configuration should be specified in /etc/vfstab.)



* exclude:
*
*    Modules appearing in the moddir path which are NOT to be loaded,
*    even if referenced. Note that `exclude' accepts either a module name,
*    or a filename which includes the directory.
*
*    Examples:
*           exclude: win
*           exclude: sys/shmsys



* forceload:
*
*    Cause these modules to be loaded at boot time, (just before mounting
*    the root filesystem) rather than at first reference. Note that
*    forceload expects a filename which includes the directory. Also
```

```
*    note that loading a module does not necessarily imply that it will
*    be installed.
*
*    Example:
*           forceload: drv/foo



* set:
*
*    Set an integer variable in the kernel or a module to a new value.
*    This facility should be used with caution.  See system(4).
*
*    Examples:
*
*    To set variables in 'unix':
*
*           set nautopush=32
*           set maxusers=40
*
*    To set a variable named 'debug' in the module named 'test_module'
*
*           set test_module:debug = 0x13

* Begin FJSVssf (do not edit)
set ftrace_atboot = 1
set kmem_flags = 0x100
set kmem_lite_maxalign = 8192
* End FJSVssf (do not edit)
forceload: drv/fjpfca
set heaplp_use_stlb=0
set autoup=480
set drmach:fmem_timeout=30
set pcie:pcie_aer_ce_mask=0x2001
set mc-opl:mc_max_rewrite_loop=10000
```

Entries in "sd.conf"

The following entries in sd.conf were defines to enable the Emulex HBAs for accessing the LUNs defined in the SPARC Enterprise M8000.

```
#
# Copyright 2006 Sun Microsystems, Inc.  All rights reserved.
# Use is subject to license terms.
#
#ident     "@(#)sd.conf 1.10   06/02/08 SMI"

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=0;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=1;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=2;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=3;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=4;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=5;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=6;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=7;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=8;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=9;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=10;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=11;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=12;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=13;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=14;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=15;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=16;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=17;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=18;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=19;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=20;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=21;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=22;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=23;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=24;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=25;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=26;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=27;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=28;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=29;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=30;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=31;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=32;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=33;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=34;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=35;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=36;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=37;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=38;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=39;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=40;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=41;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=42;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=43;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=44;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=45;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=46;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=47;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=48;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=49;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=50;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=51;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=52;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=53;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=54;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=55;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=56;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=57;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=58;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=59;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=60;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=61;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=62;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=63;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=64;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=65;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=66;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=67;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=68;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=69;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=70;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=71;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=72;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=73;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=74;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=75;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=76;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=77;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=78;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=79;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=80;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=81;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=82;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=83;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=84;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=85;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=86;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=87;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=88;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=89;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=90;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=91;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=92;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=93;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=94;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=95;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=96;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=97;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=98;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=99;
```

```
name="sd" class="scsi" class_prop="atapi"
     target=0 lun=100;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=101;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=102;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=103;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=104;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=105;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=106;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=107;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=108;

name="sd" class="scsi" class_prop="atapi"
     target=0 lun=109;

name="sd" class="scsi" class_prop="atapi"
     target=1 lun=0;

name="sd" class="scsi" class_prop="atapi"
     target=2 lun=0;

name="sd" class="scsi" class_prop="atapi"
     target=3 lun=0;

name="sd" class="scsi"
     target=4 lun=0;

name="sd" class="scsi"
     target=5 lun=0;

name="sd" class="scsi"
     target=6 lun=0;

name="sd" class="scsi"
     target=8 lun=0;

name="sd" class="scsi"
     target=9 lun=0;

name="sd" class="scsi"
     target=10 lun=0;

name="sd" class="scsi"
     target=11 lun=0;

name="sd" class="scsi"
     target=12 lun=0;
```

```
name="sd" class="scsi"
     target=13 lun=0;

name="sd" class="scsi"
     target=14 lun=0;

name="sd" class="scsi"
     target=15 lun=0;

#
# Enable Target 7 for the mpt SCSI/SAS/SATA driver.  Target 7 has
# traditionally been reserved for legacy SCSI HBAs, but SAS controllers
# supported by the mpt driver do not use target 7 for that purpose.
# Enabling Target 7 allows the use of 8 disks on those controllers.
#
name="sd" parent="mpt"
     target=7 lun=0;
```

Emulex HBA Configuration Parameters

These parameters are set in "lpfc.conf" for controlling the operation of the Emulex Fibre Channel HBAs. The following values have been changed from their default values for accessing the ETERNUS2000 Storage System.

```
#
# All Rights Reserved, Copyright (c) FUJITSU LIMITED  2000
#
#ident "@(#)$Id: fjpfca.conf,v 3.1.1.1 2001/04/20 11:19:47 hiroki Exp $ FUJITSU"

# The fjpfca driver support connection to NL_port(FC-AL) and
# F_Port/FL_Port(fabric).
# It is necessary to define "port" property in order to communicate
# with the fabric or N_port target. In addition, it is necessary
# to define "fcp-bind-target" property in order to communicate
# with the fabric. These need not be defined for FC-AL.
# Other properties like "alias" and "max-throttle" are optional.

# Alias name definition
# You can create an alias definition for a specific WWN
# with "alias" property.
# SYNOPSIS:
#   alias="alias-name:wwn", ...;
# EXAMPLE:
#   alias="TARGET_A:0x100000a0b8030001","TARGET_B:0x100000a0b8030002";
#
#alias=
#    "TARGET_0A:0x100000a0b8030001",
#    "TARGET_1A:0x100000a0b8030002",
#    "TARGET_0B:0x100000a0b8030003",
#    "TARGET_1B:0x100000a0b8030004";

# Port type definition
# The port type definition sets the port mode for a specific instance.
# If the "port" property is not defined, the fjpfca driver
# will determine the port mode automatically during the initialization.
# SYNOPSIS:
#   port="instance-name:[nport|loop]", ...;
# EXAMPLE:
#   port="fjpfca0:nport","fjpfca1:loop";
#
```

```
#port=
#    "fjpfca0:loop",
#    "fjpfca1:loop",
#    "fjpfca2:loop",
#    "fjpfca3:loop";

# Target binding definition
# fcp-bind-target binds a specific instance to a target ID.
# You can use defined alias in "alias" property for the WWN.
# SYNOPSIS:
#   fcp-bind-target="[target-name:[wwn|alias-name]", ...;
# EXAMPLE:
#   fcp-bind-target= "fjpfca0t0:0x100000a0b8030001","fjpfca1t0:TARGET_B";
#
##fcp-bind-target=
##   "fjpfca0t0:0x100000a0b8030001",
##   "fjpfca0t1:0x100000a0b8030003",
##   "fjpfca1t0:TARGET_1A",
##   "fjpfca1t1:TARGET_1B";

# Number of maximum commands per target definition
# The driver uses the value specified by the max-throttle property
# as a number a target of commands which can be issued simultaneously.
# SYNOPSIS:
#   max-throttle="[target-name:number]", ...;
# EXAMPLE:
#   max-throttle="fjpfca0t0:240","fjpfca1t0:240";
#
#max-throttle=
#    "fjpfca0t0:240",
#    "fjpfca0t1:128",
#    "fjpfca1t0:240",
#    "fjpfca1t1:128";

max-throttle-all=45;
```

ETERNUS2000 Model 200 Parameters

Transfer Rate was changed from a default value of “Auto” to a new value of “4Gbit”, as documented in APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

The ETERNUS2000 Storage Array is configured using an interactive on-line tool called ETERNUS Administrator. When an ETERNUS2000 unit is delivered from the factory, there are a set of default RAID Groups and LUNs defined, and the tool is used to modify the configuration to that needed in the customer environment. The following paragraphs outline use of this tool to define the configuration outlined within this FDR. The primary definitions for use in making the configuration are provided through an Excel spreadsheet, called a Design Sheet. The Design sheets for the TSC are provided:

"E2kM200_ConfigPlan_B2(45 drives)-20080901.xls"

This design sheet is developed by the Fujitsu SE, in consultation with the customer, and is provided to the Fujitsu factory when the order for the system is placed. The factory will configure the system according to this design, using internal Fujitsu tools.

Should a customer need to change the delivered configuration, then a series of steps must be followed, using ETERNUS Administrator. The User Guide for the ETERNUS Administrator is available for download from:

http://www.staging.fbf.fai.fujitsu.com/downloads/STRSYS/system/e2kmgrm100m200_setting.pdf

To define a new RAID Group the following steps are used:

1. Assuming that there are available drives to assign to a new RAID Group, select "RAID Group Creation" tool in the main tool bar.
2. The Define RAID Groups screen will be presented. Select the RAID Group Creation tool. Use the Browse button to obtain a list of the drives. Select Free drives to be included in the RAID Group and the desired RAID Level, leaving the Assigned CM selection to Auto. You may optionally assign the RAID Group a name and click the "Next" button. A confirmation screen is provided before the action is committed. Click the "Finish" button to complete the definition of the RAID Group.
3. Additional RAID Groups can be defined by repeating the process.

It is necessary to define one or more Logical Volumes within each of the defined RAID Groups, using the following steps:

1. Select "Create Volume" Tool in the main tool bar.
2. The Create Logical Volume Screen (Volume Creation) screen will be presented, with a list of the RAID Groups defined, and the capacity of each (in MiB). Select the RAID Group in which a Logical Volume is to be defined, and click the "Next" button.
3. A blank name and default capacity of 1024 MB (1000 MiB) is presented. Up to the entire RAID Group may be used by putting in the capacity listed for the selected RAID Group. A number of like sized volumes can be defined by setting a value in the "Volumes" field. A name may be optionally assigned to the volume. Once you have set the factors for the volume creation, click the "Create Volume" icon above the section of the screen where volumes to be created will be listed. Additional volumes may be included in the create operation by clicking the "Create Volume" icon again. When you have a list with all of the volumes you want to create, then click the "Next" button. A confirmation screen is provided before the action is

committed. Click the "Finish" button on the configuration screen to create the volumes.

4. Additional Logical Volumes can be defined by repeating the process within the RAID group and for other RAID Groups.

The configuration plan for the SPC-1 Benchmark configuration has a SPARC Enterprise M8000 server directly connected from the two dual ported HBAs to Channel Adapter ports, 4 CA port connections in all. Each port was set up using the following:

1. Select "Settings" Tool in the main tool bar.
2. The "Configure Global Settings" screen will be presented.
3. Select the "Ports" tab to review the CA Port parameters. Select a port from the tree on the left to access the settings for that port. As this is a direct connection from the server HBA port to the storage CA port, the default selection of FC-AL Connection, Loop-Id (Manual), 0x00, Class 3, and Affinity Mode Off with default Host Response apply. The only item that was changed for the benchmark was the selection of 4Gbit for the Transfer Rate. Click the "Apply" button to save the settings for the selected port.
4. With the selections complete, click the "OK" button to reach the confirmation dialog box – click "Yes" to complete the operations.
5. Each of the four ports are set up in the same manner.

The configuration plan for the SPC-1 Benchmark configuration assigns the 110 Logical Volumes as LUNs 0-109 on each of the Channel Adapter ports. There are 440 Logical Volumes in the defined configuration, 20 on each of the 22 RAID Groups, according to the configuration plan. The following steps are used to set the LUN mapping for each of the CA ports:

1. Select the "Host Affinity Groups" tab on the ETERNUS Administrator Window. This will list the various host affinity groups defined. Groups 00-03 apply to the ports with Host Affinity OFF, while group numbers 04 and greater apply to Host Affinity Groups associated with ports that have Host Affinity ON. Each port will show, under the Type column, "LUN Mapping", while the others will show "Host Affinity Group".
2. Select one of the port entries on the right side of the screen (not in the tree on the left side), which is going to have LUN mapping set up. This will enable the "Modify" button on the bottom of the screen.
3. Click the "Modify" button on the bottom of the screen and the Step 1 of 6: Host Affinity Group Name screen will be presented.
4. Enter a name to enable the "Next" button, and click the "Next" button. This will present the Step 3 of 6: Assign Volumes screen, which contains a list of the available volumes which may be assigned.
5. Select one or more of the Available Volumes for mapping, and click the "Add" button in the middle of the screen to include the volumes in the list for mapping. When all of the volumes to be mapped have been included in the list on the right for adding into the LUN Mapping list, click the "Next" button.

6. This presents the screen Step 4 of 6: LUN Mapping, which shows the list of the volumes selected, and default LUN assignments for each. The default LUN assignments may be changed by entry in the respective "SCSI LUN" column entries or using the spinner buttons on the respective LUN number entries. Select the "Next" button when all of the LUN assignments have been set, as required.
7. This presents the screen Step 6 of 6: Summary, which shows all of the LUN Mapping assignments for the selected Host Affinity Group (or Port in this case). If there are problems, use the "Back" button to return to previous screens to resolve the issues. In some cases, a Logical Volume may be included in more than one group mapping, and this is indicated in the "Duplicate Volume" section of the summary screen. Click the "Finish" button to complete the mapping configuration for the port.
8. The LUN mapping for each of the four ports are set up in the same manner.

The configuration plan also includes a Hot Spare drive, which are defined in much the same way as RAID Groups, using the following steps:

1. Select the "RAID Groups" tab on the ETERNUS Administrator Window. This will list the various RAID Groups that are defined, along with a family of buttons across the bottom of the pane.
2. Select the "Hot Spare" button, and the screen to "Select disks to register or delete HotSpare disk" will be displayed. This screen will show the current role of all of the disk drives installed in the system, by Drive Enclosure. Any drive that is in the "Free"state may be selected for assignment as a Hot Spare drive. Selecting a drive that is currently marked as a Hotspare, will change it to a pending Free state. Click the OK button, and after a confirming acknowledgment, the changes indicated will be made.

Each step along the way to completing the configuration does a small part, and the configuration plan provides the details of the specific entries that are defined, using the ETERNUS Administrator interface. For most customer systems, where the design sheets provide the complete configuration plan, the ETERNUS2000 system is pre-configured at the factory. However, when the plan is not complete or not supplied with an order, a default configuration will be applied by the factory, based on the complement of components ordered.

Scripts and Commands used to Configure Storage Volumes

There are scripts, files, and commands used to create the logical representation of the TSC used in the benchmark measurement for the ETERNUS2000 Storage system.

The **makesol** script is used to create the Solaris Volume Manager (SVM) logical volumes based on a configuration description file. This script is called by:

```
./makesol  Test_E2kM200_B-2-4_svmake.txt
```

The Configuration Description file is created by a macro within the Configuration Plan Excel workbook and contains the list of the raw disks that are used to create the SVM logical volumes assigned to ASU1, ASU2, and ASU3. It is used as an input by the **makesol** script.

The SPC1 Configuration file is also created by a macro within the Configuration Plan Excel workbook, and contains the list of Solaris Logical Volumes that form the definitions for the three ASUs used by the benchmark, ASU1, ASU2, and ASU3.

The content of both the **makesol** script and the configuration description file appear below.

makesol

```
#!/bin/ksh
# Usage: usage
#           makesol configFile
#
LABELFILE="/tmp/makesollabel"
STATFILE="/tmp/makesolstat"
AWK=nawk
usage()
{
        echo "\nUsage: $0 configFile\n"
        exit 1
}

labelDisk()
{
     echo "l" > $LABELFILE
     echo "q" >> $LABELFILE
     format -s -f $LABELFILE $1
}

checkStat()
{
     typeset -i i=0
     del1=`grep $1 $STATFILE|$AWK '{ print $1 }'`
     if [ "$del1" != "" ] ; then
            for del in $del1
            do
                   i=0
                   while (( $i < $delete ))
                   do
                          if [ ${DELETE[(($i+1))]} == $del ] ; then
                                 break
                          fi
                          i=$i+1
                   done
                   if (( $i == $delete )) ; then
                          delete=$delete+1
                          DELETE[$delete]=$del
                   fi
            done
     fi
}

getDiskSlice()
{
     vDisks=""
     for disk in ${DISKS[$1]}
     do
            ndisk=`echo $disk|$AWK 'BEGIN { FS="s"} ; { print $1 }'`
            vDisks=$vDisks$ndisk"s"$2" "
     done
}

makevol()
```

```
{
     typeset -i count=0
     typeset -i i=0
     typeset -i vcount
        tmp=`/usr/sbin/metastat -p|$AWK '{ print substr( $1, 2, length($1)-1 )}'`
     if [ "$tmp" == "" ] ; then
            i=0
     else
            for dgroup in $tmp
            do
                   if (( $dgroup > $i )) ; then
                          i=$dgroup
                   fi
            done
            i=$i+1
     fi
     while (( $count < $groups ))
     do
            count=$count+1
#echo "/usr/sbin/metainit d$i 1 ${DISK_COUNT[$count]} ${DISKS[$count]}
${STRIPE[$count]}"
            tmp=`/usr/sbin/metainit d$i 1 ${DISK_COUNT[$count]} ${DISKS[$count]}
${STRIPE[$count]}`
            i=$i+1
            if [ "${VCOUNT[$count]}" != "" ] ; then
                   vcount=1
                   while (( $vcount < ${VCOUNT[$count]} ))
                   do
                          getSlice $vcount
                          getDiskSlice $count $num
                          tmp=`/usr/sbin/metainit d$i 1 ${DISK_COUNT[$count]} $vDisks
${STRIPE[$count]}`
                          i=$i+1
                          vcount=$vcount+1
                   done
            fi
     done
}

checkDisk()
{
     typeset -i i=0
     tmp=$1"s"
     test=`grep $tmp /etc/vfstab`
     if [ "$test" != "" ] ; then
            echo "Found disk $1 in /etc/vfstab, we really shouldn't use it here"
            exit 4
     fi
     while (( $i < $groups ))
     do
            i=$i+1
            for disk in ${DISKS[$i]}
            do
                   tmp=$1"s0"
                   if [ "$disk" == $tmp ] ; then
                          echo "disk $1 repeated at line $lineno"
                          exit 4
                   fi
            done
        done
        disks=$disks+1
     part=$1"s0"
     DISKS[$groups]=${DISKS[$groups]}$part" "
```

```
      tmp=`prtvtoc -h /dev/dsk/$part 2>/dev/null`
      if [ $? != 0 ] ; then
             labelDisk $part
             tmp=`prtvtoc -h /dev/dsk/$part 2>/dev/null`
             if [ $? != 0 ] ; then
                    echo "prtvtoc failed for $part"
                    exit 4
             fi
      fi
      checkStat $1"s"
 }

 getSlice()
 {
      num=0
         case $1 in
         0)
             num=0
                 ;;
         1)
                 num=1
                 ;;
         2|3|4|5|6)
                 (( num=$1+1 ))
                 ;;
         esac
 }

 setVtoc()
 {
      typeset -i count=0
         typeset -i i=0
         while (( $i < $groups ))
         do
                 i=$i+1
                 for disk in ${DISKS[$i]}
                 do
                   if [ "${VCOUNT[$i]}" != "" ] ; then
                          sectors=`prtvtoc /dev/dsk/$disk 2>/dev/null|grep
 "accessible cylinders"|$AWK '{ print $2 }'`
                          seccyl=`prtvtoc /dev/dsk/$disk 2>/dev/null|grep
 "sectors/cylinder"|$AWK '{ print $2 }'`
                          (( sectors=$sectors-1 ))
                   fi
                   tmp=`prtvtoc -h /dev/dsk/$disk 2>/dev/null`
                   set $tmp
                   while (( $# > 5 ))
                   do
                          if (( $1 == 2 )) ; then
                                 if [ "${VCOUNT[$i]}" == "" ] ; then
                                        echo "0 4 $3 $4 $5 $6" > $LABELFILE
                                 else
                                        echo "* labelfile" > $LABELFILE
                                        (( secCount=$sectors/${VCOUNT[$i]} ))
                                        count=0
                                                 (( sc=$secCount*$seccyl ))
                                                 fs=$seccyl
                                        while (( $count < ${VCOUNT[$i]} ))
                                        do
                                               (( ls=$fs+$sc ))
                                               getSlice $count
                                               echo "$num 4 $3 $fs $sc $ls" >>
 $LABELFILE
```

```
                                                        count=$count+1
                                                (( fs=$fs+$sc ))
                                        done
                                fi
                                echo "$1 $2 $3 $4 $5 $6" >> $LABELFILE
                                tmp=`fmthard -s $LABELFILE /dev/rdsk/$disk`
                                break
                        fi
                        shift 6
                done
            done
        done
}

delGroups()
{
     typeset -i i=0
     if [ $DELETE_ALL == "yes" ] ; then
            tmp=`/usr/sbin/metastat -p |$AWK '{ print $1 }'`
            for del in $tmp
            do
                  tmp=`/usr/sbin/metaclear $del`
                  if [ $? != 0 ] ; then
                        echo "Failed to delete volume $del"
                        exit 4
                  fi
            done
            return
     fi
     while (( $i < $delete ))
     do
            i=$i+1
            tmp=`/usr/sbin/metaclear ${DELETE[$i]}`
            if [ $? != 0 ] ; then
                  echo "Failed to delete volume ${DELETE[$i]}"
                  exit 4
            fi
     done
}

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 $diskName
        done

}

checkConfig()
{
        typeset -i lineno=1
        invg="no"
     DELETE_ALL="no"
        while read -r label name skip
        do
                case $label in
                "VOLUME_GROUP:")
                        VGNAME=$VGNAME$name" "
                        invg="yes"
                        groups=$groups+1
                        getSize="yes"
                        ;;
                "#")
                        ;;
                "")
                        ;;
            "VOLUME")
                        if [ "$invg" != "yes" ]
                        then
                                echo "invalid line in config file line=$lineno
data=\"$label $name\""
                         echo "VOLUME line must be in a volume_group definition"
                                exit 4
                        fi
                   tmp=`echo $name|grep ^[1-7]$`
                   if [ "$tmp" == "" ] ; then
                         echo "invalid line in config file line=$lineno
data=\"$label $name\""
                         echo "VOLUME count must be from 1-7"
                         exit 4
                   fi
                   VCOUNT[groups]=$name
                   ;;
                "STRIPE")
                        if [ "$invg" != "yes" ]
                        then
                                echo "invalid line in config file line=$lineno
data=\"$label $name\""
                                echo "STRIPE line must be in a volume_group
definition"
                                exit 4
                        fi
                        STRIPE[groups]="-i $name"
                        ;;
            "DELETE_ALL")
                   DELETE_ALL="yes"
                   ;;
                "END")
                   DISK_COUNT[$groups]=$disks
                   disks=0
                        invg="no"
```

```
                        ;;
                *)
                        if [ "$invg" != "yes" ]
                        then
                                echo "invalid line in config file line=$lineno
 data=\"$label $name\""
                                exit 4
                        fi
                        diskName=$label
                        checkDisk $diskName
                        if [ "$name" != "" ]
                        then
                                addDisks
                        fi
                esac
                lineno=$lineno+1
        done < $CONFIG
 }


 # main()

        typeset -i delete=0
        typeset -i groups=0
        typeset -i disks=0
        test=`uname -a|grep "Linux"`
        if [ "$test" != "" ]
        then
                AWK=awk
        fi
     case $# in
     1)
           CONFIG=$1
           echo "Doing solvm config from $1"
           ;;
     *)
           usage
           ;;
     esac
     tmp=`/usr/sbin/metadb`
     if [ "$tmp" == "" ] ; then
           echo "No replica database is defined"
           exit 4
     fi
     tmp=`/usr/sbin/metastat -p > $STATFILE`
     checkConfig
     delGroups
     setVtoc
     makevol
```

Test_E2kM200_B-2-4_svmake.txt

```
DELETE_ALL
VOLUME_GROUP: asu1-1 (d0)
STRIPE 8m
VOLUME 1
c2t0d4
c3t0d4
c6t0d4
c7t0d4
c2t0d24
c3t0d24
c6t0d24
c7t0d24
c2t0d44
c3t0d44
c6t0d44
c7t0d44
c2t0d64
c3t0d64
c6t0d64
c7t0d64
c2t0d84
c3t0d84
c6t0d84
c7t0d84
c2t0d104
c3t0d104
END
VOLUME_GROUP: asu1-2 (d1)
STRIPE 8m
VOLUME 1
c2t0d5
c3t0d5
c6t0d5
c7t0d5
c2t0d25
c3t0d25
c6t0d25
c7t0d25
c2t0d45
c3t0d45
c6t0d45
c7t0d45
c2t0d65
c3t0d65
c6t0d65
c7t0d65
c2t0d85
c3t0d85
c6t0d85
c7t0d85
c2t0d105
c3t0d105
END
VOLUME_GROUP: asu1-3 (d2)
STRIPE 8m
VOLUME 1
c2t0d6
c3t0d6
```

```
c6t0d6
c7t0d6
c2t0d26
c3t0d26
c6t0d26
c7t0d26
c2t0d46
c3t0d46
c6t0d46
c7t0d46
c2t0d66
c3t0d66
c6t0d66
c7t0d66
c2t0d86
c3t0d86
c6t0d86
c7t0d86
c2t0d106
c3t0d106
END
VOLUME_GROUP: asu1-4 (d3)
STRIPE 8m
VOLUME 1
c2t0d7
c3t0d7
c6t0d7
c7t0d7
c2t0d27
c3t0d27
c6t0d27
c7t0d27
c2t0d47
c3t0d47
c6t0d47
c7t0d47
c2t0d67
c3t0d67
c6t0d67
c7t0d67
c2t0d87
c3t0d87
c6t0d87
c7t0d87
c2t0d107
c3t0d107
END
VOLUME_GROUP: asu1-5 (d4)
STRIPE 8m
VOLUME 1
c2t0d8
c3t0d8
c6t0d8
c7t0d8
c2t0d28
c3t0d28
c6t0d28
c7t0d28
c2t0d48
c3t0d48
c6t0d48
c7t0d48
c2t0d68
```

```
c3t0d68
c6t0d68
c7t0d68
c2t0d88
c3t0d88
c6t0d88
c7t0d88
c2t0d108
c3t0d108
END
VOLUME_GROUP: asu1-6 (d5)
STRIPE 8m
VOLUME 1
c2t0d11
c3t0d11
c6t0d11
c7t0d11
c2t0d31
c3t0d31
c6t0d31
c7t0d31
c2t0d51
c3t0d51
c6t0d51
c7t0d51
c2t0d71
c3t0d71
c6t0d71
c7t0d71
c2t0d91
c3t0d91
c6t0d91
c7t0d91
c6t0d101
c7t0d101
END
VOLUME_GROUP: asu1-7 (d6)
STRIPE 8m
VOLUME 1
c2t0d12
c3t0d12
c6t0d12
c7t0d12
c2t0d32
c3t0d32
c6t0d32
c7t0d32
c2t0d52
c3t0d52
c6t0d52
c7t0d52
c2t0d72
c3t0d72
c6t0d72
c7t0d72
c2t0d92
c3t0d92
c6t0d92
c7t0d92
c6t0d102
c7t0d102
END
VOLUME_GROUP: asu1-8 (d7)
```

```
  STRIPE 8m
  VOLUME 1
  c2t0d13
  c3t0d13
  c6t0d13
  c7t0d13
  c2t0d33
  c3t0d33
  c6t0d33
  c7t0d33
  c2t0d53
  c3t0d53
  c6t0d53
  c7t0d53
  c2t0d73
  c3t0d73
  c6t0d73
  c7t0d73
  c2t0d93
  c3t0d93
  c6t0d93
  c7t0d93
  c6t0d103
  c7t0d103
  END
  VOLUME_GROUP: asu1-9 (d8)
  STRIPE 8m
  VOLUME 1
  c2t0d14
  c3t0d14
  c6t0d14
  c7t0d14
  c2t0d34
  c3t0d34
  c6t0d34
  c7t0d34
  c2t0d54
  c3t0d54
  c6t0d54
  c7t0d54
  c2t0d74
  c3t0d74
  c6t0d74
  c7t0d74
  c2t0d94
  c3t0d94
  c6t0d94
  c7t0d94
  c6t0d104
  c7t0d104
  END
  VOLUME_GROUP: asu2-1 (d9)
  STRIPE 8m
  VOLUME 1
  c2t0d0
  c3t0d0
  c6t0d0
  c7t0d0
  c2t0d20
  c3t0d20
  c6t0d20
  c7t0d20
  c2t0d40
```

```
c3t0d40
c6t0d40
c7t0d40
c2t0d60
c3t0d60
c6t0d60
c7t0d60
c2t0d80
c3t0d80
c6t0d80
c7t0d80
c2t0d100
c3t0d100
END
VOLUME_GROUP: asu2-2 (d10)
STRIPE 8m
VOLUME 1
c2t0d1
c3t0d1
c6t0d1
c7t0d1
c2t0d21
c3t0d21
c6t0d21
c7t0d21
c2t0d41
c3t0d41
c6t0d41
c7t0d41
c2t0d61
c3t0d61
c6t0d61
c7t0d61
c2t0d81
c3t0d81
c6t0d81
c7t0d81
c2t0d101
c3t0d101
END
VOLUME_GROUP: asu2-3 (d11)
STRIPE 8m
VOLUME 1
c2t0d2
c3t0d2
c6t0d2
c7t0d2
c2t0d22
c3t0d22
c6t0d22
c7t0d22
c2t0d42
c3t0d42
c6t0d42
c7t0d42
c2t0d62
c3t0d62
c6t0d62
c7t0d62
c2t0d82
c3t0d82
c6t0d82
c7t0d82
```

```
c2t0d102
c3t0d102
END
VOLUME_GROUP: asu2-4 (d12)
STRIPE 8m
VOLUME 1
c2t0d3
c3t0d3
c6t0d3
c7t0d3
c2t0d23
c3t0d23
c6t0d23
c7t0d23
c2t0d43
c3t0d43
c6t0d43
c7t0d43
c2t0d63
c3t0d63
c6t0d63
c7t0d63
c2t0d83
c3t0d83
c6t0d83
c7t0d83
c2t0d103
c3t0d103
END
VOLUME_GROUP: asu2-5 (d13)
STRIPE 8m
VOLUME 1
c2t0d15
c3t0d15
c6t0d15
c7t0d15
c2t0d35
c3t0d35
c6t0d35
c7t0d35
c2t0d55
c3t0d55
c6t0d55
c7t0d55
c2t0d75
c3t0d75
c6t0d75
c7t0d75
c2t0d95
c3t0d95
c6t0d95
c7t0d95
c6t0d105
c7t0d105
END
VOLUME_GROUP: asu2-6 (d14)
STRIPE 8m
VOLUME 1
c2t0d16
c3t0d16
c6t0d16
c7t0d16
c2t0d36
```

```
c3t0d36
c6t0d36
c7t0d36
c2t0d56
c3t0d56
c6t0d56
c7t0d56
c2t0d76
c3t0d76
c6t0d76
c7t0d76
c2t0d96
c3t0d96
c6t0d96
c7t0d96
c6t0d106
c7t0d106
END
VOLUME_GROUP: asu2-7 (d15)
STRIPE 8m
VOLUME 1
c2t0d17
c3t0d17
c6t0d17
c7t0d17
c2t0d37
c3t0d37
c6t0d37
c7t0d37
c2t0d57
c3t0d57
c6t0d57
c7t0d57
c2t0d77
c3t0d77
c6t0d77
c7t0d77
c2t0d97
c3t0d97
c6t0d97
c7t0d97
c6t0d107
c7t0d107
END
VOLUME_GROUP: asu2-8 (d16)
STRIPE 8m
VOLUME 1
c2t0d18
c3t0d18
c6t0d18
c7t0d18
c2t0d38
c3t0d38
c6t0d38
c7t0d38
c2t0d58
c3t0d58
c6t0d58
c7t0d58
c2t0d78
c3t0d78
c6t0d78
c7t0d78
```

```
c2t0d98
c3t0d98
c6t0d98
c7t0d98
c6t0d108
c7t0d108
END
VOLUME_GROUP: asu2-9 (d17)
STRIPE 8m
VOLUME 1
c2t0d19
c3t0d19
c6t0d19
c7t0d19
c2t0d39
c3t0d39
c6t0d39
c7t0d39
c2t0d59
c3t0d59
c6t0d59
c7t0d59
c2t0d79
c3t0d79
c6t0d79
c7t0d79
c2t0d99
c3t0d99
c6t0d99
c7t0d99
c6t0d109
c7t0d109
END
VOLUME_GROUP: asu3-1 (d18)
STRIPE 8m
VOLUME 1
c2t0d9
c3t0d9
c6t0d9
c7t0d9
c2t0d29
c3t0d29
c6t0d29
c7t0d29
c2t0d49
c3t0d49
c6t0d49
c7t0d49
c2t0d69
c3t0d69
c6t0d69
c7t0d69
c2t0d89
c3t0d89
c6t0d89
c7t0d89
c2t0d109
c3t0d109
END
VOLUME_GROUP: asu3-2 (d19)
STRIPE 8m
VOLUME 1
c2t0d10
```

```
  c3t0d10
  c6t0d10
  c7t0d10
  c2t0d30
  c3t0d30
  c6t0d30
  c7t0d30
  c2t0d50
  c3t0d50
  c6t0d50
  c7t0d50
  c2t0d70
  c3t0d70
  c6t0d70
  c7t0d70
  c2t0d90
  c3t0d90
  c6t0d90
  c7t0d90
  c6t0d100
  c7t0d100
  END
```

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

The content of SPC-1 Workload Generator command and parameter file, used in this benchmark, is listed below.

```
sd=asu1_1,lun=/dev/md/rdsk/d0,size=96.150g
sd=asu1_2,lun=/dev/md/rdsk/d1,size=96.150g
sd=asu1_3,lun=/dev/md/rdsk/d2,size=96.150g
sd=asu1_4,lun=/dev/md/rdsk/d3,size=96.150g
sd=asu1_5,lun=/dev/md/rdsk/d4,size=96.150g
sd=asu1_6,lun=/dev/md/rdsk/d5,size=96.150g
sd=asu1_7,lun=/dev/md/rdsk/d6,size=96.150g
sd=asu1_8,lun=/dev/md/rdsk/d7,size=96.150g
sd=asu1_9,lun=/dev/md/rdsk/d8,size=96.150g
sd=asu2_1,lun=/dev/md/rdsk/d9,size=96.150g
sd=asu2_2,lun=/dev/md/rdsk/d10,size=96.150g
sd=asu2_3,lun=/dev/md/rdsk/d11,size=96.150g
sd=asu2_4,lun=/dev/md/rdsk/d12,size=96.150g
sd=asu2_5,lun=/dev/md/rdsk/d13,size=96.150g
sd=asu2_6,lun=/dev/md/rdsk/d14,size=96.150g
sd=asu2_7,lun=/dev/md/rdsk/d15,size=96.150g
sd=asu2_8,lun=/dev/md/rdsk/d16,size=96.150g
sd=asu2_9,lun=/dev/md/rdsk/d17,size=96.150g
sd=asu3_1,lun=/dev/md/rdsk/d18,size=96.150g
sd=asu3_2,lun=/dev/md/rdsk/d19,size=96.150g
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

Primary Metrics Test, Repeatability Test, and Persistence Test Run 1

The following script was used to execute the Primary Metrics Test *(Sustainability Test Phase, IOPS Test Phase, and Response Time Ramp Test Phase)*, Repeatability Test *(Repeatability Test Phase 1 and Repeatability Test Phase 2)*, and Persistence Test Run 1 in an uninterrupted sequence.

```
#e2k_080908_fdr1.sh

sleep

#metrics
java -Xmx1024m -Xms1024m -Xss512k metrics -b 265
#repeat-1
java -Xmx1024m -Xms1024m -Xss512k repeat1 -b 265
#repeat-2
java -Xmx1024m -Xms1024m -Xss512k repeat2 -b 265
#persist-1
java -Xmx1024m -Xms1024m -Xss512k persist1 -b 265
```

Persistence Test Run 2

The following script was used to execute Persistence Test Run 2.

```
#e2k_080908_fdr2.sh

#persist2
java -Xmx1024m -Xms1024m -Xss512k persist2

mv metrics metrics_080908_265
mv repeatability1 repeat1_080908_265
mv repeatability2 repeat2_080908_265
mv persistence1 persist1_080908_265
mv persistence2 persist2_080908_265
mv SPCOut SPCOut_080908_265

zip -r metrics_080908_265.zip metrics_080908_265
zip -r repeat1_080908_265.zip repeat1_080908_265
zip -r repeat2_080908_265.zip repeat2_080908_265
zip -r persist1_080908_265.zip persist1_080908_265
zip -r persist2_080908_265.zip persist2_080908_265
zip -r SPCOut_080908_265.zip SPCOut_080908_265
```