SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

FUJITSU LIMITED
FUJITSU STORAGE SYSTEMS ETERNUS DX440

SPC-1 V1.12

Submitted for Review: March 5, 2010
Submission Identifier: A00089

First Edition – March 2010

Trademarks

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AUDIT CERTIFICATION

C. A. Wilson
Fujitsu Limited
1250 East Arques Ave.
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Sunnyvale, CA 94088 3470

March 4, 2010

The SPC Benchmark 1™ results listed below for the Fujitsu Storage Systems ETERNUS DX440 were produced in compliance with the SPC Benchmark 1™ 1.12 Remote Audit requirements.

SPC Benchmark 1™ 1.12 Results	
Tested Storage Configuration (TSC) Name: Fujitsu Storage Systems ETERNUS DX440	
Metric	**Reported Result**
SPC-1 IOPS™	97,498.25
SPC-1 Price-Performance	$5.51/SPC-1 IOPS™
Total ASU Capacity	36,073.698 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$537,671

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with 1.12 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.

Storage Performance Council
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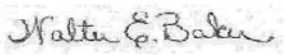
AUDIT CERTIFICATION *(CONT.)*

- 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 each Host System.
  - ✓ The TSC boundary within each 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.
- 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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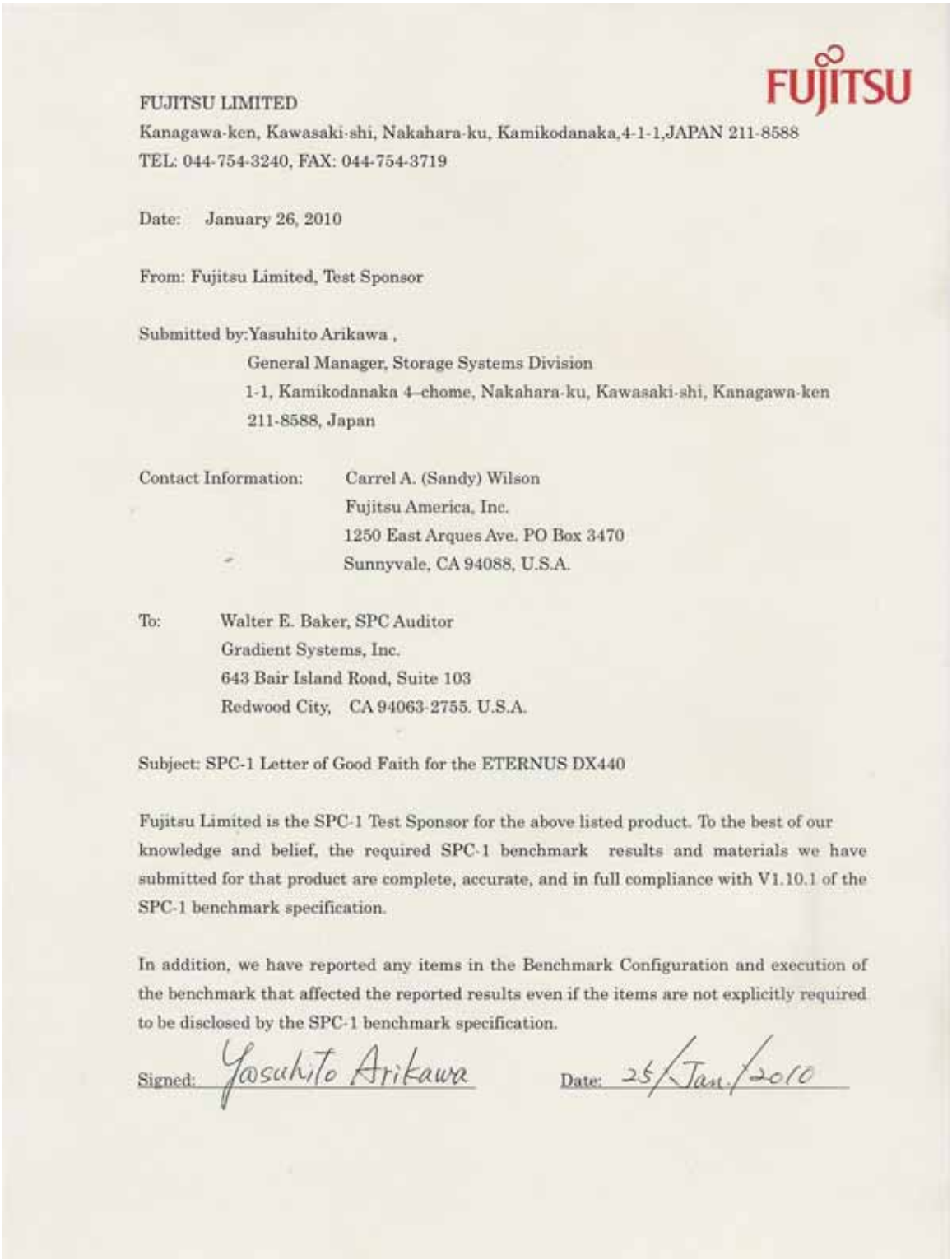
LETTER OF GOOD FAITH



FUJITSU

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Date: January 26, 2010

From: Fujitsu Limited, Test Sponsor

Submitted by:Yasuhito Arikawa ,
General Manager, Storage Systems Division
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Contact Information: Carrel A. (Sandy) Wilson
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1250 East Arques Ave. PO Box 3470
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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 ETERNUS DX440

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: Yasuhito Arikawa Date: 25/Jan./2010

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
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Revision Information and Key Dates

Revision Information and Key Dates	
SPC-1 Specification revision number	V1.12
SPC-1 Workload Generator revision number	V2.1.0
Date Results were first used publicly	March 5, 2010
Date the FDR was submitted to the SPC	March 5, 2010
Date the priced storage configuration is available for shipment to customers	currently available
Date the TSC completed audit certification	March 4, 2010

Tested Storage Product (TSP) Description

The Fujitsu ETERNUS DX440 is a flexible, highly reliable storage array, equipped with redundant components to provide uncompromised availability for the mid market requirements. A mixture of 300GB, 450GB, and 600GB 15krpm Fibre Channel disk drives, as well as 500GB, 750GB, and 1TB Nearline SATA disk drives may be used, up to a maximum of 420 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), and iSCSI host connection options. Up to 16 Fibre Channel ports or up to 8 iSCSI ports, or a mixture of port types may be provided. 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 ETERNUS DX440	
Metric	**Reported Result**
SPC-1 IOPS™	97,498.25
SPC-1 Price-Performance	$5.51/SPC-1 IOPS™
Total ASU Capacity	36,073.698 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$537,671

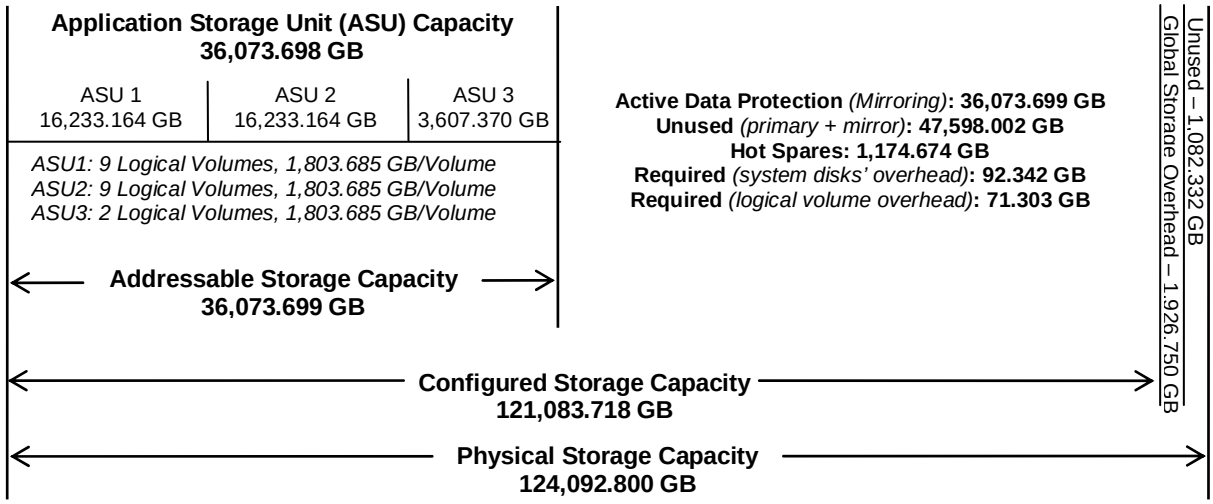
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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 **Protected** using ***Mirroring*** configures two or more identical copies of user data.

Storage Capacities, Relationships, and Utilization

The following diagram and table document the various storage capacities, used in this benchmark, and their relationships, as well as the storage utilization values required to be reported.



SPC-1 Storage Capacity Utilization	
Application Utilization	29.07%
Protected Application Utilization	58.17%
Unused Storage Ratio	39.23%

Application Utilization: Total ASU Capacity *(36,073.698 GB)* divided by Physical Storage Capacity *(124,092.800 GB)*.

Protected Application Utilization: Total ASU Capacity *(36,073.698 GB)* plus total Data Protection Capacity *(59,908.351 GB)* minus unused Data Protection Capacity *(23,799.001 GB)* divided by Physical Storage Capacity *(124,092.800 GB)*.

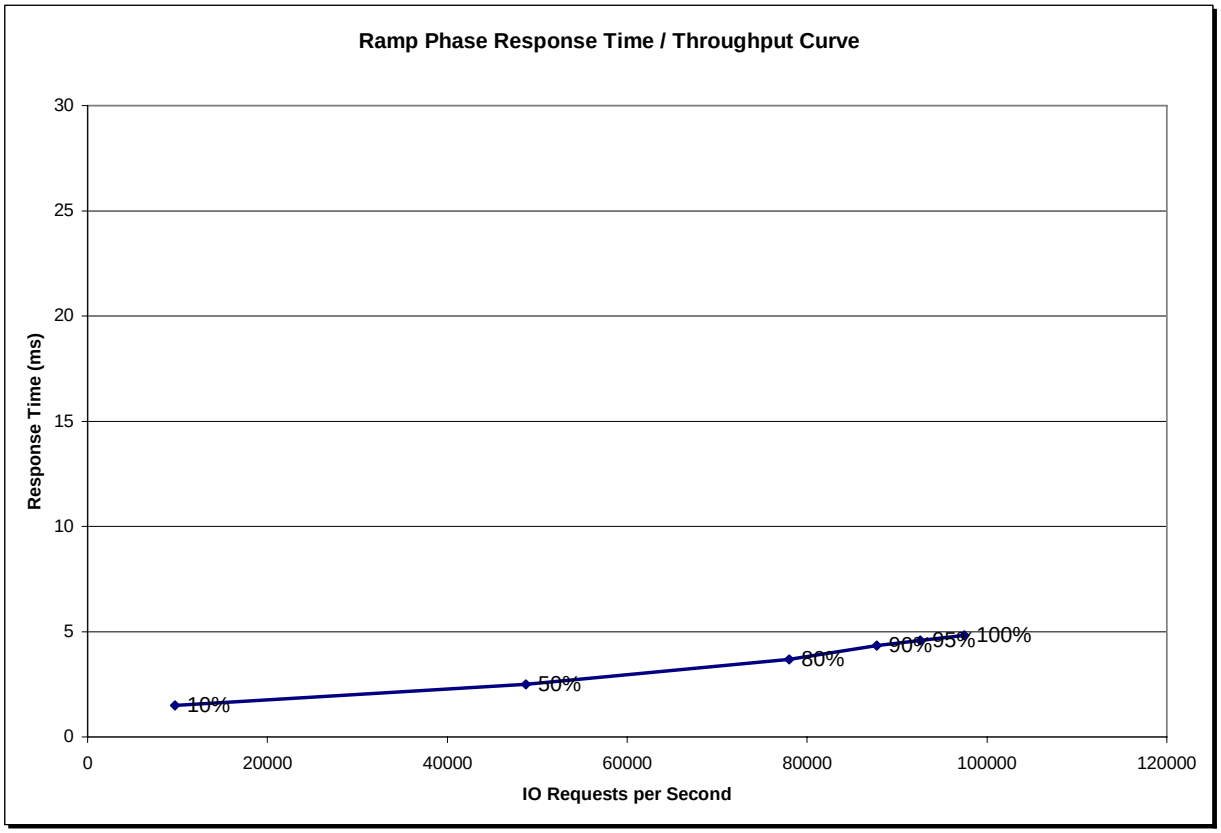
Unused Storage Ratio: Total ASU Capacity *(36,073.698 GB)* plus total Data Protection Capacity *(59,908.351 GB)* minus unused Data Protection Capacity *(23,799.001 GB)* divided by Physical Storage Capacity *(124,092.800 GB)*.

Detailed information for the various storage capacities and utilizations is available on pages 19-20 in the Full Disclosure Report.

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	9,749.74	48,742.72	78,009.39	87,736.79	92,578.86	97,498.25
Average Response Time (ms):						
All ASUs	1.50	2.50	3.69	4.33	4.59	4.83
ASU-1	2.05	3.22	4.55	5.24	5.54	5.81
ASU-2	1.34	2.56	3.98	4.75	5.11	5.47
ASU-3	0.40	0.93	1.75	2.20	2.35	2.47
Reads	3.22	4.93	6.74	7.70	8.16	8.62
Writes	0.38	0.92	1.70	2.13	2.26	2.36

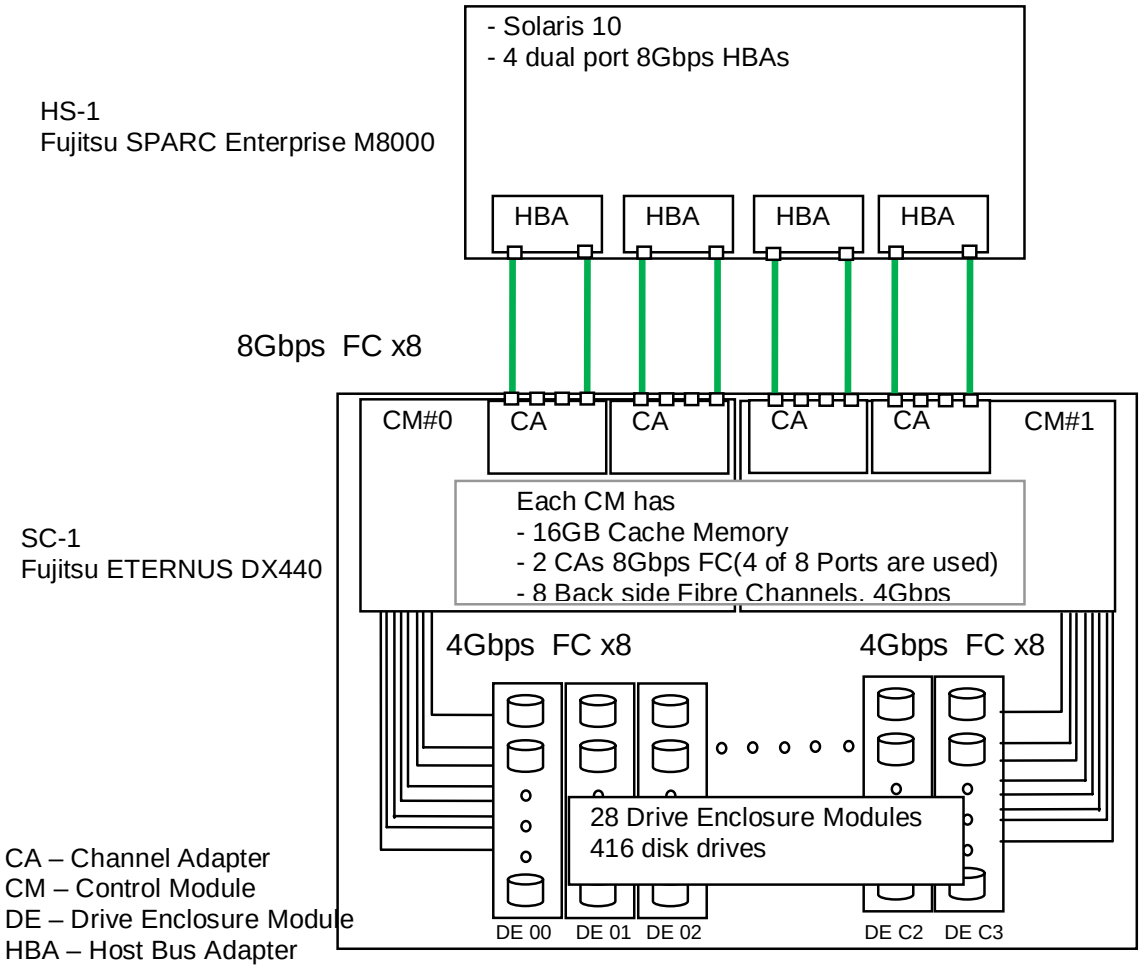
Priced Storage Configuration Pricing

Item	Fujitsu ETERNUS DX440 Product Id	Description	Qty	Unit $	Extd $
1	ET44S20AU	ETERNUS DX440 FLOOR STAND MODEL	1		
2	ETMDE2BU	ADDITIONAL DRIVE ENCLOSURES FOR DX440	9		
3	ETMDE3BU	ADDITIONAL DRIVE ENCLOSURES FOR DX440 (Extension Cable Type)	4		
3	ETMER4U	EXPANSION RACK FOR DX440	2		
4	ETMM44U	16GB CACHE MEMORY FOR DX440	2		
5	ETMHF88U	HOST INTERFACE (8GBPS, FC, 8-PORT)	2		
6	ETMFC3MU	300GB/15KRPM DISK DRIVE X2 (RAID1) (includes qty 416 disk drives)	208		
7	Item #1 through #6 total	ETERNUS DX440 Storage Array System	1	$712,194	$712,194
8	61-343827-015	LC/LC Fibre Channel Cable, 15 M. (Multimode - 50/125um, Riser Rated)	8	$181	$1,448
9	QLE2562-2	Qlogic 8Gbps HBA	4	$2,533	$10,132
10	ETDX44-W059360-AAI	ETDX 440 Warranty, 36 Months, Basic Level, Mon-Fri, 12x5 Phone Support 8AM-8PM Local Time, 9x5 Onsite and Parts 8AM-5PM Local	1	$0	
11	ETDX44-U004361-AAI	ETDX 440 Warranty Uplift, 36 Months Enhanced Plus Level, 24x7x365 Phone Onsite and Parts (Sev1 Resp. Time - 4 Hours),	1	$132,588	$132,588
12	ETDX44-N067005-AAI	ETDX 440 Installation during normal business hours Eternus Installation, One Time billing	1	$1,575	$1,575
13	FTSPS-ET-QSDX440	Professional Services-ETERNUSDX Model 440 Quickstart	1	$11,275	$11,275
		Total Fujitsu Product List Price			$712,194
		Product Discount		40%	
		Net Product Price			$427,316
		Total Non Fujitsu Product List Price			$11,580
		Product Discount		40%	
		Net Non Fujitsu Product Price			$6,948
		Total Service List Price			$145,438
		Service Discount		29%	
		Net Service Price			$103,407
		Total Sell Price, including 3 years Service			**$537,671**

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

Due to the availability of equipment within the test lab, the expansion cabinets used for the benchmark, containing the expansion drive enclosures had the drive enclosures mounted differently than they are for the DX440. Physically they are the same drive enclosures, but in these two expansion cabinets, they were mounted with the long dimension in the vertical, while in the normal mounting for the DX440, the long dimension is horizontal. The electrical / optical fibre channel connections were the same as in the standard mounting for the DX440. There is no affect on performance of the orientation of the drive enclosures within the expansion cabinets. The four drive enclosures in the base cabinet were mounted in the standard horizontal structure for the DX440.

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



Benchmark Configuration (BC)/Tested Storage Configuration (TSC)/ Priced Storage Configuration Components

Host System:
HS-1: Fujitsu SPARC Enterprise M8000 16 – 2.4 GHz SPARC64 VI chips each with: 128 KB L1 instruction cache, 128 KB L1 data cache, 6 MB L2 cache
512 GB main memory
Solaris 10
Solaris Volume Manager
PCIe
WG

Tested Storage Configuration (TSC) / Priced Storage Configuration:
4 –Qlogic QLE2562-2 dual-port 8 Gbps HBAs
SC-1: Fujitsu Storage Systems ETERNUS DX440 2 – Controller Modules, each with: 16 GB cache *(32 GB total)* 2 – Channel Adapter modules *(4 total)*, each Channel Adapter with 4 – Fibre Channel ports *(16 ports total, 8 ports used)* 8 – Fibre Channel Expander Drive Interfaces *(16 total)*
8 – Front side Fibre Channels (8 Gbps) 16 – Back side Fibre Channels (4 Gbps)
28 – Drive Enclosure Modules, each with dual switched FC-AL interfaces, 15 hot swap drive slots
416 – 300 GB 15K RPM disk drives *(408 in 68 RAID Groups, 4 reserved for system use, and 4 Hot Spares)*

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 9.4.3.4.1

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

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 15 *(Benchmark Configuration (BC)/Tested Storage Configuration (TSC)/ Priced Storage Configuration Diagram).*

Storage Network Configuration

Clause 9.4.3.4.1

…

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 9.4.3.4.2.*

Clause 9.4.3.4.2

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.4.3.4.1 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 Tested Storage Configuration did not utilize network storage..

Host System and Tested Storage Configuration (TSC) Table of Components

Clause 9.4.3.4.3

The FDR will contain a table that lists the major components of each Host System and the Tested Storage Configuration (TSC). Table 9-10 specifies the content, format, and appearance of the table.

The Host System and TSC table of components may be found on page 16 *(Benchmark Configuration (BC)/Tested Storage Configuration (TSC)/ Priced Storage Configuration Components).*

Customer Tunable Parameters and Options

Clause 9.4.3.5.1

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 63 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Description

Clause 9.4.3.5.2

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 75 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.4.3.5.3

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 107.

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 59 contains definitions of terms specific to the SPC-1 Data Repository.

Storage Capacities and Relationships

Clause 9.4.3.6.1

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)	36,073.698
Addressable Storage Capacity	Gigabytes (GB)	36,073.699
Configured Storage Capacity	Gigabytes (GB)	121,083.718
Physical Storage Capacity	Gigabytes (GB)	124,092.800
Data Protection *(Mirroring)*	Gigabytes (GB)	59,908.351
Required Storage *(including spares)*	Gigabytes (GB)	1,338.319
Global Storage Overhead	Gigabytes (GB)	1,926.750
Total Unused Storage	Gigabytes (GB)	48.680.335

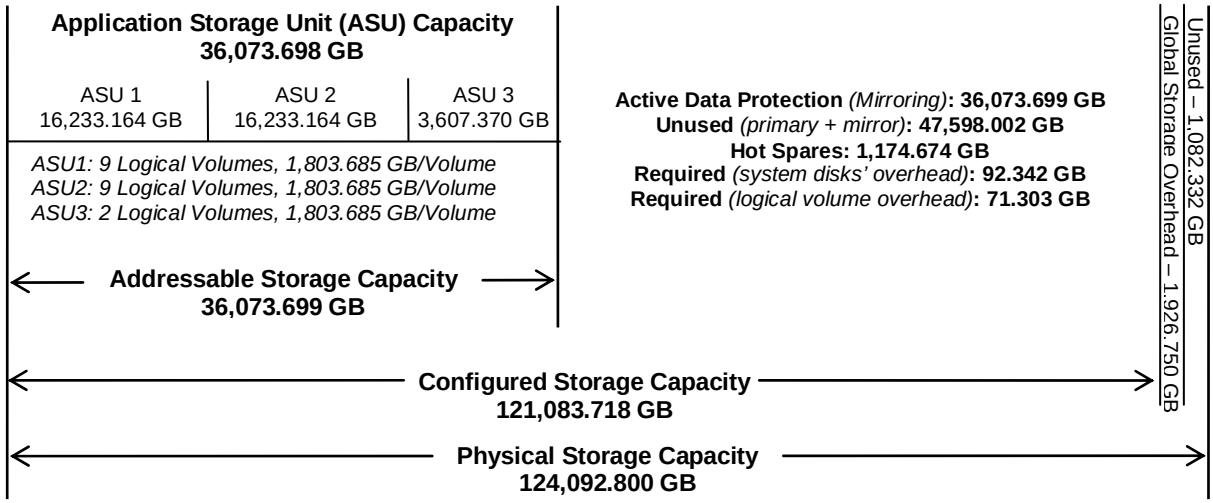
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	100.00%	29.79%	29.07%
Required for Data Protection *(Mirrored)*		49.48%	48.28
Addressable Storage Capacity		29.79%	29.07%
Required Storage *(including spares)*		1,11%	1.08%
Configured Storage Capacity			97.58%
Global Storage Overhead			1.55%
Unused Storage:			
Addressable	0.00%		
Configured		39.31%	
Physical			0.87%

The Physical Storage Capacity consisted of 124,092.800 GB distributed over 416 disk drives each with a formatted capacity of 298.300 GB. There was 1,082.33 GB (0.87%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 1,926.750 GB (1.55%) of Physical Storage Capacity. There was 47,598.022 GB (39.31%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 100.00% of the Addressable Storage Capacity resulting in 0.001 GB (0.00%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(mirroring)* capacity was 59,908.351 GB of which 36.073,698 GB was utilized. The total Unused Storage was 48,680.335 GB.

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 9.4.3.6.3

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 (16,233.164 GB)	**ASU-2 (16,233.164 GB)**	**ASU-3 (3,607.370 GB)**
9 Logical Volume 1,803.685 GB per Logical Volume (1,803.685 GB used per Logical Volume)	9 Logical Volume 1,803.685 GB per Logical Volume (1,803.685 GB used per Logical Volume)	2 Logical Volume 1,803.685 GB per Logical Volume (1,803.685 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.

Storage Capacity Utilization

Clause 9.4.3.6.2

The FDR will include a table illustrating the storage capacity utilization values defined for Application Utilization (Clause 2.8.1), Protected Application Utilization (Clause 2.8.2), and Unused Storage Ratio (Clause 2.8.3).

Clause 2,8.1

Application Utilization is defined as Total ASU Capacity divided by Physical Storage Capacity.

Clause 2,8.2

Protected Application Utilization is defined as (Total ASU Capacity plus total Data Protection Capacity minus unused Data Protection Capacity) divided by Physical Storage Capacity.

Clause 2,8.3

Unused Storage Ratio is defined as Total Unused Capacity divided by Physical Storage Capacity and may not exceed 45%.

SPC-1 Storage Capacity Utilization	
Application Utilization	29.07%
Protected Application Utilization	58.17%
Unused Storage Ratio	39.23%

Assignment of RAID Groups and LUNs

The 68 RAID Group Assignments are RAID1+0(3+3) sets, each divided into 20 Logical Volumes, for a total of 1360 LVs.

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

A02 Configuration using 408 drives in 68 groups with high activity portions in the middle of the drives.

Drive Slot: DE:	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
00	HS	RG-03 CM#0 CPU#1			RG-02 CM#1 CPU#0			RG-01 CM#1 CPU#1			RG-00 CM#0 CPU#0			SY	SY
01	HS													SY	SY
02	HS	RG-07 CM#0 CPU#1			RG-06 CM#1 CPU#0			RG-05 CM#1 CPU#1			RG-04 CM#0 CPU#0				
03	HS														
20	RG-12 CM#0 CPU#0			RG-11 CM#0 CPU#1			RG-10 CM#1 CPU#0			RG-09 CM#1 CPU#1			RG-08 CM#0 CPU#0		
21															
22	RG-17 CM#0 CPU#0			RG-16 CM#0 CPU#1			RG-15 CM#1 CPU#0			RG-14 CM#1 CPU#1			RG-13 CM#0 CPU#0		
23															
40	RG-22 CM#1 CPU#1			RG-21 CM#0 CPU#0			RG-20 CM#0 CPU#1			RG-19 CM#1 CPU#0			RG-18 CM#1 CPU#1		
41															
42	RG-27 CM#1 CPU#1			RG-26 CM#0 CPU#0			RG-25 CM#0 CPU#1			RG-24 CM#1 CPU#0			RG-23 CM#1 CPU#1		
43															
60	RG-32 CM#1 CPU#0			RG-31 CM#1 CPU#1			RG-30 CM#0 CPU#0			RG-29 CM#0 CPU#1			RG-28 CM#1 CPU#0		
61															
62	RG-37 CM#1 CPU#0			RG-36 CM#1 CPU#1			RG-35 CM#0 CPU#0			RG-34 CM#0 CPU#1			RG-33 CM#1 CPU#0		
63															
80	RG-42 CM#0 CPU#1			RG-41 CM#1 CPU#0			RG-40 CM#1 CPU#1			RG-39 CM#0 CPU#0			RG-38 CM#0 CPU#1		
81															
82	RG-47 CM#0 CPU#1			RG-46 CM#1 CPU#0			RG-45 CM#1 CPU#1			RG-44 CM#0 CPU#0			RG-43 CM#0 CPU#1		
83															
A0	RG-52 CM#0 CPU#0			RG-51 CM#0 CPU#1			RG-50 CM#1 CPU#0			RG-49 CM#1 CPU#1			RG-48 CM#0 CPU#0		
A1															
A2	RG-57 CM#0 CPU#0			RG-56 CM#0 CPU#1			RG-55 CM#1 CPU#0			RG-54 CM#1 CPU#1			RG-53 CM#0 CPU#0		
A3															
C0	RG-66 CM#1 CPU#0			RG-64 CM#0 CPU#0			RG-60 CM#0 CPU#1			RG-59 CM#1 CPU#0			RG-58 CM#1 CPU#1		
C1															
C2	RG-67 CM#0 CPU#1			RG-65 CM#1 CPU#1			RG-63 CM#0 CPU#1			RG-62 CM#1 CPU#0			RG-61 CM#1 CPU#1		
C3															

System Drives - treated as Global Overhead
Hot Spare Drives - treated as part of Configured Storage
Removed Drives - to configure reduced system

The RAID Groups and LUN assignments are set up through a series of actions on the GUI Management Interface (ETERNUS Administrator, also known as ETERNUSmgr). 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+0 configurations. In this configuration, all of the RAID Groups are 1+0(3+3) arrangements. Please see *"Appendix C: Tested Storage Configuration (TSC) Creation"* on page 75 for further details on preparing the configuration.

There are four (4) of the drives reserved exclusively for system use in this configuration, however portions of each of those drives may be assigned for user space in other configurations, so that space is included in the Unused not configured totals. Four (4) Hot Spare drives have been included in the configuration. There are four (4) empty drive slots in this configuration, as well.

The 1360 Logical Volumes are grouped into eight separate sets of LUNs each with 170 LUNs. These are connected to the logical host server through the 8 ports and directly connected HBA ports. The LUNs, seen through the eight 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 68 LUNs are used for ASU1 and another nine for ASU2, while two Volumes, also each with 68 LUNs are used for ASU3. The sizes are reflected in the ASU Logical Volume Mapping chart.

Two optional facilities in the ETERNUS DX440 (ESC and Trace), which may be 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, as well as the ECO (MAID) feature.

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 60 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 9.4.3.7.1

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 108.

Sustainability Test Results File

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

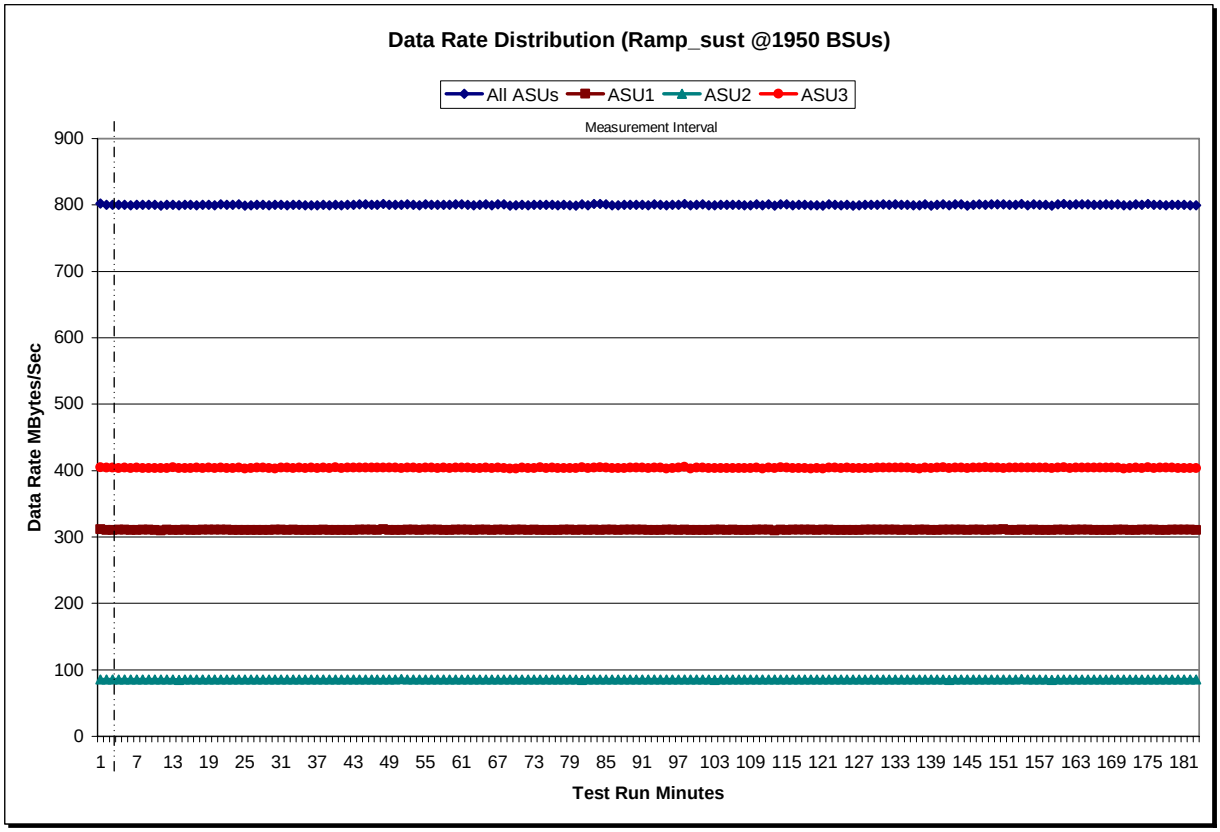
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	16:39:47	16:42:47	0-2	0:03:00
Measurement Interval	16:42:47	19:42:47	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	801.86	311.40	85.56	404.90	63	800.19	310.89	85.64	403.66	126	799.50	310.48	85.63	403.38
1	800.36	310.67	85.46	404.22	64	800.76	311.15	85.25	404.36	127	800.38	310.93	85.56	403.89
2	800.20	310.36	85.34	404.51	65	799.86	310.54	85.57	403.75	128	800.49	311.06	85.51	403.92
3	800.26	311.12	85.37	403.76	66	800.95	311.07	85.65	404.23	129	800.44	310.81	85.48	404.15
4	800.38	310.87	85.42	404.08	67	800.82	311.33	85.68	403.81	130	800.64	310.92	85.26	404.46
5	799.56	310.30	85.52	403.75	68	799.04	310.38	85.78	402.88	131	800.52	310.84	85.27	404.41
6	800.02	310.39	85.53	404.10	69	799.75	311.14	85.72	402.89	132	800.64	310.81	85.66	404.17
7	800.09	310.76	85.42	403.90	70	800.46	310.78	85.46	404.22	133	800.27	310.44	85.41	404.42
8	800.04	310.78	85.44	403.81	71	799.46	310.66	85.26	403.54	134	800.37	310.80	85.40	404.18
9	800.05	310.38	85.81	403.86	72	800.43	310.87	85.61	403.95	135	799.69	310.52	85.75	403.42
10	799.11	309.89	85.37	403.85	73	800.48	310.49	85.22	404.77	136	799.51	310.76	85.52	403.23
11	800.26	310.76	85.52	403.98	74	799.92	310.50	85.52	403.90	137	800.82	311.09	85.49	404.25
12	800.26	310.38	85.22	404.66	75	800.06	310.05	85.70	404.32	138	799.01	310.13	85.41	403.47
13	799.49	310.68	85.12	403.69	76	799.50	310.55	85.28	403.66	139	800.42	310.66	85.59	404.17
14	800.27	310.87	85.57	403.83	77	799.96	310.81	85.66	403.49	140	800.93	310.73	85.53	404.67
15	799.91	310.63	85.29	404.00	78	799.80	310.95	85.35	403.50	141	799.31	310.71	85.16	403.45
16	799.81	310.39	85.38	404.05	79	798.93	310.16	85.24	403.53	142	800.81	310.86	85.78	404.17
17	800.42	310.93	85.50	403.98	80	801.13	310.93	85.03	405.17	143	800.65	310.79	85.70	404.17
18	800.09	310.70	85.34	404.05	81	799.68	310.25	85.50	403.93	144	799.13	310.35	85.43	403.35
19	799.53	310.69	85.39	403.45	82	801.33	311.24	85.51	404.58	145	800.25	310.71	85.54	404.00
20	800.96	311.14	85.42	404.40	83	801.19	310.64	85.53	405.02	146	800.62	310.74	85.33	404.56
21	800.30	310.91	85.58	403.81	84	800.97	311.13	85.59	404.25	147	800.29	310.23	85.40	404.66
22	800.08	310.49	85.67	403.92	85	799.49	310.78	85.28	403.43	148	800.99	311.06	85.33	404.60
23	800.55	310.38	85.53	404.64	86	799.83	310.67	85.46	403.70	149	800.88	311.29	85.29	404.30
24	798.63	310.27	85.44	402.92	87	800.18	311.01	85.35	403.82	150	800.81	311.45	85.45	403.91
25	799.84	310.62	85.33	403.89	88	800.35	311.03	85.27	404.05	151	799.98	310.40	85.29	404.29
26	800.29	310.53	85.61	404.15	89	800.14	310.79	85.26	404.09	152	800.34	310.65	85.42	404.27
27	800.50	310.46	85.55	404.49	90	800.20	310.80	85.23	404.17	153	801.28	310.85	85.85	404.57
28	799.51	310.60	85.34	403.56	91	799.64	310.23	85.43	403.98	154	799.76	310.27	85.43	404.05
29	800.23	311.33	85.60	403.30	92	800.57	310.59	85.41	404.57	155	800.93	311.30	85.61	404.01
30	800.34	311.02	85.27	404.05	93	799.93	310.35	85.40	404.18	156	800.27	310.46	85.74	404.07
31	799.61	310.32	85.28	404.01	94	799.31	310.74	85.42	403.15	157	800.17	310.37	85.65	404.15
32	800.08	310.72	85.61	403.75	95	800.25	310.86	85.76	403.62	158	799.23	310.26	85.18	403.80
33	800.01	310.20	85.69	404.12	96	799.98	310.45	85.49	404.04	159	800.90	311.21	85.49	404.20
34	799.84	310.53	85.64	403.67	97	801.51	310.83	85.26	405.41	160	801.41	310.88	85.65	404.88
35	799.53	310.14	85.31	404.08	98	799.29	310.68	85.74	402.87	161	800.06	310.55	85.60	403.91
36	799.28	310.39	85.35	403.54	99	799.96	310.34	85.38	404.25	162	800.67	311.05	85.62	404.01
37	800.16	310.73	85.43	404.00	100	800.79	310.65	85.67	404.48	163	800.70	310.87	85.54	404.29
38	799.84	310.44	85.75	403.65	101	799.84	310.41	85.54	403.89	164	800.80	310.91	85.59	404.30
39	800.46	310.27	85.44	404.76	102	799.35	310.76	85.09	403.50	165	800.05	310.50	85.37	404.18
40	799.83	310.66	85.37	403.80	103	800.31	310.92	85.51	403.88	166	799.99	310.41	85.28	404.31
41	800.09	310.48	85.50	404.11	104	799.98	310.59	85.69	403.70	167	800.77	310.68	85.49	404.60
42	799.91	310.29	85.29	404.34	105	800.03	310.87	85.22	403.94	168	800.49	310.43	85.46	404.60
43	800.93	311.03	85.71	404.19	106	800.11	310.61	85.72	403.78	169	800.70	310.76	85.58	404.36
44	801.06	310.99	85.63	404.45	107	799.51	310.22	85.30	403.99	170	799.80	310.96	85.68	403.16
45	800.49	310.92	85.49	404.08	108	799.80	310.54	85.51	403.75	171	799.81	310.67	85.42	403.73
46	800.37	310.61	85.50	404.26	109	800.82	311.18	85.59	404.05	172	800.73	310.53	85.64	404.57
47	801.39	311.41	85.35	404.63	110	799.73	310.83	85.58	403.32	173	800.27	310.97	85.59	403.71
48	800.33	310.68	85.54	404.11	111	800.57	311.16	85.28	404.13	174	801.55	310.82	85.70	405.03
49	800.45	310.67	85.61	404.18	112	799.03	309.88	85.73	403.43	175	800.08	310.84	85.56	403.68
50	800.16	310.47	86.01	403.67	113	800.92	310.73	85.52	404.67	176	800.04	310.49	85.38	404.17
51	800.77	311.09	85.41	404.27	114	800.57	310.51	85.71	404.35	177	799.81	310.43	85.23	404.15
52	800.45	310.84	85.42	404.19	115	799.87	310.74	85.39	403.75	178	800.36	310.79	85.53	404.04
53	799.47	310.44	85.68	403.35	116	800.19	311.20	85.33	403.67	179	800.33	310.78	85.55	404.00
54	800.70	310.88	85.45	404.37	117	800.17	310.71	85.52	403.94	180	800.07	311.03	85.50	403.54
55	800.33	310.83	85.26	404.24	118	799.39	311.13	85.29	402.97	181	799.57	310.78	85.30	403.50
56	800.21	311.04	85.50	403.66	119	799.64	310.50	85.21	403.93	182	799.59	310.47	85.58	403.54
57	800.39	310.60	85.24	404.56	120	799.21	310.71	85.41	403.09					
58	800.13	310.66	85.49	403.98	121	800.92	310.97	85.64	404.30					
59	800.74	310.79	85.70	404.25	122	800.20	310.37	85.82	404.01					
60	800.67	311.01	85.44	404.22	123	799.31	310.61	85.21	403.49					
61	800.37	310.75	85.23	404.39	124	800.34	310.59	85.54	404.21					
62	799.50	310.58	85.39	403.54	125	799.19	310.32	85.26	403.62					

Sustainability – Data Rate Distribution Graph

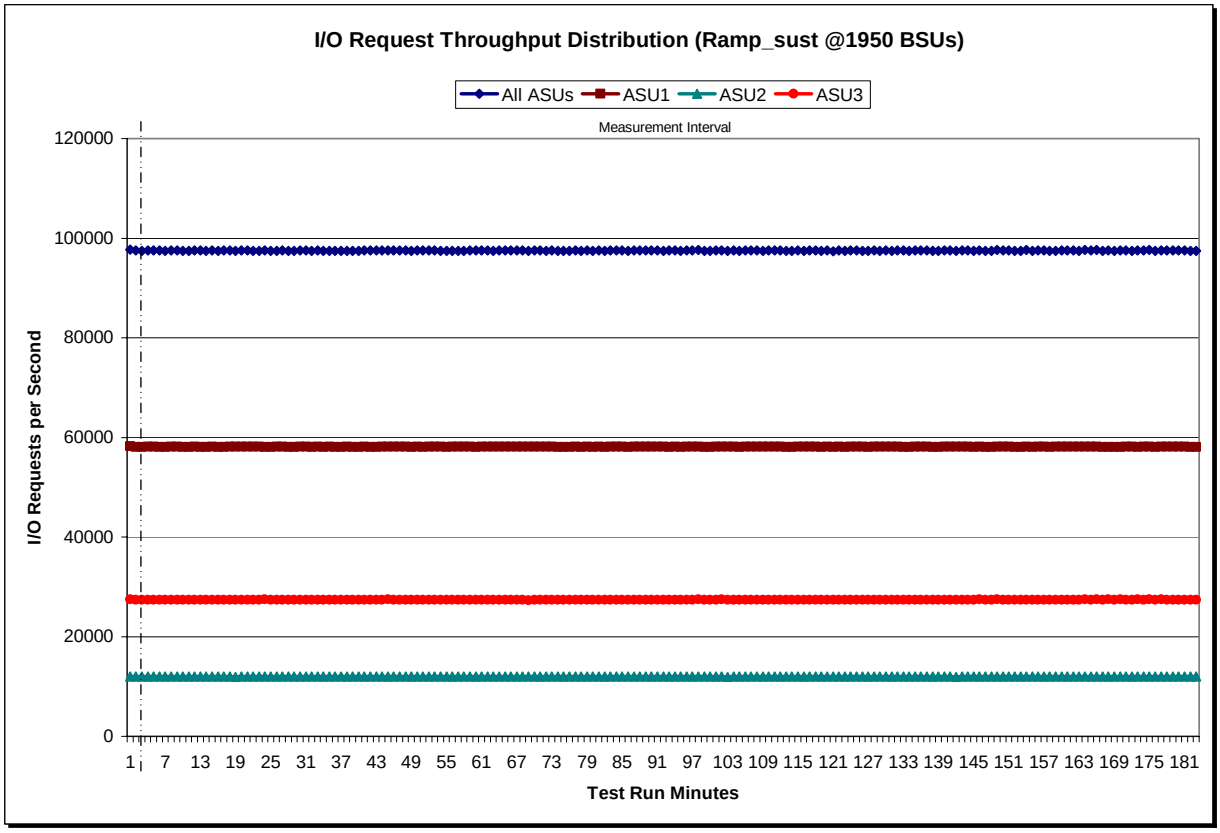


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	16:39:47	16:42:47	0-2	0:03:00
Measurement Interval	16:42:47	19:42:47	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	97,734.33	58,252.20	12,006.05	27,476.08	63	97,520.00	58,141.82	11,989.57	27,388.62	126	97,473.53	58,072.85	11,994.07	27,406.62
1	97,497.20	58,089.50	11,992.75	27,414.95	64	97,521.00	58,152.35	11,977.37	27,391.28	127	97,517.85	58,125.47	12,002.00	27,390.38
2	97,467.40	58,086.18	11,993.33	27,387.88	65	97,555.50	58,133.13	11,996.73	27,425.63	128	97,467.07	58,114.12	11,993.03	27,359.92
3	97,529.67	58,146.70	11,989.33	27,393.63	66	97,548.05	58,133.33	12,008.20	27,406.52	129	97,516.87	58,115.17	11,977.38	27,424.32
4	97,549.72	58,141.17	12,011.12	27,397.43	67	97,530.30	58,139.33	12,005.52	27,385.45	130	97,481.85	58,104.50	11,973.52	27,403.83
5	97,510.85	58,094.80	11,993.78	27,422.27	68	97,449.48	58,105.52	12,005.37	27,338.60	131	97,548.43	58,153.18	11,989.77	27,405.48
6	97,480.17	58,065.07	11,995.15	27,419.95	69	97,527.12	58,127.95	12,026.52	27,372.65	132	97,527.82	58,089.27	12,019.40	27,419.15
7	97,503.87	58,121.27	11,997.03	27,385.57	70	97,526.15	58,128.62	11,991.38	27,406.15	133	97,454.07	58,069.17	11,987.32	27,397.58
8	97,498.57	58,116.62	11,982.60	27,399.35	71	97,439.53	58,109.93	11,974.07	27,355.53	134	97,553.63	58,122.17	12,007.72	27,423.75
9	97,466.00	58,086.27	12,010.07	27,369.67	72	97,539.98	58,123.77	12,012.55	27,403.67	135	97,520.67	58,122.13	12,011.35	27,387.18
10	97,420.48	58,035.10	11,982.52	27,402.87	73	97,474.05	58,083.20	11,978.50	27,412.35	136	97,496.17	58,125.00	11,976.97	27,394.20
11	97,539.28	58,119.70	12,016.20	27,403.38	74	97,454.42	58,078.97	11,991.28	27,384.17	137	97,444.18	58,067.23	11,984.60	27,392.35
12	97,513.27	58,099.18	11,986.05	27,428.03	75	97,472.47	58,043.93	12,004.30	27,424.23	138	97,428.40	58,068.23	11,987.17	27,373.00
13	97,465.37	58,098.52	11,975.93	27,390.92	76	97,537.68	58,135.15	11,996.32	27,406.22	139	97,502.08	58,116.60	11,997.12	27,388.37
14	97,522.65	58,116.23	12,005.55	27,400.87	77	97,416.18	58,060.75	11,980.12	27,375.32	140	97,533.95	58,103.88	12,000.98	27,429.08
15	97,448.18	58,053.38	11,983.23	27,411.57	78	97,511.58	58,136.02	11,996.82	27,378.75	141	97,459.63	58,130.15	11,964.12	27,365.37
16	97,500.07	58,093.65	12,008.55	27,397.87	79	97,481.47	58,086.22	12,001.82	27,393.43	142	97,557.92	58,105.25	12,038.98	27,413.68
17	97,526.40	58,126.05	11,996.98	27,403.37	80	97,521.20	58,131.72	11,972.83	27,416.65	143	97,535.08	58,117.48	12,025.57	27,392.03
18	97,467.68	58,108.97	11,960.97	27,397.75	81	97,460.10	58,090.88	11,969.88	27,399.33	144	97,452.35	58,067.68	11,990.22	27,394.45
19	97,534.48	58,137.45	11,998.90	27,398.13	82	97,579.32	58,160.27	11,994.53	27,424.52	145	97,542.65	58,115.92	11,995.57	27,431.17
20	97,556.83	58,130.52	12,000.45	27,425.87	83	97,507.38	58,102.68	11,982.95	27,421.75	146	97,468.02	58,075.33	11,990.10	27,402.58
21	97,488.13	58,125.60	11,978.72	27,383.82	84	97,519.97	58,144.10	11,990.60	27,385.27	147	97,453.62	58,066.03	11,984.20	27,403.38
22	97,478.33	58,126.20	11,973.63	27,378.50	85	97,469.13	58,090.52	11,974.10	27,404.52	148	97,589.58	58,156.92	12,001.90	27,430.77
23	97,536.30	58,092.28	12,004.45	27,439.57	86	97,519.45	58,133.12	12,004.22	27,382.12	149	97,525.98	58,137.77	11,989.82	27,398.40
24	97,412.05	58,047.23	11,993.88	27,370.93	87	97,538.30	58,137.25	11,988.60	27,412.45	150	97,556.32	58,153.82	12,000.40	27,402.10
25	97,453.15	58,104.55	11,967.82	27,380.78	88	97,524.70	58,141.42	11,980.88	27,402.40	151	97,487.12	58,093.72	11,990.48	27,402.92
26	97,507.78	58,131.52	11,993.78	27,382.48	89	97,498.02	58,112.68	11,990.40	27,394.93	152	97,452.48	58,078.33	11,969.63	27,404.52
27	97,466.48	58,088.97	11,974.52	27,403.00	90	97,562.53	58,154.23	11,979.88	27,428.42	153	97,591.62	58,138.40	12,031.07	27,422.15
28	97,485.65	58,091.68	11,998.50	27,395.47	91	97,475.33	58,100.82	11,991.90	27,382.62	154	97,457.80	58,062.88	11,996.80	27,398.12
29	97,562.42	58,133.38	12,009.75	27,419.28	92	97,500.40	58,084.75	11,987.68	27,427.97	155	97,551.60	58,178.68	11,990.45	27,382.47
30	97,572.03	58,167.27	12,000.98	27,403.78	93	97,503.53	58,102.35	11,986.45	27,414.73	156	97,563.33	58,153.32	11,994.83	27,415.18
31	97,418.38	58,025.95	11,968.15	27,424.28	94	97,439.80	58,086.98	11,972.62	27,380.20	157	97,477.95	58,076.33	11,999.22	27,402.40
32	97,500.50	58,103.00	12,006.28	27,391.22	95	97,522.57	58,123.58	12,002.75	27,396.23	158	97,489.93	58,132.80	11,965.68	27,391.45
33	97,444.45	58,043.53	12,002.55	27,398.37	96	97,506.82	58,115.92	11,988.30	27,402.60	159	97,542.20	58,121.25	12,008.03	27,412.92
34	97,472.73	58,111.60	11,993.62	27,367.52	97	97,621.30	58,176.47	11,998.95	27,445.88	160	97,529.15	58,120.15	11,990.27	27,418.73
35	97,435.02	58,075.30	11,978.42	27,381.30	98	97,450.12	58,079.15	12,017.67	27,353.30	161	97,531.02	58,128.55	11,995.55	27,406.92
36	97,429.02	58,073.65	11,975.02	27,380.35	99	97,452.82	58,060.27	11,981.08	27,411.47	162	97,480.80	58,119.03	11,980.92	27,380.85
37	97,463.95	58,106.27	11,982.38	27,375.30	100	97,505.98	58,114.72	11,991.98	27,399.28	163	97,596.82	58,158.98	11,993.08	27,444.75
38	97,420.42	58,058.77	11,994.82	27,366.83	101	97,556.55	58,107.05	12,003.93	27,445.57	164	97,549.65	58,137.28	12,001.72	27,410.65
39	97,448.15	58,046.68	11,983.00	27,418.47	102	97,453.27	58,116.12	11,964.08	27,373.07	165	97,599.52	58,161.03	12,004.88	27,433.60
40	97,508.88	58,118.97	11,995.97	27,393.95	103	97,518.18	58,137.25	11,993.68	27,387.25	166	97,460.00	58,050.00	12,002.55	27,407.45
41	97,514.78	58,093.52	12,007.60	27,413.67	104	97,483.02	58,068.38	12,026.02	27,388.62	167	97,533.95	58,085.63	12,005.47	27,442.85
42	97,494.92	58,096.90	11,987.28	27,410.73	105	97,527.35	58,147.63	11,998.83	27,380.88	168	97,470.73	58,078.73	11,980.13	27,411.87
43	97,534.12	58,142.98	11,998.10	27,393.03	106	97,545.63	58,138.73	11,999.82	27,407.08	169	97,504.18	58,071.50	11,996.65	27,436.03
44	97,572.77	58,128.23	12,012.88	27,431.65	107	97,518.97	58,117.22	11,998.07	27,403.68	170	97,505.48	58,129.83	12,009.80	27,365.85
45	97,561.82	58,128.90	12,013.87	27,419.05	108	97,471.47	58,115.57	11,974.33	27,381.57	171	97,490.23	58,113.28	11,988.42	27,388.53
46	97,528.42	58,116.42	11,993.35	27,418.65	109	97,525.37	58,147.15	11,995.37	27,382.85	172	97,534.57	58,096.05	11,995.90	27,442.62
47	97,578.75	58,175.40	11,980.02	27,423.33	110	97,512.75	58,146.13	11,995.12	27,371.50	173	97,543.93	58,135.13	12,001.03	27,407.77
48	97,461.77	58,085.38	11,968.40	27,407.98	111	97,505.97	58,126.70	11,988.58	27,390.68	174	97,581.88	58,135.55	12,012.70	27,433.63
49	97,510.28	58,107.28	11,987.05	27,415.95	112	97,465.02	58,043.82	12,011.82	27,409.38	175	97,431.90	58,083.58	11,985.78	27,362.53
50	97,500.62	58,081.10	12,030.75	27,388.77	113	97,481.10	58,086.52	11,996.37	27,398.22	176	97,550.97	58,121.87	11,995.83	27,433.27
51	97,544.25	58,128.67	11,998.43	27,417.15	114	97,573.20	58,179.77	11,981.25	27,412.18	177	97,524.00	58,119.63	11,992.85	27,411.52
52	97,509.10	58,108.90	11,982.83	27,417.37	115	97,466.22	58,101.87	11,986.22	27,378.13	178	97,564.70	58,153.65	11,999.33	27,411.72
53	97,480.80	58,108.18	12,003.15	27,369.47	116	97,518.97	58,145.72	11,992.93	27,380.32	179	97,533.40	58,123.78	12,017.12	27,392.50
54	97,480.70	58,092.57	11,985.02	27,403.12	117	97,552.58	58,126.98	12,020.37	27,405.23	180	97,504.53	58,135.77	11,966.60	27,402.17
55	97,492.80	58,104.55	11,985.00	27,403.25	118	97,425.48	58,095.03	11,985.28	27,345.17	181	97,448.20	58,077.57	11,969.35	27,401.28
56	97,455.52	58,100.72	11,986.73	27,368.07	119	97,521.80	58,124.32	11,982.22	27,415.27	182	97,473.70	58,080.10	12,009.62	27,383.98
57	97,457.38	58,105.30	11,966.02	27,386.07	120	97,400.30	58,069.03	11,981.28	27,349.98	Average	97,503.22	58,110.21	11,993.45	27,399.57
58	97,507.20	58,132.62	11,997.70	27,376.88	121	97,524.42	58,118.68	12,011.95	27,393.78					
59	97,504.90	58,096.95	12,010.78	27,397.17	122	97,417.58	58,038.07	12,009.80	27,369.72					
60	97,514.18	58,133.87	11,987.05	27,393.27	123	97,529.20	58,120.20	12,001.63	27,407.37					
61	97,537.82	58,145.83	11,987.00	27,404.98	124	97,530.45	58,122.30	12,007.82	27,400.33					
62	97,461.38	58,107.38	11,983.83	27,370.17	125	97,465.12	58,100.73	11,981.40	27,382.98					

Sustainability – I/O Request Throughput Distribution Graph

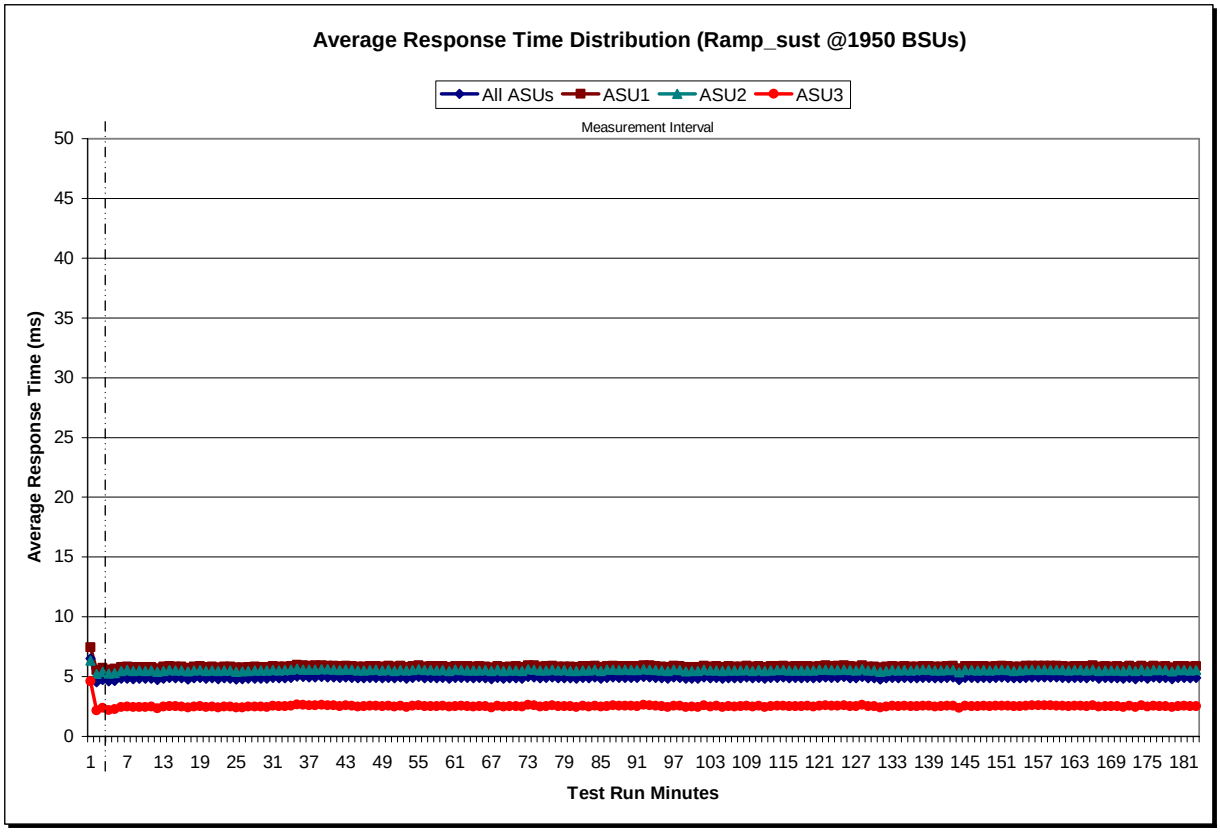


Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	16:39:47	16:42:47	0-2	0:03:00
Measurement Interval	16:42:47	19:42:47	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	6.53	7.47	6.33	4.61	63	4.85	5.82	5.50	2.49	126	4.86	5.84	5.51	2.51
1	4.55	5.54	5.22	2.16	64	4.88	5.85	5.52	2.53	127	4.98	5.95	5.63	2.62
2	4.73	5.71	5.38	2.37	65	4.87	5.84	5.55	2.52	128	4.87	5.84	5.51	2.52
3	4.59	5.58	5.26	2.21	66	4.80	5.78	5.46	2.43	129	4.87	5.85	5.51	2.51
4	4.66	5.64	5.31	2.28	67	4.91	5.89	5.57	2.56	130	4.77	5.75	5.41	2.41
5	4.81	5.79	5.48	2.45	68	4.83	5.80	5.47	2.47	131	4.84	5.82	5.49	2.48
6	4.84	5.82	5.53	2.48	69	4.87	5.84	5.50	2.51	132	4.90	5.88	5.54	2.54
7	4.80	5.78	5.45	2.43	70	4.88	5.85	5.52	2.53	133	4.86	5.84	5.49	2.51
8	4.83	5.81	5.49	2.45	71	4.82	5.79	5.46	2.47	134	4.90	5.88	5.54	2.55
9	4.81	5.79	5.46	2.46	72	4.97	5.95	5.62	2.61	135	4.86	5.84	5.50	2.51
10	4.83	5.81	5.50	2.47	73	4.95	5.93	5.57	2.60	136	4.87	5.84	5.53	2.51
11	4.70	5.68	5.39	2.32	74	4.86	5.83	5.52	2.49	137	4.90	5.87	5.57	2.54
12	4.84	5.82	5.48	2.47	75	4.89	5.87	5.51	2.53	138	4.91	5.88	5.57	2.56
13	4.88	5.86	5.54	2.53	76	4.94	5.91	5.58	2.58	139	4.86	5.84	5.52	2.50
14	4.87	5.84	5.52	2.51	77	4.88	5.85	5.52	2.53	140	4.87	5.85	5.52	2.51
15	4.85	5.82	5.51	2.49	78	4.87	5.85	5.53	2.51	141	4.90	5.88	5.55	2.54
16	4.76	5.74	5.44	2.40	79	4.85	5.83	5.48	2.50	142	4.92	5.89	5.54	2.57
17	4.85	5.82	5.52	2.49	80	4.82	5.80	5.45	2.45	143	4.73	5.70	5.37	2.37
18	4.89	5.86	5.55	2.52	81	4.89	5.86	5.52	2.54	144	4.89	5.86	5.54	2.55
19	4.82	5.80	5.49	2.46	82	4.87	5.86	5.51	2.50	145	4.88	5.86	5.53	2.53
20	4.84	5.82	5.50	2.48	83	4.93	5.91	5.56	2.57	146	4.87	5.85	5.49	2.52
21	4.79	5.76	5.45	2.43	84	4.83	5.81	5.48	2.47	147	4.89	5.86	5.53	2.54
22	4.84	5.82	5.51	2.48	85	4.89	5.86	5.57	2.53	148	4.87	5.85	5.51	2.52
23	4.84	5.81	5.50	2.48	86	4.93	5.90	5.58	2.59	149	4.90	5.88	5.55	2.55
24	4.76	5.74	5.42	2.40	87	4.90	5.87	5.54	2.56	150	4.92	5.89	5.58	2.57
25	4.78	5.75	5.42	2.42	88	4.91	5.88	5.58	2.55	151	4.89	5.87	5.55	2.54
26	4.82	5.80	5.47	2.47	89	4.91	5.88	5.56	2.56	152	4.85	5.83	5.48	2.51
27	4.84	5.82	5.50	2.48	90	4.89	5.86	5.53	2.54	153	4.86	5.83	5.50	2.51
28	4.83	5.80	5.51	2.47	91	4.96	5.94	5.62	2.61	154	4.91	5.89	5.54	2.55
29	4.82	5.80	5.51	2.44	92	4.94	5.92	5.58	2.59	155	4.93	5.91	5.56	2.57
30	4.90	5.87	5.54	2.54	93	4.91	5.88	5.56	2.56	156	4.92	5.89	5.55	2.58
31	4.86	5.83	5.50	2.51	94	4.87	5.84	5.50	2.53	157	4.93	5.90	5.57	2.59
32	4.86	5.83	5.53	2.51	95	4.82	5.80	5.46	2.47	158	4.94	5.92	5.56	2.60
33	4.91	5.88	5.57	2.57	96	4.92	5.90	5.57	2.57	159	4.92	5.89	5.56	2.57
34	5.01	5.98	5.66	2.65	97	4.90	5.87	5.55	2.55	160	4.90	5.87	5.54	2.56
35	4.95	5.92	5.58	2.61	98	4.81	5.79	5.43	2.46	161	4.86	5.84	5.49	2.52
36	4.94	5.91	5.58	2.59	99	4.84	5.81	5.49	2.48	162	4.90	5.88	5.55	2.55
37	4.95	5.93	5.58	2.58	100	4.82	5.79	5.48	2.46	163	4.90	5.88	5.54	2.55
38	4.97	5.94	5.63	2.63	101	4.94	5.92	5.60	2.59	164	4.87	5.85	5.51	2.52
39	4.94	5.91	5.61	2.59	102	4.86	5.84	5.50	2.50	165	4.95	5.93	5.59	2.60
40	4.94	5.91	5.58	2.59	103	4.89	5.87	5.52	2.54	166	4.84	5.81	5.48	2.50
41	4.89	5.87	5.53	2.54	104	4.82	5.80	5.47	2.45	167	4.88	5.86	5.52	2.53
42	4.93	5.90	5.59	2.58	105	4.88	5.86	5.50	2.52	168	4.86	5.84	5.50	2.50
43	4.90	5.87	5.56	2.55	106	4.86	5.84	5.50	2.49	169	4.87	5.86	5.50	2.51
44	4.85	5.82	5.50	2.49	107	4.87	5.85	5.51	2.52	170	4.83	5.81	5.48	2.46
45	4.86	5.84	5.51	2.51	108	4.92	5.90	5.55	2.56	171	4.91	5.89	5.55	2.56
46	4.90	5.87	5.54	2.55	109	4.84	5.82	5.47	2.49	172	4.80	5.78	5.46	2.45
47	4.91	5.88	5.59	2.56	110	4.90	5.87	5.53	2.55	173	4.93	5.90	5.57	2.58
48	4.86	5.83	5.52	2.51	111	4.82	5.79	5.45	2.46	174	4.83	5.81	5.47	2.47
49	4.91	5.89	5.57	2.55	112	4.88	5.86	5.51	2.53	175	4.91	5.89	5.56	2.56
50	4.84	5.82	5.48	2.49	113	4.91	5.88	5.56	2.57	176	4.87	5.85	5.53	2.50
51	4.92	5.90	5.55	2.55	114	4.92	5.90	5.56	2.56	177	4.88	5.86	5.53	2.51
52	4.83	5.81	5.49	2.46	115	4.86	5.83	5.51	2.51	178	4.80	5.77	5.44	2.44
53	4.90	5.87	5.55	2.55	116	4.88	5.86	5.52	2.53	179	4.89	5.86	5.53	2.53
54	4.95	5.93	5.62	2.61	117	4.88	5.86	5.52	2.51	180	4.90	5.87	5.56	2.54
55	4.87	5.84	5.54	2.51	118	4.89	5.86	5.53	2.54	181	4.87	5.85	5.52	2.52
56	4.88	5.86	5.53	2.53	119	4.85	5.83	5.50	2.49	182	4.89	5.86	5.55	2.52
57	4.88	5.86	5.52	2.52	120	4.90	5.87	5.56	2.55	Average	4.87	5.85	5.52	2.52
58	4.90	5.88	5.53	2.54	121	4.95	5.92	5.59	2.59					
59	4.83	5.81	5.48	2.47	122	4.89	5.87	5.55	2.54					
60	4.90	5.87	5.57	2.54	123	4.91	5.89	5.55	2.55					
61	4.90	5.87	5.54	2.55	124	4.95	5.93	5.59	2.60					
62	4.88	5.86	5.52	2.53	125	4.87	5.85	5.53	2.51					

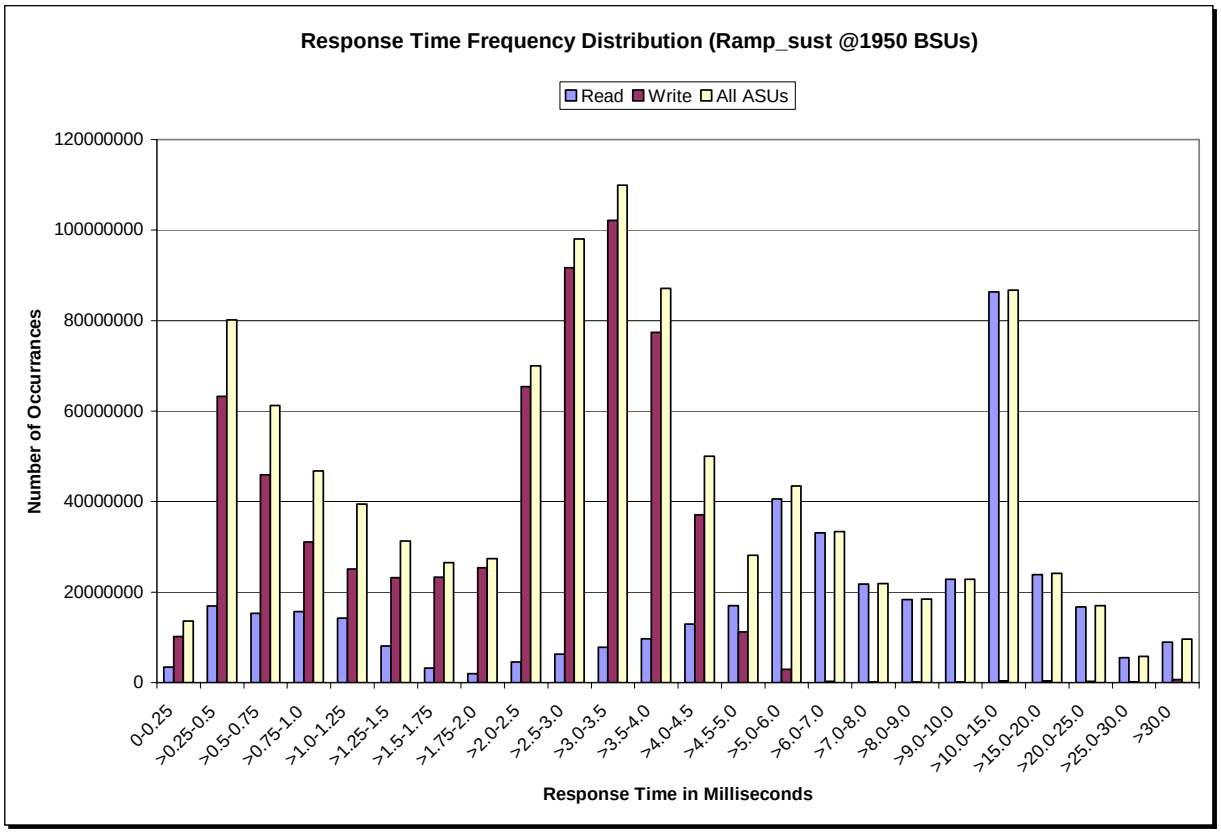
Sustainability – Average Response Time (ms) Distribution Graph



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	3,417,220	16,929,433	15,293,638	15,717,782	14,304,045	8,064,177	3,252,084	1,994,800
Write	10,208,595	63,256,347	45,928,730	31,089,837	25,113,148	23,212,357	23,283,087	25,418,459
All ASUs	13,625,815	80,185,780	61,222,368	46,807,619	39,417,193	31,276,534	26,535,171	27,413,259
ASU1	7,904,951	41,619,275	31,147,366	25,241,120	21,798,786	16,171,570	12,457,716	12,426,678
ASU2	1,997,736	10,819,734	8,162,415	6,721,035	5,836,668	4,326,073	3,326,555	3,306,031
ASU3	3,723,128	27,746,771	21,912,587	14,845,464	11,781,739	10,778,891	10,750,900	11,680,550
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	4,595,680	6,303,258	7,786,345	9,692,574	12,928,944	16,974,578	40,580,085	33,085,357
Write	65,424,833	91,698,345	102,161,799	77,398,402	37,079,424	11,182,434	2,910,752	254,018
All ASUs	70,020,513	98,001,603	109,948,144	87,090,976	50,008,368	28,157,012	43,490,837	33,339,375
ASU1	31,705,058	44,593,741	50,697,887	41,976,591	27,579,027	20,073,618	37,631,984	29,349,668
ASU2	8,339,424	11,340,468	11,988,243	8,786,820	4,633,572	2,512,813	4,283,297	3,816,381
ASU3	29,976,031	42,067,394	47,262,014	36,327,565	17,795,769	5,570,581	1,575,556	173,326
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	21,781,138	18,366,072	22,794,689	86,347,571	23,832,583	16,738,205	5,553,555	8,932,529
Write	118,850	66,633	50,066	372,773	359,594	264,491	230,549	684,471
All ASUs	21,899,988	18,432,705	22,844,755	86,720,344	24,192,177	17,002,696	5,784,104	9,617,000
ASU1	19,209,222	16,245,906	20,110,379	75,025,739	20,098,559	13,720,133	4,392,887	6,412,017
ASU2	2,599,107	2,133,568	2,694,777	11,378,770	3,765,152	3,036,861	1,172,911	2,550,798
ASU3	91,659	53,231	39,599	315,835	328,466	245,702	218,306	654,185

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 5.1.10 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	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.002	0.001	0.002	0.001	0.003	0.001	0.002	0.001

Primary Metrics Test – IOPS Test Phase

Clause 5.4.4.2

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 9.4.3.7.2

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 108.

IOPS Test Results File

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

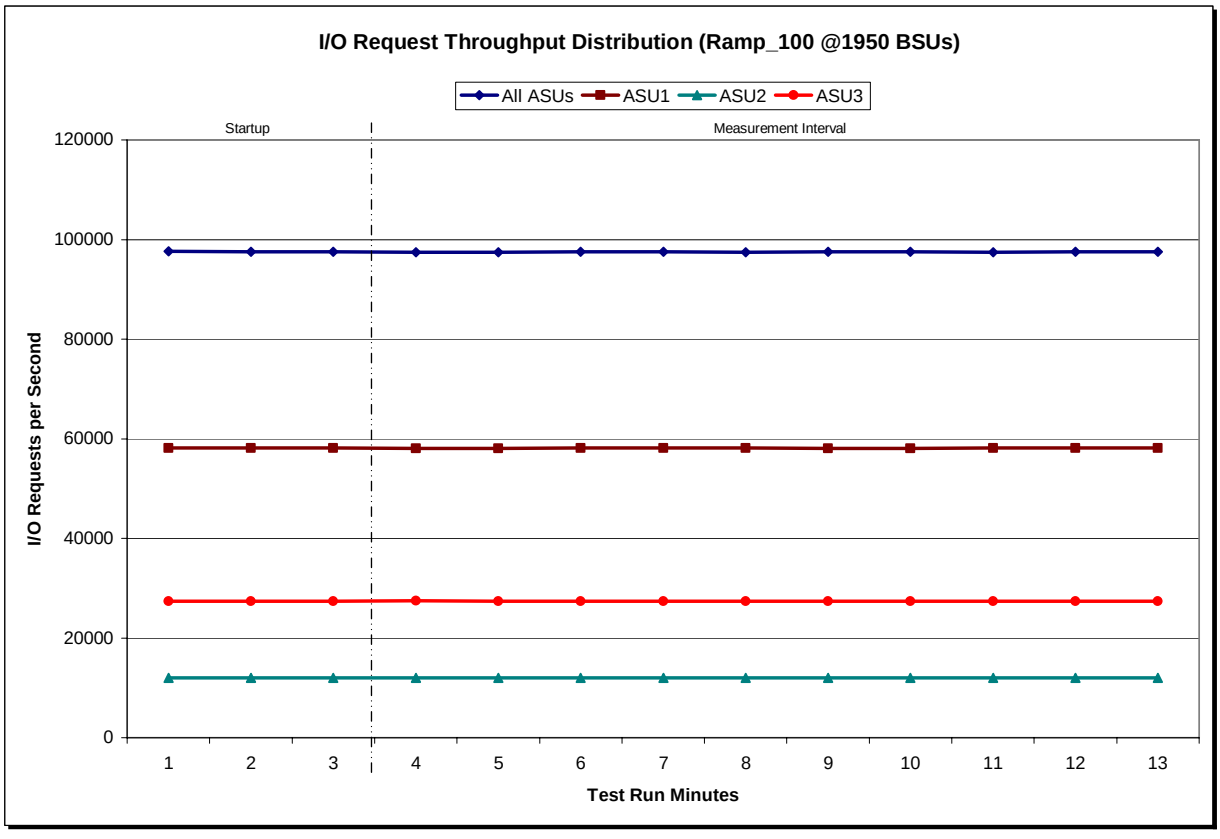
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

1950 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:43:45	19:46:46	0-2	0:03:01
Measurement Interval	19:46:46	19:56:46	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	97,615.52	58,178.67	12,015.50	27,421.35
1	97,528.33	58,139.17	11,992.72	27,396.45
2	97,527.10	58,115.47	12,006.05	27,405.58
3	97,460.20	58,049.42	11,977.85	27,432.93
4	97,451.42	58,083.88	11,999.60	27,367.93
5	97,502.08	58,119.42	12,003.00	27,379.67
6	97,531.60	58,128.58	11,997.82	27,405.20
7	97,483.92	58,115.58	11,978.57	27,389.77
8	97,499.63	58,082.07	11,989.88	27,427.68
9	97,500.42	58,093.45	12,010.17	27,396.80
10	97,480.97	58,105.43	11,979.33	27,396.20
11	97,507.32	58,107.65	11,994.90	27,404.77
12	97,564.98	58,136.78	12,019.83	27,408.37
Average	***97,498.25***	***58,102.23***	***11,995.10***	***27,400.93***

IOPS Test Run – I/O Request Throughput Distribution Graph

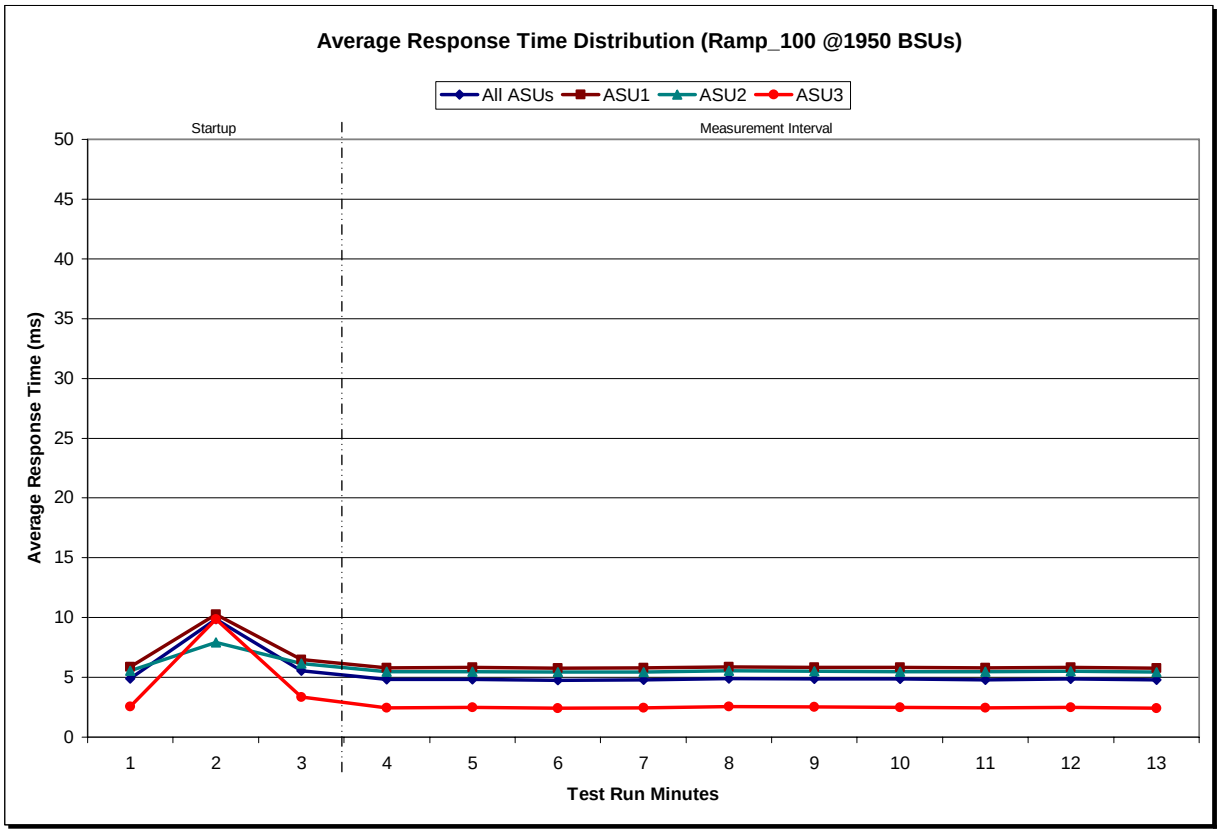


IOPS Test Run – Average Response Time (ms) Distribution Data

1950 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:43:45	19:46:46	0-2	0:03:01
Measurement Interval	19:46:46	19:56:46	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	4.91	5.88	5.55	2.57
1	9.86	10.26	7.92	9.85
2	5.56	6.49	6.14	3.34
3	4.82	5.80	5.46	2.46
4	4.84	5.82	5.48	2.49
5	4.77	5.75	5.42	2.40
6	4.80	5.78	5.44	2.44
7	4.90	5.88	5.56	2.54
8	4.87	5.84	5.52	2.52
9	4.86	5.84	5.49	2.50
10	4.81	5.78	5.46	2.45
11	4.84	5.82	5.50	2.48
12	4.77	5.75	5.43	2.41
Average	***4.83***	***5.81***	***5.47***	***2.47***

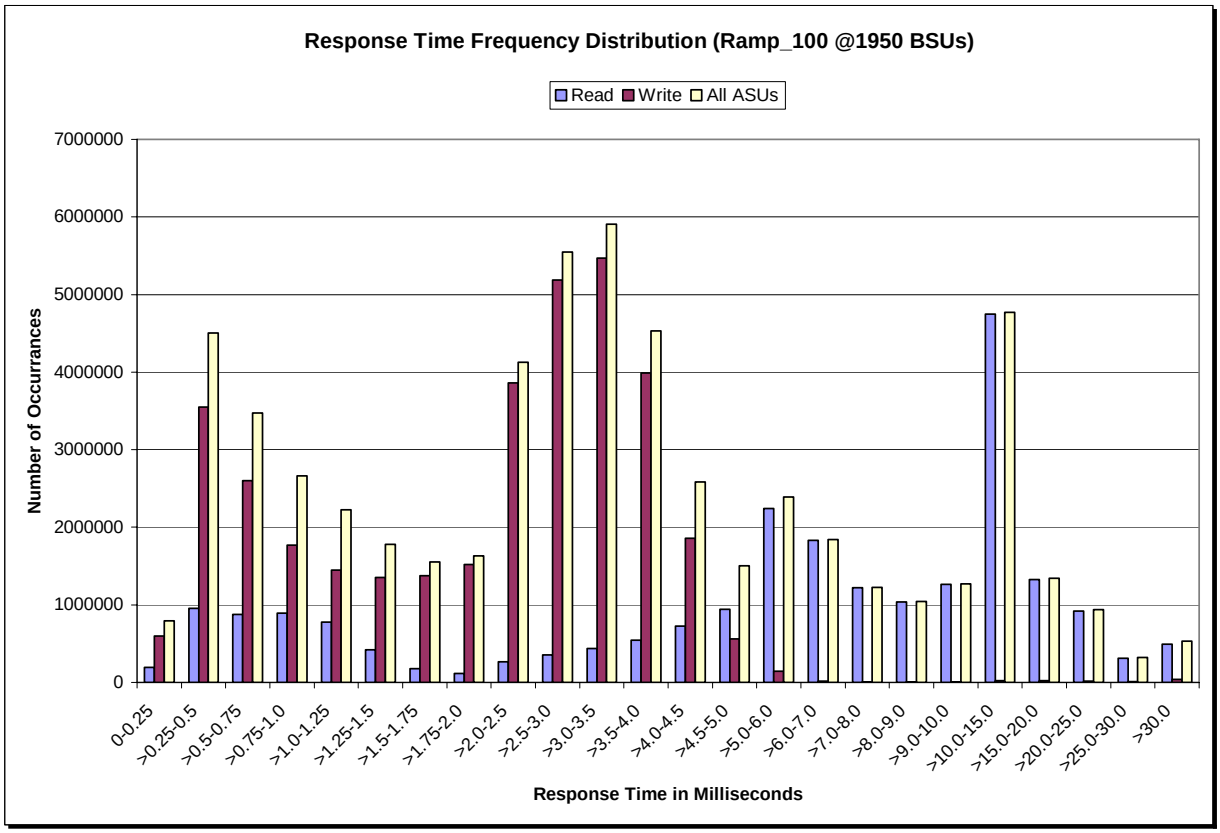
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	193,330	952,452	873,634	894,493	776,751	422,732	175,870	114,500
Write	598,915	3,552,419	2,600,313	1,769,483	1,446,935	1,355,028	1,378,134	1,517,291
All ASUs	792,245	4,504,871	3,473,947	2,663,976	2,223,686	1,777,760	1,554,004	1,631,791
ASU1	457,557	2,334,803	1,770,128	1,436,873	1,218,689	905,635	724,857	738,902
ASU2	116,018	611,079	465,679	383,463	327,162	242,558	193,336	196,404
ASU3	218,670	1,558,989	1,238,140	843,640	677,835	629,567	635,811	696,485
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	266,778	357,727	437,497	543,964	726,042	944,119	2,243,148	1,828,577
Write	3,861,151	5,187,417	5,471,477	3,987,493	1,857,574	560,541	144,939	14,173
All ASUs	4,127,929	5,545,144	5,908,974	4,531,457	2,583,616	1,504,660	2,388,087	1,842,750
ASU1	1,868,422	2,525,165	2,734,372	2,202,398	1,450,552	1,090,044	2,072,962	1,621,645
ASU2	489,932	635,146	637,742	452,792	238,106	134,259	235,668	211,188
ASU3	1,769,575	2,384,833	2,536,860	1,876,267	894,958	280,357	79,457	9,917
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	1,220,951	1,037,180	1,266,925	4,746,542	1,324,248	922,845	309,991	494,513
Write	6,723	3,815	2,882	20,965	19,861	14,852	12,892	38,333
All ASUs	1,227,674	1,040,995	1,269,807	4,767,507	1,344,109	937,697	322,883	532,846
ASU1	1,076,607	917,446	1,116,905	4,124,462	1,116,448	756,757	245,047	354,276
ASU2	145,874	120,540	150,629	625,223	209,529	167,095	65,654	141,911
ASU3	5,193	3,009	2,273	17,822	18,132	13,845	12,182	36,659

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
58,498,415	57,965,569	532,846

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 5.1.10 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	0.2810
COV	0.002	0.001	0.001	0.001	0.002	0.001	0.002	0.001

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.4.3

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 13.

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 9.4.3.7.3

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 108.

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 - 1950 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:43:45	19:46:46	0-2	0:03:01
Measurement Interval	19:46:46	19:56:46	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	97,615.52	58,178.67	12,015.50	27,421.35
1	97,528.33	58,139.17	11,992.72	27,396.45
2	97,527.10	58,115.47	12,006.05	27,405.58
3	97,460.20	58,049.42	11,977.85	27,432.93
4	97,451.42	58,083.88	11,999.60	27,367.93
5	97,502.08	58,119.42	12,003.00	27,379.67
6	97,531.60	58,128.58	11,997.82	27,405.20
7	97,483.92	58,115.58	11,978.57	27,389.77
8	97,499.63	58,082.07	11,989.88	27,427.68
9	97,500.42	58,093.45	12,010.17	27,396.80
10	97,480.97	58,105.43	11,979.33	27,396.20
11	97,507.32	58,107.65	11,994.90	27,404.77
12	97,564.98	58,136.78	12,019.83	27,408.37
Average	97,498.25	58,102.23	11,995.10	27,400.93

95% Load Level - 1852 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	19:57:21	20:00:22	0-2	0:03:01
Measurement Interval	20:00:22	20:10:22	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	92,710.20	55,293.00	11,402.42	26,014.78
1	92,618.18	55,205.22	11,427.02	25,985.95
2	92,624.37	55,198.35	11,389.82	26,036.20
3	92,616.18	55,213.93	11,396.25	26,006.00
4	92,553.67	55,155.27	11,391.20	26,007.20
5	92,535.17	55,174.03	11,369.77	25,991.37
6	92,561.97	55,167.63	11,393.98	26,000.35
7	92,591.42	55,192.92	11,399.50	25,999.00
8	92,585.40	55,182.37	11,378.37	26,024.67
9	92,607.18	55,182.17	11,408.47	26,016.55
10	92,599.35	55,195.75	11,383.52	26,020.08
11	92,477.60	55,102.12	11,361.73	26,013.75
12	92,660.67	55,226.28	11,382.13	26,052.25
Average	92,578.86	55,179.25	11,386.49	26,013.12

90% Load Level - 1755 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:10:58	20:13:59	0-2	0:03:01
Measurement Interval	20:13:59	20:24:00	3-12	0:10:01

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	87,841.80	52,357.37	10,817.50	24,666.93
1	87,734.08	52,301.13	10,769.55	24,663.40
2	87,729.40	52,270.72	10,814.73	24,643.95
3	87,697.25	52,248.78	10,807.30	24,641.17
4	87,707.10	52,271.42	10,804.57	24,631.12
5	87,774.60	52,304.28	10,783.10	24,687.22
6	87,730.72	52,299.27	10,806.42	24,625.03
7	87,774.70	52,320.15	10,807.85	24,646.70
8	87,709.00	52,268.02	10,786.02	24,654.97
9	87,745.88	52,320.27	10,780.85	24,644.77
10	87,717.17	52,282.33	10,787.70	24,647.13
11	87,826.95	52,345.33	10,794.40	24,687.22
12	87,684.57	52,247.85	10,795.77	24,640.95
Average	87,736.79	52,290.77	10,795.40	24,650.63

80% Load Level - 1560 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:24:35	20:27:36	0-2	0:03:01
Measurement Interval	20:27:36	20:37:36	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	77,987.83	46,494.43	9,593.03	21,900.37
1	77,972.03	46,489.88	9,579.22	21,902.93
2	77,986.60	46,463.12	9,575.72	21,947.77
3	78,013.32	46,491.62	9,580.55	21,941.15
4	78,053.72	46,513.45	9,615.38	21,924.88
5	78,036.98	46,515.35	9,601.52	21,920.12
6	78,045.25	46,491.60	9,584.02	21,969.63
7	78,075.95	46,530.38	9,598.47	21,947.10
8	77,982.35	46,465.42	9,605.97	21,910.97
9	77,961.60	46,514.07	9,557.72	21,889.82
10	78,013.05	46,483.65	9,605.00	21,924.40
11	77,944.53	46,454.08	9,580.38	21,910.07
12	77,967.17	46,470.60	9,585.68	21,910.88
Average	78,009.39	46,493.02	9,591.47	21,924.90

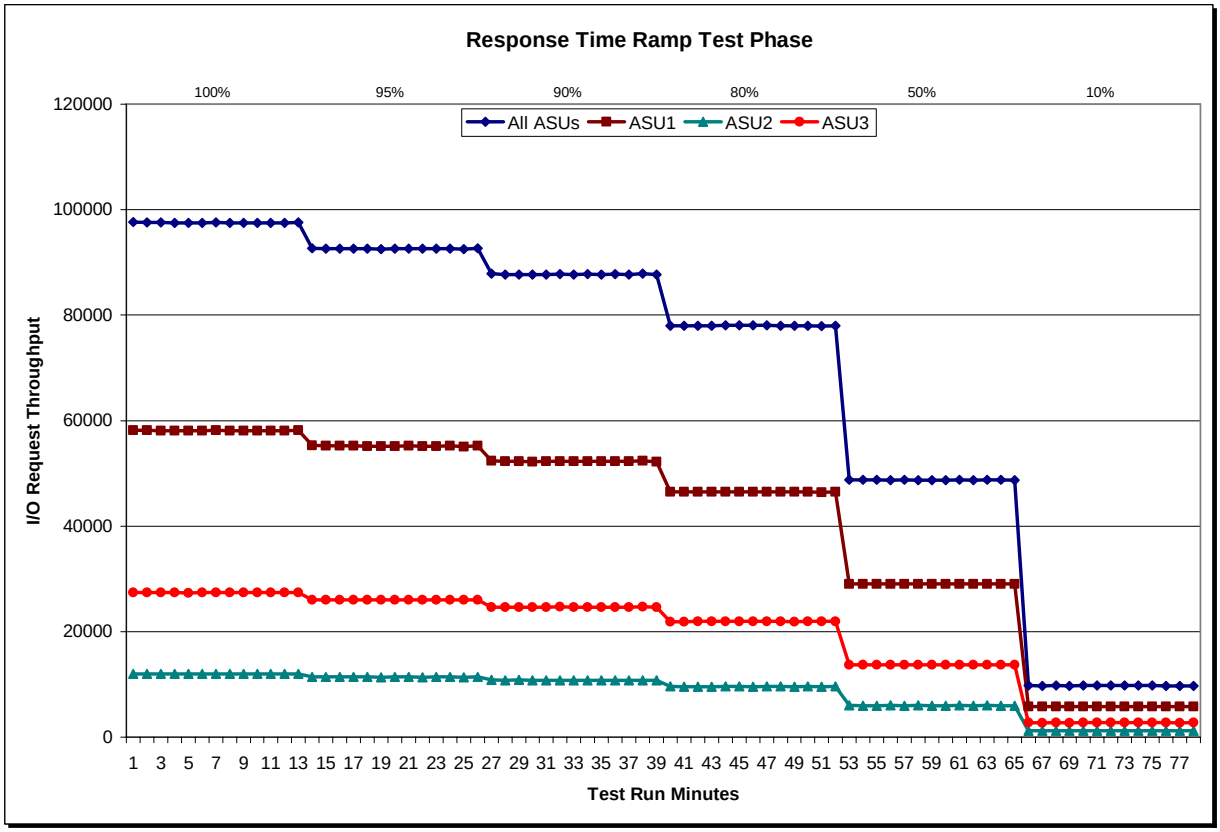
50% Load Level - 975 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:38:10	20:41:11	0-2	0:03:01
Measurement Interval	20:41:11	20:51:11	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	48,798.78	29,079.68	6,012.67	13,706.43
1	48,759.58	29,052.18	5,991.55	13,715.85
2	48,756.87	29,062.70	5,989.97	13,704.20
3	48,729.70	29,039.25	5,999.00	13,691.45
4	48,750.02	29,067.63	5,980.97	13,701.42
5	48,738.83	29,024.83	6,013.13	13,700.87
6	48,738.42	29,045.27	5,984.47	13,708.68
7	48,734.53	29,042.15	5,990.78	13,701.60
8	48,780.38	29,081.23	6,001.05	13,698.10
9	48,710.22	29,038.17	5,994.53	13,677.52
10	48,752.37	29,063.65	5,997.93	13,690.78
11	48,769.17	29,073.13	5,986.05	13,709.98
12	48,723.53	29,035.23	5,987.10	13,701.20
Average	48,742.72	29,051.06	5,993.50	13,698.16

10% Load Level - 195 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:51:41	20:54:42	0-2	0:03:01
Measurement Interval	20:54:42	21:04:42	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	9,753.17	5,812.50	1,196.23	2,744.43
1	9,721.70	5,797.42	1,192.05	2,732.23
2	9,763.92	5,823.43	1,199.55	2,740.93
3	9,745.42	5,814.45	1,200.27	2,730.70
4	9,752.80	5,808.17	1,194.25	2,750.38
5	9,748.88	5,804.27	1,200.85	2,743.77
6	9,750.53	5,807.97	1,207.22	2,735.35
7	9,770.50	5,826.37	1,206.90	2,737.23
8	9,760.70	5,826.07	1,195.00	2,739.63
9	9,758.57	5,813.10	1,200.90	2,744.57
10	9,744.18	5,806.65	1,198.27	2,739.27
11	9,719.42	5,794.25	1,199.03	2,726.13
12	9,746.37	5,798.07	1,199.25	2,749.05
Average	9,749.74	5,809.94	1,200.19	2,739.61

Response Time Ramp Distribution (IOPS) Graph

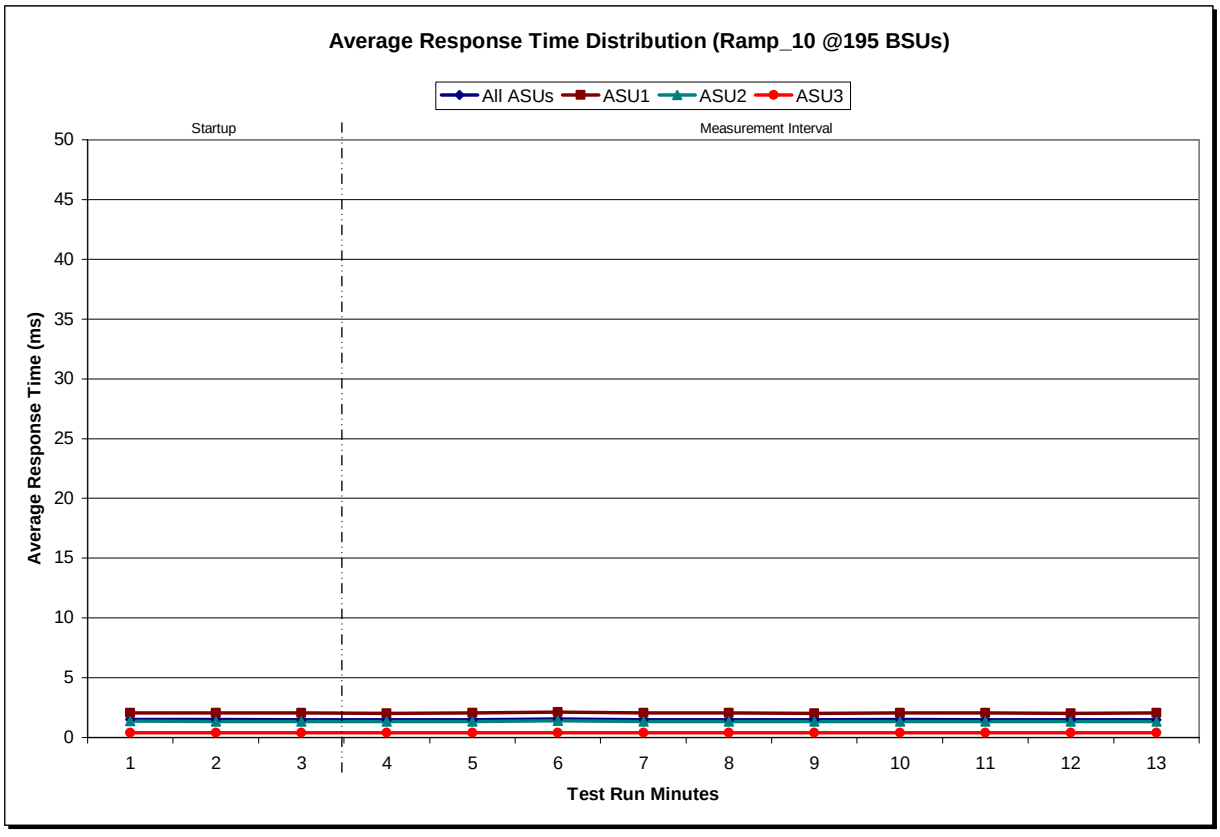


SPC-1 LRT™ Average Response Time (ms) Distribution Data

195 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	20:51:41	20:54:42	0-2	0:03:01
Measurement Interval	20:54:42	21:04:42	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	1.50	2.04	1.37	0.39
1	1.50	2.05	1.34	0.39
2	1.49	2.04	1.34	0.39
3	1.49	2.03	1.34	0.39
4	1.49	2.04	1.34	0.40
5	1.55	2.13	1.39	0.39
6	1.49	2.04	1.33	0.40
7	1.49	2.04	1.34	0.40
8	1.48	2.03	1.32	0.40
9	1.50	2.06	1.33	0.40
10	1.49	2.03	1.33	0.40
11	1.49	2.03	1.35	0.39
12	1.49	2.05	1.34	0.40
Average	***1.50***	***2.05***	***1.34***	***0.40***

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 5.1.10 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	0.2100	0.0180	0.0699	0.0351	0.2810
COV	0.006	0.002	0.004	0.002	0.007	0.006	0.006	0.002

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% or less than the SPC-1 LRT™ metric plus one (1) millisecond (ms).

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 9.4.3.7.4

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 108.

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	***97,498.25***
Repeatability Test Phase 1	97,504.12
Repeatability Test Phase 2	97,486.52

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	***1.50 ms***
Repeatability Test Phase 1	1.49 ms
Repeatability Test Phase 2	1.51 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 or less than the reported SPC-1 LRT™ Primary Metric minus one (1) millisecond (ms)..

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

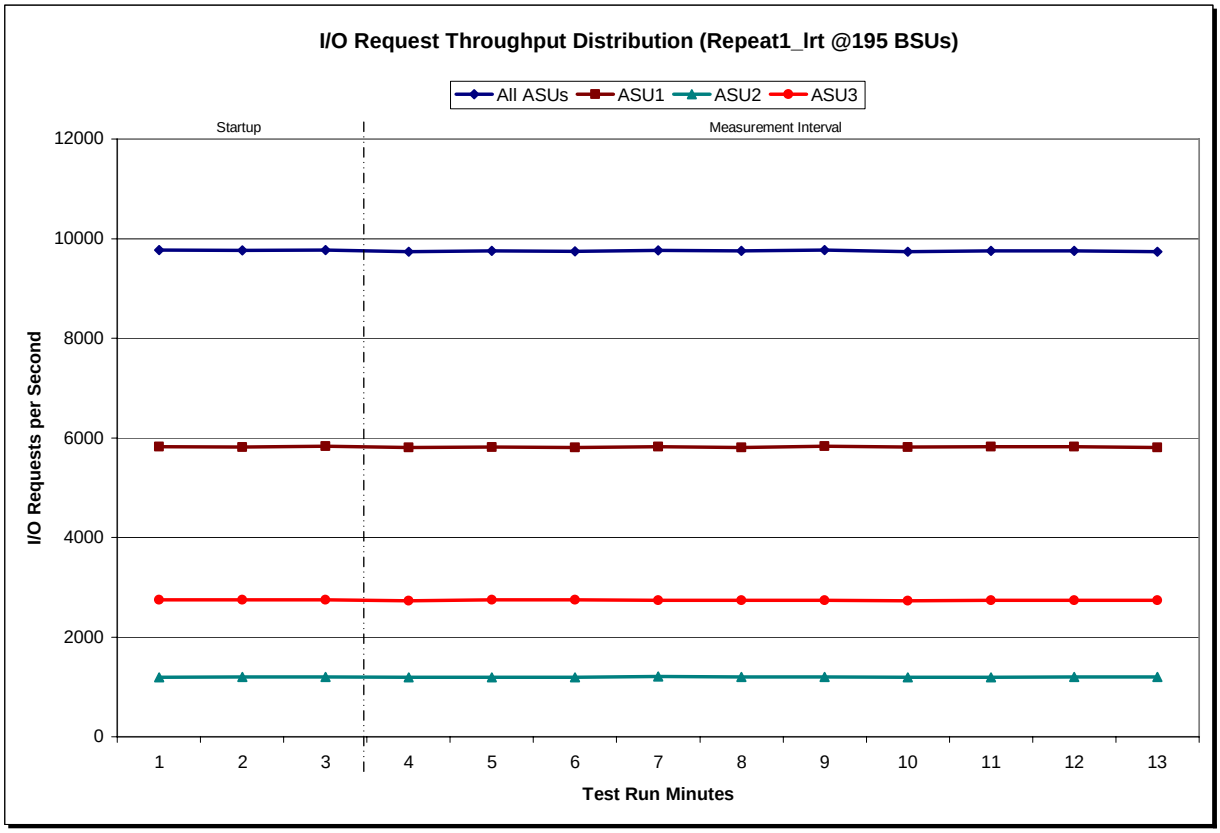
Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

195 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:05:48	21:08:48	0-2	0:03:00
Measurement Interval	21:08:48	21:18:48	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	9,767.50	5,824.42	1,195.38	2,747.70
1	9,761.10	5,813.63	1,202.03	2,745.43
2	9,775.10	5,832.10	1,197.20	2,745.80
3	9,734.35	5,806.02	1,194.87	2,733.47
4	9,753.93	5,815.25	1,195.60	2,743.08
5	9,741.60	5,802.02	1,194.95	2,744.63
6	9,763.23	5,819.42	1,207.75	2,736.07
7	9,756.15	5,809.45	1,204.25	2,742.45
8	9,767.73	5,831.58	1,200.72	2,735.43
9	9,737.10	5,812.82	1,189.97	2,734.32
10	9,752.15	5,818.72	1,194.23	2,739.20
11	9,757.80	5,819.57	1,198.58	2,739.65
12	9,739.50	5,802.43	1,199.47	2,737.60
Average	***9,750.36***	***5,813.73***	***1,198.04***	***2,738.59***

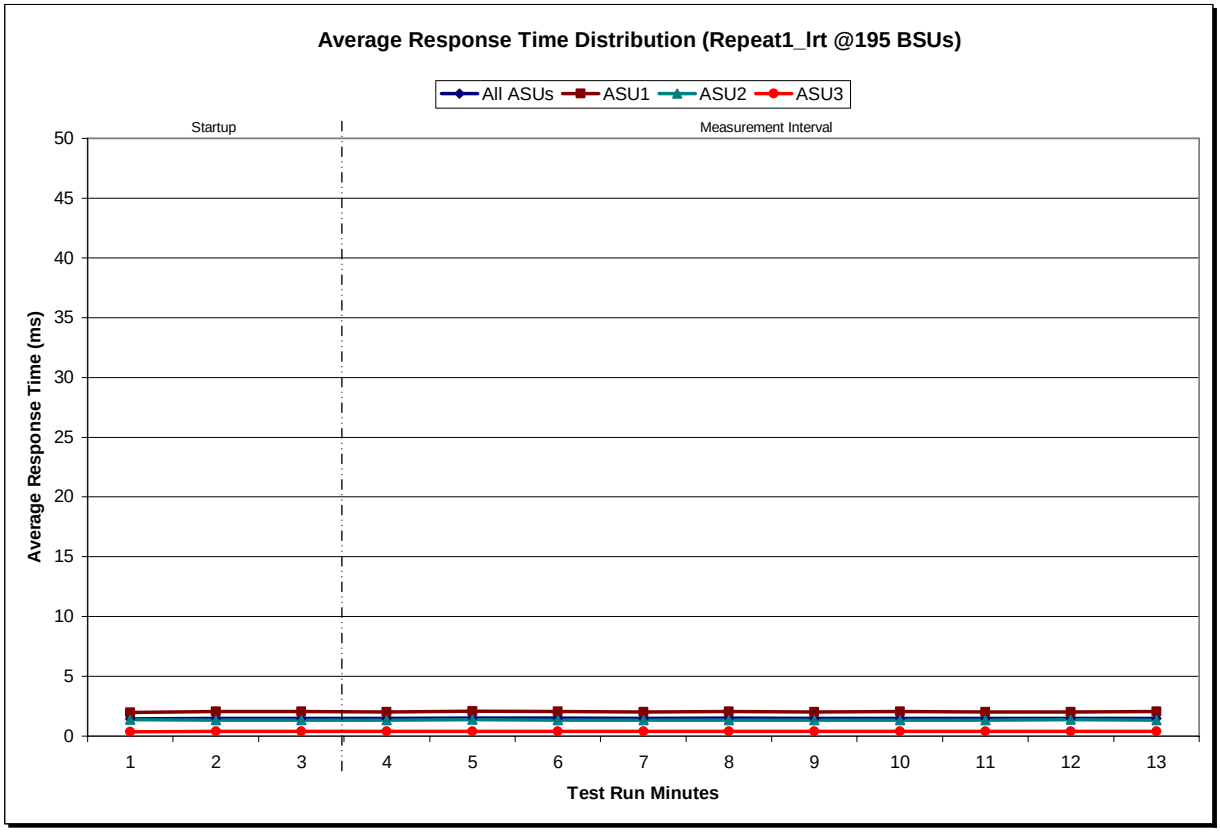
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

195 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:05:48	21:08:48	0-2	0:03:00
Measurement Interval	21:08:48	21:18:48	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.44	1.97	1.35	0.38
1	1.49	2.04	1.34	0.39
2	1.49	2.04	1.34	0.40
3	1.48	2.03	1.34	0.40
4	1.53	2.09	1.37	0.39
5	1.50	2.05	1.33	0.39
6	1.48	2.03	1.33	0.39
7	1.49	2.05	1.32	0.39
8	1.49	2.03	1.32	0.39
9	1.49	2.04	1.34	0.39
10	1.48	2.03	1.34	0.39
11	1.49	2.03	1.35	0.39
12	1.49	2.04	1.33	0.39
Average	***1.49***	***2.04***	***1.34***	***0.39***

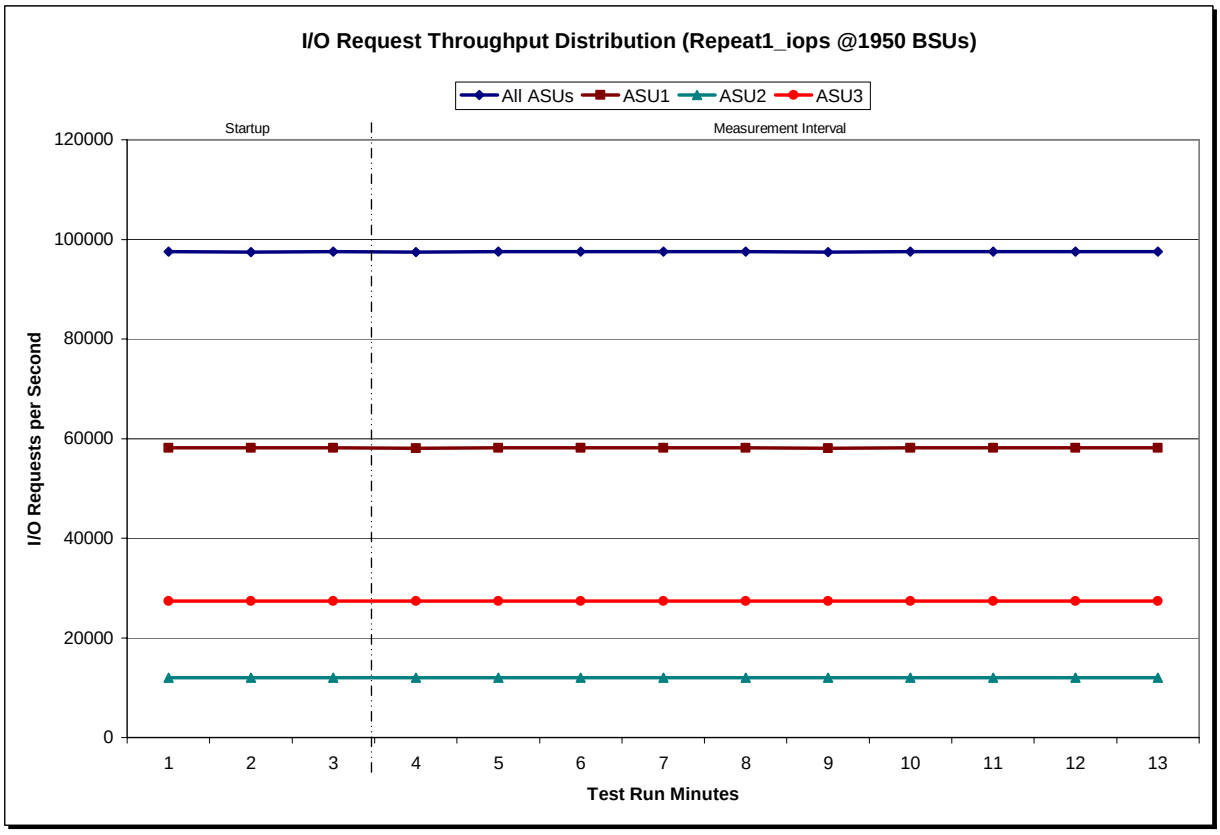
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

1950 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:19:28	21:22:29	0-2	0:03:01
Measurement Interval	21:22:29	21:32:29	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	97,573.17	58,118.30	12,033.73	27,421.13
1	97,476.50	58,105.25	11,968.78	27,402.47
2	97,511.25	58,109.13	11,986.28	27,415.83
3	97,430.55	58,061.02	12,007.80	27,361.73
4	97,535.70	58,147.53	11,985.47	27,402.70
5	97,526.70	58,141.67	11,973.08	27,411.95
6	97,500.80	58,104.88	11,994.52	27,401.40
7	97,499.13	58,134.73	11,980.05	27,384.35
8	97,423.03	58,057.70	11,995.82	27,369.52
9	97,510.67	58,122.27	11,999.42	27,388.98
10	97,561.92	58,154.23	11,990.87	27,416.82
11	97,545.85	58,135.77	11,988.42	27,421.67
12	97,506.83	58,099.83	11,990.23	27,416.77
Average	***97,504.12***	***58,115.96***	***11,990.57***	***27,397.59***

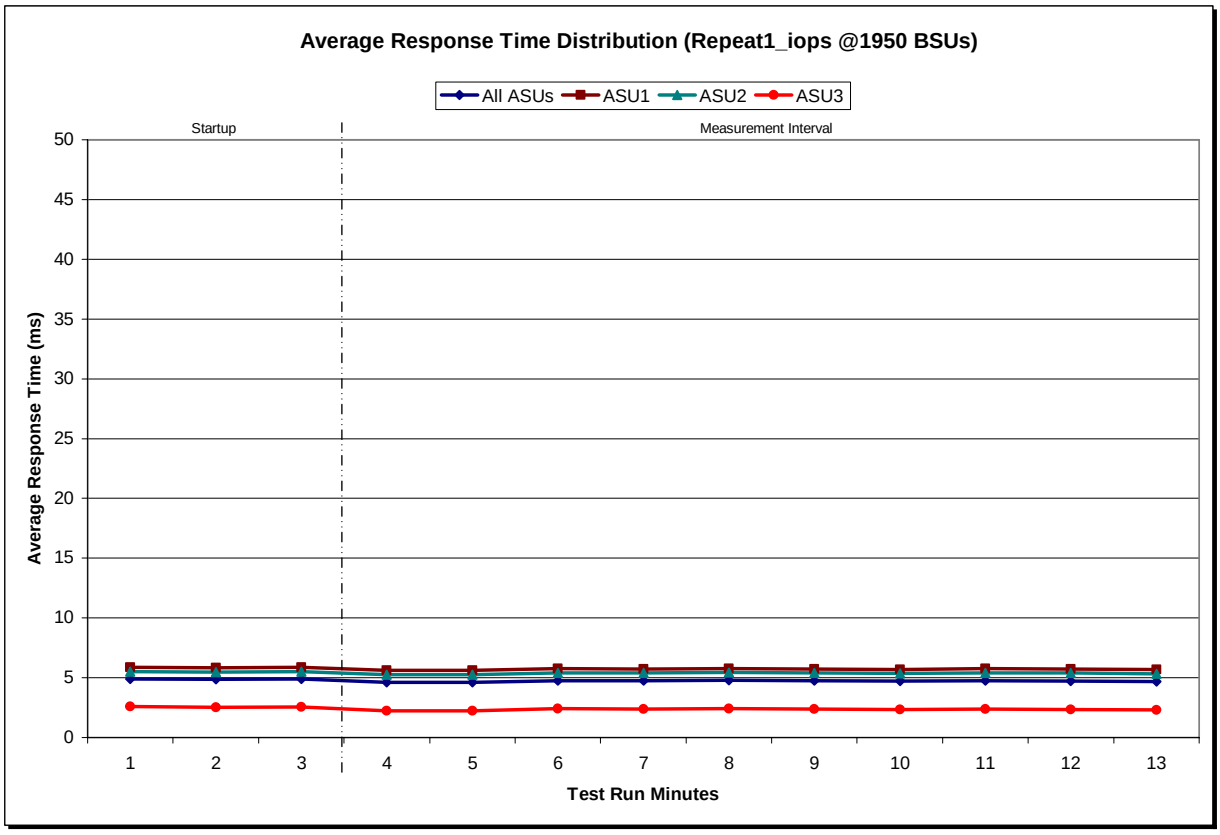
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

1950 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:19:28	21:22:29	0-2	0:03:01
Measurement Interval	21:22:29	21:32:29	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	4.91	5.88	5.52	2.58
1	4.85	5.83	5.48	2.51
2	4.90	5.88	5.51	2.55
3	4.62	5.61	5.25	2.24
4	4.62	5.61	5.27	2.25
5	4.77	5.75	5.42	2.40
6	4.74	5.73	5.39	2.37
7	4.79	5.77	5.42	2.42
8	4.74	5.72	5.40	2.37
9	4.71	5.69	5.35	2.35
10	4.77	5.76	5.41	2.39
11	4.72	5.71	5.40	2.34
12	4.68	5.67	5.32	2.31
Average	***4.72***	***5.70***	***5.36***	***2.34***

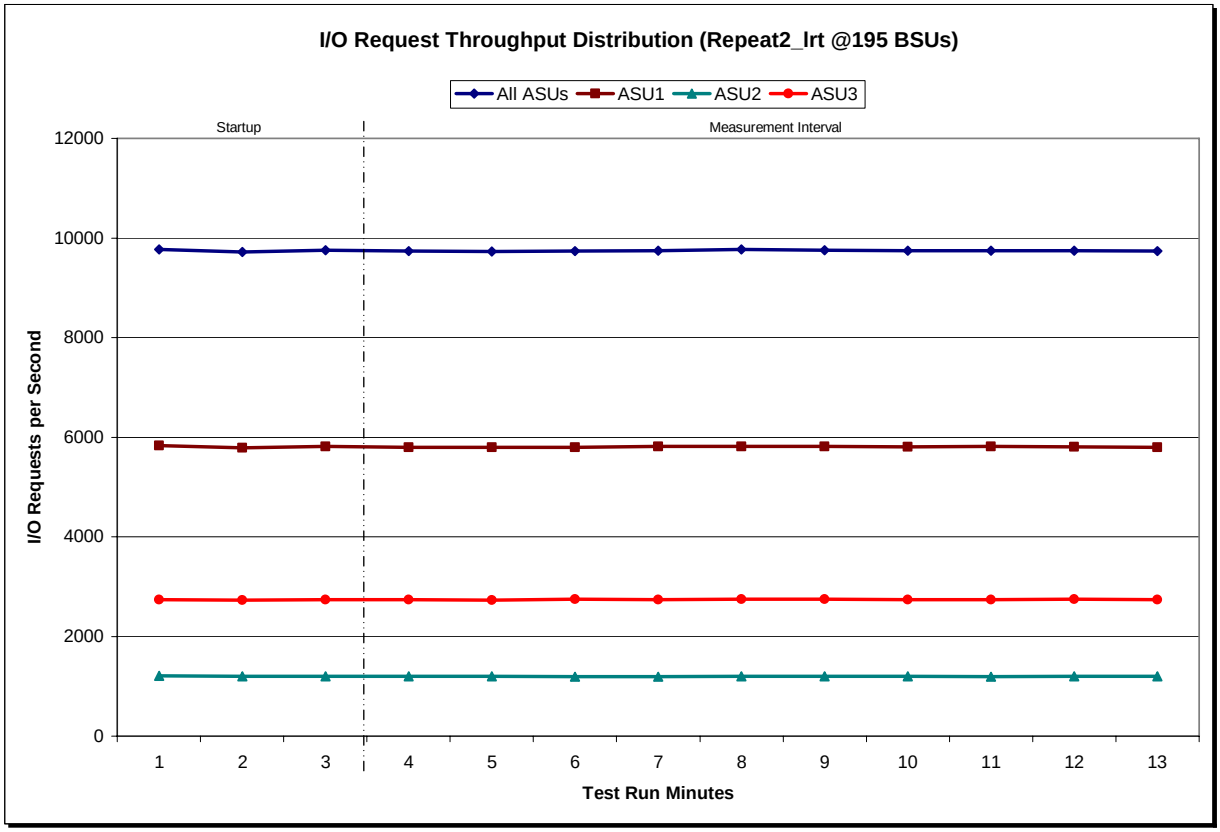
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

195 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:33:37	21:36:37	0-2	0:03:00
Measurement Interval	21:36:37	21:46:37	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	9,773.40	5,828.08	1,207.18	2,738.13
1	9,719.80	5,785.90	1,201.78	2,732.12
2	9,750.25	5,815.70	1,198.48	2,736.07
3	9,734.48	5,796.18	1,198.13	2,740.17
4	9,730.05	5,796.30	1,202.85	2,730.90
5	9,739.12	5,799.77	1,189.75	2,749.60
6	9,742.18	5,814.25	1,192.05	2,735.88
7	9,768.70	5,813.37	1,204.98	2,750.35
8	9,757.32	5,810.28	1,203.70	2,743.33
9	9,748.70	5,808.40	1,199.27	2,741.03
10	9,743.92	5,815.25	1,189.25	2,739.42
11	9,748.82	5,804.02	1,201.00	2,743.80
12	9,736.48	5,794.87	1,199.72	2,741.90
Average	***9,744.98***	***5,805.27***	***1,198.07***	***2,741.64***

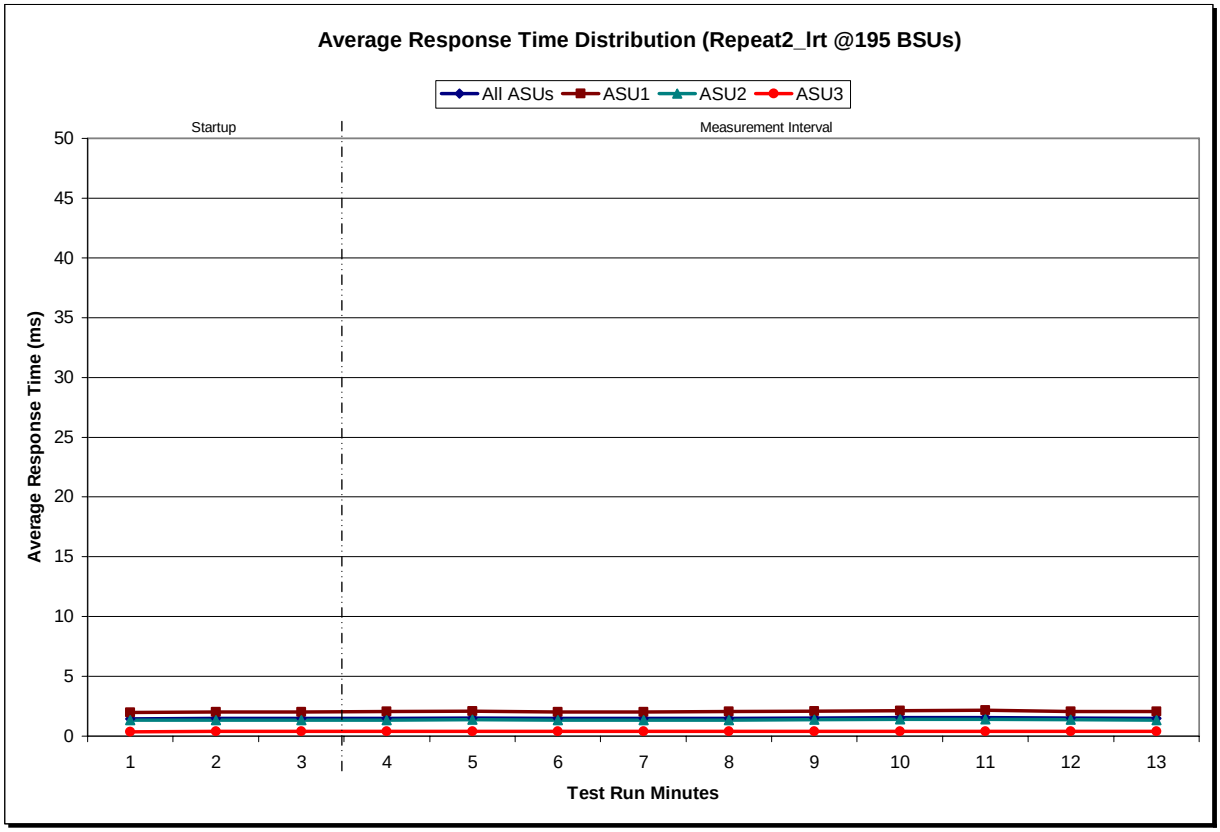
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

195 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:33:37	21:36:37	0-2	0:03:00
Measurement Interval	21:36:37	21:46:37	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.45	1.97	1.34	0.38
1	1.48	2.02	1.33	0.39
2	1.48	2.02	1.33	0.39
3	1.49	2.04	1.33	0.39
4	1.51	2.07	1.36	0.39
5	1.48	2.02	1.32	0.39
6	1.49	2.03	1.34	0.39
7	1.49	2.04	1.33	0.40
8	1.53	2.09	1.36	0.40
9	1.56	2.14	1.42	0.40
10	1.56	2.14	1.40	0.39
11	1.50	2.05	1.37	0.39
12	1.49	2.05	1.33	0.39
Average	***1.51***	***2.07***	***1.36***	***0.39***

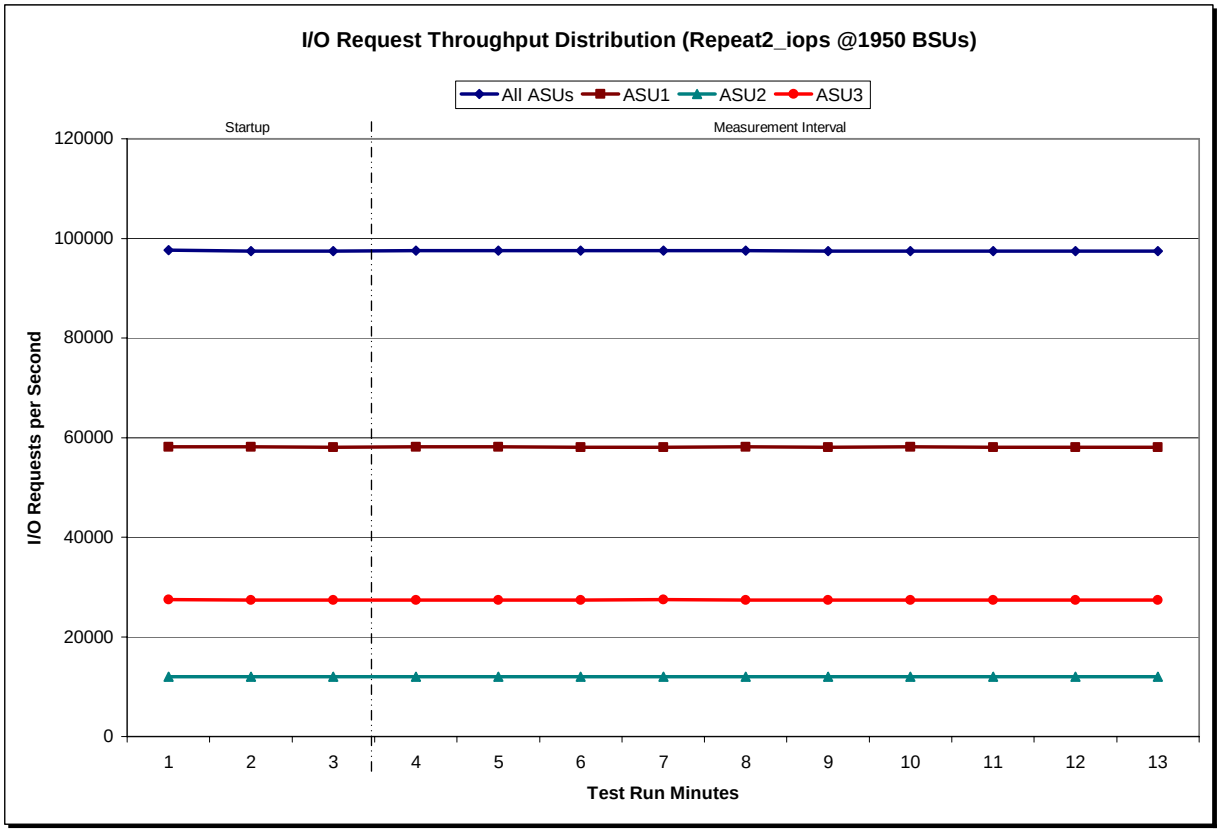
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

1950 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:47:17	21:50:18	0-2	0:03:01
Measurement Interval	21:50:18	22:00:18	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	97,650.97	58,167.40	12,027.72	27,455.85
1	97,485.92	58,110.15	11,999.27	27,376.50
2	97,461.68	58,098.05	11,985.63	27,378.00
3	97,522.27	58,128.53	12,003.62	27,390.12
4	97,549.72	58,143.75	12,004.92	27,401.05
5	97,511.90	58,097.72	12,004.02	27,410.17
6	97,501.07	58,077.27	11,976.62	27,447.18
7	97,545.30	58,157.72	11,981.25	27,406.33
8	97,438.68	58,060.50	11,984.67	27,393.52
9	97,476.87	58,112.05	11,984.23	27,380.58
10	97,430.18	58,050.83	11,985.07	27,394.28
11	97,448.75	58,093.55	11,974.68	27,380.52
12	97,440.45	58,055.70	11,984.52	27,400.23
Average	***97,486.52***	***58,097.76***	***11,988.36***	***27,400.40***

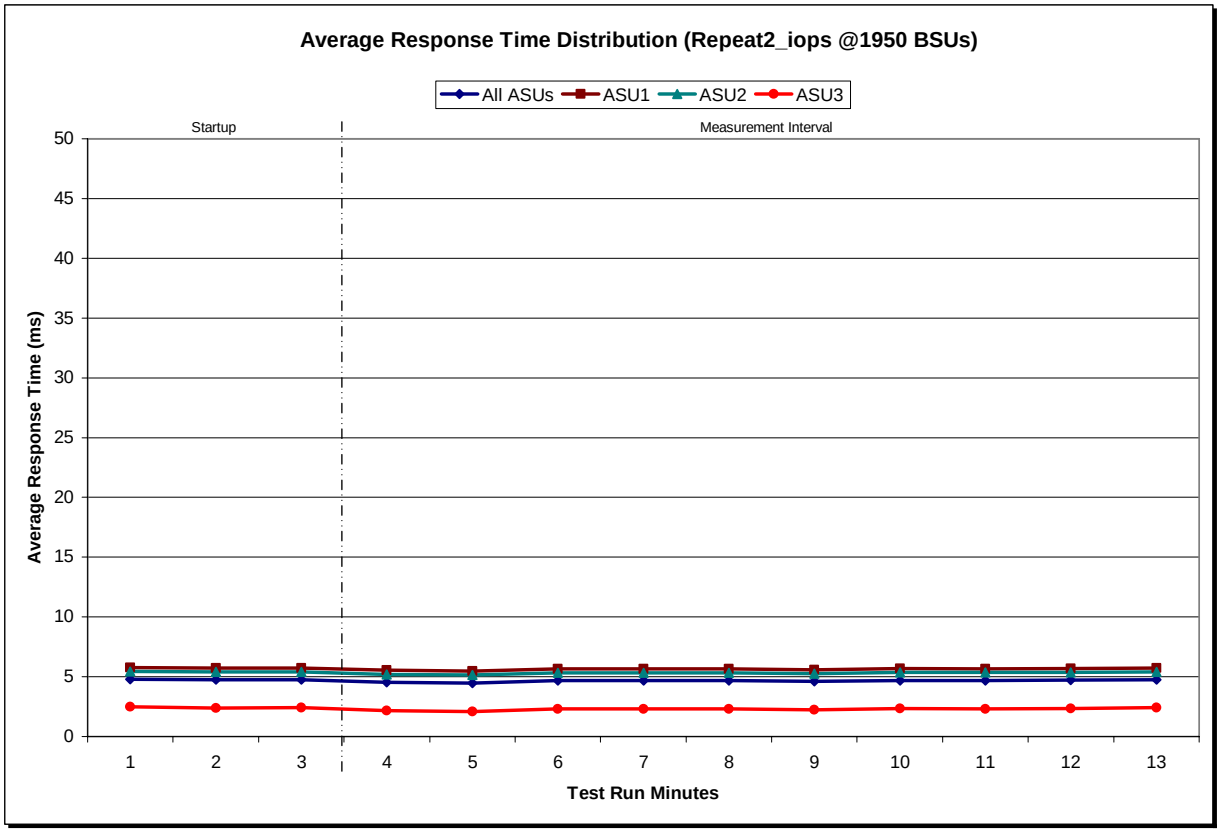
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

1950 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	21:47:17	21:50:18	0-2	0:03:01
Measurement Interval	21:50:18	22:00:18	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	4.80	5.77	5.45	2.47
1	4.74	5.72	5.39	2.39
2	4.76	5.73	5.42	2.41
3	4.55	5.54	5.20	2.16
4	4.47	5.45	5.15	2.07
5	4.67	5.65	5.34	2.30
6	4.68	5.66	5.32	2.31
7	4.67	5.65	5.34	2.31
8	4.60	5.59	5.24	2.23
9	4.69	5.67	5.35	2.32
10	4.68	5.66	5.35	2.31
11	4.72	5.70	5.38	2.36
12	4.75	5.73	5.39	2.39
Average	***4.65***	***5.63***	***5.31***	***2.28***

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 5.1.10 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	0.2809	0.0701	0.2103	0.0180	0.0700	0.0349	0.2809
COV	0.007	0.002	0.006	0.002	0.010	0.002	0.009	0.002

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

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

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	0.0349	0.2808	0.0699	0.2101	0.0180	0.0698	0.0351	0.2813
COV	0.008	0.003	0.005	0.002	0.008	0.006	0.008	0.002

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2101	0.0180	0.0700	0.0350	0.2811
COV	0.001	0.001	0.001	0.001	0.003	0.001	0.002	0.001

Data Persistence Test

Clause 6

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

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

Execution of Persistence Test Run 1 will cause the SPC-1 Workload Generator to write a specific pattern at randomly selected locations throughout the Total ASU Capacity. The SPC-1 Workload Generator will retain the information necessary to later validate the pattern written at each location

The Tested Storage Configuration (TSC) 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. If the TSC includes the Host System(s), the Host System(s) must also be shutdown and restarted using a power off/power on cycle.

Persistence Test Run 2, executed after the TSC has been restarted, will utilize the retained data from Persistence Test Run 1 to validate the patterns written at each location during Persistence Test Run 1.

Clause 9.4.3.8

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 (may optionally be referenced in an appendix).*
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 9-16. 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 108.

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	233,841,424
Total Number of Logical Blocks Verified	155,026,784
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 for the Priced Storage Configuration must be the date at which all components are committed to be available.

The Fujitsu Storage Systems ETERNUS DX440 as documented in this Full Disclosure Report is currently available for customer purchase and shipment.

PRICING INFORMATION

Clause 9.4.3.3.6

The Executive Summary shall contain a pricing spreadsheet as documented in Clause 8.3.1.

Pricing information may found in the Priced Storage Configuration Pricing section on page 14.

TESTED STORAGE CONFIGURATION (TSC) AND PRICED STORAGE CONFIGURATION DIFFERENCES

Clause 9.4.3.3.7

The Executive Summary shall contain a pricing a list of all differenced between the Tested Storage Configuration (TSC) and the Priced Storage Configuration.

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 14.

ANOMALIES OR IRREGULARITIES

Clause 9.4.3.10

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 ETERNUS DX440 .

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

Protected: This level will ensure data protection in the event of a single point of failure of any configured storage device. A brief description of the data protection utilized is included in the Executive Summary.

Unprotected: No claim of data protection is asserted in the event of a single point of failure.

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.

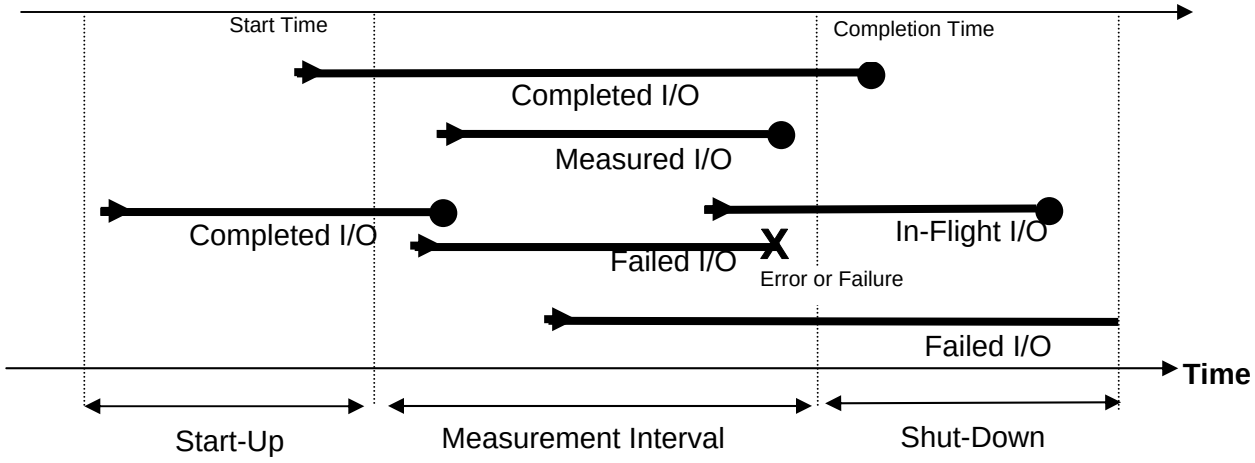
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

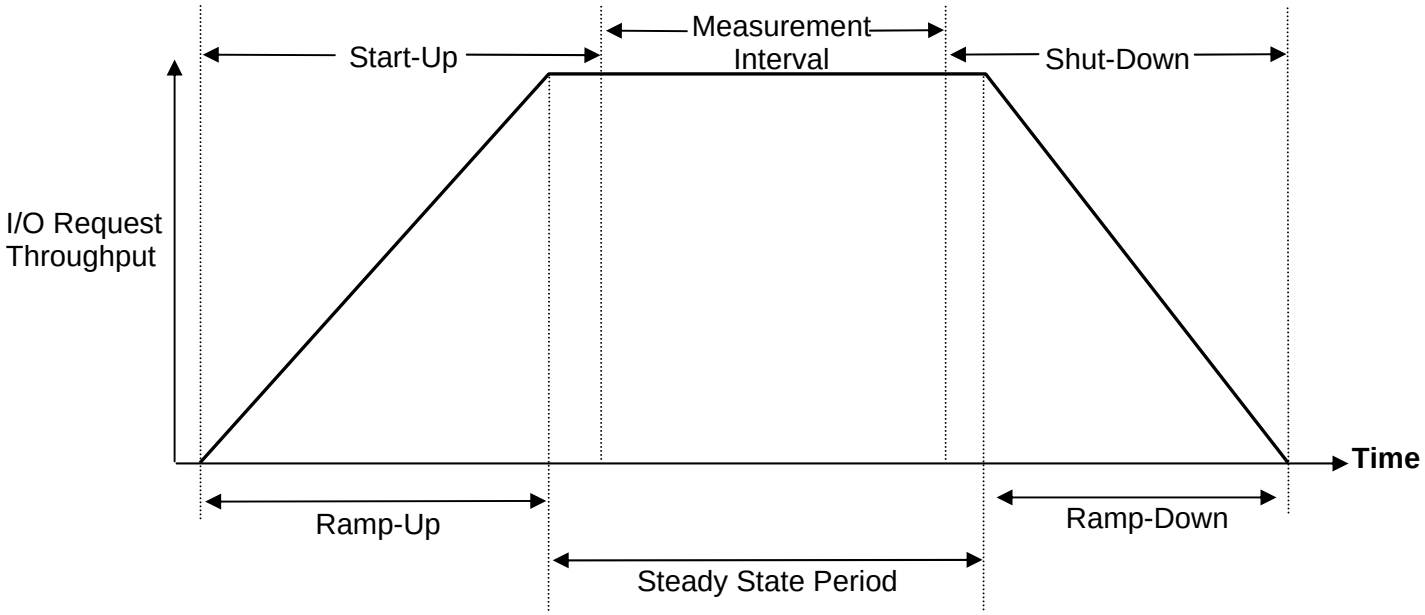
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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=20000
set maxfastscan=0x2000
```

Entries in "sd.conf"

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

```
#
# 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"
        target=0 lun=0;

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

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

name="sd" class="scsi"
        target=0 lun=3;
```

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

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

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

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

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

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

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

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

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

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

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

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

 name="sd" class="scsi"
        target=0 lun=16;

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

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

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

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

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

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

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

 name="sd" class="scsi"
        target=0 lun=24;
```

```
name="sd" class="scsi"
        target=0 lun=25;

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

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

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

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

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

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

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

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

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

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

name="sd" class="scsi"
        target=0 lun=36;

name="sd" class="scsi"
        target=0 lun=37;

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

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

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

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

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

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

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

name="sd" class="scsi"
        target=0 lun=45;
```

```
 name="sd" class="scsi"
        target=0 lun=46;

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

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

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

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

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

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

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

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

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

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

 name="sd" class="scsi"
        target=0 lun=57;

 name="sd" class="scsi"
        target=0 lun=58;

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

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

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

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

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

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

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

 name="sd" class="scsi"
        target=0 lun=66;
```

```
name="sd" class="scsi"
        target=0 lun=67;

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

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

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

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

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

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

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

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

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

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

name="sd" class="scsi"
        target=0 lun=78;

name="sd" class="scsi"
        target=0 lun=79;

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

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

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

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

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

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

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

name="sd" class="scsi"
        target=0 lun=87;
```

```
name="sd" class="scsi"
        target=0 lun=88;

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

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

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

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

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

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

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

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

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

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

name="sd" class="scsi"
        target=0 lun=99;

name="sd" class="scsi"
        target=0 lun=100;

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

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

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

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

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

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

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

name="sd" class="scsi"
        target=0 lun=108;
```

```
name="sd" class="scsi"
        target=0 lun=109;

name="sd" class="scsi"
        target=0 lun=110;

name="sd" class="scsi"
        target=0 lun=111;

name="sd" class="scsi"
        target=0 lun=112;

name="sd" class="scsi"
        target=0 lun=113;

name="sd" class="scsi"
        target=0 lun=114;

name="sd" class="scsi"
        target=0 lun=115;

name="sd" class="scsi"
        target=0 lun=116;

name="sd" class="scsi"
        target=0 lun=117;

name="sd" class="scsi"
        target=0 lun=118;

name="sd" class="scsi"
        target=0 lun=119;

name="sd" class="scsi"
        target=0 lun=120;

name="sd" class="scsi"
        target=0 lun=121;

name="sd" class="scsi"
        target=0 lun=122;

name="sd" class="scsi"
        target=0 lun=123;

name="sd" class="scsi"
        target=0 lun=124;

name="sd" class="scsi"
        target=0 lun=125;

name="sd" class="scsi"
        target=0 lun=126;

name="sd" class="scsi"
        target=0 lun=127;

name="sd" class="scsi"
        target=0 lun=128;

name="sd" class="scsi"
        target=0 lun=129;
```

```
name="sd" class="scsi"
        target=0 lun=130;

name="sd" class="scsi"
        target=0 lun=131;

name="sd" class="scsi"
        target=0 lun=132;

name="sd" class="scsi"
        target=0 lun=133;

name="sd" class="scsi"
        target=0 lun=134;

name="sd" class="scsi"
        target=0 lun=135;

name="sd" class="scsi"
        target=0 lun=136;

name="sd" class="scsi"
        target=0 lun=137;

name="sd" class="scsi"
        target=0 lun=138;

name="sd" class="scsi"
        target=0 lun=139;

name="sd" class="scsi"
        target=0 lun=140;

name="sd" class="scsi"
        target=0 lun=141;

name="sd" class="scsi"
        target=0 lun=142;

name="sd" class="scsi"
        target=0 lun=143;

name="sd" class="scsi"
        target=0 lun=144;

name="sd" class="scsi"
        target=0 lun=145;

name="sd" class="scsi"
        target=0 lun=146;

name="sd" class="scsi"
        target=0 lun=147;

name="sd" class="scsi"
        target=0 lun=148;

name="sd" class="scsi"
        target=0 lun=149;

name="sd" class="scsi"
        target=0 lun=150;
```

```
 name="sd" class="scsi"
        target=0 lun=151;

 name="sd" class="scsi"
        target=0 lun=152;

 name="sd" class="scsi"
        target=0 lun=153;

 name="sd" class="scsi"
        target=0 lun=154;

 name="sd" class="scsi"
        target=0 lun=155;

 name="sd" class="scsi"
        target=0 lun=156;

 name="sd" class="scsi"
        target=0 lun=157;

 name="sd" class="scsi"
        target=0 lun=158;

 name="sd" class="scsi"
        target=0 lun=159;

 name="sd" class="scsi"
        target=0 lun=160;

 name="sd" class="scsi"
        target=0 lun=161;

 name="sd" class="scsi"
        target=0 lun=162;

 name="sd" class="scsi"
        target=0 lun=163;

 name="sd" class="scsi"
        target=0 lun=164;

 name="sd" class="scsi"
        target=0 lun=165;

 name="sd" class="scsi"
        target=0 lun=166;

 name="sd" class="scsi"
        target=0 lun=167;

 name="sd" class="scsi"
        target=0 lun=168;

 name="sd" class="scsi"
        target=0 lun=169;

 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;

#
# 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 **fjpfca.conf** for controlling the operation of the Fibre Channel HBAs. The following values have been changed from their default values for accessing the ETERNUS DX440 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=255;
```

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

The ETERNUS DX440 Storage Array is configured using an interactive on-line tool called ETERNUS Administrator. When an ETERNUS DX440 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:

DX440_config_r_68rg_1360lun-cw_0106.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.fujitsu.com/downloads/STRSYS/system/dx400-dx8000_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 four dual ported HBAs to Channel Adapter ports, 8 ports connections in all. Each port was set up using the following:

1. Select "Volume Settings" Tool in the main tool bar.
2. Select "Host I/FManagement" Tool in the tool bar.
3. When the "Set FC_Port parameters" is clicked, the screen will be presented.
4. 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 8Gbps for the Transfer Rate. Click the "Apply" button to save the settings for the selected port.
5. With the selections complete, click the "OK" button to reach the confirmation dialog box – click "Yes" to complete the operations.
6. Each of the eight ports in use for the benchmark are set up in the same manner.

The configuration plan for the SPC-1 Benchmark configuration assigns the 170 Logical Volumes as LUNs 0-169 on each of the Channel Adapter ports. There are 1360 Logical Volumes in the defined configuration, 20 on each of the 68 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 00-07 apply to the ports with Host Affinity OFF. 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.
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. 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 Hot Spare drives, 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 ETERNUS DX440 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 ETERNUS DX440 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 apl_dx440_p1_svmake_8GHBA.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 SPC-1 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
```

apl_dx440_p1_svmake_8GHBA.txt

```
DELETE_ALL
VOLUME_GROUP: asu1-1 (d0)
STRIPE 8m
VOLUME 1
c32t0d4
c33t0d4
c36t0d4
c38t0d4
c32t0d14
```

```
c33t0d14
c36t0d14
c38t0d14
c32t0d24
c33t0d24
c36t0d24
c38t0d24
c32t0d34
c33t0d34
c36t0d34
c38t0d34
c32t0d44
c33t0d44
c36t0d44
c38t0d44
c32t0d54
c33t0d54
c36t0d54
c38t0d54
c32t0d64
c33t0d64
c36t0d64
c38t0d64
c32t0d74
c33t0d74
c36t0d74
c38t0d74
c32t0d84
c33t0d84
c36t0d84
c38t0d84
c32t0d94
c33t0d94
c36t0d94
c38t0d94
c32t0d104
c33t0d104
c36t0d104
c38t0d104
c32t0d114
c33t0d114
c36t0d114
c38t0d114
c32t0d124
c33t0d124
c36t0d124
c38t0d124
c32t0d134
c33t0d134
c36t0d134
c38t0d134
c32t0d144
c33t0d144
c36t0d144
c38t0d144
c32t0d154
c33t0d154
c36t0d154
c38t0d154
c32t0d164
c33t0d164
c36t0d164
c38t0d164
```

```
END
VOLUME_GROUP: asu1-2 (d1)
STRIPE 8m
VOLUME 1
c32t0d5
c33t0d5
c36t0d5
c38t0d5
c32t0d15
c33t0d15
c36t0d15
c38t0d15
c32t0d25
c33t0d25
c36t0d25
c38t0d25
c32t0d35
c33t0d35
c36t0d35
c38t0d35
c32t0d45
c33t0d45
c36t0d45
c38t0d45
c32t0d55
c33t0d55
c36t0d55
c38t0d55
c32t0d65
c33t0d65
c36t0d65
c38t0d65
c32t0d75
c33t0d75
c36t0d75
c38t0d75
c32t0d85
c33t0d85
c36t0d85
c38t0d85
c32t0d95
c33t0d95
c36t0d95
c38t0d95
c32t0d105
c33t0d105
c36t0d105
c38t0d105
c32t0d115
c33t0d115
c36t0d115
c38t0d115
c32t0d125
c33t0d125
c36t0d125
c38t0d125
c32t0d135
c33t0d135
c36t0d135
c38t0d135
c32t0d145
c33t0d145
c36t0d145
```

```
c38t0d145
c32t0d155
c33t0d155
c36t0d155
c38t0d155
c32t0d165
c33t0d165
c36t0d165
c38t0d165
END
VOLUME_GROUP: asu1-3 (d2)
STRIPE 8m
VOLUME 1
c32t0d6
c33t0d6
c36t0d6
c38t0d6
c32t0d16
c33t0d16
c36t0d16
c38t0d16
c32t0d26
c33t0d26
c36t0d26
c38t0d26
c32t0d36
c33t0d36
c36t0d36
c38t0d36
c32t0d46
c33t0d46
c36t0d46
c38t0d46
c32t0d56
c33t0d56
c36t0d56
c38t0d56
c32t0d66
c33t0d66
c36t0d66
c38t0d66
c32t0d76
c33t0d76
c36t0d76
c38t0d76
c32t0d86
c33t0d86
c36t0d86
c38t0d86
c32t0d96
c33t0d96
c36t0d96
c38t0d96
c32t0d106
c33t0d106
c36t0d106
c38t0d106
c32t0d116
c33t0d116
c36t0d116
c38t0d116
c32t0d126
c33t0d126
```

```
  c36t0d126
  c38t0d126
  c32t0d136
  c33t0d136
  c36t0d136
  c38t0d136
  c32t0d146
  c33t0d146
  c36t0d146
  c38t0d146
  c32t0d156
  c33t0d156
  c36t0d156
  c38t0d156
  c32t0d166
  c33t0d166
  c36t0d166
  c38t0d166
  END
  VOLUME_GROUP: asu1-4 (d3)
  STRIPE 8m
  VOLUME 1
  c32t0d7
  c33t0d7
  c36t0d7
  c38t0d7
  c32t0d17
  c33t0d17
  c36t0d17
  c38t0d17
  c32t0d27
  c33t0d27
  c36t0d27
  c38t0d27
  c32t0d37
  c33t0d37
  c36t0d37
  c38t0d37
  c32t0d47
  c33t0d47
  c36t0d47
  c38t0d47
  c32t0d57
  c33t0d57
  c36t0d57
  c38t0d57
  c32t0d67
  c33t0d67
  c36t0d67
  c38t0d67
  c32t0d77
  c33t0d77
  c36t0d77
  c38t0d77
  c32t0d87
  c33t0d87
  c36t0d87
  c38t0d87
  c32t0d97
  c33t0d97
  c36t0d97
  c38t0d97
  c32t0d107
```

```
c33t0d107
c36t0d107
c38t0d107
c32t0d117
c33t0d117
c36t0d117
c38t0d117
c32t0d127
c33t0d127
c36t0d127
c38t0d127
c32t0d137
c33t0d137
c36t0d137
c38t0d137
c32t0d147
c33t0d147
c36t0d147
c38t0d147
c32t0d157
c33t0d157
c36t0d157
c38t0d157
c32t0d167
c33t0d167
c36t0d167
c38t0d167
END
VOLUME_GROUP: asu1-5 (d4)
STRIPE 8m
VOLUME 1
c32t0d8
c33t0d8
c36t0d8
c38t0d8
c32t0d18
c33t0d18
c36t0d18
c38t0d18
c32t0d28
c33t0d28
c36t0d28
c38t0d28
c32t0d38
c33t0d38
c36t0d38
c38t0d38
c32t0d48
c33t0d48
c36t0d48
c38t0d48
c32t0d58
c33t0d58
c36t0d58
c38t0d58
c32t0d68
c33t0d68
c36t0d68
c38t0d68
c32t0d78
c33t0d78
c36t0d78
c38t0d78
```

```
c32t0d88
c33t0d88
c36t0d88
c38t0d88
c32t0d98
c33t0d98
c36t0d98
c38t0d98
c32t0d108
c33t0d108
c36t0d108
c38t0d108
c32t0d118
c33t0d118
c36t0d118
c38t0d118
c32t0d128
c33t0d128
c36t0d128
c38t0d128
c32t0d138
c33t0d138
c36t0d138
c38t0d138
c32t0d148
c33t0d148
c36t0d148
c38t0d148
c32t0d158
c33t0d158
c36t0d158
c38t0d158
c32t0d168
c33t0d168
c36t0d168
c38t0d168
END
VOLUME_GROUP: asu1-6 (d5)
STRIPE 8m
VOLUME 1
c35t0d1
c34t0d1
c37t0d1
c39t0d1
c35t0d11
c34t0d11
c37t0d11
c39t0d11
c35t0d21
c34t0d21
c37t0d21
c39t0d21
c35t0d31
c34t0d31
c37t0d31
c39t0d31
c35t0d41
c34t0d41
c37t0d41
c39t0d41
c35t0d51
c34t0d51
c37t0d51
```

```
  c39t0d51
  c35t0d61
  c34t0d61
  c37t0d61
  c39t0d61
  c35t0d71
  c34t0d71
  c37t0d71
  c39t0d71
  c35t0d81
  c34t0d81
  c37t0d81
  c39t0d81
  c35t0d91
  c34t0d91
  c37t0d91
  c39t0d91
  c35t0d101
  c34t0d101
  c37t0d101
  c39t0d101
  c35t0d111
  c34t0d111
  c37t0d111
  c39t0d111
  c35t0d121
  c34t0d121
  c37t0d121
  c39t0d121
  c35t0d131
  c34t0d131
  c37t0d131
  c39t0d131
  c35t0d141
  c34t0d141
  c37t0d141
  c39t0d141
  c35t0d151
  c34t0d151
  c37t0d151
  c39t0d151
  c35t0d161
  c34t0d161
  c37t0d161
  c39t0d161
  END
  VOLUME_GROUP: asu1-7 (d6)
  STRIPE 8m
  VOLUME 1
  c35t0d2
  c34t0d2
  c37t0d2
  c39t0d2
  c35t0d12
  c34t0d12
  c37t0d12
  c39t0d12
  c35t0d22
  c34t0d22
  c37t0d22
  c39t0d22
  c35t0d32
  c34t0d32
```

```
  c37t0d32
  c39t0d32
  c35t0d42
  c34t0d42
  c37t0d42
  c39t0d42
  c35t0d52
  c34t0d52
  c37t0d52
  c39t0d52
  c35t0d62
  c34t0d62
  c37t0d62
  c39t0d62
  c35t0d72
  c34t0d72
  c37t0d72
  c39t0d72
  c35t0d82
  c34t0d82
  c37t0d82
  c39t0d82
  c35t0d92
  c34t0d92
  c37t0d92
  c39t0d92
  c35t0d102
  c34t0d102
  c37t0d102
  c39t0d102
  c35t0d112
  c34t0d112
  c37t0d112
  c39t0d112
  c35t0d122
  c34t0d122
  c37t0d122
  c39t0d122
  c35t0d132
  c34t0d132
  c37t0d132
  c39t0d132
  c35t0d142
  c34t0d142
  c37t0d142
  c39t0d142
  c35t0d152
  c34t0d152
  c37t0d152
  c39t0d152
  c35t0d162
  c34t0d162
  c37t0d162
  c39t0d162
  END
  VOLUME_GROUP: asu1-8 (d7)
  STRIPE 8m
  VOLUME 1
  c35t0d3
  c34t0d3
  c37t0d3
  c39t0d3
  c35t0d13
```

```
c34t0d13
c37t0d13
c39t0d13
c35t0d23
c34t0d23
c37t0d23
c39t0d23
c35t0d33
c34t0d33
c37t0d33
c39t0d33
c35t0d43
c34t0d43
c37t0d43
c39t0d43
c35t0d53
c34t0d53
c37t0d53
c39t0d53
c35t0d63
c34t0d63
c37t0d63
c39t0d63
c35t0d73
c34t0d73
c37t0d73
c39t0d73
c35t0d83
c34t0d83
c37t0d83
c39t0d83
c35t0d93
c34t0d93
c37t0d93
c39t0d93
c35t0d103
c34t0d103
c37t0d103
c39t0d103
c35t0d113
c34t0d113
c37t0d113
c39t0d113
c35t0d123
c34t0d123
c37t0d123
c39t0d123
c35t0d133
c34t0d133
c37t0d133
c39t0d133
c35t0d143
c34t0d143
c37t0d143
c39t0d143
c35t0d153
c34t0d153
c37t0d153
c39t0d153
c35t0d163
c34t0d163
c37t0d163
c39t0d163
```

```
END
VOLUME_GROUP: asu1-9 (d8)
STRIPE 8m
VOLUME 1
c35t0d4
c34t0d4
c37t0d4
c39t0d4
c35t0d14
c34t0d14
c37t0d14
c39t0d14
c35t0d24
c34t0d24
c37t0d24
c39t0d24
c35t0d34
c34t0d34
c37t0d34
c39t0d34
c35t0d44
c34t0d44
c37t0d44
c39t0d44
c35t0d54
c34t0d54
c37t0d54
c39t0d54
c35t0d64
c34t0d64
c37t0d64
c39t0d64
c35t0d74
c34t0d74
c37t0d74
c39t0d74
c35t0d84
c34t0d84
c37t0d84
c39t0d84
c35t0d94
c34t0d94
c37t0d94
c39t0d94
c35t0d104
c34t0d104
c37t0d104
c39t0d104
c35t0d114
c34t0d114
c37t0d114
c39t0d114
c35t0d124
c34t0d124
c37t0d124
c39t0d124
c35t0d134
c34t0d134
c37t0d134
c39t0d134
c35t0d144
c34t0d144
c37t0d144
```

```
c39t0d144
c35t0d154
c34t0d154
c37t0d154
c39t0d154
c35t0d164
c34t0d164
c37t0d164
c39t0d164
END
VOLUME_GROUP: asu2-1 (d9)
STRIPE 8m
VOLUME 1
c32t0d0
c33t0d0
c36t0d0
c38t0d0
c32t0d10
c33t0d10
c36t0d10
c38t0d10
c32t0d20
c33t0d20
c36t0d20
c38t0d20
c32t0d30
c33t0d30
c36t0d30
c38t0d30
c32t0d40
c33t0d40
c36t0d40
c38t0d40
c32t0d50
c33t0d50
c36t0d50
c38t0d50
c32t0d60
c33t0d60
c36t0d60
c38t0d60
c32t0d70
c33t0d70
c36t0d70
c38t0d70
c32t0d80
c33t0d80
c36t0d80
c38t0d80
c32t0d90
c33t0d90
c36t0d90
c38t0d90
c32t0d100
c33t0d100
c36t0d100
c38t0d100
c32t0d110
c33t0d110
c36t0d110
c38t0d110
c32t0d120
c33t0d120
```

```
  c36t0d120
  c38t0d120
  c32t0d130
  c33t0d130
  c36t0d130
  c38t0d130
  c32t0d140
  c33t0d140
  c36t0d140
  c38t0d140
  c32t0d150
  c33t0d150
  c36t0d150
  c38t0d150
  c32t0d160
  c33t0d160
  c36t0d160
  c38t0d160
  END
  VOLUME_GROUP: asu2-2 (d10)
  STRIPE 8m
  VOLUME 1
  c32t0d1
  c33t0d1
  c36t0d1
  c38t0d1
  c32t0d11
  c33t0d11
  c36t0d11
  c38t0d11
  c32t0d21
  c33t0d21
  c36t0d21
  c38t0d21
  c32t0d31
  c33t0d31
  c36t0d31
  c38t0d31
  c32t0d41
  c33t0d41
  c36t0d41
  c38t0d41
  c32t0d51
  c33t0d51
  c36t0d51
  c38t0d51
  c32t0d61
  c33t0d61
  c36t0d61
  c38t0d61
  c32t0d71
  c33t0d71
  c36t0d71
  c38t0d71
  c32t0d81
  c33t0d81
  c36t0d81
  c38t0d81
  c32t0d91
  c33t0d91
  c36t0d91
  c38t0d91
  c32t0d101
```

```
c33t0d101
c36t0d101
c38t0d101
c32t0d111
c33t0d111
c36t0d111
c38t0d111
c32t0d121
c33t0d121
c36t0d121
c38t0d121
c32t0d131
c33t0d131
c36t0d131
c38t0d131
c32t0d141
c33t0d141
c36t0d141
c38t0d141
c32t0d151
c33t0d151
c36t0d151
c38t0d151
c32t0d161
c33t0d161
c36t0d161
c38t0d161
END
VOLUME_GROUP: asu2-3 (d11)
STRIPE 8m
VOLUME 1
c32t0d2
c33t0d2
c36t0d2
c38t0d2
c32t0d12
c33t0d12
c36t0d12
c38t0d12
c32t0d22
c33t0d22
c36t0d22
c38t0d22
c32t0d32
c33t0d32
c36t0d32
c38t0d32
c32t0d42
c33t0d42
c36t0d42
c38t0d42
c32t0d52
c33t0d52
c36t0d52
c38t0d52
c32t0d62
c33t0d62
c36t0d62
c38t0d62
c32t0d72
c33t0d72
c36t0d72
c38t0d72
```

```
c32t0d82
c33t0d82
c36t0d82
c38t0d82
c32t0d92
c33t0d92
c36t0d92
c38t0d92
c32t0d102
c33t0d102
c36t0d102
c38t0d102
c32t0d112
c33t0d112
c36t0d112
c38t0d112
c32t0d122
c33t0d122
c36t0d122
c38t0d122
c32t0d132
c33t0d132
c36t0d132
c38t0d132
c32t0d142
c33t0d142
c36t0d142
c38t0d142
c32t0d152
c33t0d152
c36t0d152
c38t0d152
c32t0d162
c33t0d162
c36t0d162
c38t0d162
END
VOLUME_GROUP: asu2-4 (d12)
STRIPE 8m
VOLUME 1
c32t0d3
c33t0d3
c36t0d3
c38t0d3
c32t0d13
c33t0d13
c36t0d13
c38t0d13
c32t0d23
c33t0d23
c36t0d23
c38t0d23
c32t0d33
c33t0d33
c36t0d33
c38t0d33
c32t0d43
c33t0d43
c36t0d43
c38t0d43
c32t0d53
c33t0d53
c36t0d53
```

```
c38t0d53
c32t0d63
c33t0d63
c36t0d63
c38t0d63
c32t0d73
c33t0d73
c36t0d73
c38t0d73
c32t0d83
c33t0d83
c36t0d83
c38t0d83
c32t0d93
c33t0d93
c36t0d93
c38t0d93
c32t0d103
c33t0d103
c36t0d103
c38t0d103
c32t0d113
c33t0d113
c36t0d113
c38t0d113
c32t0d123
c33t0d123
c36t0d123
c38t0d123
c32t0d133
c33t0d133
c36t0d133
c38t0d133
c32t0d143
c33t0d143
c36t0d143
c38t0d143
c32t0d153
c33t0d153
c36t0d153
c38t0d153
c32t0d163
c33t0d163
c36t0d163
c38t0d163
END
VOLUME_GROUP: asu2-5 (d13)
STRIPE 8m
VOLUME 1
c35t0d5
c34t0d5
c37t0d5
c39t0d5
c35t0d15
c34t0d15
c37t0d15
c39t0d15
c35t0d25
c34t0d25
c37t0d25
c39t0d25
c35t0d35
c34t0d35
```

```
c37t0d35
c39t0d35
c35t0d45
c34t0d45
c37t0d45
c39t0d45
c35t0d55
c34t0d55
c37t0d55
c39t0d55
c35t0d65
c34t0d65
c37t0d65
c39t0d65
c35t0d75
c34t0d75
c37t0d75
c39t0d75
c35t0d85
c34t0d85
c37t0d85
c39t0d85
c35t0d95
c34t0d95
c37t0d95
c39t0d95
c35t0d105
c34t0d105
c37t0d105
c39t0d105
c35t0d115
c34t0d115
c37t0d115
c39t0d115
c35t0d125
c34t0d125
c37t0d125
c39t0d125
c35t0d135
c34t0d135
c37t0d135
c39t0d135
c35t0d145
c34t0d145
c37t0d145
c39t0d145
c35t0d155
c34t0d155
c37t0d155
c39t0d155
c35t0d165
c34t0d165
c37t0d165
c39t0d165
END
VOLUME_GROUP: asu2-6 (d14)
STRIPE 8m
VOLUME 1
c35t0d6
c34t0d6
c37t0d6
c39t0d6
c35t0d16
```

```
c34t0d16
c37t0d16
c39t0d16
c35t0d26
c34t0d26
c37t0d26
c39t0d26
c35t0d36
c34t0d36
c37t0d36
c39t0d36
c35t0d46
c34t0d46
c37t0d46
c39t0d46
c35t0d56
c34t0d56
c37t0d56
c39t0d56
c35t0d66
c34t0d66
c37t0d66
c39t0d66
c35t0d76
c34t0d76
c37t0d76
c39t0d76
c35t0d86
c34t0d86
c37t0d86
c39t0d86
c35t0d96
c34t0d96
c37t0d96
c39t0d96
c35t0d106
c34t0d106
c37t0d106
c39t0d106
c35t0d116
c34t0d116
c37t0d116
c39t0d116
c35t0d126
c34t0d126
c37t0d126
c39t0d126
c35t0d136
c34t0d136
c37t0d136
c39t0d136
c35t0d146
c34t0d146
c37t0d146
c39t0d146
c35t0d156
c34t0d156
c37t0d156
c39t0d156
c35t0d166
c34t0d166
c37t0d166
c39t0d166
```

```
END
VOLUME_GROUP: asu2-7 (d15)
STRIPE 8m
VOLUME 1
c35t0d7
c34t0d7
c37t0d7
c39t0d7
c35t0d17
c34t0d17
c37t0d17
c39t0d17
c35t0d27
c34t0d27
c37t0d27
c39t0d27
c35t0d37
c34t0d37
c37t0d37
c39t0d37
c35t0d47
c34t0d47
c37t0d47
c39t0d47
c35t0d57
c34t0d57
c37t0d57
c39t0d57
c35t0d67
c34t0d67
c37t0d67
c39t0d67
c35t0d77
c34t0d77
c37t0d77
c39t0d77
c35t0d87
c34t0d87
c37t0d87
c39t0d87
c35t0d97
c34t0d97
c37t0d97
c39t0d97
c35t0d107
c34t0d107
c37t0d107
c39t0d107
c35t0d117
c34t0d117
c37t0d117
c39t0d117
c35t0d127
c34t0d127
c37t0d127
c39t0d127
c35t0d137
c34t0d137
c37t0d137
c39t0d137
c35t0d147
c34t0d147
c37t0d147
```

```
c39t0d147
c35t0d157
c34t0d157
c37t0d157
c39t0d157
c35t0d167
c34t0d167
c37t0d167
c39t0d167
END
VOLUME_GROUP: asu2-8 (d16)
STRIPE 8m
VOLUME 1
c35t0d8
c34t0d8
c37t0d8
c39t0d8
c35t0d18
c34t0d18
c37t0d18
c39t0d18
c35t0d28
c34t0d28
c37t0d28
c39t0d28
c35t0d38
c34t0d38
c37t0d38
c39t0d38
c35t0d48
c34t0d48
c37t0d48
c39t0d48
c35t0d58
c34t0d58
c37t0d58
c39t0d58
c35t0d68
c34t0d68
c37t0d68
c39t0d68
c35t0d78
c34t0d78
c37t0d78
c39t0d78
c35t0d88
c34t0d88
c37t0d88
c39t0d88
c35t0d98
c34t0d98
c37t0d98
c39t0d98
c35t0d108
c34t0d108
c37t0d108
c39t0d108
c35t0d118
c34t0d118
c37t0d118
c39t0d118
c35t0d128
c34t0d128
```

```
  c37t0d128
  c39t0d128
  c35t0d138
  c34t0d138
  c37t0d138
  c39t0d138
  c35t0d148
  c34t0d148
  c37t0d148
  c39t0d148
  c35t0d158
  c34t0d158
  c37t0d158
  c39t0d158
  c35t0d168
  c34t0d168
  c37t0d168
  c39t0d168
  END
  VOLUME_GROUP: asu2-9 (d17)
  STRIPE 8m
  VOLUME 1
  c35t0d9
  c34t0d9
  c37t0d9
  c39t0d9
  c35t0d19
  c34t0d19
  c37t0d19
  c39t0d19
  c35t0d29
  c34t0d29
  c37t0d29
  c39t0d29
  c35t0d39
  c34t0d39
  c37t0d39
  c39t0d39
  c35t0d49
  c34t0d49
  c37t0d49
  c39t0d49
  c35t0d59
  c34t0d59
  c37t0d59
  c39t0d59
  c35t0d69
  c34t0d69
  c37t0d69
  c39t0d69
  c35t0d79
  c34t0d79
  c37t0d79
  c39t0d79
  c35t0d89
  c34t0d89
  c37t0d89
  c39t0d89
  c35t0d99
  c34t0d99
  c37t0d99
  c39t0d99
  c35t0d109
```

```
c34t0d109
c37t0d109
c39t0d109
c35t0d119
c34t0d119
c37t0d119
c39t0d119
c35t0d129
c34t0d129
c37t0d129
c39t0d129
c35t0d139
c34t0d139
c37t0d139
c39t0d139
c35t0d149
c34t0d149
c37t0d149
c39t0d149
c35t0d159
c34t0d159
c37t0d159
c39t0d159
c35t0d169
c34t0d169
c37t0d169
c39t0d169
END
VOLUME_GROUP: asu3-1 (d18)
STRIPE 8m
VOLUME 1
c32t0d9
c33t0d9
c36t0d9
c38t0d9
c32t0d19
c33t0d19
c36t0d19
c38t0d19
c32t0d29
c33t0d29
c36t0d29
c38t0d29
c32t0d39
c33t0d39
c36t0d39
c38t0d39
c32t0d49
c33t0d49
c36t0d49
c38t0d49
c32t0d59
c33t0d59
c36t0d59
c38t0d59
c32t0d69
c33t0d69
c36t0d69
c38t0d69
c32t0d79
c33t0d79
c36t0d79
c38t0d79
```

```
c32t0d89
c33t0d89
c36t0d89
c38t0d89
c32t0d99
c33t0d99
c36t0d99
c38t0d99
c32t0d109
c33t0d109
c36t0d109
c38t0d109
c32t0d119
c33t0d119
c36t0d119
c38t0d119
c32t0d129
c33t0d129
c36t0d129
c38t0d129
c32t0d139
c33t0d139
c36t0d139
c38t0d139
c32t0d149
c33t0d149
c36t0d149
c38t0d149
c32t0d159
c33t0d159
c36t0d159
c38t0d159
c32t0d169
c33t0d169
c36t0d169
c38t0d169
END
VOLUME_GROUP: asu3-2 (d19)
STRIPE 8m
VOLUME 1
c35t0d0
c34t0d0
c37t0d0
c39t0d0
c35t0d10
c34t0d10
c37t0d10
c39t0d10
c35t0d20
c34t0d20
c37t0d20
c39t0d20
c35t0d30
c34t0d30
c37t0d30
c39t0d30
c35t0d40
c34t0d40
c37t0d40
c39t0d40
c35t0d50
c34t0d50
c37t0d50
```

```
  c39t0d50
  c35t0d60
  c34t0d60
  c37t0d60
  c39t0d60
  c35t0d70
  c34t0d70
  c37t0d70
  c39t0d70
  c35t0d80
  c34t0d80
  c37t0d80
  c39t0d80
  c35t0d90
  c34t0d90
  c37t0d90
  c39t0d90
  c35t0d100
  c34t0d100
  c37t0d100
  c39t0d100
  c35t0d110
  c34t0d110
  c37t0d110
  c39t0d110
  c35t0d120
  c34t0d120
  c37t0d120
  c39t0d120
  c35t0d130
  c34t0d130
  c37t0d130
  c39t0d130
  c35t0d140
  c34t0d140
  c37t0d140
  c39t0d140
  c35t0d150
  c34t0d150
  c37t0d150
  c39t0d150
  c35t0d160
  c34t0d160
  c37t0d160
  c39t0d160
  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 to execute the Primary Metrics, Repeatability, and Persistence Tests, is listed below.

```
javaparms="-Xmx1024m -Xms1024m -Xss512k"
sd=asu1_1,lun=/dev/md/rdsk/d0,size=1803.6849g
sd=asu1_2,lun=/dev/md/rdsk/d1,size=1803.6849g
sd=asu1_3,lun=/dev/md/rdsk/d2,size=1803.6849g
sd=asu1_4,lun=/dev/md/rdsk/d3,size=1803.6849g
sd=asu1_5,lun=/dev/md/rdsk/d4,size=1803.6849g
sd=asu1_6,lun=/dev/md/rdsk/d5,size=1803.6849g
sd=asu1_7,lun=/dev/md/rdsk/d6,size=1803.6849g
sd=asu1_8,lun=/dev/md/rdsk/d7,size=1803.6849g
sd=asu1_9,lun=/dev/md/rdsk/d8,size=1803.6849g
sd=asu2_1,lun=/dev/md/rdsk/d9,size=1803.6849g
sd=asu2_2,lun=/dev/md/rdsk/d10,size=1803.6849g
sd=asu2_3,lun=/dev/md/rdsk/d11,size=1803.6849g
sd=asu2_4,lun=/dev/md/rdsk/d12,size=1803.6849g
sd=asu2_5,lun=/dev/md/rdsk/d13,size=1803.6849g
sd=asu2_6,lun=/dev/md/rdsk/d14,size=1803.6849g
sd=asu2_7,lun=/dev/md/rdsk/d15,size=1803.6849g
sd=asu2_8,lun=/dev/md/rdsk/d16,size=1803.6849g
sd=asu2_9,lun=/dev/md/rdsk/d17,size=1803.6849g
sd=asu3_1,lun=/dev/md/rdsk/d18,size=1803.6849g
sd=asu3_2,lun=/dev/md/rdsk/d19,size=1803.6849g
```

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.

```
#sleep 9000

#metrics
java -Xmx1024m -Xms1024m -Xss512k metrics -b 1950

#repeat-1
java -Xmx1024m -Xms1024m -Xss512k repeat1 -b 1950

#repeat-2
java -Xmx1024m -Xms1024m -Xss512k repeat2 -b 1950

#persist-1
java -Xmx1024m -Xms1024m -Xss512k persist1 -b 1950
```

Persistence Test Run 2

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

```
java -Xmx1024m -Xms1024m -Xss512k persist2

mv metrics metrics_DX440_091215_FDR_bsu1950
mv repeatability1 repeat1_DX440_091215_FDR_bsu1950
mv repeatability2 repeat2_DX440_091215_FDR_bsu1950
mv persistence1 persist1_DX440_091215_FDR_bsu1950
mv persistence2 persist2_DX440_091215_FDR_bsu1950
mv SPCOut SPCOut_DX440_091215_FDR_bsu1950

zip -r metrics_DX440_091215_FDR_bsu1950.zip metrics_DX440_091215_FDR_bsu1950
zip -r repeat1_DX440_091215_FDR_bsu1950.zip repeat1_DX440_091215_FDR_bsu1950
zip -r repeat2_DX440_091215_FDR_bsu1950.zip repeat2_DX440_091215_FDR_bsu1950
zip -r persist1_DX440_091215_FDR_bsu1950.zip persist1_DX440_091215_FDR_bsu1950
zip -r persist2_DX440_091215_FDR_bsu1950.zip persist2_DX440_091215_FDR_bsu1950
zip -r SPCOut_DX440_091215_FDR_bsu1950.zip SPCOut_DX440_091215_FDR_bsu1950
```