FUJITSU

THE POSSIBILITIES ARE INFINITE

SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

FUJITSU LIMITED
FUJITSU STORAGE SYSTEMS ETERNUS DX80 S2

SPC-1 V1.12

Submitted for Review: December 27, 2011
Submission Identifier: A00111

First Edition – December 2011

Trademarks

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AUDIT CERTIFICATION

C. A. (Sandy) Wilson
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P.O. Box 3470
Sunnyvale, CA 94088 3470

December 27, 2011

The SPC Benchmark 1™ Reported Data listed below for the Fujitsu Storage Systems ETERNUS DX80 S2 were produced in compliance with the SPC Benchmark 1™ v1.12 Remote Audit requirements.

SPC Benchmark 1™ v1.12 Reported Data	
Tested Storage Product (TSP) Name: Fujitsu Storage Systems ETERNUS DX80 S2	
Metric	**Reported Result**
SPC-1 IOPS™	34,995.02
SPC-1 Price-Performance	$2.25/SPC-1 IOPS™
Total ASU Capacity	9,700.000 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$78,757.00

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 were verified by information supplied by Fujitsu Limited:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of each Application Storage Unit (ASU) and requirements.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters that were changed from default values.

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643 Bair Island Road, Suite 103
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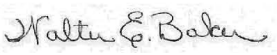
AUDIT CERTIFICATION *(CONT.)*

- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.
- The following Host System requirements were verified by physical inspection and information supplied by Fujitsu Limited:
  - ✓ The type of Host System including the number of processors and main memory.
  - ✓ The presence and version number of the SPC-1 Workload Generator on the Host System.
  - ✓ The TSC boundary within the Host System.
- The Test Results Files and resultant Summary Results Files received from Fujitsu Limited for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability Test
- The documented differences between the Tested Storage Configuration (TSC) and the Priced Storage Configuration, if applied to the TSC, would not have had any impact on the audited benchmark measurements.
- 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

Kanagawa-ken,Kawasaki-shi,Nakahara-ku,Kamikodanaka,4-1-1,JAPAN211-8588
Phone: 044-754-3240

Nov 17, 2011
From: Tetsuro Kudo, Fujitsu Limited

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

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

Subject: SPC-1 Letter of Good Faith for the ETERNUS DX80S2

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 V2.1.0 of the SPC-1 benchmark specification.

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

Signed: Date:

Tetsuro Kudo 17/11/2011

Tetsuro Kudo
Senior vice-president, Storage System Unit

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Fujitsu Limited – http://www.fujitsu.com/services/computing/storage/ Fujitsu America, Inc. C.A. (Sandy) Wilson Sandy_Wilson@us.fujitsu.com 1250 East Arques Ave PO Box 3470 Sunnyvale, CA 94088-3470 Phone: (916) 434-8593
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Test Sponsor Alternate Contact	Fujitsu Limited http://www.fujitsu.com/services/computing/storage/ Yasuhito Arikawa y.arikawa@jp.fujitsu.com 1-1 Kamikodanaka 4-chome, Nakahara-ku, Kawasaki-shi, Kanagawa-ken 211-8588, Japan Phone: (044) 754-3632 FAX: (044) 754-3719
Auditor	Storage Performance Council – http://www.storageperformance.org Walter E. Baker – AuditService@StoragePerformance.org 643 Bair Island Road, Suite 103 Redwood City, CA 94063 Phone: (650) 556-9384 FAX: (650) 556-9385

Revision Information and Key Dates

Revision Information and Key Dates	
SPC-1 Specification revision number	V1.12
SPC-1 Workload Generator revision number	V2.1.0
Date Results were first used publicly	December 27, 2011
Date the FDR was submitted to the SPC	December 27, 2011
Date the Priced Storage Configuration is available for shipment to customers	currently available
Date the TSC completed audit certification	December 27, 2011

Tested Storage Product (TSP) Description

The Fujitsu ETERNUS DX80 S2 is a flexible, highly reliable storage array, equipped with redundant components to provide uncompromised availability to the SMB Market requirements. A mixture of 300GB, 450GB, and 600GB disk drives in either 2.5" 10krpm or 3.5" 15krpm SAS are available. There are also 1TB and 2TB 7200rpm Nearline SAS drives and 100GB or 200GB SSD drives available. The product is offered with a choice of host interface connections, including Fibre Channel (as tested), iSCSI (1Gbps & 10Gbps), SAS (6Gbps), and FCoE (10Gbps). Up to 8 host ports can be provided, 4 on each of the two Control Modules. A number of different snapshot and replication facilities are available along with native disk data encryption, and MAID capabilities.

Summary of Results

SPC-1 Reported Data	
Tested Storage Product (TSP) Name: Fujitsu Storage Systems ETERNUS DX80 S2	
Metric	**Reported Result**
SPC-1 IOPS™	34,995.02
SPC-1 Price-Performance™	$2.25/SPC-1 IOPS™
Total ASU Capacity	9,700.000GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$78.757.00

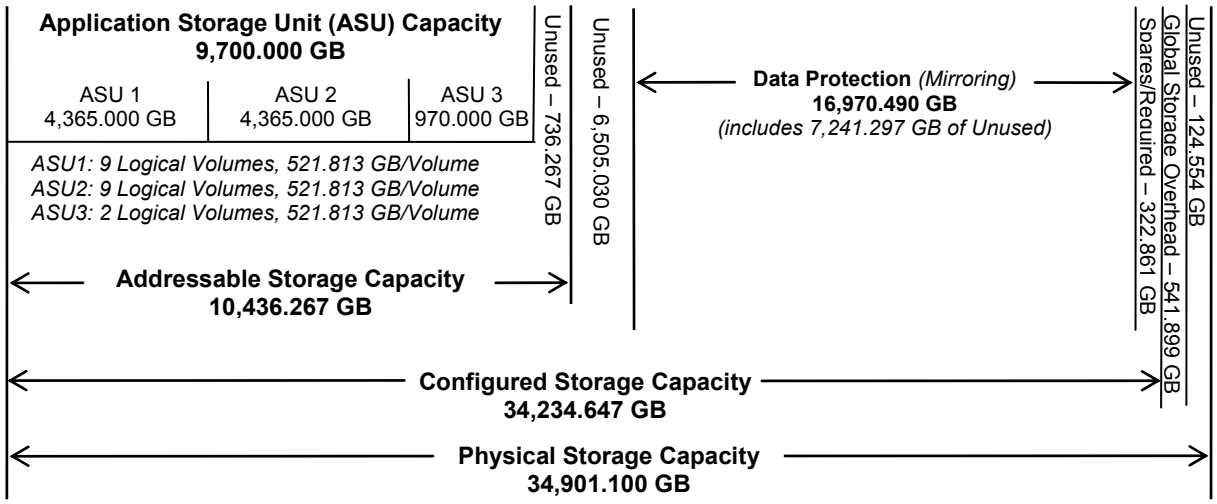
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

A **Data Protection Level** of **Protected *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	27.79%
Protected Application Utilization	55.67%
Unused Storage Ratio	41.85%

Application Utilization: Total ASU Capacity *(9,700.000 GB)* divided by Physical Storage Capacity *(34,901.100 GB)*

Protected Application Utilization: (Total ASU Capacity *(9,700.000 GB)* plus total Data Protection Capacity *(16,970.490 GB)* minus unused Data Protection Capacity *(7,241.297 GB)* divided by Physical Storage Capacity *(34,901.100 GB)*

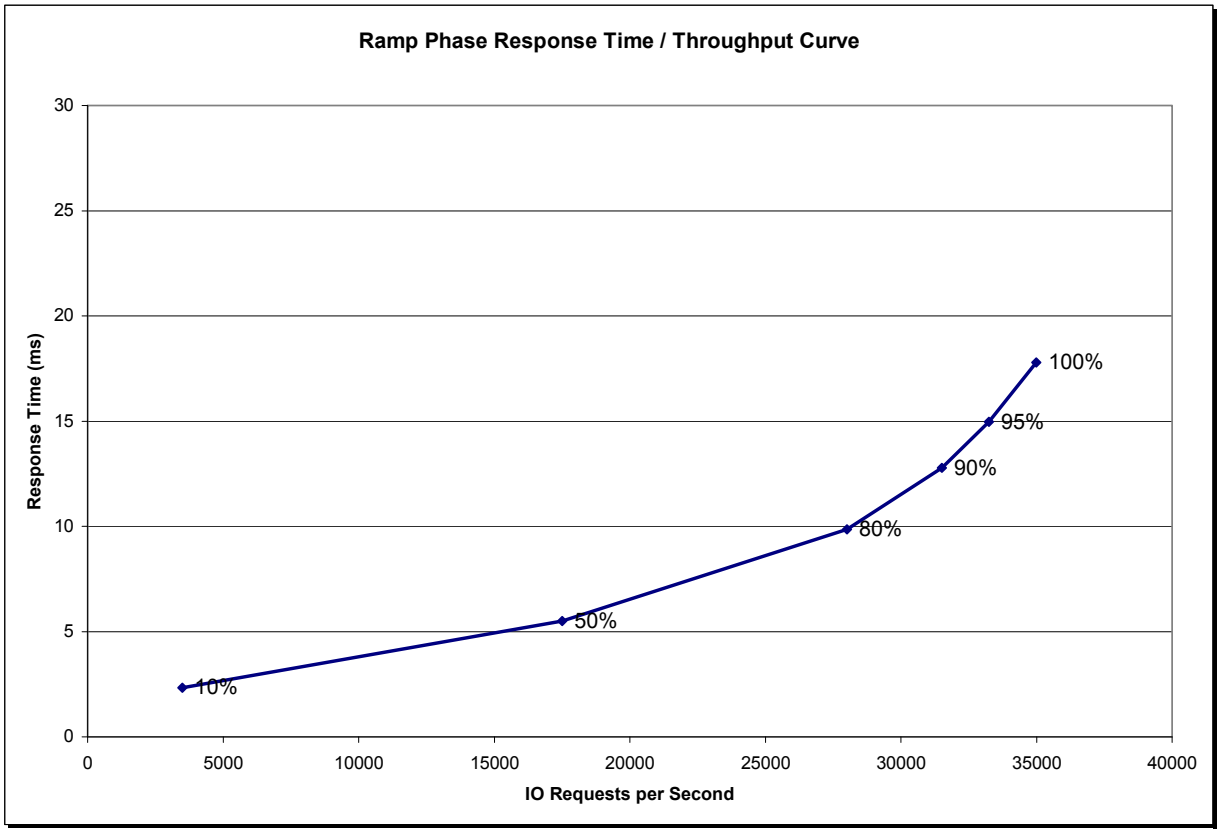
Unused Storage Ratio: Total Unused Capacity *(14,607.148 GB)* divided by Physical Storage Capacity *(34,901.100 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 20-21 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	3,496.86	17,507.97	28,005.44	31,502.57	33,244.01	34,995.02
Average Response Time (ms):						
All ASUs	2.33	5.50	9.85	12.78	14.97	17.79
ASU-1	3.17	6.75	11.12	13.62	15.34	17.68
ASU-2	2.27	6.27	12.93	17.81	21.25	25.26
ASU-3	0.55	2.52	5.80	8.80	11.44	14.77
Reads	5.06	10.15	17.19	21.71	24.85	28.99
Writes	0.55	2.47	5.06	6.97	8.53	10.50

Priced Storage Configuration Pricing

Product ID	Product Name	Qty	Unit List Price	Extended LP	Discount %	Discounted Price
ET082DCU	DX80 S2 Base System Rackmount (AC200V, 2RU) (2.5" HDD, Dual CM type)	1	$8,250.00	$8,250.00	30%	$5,775.00
ETEAD2CU	Drive Enclosure Rackmount (AC200V, 2RU) (2.5" HDD, Dual CM type)	4	$3,900.00	$15,600.00	30%	$10,920.00
ETEHF12	FC Host Interface, 2 ports (2/4/8Gbps, Host/Remote Connect)	4	$850.00	$3,400.00	30%	$2,380.00
ETED3HC	300GB/10krpm 2.5" Disk Drives	117	$460.00	$53,820.00	30%	$37,674.00
QLE2562 *(third-party)*	QLogic 8Gbps Dual Port Fibre Channel Host Bus Adapter	4	$2,598.00	$10,392.00	10%	$9,352.80
61-343827-003	Fibre Channel Cable LC-LC 3 m	8	$132.00	$1,056.00	30%	$739.20
	(Provide 24 hour per day / 7days per week 4 hour response maintenance for 36 months)					
ET082DCU	Base (36 mos, Enhanced Plus)	1	$3,276.00	$3,276.00		$3,276.00
ETEAD2CU	DE (36 mos, Enhanced Plus) ea.	4	$2,160.00	$8,640.00		$8,640.00
	SFPs are included.			**Total:**		**$78,757.00**

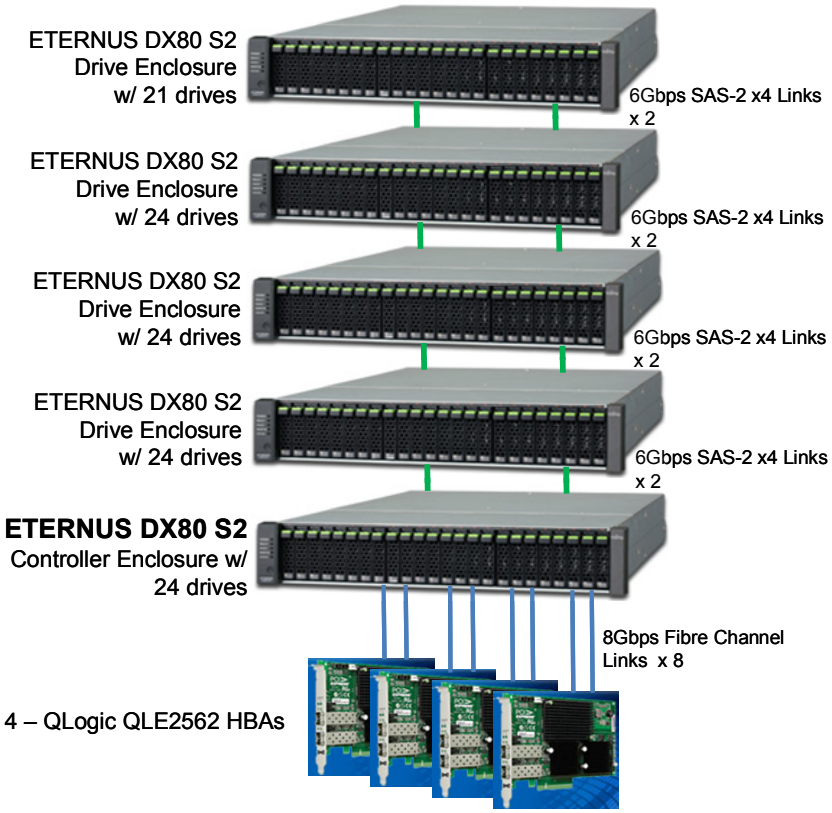
The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- Acknowledgement of new and existing problems with four (4) hours.
- Onsite present of a qualified maintenance engineer or provision of a customer replaceable part within four (4) hours of the above acknowledgement for any hardware failure that results in an inoperative Price Storage Configuration that can be remedied by the repair or replacement of a Priced Storage Configuration component.

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

The TSC was configured with eight (8) dual-port HBAs, of which four (4) were used in the benchmark measurements. The Priced Storage Configuration included only the four (4) HBAs that were used. This difference, if applied to the TSC, would not have had any impact on the benchmark measurements.

Priced Storage Configuration Diagram



Priced Storage Configuration Components

Priced Storage Configuration
4 – QLogic QLE2562 dual-port 8 Gbps FC HBAs
Fujitsu Storage Systems ETERNUS DX80 S2 2 – Controller Modules, each with: 4 GB cache *(8 GB total)* Flash Memory power fail protection 1 - SAS QSFP SAS Drive Enclosure interface *(backend connections to first drive enclosure; 2 total, 2 used)* 2 – Channel Adapter modules, each with 2 –8 Gbps Fibre Channel ports *(front-end Host connections, 8 total, 8 used)*
4 –ETERNUS DX80 S2 Drive Enclosures, each with 2 – I/O Modules, each with SAS QSFP SAS Drive Enclosure interface *(2 total, 2 used)*
117 – 300 GB 10K RPM 2.5" SAS Disk Drives *24 – ETERNUS DX80 S2 Controller Enclosure* *24 – ETERNUS DX80 S2 Drive Enclosure x 3* *21 – ETERNUS DX80 S2 Drive Enclosure x 1*

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 17 *(Benchmark Configuration/Tested 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 Benchmark Configuration (BC)/Tested Storage Configuration (TSC) was configured with local storage and, as such, did not employ a storage network.

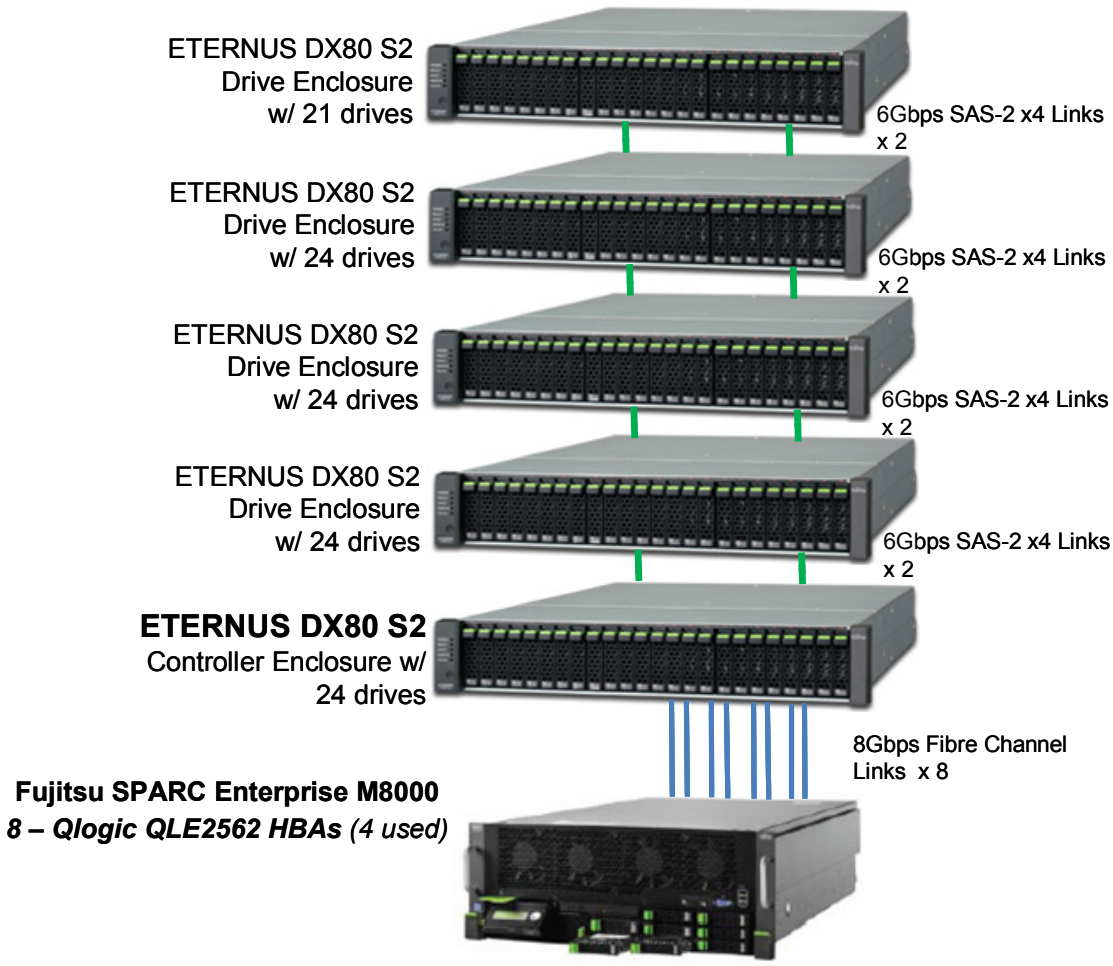
Host System and Tested Storage Configuration (TSC) Table of Components

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 18 *(Host Systems and Tested Storage Configuration Components).*

Benchmark Configuration/Tested Storage Configuration Diagram



Host Systems and Tested Storage Configuration Components

Host System:	Tested Storage Configuration (TSC):
Fujitsu SPARC Enterprise M80000 16 – SPARC64 VI 2.28 GHz quad-core processors, each with 128 KB L1 instruction cache and 6 MB L2 cache	4 – QLogic QLE2562 dual-port 8 Gbps FC HBAs
512 GB main memory	**Fujitsu Storage Systems ETERNUS DX80 S2** 2 – Controller Modules, each with: 4 GB cache *(8 GB total)* Flash Memory power fail protection 1 - SAS QSFP SAS Drive Enclosure interface *(backend connections to first drive enclosure; 2 total, 2 used)* 2 – Channel Adapter modules, each with 2 –8 Gbps Fibre Channel ports *(front-end Host connections, 8 total, 8 used)*
Solaris 10	4 –ETERNUS DX80 S2 Drive Enclosures, each with 2 – I/O Modules, each with SAS QSFP SAS Drive Enclosure interface *(2 total, 2 used)*
Point-to-Point crossbar with PCI I/O slots	117 – 300 GB 10K RPM 2.5" SAS Disk Drives *24 – ETERNUS DX80 S2 Controller Enclosure* *24 – ETERNUS DX80 S2 Drive Enclosure x 3* *21 – ETERNUS DX80 S2 Drive Enclosure x 1*

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

Tested Storage Configuration (TSC) Description

Clause 9.4.3.5.2

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 60 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 79.

SPC-1 DATA REPOSITORY

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

Storage Capacities and Relationships

Clause 9.4.3.6.1

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)	9,700.000
Addressable Storage Capacity	Gigabytes (GB)	10,436.267
Configured Storage Capacity	Gigabytes (GB)	34,234.647
Physical Storage Capacity	Gigabytes (GB)	34,901.100
Data Protection *(Mirroring)*	Gigabytes (GB)	16,970.490
Required Storage *(sparing)*	Gigabytes (GB)	322.861
Global Storage Overhead	Gigabytes (GB)	541.899
Total Unused Storage	Gigabytes (GB)	14,607.148

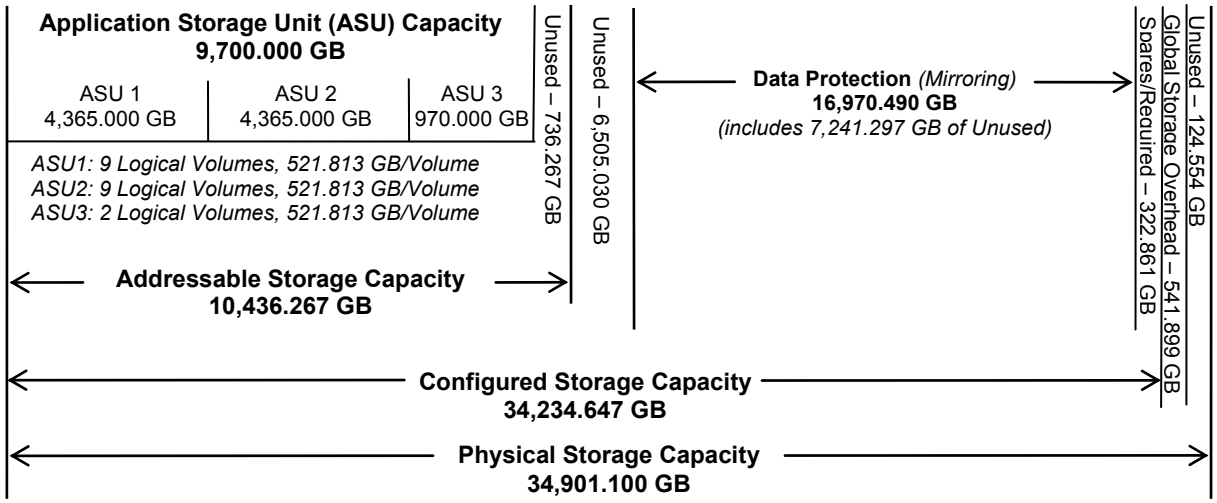
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	92.95%	28.33%	27.79%
Required for Data Protection *(Mirroring)*		49.57%	48.62%
Addressable Storage Capacity		30.48%	29.90%
Required Storage		0.94%	0.93%
Configured Storage Capacity			98.09%
Global Storage Overhead			1.55%
Unused Storage:			
Addressable	7.05%		
Configured		38.00%	
Physical			0.36%

The Physical Storage Capacity consisted of 34,901.100 GB distributed over 117 disk drives, each with a formatted capacity of 298.300 GB. There was 124.554 GB (0.36%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 541.899 GB (1.55%) of the Physical Storage Capacity. There was 13,010.060 GB (38.00%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 92.95% of the Addressable Storage Capacity resulting in 736.267 GB (7.05%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(Mirroring)* capacity was 16,970.490 GB of which 9,729.192 GB was utilized. The total Unused Storage was 14,607.148 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 (4,365.000 GB)	**ASU-2 (4,365.000 GB)**	**ASU-3 (970.000 GB)**
9 Logical Volumes 521.813 GB per Logical Volume (485.000 used per Logical Volume)	9 Logical Volumes 521.813 GB per Logical Volume (485.000 used per Logical Volume)	2 Logical Volumes 521.813 GB per Logical Volume (485.000 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	27.79%
Protected Application Utilization	55.67%
Unused Storage Ratio	41.85%

SPC-1 BENCHMARK EXECUTION RESULTS

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

Clause 5.4.3

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

SPC-1 Tests, Test Phases, and Test Runs

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

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

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

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

Primary Metrics Test – Sustainability Test Phase

Clause 5.4.4.1.1

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

Clause 5.4.4.1.2

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

Clause 5.4.4.1.4

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

Clause 9.4.3.7.1

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 80.

Sustainability Test Results File

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

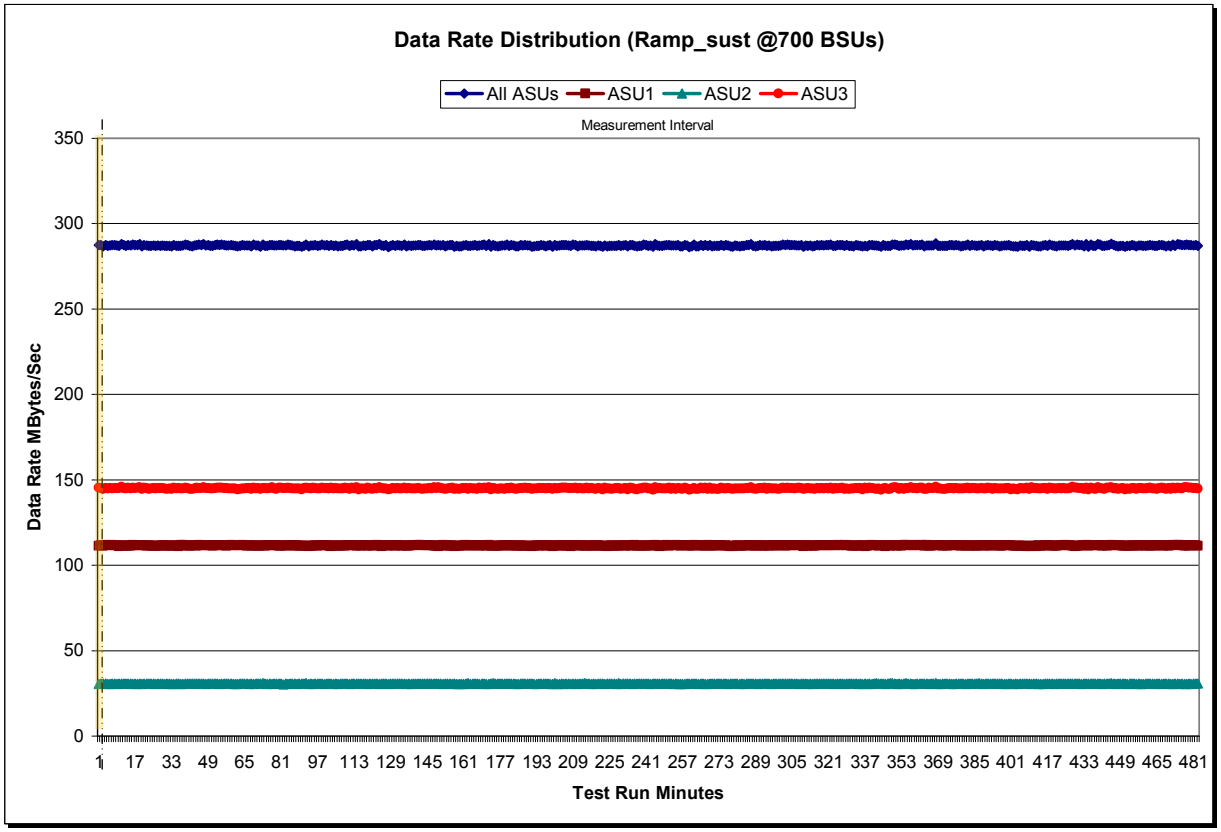
Sustainability Test Results File

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

The Sustainability Data Rate table of data is not embedded in this document due to its size. The table is available via the following URL:

Sustainability Data Tables

Sustainability – Data Rate Distribution Graph

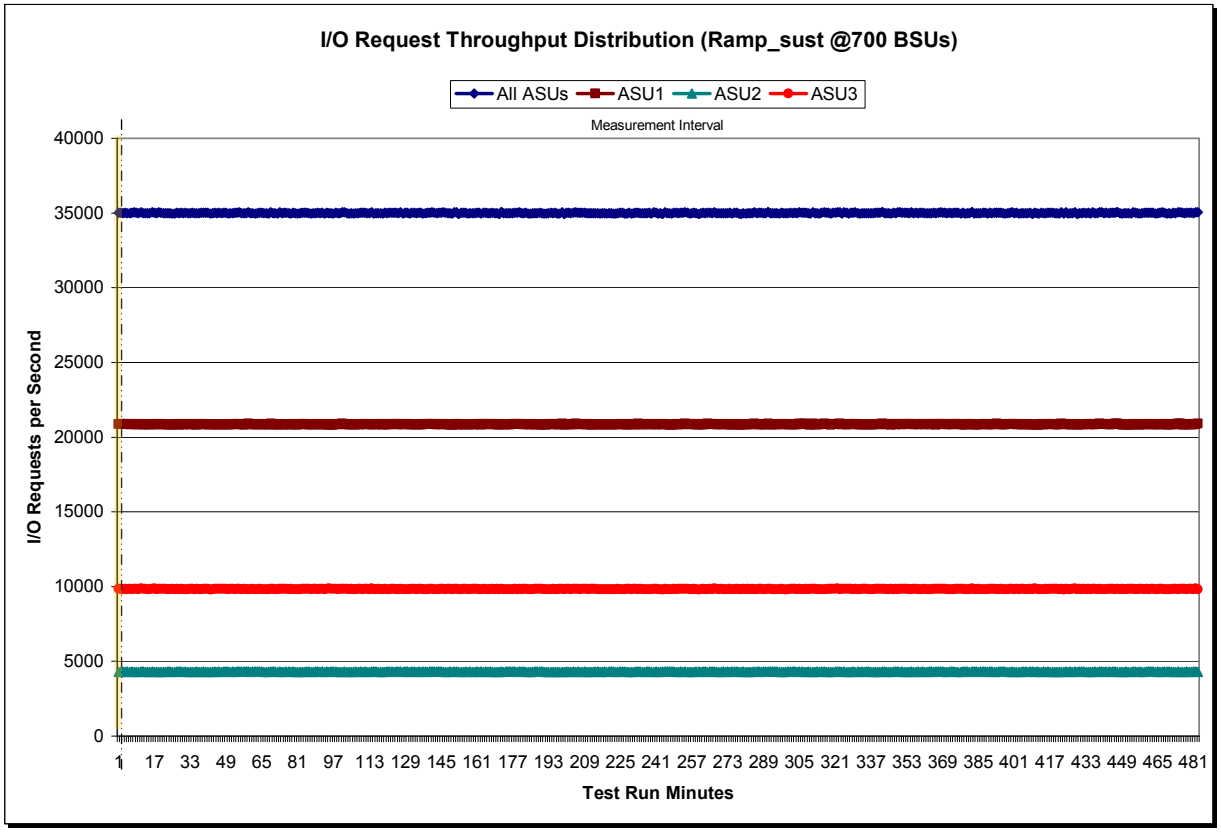


Sustainability – I/O Request Throughput Distribution Data

The Sustainability I/O Request Throughput table of data is not embedded in this document due to its size. The table is available via the following URL:

Sustainability Data Tables

Sustainability – I/O Request Throughput Distribution Graph

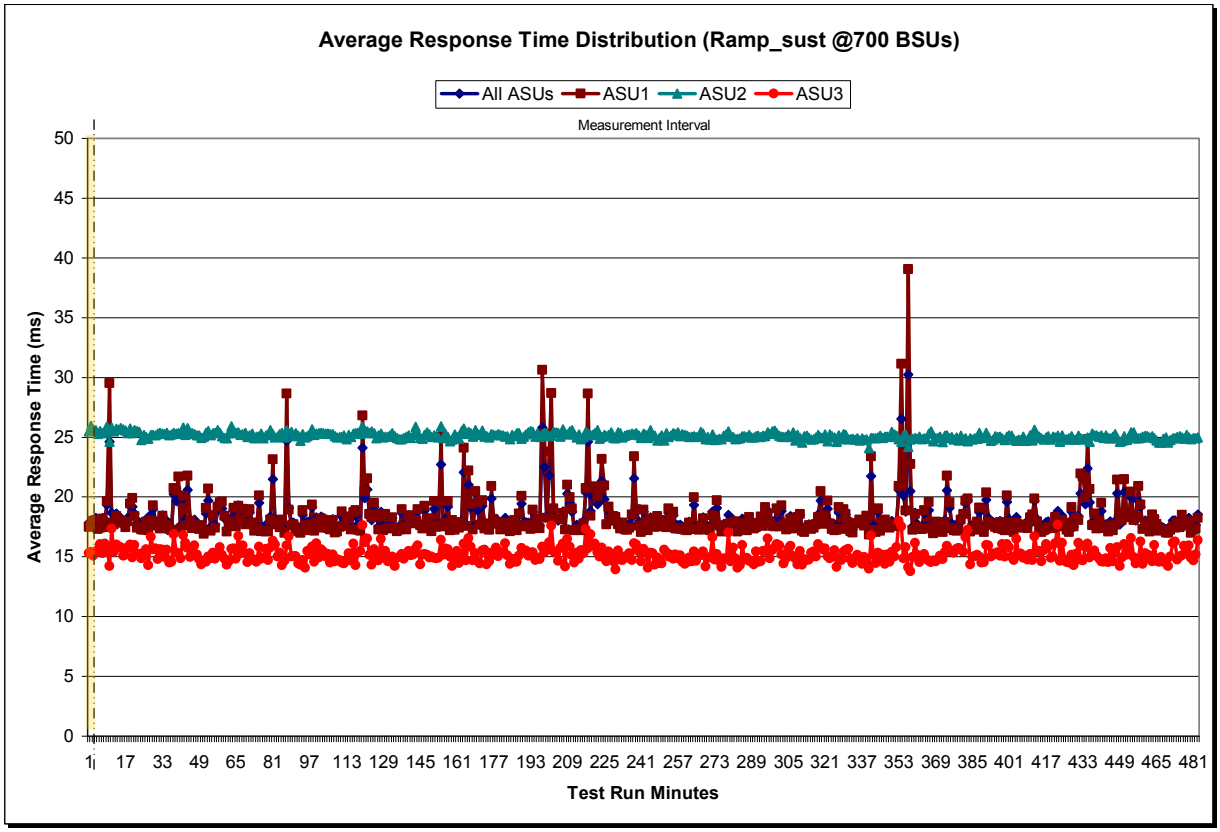


Sustainability – Average Response Time (ms) Distribution Data

The Sustainability Average Response Time table of data is not embedded in this document due to its size. The table is available via the following URL:

Sustainability Data Tables

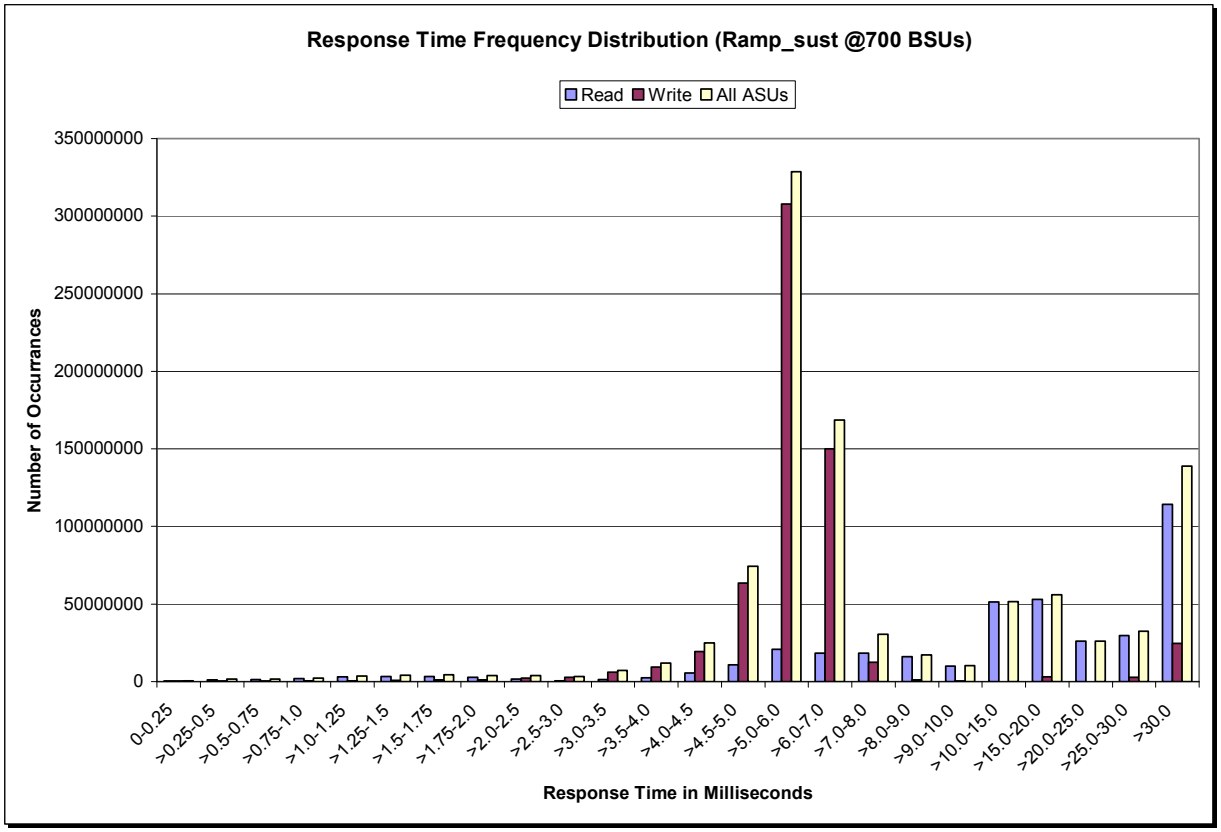
Sustainability – Average Response Time (ms) Distribution Graph



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	256,647	1,241,478	1,404,357	1,877,839	2,946,953	3,332,044	3,300,471	2,697,760
Write	177,458	407,085	392,852	447,935	591,170	828,277	999,986	1,059,060
All ASUs	434,105	1,648,563	1,797,209	2,325,774	3,538,123	4,160,321	4,300,457	3,756,820
ASU1	316,031	1,286,680	1,431,925	1,869,153	2,879,271	3,324,579	3,370,030	2,855,758
ASU2	48,692	186,207	211,358	280,201	424,297	503,899	524,675	465,169
ASU3	69,382	175,676	153,926	176,420	234,555	331,843	405,752	435,893
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	1,747,865	609,059	1,315,192	2,532,282	5,619,781	10,818,583	20,680,062	18,430,068
Write	2,186,827	2,769,657	6,022,568	9,412,611	19,384,330	63,438,184	307,956,284	150,137,753
All ASUs	3,934,692	3,378,716	7,337,760	11,944,893	25,004,111	74,256,767	328,636,346	168,567,821
ASU1	2,494,480	1,719,053	3,686,213	6,070,557	12,812,243	36,682,401	156,033,071	82,953,553
ASU2	524,923	475,888	1,030,412	1,733,579	3,701,563	9,896,237	37,486,108	17,291,328
ASU3	915,289	1,183,775	2,621,135	4,140,757	8,490,305	27,678,129	135,117,167	68,322,940
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	18,243,613	16,172,765	9,982,486	51,348,106	53,058,252	25,999,716	29,665,978	114,239,350
Write	12,352,284	989,472	228,640	100,981	3,082,881	82,294	2,764,609	24,671,474
All ASUs	30,595,897	17,162,237	10,211,126	51,449,087	56,141,133	26,082,010	32,430,587	138,910,824
ASU1	21,296,716	14,942,476	9,081,362	46,180,557	47,724,814	22,915,611	26,181,297	92,674,704
ASU2	2,671,981	1,566,672	975,459	5,208,866	6,226,446	3,110,529	4,130,126	25,312,720
ASU3	6,627,200	653,089	154,305	59,664	2,189,873	55,870	2,119,164	20,923,400

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	0.035	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.004	0.001	0.002	0.001	0.005	0.002	0.004	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 80.

IOPS Test Results File

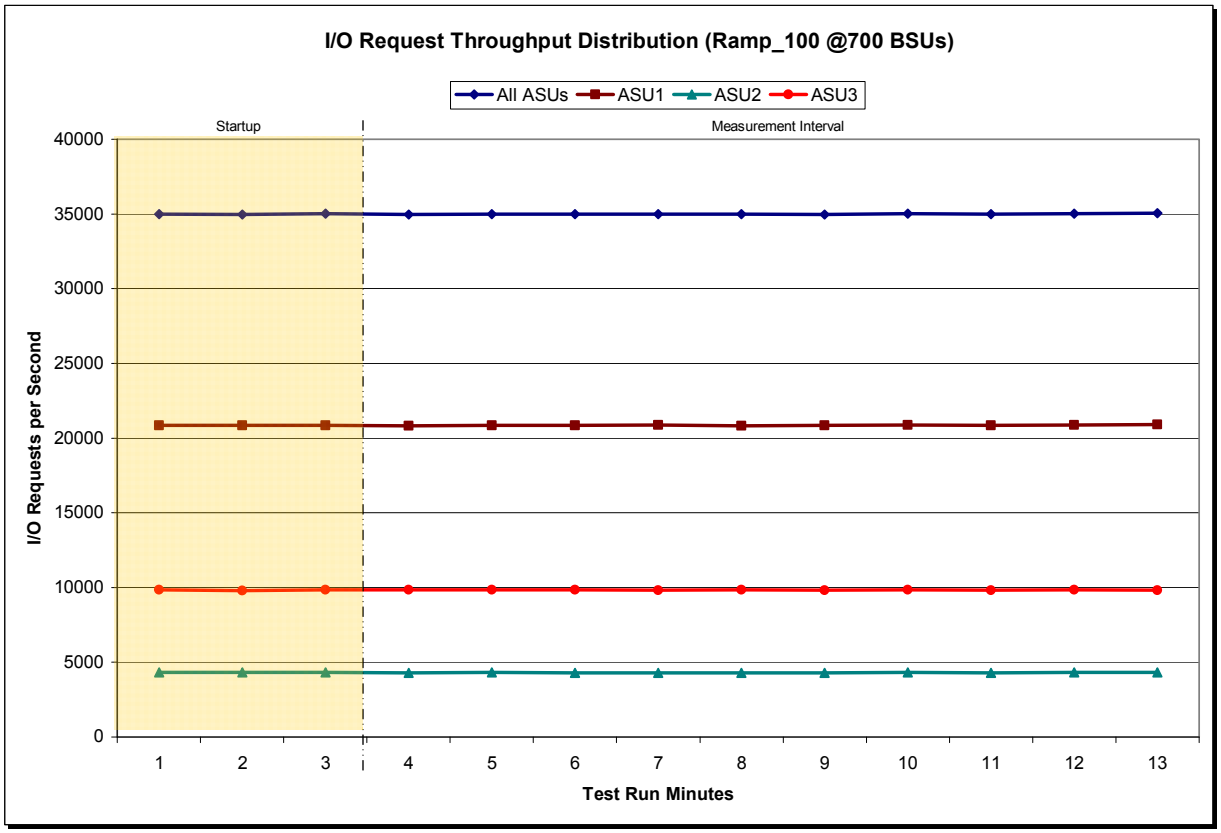
A link to the test results file generated from the IOPS Test Run is listed below.

IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

700 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:33:45	12:36:46	0-2	0:03:01
Measurement Interval	12:36:46	12:46:46	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	34,999.73	20,855.17	4,308.33	9,836.23
1	34,964.40	20,860.13	4,310.17	9,794.10
2	35,018.23	20,854.15	4,323.95	9,840.13
3	34,957.48	20,834.23	4,281.13	9,842.12
4	34,992.12	20,840.25	4,316.25	9,835.62
5	34,990.68	20,859.40	4,295.47	9,835.82
6	34,992.13	20,874.80	4,300.63	9,816.70
7	34,976.90	20,834.92	4,303.28	9,838.70
8	34,967.82	20,847.30	4,293.07	9,827.45
9	35,026.13	20,864.38	4,314.13	9,847.62
10	34,981.02	20,845.63	4,301.48	9,833.90
11	35,023.25	20,869.78	4,318.73	9,834.73
12	35,042.63	20,904.97	4,313.62	9,824.05
Average	***34,995.02***	***20,857.57***	***4,303.78***	***9,833.67***

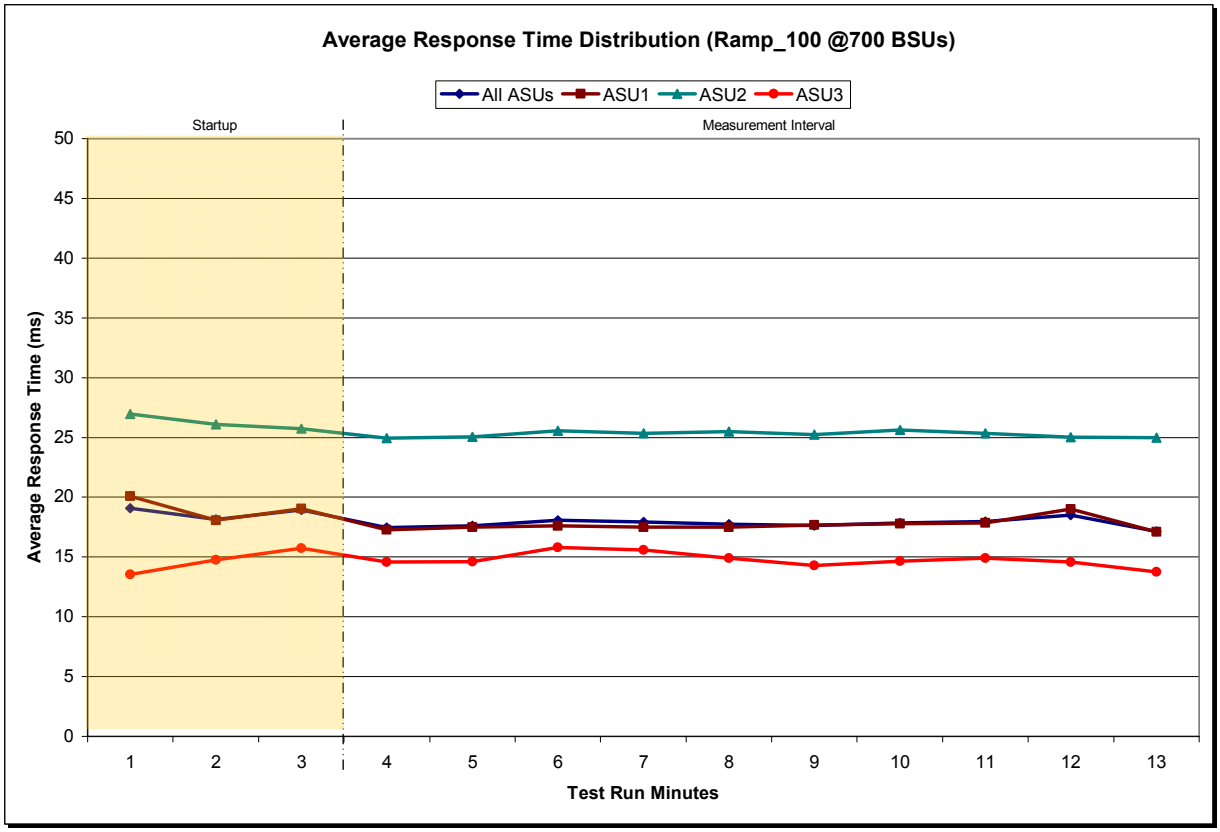
IOPS Test Run – I/O Request Throughput Distribution Graph



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

700 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:33:45	12:36:46	0-2	0:03:01
Measurement Interval	12:36:46	12:46:46	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	19.09	20.08	26.96	13.55
1	18.13	18.06	26.11	14.77
2	18.94	19.05	25.72	15.73
3	17.46	17.28	24.94	14.59
4	17.61	17.48	25.04	14.62
5	18.08	17.62	25.56	15.80
6	17.92	17.49	25.33	15.59
7	17.76	17.51	25.48	14.91
8	17.65	17.68	25.22	14.30
9	17.87	17.78	25.64	14.65
10	17.95	17.85	25.35	14.91
11	18.51	19.02	25.03	14.58
12	17.13	17.10	24.98	13.76
Average	***17.79***	***17.68***	***25.26***	***14.77***

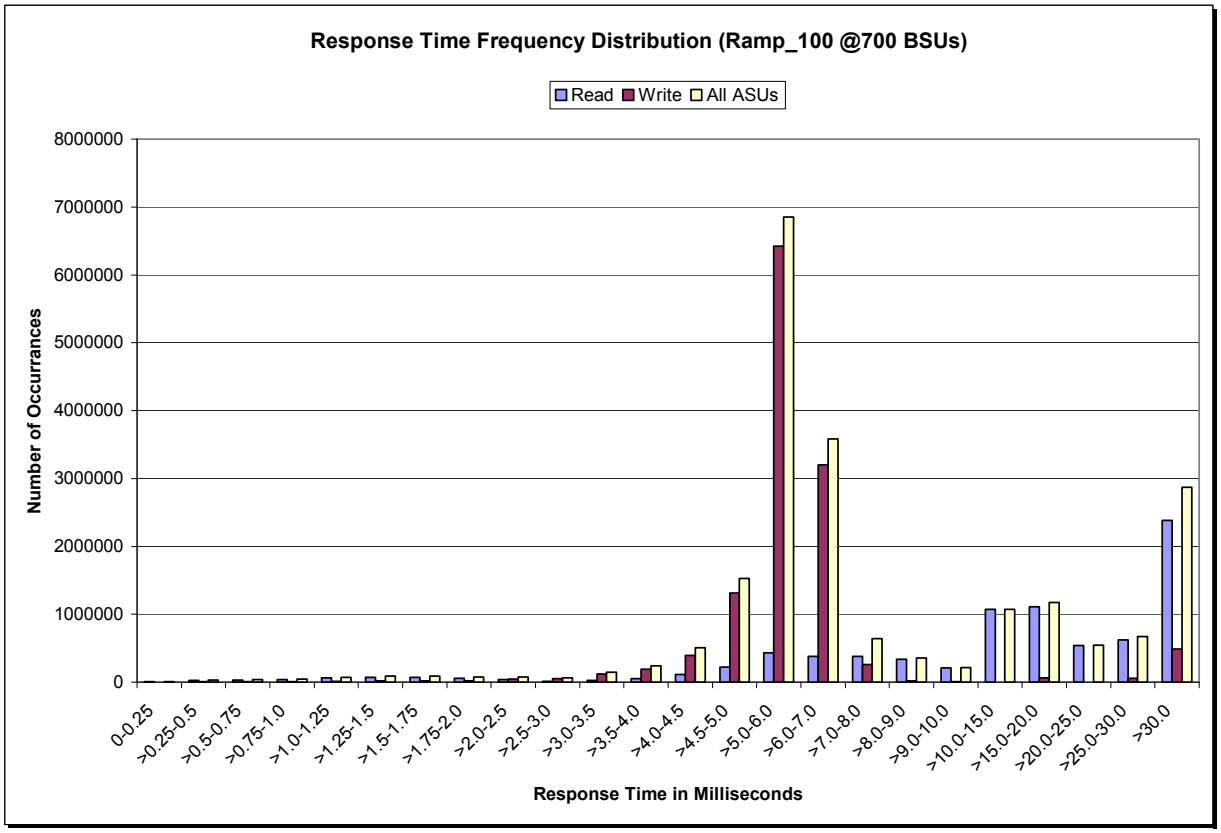
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	5,202	25,697	29,401	38,946	61,592	70,474	69,239	57,275
Write	203	4,031	6,684	8,111	11,263	16,089	19,719	20,830
All ASUs	5,405	29,728	36,085	47,057	72,855	86,563	88,958	78,105
ASU1	4,789	24,812	29,147	38,221	59,693	69,565	70,037	59,858
ASU2	552	3,455	4,434	5,737	8,852	10,585	10,973	9,775
ASU3	64	1,461	2,504	3,099	4,310	6,413	7,948	8,472
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	36,963	12,048	26,546	51,092	114,088	219,965	429,842	383,408
Write	42,154	53,309	120,162	192,155	396,140	1,309,171	6,422,987	3,201,099
All ASUs	79,117	65,357	146,708	243,247	510,228	1,529,136	6,852,829	3,584,507
ASU1	51,047	33,434	73,612	123,123	261,390	753,171	3,248,406	1,759,822
ASU2	10,608	9,180	20,735	35,551	75,261	202,872	779,986	367,459
ASU3	17,462	22,743	52,361	84,573	173,577	573,093	2,824,437	1,457,226
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	381,087	337,615	207,715	1,069,171	1,109,503	541,771	619,148	2,383,075
Write	261,122	20,492	4,661	1,662	61,181	1,308	54,787	486,238
All ASUs	642,209	358,107	212,376	1,070,833	1,170,684	543,079	673,935	2,869,313
ASU1	446,577	312,225	189,080	961,627	997,760	477,000	546,425	1,923,349
ASU2	56,209	32,636	20,268	108,245	129,938	65,151	85,804	527,907
ASU3	139,423	13,246	3,028	961	42,986	928	41,706	418,057

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
20,996,421	18,127,108	2,869,313

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	0.0179	0.0700	0.0350	0.2810
COV	0.003	0.001	0.002	0.001	0.005	0.002	0.004	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 80.

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 - 700 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:33:45	12:36:46	0-2	0:03:01
Measurement Interval	12:36:46	12:46:46	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	34,999.73	20,855.17	4,308.33	9,836.23
1	34,964.40	20,860.13	4,310.17	9,794.10
2	35,018.23	20,854.15	4,323.95	9,840.13
3	34,957.48	20,834.23	4,281.13	9,842.12
4	34,992.12	20,840.25	4,316.25	9,835.62
5	34,990.68	20,859.40	4,295.47	9,835.82
6	34,992.13	20,874.80	4,300.63	9,816.70
7	34,976.90	20,834.92	4,303.28	9,838.70
8	34,967.82	20,847.30	4,293.07	9,827.45
9	35,026.13	20,864.38	4,314.13	9,847.62
10	34,981.02	20,845.63	4,301.48	9,833.90
11	35,023.25	20,869.78	4,318.73	9,834.73
12	35,042.63	20,904.97	4,313.62	9,824.05
Average	34,995.02	20,857.57	4,303.78	9,833.67

95% Load Level - 665 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:46:54	12:49:55	0-2	0:03:01
Measurement Interval	12:49:55	12:59:55	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	33,217.68	19,786.27	4,084.73	9,346.68
1	33,259.92	19,844.83	4,088.83	9,326.25
2	33,269.32	19,810.22	4,098.87	9,360.23
3	33,256.40	19,834.75	4,096.00	9,325.65
4	33,229.80	19,807.05	4,085.98	9,336.77
5	33,262.03	19,819.98	4,085.07	9,356.98
6	33,235.62	19,821.28	4,091.02	9,323.32
7	33,254.07	19,831.37	4,091.07	9,331.63
8	33,238.88	19,808.32	4,090.97	9,339.60
9	33,266.98	19,824.60	4,093.57	9,348.82
10	33,231.38	19,791.25	4,098.78	9,341.35
11	33,252.15	19,804.92	4,082.08	9,365.15
12	33,212.75	19,788.93	4,088.48	9,335.33
Average	33,244.01	19,813.25	4,090.30	9,340.46

90% Load Level - 630 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:00:03	13:03:04	0-2	0:03:01
Measurement Interval	13:03:04	13:13:04	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	31,479.82	18,766.78	3,863.32	8,849.72
1	31,500.02	18,785.80	3,877.57	8,836.65
2	31,422.17	18,739.07	3,863.47	8,819.63
3	31,481.83	18,757.00	3,869.20	8,855.63
4	31,523.92	18,791.40	3,872.57	8,859.95
5	31,506.48	18,799.00	3,863.33	8,844.15
6	31,479.28	18,762.78	3,868.52	8,847.98
7	31,524.45	18,771.23	3,875.52	8,877.70
8	31,476.02	18,756.03	3,878.20	8,841.78
9	31,546.52	18,802.15	3,886.98	8,857.38
10	31,436.10	18,747.08	3,871.03	8,817.98
11	31,497.07	18,770.83	3,873.62	8,852.62
12	31,554.05	18,804.52	3,885.62	8,863.92
Average	31,502.57	18,776.20	3,874.46	8,851.91

80% Load Level - 560 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:13:12	13:16:13	0-2	0:03:01
Measurement Interval	13:16:13	13:26:13	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	28,016.25	16,703.40	3,444.68	7,868.17
1	27,984.23	16,694.83	3,431.98	7,857.42
2	27,990.42	16,673.43	3,445.17	7,871.82
3	28,018.12	16,698.07	3,440.32	7,879.73
4	27,998.37	16,681.18	3,445.63	7,871.55
5	27,975.18	16,678.22	3,439.25	7,857.72
6	28,012.10	16,688.15	3,450.28	7,873.67
7	28,013.83	16,696.02	3,443.42	7,874.40
8	28,000.22	16,687.73	3,456.03	7,856.45
9	28,005.80	16,700.03	3,450.07	7,855.70
10	27,991.07	16,693.62	3,441.75	7,855.70
11	28,034.17	16,707.58	3,451.00	7,875.58
12	28,005.50	16,697.47	3,447.85	7,860.18
Average	28,005.44	16,692.81	3,446.56	7,866.07

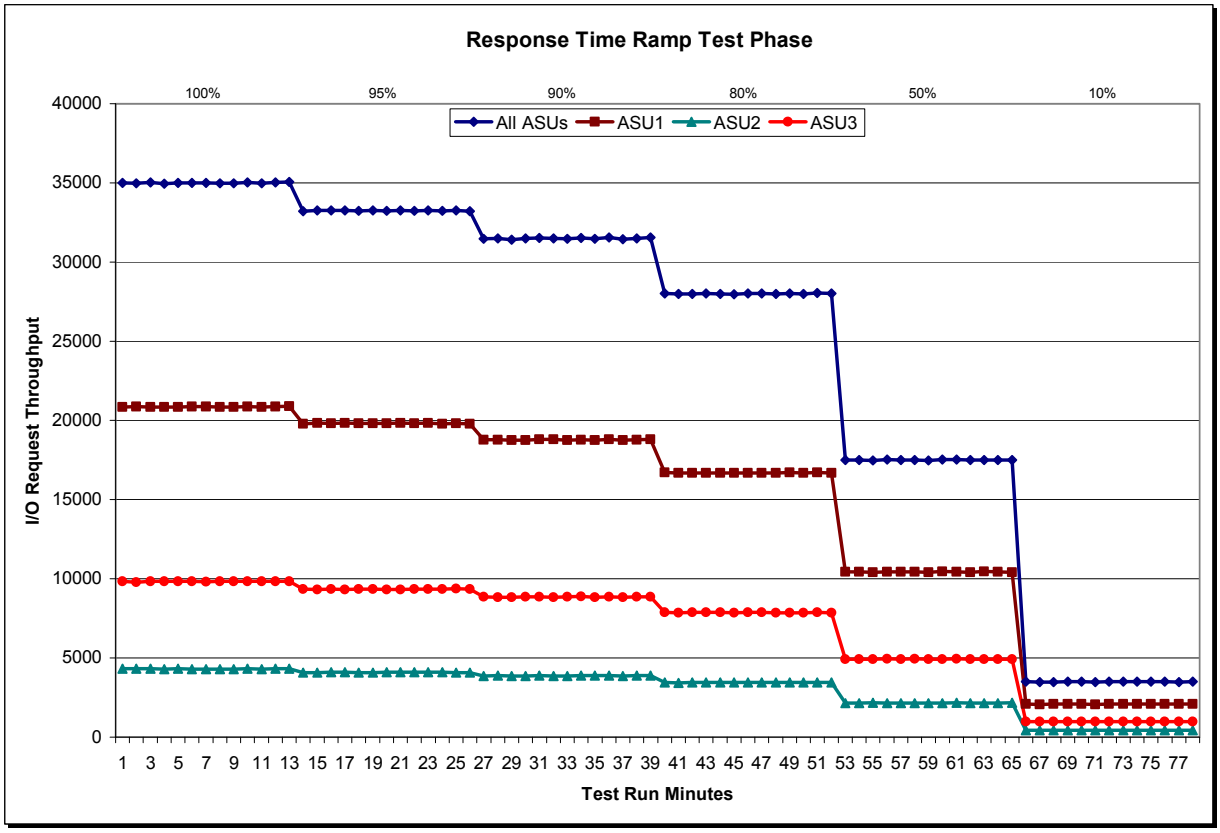
50% Load Level - 350 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:26:21	13:29:22	0-2	0:03:01
Measurement Interval	13:29:22	13:39:22	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	17,492.98	10,424.77	2,143.93	4,924.28
1	17,491.30	10,424.45	2,158.28	4,908.57
2	17,477.07	10,401.18	2,165.15	4,910.73
3	17,528.03	10,440.82	2,150.40	4,936.82
4	17,511.12	10,436.12	2,152.55	4,922.45
5	17,506.40	10,430.08	2,140.90	4,935.42
6	17,486.13	10,418.68	2,148.77	4,918.68
7	17,517.60	10,450.95	2,147.93	4,918.72
8	17,533.77	10,437.08	2,162.80	4,933.88
9	17,501.18	10,420.92	2,150.40	4,929.87
10	17,506.53	10,450.38	2,146.43	4,909.72
11	17,493.43	10,428.60	2,147.03	4,917.80
12	17,495.52	10,412.32	2,164.63	4,918.57
Average	17,507.97	10,432.60	2,151.19	4,924.19

10% Load Level - 70 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:39:30	13:42:31	0-2	0:03:01
Measurement Interval	13:42:31	13:52:31	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	3,507.48	2,087.92	432.80	986.77
1	3,486.33	2,075.52	427.30	983.52
2	3,488.52	2,082.20	429.37	976.95
3	3,498.90	2,083.28	434.92	980.70
4	3,497.97	2,083.20	430.67	984.10
5	3,489.98	2,078.22	430.17	981.60
6	3,499.37	2,085.62	427.75	986.00
7	3,492.28	2,083.08	424.87	984.33
8	3,494.87	2,083.50	433.27	978.10
9	3,495.82	2,080.97	431.27	983.58
10	3,511.28	2,091.83	430.90	988.55
11	3,489.85	2,080.67	425.47	983.72
12	3,498.27	2,084.17	429.95	984.15
Average	3,496.86	2,083.45	429.92	983.48

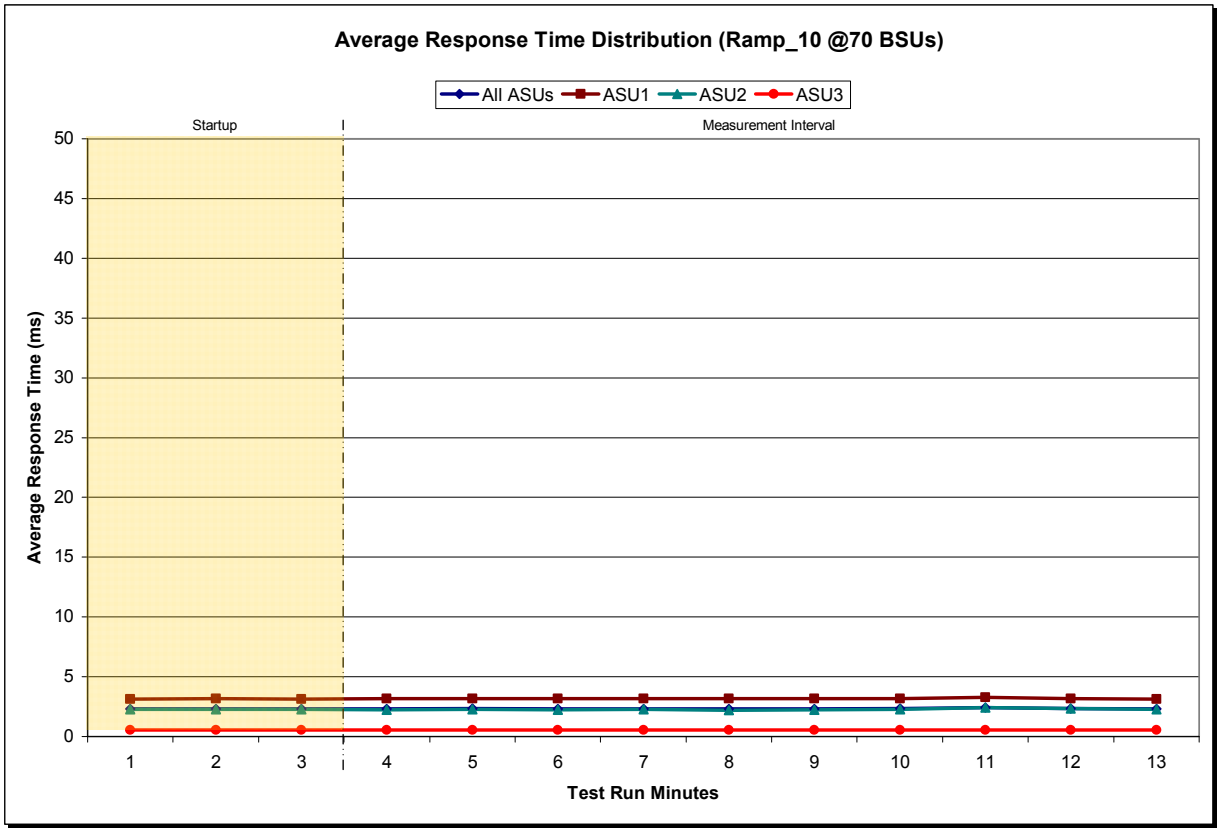
Response Time Ramp Distribution (IOPS) Graph



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

70 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:39:30	13:42:31	0-2	0:03:01
Measurement Interval	13:42:31	13:52:31	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.31	3.15	2.26	0.55
1	2.31	3.16	2.25	0.55
2	2.31	3.15	2.27	0.55
3	2.31	3.16	2.23	0.55
4	2.33	3.18	2.27	0.55
5	2.31	3.16	2.24	0.55
6	2.31	3.16	2.26	0.55
7	2.31	3.16	2.21	0.55
8	2.31	3.15	2.22	0.55
9	2.33	3.18	2.28	0.55
10	2.40	3.27	2.40	0.56
11	2.34	3.18	2.34	0.55
12	2.31	3.15	2.27	0.55
Average	***2.33***	***3.17***	***2.27***	***0.55***

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	0.0351	0.2803	0.0703	0.2101	0.0179	0.0700	0.0350	0.2812
COV	0.013	0.003	0.007	0.003	0.008	0.005	0.016	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 80.

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	***34,995.02***
Repeatability Test Phase 1	35,001.55
Repeatability Test Phase 2	35,005.19

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	***2.33 ms***
Repeatability Test Phase 1	2.31 ms
Repeatability Test Phase 2	2.31 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)..

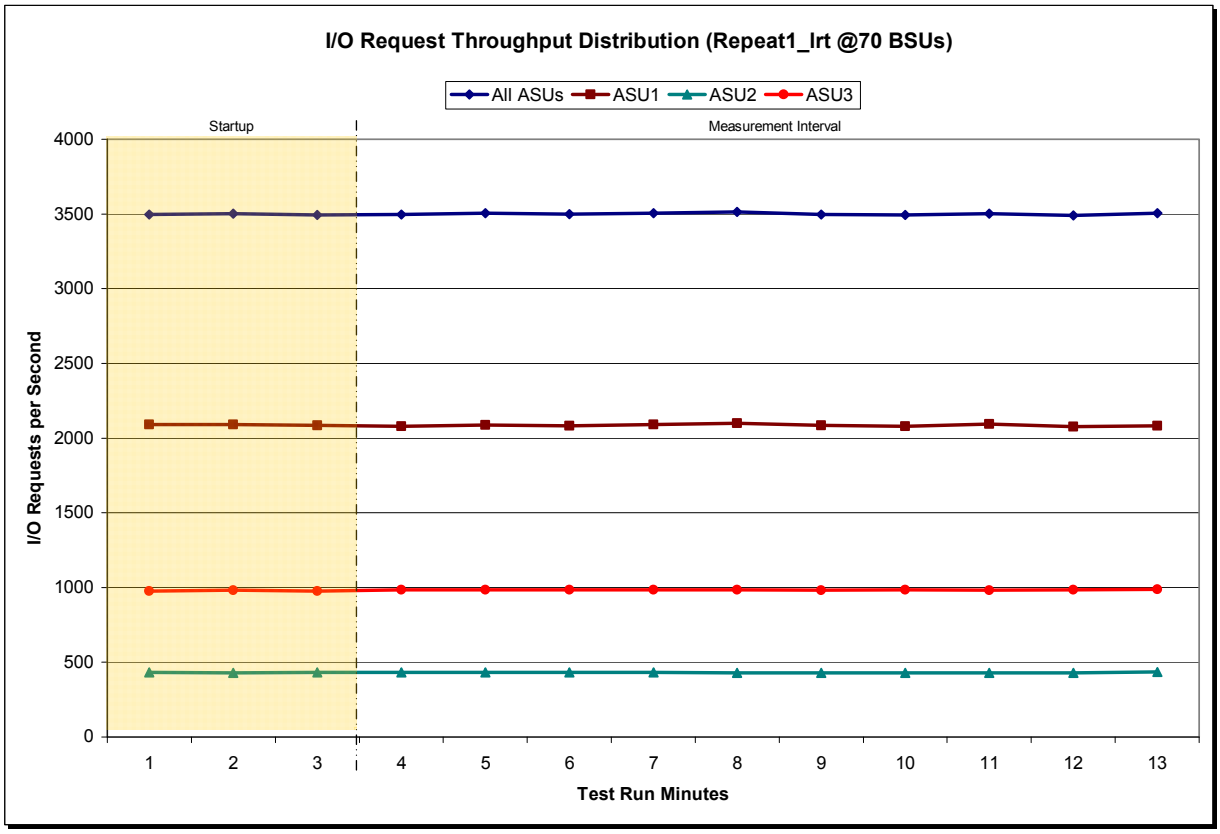
A link to the test result file generated from each Repeatability Test Run is listed below.

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

70 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:52:50	13:55:50	0-2	0:03:00
Measurement Interval	13:55:50	14:05:50	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	3,496.62	2,089.72	430.78	976.12
1	3,501.87	2,090.92	428.95	982.00
2	3,492.45	2,086.00	430.70	975.75
3	3,495.73	2,079.75	432.10	983.88
4	3,505.52	2,088.35	432.43	984.73
5	3,500.28	2,081.68	432.50	986.10
6	3,504.45	2,089.50	430.58	984.37
7	3,512.08	2,099.15	429.08	983.85
8	3,497.27	2,084.57	430.27	982.43
9	3,492.50	2,080.15	427.72	984.63
10	3,502.78	2,092.62	429.35	980.82
11	3,489.05	2,076.15	428.72	984.18
12	3,505.55	2,083.08	434.88	987.58
Average	***3,500.52***	***2,085.50***	***430.76***	***984.26***

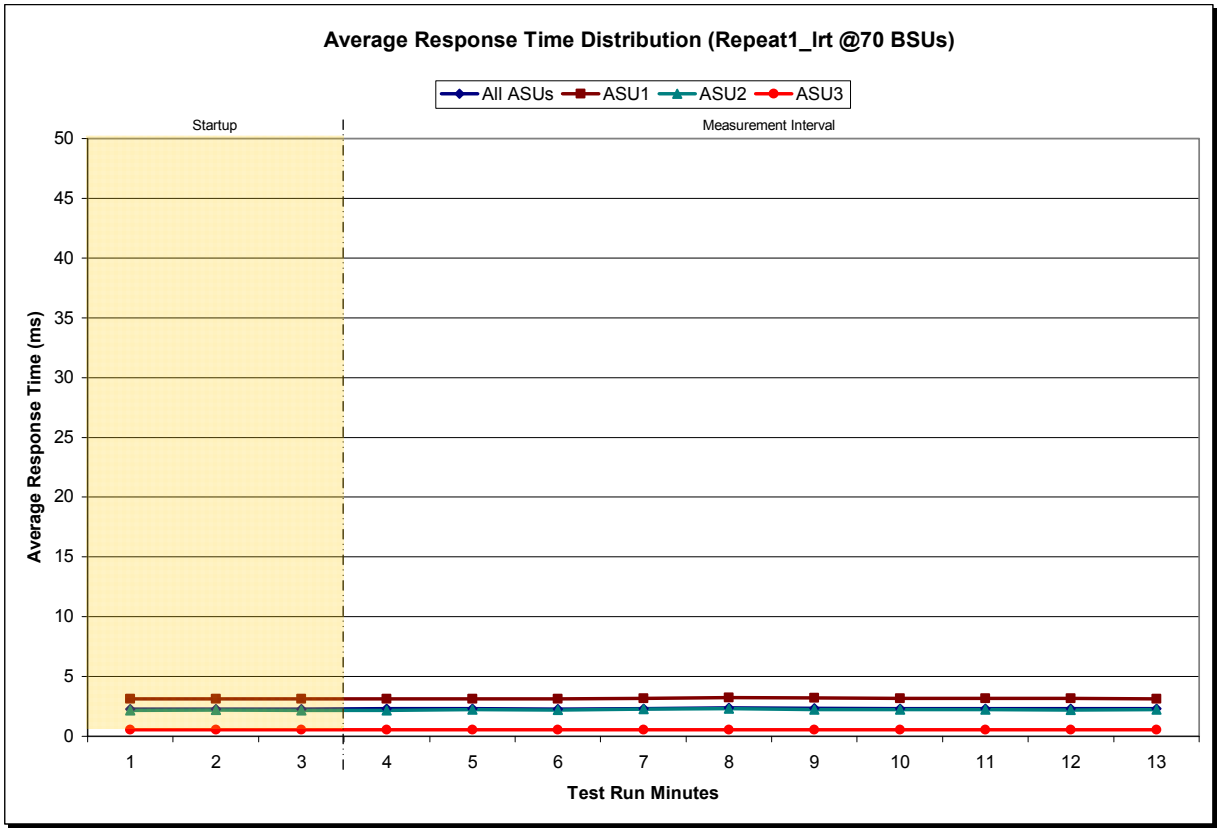
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

70 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:52:50	13:55:50	0-2	0:03:00
Measurement Interval	13:55:50	14:05:50	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.28	3.12	2.17	0.54
1	2.28	3.12	2.18	0.55
2	2.28	3.12	2.16	0.55
3	2.29	3.14	2.17	0.55
4	2.29	3.13	2.24	0.55
5	2.28	3.12	2.21	0.55
6	2.32	3.17	2.26	0.55
7	2.36	3.22	2.29	0.55
8	2.33	3.19	2.23	0.55
9	2.31	3.16	2.24	0.55
10	2.31	3.15	2.22	0.55
11	2.30	3.16	2.19	0.55
12	2.30	3.14	2.22	0.55
Average	***2.31***	***3.16***	***2.23***	***0.55***

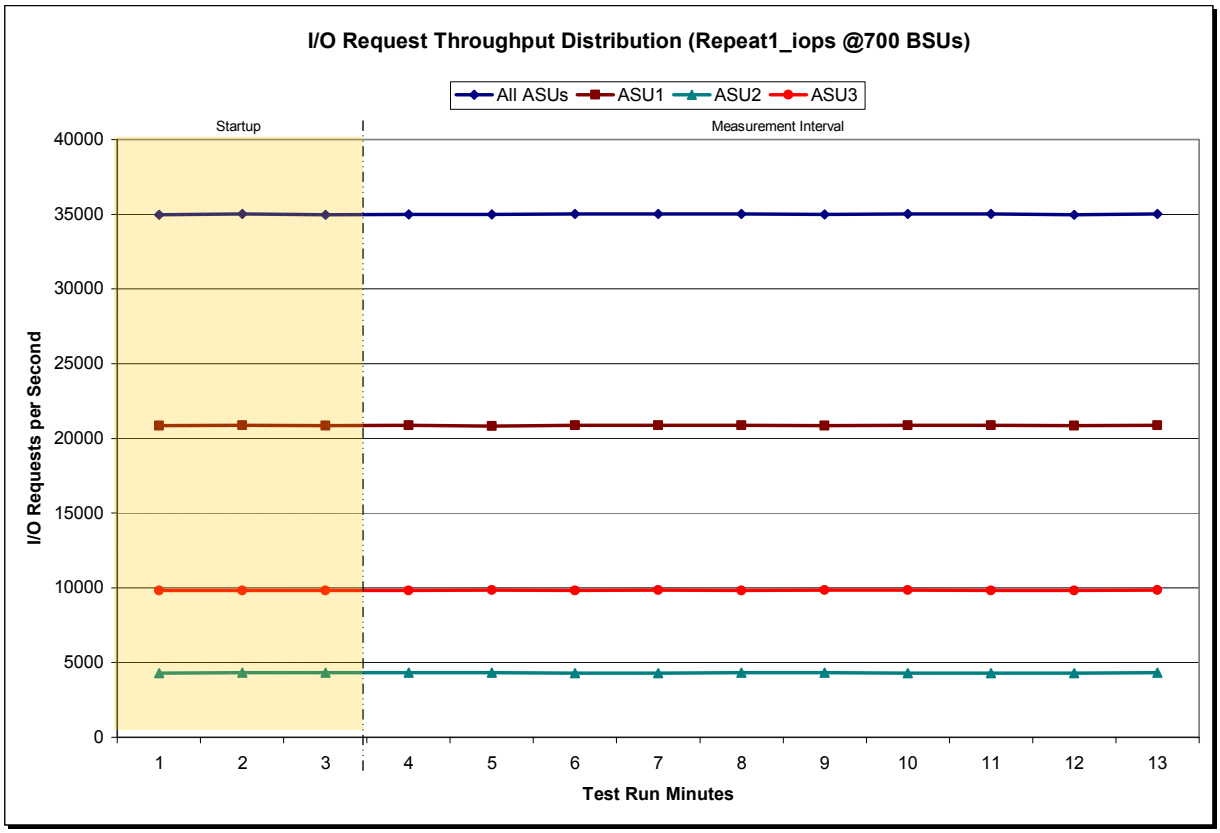
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

700 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:05:59	14:09:00	0-2	0:03:01
Measurement Interval	14:09:00	14:19:00	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	34,961.57	20,846.87	4,290.23	9,824.47
1	35,020.10	20,877.12	4,313.23	9,829.75
2	34,964.15	20,838.23	4,306.70	9,819.22
3	34,998.92	20,867.03	4,314.57	9,817.32
4	34,989.25	20,834.73	4,309.25	9,845.27
5	35,005.33	20,879.85	4,302.05	9,823.43
6	35,018.07	20,871.68	4,296.53	9,849.85
7	35,010.60	20,873.82	4,312.68	9,824.10
8	34,980.23	20,836.55	4,307.13	9,836.55
9	35,017.98	20,874.62	4,305.17	9,838.20
10	35,003.97	20,878.17	4,296.78	9,829.02
11	34,965.52	20,849.12	4,300.23	9,816.17
12	35,025.63	20,878.30	4,311.25	9,836.08
Average	***35,001.55***	***20,864.39***	***4,305.57***	***9,831.60***

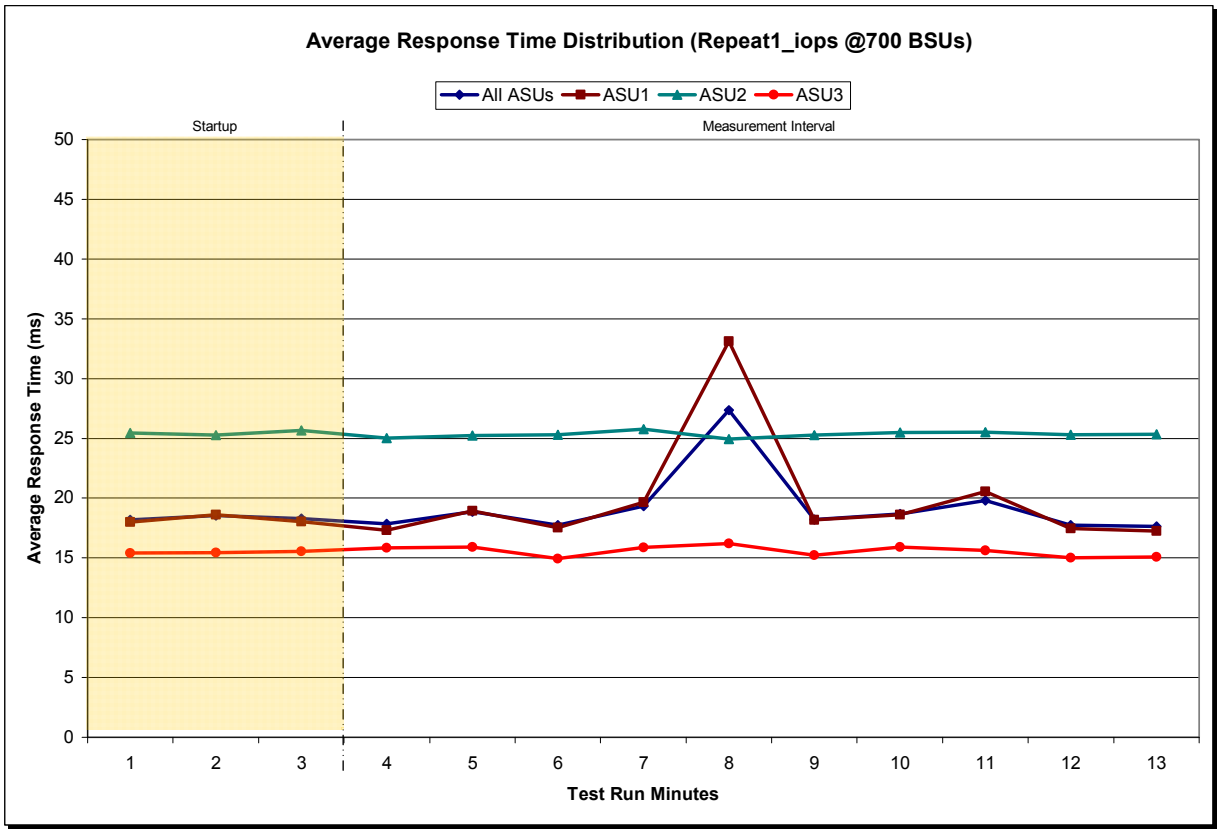
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

700 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:05:59	14:09:00	0-2	0:03:01
Measurement Interval	14:09:00	14:19:00	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	18.19	18.00	25.46	15.41
1	18.55	18.62	25.26	15.44
2	18.28	18.04	25.65	15.55
3	17.84	17.30	25.00	15.85
4	18.86	18.94	25.22	15.92
5	17.76	17.54	25.31	14.93
6	19.33	19.65	25.78	15.86
7	27.37	33.13	24.96	16.20
8	18.22	18.18	25.28	15.22
9	18.70	18.62	25.47	15.91
10	19.79	20.57	25.51	15.62
11	17.74	17.46	25.32	15.00
12	17.64	17.25	25.36	15.09
Average	***19.33***	***19.86***	***25.32***	***15.56***

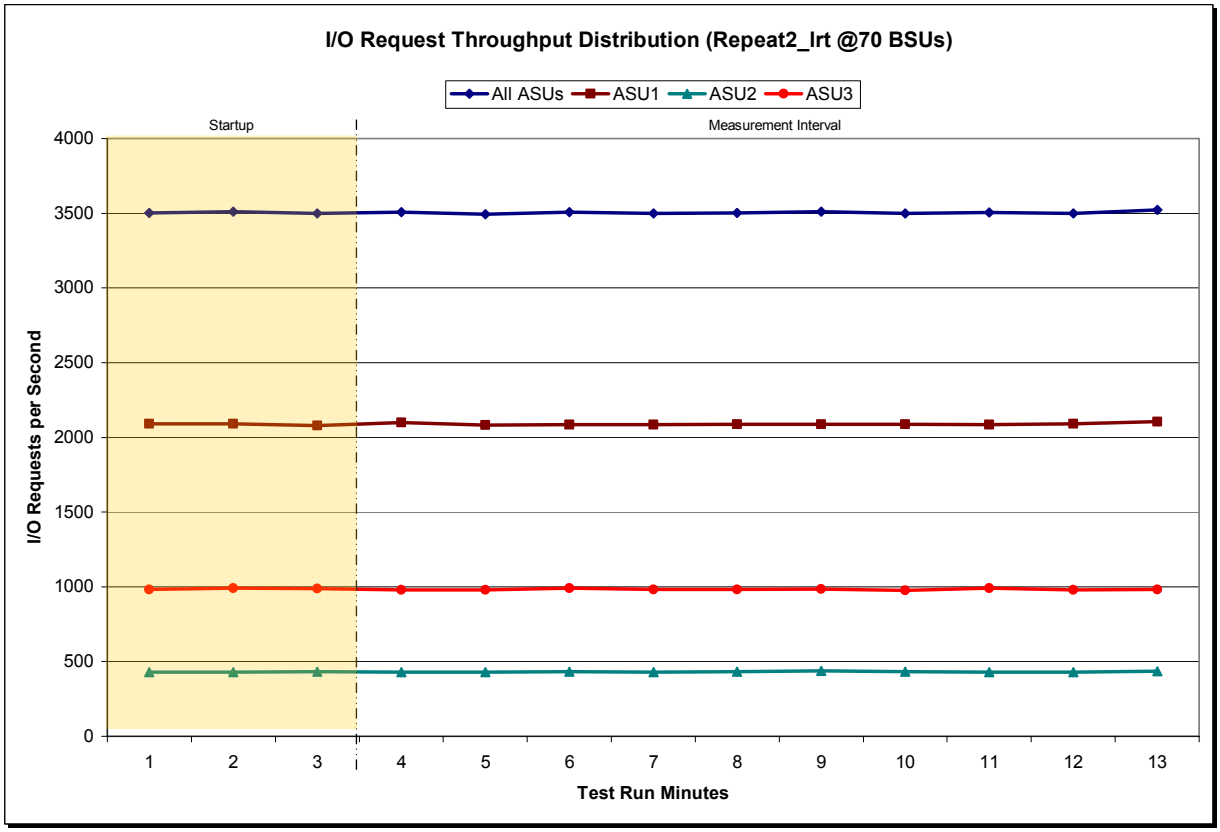
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

70 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:19:19	14:22:19	0-2	0:03:00
Measurement Interval	14:22:19	14:32:19	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	3,501.02	2,092.03	428.18	980.80
1	3,511.02	2,091.32	429.77	989.93
2	3,499.62	2,079.03	432.78	987.80
3	3,508.82	2,098.23	430.30	980.28
4	3,493.78	2,083.37	430.28	980.13
5	3,507.33	2,085.15	431.43	990.75
6	3,497.83	2,086.15	430.25	981.43
7	3,502.37	2,088.67	432.85	980.85
8	3,509.48	2,087.18	438.10	984.20
9	3,497.95	2,088.78	432.20	976.97
10	3,504.45	2,084.97	429.85	989.63
11	3,497.50	2,090.23	429.17	978.10
12	3,522.95	2,106.42	433.72	982.82
Average	***3,504.25***	***2,089.92***	***431.82***	***982.52***

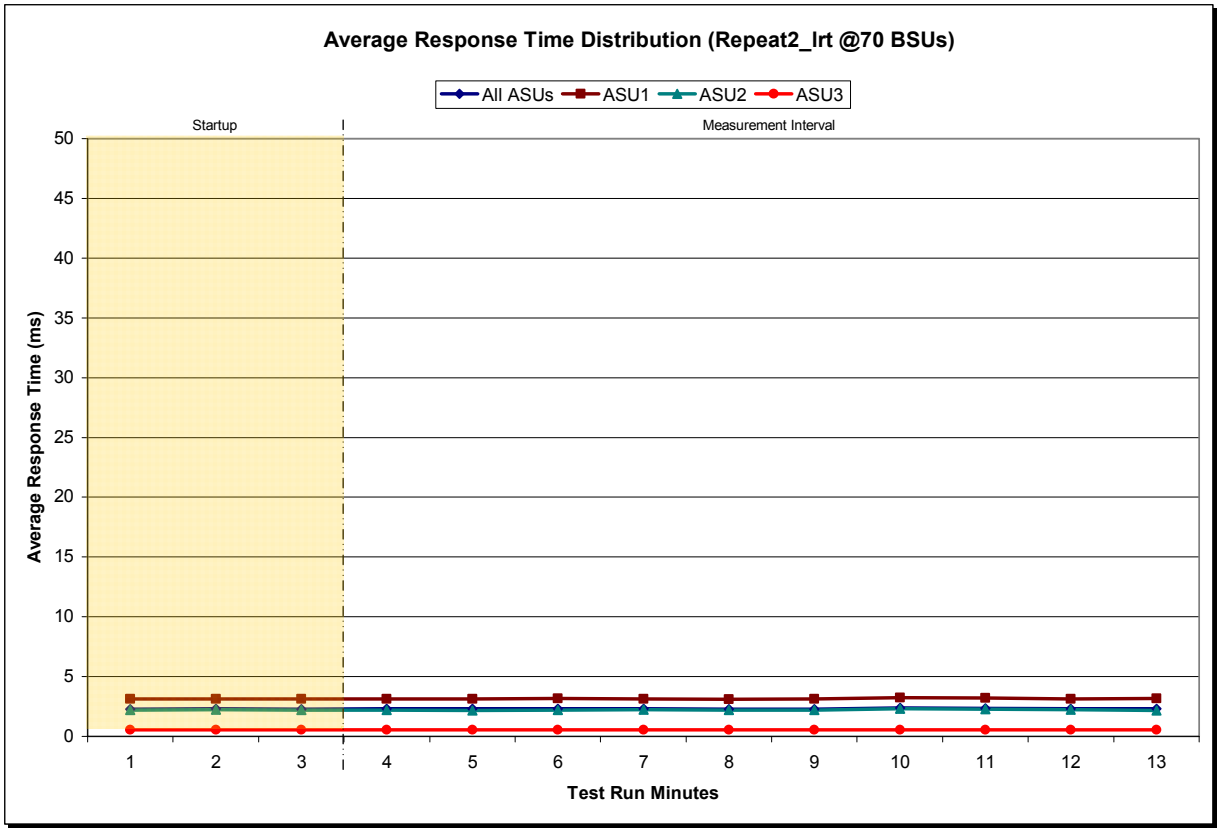
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

70 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:19:19	14:22:19	0-2	0:03:00
Measurement Interval	14:22:19	14:32:19	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	2.28	3.11	2.18	0.54
1	2.29	3.12	2.21	0.55
2	2.28	3.13	2.18	0.54
3	2.29	3.13	2.19	0.55
4	2.29	3.14	2.17	0.54
5	2.30	3.15	2.19	0.55
6	2.30	3.15	2.22	0.55
7	2.28	3.11	2.18	0.55
8	2.28	3.12	2.18	0.55
9	2.38	3.26	2.30	0.55
10	2.34	3.21	2.28	0.55
11	2.31	3.14	2.24	0.54
12	2.31	3.16	2.17	0.55
Average	***2.31***	***3.16***	***2.21***	***0.55***

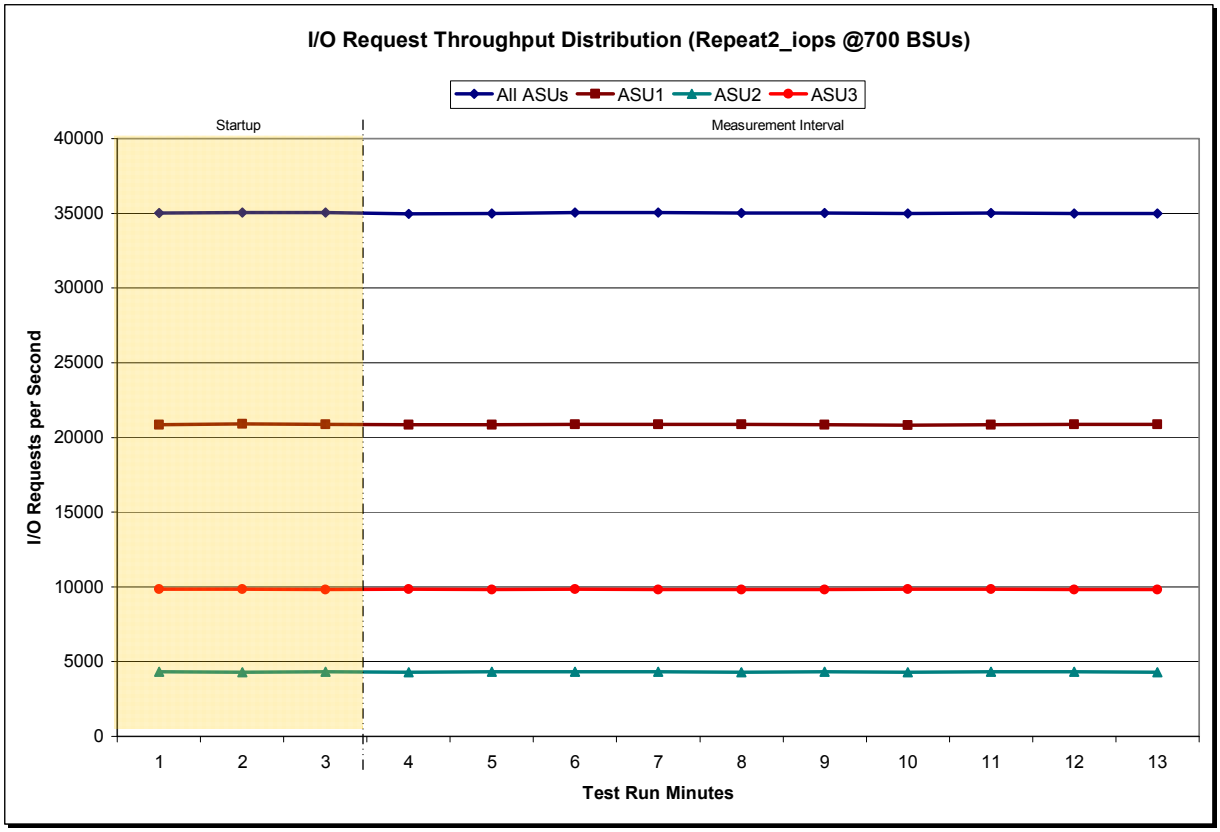
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

700 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:32:28	14:35:29	0-2	0:03:01
Measurement Interval	14:35:29	14:45:29	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	35,016.57	20,839.28	4,322.37	9,854.92
1	35,045.60	20,895.70	4,303.23	9,846.67
2	35,037.45	20,890.55	4,313.58	9,833.32
3	34,970.30	20,837.52	4,294.10	9,838.68
4	34,977.30	20,851.03	4,310.27	9,816.00
5	35,059.63	20,890.18	4,314.78	9,854.67
6	35,038.60	20,892.10	4,313.28	9,833.22
7	35,014.05	20,881.02	4,304.23	9,828.80
8	35,007.53	20,857.42	4,316.85	9,833.27
9	34,983.52	20,835.03	4,291.25	9,857.23
10	35,011.15	20,863.05	4,305.73	9,842.37
11	35,001.73	20,870.22	4,305.67	9,825.85
12	34,988.08	20,871.60	4,297.85	9,818.63
Average	***35,005.19***	***20,864.92***	***4,305.40***	***9,834.87***

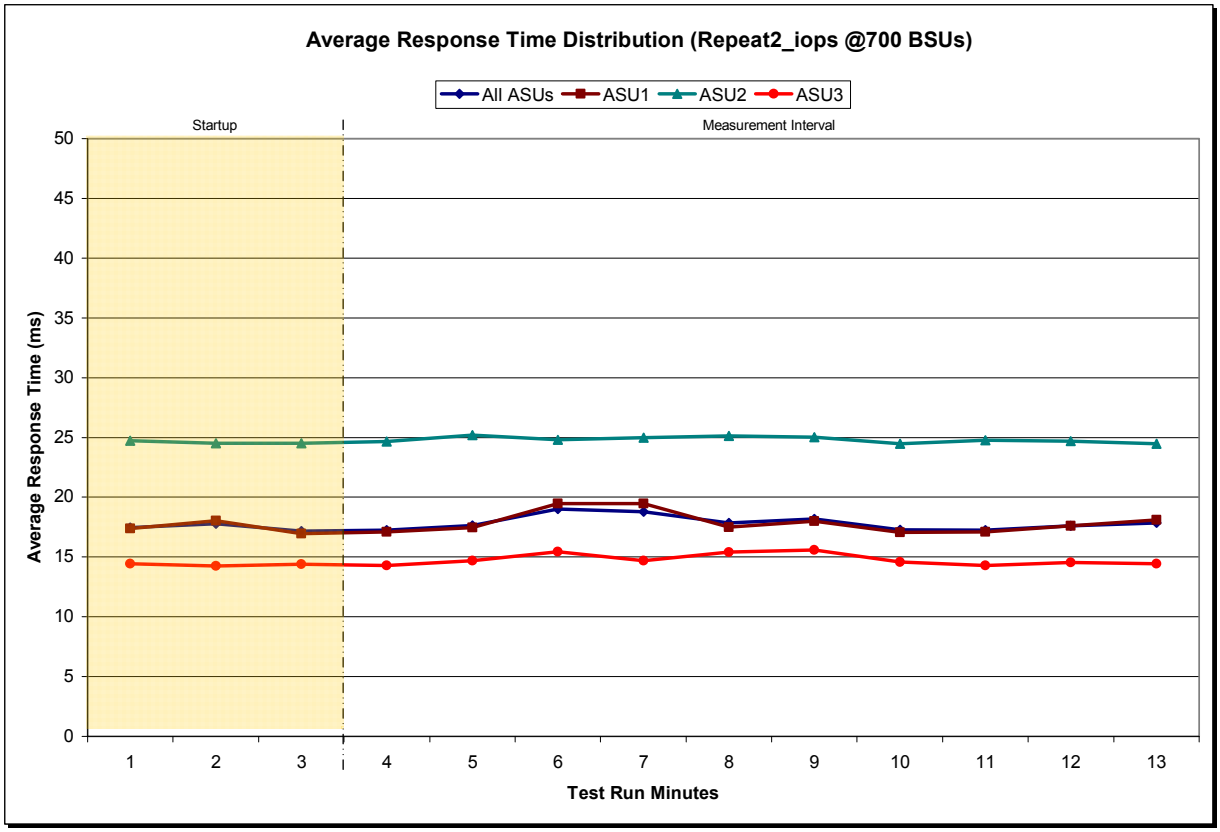
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

700 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:32:28	14:35:29	0-2	0:03:01
Measurement Interval	14:35:29	14:45:29	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	17.45	17.37	24.72	14.45
1	17.77	18.03	24.52	14.27
2	17.17	16.96	24.52	14.39
3	17.24	17.10	24.65	14.30
4	17.64	17.47	25.18	14.69
5	19.00	19.48	24.80	15.45
6	18.80	19.47	24.99	14.68
7	17.84	17.49	25.14	15.40
8	18.19	18.00	25.01	15.59
9	17.28	17.08	24.47	14.57
10	17.25	17.11	24.76	14.28
11	17.62	17.61	24.71	14.54
12	17.86	18.11	24.46	14.43
Average	***17.87***	***17.89***	***24.82***	***14.79***

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	0.0351	0.2809	0.0698	0.2100	0.0179	0.0700	0.0351	0.2812
COV	0.014	0.003	0.008	0.006	0.020	0.006	0.009	0.003

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	0.2809
COV	0.004	0.001	0.002	0.001	0.006	0.003	0.004	0.001

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2814	0.0701	0.2100	0.0181	0.0701	0.0350	0.2804
COV	0.011	0.004	0.005	0.004	0.015	0.006	0.015	0.004

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0349	0.2812	0.0700	0.2099	0.0180	0.0700	0.0350	0.2810
COV	0.004	0.001	0.003	0.002	0.003	0.003	0.003	0.001

Data Persistence Test

Clause 6

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

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

The SPC-1 Workload Generator will write 16 block I/O requests at random over the total Addressable Storage Capacity of the TSC for ten (10) minutes at a minimum of 25% of the load used to generate the SPC-1 IOPS™ primary metric. The bit pattern selected to be written to each block as well as the address of the block will be retained in a log file.

The 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.

The SPC-1 Workload Generator will then use the above log file to verify each block written contains the correct bit pattern.

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.*
2. *For the successful Data Persistence Test Run, a table illustrating key results. The content, appearance, and format of this table are specified in Table 9-12. Information displayed in this table shall be obtained from the Test Run Results File referenced below in #3.*
3. *For the successful Data Persistence Test Run, the human readable Test Run Results File produced by the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 80.

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	
Total Number of Logical Blocks Verified	
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 DX80 S2 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 DX80 S2 .

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.

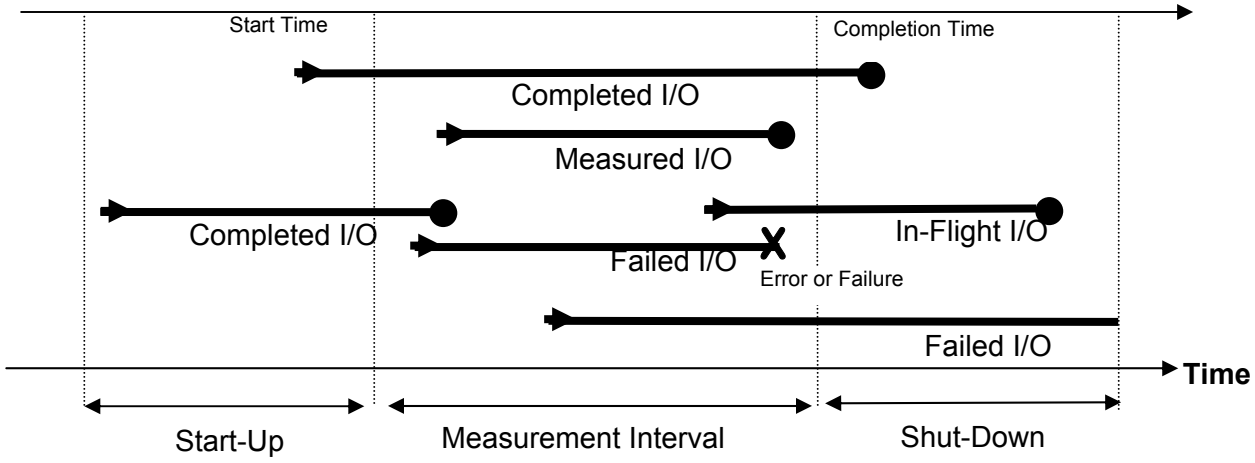
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

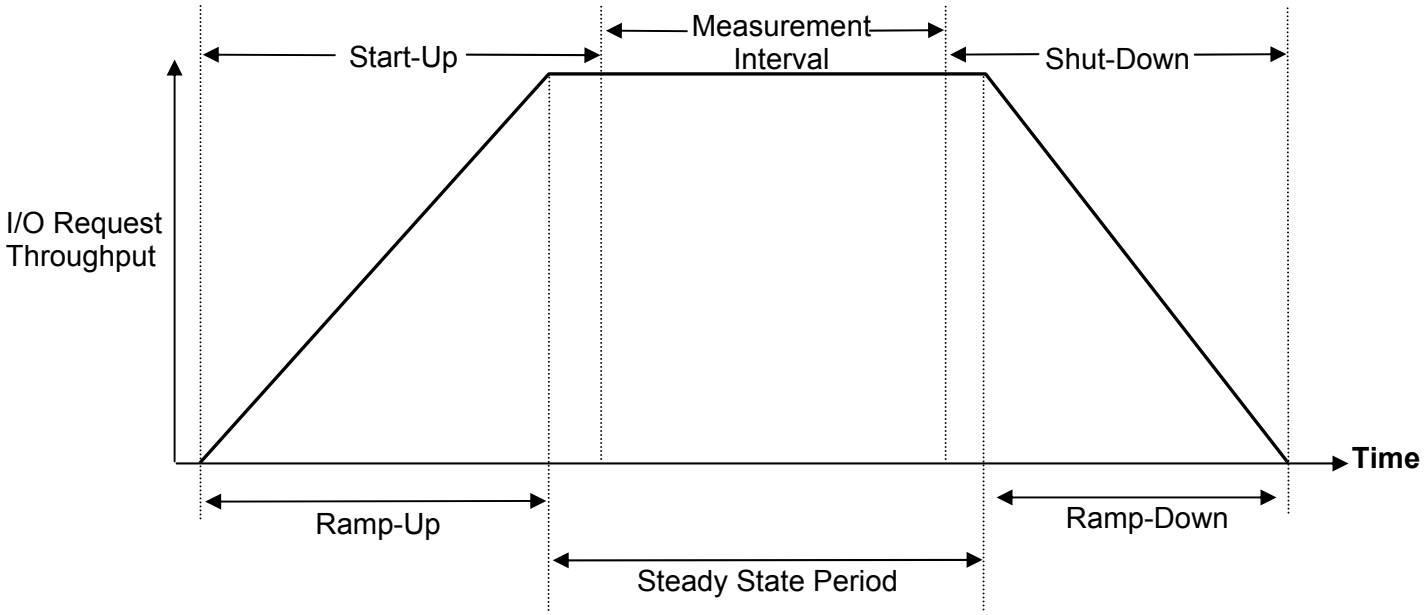
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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

The **pci-max-read-request** parameter for each HBA was set to a value of 2048 *(bytes)*.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

The first step to configure the TSC was to log into the DX80 S2 and execute the CLI commands listed in the file, **DX80S2_SPC1_29RG_580LUN_17184mb.log.** That file was created manually using a planning spreadsheet, which would be prepared by a Fujitsu SE in consultation with a customer. The CLI commands:

- Creates 29 RAID groups with a set of four disk drives configured in each RAID10 (2+2) group.
- Create 20 logical volumes in each of the 29 RAID10 groups with a capacity of 17,184 MiB for each logical volume.
- Reserves on disk drive as a Global Hot Spare.
- Sets the mapping for the eight fibre channel Host Channel Adapters to provide the Host System with access to each of the 580 logical volumes.

The next configuration step is to execute **makesol** shell script, using the **DX80S2_R10_29RG_580lun_svmake.txt** file as input. That file was created manually using a planning spreadsheet, which would be prepared by a Fujitsu SE in consultation with a customer. That configuration step creates 19 Solaris Logical Volumes, based on the logical volumes that were mapped to the Host System. Those Solaris Logical Volumes correspond to the SPC-1 Logical Volumes, which comprise the three required SPC-1 ASUs.

The above referenced files and script appear below.

DX80S2_SPC1_29RG_580LUN_17184mb.log

```
spawn telnet spcdx80
Trying 10.21.151.60...

Connected to spcdx80.fs1.file.cs.fujitsu.co.jp (10.21.151.60).

Escape character is '^]'.

ETERNUS login is required. [2011-11-12 20:05:23]
Login:root
Password:

CLI> create raid-group -name R10-0 -disks 0000-0003 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-1 -disks 0004-0007 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-2 -disks 0008-0011 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-3 -disks 0012-0015 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-4 -disks 0016-0019 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-5 -disks 0020-0023 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-6 -disks 0100-0103 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-7 -disks 0104-0107 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-8 -disks 0108-0111 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-9 -disks 0112-0115 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-10 -disks 0116-0119 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-11 -disks 0120-0123 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-12 -disks 0200-0203 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-13 -disks 0204-0207 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-14 -disks 0208-0211 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-15 -disks 0212-0215 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-16 -disks 0216-0219 -level 10 -assigned-cm 0
```

```
CLI> create raid-group -name R10-17 -disks 0220-0223 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-18 -disks 0300-0303 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-19 -disks 0304-0307 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-20 -disks 0308-0311 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-21 -disks 0312-0315 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-22 -disks 0316-0319 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-23 -disks 0320-0323 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-24 -disks 0400-0403 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-25 -disks 0404-0407 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-26 -disks 0408-0411 -level 10 -assigned-cm 0
CLI> create raid-group -name R10-27 -disks 0412-0415 -level 10 -assigned-cm 1
CLI> create raid-group -name R10-28 -disks 0416-0419 -level 10 -assigned-cm 0
CLI> create volume -name R10-V# -count 20 -rg-name R10-0 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-1 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-2 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-3 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-4 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-5 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-6 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-7 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-8 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-9 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-10 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-11 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-12 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-13 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-14 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-15 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-16 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-17 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-18 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-19 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-20 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-21 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-22 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-23 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-24 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-25 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-26 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-27 -type open -size 17184mb
CLI> create volume -name R10-V# -count 20 -rg-name R10-28 -type open -size 17184mb
CLI> set global-spare -disks 0423
CLI> set mapping -port 000 -volume-number 0-19 -lun 0-19
CLI> set mapping -port 000 -volume-number 160-179 -lun 20-39
CLI> set mapping -port 000 -volume-number 320-339 -lun 40-59
CLI> set mapping -port 000 -volume-number 480-499 -lun 60-79
CLI> set mapping -port 001 -volume-number 80-99 -lun 0-19
CLI> set mapping -port 001 -volume-number 240-259 -lun 20-39
CLI> set mapping -port 001 -volume-number 400-419 -lun 40-59
CLI> set mapping -port 001 -volume-number 560-579 -lun 60-79
CLI> set mapping -port 010 -volume-number 40-59 -lun 0-19
CLI> set mapping -port 010 -volume-number 200-219 -lun 20-39
CLI> set mapping -port 010 -volume-number 360-379 -lun 40-59
CLI> set mapping -port 010 -volume-number 520-539 -lun 60-79
CLI> set mapping -port 011 -volume-number 120-139 -lun 0-19
CLI> set mapping -port 011 -volume-number 280-299 -lun 20-39
CLI> set mapping -port 011 -volume-number 440-459 -lun 40-59
CLI> set mapping -port 100 -volume-number 20-39 -lun 0-19
CLI> set mapping -port 100 -volume-number 180-199 -lun 20-39
CLI> set mapping -port 100 -volume-number 340-359 -lun 40-59
CLI> set mapping -port 100 -volume-number 500-519 -lun 60-79
CLI> set mapping -port 101 -volume-number 100-119 -lun 0-19
CLI> set mapping -port 101 -volume-number 260-279 -lun 20-39
```

```
CLI> set mapping -port 101 -volume-number 420-439 -lun 40-59
CLI> set mapping -port 110 -volume-number 60-79 -lun 0-19
CLI> set mapping -port 110 -volume-number 220-239 -lun 20-39
CLI> set mapping -port 110 -volume-number 380-399 -lun 40-59
CLI> set mapping -port 110 -volume-number 540-559 -lun 60-79
CLI> set mapping -port 111 -volume-number 140-159 -lun 0-19
CLI> set mapping -port 111 -volume-number 300-319 -lun 20-39
CLI> set mapping -port 111 -volume-number 460-479 -lun 40-59
CLI>
```

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
```

DX80S2_R10_29RG_580lun_svmake.txt

```
DELETE_ALL
VOLUME_GROUP: asu1-1 (d0)
STRIPE 8m
VOLUME 1
c1t0d4
c2t0d4
```

```
c3t0d4
c4t0d4
c5t0d4
c6t0d4
c7t0d4
c8t0d4
c1t0d24
c2t0d24
c3t0d24
c4t0d24
c5t0d24
c6t0d24
c7t0d24
c8t0d24
c1t0d44
c2t0d44
c3t0d44
c4t0d44
c5t0d44
c6t0d44
c7t0d44
c8t0d44
c1t0d64
c2t0d64
c3t0d64
c4t0d64
c5t0d64
END
VOLUME_GROUP: asu1-2 (d1)
STRIPE 8m
VOLUME 1
c1t0d5
c2t0d5
c3t0d5
c4t0d5
c5t0d5
c6t0d5
c7t0d5
c8t0d5
c1t0d25
c2t0d25
c3t0d25
c4t0d25
c5t0d25
c6t0d25
c7t0d25
c8t0d25
c1t0d45
c2t0d45
c3t0d45
c4t0d45
c5t0d45
c6t0d45
c7t0d45
c8t0d45
c1t0d65
c2t0d65
c3t0d65
c4t0d65
c5t0d65
END
VOLUME_GROUP: asu1-3 (d2)
STRIPE 8m
```

```
VOLUME 1
c1t0d6
c2t0d6
c3t0d6
c4t0d6
c5t0d6
c6t0d6
c7t0d6
c8t0d6
c1t0d26
c2t0d26
c3t0d26
c4t0d26
c5t0d26
c6t0d26
c7t0d26
c8t0d26
c1t0d46
c2t0d46
c3t0d46
c4t0d46
c5t0d46
c6t0d46
c7t0d46
c8t0d46
c1t0d66
c2t0d66
c3t0d66
c4t0d66
c5t0d66
END
VOLUME_GROUP: asu1-4 (d3)
STRIPE 8m
VOLUME 1
c1t0d7
c2t0d7
c3t0d7
c4t0d7
c5t0d7
c6t0d7
c7t0d7
c8t0d7
c1t0d27
c2t0d27
c3t0d27
c4t0d27
c5t0d27
c6t0d27
c7t0d27
c8t0d27
c1t0d47
c2t0d47
c3t0d47
c4t0d47
c5t0d47
c6t0d47
c7t0d47
c8t0d47
c1t0d67
c2t0d67
c3t0d67
c4t0d67
c5t0d67
```

```
END
VOLUME_GROUP: asu1-5 (d4)
STRIPE 8m
VOLUME 1
c1t0d8
c2t0d8
c3t0d8
c4t0d8
c5t0d8
c6t0d8
c7t0d8
c8t0d8
c1t0d28
c2t0d28
c3t0d28
c4t0d28
c5t0d28
c6t0d28
c7t0d28
c8t0d28
c1t0d48
c2t0d48
c3t0d48
c4t0d48
c5t0d48
c6t0d48
c7t0d48
c8t0d48
c1t0d68
c2t0d68
c3t0d68
c4t0d68
c5t0d68
END
VOLUME_GROUP: asu1-6 (d5)
STRIPE 8m
VOLUME 1
c1t0d11
c2t0d11
c3t0d11
c4t0d11
c5t0d11
c6t0d11
c7t0d11
c8t0d11
c1t0d31
c2t0d31
c3t0d31
c4t0d31
c5t0d31
c6t0d31
c7t0d31
c8t0d31
c1t0d51
c2t0d51
c3t0d51
c4t0d51
c5t0d51
c6t0d51
c7t0d51
c8t0d51
c1t0d71
c2t0d71
```

```
c3t0d71
c4t0d71
c5t0d71
END
VOLUME_GROUP: asu1-7 (d6)
STRIPE 8m
VOLUME 1
c1t0d12
c2t0d12
c3t0d12
c4t0d12
c5t0d12
c6t0d12
c7t0d12
c8t0d12
c1t0d32
c2t0d32
c3t0d32
c4t0d32
c5t0d32
c6t0d32
c7t0d32
c8t0d32
c1t0d52
c2t0d52
c3t0d52
c4t0d52
c5t0d52
c6t0d52
c7t0d52
c8t0d52
c1t0d72
c2t0d72
c3t0d72
c4t0d72
c5t0d72
END
VOLUME_GROUP: asu1-8 (d7)
STRIPE 8m
VOLUME 1
c1t0d13
c2t0d13
c3t0d13
c4t0d13
c5t0d13
c6t0d13
c7t0d13
c8t0d13
c1t0d33
c2t0d33
c3t0d33
c4t0d33
c5t0d33
c6t0d33
c7t0d33
c8t0d33
c1t0d53
c2t0d53
c3t0d53
c4t0d53
c5t0d53
c6t0d53
c7t0d53
```

```
c8t0d53
c1t0d73
c2t0d73
c3t0d73
c4t0d73
c5t0d73
END
VOLUME_GROUP: asu1-9 (d8)
STRIPE 8m
VOLUME 1
c1t0d14
c2t0d14
c3t0d14
c4t0d14
c5t0d14
c6t0d14
c7t0d14
c8t0d14
c1t0d34
c2t0d34
c3t0d34
c4t0d34
c5t0d34
c6t0d34
c7t0d34
c8t0d34
c1t0d54
c2t0d54
c3t0d54
c4t0d54
c5t0d54
c6t0d54
c7t0d54
c8t0d54
c1t0d74
c2t0d74
c3t0d74
c4t0d74
c5t0d74
END
VOLUME_GROUP: asu2-1 (d9)
STRIPE 8m
VOLUME 1
c1t0d0
c2t0d0
c3t0d0
c4t0d0
c5t0d0
c6t0d0
c7t0d0
c8t0d0
c1t0d20
c2t0d20
c3t0d20
c4t0d20
c5t0d20
c6t0d20
c7t0d20
c8t0d20
c1t0d40
c2t0d40
c3t0d40
c4t0d40
```

```
c5t0d40
c6t0d40
c7t0d40
c8t0d40
c1t0d60
c2t0d60
c3t0d60
c4t0d60
c5t0d60
END
VOLUME_GROUP: asu2-2 (d10)
STRIPE 8m
VOLUME 1
c1t0d1
c2t0d1
c3t0d1
c4t0d1
c5t0d1
c6t0d1
c7t0d1
c8t0d1
c1t0d21
c2t0d21
c3t0d21
c4t0d21
c5t0d21
c6t0d21
c7t0d21
c8t0d21
c1t0d41
c2t0d41
c3t0d41
c4t0d41
c5t0d41
c6t0d41
c7t0d41
c8t0d41
c1t0d61
c2t0d61
c3t0d61
c4t0d61
c5t0d61
END
VOLUME_GROUP: asu2-3 (d11)
STRIPE 8m
VOLUME 1
c1t0d2
c2t0d2
c3t0d2
c4t0d2
c5t0d2
c6t0d2
c7t0d2
c8t0d2
c1t0d22
c2t0d22
c3t0d22
c4t0d22
c5t0d22
c6t0d22
c7t0d22
c8t0d22
c1t0d42
```

```
c2t0d42
c3t0d42
c4t0d42
c5t0d42
c6t0d42
c7t0d42
c8t0d42
c1t0d62
c2t0d62
c3t0d62
c4t0d62
c5t0d62
END
VOLUME_GROUP: asu2-4 (d12)
STRIPE 8m
VOLUME 1
c1t0d3
c2t0d3
c3t0d3
c4t0d3
c5t0d3
c6t0d3
c7t0d3
c8t0d3
c1t0d23
c2t0d23
c3t0d23
c4t0d23
c5t0d23
c6t0d23
c7t0d23
c8t0d23
c1t0d43
c2t0d43
c3t0d43
c4t0d43
c5t0d43
c6t0d43
c7t0d43
c8t0d43
c1t0d63
c2t0d63
c3t0d63
c4t0d63
c5t0d63
END
VOLUME_GROUP: asu2-5 (d13)
STRIPE 8m
VOLUME 1
c1t0d15
c2t0d15
c3t0d15
c4t0d15
c5t0d15
c6t0d15
c7t0d15
c8t0d15
c1t0d35
c2t0d35
c3t0d35
c4t0d35
c5t0d35
c6t0d35
```

```
c7t0d35
c8t0d35
c1t0d55
c2t0d55
c3t0d55
c4t0d55
c5t0d55
c6t0d55
c7t0d55
c8t0d55
c1t0d75
c2t0d75
c3t0d75
c4t0d75
c5t0d75
END
VOLUME_GROUP: asu2-6 (d14)
STRIPE 8m
VOLUME 1
c1t0d16
c2t0d16
c3t0d16
c4t0d16
c5t0d16
c6t0d16
c7t0d16
c8t0d16
c1t0d36
c2t0d36
c3t0d36
c4t0d36
c5t0d36
c6t0d36
c7t0d36
c8t0d36
c1t0d56
c2t0d56
c3t0d56
c4t0d56
c5t0d56
c6t0d56
c7t0d56
c8t0d56
c1t0d76
c2t0d76
c3t0d76
c4t0d76
c5t0d76
END
VOLUME_GROUP: asu2-7 (d15)
STRIPE 8m
VOLUME 1
c1t0d17
c2t0d17
c3t0d17
c4t0d17
c5t0d17
c6t0d17
c7t0d17
c8t0d17
c1t0d37
c2t0d37
c3t0d37
```

```
c4t0d37
c5t0d37
c6t0d37
c7t0d37
c8t0d37
c1t0d57
c2t0d57
c3t0d57
c4t0d57
c5t0d57
c6t0d57
c7t0d57
c8t0d57
c1t0d77
c2t0d77
c3t0d77
c4t0d77
c5t0d77
END
VOLUME_GROUP: asu2-8 (d16)
STRIPE 8m
VOLUME 1
c1t0d18
c2t0d18
c3t0d18
c4t0d18
c5t0d18
c6t0d18
c7t0d18
c8t0d18
c1t0d38
c2t0d38
c3t0d38
c4t0d38
c5t0d38
c6t0d38
c7t0d38
c8t0d38
c1t0d58
c2t0d58
c3t0d58
c4t0d58
c5t0d58
c6t0d58
c7t0d58
c8t0d58
c1t0d78
c2t0d78
c3t0d78
c4t0d78
c5t0d78
END
VOLUME_GROUP: asu2-9 (d17)
STRIPE 8m
VOLUME 1
c1t0d19
c2t0d19
c3t0d19
c4t0d19
c5t0d19
c6t0d19
c7t0d19
c8t0d19
```

```
c1t0d39
c2t0d39
c3t0d39
c4t0d39
c5t0d39
c6t0d39
c7t0d39
c8t0d39
c1t0d59
c2t0d59
c3t0d59
c4t0d59
c5t0d59
c6t0d59
c7t0d59
c8t0d59
c1t0d79
c2t0d79
c3t0d79
c4t0d79
c5t0d79
END
VOLUME_GROUP: asu3-1 (d18)
STRIPE 8m
VOLUME 1
c1t0d9
c2t0d9
c3t0d9
c4t0d9
c5t0d9
c6t0d9
c7t0d9
c8t0d9
c1t0d29
c2t0d29
c3t0d29
c4t0d29
c5t0d29
c6t0d29
c7t0d29
c8t0d29
c1t0d49
c2t0d49
c3t0d49
c4t0d49
c5t0d49
c6t0d49
c7t0d49
c8t0d49
c1t0d69
c2t0d69
c3t0d69
c4t0d69
c5t0d69
END
VOLUME_GROUP: asu3-2 (d19)
STRIPE 8m
VOLUME 1
c1t0d10
c2t0d10
c3t0d10
c4t0d10
c5t0d10
```

```
c6t0d10
c7t0d10
c8t0d10
c1t0d30
c2t0d30
c3t0d30
c4t0d30
c5t0d30
c6t0d30
c7t0d30
c8t0d30
c1t0d50
c2t0d50
c3t0d50
c4t0d50
c5t0d50
c6t0d50
c7t0d50
c8t0d50
c1t0d70
c2t0d70
c3t0d70
c4t0d70
c5t0d70
END
```

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

The content of SPC-1 Workload Generator command and parameter files, used in this benchmark to execute the Primary Metrics and Repeatability, is listed below.

```
javaparms="-Xmx1024m -Xms1024m -Xss512k"
sd=asu1_1,lun=/dev/md/rdsk/d0,size=485.000g
sd=asu1_2,lun=/dev/md/rdsk/d1,size=485.000g
sd=asu1_3,lun=/dev/md/rdsk/d2,size=485.000g
sd=asu1_4,lun=/dev/md/rdsk/d3,size=485.000g
sd=asu1_5,lun=/dev/md/rdsk/d4,size=485.000g
sd=asu1_6,lun=/dev/md/rdsk/d5,size=485.000g
sd=asu1_7,lun=/dev/md/rdsk/d6,size=485.000g
sd=asu1_8,lun=/dev/md/rdsk/d7,size=485.000g
sd=asu1_9,lun=/dev/md/rdsk/d8,size=485.000g
sd=asu2_1,lun=/dev/md/rdsk/d9,size=485.000g
sd=asu2_2,lun=/dev/md/rdsk/d10,size=485.000g
sd=asu2_3,lun=/dev/md/rdsk/d11,size=485.000g
sd=asu2_4,lun=/dev/md/rdsk/d12,size=485.000g
sd=asu2_5,lun=/dev/md/rdsk/d13,size=485.000g
sd=asu2_6,lun=/dev/md/rdsk/d14,size=485.000g
sd=asu2_7,lun=/dev/md/rdsk/d15,size=485.000g
sd=asu2_8,lun=/dev/md/rdsk/d16,size=485.000g
sd=asu2_9,lun=/dev/md/rdsk/d17,size=485.000g
sd=asu3_1,lun=/dev/md/rdsk/d18,size=485.000g
sd=asu3_2,lun=/dev/md/rdsk/d19,size=485.000g
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

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

The following scripts 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.

```
CLASSPATH=/usr/local/spc/spc1;export CLASSPATH
LD_LIBRARY_PATH=/usr/local/spc/spc1;export LD_LIBRARY_PATH

#metrics
java -Xmx1024m -Xms1024m -Xss512k metrics -b 700 -t 28800

#repeat-1
java -Xmx1024m -Xms1024m -Xss512k repeat1 -b 700

#repeat-2
java -Xmx1024m -Xms1024m -Xss512k repeat2 -b 700

#persist-1
java -Xmx1024m -Xms1024m -Xss512k persist1 -b 700
```

Persistence Test Run 2

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

```
CLASSPATH=/usr/local/spc/spc1;export CLASSPATH
LD_LIBRARY_PATH=/usr/local/spc/spc1;export LD_LIBRARY_PATH

java -Xmx1024m -Xms1024m -Xss512k persist2

mv metrics metrics_DX80S2_111115_FDR_bsu700
mv repeatability1 repeat1_DX80S2_111115_FDR_bsu700
mv repeatability2 repeat2_DX80S2_111115_FDR_bsu700
mv persistence1 persist1_DX80S2_111115_FDR_bsu700
mv persistence2 persist2_DX80S2_111115_FDR_bsu700
mv SPCOut SPCOut_DX80S2_111115_FDR_bsu700

zip -r metrics_DX80S2_111115_FDR_bsu700.zip metrics_DX80S2_111115_FDR_bsu700
zip -r repeat1_DX80S2_111115_FDR_bsu700.zip repeat1_DX80S2_111115_FDR_bsu700
zip -r repeat2_DX80S2_111115_FDR_bsu700.zip repeat2_DX80S2_111115_FDR_bsu700
zip -r persist1_DX80S2_111115_FDR_bsu700.zip persist1_DX80S2_111115_FDR_bsu700
zip -r persist2_DX80S2_111115_FDR_bsu700.zip persist2_DX80S2_111115_FDR_bsu700
zip -r SPCOut_DX80S2_111115_FDR_bsu700.zip SPCOut_DX80S2_111115_FDR_bsu700
```

APPENDIX F: THIRD-PARTY QUOTATIONS

Qlogic QLE2562 8 Gbps Dual Port Fibre Channel HBAs

ECExpress - QUOTE INFORMATION Page 1 of 1

QUOTE INFORMATION
generated 11/11/11

Reseller Account	PO/Quote#	Pricing
156408	#32182927	Regular

Bill-to	Ship-to	General Info
FUJITSU PC CORPORATION PO BOX 58112, SANTA CLARA, CA 95054	Fujitsu America Inc 1250 East Arques Ave Sunnyvale, CA 94085	**Quote Description:**11/11/11 2:52:12 PM PST **PO#:**#32182927 **End User PO#:**#32182927 **Confirmation#:**32182927 **Buyer:** AL VITI **Phone:** 972-803-9178 **Email:** al.viti@us.fujitsu.com **User ID:** 108305, Old UID: 156408 **Payment Terms:** NET 30 DAYS **Ship Method:**FG **Freight Acct#:** **Special Pricing:**VS **Pring Ref #s:** **End User:**
Licensee Info	**Reseller**	
N/A	FUJITSU PC CORPORATION	

SKU	Mfg. P/N	Description	MSRP	Availability	Reseller Price	Qty	Ext. Price
2079553	QLE2562-CK	Qlogic 8Gb PCI-e (x4) Dual Port HBA	$2,598.00	104	$1,293.41 Reg.~~$1,319.14~~	1	$1,293.41

General Information

All prices are displayed in **USD**
Available Inventory subject to change without notice.
Month Lease Payment is an estimate and subject to change prior to approval
Product Pricing/Availability updated frequently and may change without notice
PO subject to Freight and Taxes, actual Charge(s)/Wavier(s) may change during Order Processing

Sub-total:	$1,293.41
Estimated S&H fee:	$9.38
Estimated Taxes:	$0.00
TOTAL:	$1,302.79

http://ec.synnex.com/ecexpress/order/viewEndUserQuote.do 11/11/2011