SPC BENCHMARK 1/ENERGY™
FULL DISCLOSURE REPORT

HEWLETT-PACKARD COMPANY
HP STORAGEWORKS 6400
ENTERPRISE VIRTUAL ARRAY

SPC-1/E™ V1.12

Submitted for Review: July 30, 2010
Submission Identifier: AE00003

First Edition – July 2010

Trademarks

Table of Contents

AUDIT CERTIFICATION

Chuck Paridon
Hewlett-Packard Company
8000 Foothills Blvd., M/S 5785
Roseville, CA 95747 5785

July 28, 2010

The SPC Benchmark 1/Energy™ Reported Data listed below for the HP StorageWorks 6400 Enterprise Virtual Array were produced in compliance with the SPC Benchmark 1/Energy™ V1.12 Onsite Audit requirements.

SPC Benchmark 1/Energy™ V1.12 Reported Data	
Tested Storage Configuration (TSC) Name: HP StorageWorks 6400 Enterprise Virtual Array	
Metric	**Reported Result**
SPC-1 IOPS™	16,741.16
SPC-1 Price-Performance	$7.28/SPC-1 IOPS™
Total ASU Capacity	347.892 GB
Data Protection Level	Protected *(RAID-5)*
Total TSC Price (including three-year maintenance)	$121,835

Power Environment

Average RMS Voltage: 210.15 **Average Power Factor:** 0.819

Usage Profile

	Hours of Use per Day			Nominal	Nominal	Nominal	Nominal
	Heavy	Moderate	Idle	Power, W	Traffic, IOPS	IOPS/W	Heat, BTU/hr
Low Daily Usage:	0	8	16	465.00	2783.70	5.99	1,586.63
Medium Daily Usage:	4	14	6	468.07	7105.15	15.18	1,597.10
High Daily Usage:	18	6	0	471.86	12139.29	25.73	1,610.04
			Composite Metrics:	468.31	7,342.71	15.68	

Annual Energy Use, kWh: 4,102.40
Energy Cost, $/kWh: $ 0.12 **Annual Energy Cost, $:** $ 492.29

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

AUDIT CERTIFICATION *(CONT.)*

The following SPC Benchmark 1/Energy™ Onsite Audit requirements were reviewed and found compliant with V1.12 of the SPC Benchmark 1/Energy™ Specification:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified by physical inspection and information supplied by Hewlett-Packard Company:
  - ✓ 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/Tested Storage Configuration.
- Physical verification of the components to match the above diagram.
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters that were changed from default values.
- 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 Hewlett-Packard Company:
  - ✓ 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.
  - ✓ A valid SPC-1™ site license.
  - ✓ The TSC boundary within the Host System.
- The execution of each Test, Test Phase, and Test Run was observed and found compliant with all of the requirements and constraints of Clauses 4, 5, and 11 of the SPC-1 Benchmark Specification.
- The Test Results Files and resultant Summary Results Files received from Hewlett-Packard Company for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4, 5, and 11 of the SPC Benchmark 1/Energy™ Specification:
  - ✓ Idle Test
    - Conditioning Phase
    - Application Idle Phase
    - Recovery Phase
  - ✓ Primary Metrics Test:
    - Sustainability Test Phase
    - IOPS Test Phase
    - Response Time Ramp Test Phase
  - ✓ Repeatability Test
  - ✓ Data Persistence Test
- The Yokogawa WT230 Digital Power Meter, used to record power consumption, was verified as an SPC approved "Power Extension apparatus" with a current calibration certificate.
- All power supplies present in the Tested Storage Configuration were verified as active.

Storage Performance Council
643 Bair Island Road, Suite 103
Redwood City, CA 94062
AuditService@storageperformance.org
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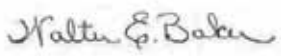
AUDIT CERTIFICATION *(CONT.)*

- Hewlett-Packard Company provided documentation of the following:
  - ✓ Voltage *(220)*, amperage *(30)*, and phase characteristics *(single)* of the AC inputs used for powering the Tested Storage Configuration.
  - ✓ The configured power supplies were configured for mutual failover.
- Concurrent power measurements were taken at each active AC input so that the total power requirement of the Tested Storage Configuration was recorded.
- The ambient temperature was recorded at the following times in near proximity to the Tested Storage configuration with a precision of at least ±0.1°C:
  - ✓ During the first one minute of the Idle Test *(Initial Energy Extension temperature)*.
  - ✓ During the last one minute of the Primary Metrics Test *(Final Energy Extension temperature)*.
- The Benchmark Configuration/Tested Storage Configuration diagram included the electrical metering, which illustrates the measurement apparatus used and the relationship between the active AC inputs and the associated measurement apparatus inputs.
- There were no differences between the Tested Storage Configuration and Priced Storage Configuration.
- The submitted pricing information met all of the requirements and constraints of Clause 8 of the SPC Benchmark 1/Energy™ Specification.
- The Full Disclosure Report *(FDR)* met all of the requirements in Clauses 9 and 11 of the SPC Benchmark 1/Energy™ 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

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

LETTER OF GOOD FAITH

Hewlett-Packard Company
3000 Hanover Street
Palo Alto, CA 94304
www.hp.com

July 16 , 2010

Walter E. Baker, SPC Auditor
Storage Performance Council (SPC)
643 Bair Island Road, Suite 103
Redwood City, CA 94063-2755

Sender:
Chuck Paridon
Solutions Performance Team
Tel. +1-916-785-5155
chuck.paridon@hp.com

Subject: SPC-1E Letter of Good Faith for the HP StorageWorks 6400 Enterprise Virtual Array

Hewlett-Packard is the SPC-1E Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1E benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with V1.13 of the SPC-1E 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 above SPC-1E benchmark specification

Signed: Neil B. MacDonald

Neil MacDonald, Vice President
EVA, StorageWorks Division

Date: 7/16/10

Date of Signature

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Hewlett-Packard Company – http://www.hp.com Chuck Paridon – chuck.paridon@hp.com 8000 Foothills Blvd M/S 5785 Roseville, CA 95747-5785 Phone: (916) 785-5155 FAX: (916) 785-1648
Test Sponsor Alternate Contact	Hewlett-Packard Company – http://www.hp.com Brian Fridly – brian.fridly@hp.com 8000 Foothills Blvd M/S 5785 Roseville, CA 95747-5785 Phone: (916) 785-2006 FAX: (916) 785-1648
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	July 30, 2010
Date the FDR was submitted to the SPC	July 30, 2010
Date the priced storage configuration is available for shipment to customers	currently available
Date the TSC completed audit certification	July 28, 2010

Tested Storage Product (TSP) Description

The HP StorageWorks 6400 Enterprise Virtual Array (EVA) is an enterprise class storage array system designed to aggregate and automate your array management tasks to manage more storage capacity with fewer resources. The EVA is designed specifically for customers in the business critical, enterprise marketplace and is a scalable, highly available and highly reliable "virtual" array storage solution. The EVA6400 saves time, space, and costs compared to traditionally architected storage. It is supported by a powerfully simple suite of management software making it easy to provision storage and to achieve the highest level of productivity.

The HP StorageWorks 6400 Enterprise Virtual Array family is designed for the data center where there is a critical need for improved storage utilization and scalability. The EVA meets application specific demands for transaction I/O performance for mid-range and enterprise customers. It provides easy capacity expansion, instantaneous replication and simplified storage administration. The Enterprise Virtual Array combined with HP StorageWorks Command View EVA software provides a comprehensive solution designed to simplify management and maximize performance.

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: HP StorageWorks 6400 Enterprise Virtual Array	
Metric	**Reported Result**
SPC-1 IOPS™	16,741.16
SPC-1 Price-Performance	$7.28/SPC-1 IOPS™
Total ASU Capacity	347.892GB
Data Protection Level	Protected *(RAID-5)*
Total TSC Price (including three-year maintenance)	$121,835

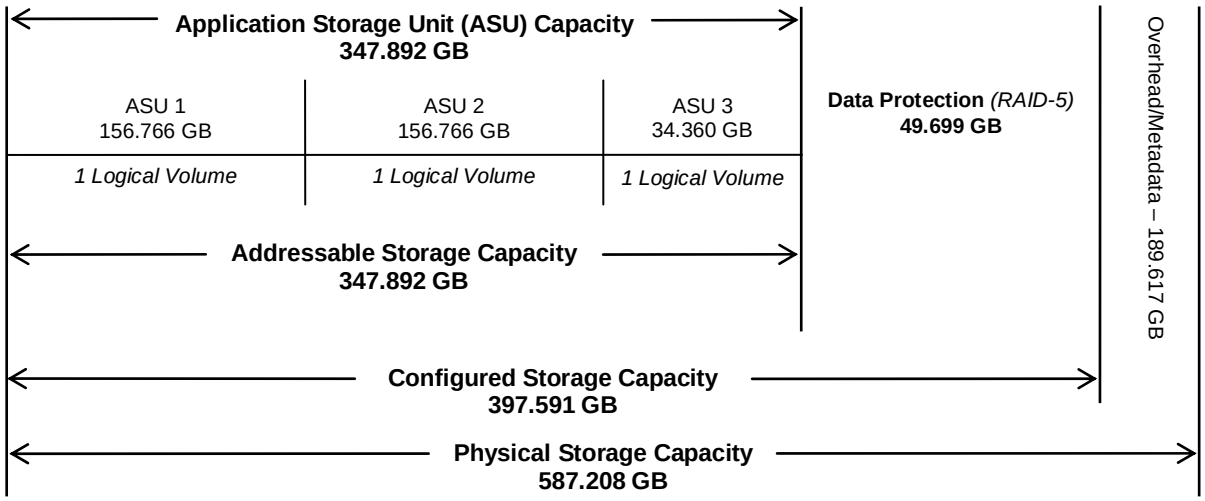
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

A **Data Protection Level** of **Protected** using ***RAID-5*** which provides data protection by distributing check data corresponding to user data across multiple disks in the form of bit-by-bit parity.

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	59.25%
Protected Application Utilization	67.71%
Unused Storage Ratio	0.00%

Application Utilization: Total ASU Capacity *(347.892 GB)* divided by Physical Storage Capacity *(587.208 GB)*.

Protected Application Utilization: Total ASU Capacity *(347.892 GB)* plus total Data Protection Capacity *(49.699 GB)* minus unused Data Protection Capacity *(0.000 GB)* divided by Physical Storage Capacity *(587.208 GB)*.

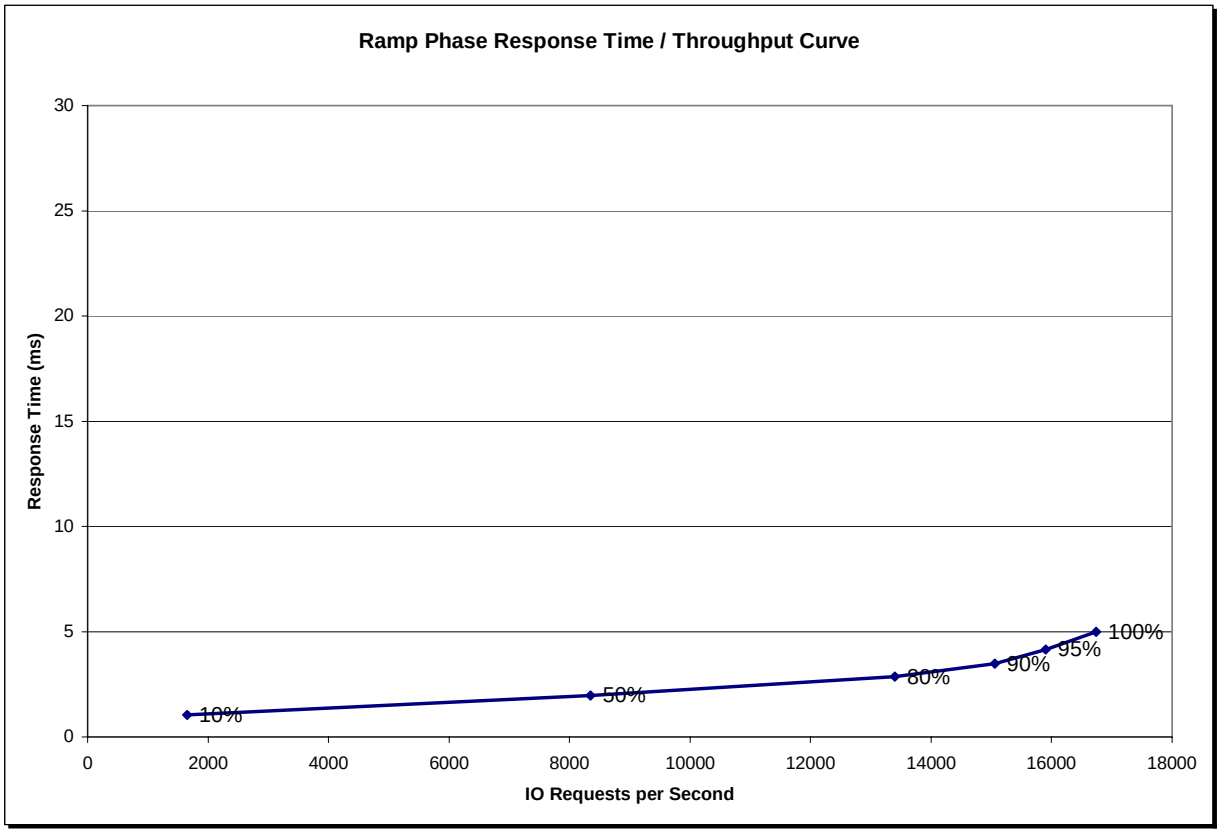
Unused Storage Ratio: Total unused capacity *(0.000 GB)* divided by Physical Storage Capacity *(587.208 GB)*. The Unused Storage Ratio cannot exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 23-24 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	1,651.13	8,351.11	13,402.02	15,060.81	15,907.01	16,741.16
Average Response Time (ms):						
All ASUs	1.05	1.96	2.86	3.47	4.16	5.00
ASU-1	1.00	1.95	2.86	3.36	3.87	4.51
ASU-2	1.10	2.26	3.29	4.01	4.79	5.67
ASU-3	1.14	1.85	2.68	3.47	4.50	5.74
Reads	0.95	2.14	3.15	3.52	3.78	4.06
Writes	1.11	1.84	2.68	3.44	4.41	5.61

SPC-1/E Reported Data

The initial SPC-1/E energy extension temperature, recorded during the first one minute of the Idle Test was 73.50F. The final SPC-1/E energy extension temperature, recorded during the last one minute of the Primary Metrics Test was 73.62F.

Power Environment

Average RMS Voltage:	**210.15**	**Average Power Factor:**	**0.819**

Usage Profile

	Hours of Use per Day			Nominal	Nominal	Nominal	Nominal
	Heavy	Moderate	Idle	Power, W	Traffic, IOPS	IOPS/W	Heat, BTU/hr
Low Daily Usage:	0	8	16	**465.00**	**2783.70**	**5.99**	**1,586.63**
Medium Daily Usage:	4	14	6	**468.07**	**7105.15**	**15.18**	**1,597.10**
High Daily Usage:	18	6	0	**471.86**	**12139.29**	**25.73**	**1,610.04**
			Composite Metrics:	**468.31**	**7,342.71**	**15.68**	

Annual Energy Use, kWh:	**4,102.40**		
Energy Cost, $/kWh:	$ 0.12	**Annual Energy Cost, $:**	**$ 492.29**

The above usage profile describes conditions in environments that respectively impose light ("low"), moderate ("medium"), and extensive ("high") demands on the Tested Storage Configuration (TSC).

HEAVY SPC-1 Workload: 472.87W at 80% of maximum reported performance *(13,402.02 SPC-1 IOPS)*.

MODERATE SPC-1 Workload: 468.83W at 50% of maximum reported performance *(8,351.11 SPC-1 IOPS)*.

IDLE SPC-1 Workload: 463.09W at 0% of maximum reported performance *(0.00 SPC-1 IOPS)*.

AVERAGE RMS VOLTAGE: The average supply voltage applied to the Tested Storage Product (TSP) as measured during the Measurement Intervals of the SPC-1/E Tests.

AVERAGE POWER FACTOR: The ratio of average real power, in watts, to the average apparent power, in volt-amps flowing into the Tested Storage Product (TSP) during the Measurement Intervals of the SPC-1/E Tests.

NOMINAL POWER, W: The average power consumption over the course of a day *(24 hours)*, taking into account hourly load variations.

NOMINAL TRAFFIC, IOPS: The average level of I/O requests over the course of a day *(24 hours)*, taking into account hourly load variations.

NOMINAL IOPS/W: The overall efficiency with which I/O requests can be supported, reflected by the ratio of **NOMINAL TRAFFIC** versus the **NOMINAL POWER**.

NOMINAL HEAT, BTU/HR: The average amount of heat required to be dissipated over the course of a day *(24 hours)*, taking into account hourly load variations. *(1 watt = 3.412 BTU/hr)*

COMPOSITE METRICS: The aggregated **NOMINAL POWER**, **NOMINAL TRAFFIC**, and **NOMINAL IOPS/W** for all three environments: **LOW**, **MEDIUM**, and **HIGH DAILY USAGE**.

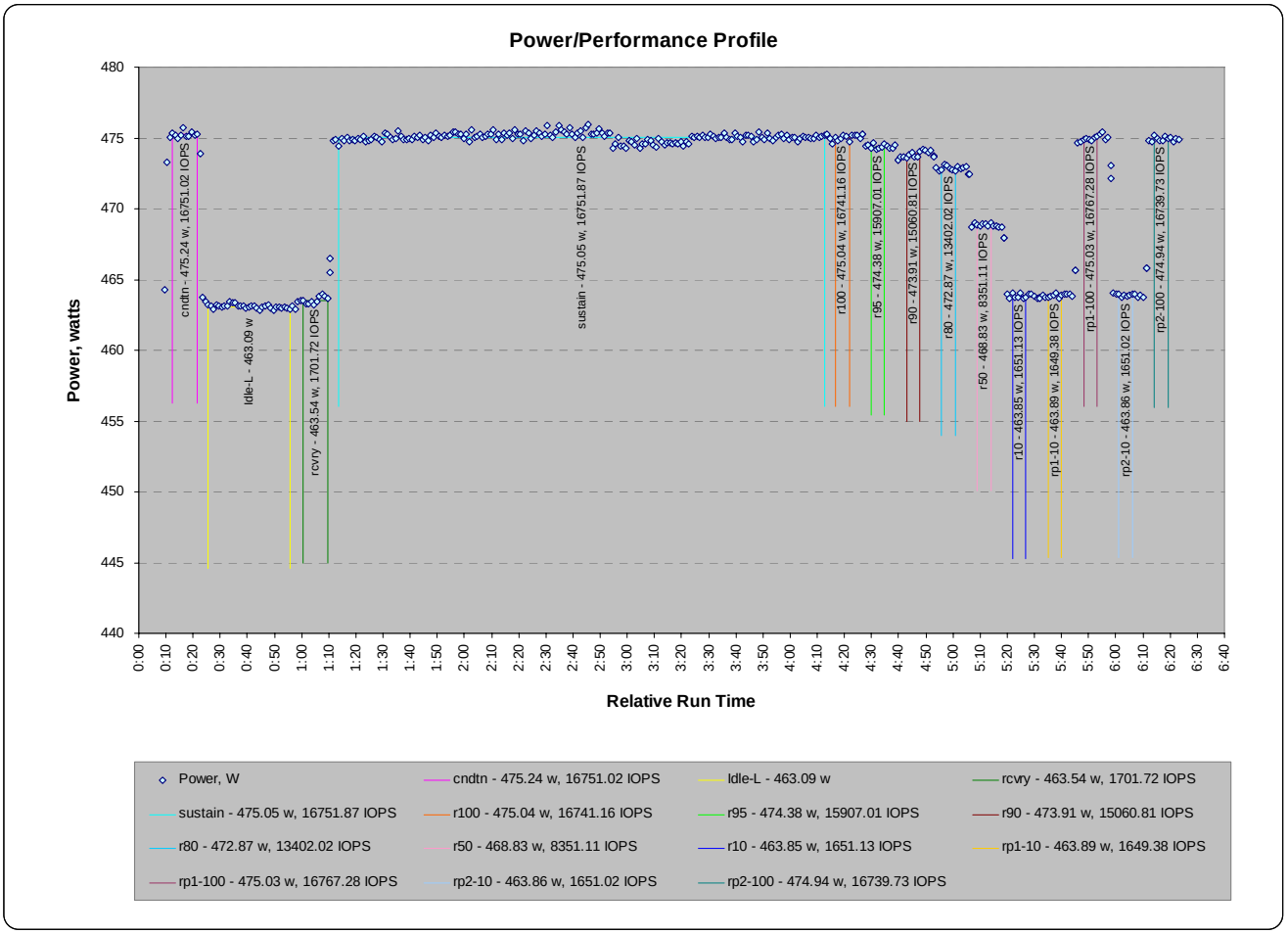
ANNUAL ENERGY USE, KWH: An estimate of the average energy use across the three environments over the course of a year and computed as (**NOMINAL POWER** * 24 *0.365).

ENERGY COST, $/KWH: A standardized energy cost per kilowatt hour.

ANNUAL ENERGY COST: An estimate of the annual energy use across the three environments over the course of a year and computed as (**ANNUAL ENERGY USE** * **ENERGY COST**).

SPC-1/E Power/Performance Profile

The SPC-1/E Power/Performance Profile chart provides a complete "at a glance" illustration and report for each SPC-1/E execution component. The power consumption at each step is reported and, where appropriate the measured SPC-1 performance *(SPC-1 IOPS™)* is also reported.



Priced Storage Configuration Pricing

Quantity	Product Number	Description	List Price	Ext Price	Discount	Ext. Net Price
1	AF002A	HP Universal Rack 10642 G2 Shock Rack	$1,489	$1,489	27%	$1,087
1	AF002A 001	Factory Express Base Racking	$300	$300	27%	$219
1	AP884A	HP EVA6400 for Storage Rack	$21,820	$21,820	27%	$15,929
1	AP884A 0D1	Factory integrated	$0	$0	27%	$0
2	AG638B	HP M6412-A Fibre Channel Drive Enclosure	$3,890	$7,780	27%	$5,679
2	AG638B 0D1	Factory integrated	$0	$0	27%	$0
8	AR055A	HP EVA M6412 72GB 4Gb FC 2-port SSD	$10,125	$81,000	27%	$59,130
8	AR055A 0D1	Factory integrated	$0	$0	27%	$0
2	252663-D72	HP 24A High Voltage US/JP Modular PDU	$299	$598	27%	$437
2	252663-D72 0D2	Factory horizontal mount of PDU	$0	$0	27%	$0
1	AF062A	HP 10K G2 600mm Stabilizer Kit	$229	$229	27%	$167
1	AF062A B01	Include with complete system	$0	$0	27%	$0
1	AF054A	HP 10642 G2 Sidepanel Kit	$359	$359	27%	$262
1	AF054A 0D1	Factory integrated	$0	$0	27%	$0
1	T5494EAE	HP CV EVA V9.2 RSM V5.1 E-Media Kit	$125	$125	27%	$91
1	TA646AAE	HP Command View EVA6400 Unlimited E-LTU	$28,000	$28,000	27%	$20,440
1	HA110A3	HP 3y Support Plus 24 SVC	$0	$0	27%	$0
1	HA110A3 4R2	EVA 6400 Command View EVA Unlim LTU Supp	$14,373	$14,373	27%	$10,492
8	HA110A3 9BC	EVA M6412 72GB FC 2 port SSD Support	$199	$1,592	27%	$1,162
1	HA110A3 9DP	EVA 6400 Array Support	$2,084	$2,084	27%	$1,521
2	HA110A3 9DS	EVA M6412A FC Drive Enclosure Support	$532	$1,064	27%	$777
2	456972 B21	HP BLc Emulex LPe1205 8Gb FC HBA Opt	$849	$1,698	12%	$1,494
4	AJ716A	HP 8Gb Shortwave B-series FC SFP	$57	$228	12%	$201
1	581874 005	HP S-Buy DL120 G6 X3440 NHP SATA US Svr	$1,189	$1,189	8%	$1,094
1	AP767A	HP StorageWorks PCIe 4Gb FC Single Port HBA	$1,105	$1,105	8%	$1,017
5	AJ836A	HP 5m Multi-mode OM3 LC/LC FC Cable	$95	$475	27%	$347
4	AJ706A	HP EVA Loopback Connector	$99	$396	27%	$289
				$165,904		**$121,835**

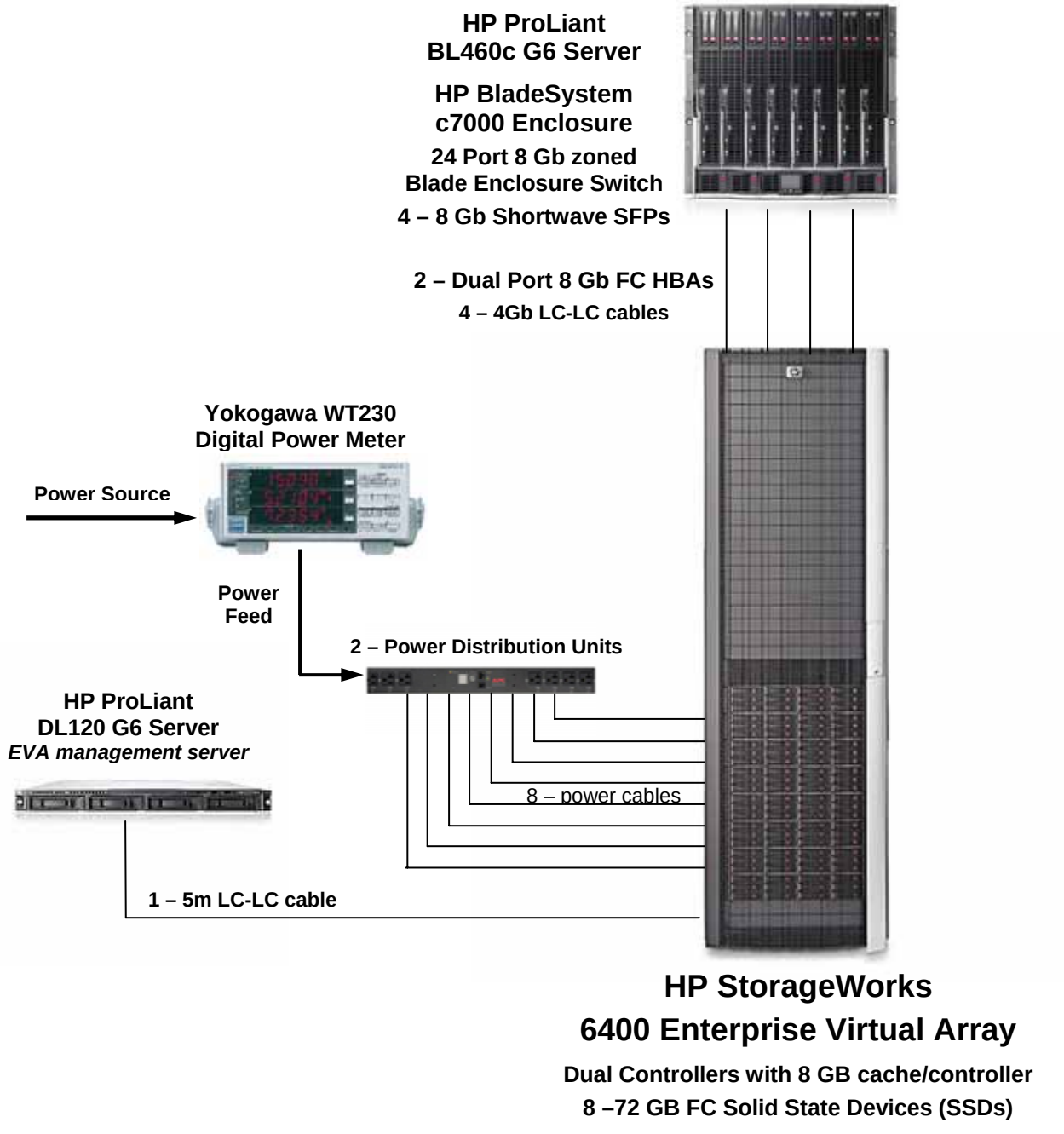
The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- 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

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

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



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

Host System:	Tested Storage Configuration (TSC)
1 – HP ProLiant BL460c G6 Server **1 – HP BladeSystem c7000 Enclosure**	2 – Dual Port 8 Gb FC HBAs
	4 – 8 Gb Shortwave FC SFPs
2 – Intel® Xeon® 5500 series 2.4 Ghz processors, each processor with: 4 cores, 128 KB L1 cache,1024 KB L2 cache 8192 KB L3 cache	**HP StorageWorks 6400 Enterprise Virtual Array** Dual Controllers with 8 GB cache/controller *(16 GB total)* dual power supplies for each controller *(4 total)*
8 GB main memory	4 – 4 Gb FC front-end physical connections *(4 used)*
Microsoft Windows Server 2003 R2 Enterprise x64	2 – 4 Gb FC backend physical connection *(2 used)*
24 Port, 8 Gb zoned Blade Enclosure switch	1 – HP Universal Rack
PCI Blade	2 – HP Fibre Channel Drive Enclosures dual power supplies for each drive enclosure *(4 total)*
Other BC components:	
1 – HP ProLiant DL120 G6 Server *(EVA management server)*	8 –72 GB FC Solid State Devices *(SSDs)*
1 – Yokogawa WT230 Digital Power Meter	HP StorageWorks Command View EVA
2 – Power Distribution Units (PDUs)	

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 19 *(Benchmark Configuration (BC)/Tested Storage Configuration (TSC)/ Priced Storage Configuration Diagram).*

Storage Network Configuration

Clause 9.4.3.4.1

…

5. *If the TSC contains network storage, the diagram will include the network configuration. If a single diagram is not sufficient to illustrate both the Benchmark Configuration and network configuration in sufficient detail, the Benchmark Configuration diagram will include a high-level network illustration as shown in Figure 9-8. In that case, a separate, detailed network configuration diagram will also be included as described in Clause 9.4.3.4.2.*

Clause 9.4.3.4.2

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.4.3.4.1 contains a high-level illustration of the network configuration, the Executive Summary will contain a one page topology diagram of the storage network as illustrated in Figure 9-9.

The Tested Storage Configuration did not utilize network storage.

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

Clause 9.4.3.4.3

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

The Host System and Tested Storage Configuration (TSC) table of components is appears on page 20 ***(****Benchmark Configuration (BC)/Tested Storage Configuration (TSC)/ Priced Storage Configuration Components).*

Customer Tunable Parameters and Options

Clause 9.4.3.5.1

All Benchmark Configuration (BC) components with customer tunable parameter and options that have been altered from their default values must be listed in the FDR. The FDR entry for each of those components must include both the name of the component and the altered value of the parameter or option. If the parameter name is not self-explanatory to a knowledgeable practitioner, a brief description of the parameter's use must also be included in the FDR entry.

"Appendix B: Customer Tunable Parameters and Options" on page 65 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 66 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 71.

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 61 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)	347.892
Addressable Storage Capacity	Gigabytes (GB)	347.892
Configured Storage Capacity	Gigabytes (GB)	447.290
Physical Storage Capacity	Gigabytes (GB)	587.208
Data Protection *(RAID-5)*	Gigabytes (GB)	49.699
Required Storage *(metadata/overhead)*	Gigabytes (GB)	139.918
Global Storage Overhead	Gigabytes (GB)	0.000
Total Unused Storage	Gigabytes (GB)	0.000

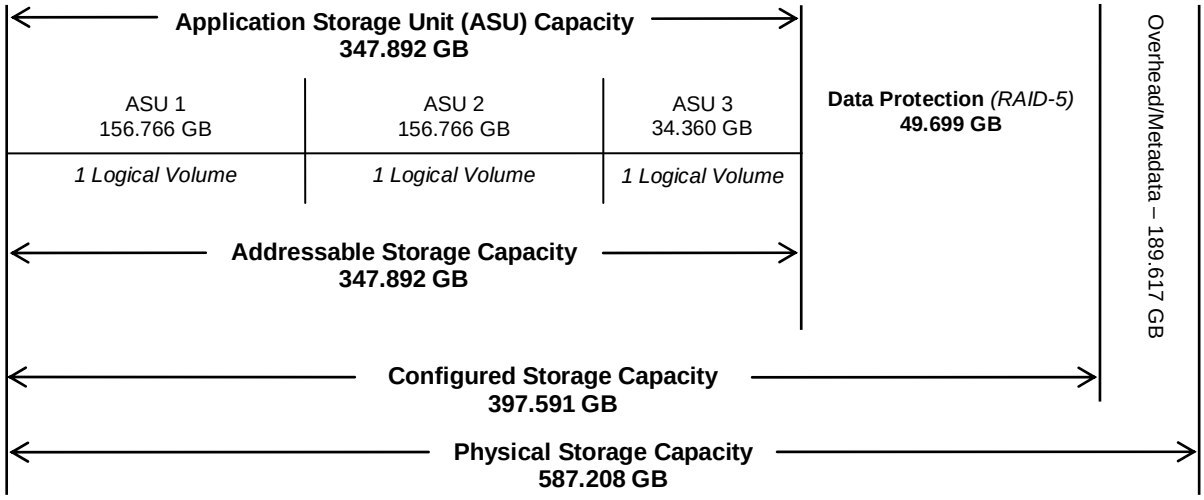
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	100.00%	87.50%	59.25%
Required for Data Protection *(Mirrored)*		12.50%	8.46%
Addressable Storage Capacity		87.50%	59.25%
Required Storage *(including spares)*		47.69%	32.29%
Configured Storage Capacity			67.71%
Global Storage Overhead			0.00%
Unused Storage:			
Addressable	0.00%		
Configured		0.00%	
Physical			0.00%

The Physical Storage Capacity consisted of 587.208 GB distributed over 8 solid state storage devices (SSDs) each with a formatted capacity of 73.401 GB. There was 0.000 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 0.000 GB (0.00%) of Physical Storage Capacity. There was 0.000 GB (0.00%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 100.00% of the Addressable Storage Capacity resulting in 0.000 GB (0.00%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(RAID-5)* capacity was 49.699 GB of which 49.699 GB was utilized. The total Unused Storage was 0.000 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 (156.766 GB)	**ASU-2 (156.766 GB)**	**ASU-3 (34.360 GB)**
1 Logical Volume 156.766 GB per Logical Volume (156.766 GB used per Logical Volume)	1 Logical Volume 156.766 GB per Logical Volume (156.766 GB used per Logical Volume)	1 Logical Volume 34.360 GB per Logical Volume (34.360 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was "Mirrored" as described on page 12. 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	59.25%
Protected Application Utilization	67.71%
Unused Storage Ratio	0.00%

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 62 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 72.

Sustainability Test Results File

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

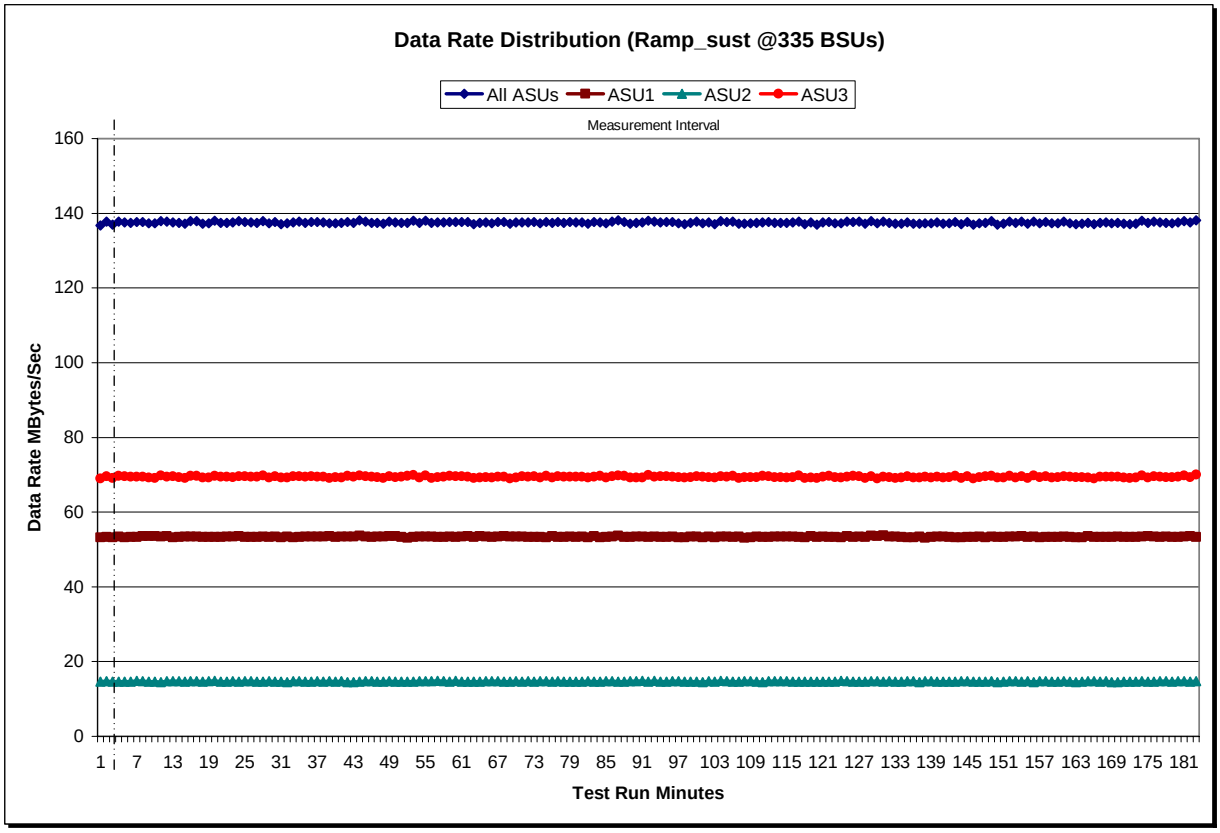
Sustainability Test Results File

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

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	20:10:38	20:13:38	0-2	0:03:00
Measurement Interval	20:13:38	23:13:38	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	136.69	53.16	14.58	68.95	63	137.42	53.56	14.67	69.19	126	137.75	53.49	14.66	69.61
1	137.74	53.38	14.78	69.58	64	137.57	53.47	14.71	69.39	127	137.15	53.31	14.67	69.16
2	137.02	53.25	14.62	69.15	65	137.30	53.38	14.73	69.19	128	137.87	53.65	14.69	69.52
3	137.76	53.45	14.60	69.71	66	137.63	53.44	14.72	69.46	129	137.27	53.53	14.71	69.02
4	137.51	53.24	14.66	69.62	67	137.66	53.54	14.68	69.44	130	137.79	53.78	14.60	69.41
5	137.41	53.32	14.64	69.45	68	137.18	53.47	14.66	69.05	131	137.46	53.42	14.71	69.33
6	137.68	53.37	14.90	69.41	69	137.51	53.49	14.80	69.22	132	137.19	53.41	14.64	69.14
7	137.71	53.56	14.74	69.41	70	137.59	53.44	14.58	69.57	133	137.20	53.37	14.63	69.20
8	137.35	53.57	14.57	69.21	71	137.50	53.29	14.73	69.48	134	137.53	53.18	14.73	69.62
9	137.27	53.53	14.58	69.16	72	137.67	53.37	14.69	69.61	135	137.17	53.22	14.73	69.22
10	137.83	53.49	14.55	69.79	73	137.36	53.37	14.77	69.21	136	137.21	53.40	14.53	69.28
11	137.78	53.52	14.76	69.49	74	137.62	53.19	14.72	69.70	137	137.33	53.15	14.70	69.48
12	137.55	53.25	14.74	69.56	75	137.39	53.52	14.66	69.21	138	137.31	53.39	14.72	69.19
13	137.44	53.37	14.69	69.37	76	137.60	53.38	14.70	69.53	139	137.58	53.46	14.66	69.45
14	137.18	53.42	14.68	69.07	77	137.45	53.39	14.65	69.41	140	137.25	53.46	14.59	69.20
15	137.88	53.44	14.75	69.68	78	137.61	53.50	14.68	69.43	141	137.31	53.36	14.60	69.35
16	137.91	53.50	14.72	69.69	79	137.50	53.35	14.65	69.50	142	137.66	53.27	14.67	69.72
17	137.20	53.28	14.68	69.24	80	137.54	53.43	14.61	69.49	143	137.05	53.26	14.71	69.09
18	137.28	53.31	14.75	69.22	81	137.19	53.20	14.72	69.27	144	137.70	53.30	14.78	69.61
19	137.95	53.39	14.86	69.70	82	137.69	53.53	14.67	69.49	145	136.92	53.28	14.62	69.02
20	137.45	53.28	14.68	69.49	83	137.57	53.19	14.68	69.70	146	137.36	53.40	14.61	69.34
21	137.41	53.39	14.58	69.43	84	137.36	53.37	14.73	69.26	147	137.46	53.21	14.63	69.61
22	137.51	53.42	14.71	69.38	85	137.76	53.40	14.78	69.58	148	137.83	53.42	14.73	69.69
23	137.84	53.57	14.65	69.62	86	138.06	53.67	14.63	69.75	149	136.98	53.31	14.47	69.21
24	137.61	53.37	14.72	69.53	87	137.64	53.30	14.63	69.71	150	137.15	53.30	14.62	69.23
25	137.57	53.33	14.78	69.46	88	137.24	53.29	14.70	69.24	151	137.79	53.44	14.70	69.65
26	137.41	53.32	14.59	69.50	89	137.42	53.41	14.73	69.28	152	137.37	53.41	14.76	69.19
27	137.86	53.46	14.65	69.75	90	137.51	53.39	14.90	69.22	153	137.73	53.55	14.66	69.53
28	137.25	53.29	14.71	69.26	91	137.96	53.38	14.64	69.94	154	137.18	53.31	14.75	69.13
29	137.65	53.43	14.66	69.56	92	137.80	53.50	14.81	69.49	155	137.77	53.47	14.54	69.76
30	137.04	53.17	14.64	69.23	93	137.52	53.35	14.59	69.58	156	137.28	53.26	14.70	69.32
31	137.26	53.41	14.57	69.28	94	137.62	53.36	14.68	69.58	157	137.67	53.36	14.78	69.53
32	137.59	53.26	14.71	69.63	95	137.63	53.39	14.76	69.48	158	137.33	53.37	14.68	69.28
33	137.73	53.34	14.76	69.62	96	137.33	53.27	14.73	69.33	159	137.35	53.32	14.65	69.39
34	137.46	53.46	14.59	69.42	97	137.11	53.22	14.68	69.21	160	137.81	53.48	14.71	69.61
35	137.69	53.48	14.64	69.57	98	137.40	53.49	14.62	69.30	161	137.34	53.28	14.61	69.46
36	137.70	53.48	14.73	69.50	99	137.73	53.50	14.68	69.55	162	137.09	53.26	14.52	69.30
37	137.53	53.43	14.60	69.51	100	137.28	53.23	14.56	69.49	163	137.25	53.26	14.61	69.38
38	137.34	53.55	14.69	69.09	101	137.50	53.48	14.72	69.30	164	137.47	53.51	14.71	69.25
39	137.27	53.31	14.58	69.38	102	137.10	53.25	14.62	69.22	165	137.08	53.32	14.75	69.01
40	137.48	53.49	14.76	69.23	103	137.91	53.47	14.89	69.56	166	137.38	53.28	14.68	69.41
41	137.63	53.42	14.54	69.67	104	137.64	53.44	14.73	69.47	167	137.50	53.31	14.72	69.46
42	137.44	53.40	14.55	69.49	105	137.75	53.36	14.68	69.71	168	137.29	53.33	14.49	69.46
43	138.14	53.63	14.66	69.85	106	137.18	53.43	14.61	69.15	169	137.44	53.43	14.57	69.44
44	137.74	53.40	14.73	69.62	107	137.14	53.15	14.70	69.29	170	137.21	53.33	14.68	69.20
45	137.48	53.37	14.70	69.41	108	137.27	53.26	14.70	69.31	171	137.09	53.30	14.62	69.17
46	137.43	53.49	14.59	69.36	109	137.41	53.40	14.65	69.36	172	137.20	53.32	14.69	69.19
47	137.24	53.43	14.65	69.16	110	137.54	53.31	14.57	69.66	173	137.98	53.44	14.76	69.79
48	137.76	53.52	14.69	69.54	111	137.67	53.36	14.76	69.55	174	137.43	53.61	14.65	69.18
49	137.58	53.55	14.67	69.36	112	137.46	53.40	14.72	69.35	175	137.76	53.49	14.65	69.63
50	137.40	53.29	14.62	69.48	113	137.46	53.47	14.69	69.30	176	137.57	53.38	14.77	69.42
51	137.42	53.14	14.61	69.66	114	137.38	53.45	14.75	69.19	177	137.48	53.42	14.75	69.30
52	137.95	53.39	14.68	69.88	115	137.55	53.48	14.68	69.39	178	137.32	53.35	14.66	69.31
53	137.39	53.44	14.74	69.20	116	137.78	53.30	14.64	69.85	179	137.53	53.37	14.70	69.46
54	137.98	53.41	14.74	69.82	117	137.03	53.26	14.64	69.13	180	137.92	53.43	14.74	69.75
55	137.37	53.50	14.76	69.11	118	137.52	53.60	14.65	69.27	181	137.49	53.53	14.64	69.32
56	137.54	53.35	14.80	69.38	119	136.97	53.33	14.57	69.07	182	138.09	53.35	14.76	69.98
57	137.55	53.29	14.76	69.49	120	137.49	53.48	14.59	69.42					
58	137.69	53.41	14.58	69.70	121	137.68	53.34	14.65	69.69					
59	137.64	53.30	14.82	69.52	122	137.28	53.35	14.62	69.31					
60	137.69	53.45	14.62	69.62	123	137.30	53.23	14.82	69.25					
61	137.64	53.56	14.65	69.43	124	137.72	53.51	14.73	69.48					
62	137.04	53.28	14.67	69.08	125	137.69	53.39	14.58	69.72					

Sustainability – Data Rate Distribution Graph

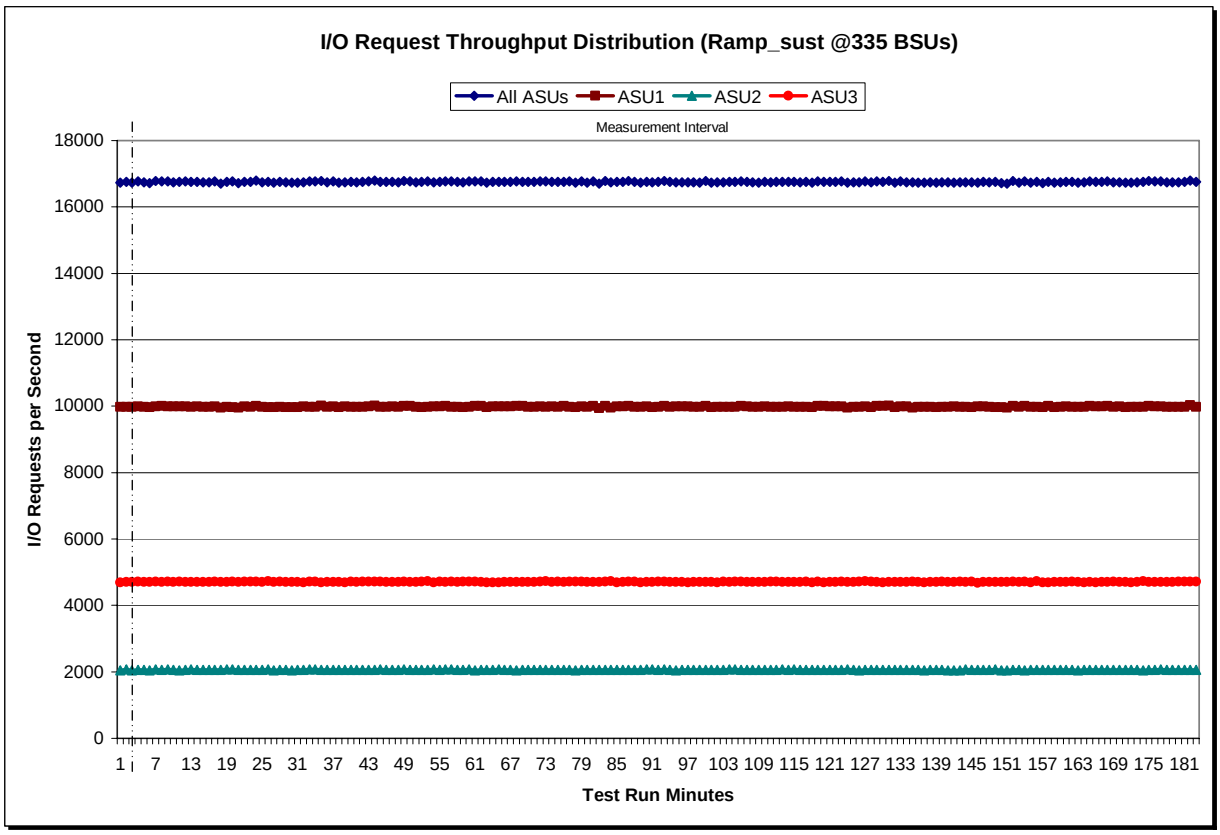


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	20:10:38	20:13:38	0-2	0:03:00
Measurement Interval	20:13:38	23:13:38	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	16,724.20	9,980.40	2,050.50	4,693.30	63	16,754.00	9,990.07	2,066.57	4,697.37	126	16,767.52	9,987.60	2,054.47	4,725.45
1	16,750.70	9,977.88	2,069.22	4,703.60	64	16,760.32	9,995.97	2,068.88	4,695.47	127	16,748.27	9,970.20	2,065.52	4,712.55
2	16,735.03	9,980.43	2,050.57	4,704.03	65	16,754.37	9,988.35	2,063.77	4,702.25	128	16,774.12	10,009.30	2,061.08	4,703.73
3	16,774.02	9,996.18	2,063.30	4,714.53	66	16,758.08	9,993.83	2,059.13	4,705.12	129	16,752.80	10,002.08	2,058.95	4,691.77
4	16,738.33	9,979.52	2,055.48	4,703.33	67	16,763.48	10,004.10	2,052.35	4,707.03	130	16,776.93	10,016.45	2,058.08	4,702.40
5	16,721.47	9,967.63	2,052.35	4,701.48	68	16,756.52	9,998.87	2,059.77	4,697.88	131	16,735.60	9,970.83	2,065.63	4,699.13
6	16,781.10	9,991.50	2,073.43	4,716.17	69	16,750.68	9,984.23	2,062.72	4,703.73	132	16,763.63	9,994.80	2,060.58	4,708.25
7	16,770.05	9,999.30	2,065.67	4,705.08	70	16,751.22	9,981.18	2,060.12	4,709.92	133	16,749.30	9,991.77	2,054.97	4,702.57
8	16,771.60	9,992.77	2,067.27	4,711.57	71	16,767.22	9,987.82	2,061.97	4,717.43	134	16,737.68	9,955.07	2,060.25	4,722.37
9	16,749.42	9,987.27	2,058.45	4,703.70	72	16,773.65	9,981.95	2,066.93	4,724.77	135	16,735.62	9,977.67	2,054.93	4,703.02
10	16,758.70	9,995.62	2,050.08	4,713.00	73	16,754.55	9,990.88	2,055.33	4,708.33	136	16,729.33	9,981.80	2,050.52	4,697.02
11	16,764.25	9,994.03	2,064.40	4,705.82	74	16,758.47	9,983.28	2,059.10	4,716.08	137	16,739.38	9,976.47	2,060.03	4,702.88
12	16,751.43	9,977.18	2,067.48	4,706.77	75	16,762.32	9,999.58	2,060.62	4,702.12	138	16,726.98	9,969.63	2,057.68	4,699.67
13	16,756.18	9,989.17	2,064.08	4,702.93	76	16,764.90	9,978.53	2,064.50	4,721.87	139	16,747.70	9,976.83	2,059.35	4,711.52
14	16,743.12	9,979.07	2,065.05	4,699.00	77	16,734.67	9,970.12	2,053.07	4,711.48	140	16,742.02	9,982.85	2,053.18	4,705.98
15	16,748.42	9,978.48	2,061.37	4,708.57	78	16,773.32	9,995.17	2,062.32	4,715.83	141	16,732.32	9,988.25	2,044.05	4,700.02
16	16,767.85	9,988.32	2,066.10	4,713.43	79	16,728.13	9,973.62	2,054.03	4,700.48	142	16,738.32	9,973.93	2,046.82	4,717.57
17	16,708.03	9,951.28	2,054.70	4,702.05	80	16,763.02	9,998.43	2,056.78	4,707.80	143	16,747.15	9,979.50	2,067.80	4,699.85
18	16,751.00	9,977.95	2,073.92	4,699.13	81	16,707.12	9,945.48	2,055.03	4,706.60	144	16,746.37	9,969.25	2,066.25	4,710.87
19	16,763.92	9,965.88	2,074.93	4,723.10	82	16,786.02	10,002.12	2,066.53	4,717.37	145	16,732.10	9,993.28	2,055.43	4,683.38
20	16,721.48	9,957.23	2,057.40	4,706.85	83	16,745.42	9,956.37	2,060.08	4,728.97	146	16,762.23	9,994.28	2,059.17	4,708.78
21	16,762.35	9,986.07	2,058.58	4,717.70	84	16,749.77	9,989.57	2,063.20	4,697.00	147	16,743.33	9,972.52	2,064.95	4,705.87
22	16,758.92	9,979.30	2,064.50	4,715.12	85	16,753.30	9,988.12	2,059.32	4,705.87	148	16,750.18	9,971.47	2,068.93	4,709.78
23	16,790.80	10,005.83	2,064.47	4,720.50	86	16,783.67	10,004.87	2,057.97	4,720.83	149	16,714.78	9,968.73	2,042.98	4,703.07
24	16,748.78	9,982.32	2,061.25	4,705.22	87	16,753.92	9,981.12	2,058.65	4,714.15	150	16,707.92	9,949.22	2,052.70	4,706.00
25	16,760.32	9,968.43	2,067.98	4,723.90	88	16,725.27	9,976.70	2,061.48	4,687.08	151	16,776.82	10,002.08	2,061.33	4,713.40
26	16,726.13	9,966.28	2,052.42	4,707.43	89	16,752.43	9,985.48	2,067.43	4,699.52	152	16,727.12	9,973.67	2,054.18	4,699.27
27	16,753.45	9,979.65	2,062.00	4,711.80	90	16,744.67	9,968.55	2,067.33	4,708.78	153	16,773.05	10,007.30	2,050.80	4,714.95
28	16,738.37	9,969.75	2,062.20	4,706.42	91	16,754.72	9,979.00	2,054.00	4,721.72	154	16,736.27	9,978.05	2,061.57	4,696.65
29	16,727.23	9,970.00	2,053.58	4,703.65	92	16,778.52	9,998.43	2,067.62	4,712.47	155	16,761.83	9,981.38	2,054.65	4,725.80
30	16,730.93	9,971.77	2,058.38	4,700.78	93	16,749.98	9,981.92	2,057.92	4,710.15	156	16,718.03	9,964.57	2,058.40	4,695.07
31	16,745.42	9,989.47	2,059.20	4,696.75	94	16,747.48	9,989.27	2,048.82	4,709.40	157	16,756.58	10,000.98	2,061.78	4,693.82
32	16,762.60	9,980.65	2,069.73	4,712.22	95	16,749.15	9,988.32	2,055.18	4,705.65	158	16,733.90	9,968.67	2,055.57	4,709.67
33	16,768.85	9,980.40	2,077.43	4,711.02	96	16,746.25	9,988.47	2,061.42	4,696.37	159	16,745.28	9,977.30	2,059.08	4,708.90
34	16,775.67	10,015.72	2,065.13	4,694.82	97	16,736.63	9,977.33	2,060.63	4,698.67	160	16,759.43	9,989.37	2,061.42	4,708.65
35	16,743.97	9,976.65	2,059.10	4,708.22	98	16,730.15	9,974.35	2,057.03	4,698.77	161	16,749.50	9,976.95	2,057.42	4,715.13
36	16,765.47	9,995.10	2,066.10	4,704.27	99	16,777.00	10,006.62	2,061.98	4,708.40	162	16,727.48	9,980.45	2,046.35	4,700.68
37	16,734.62	9,970.18	2,054.77	4,709.67	100	16,729.35	9,971.75	2,059.15	4,698.45	163	16,743.13	9,982.35	2,063.72	4,697.07
38	16,745.28	9,990.65	2,057.13	4,697.50	101	16,737.07	9,983.82	2,059.10	4,694.15	164	16,766.33	10,001.68	2,058.83	4,705.82
39	16,757.23	9,979.72	2,055.27	4,722.25	102	16,742.22	9,975.65	2,055.77	4,710.80	165	16,751.33	9,989.52	2,064.20	4,697.62
40	16,747.78	9,983.73	2,057.92	4,706.13	103	16,755.47	9,977.90	2,067.85	4,709.72	166	16,755.38	9,987.02	2,066.18	4,702.18
41	16,756.67	9,979.87	2,062.10	4,714.70	104	16,758.53	9,975.82	2,070.30	4,712.42	167	16,764.68	10,000.62	2,063.45	4,700.62
42	16,767.15	9,990.72	2,057.70	4,718.73	105	16,770.78	9,999.48	2,056.23	4,715.07	168	16,741.88	9,974.43	2,054.67	4,712.78
43	16,796.12	10,019.50	2,062.70	4,713.92	106	16,754.27	9,987.98	2,057.95	4,708.33	169	16,748.12	9,988.15	2,056.33	4,703.63
44	16,759.20	9,980.32	2,068.00	4,710.88	107	16,744.38	9,972.92	2,062.78	4,708.68	170	16,728.82	9,971.82	2,058.65	4,698.35
45	16,755.73	9,980.65	2,066.33	4,708.75	108	16,735.47	9,973.57	2,057.63	4,704.27	171	16,730.95	9,973.57	2,059.82	4,697.57
46	16,761.02	9,997.20	2,058.58	4,705.23	109	16,752.00	9,990.03	2,057.70	4,704.27	172	16,742.80	9,984.13	2,057.55	4,701.12
47	16,742.52	9,978.38	2,058.68	4,705.45	110	16,744.17	9,973.62	2,055.20	4,715.35	173	16,755.53	9,976.93	2,052.77	4,725.83
48	16,786.45	10,001.52	2,071.65	4,713.28	111	16,757.52	9,979.60	2,059.93	4,717.98	174	16,776.68	10,006.40	2,065.25	4,705.03
49	16,771.95	10,004.55	2,063.67	4,703.73	112	16,750.48	9,974.90	2,067.40	4,708.18	175	16,766.47	9,996.55	2,060.02	4,709.90
50	16,745.10	9,978.92	2,060.62	4,705.57	113	16,761.42	9,992.75	2,062.95	4,705.72	176	16,763.97	9,985.83	2,071.07	4,707.07
51	16,752.55	9,969.95	2,060.52	4,722.08	114	16,749.67	9,978.53	2,069.73	4,701.40	177	16,746.38	9,982.58	2,065.77	4,698.03
52	16,769.22	9,976.50	2,064.50	4,728.22	115	16,736.80	9,977.88	2,058.92	4,700.00	178	16,742.07	9,975.18	2,063.05	4,703.83
53	16,745.25	9,987.22	2,068.03	4,690.00	116	16,756.52	9,971.95	2,062.25	4,722.32	179	16,745.25	9,972.10	2,062.50	4,710.65
54	16,758.10	9,990.90	2,056.52	4,710.68	117	16,726.92	9,969.42	2,062.72	4,694.78	180	16,752.10	9,975.27	2,060.93	4,715.90
55	16,774.52	10,001.37	2,068.77	4,704.38	118	16,774.70	10,006.85	2,055.75	4,712.10	181	16,800.85	10,026.75	2,062.62	4,711.48
56	16,762.82	9,979.55	2,071.23	4,712.03	119	16,761.35	10,009.18	2,059.92	4,692.25	182	16,756.05	9,975.38	2,065.83	4,714.83
57	16,752.97	9,982.15	2,063.22	4,707.60	120	16,757.72	9,985.83	2,064.55	4,707.33	***Average***	***16,751.87***	***9,983.78***	***2,060.59***	***4,707.50***
58	16,737.22	9,968.43	2,054.18	4,714.60	121	16,749.58	9,987.42	2,054.63	4,707.53					
59	16,768.78	9,979.48	2,071.00	4,718.30	122	16,770.98	9,986.55	2,065.45	4,718.98					
60	16,763.12	9,999.95	2,047.28	4,715.88	123	16,728.23	9,956.20	2,067.12	4,704.92					
61	16,763.42	10,007.12	2,057.10	4,699.20	124	16,747.15	9,982.77	2,058.53	4,705.85					
62	16,725.97	9,970.18	2,060.63	4,695.15	125	16,737.77	9,974.33	2,051.38	4,712.05					

Sustainability – I/O Request Throughput Distribution Graph

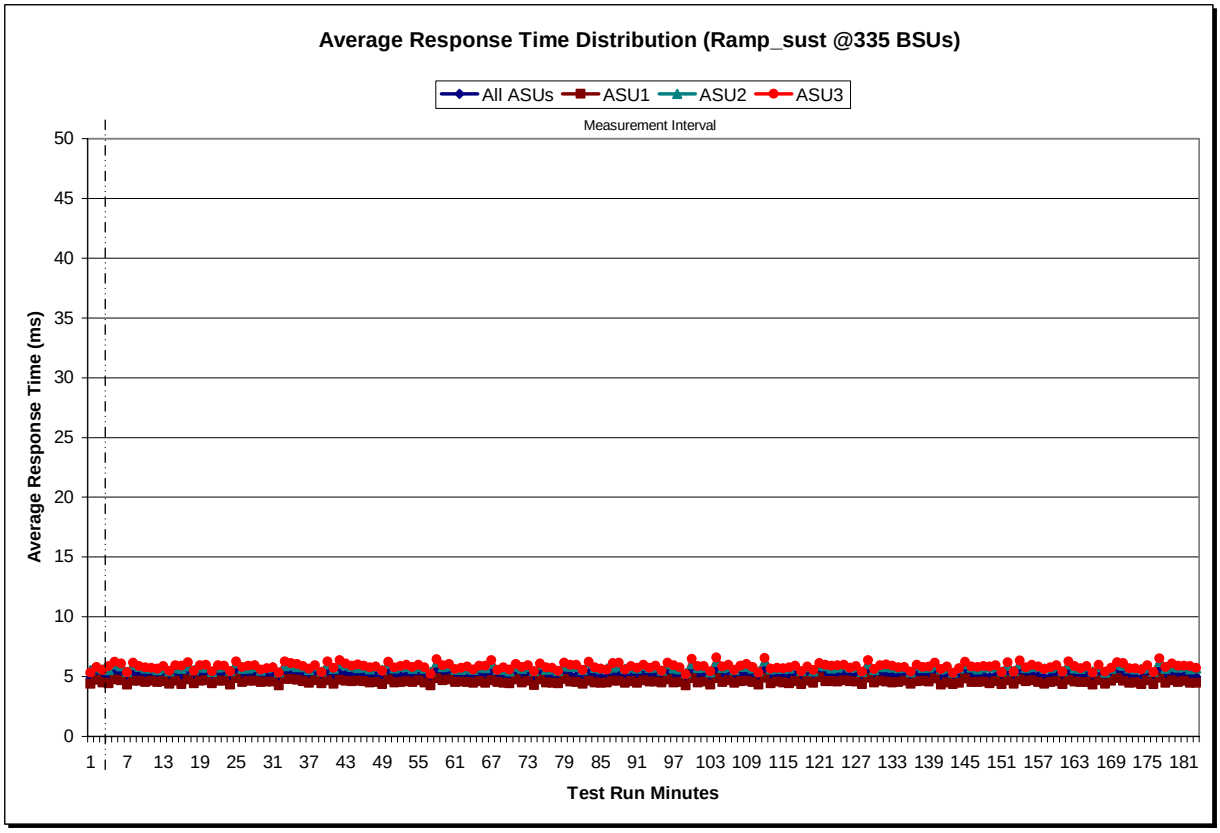


Sustainability – Average Response Time (ms) Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	20:10:38	20:13:38	0-2	0:03:00
Measurement Interval	20:13:38	23:13:38	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	4.81	4.41	5.54	5.34	63	4.91	4.46	5.56	5.58	126	5.09	4.57	5.79	5.86
1	5.14	4.70	5.76	5.80	64	5.11	4.60	5.76	5.90	127	4.78	4.37	5.40	5.39
2	4.93	4.49	5.62	5.56	65	5.01	4.45	5.71	5.91	128	5.45	4.89	6.06	6.36
3	4.97	4.43	5.53	5.87	66	5.34	4.69	6.10	6.37	129	4.93	4.48	5.53	5.60
4	5.32	4.74	6.00	6.24	67	4.93	4.52	5.57	5.53	130	5.14	4.63	5.81	5.94
5	5.22	4.68	5.85	6.07	68	4.97	4.46	5.58	5.76	131	5.14	4.59	5.78	6.02
6	4.74	4.31	5.39	5.35	69	4.86	4.41	5.45	5.56	132	5.06	4.51	5.75	5.91
7	5.23	4.64	5.98	6.15	70	5.25	4.75	5.84	6.05	133	5.02	4.52	5.71	5.77
8	5.13	4.63	5.84	5.87	71	5.00	4.49	5.67	5.78	134	5.11	4.66	5.75	5.80
9	5.03	4.55	5.70	5.74	72	5.16	4.64	5.83	5.95	135	4.79	4.38	5.37	5.40
10	5.08	4.64	5.68	5.74	73	4.74	4.28	5.47	5.42	136	5.15	4.60	5.90	5.98
11	4.97	4.53	5.54	5.66	74	5.28	4.75	5.97	6.10	137	5.10	4.63	5.74	5.80
12	5.10	4.62	5.68	5.85	75	4.98	4.49	5.59	5.76	138	5.07	4.57	5.77	5.82
13	4.83	4.39	5.45	5.49	76	4.97	4.47	5.62	5.73	139	5.33	4.82	5.94	6.14
14	5.14	4.64	5.73	5.93	77	4.84	4.41	5.48	5.46	140	4.84	4.32	5.60	5.60
15	4.96	4.36	5.67	5.91	78	5.31	4.79	5.88	6.15	141	5.02	4.49	5.74	5.85
16	5.30	4.76	5.87	6.20	79	5.12	4.58	5.82	5.96	142	4.75	4.37	5.34	5.30
17	4.86	4.43	5.53	5.46	80	5.09	4.54	5.79	5.96	143	4.97	4.47	5.69	5.70
18	5.14	4.63	5.76	5.96	81	4.86	4.41	5.55	5.53	144	5.37	4.82	6.05	6.23
19	5.17	4.67	5.75	5.99	82	5.28	4.65	6.13	6.23	145	5.04	4.53	5.77	5.83
20	4.83	4.43	5.39	5.43	83	5.02	4.51	5.74	5.76	146	5.01	4.52	5.62	5.80
21	5.14	4.65	5.74	5.92	84	4.93	4.45	5.66	5.65	147	5.07	4.56	5.77	5.86
22	5.15	4.65	5.84	5.89	85	4.96	4.50	5.69	5.59	148	4.98	4.43	5.75	5.81
23	4.78	4.33	5.49	5.44	86	5.20	4.65	5.76	6.13	149	5.12	4.60	5.81	5.94
24	5.41	4.87	6.10	6.27	87	5.21	4.63	5.87	6.14	150	4.78	4.37	5.42	5.38
25	5.04	4.55	5.66	5.81	88	4.93	4.48	5.64	5.58	151	5.26	4.68	5.90	6.20
26	5.13	4.64	5.69	5.92	89	5.11	4.62	5.76	5.86	152	4.81	4.39	5.46	5.42
27	5.15	4.65	5.79	5.93	90	4.97	4.47	5.68	5.73	153	5.37	4.77	6.06	6.35
28	4.94	4.53	5.50	5.58	91	5.20	4.69	5.91	5.98	154	5.06	4.59	5.71	5.77
29	5.03	4.58	5.72	5.69	92	5.02	4.56	5.71	5.71	155	5.19	4.69	5.82	5.97
30	5.05	4.56	5.78	5.77	93	5.10	4.58	5.77	5.90	156	5.07	4.55	5.81	5.84
31	4.69	4.25	5.38	5.32	94	4.89	4.50	5.50	5.47	157	4.90	4.40	5.67	5.62
32	5.34	4.78	5.87	6.27	95	5.30	4.74	6.05	6.17	158	5.02	4.53	5.71	5.76
33	5.30	4.78	5.93	6.12	96	5.04	4.49	5.69	5.93	159	5.14	4.62	5.87	5.94
34	5.21	4.70	5.78	6.05	97	5.00	4.52	5.60	5.76	160	4.78	4.35	5.47	5.39
35	5.12	4.62	5.78	5.88	98	4.62	4.23	5.29	5.17	161	5.31	4.71	6.02	6.28
36	4.94	4.47	5.54	5.65	99	5.47	4.86	6.05	6.49	162	5.08	4.58	5.69	5.87
37	5.17	4.67	5.87	5.93	100	5.04	4.50	5.72	5.87	163	5.00	4.55	5.64	5.69
38	4.83	4.45	5.44	5.38	101	5.07	4.56	5.77	5.86	164	5.06	4.52	5.84	5.88
39	5.30	4.69	6.01	6.26	102	4.77	4.33	5.37	5.43	165	4.74	4.31	5.43	5.34
40	4.91	4.38	5.66	5.71	103	5.52	4.88	6.24	6.57	166	5.18	4.67	5.81	5.97
41	5.35	4.71	6.07	6.38	104	5.06	4.54	5.74	5.85	167	4.80	4.41	5.34	5.38
42	5.21	4.63	5.96	6.09	105	5.18	4.67	5.82	5.97	168	5.07	4.64	5.66	5.73
43	5.13	4.62	5.83	5.91	106	4.89	4.46	5.53	5.53	169	5.38	4.87	6.00	6.20
44	5.17	4.65	5.73	6.03	107	5.12	4.60	5.82	5.91	170	5.21	4.65	5.92	6.10
45	5.11	4.59	5.76	5.91	108	5.19	4.65	5.82	6.04	171	4.96	4.46	5.67	5.70
46	4.98	4.49	5.62	5.75	109	5.03	4.55	5.69	5.78	172	4.96	4.49	5.60	5.67
47	5.06	4.55	5.84	5.82	110	4.75	4.33	5.44	5.32	173	4.86	4.35	5.64	5.59
48	4.82	4.36	5.58	5.46	111	5.54	4.91	6.27	6.56	174	5.17	4.69	5.73	5.95
49	5.33	4.75	6.05	6.24	112	4.91	4.42	5.61	5.65	175	4.76	4.35	5.40	5.37
50	5.01	4.50	5.69	5.78	113	5.03	4.56	5.66	5.73	176	5.52	4.90	6.24	6.51
51	5.06	4.52	5.83	5.85	114	4.97	4.49	5.67	5.67	177	4.99	4.47	5.65	5.80
52	5.14	4.60	5.80	5.97	115	4.96	4.43	5.69	5.74	178	5.22	4.67	5.85	6.09
53	5.02	4.53	5.65	5.79	116	5.13	4.61	5.89	5.89	179	5.07	4.54	5.76	5.89
54	5.20	4.69	5.83	5.99	117	4.80	4.37	5.47	5.43	180	5.13	4.63	5.83	5.90
55	4.99	4.48	5.65	5.77	118	5.11	4.64	5.78	5.82	181	5.01	4.48	5.61	5.88
56	4.66	4.24	5.38	5.22	119	4.88	4.46	5.45	5.53	182	4.98	4.48	5.70	5.72
57	5.46	4.85	6.18	6.45	120	5.39	4.94	5.92	6.10	***Average***	***5.07***	***4.57***	***5.73***	***5.84***
58	5.16	4.67	5.79	5.94	121	5.14	4.60	5.85	5.98					
59	5.24	4.73	5.87	6.05	122	5.11	4.61	5.68	5.92					
60	4.98	4.54	5.59	5.63	123	5.11	4.57	5.78	5.96					
61	5.03	4.58	5.57	5.73	124	5.19	4.67	5.96	5.96					
62	5.05	4.55	5.67	5.84	125	5.06	4.60	5.78	5.71					

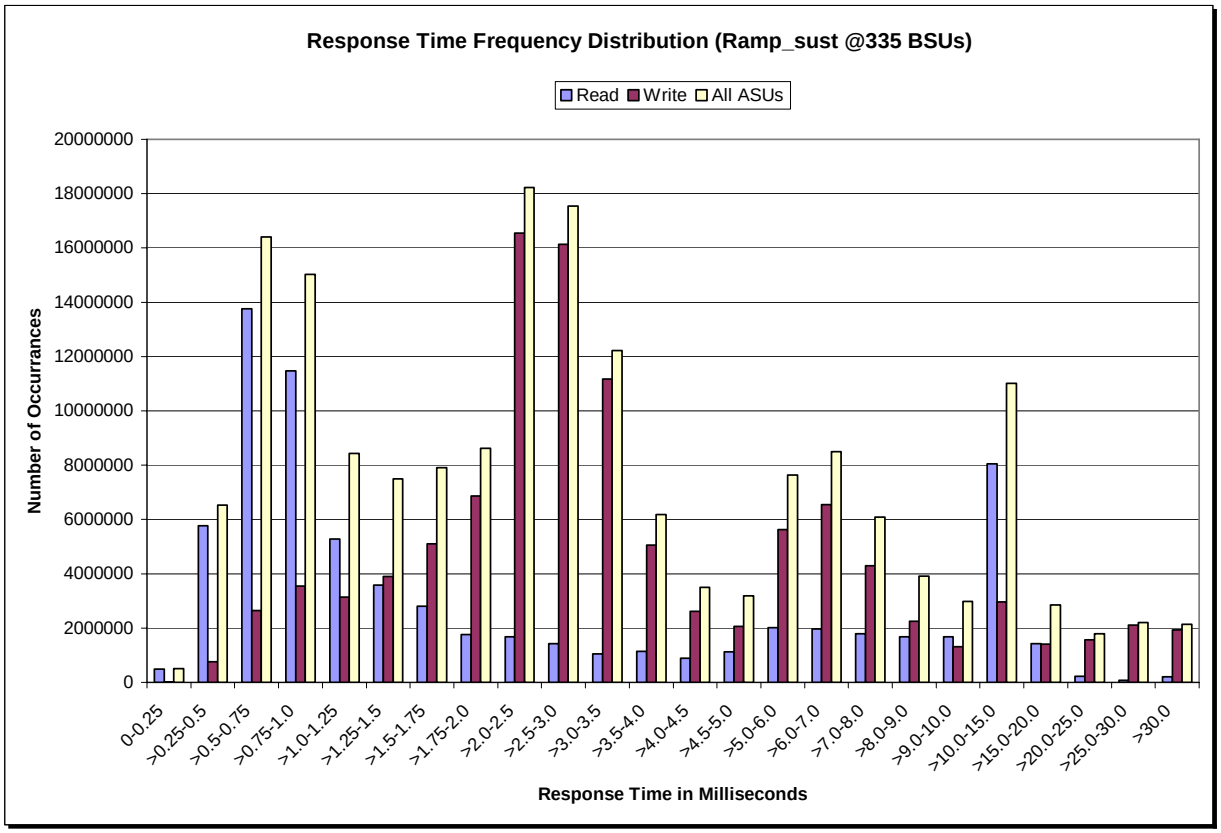
Sustainability – Average Response Time (ms) Distribution Graph



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	483,422	5,775,638	13,763,375	11,470,315	5,281,473	3,586,186	2,812,462	1,765,280
Write	18,823	760,044	2,645,414	3,555,832	3,144,166	3,903,508	5,097,057	6,857,016
All ASUs	502,245	6,535,682	16,408,789	15,026,147	8,425,639	7,489,694	7,909,519	8,622,296
ASU1	467,431	5,862,385	14,276,887	12,249,178	5,921,143	4,879,640	4,625,590	4,387,474
ASU2	28,346	371,922	988,386	1,150,397	1,067,743	1,228,164	1,380,617	1,381,360
ASU3	6,468	301,375	1,143,516	1,626,572	1,436,753	1,381,890	1,903,312	2,853,462
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	1,676,275	1,422,463	1,053,494	1,136,237	893,587	1,119,849	2,012,609	1,960,179
Write	16,545,796	16,126,047	11,167,008	5,050,137	2,616,528	2,061,672	5,631,458	6,539,585
All ASUs	18,222,071	17,548,510	12,220,502	6,186,374	3,510,115	3,181,521	7,644,067	8,499,764
ASU1	8,519,433	8,331,945	4,149,564	2,778,849	1,661,163	1,816,593	4,247,522	4,356,805
ASU2	2,356,913	1,928,957	1,595,830	751,771	462,326	399,512	913,593	1,031,987
ASU3	7,345,725	7,287,608	6,475,108	2,655,754	1,386,626	965,416	2,482,952	3,110,972
Response Time (ms)	**>7.0-8.0**	**>8.0-9.0**	**>9.0-10.0**	**>10.0-15.0**	**>15.0-20.0**	**>20.0-25.0**	**>25.0-30.0**	**>30.0**
Read	1,792,142	1,676,764	1,675,092	8,053,387	1,427,985	221,852	85,579	205,327
Write	4,293,039	2,245,420	1,312,089	2,963,643	1,417,459	1,574,831	2,111,265	1,931,368
All ASUs	6,085,181	3,922,184	2,987,181	11,017,030	2,845,444	1,796,683	2,196,844	2,136,695
ASU1	3,284,772	2,291,402	1,936,640	7,606,312	1,457,801	742,381	1,067,471	906,399
ASU2	782,292	550,758	449,085	2,000,647	660,202	281,333	254,608	237,619
ASU3	2,018,117	1,080,024	601,456	1,410,071	727,441	772,969	874,765	992,677

Sustainability – Response Time Frequency Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.10 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.005	0.002	0.004	0.002	0.007	0.003	0.005	0.002

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 72.

IOPS Test Results File

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

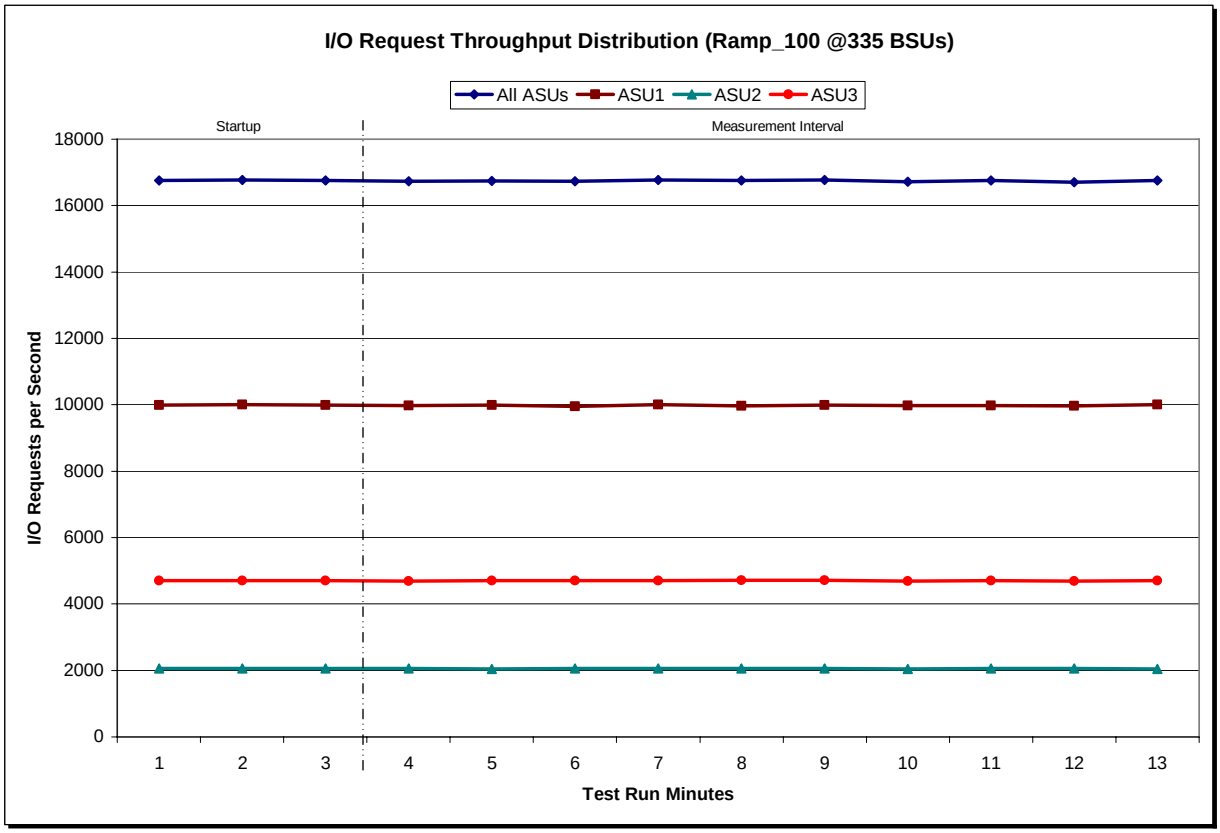
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

335 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:13:41	23:16:42	0-2	0:03:01
Measurement Interval	23:16:42	23:26:42	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	16,759.55	9,993.33	2,059.95	4,706.27
1	16,764.08	10,000.60	2,055.33	4,708.15
2	16,755.03	9,993.57	2,060.60	4,700.87
3	16,725.52	9,974.38	2,055.97	4,695.17
4	16,746.90	9,990.98	2,052.30	4,703.62
5	16,724.18	9,957.22	2,061.58	4,705.38
6	16,763.33	10,004.47	2,057.28	4,701.58
7	16,751.72	9,968.67	2,065.05	4,718.00
8	16,764.10	9,990.12	2,060.90	4,713.08
9	16,716.93	9,978.78	2,051.30	4,686.85
10	16,750.97	9,978.55	2,063.10	4,709.32
11	16,706.78	9,963.00	2,055.37	4,688.42
12	16,761.15	10,001.25	2,050.27	4,709.63
Average	***16,741.16***	***9,980.74***	***2,057.31***	***4,703.11***

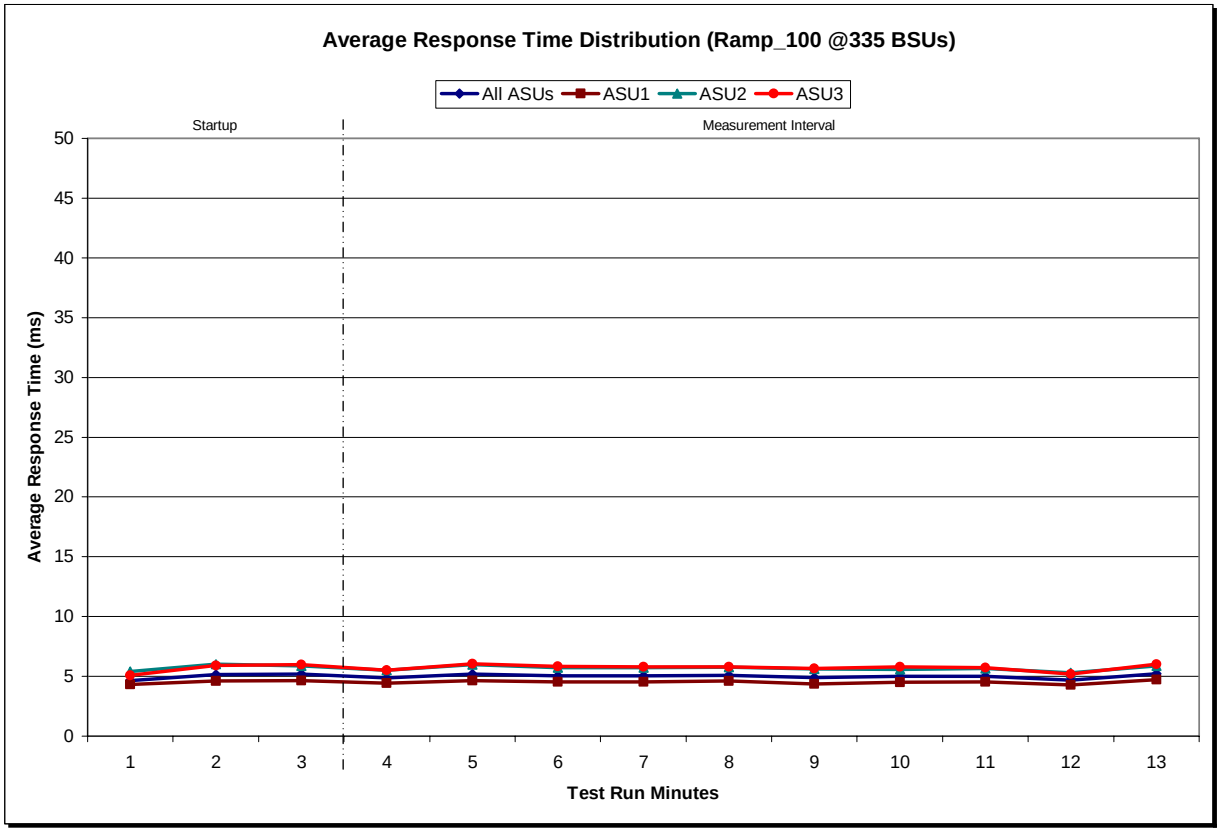
IOPS Test Run – I/O Request Throughput Distribution Graph



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

335 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:13:41	23:16:42	0-2	0:03:01
Measurement Interval	23:16:42	23:26:42	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	4.66	4.31	5.39	5.07
1	5.15	4.62	6.01	5.91
2	5.18	4.65	5.86	5.99
3	4.85	4.41	5.51	5.50
4	5.19	4.63	5.99	6.03
5	5.05	4.53	5.74	5.83
6	5.04	4.55	5.72	5.79
7	5.09	4.62	5.75	5.80
8	4.89	4.37	5.63	5.66
9	4.99	4.49	5.56	5.80
10	5.00	4.52	5.66	5.72
11	4.66	4.28	5.28	5.20
12	5.21	4.70	5.88	6.01
Average	***5.00***	***4.51***	***5.67***	***5.74***

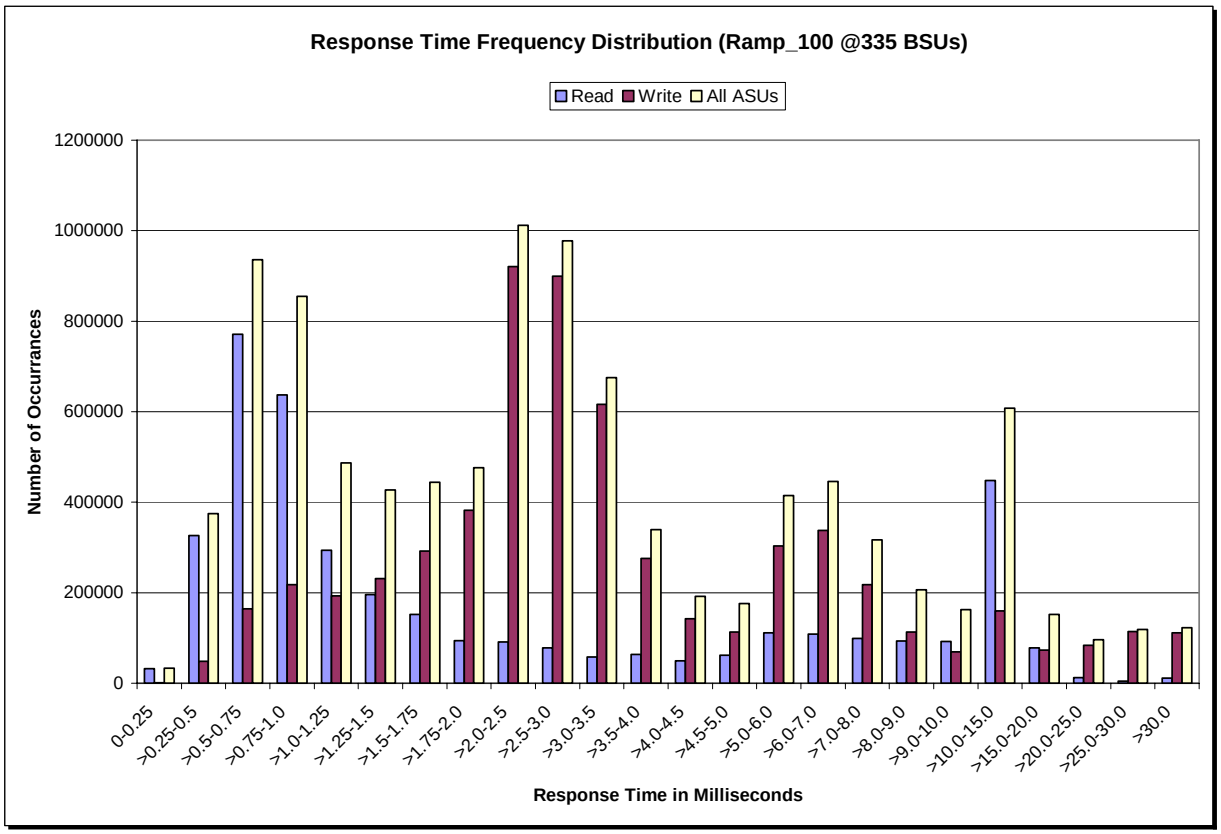
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	32,433	325,858	771,101	637,013	293,674	195,754	151,675	94,610
Write	1,207	48,601	164,455	217,781	193,374	231,203	291,988	382,106
All ASUs	33,640	374,459	935,556	854,794	487,048	426,957	443,663	476,716
ASU1	30,918	332,337	805,351	688,363	337,566	274,405	257,333	242,104
ASU2	2,291	22,788	58,917	66,515	61,233	69,147	76,666	75,943
ASU3	431	19,334	71,288	99,916	88,249	83,405	109,664	158,669
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	91,103	78,298	58,414	63,279	49,851	62,194	111,333	108,024
Write	920,168	899,490	616,475	275,848	142,433	113,291	302,911	337,744
All ASUs	1,011,271	977,788	674,889	339,127	192,284	175,485	414,244	445,768
ASU1	472,585	462,819	229,354	152,616	91,204	100,568	231,573	229,977
ASU2	129,538	107,011	87,550	41,191	25,613	22,090	49,641	54,241
ASU3	409,148	407,958	357,985	145,320	75,467	52,827	133,030	161,550
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	99,094	93,005	92,697	447,481	78,233	12,012	4,452	11,270
Write	217,365	113,006	69,514	159,790	73,589	83,763	113,973	111,727
All ASUs	316,459	206,011	162,211	607,271	151,822	95,775	118,425	122,997
ASU1	172,500	122,607	106,057	421,597	78,287	39,795	58,173	50,334
ASU2	41,379	28,904	24,556	109,848	36,224	15,201	13,763	14,133
ASU3	102,580	54,500	31,598	75,826	37,311	40,779	46,489	58,530

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
10,044,660	9,921,663	122,997

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	0.0349	0.2812	0.0701	0.2100	0.0180	0.0699	0.0350	0.2809
COV	0.007	0.002	0.005	0.002	0.005	0.003	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 14.

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 72.

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 - 335 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:13:41	23:16:42	0-2	0:03:01
Measurement Interval	23:16:42	23:26:42	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	16,759.55	9,993.33	2,059.95	4,706.27
1	16,764.08	10,000.60	2,055.33	4,708.15
2	16,755.03	9,993.57	2,060.60	4,700.87
3	16,725.52	9,974.38	2,055.97	4,695.17
4	16,746.90	9,990.98	2,052.30	4,703.62
5	16,724.18	9,957.22	2,061.58	4,705.38
6	16,763.33	10,004.47	2,057.28	4,701.58
7	16,751.72	9,968.67	2,065.05	4,718.00
8	16,764.10	9,990.12	2,060.90	4,713.08
9	16,716.93	9,978.78	2,051.30	4,686.85
10	16,750.97	9,978.55	2,063.10	4,709.32
11	16,706.78	9,963.00	2,055.37	4,688.42
12	16,761.15	10,001.25	2,050.27	4,709.63
Average	16,741.16	9,980.74	2,057.31	4,703.11

95% Load Level - 318 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:26:44	23:29:45	0-2	0:03:01
Measurement Interval	23:29:45	23:39:45	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	15,910.55	9,472.48	1,959.07	4,479.00
1	15,901.13	9,466.82	1,956.37	4,477.95
2	15,910.10	9,487.17	1,962.77	4,460.17
3	15,912.97	9,467.43	1,955.93	4,489.60
4	15,895.58	9,458.15	1,959.23	4,478.20
5	15,949.30	9,500.08	1,965.27	4,483.95
6	15,866.73	9,456.57	1,950.70	4,459.47
7	15,892.92	9,461.20	1,960.38	4,471.33
8	15,882.50	9,472.98	1,947.72	4,461.80
9	15,910.87	9,488.35	1,952.92	4,469.60
10	15,930.22	9,501.05	1,950.57	4,478.60
11	15,912.53	9,487.90	1,952.00	4,472.63
12	15,916.48	9,479.97	1,961.40	4,475.12
Average	15,907.01	9,477.37	1,955.61	4,474.03

90% Load Level - 301 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:39:47	23:42:48	0-2	0:03:01
Measurement Interval	23:42:48	23:52:48	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	15,043.48	8,968.75	1,848.70	4,226.03
1	15,039.38	8,959.18	1,848.90	4,231.30
2	15,059.53	8,961.22	1,854.13	4,244.18
3	15,021.62	8,950.85	1,843.57	4,227.20
4	15,081.07	8,989.32	1,863.82	4,227.93
5	15,065.63	8,984.18	1,845.63	4,235.82
6	15,073.02	8,997.75	1,852.87	4,222.40
7	15,066.47	8,973.65	1,857.83	4,234.98
8	15,044.97	8,960.42	1,858.67	4,225.88
9	15,062.95	8,969.08	1,860.05	4,233.82
10	15,060.00	8,967.28	1,856.03	4,236.68
11	15,060.95	8,988.30	1,847.05	4,225.60
12	15,071.40	8,980.63	1,856.33	4,234.43
Average	15,060.81	8,976.15	1,854.19	4,230.48

80% Load Level - 268 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:52:50	23:55:51	0-2	0:03:01
Measurement Interval	23:55:51	0:05:51	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	13,398.97	7,983.32	1,646.55	3,769.10
1	13,423.80	8,002.17	1,643.18	3,778.45
2	13,418.57	7,995.95	1,648.43	3,774.18
3	13,401.67	7,979.48	1,644.95	3,777.23
4	13,409.37	7,988.70	1,643.80	3,776.87
5	13,387.67	7,980.57	1,650.23	3,756.87
6	13,373.35	7,983.57	1,637.82	3,751.97
7	13,411.15	7,987.12	1,650.88	3,773.15
8	13,416.58	8,010.47	1,645.10	3,761.02
9	13,389.73	7,980.67	1,649.47	3,759.60
10	13,402.73	7,985.63	1,651.20	3,765.90
11	13,448.80	8,021.18	1,654.45	3,773.17
12	13,379.15	7,979.37	1,640.28	3,759.50
Average	13,402.02	7,989.68	1,646.82	3,765.53

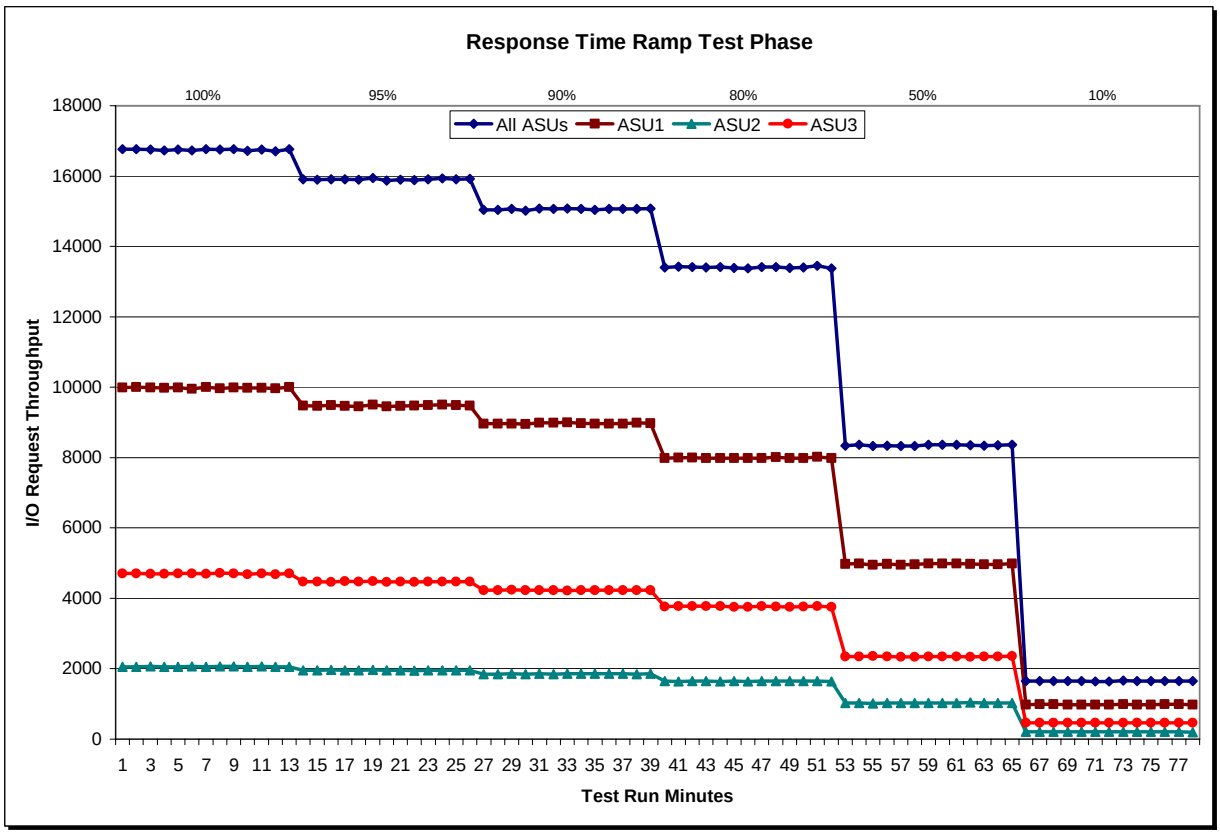
50% Load Level - 167 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:05:53	0:08:54	0-2	0:03:01
Measurement Interval	0:08:54	0:18:54	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	8,343.62	4,973.47	1,023.03	2,347.12
1	8,361.60	4,986.45	1,028.02	2,347.13
2	8,326.72	4,955.45	1,017.12	2,354.15
3	8,345.40	4,979.13	1,023.92	2,342.35
4	8,327.35	4,958.03	1,029.80	2,339.52
5	8,326.53	4,964.93	1,027.32	2,334.28
6	8,361.35	4,986.95	1,021.52	2,352.88
7	8,364.07	4,990.15	1,030.43	2,343.48
8	8,368.03	4,992.87	1,028.45	2,346.72
9	8,355.65	4,979.95	1,034.37	2,341.33
10	8,345.72	4,962.92	1,030.73	2,352.07
11	8,346.93	4,967.25	1,027.62	2,352.07
12	8,370.02	4,987.62	1,023.28	2,359.12
Average	8,351.11	4,976.98	1,027.74	2,346.38

10% Load Level - 33 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:18:56	0:21:57	0-2	0:03:01
Measurement Interval	0:21:57	0:31:57	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	1,646.85	980.38	202.97	463.50
1	1,655.98	989.32	204.60	462.07
2	1,656.08	988.22	202.72	465.15
3	1,650.83	984.22	202.00	464.62
4	1,648.85	983.23	202.08	463.53
5	1,644.02	979.00	202.25	462.77
6	1,642.07	979.63	202.97	459.47
7	1,658.93	991.72	204.65	462.57
8	1,653.18	983.67	202.98	466.53
9	1,652.40	984.10	202.30	466.00
10	1,655.47	985.20	204.42	465.85
11	1,654.53	986.10	203.53	464.90
12	1,650.98	981.05	200.12	469.82
Average	1,651.13	983.79	202.73	464.61

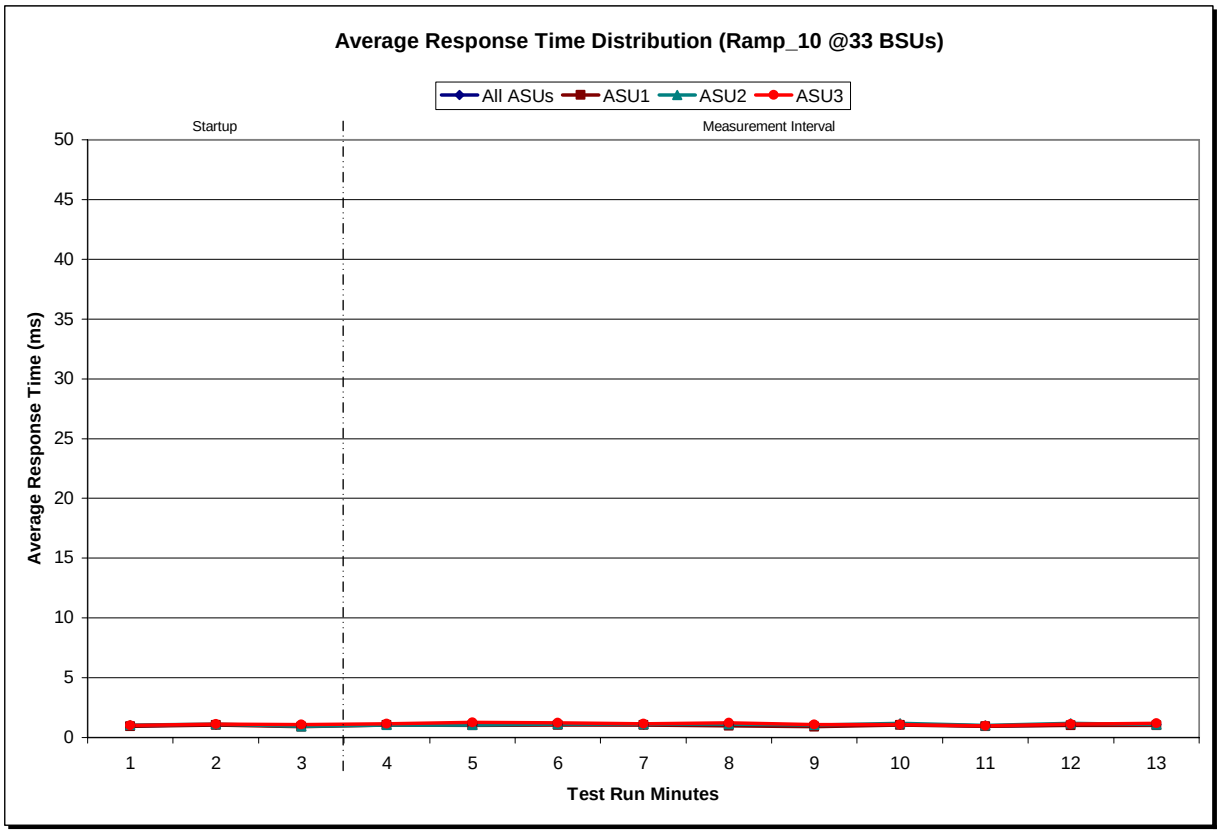
Response Time Ramp Distribution (IOPS) Graph



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

33 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:18:56	0:21:57	0-2	0:03:01
Measurement Interval	0:21:57	0:31:57	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.96	0.92	1.04	1.01
1	1.08	1.06	1.11	1.11
2	0.96	0.91	0.94	1.07
3	1.07	1.03	1.06	1.15
4	1.08	1.01	1.04	1.25
5	1.10	1.05	1.12	1.21
6	1.07	1.03	1.12	1.14
7	1.07	0.98	1.13	1.23
8	0.97	0.91	1.03	1.07
9	1.06	1.03	1.19	1.07
10	0.96	0.95	1.02	0.96
11	1.06	1.01	1.17	1.12
12	1.07	1.02	1.08	1.17
Average	***1.05***	***1.00***	***1.10***	***1.14***

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	0.0349	0.2812	0.0697	0.2100	0.0180	0.0701	0.0347	0.2814
COV	0.019	0.005	0.011	0.007	0.019	0.011	0.021	0.005

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 72.

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	***16,741.16***
Repeatability Test Phase 1	16,767.28
Repeatability Test Phase 2	16,739.73

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

	SPC-1 LRT™
Primary Metrics	***1.05 ms***
Repeatability Test Phase 1	1.04 ms
Repeatability Test Phase 2	1.04 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.

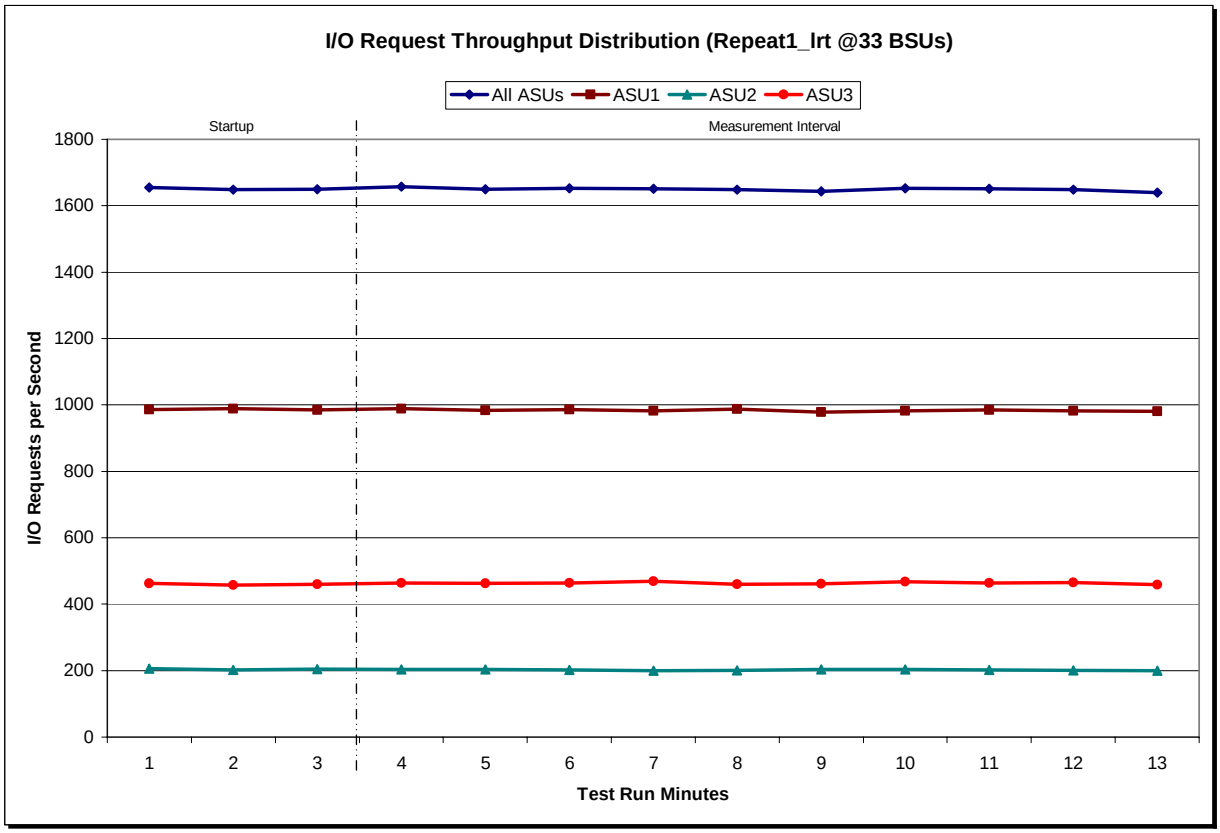
Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

33 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:32:02	0:35:02	0-2	0:03:00
Measurement Interval	0:35:02	0:45:02	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	1,655.27	986.65	205.45	463.17
1	1,648.32	988.42	202.37	457.53
2	1,649.20	984.50	205.25	459.45
3	1,657.05	988.57	204.00	464.48
4	1,650.05	983.65	204.07	462.33
5	1,652.53	986.03	202.55	463.95
6	1,651.38	982.68	200.15	468.55
7	1,647.98	987.20	200.22	460.57
8	1,643.18	977.92	203.65	461.62
9	1,652.65	981.68	203.58	467.38
10	1,650.68	985.52	201.88	463.28
11	1,648.62	982.77	200.57	465.28
12	1,639.68	981.07	199.97	458.65
Average	***1,649.38***	***983.71***	***202.06***	***463.61***

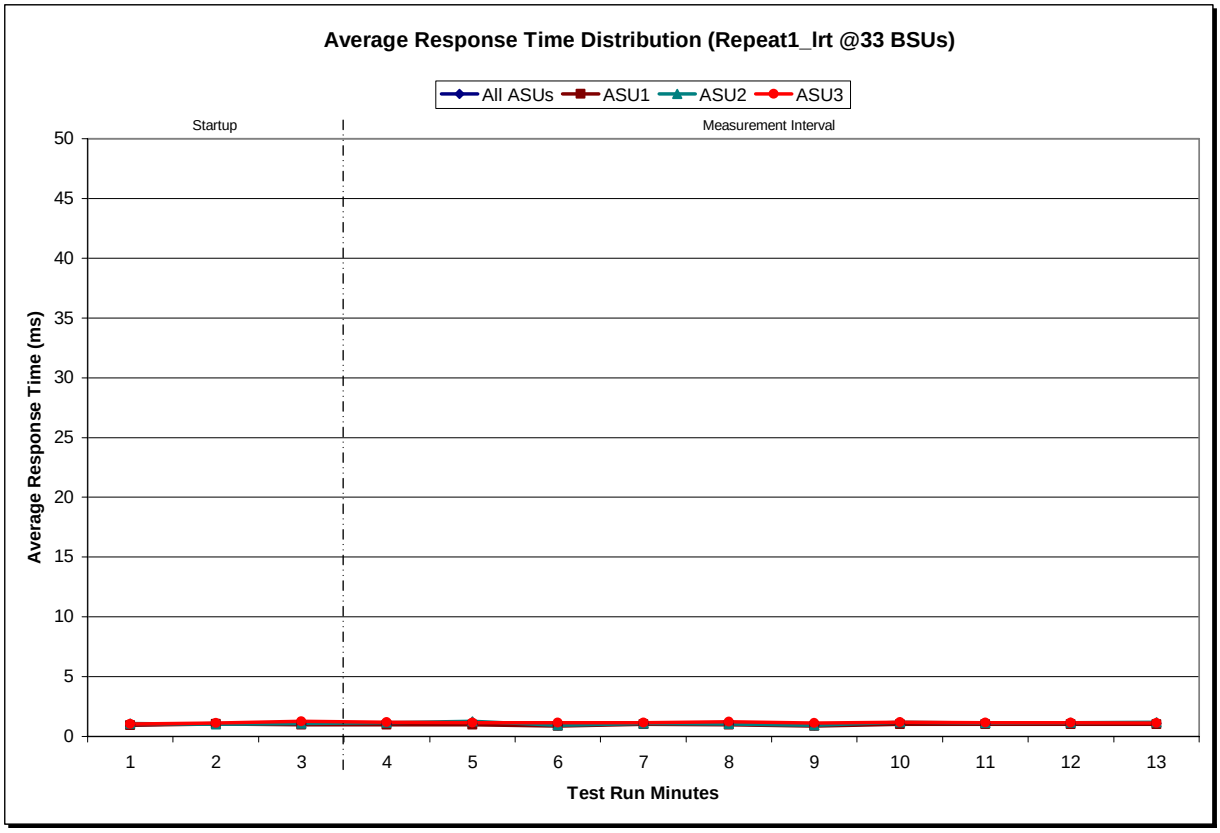
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

33 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:32:02	0:35:02	0-2	0:03:00
Measurement Interval	0:35:02	0:45:02	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.98	0.93	1.08	1.03
1	1.07	1.06	1.00	1.11
2	1.06	0.96	1.10	1.25
3	1.06	0.98	1.15	1.20
4	1.06	0.97	1.25	1.14
5	0.95	0.86	0.93	1.15
6	1.06	1.02	1.08	1.15
7	1.06	0.98	1.04	1.23
8	0.95	0.87	0.94	1.12
9	1.08	1.01	1.19	1.18
10	1.06	1.00	1.13	1.14
11	1.07	1.01	1.13	1.17
12	1.07	1.02	1.20	1.12
Average	***1.04***	***0.97***	***1.10***	***1.16***

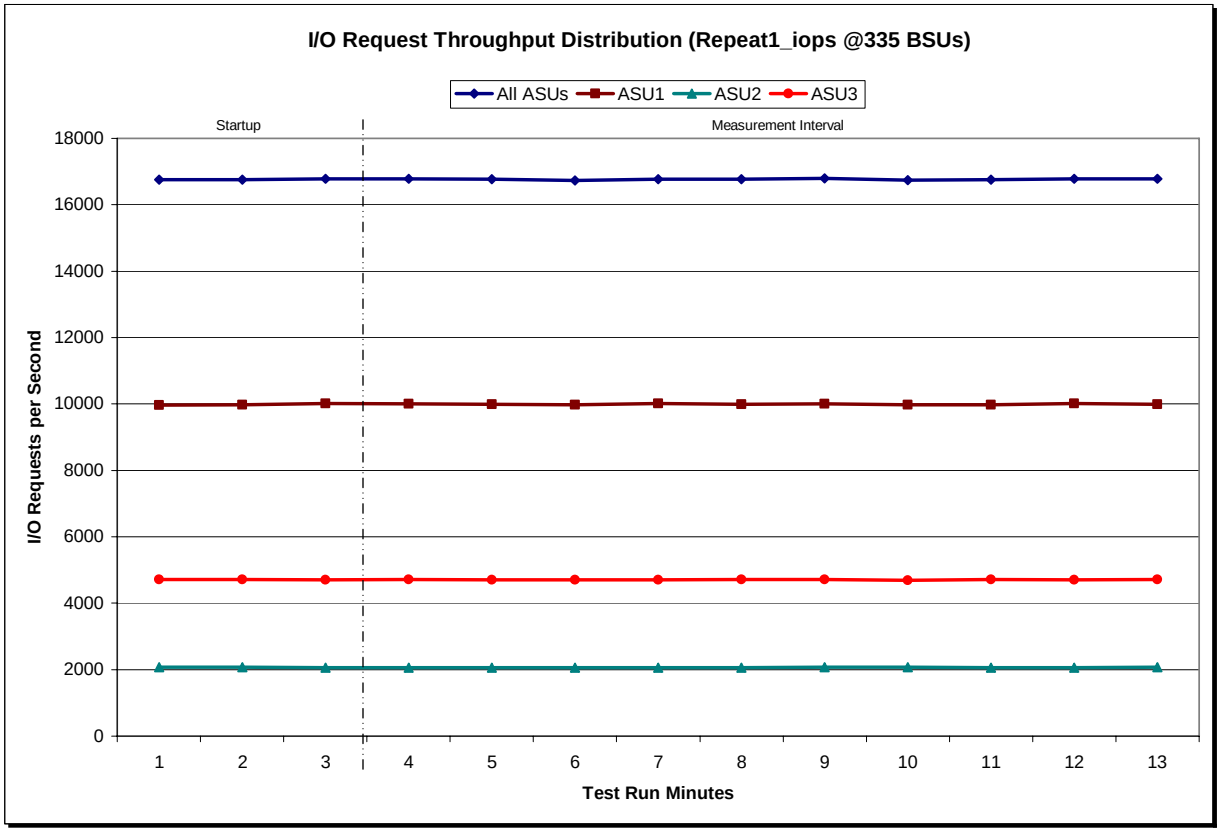
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

335 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:45:04	0:48:05	0-2	0:03:01
Measurement Interval	0:48:05	0:58:05	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	16,749.98	9,970.37	2,068.15	4,711.47
1	16,758.72	9,980.07	2,067.73	4,710.92
2	16,779.43	10,017.53	2,060.62	4,701.28
3	16,781.23	10,008.57	2,058.42	4,714.25
4	16,767.63	9,994.87	2,065.05	4,707.72
5	16,730.15	9,974.22	2,058.08	4,697.85
6	16,772.63	10,011.58	2,061.25	4,699.80
7	16,775.05	9,997.08	2,061.35	4,716.62
8	16,792.12	10,004.92	2,068.37	4,718.83
9	16,739.75	9,975.52	2,071.27	4,692.97
10	16,750.10	9,982.20	2,055.22	4,712.68
11	16,788.25	10,020.35	2,057.52	4,710.38
12	16,775.83	9,988.68	2,072.72	4,714.43
Average	***16,767.28***	***9,995.80***	***2,062.92***	***4,708.55***

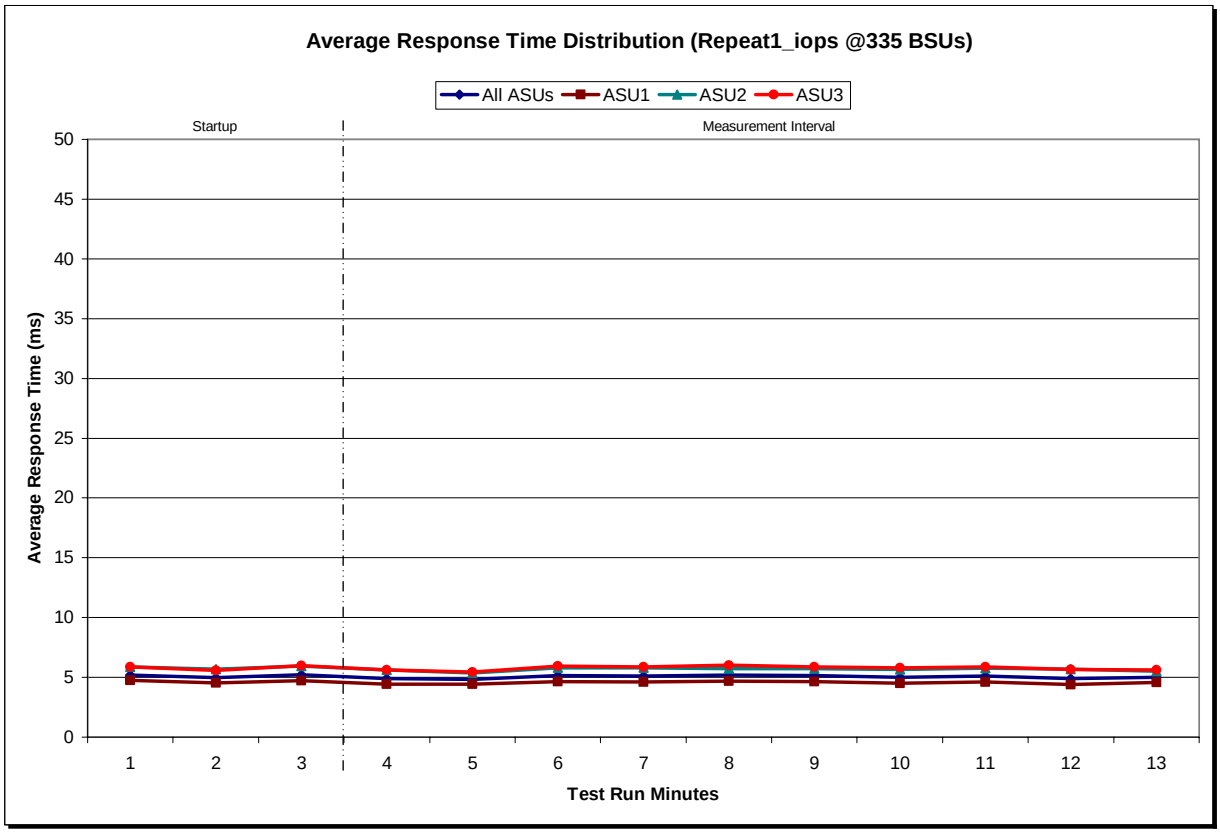
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

335 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:45:04	0:48:05	0-2	0:03:01
Measurement Interval	0:48:05	0:58:05	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	5.20	4.74	5.88	5.88
1	4.96	4.52	5.67	5.59
2	5.22	4.72	5.93	5.97
3	4.90	4.41	5.62	5.63
4	4.82	4.42	5.37	5.44
5	5.14	4.63	5.78	5.94
6	5.11	4.62	5.78	5.88
7	5.19	4.70	5.74	6.00
8	5.14	4.66	5.74	5.88
9	5.02	4.51	5.66	5.80
10	5.10	4.59	5.75	5.89
11	4.90	4.38	5.69	5.64
12	4.99	4.58	5.50	5.62
Average	***5.03***	***4.55***	***5.66***	***5.77***

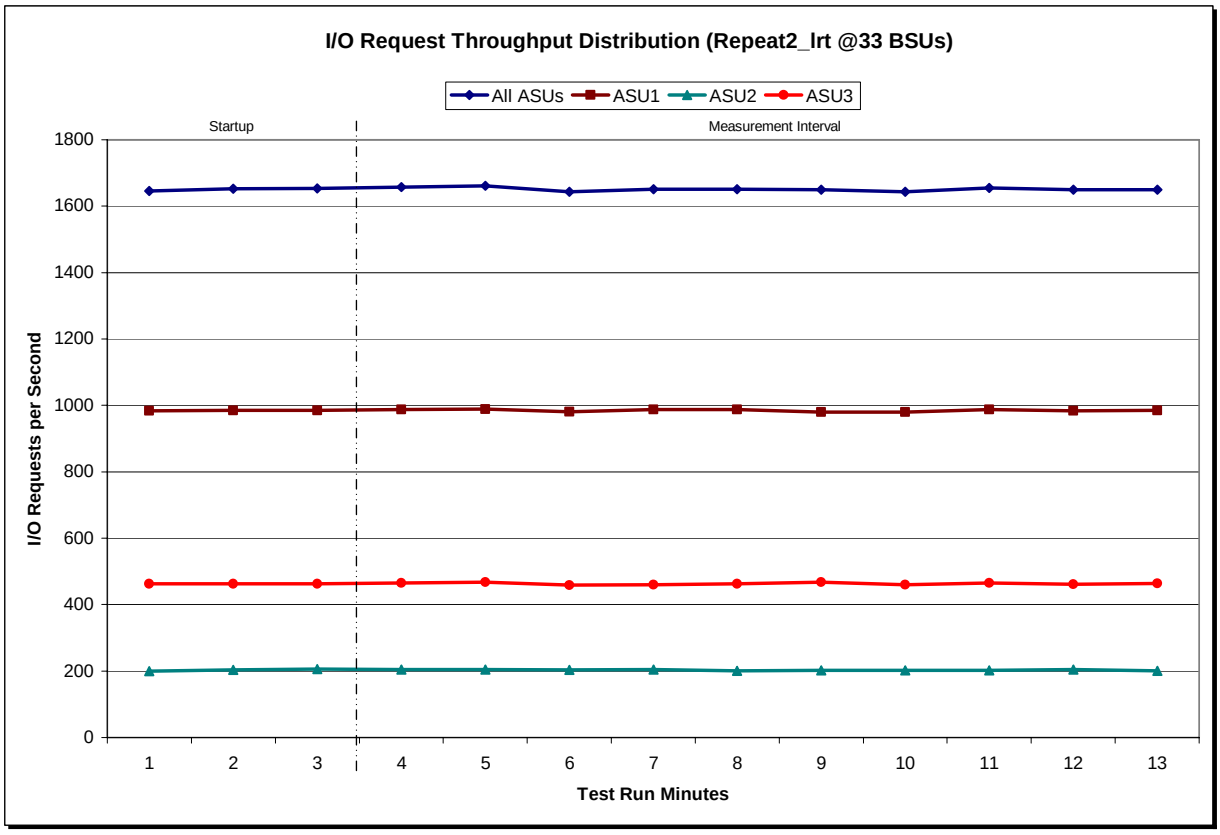
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

33 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:58:09	1:01:09	0-2	0:03:00
Measurement Interval	1:01:09	1:11:09	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1,645.80	983.45	199.72	462.63
1	1,651.65	985.15	204.10	462.40
2	1,653.10	984.90	205.90	462.30
3	1,657.02	987.08	204.55	465.38
4	1,661.53	988.93	204.40	468.20
5	1,643.33	980.87	203.77	458.70
6	1,651.48	986.98	204.52	459.98
7	1,650.55	986.88	200.87	462.80
8	1,649.87	979.55	202.58	467.73
9	1,642.93	980.08	202.37	460.48
10	1,654.45	987.02	202.73	464.70
11	1,649.08	983.13	204.23	461.72
12	1,649.92	984.92	201.32	463.68
Average	***1,651.02***	***984.55***	***203.13***	***463.34***

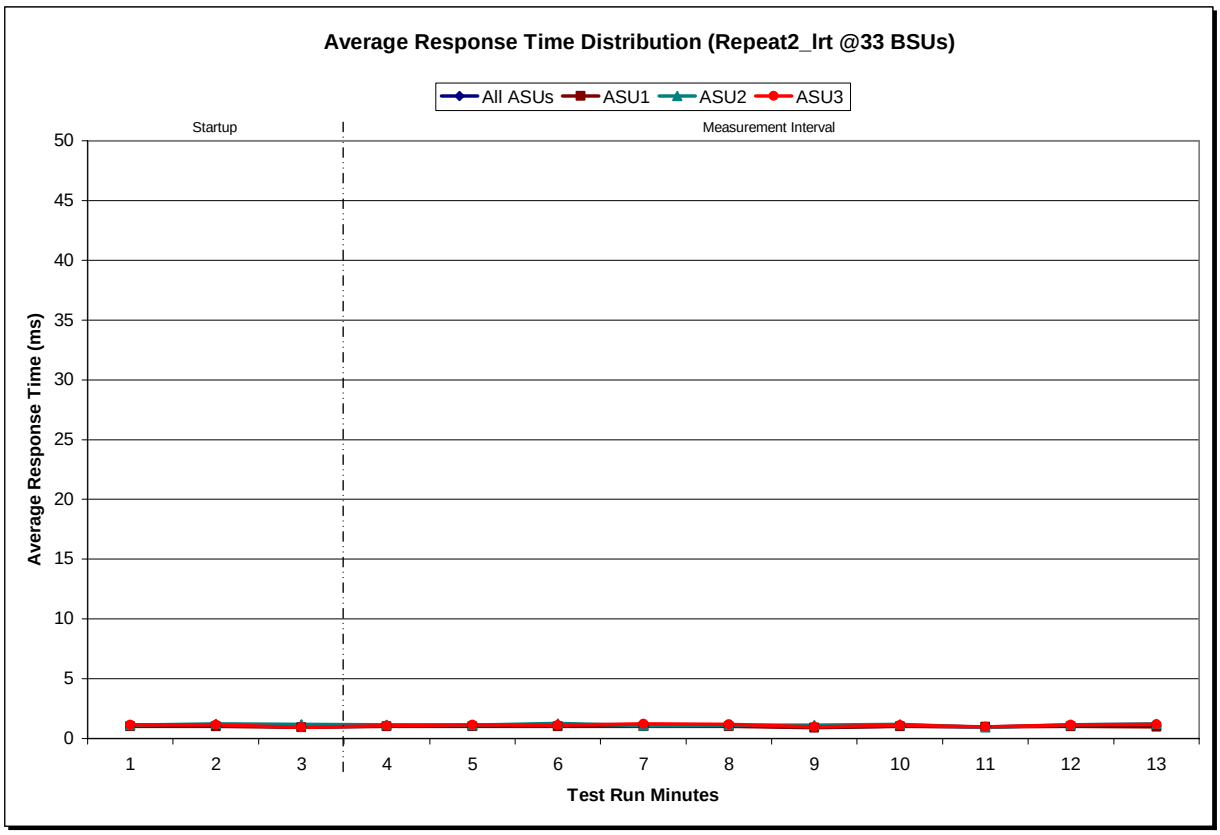
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

33 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:58:09	1:01:09	0-2	0:03:00
Measurement Interval	1:01:09	1:11:09	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.06	1.01	1.11	1.15
1	1.08	1.02	1.23	1.16
2	0.98	0.95	1.19	0.94
3	1.05	1.01	1.15	1.10
4	1.05	0.99	1.12	1.15
5	1.07	1.01	1.28	1.10
6	1.07	1.01	1.06	1.22
7	1.06	0.99	1.11	1.19
8	0.95	0.89	1.11	0.99
9	1.06	1.00	1.19	1.12
10	0.97	0.96	0.95	0.99
11	1.06	1.01	1.15	1.14
12	1.06	0.97	1.23	1.19
Average	***1.04***	***0.98***	***1.13***	***1.12***

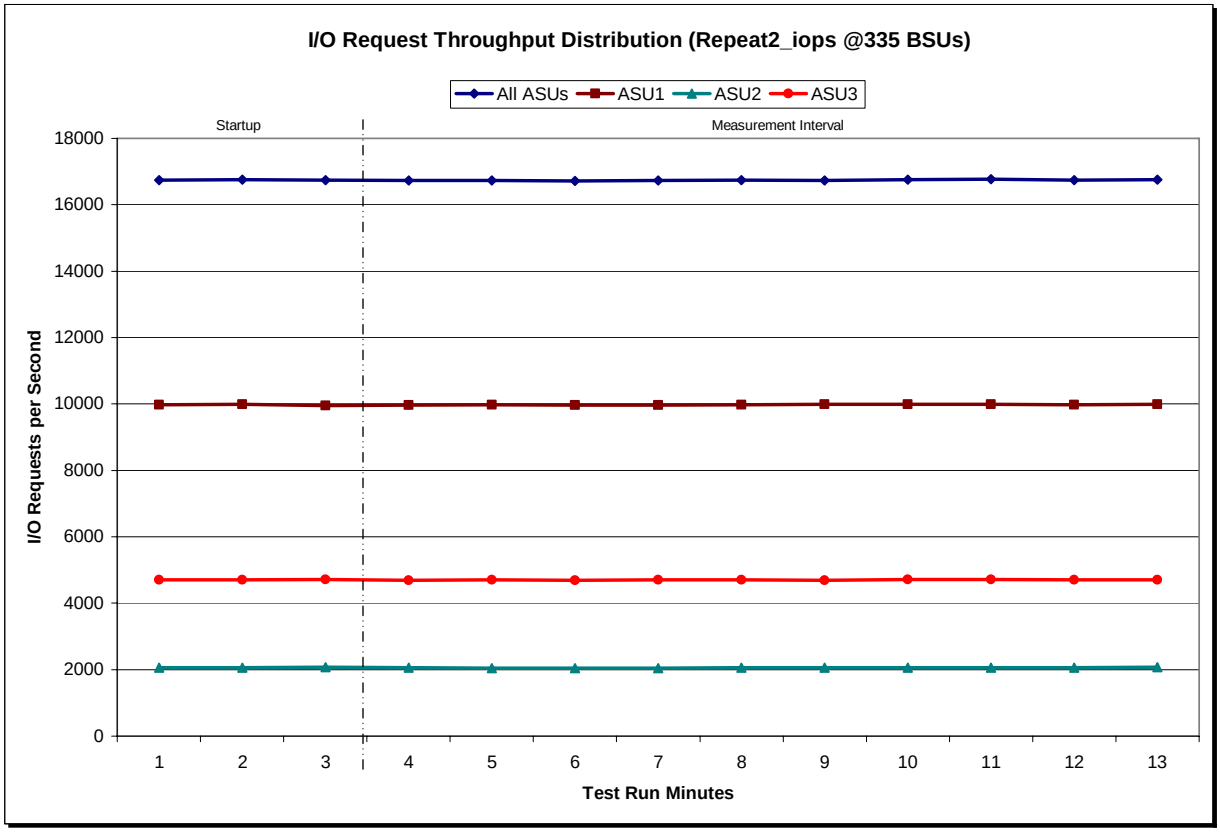
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

335 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:11:11	1:14:12	0-2	0:03:01
Measurement Interval	1:14:12	1:24:12	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	16,737.83	9,977.48	2,055.58	4,704.77
1	16,761.33	9,989.97	2,064.73	4,706.63
2	16,748.55	9,956.63	2,075.70	4,716.22
3	16,723.58	9,971.17	2,061.70	4,690.72
4	16,730.53	9,977.53	2,051.37	4,701.63
5	16,717.15	9,969.13	2,053.58	4,694.43
6	16,725.55	9,969.87	2,053.22	4,702.47
7	16,741.57	9,981.18	2,058.92	4,701.47
8	16,735.88	9,989.18	2,057.82	4,688.88
9	16,756.28	9,989.38	2,055.15	4,711.75
10	16,764.60	9,994.03	2,059.47	4,711.10
11	16,744.57	9,984.83	2,061.22	4,698.52
12	16,757.60	9,984.92	2,067.05	4,705.63
Average	***16,739.73***	***9,981.12***	***2,057.95***	***4,700.66***

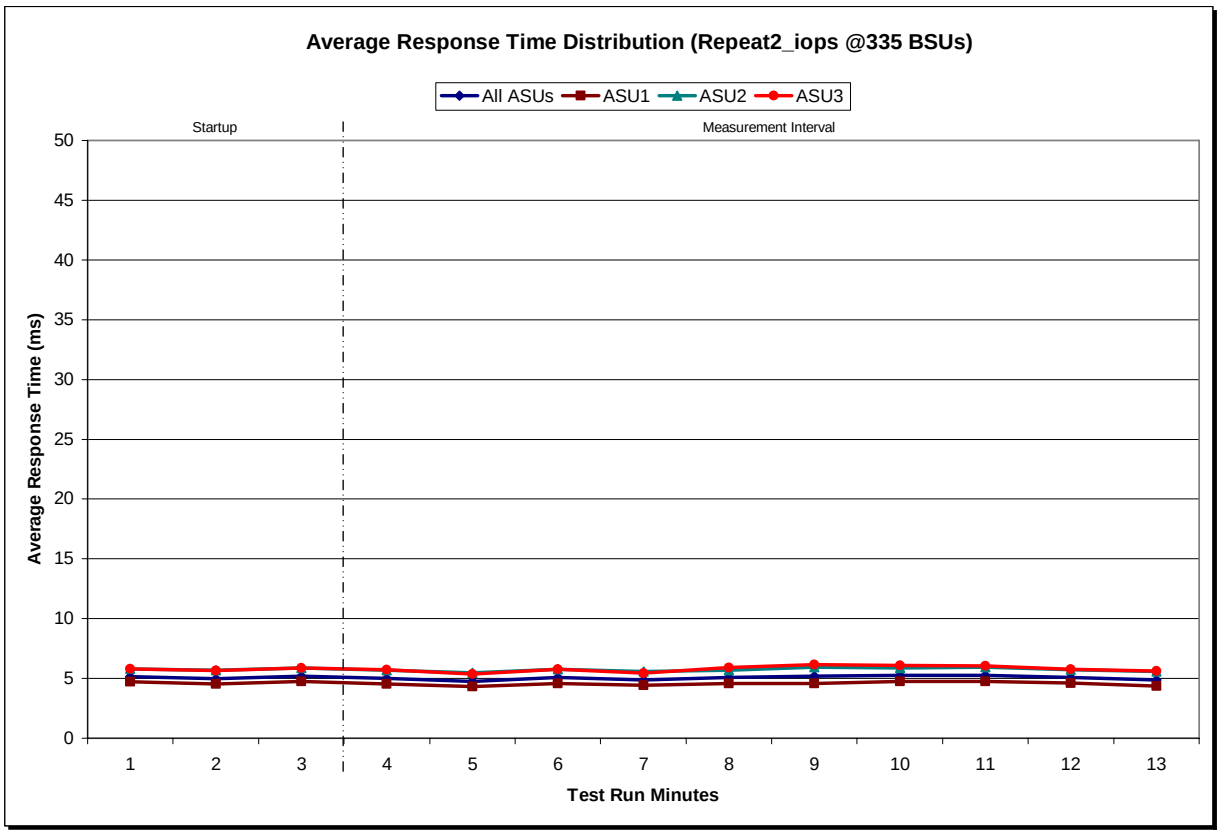
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

335 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:11:11	1:14:12	0-2	0:03:01
Measurement Interval	1:14:12	1:24:12	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	5.15	4.70	5.79	5.81
1	4.98	4.52	5.69	5.63
2	5.20	4.74	5.85	5.88
3	5.01	4.52	5.68	5.74
4	4.76	4.32	5.46	5.38
5	5.06	4.59	5.74	5.76
6	4.85	4.42	5.56	5.44
7	5.07	4.56	5.67	5.89
8	5.19	4.59	5.94	6.15
9	5.26	4.75	5.86	6.09
10	5.27	4.76	5.95	6.07
11	5.07	4.60	5.72	5.77
12	4.87	4.37	5.59	5.62
Average	***5.04***	***4.55***	***5.72***	***5.79***

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	0.0352	0.2815	0.0703	0.2094	0.0180	0.0697	0.0348	0.2811
COV	0.013	0.005	0.013	0.006	0.025	0.013	0.019	0.005

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2811	0.0700	0.2101	0.0180	0.0700	0.0350	0.2808
COV	0.005	0.002	0.005	0.002	0.009	0.004	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	0.0349	0.2816	0.0699	0.2099	0.0180	0.0702	0.0349	0.2806
COV	0.016	0.005	0.015	0.008	0.021	0.010	0.022	0.005

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0699	0.2103	0.0180	0.0700	0.0350	0.2808
COV	0.003	0.002	0.003	0.002	0.007	0.004	0.004	0.001

Data Persistence Test

Clause 6

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

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

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

The Tested Storage Configuration (TSC) will be shutdown and restarted using a power off/power on cycle at the end of the above sequence of write operations. In addition, any caches employing battery backup must be flushed/emptied. If the TSC includes the Host System(s), the Host System(s) must also be shutdown and restarted using a power off/power on cycle.

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

Clause 9.4.3.8

The following content shall appear in this section of the FDR:

1. *A listing or screen image of all input parameters supplied to the Workload Generator (may optionally be referenced in an appendix).*
2. *For the successful Data Persistence Test Run, a table illustrating key results. The content, appearance, and format of this table are specified in Table 9-16. Information displayed in this table shall be obtained from the Test Run Results File referenced below in #3.*
3. *For the successful Data Persistence Test Run, the human readable Test Run Results File produced by the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 72.

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	39,883,504
Total Number of Logical Blocks Verified	28,812,048
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 HP StorageWorks 6400 Enterprise Virtual Array 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 15.

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 15.

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 Onsite Audit of the HP StorageWorks 6400 Enterprise Virtual Array .

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.

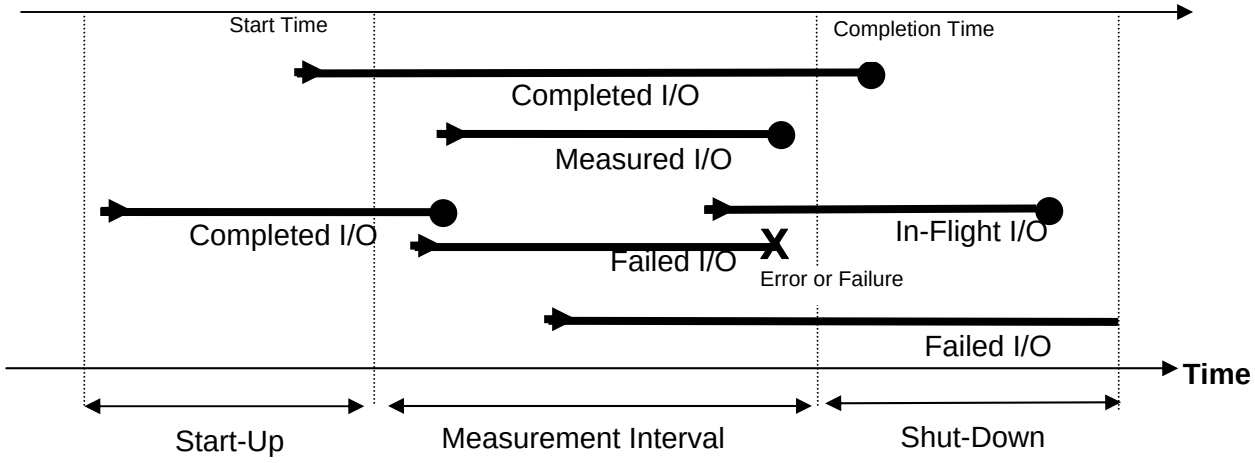
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

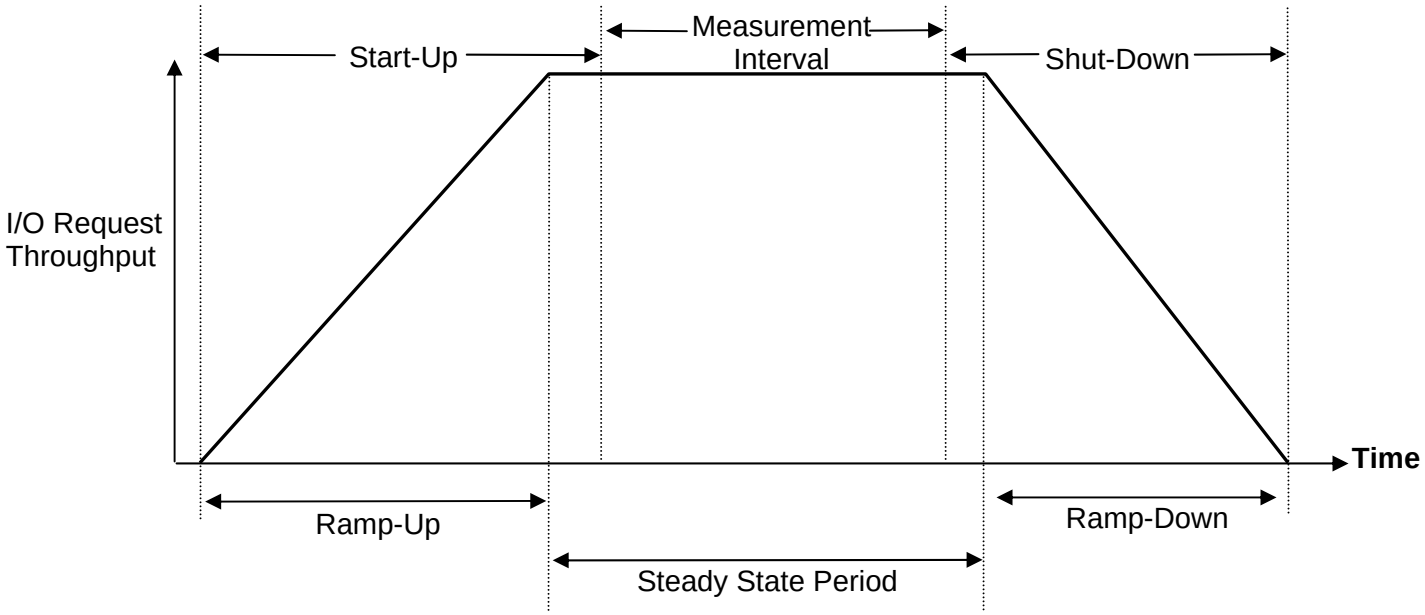
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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



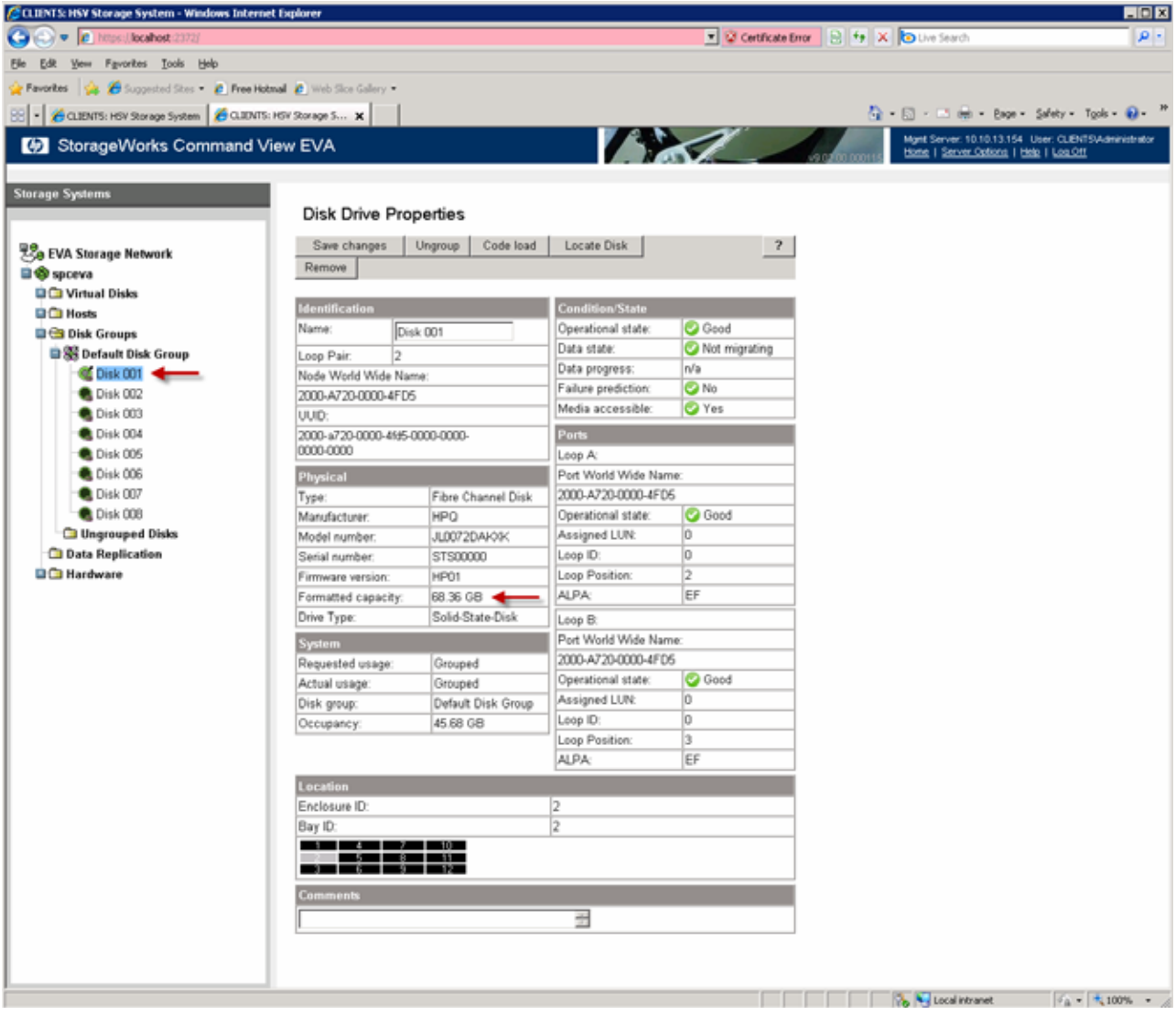
APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

The FC HBA **queuedepth** parameter was changed from a default of 32 to a value 254 for the benchmark measurements.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

HP StorageWorks Command View EVA Software provides storage management for the HP StorageWorks 6400 Enterprise Virtual Array (EVA). The software was used, as described below, to create the SPC-1/E Logical Volumes used in the audited measurements.

Physical storage devices installed that have not been assigned to a disk group are placed in the default disk group. The default disk group on the Tested Storage Configuration (TSC) contained a total of 8 Solid State Devices (SSDs), with a physical capacity of 68.36 GiB per SSD..



Once all drives are assigned to a disk group, the total available disk group capacity for the selected level of data protection, Vraid5, is 324GiB. Vdisks (LUNs) can now be created on the Disk Group by selecting the Virtual Disks folder. Once all settings and options, as illustrated below, have been assigned, select the Create Vdisk button. .

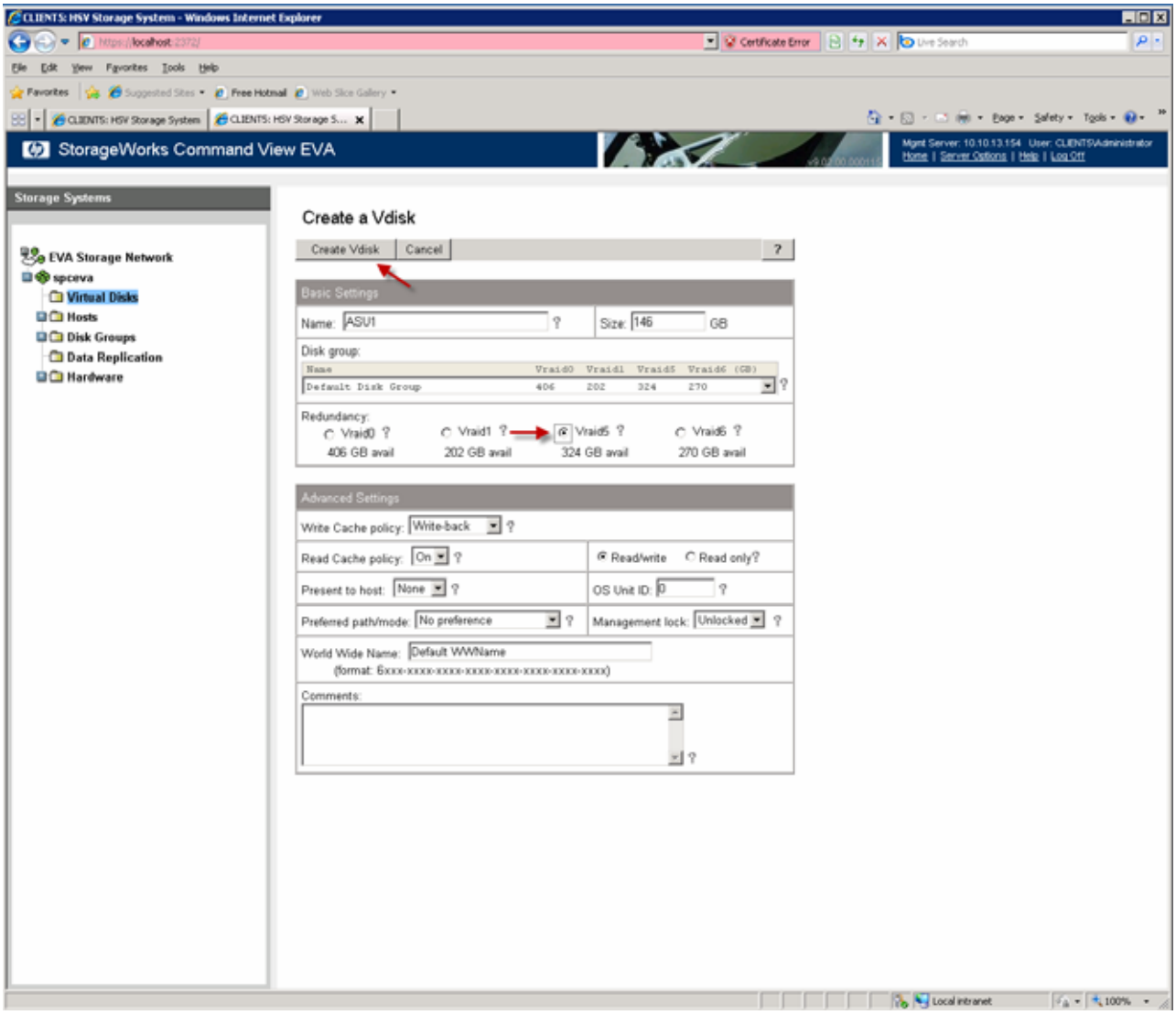
The three SPC-1/E Logical Volumes (ASUs) were defined as:

45% of the total Disk Group Capacity as ASU1 at 146GiB.

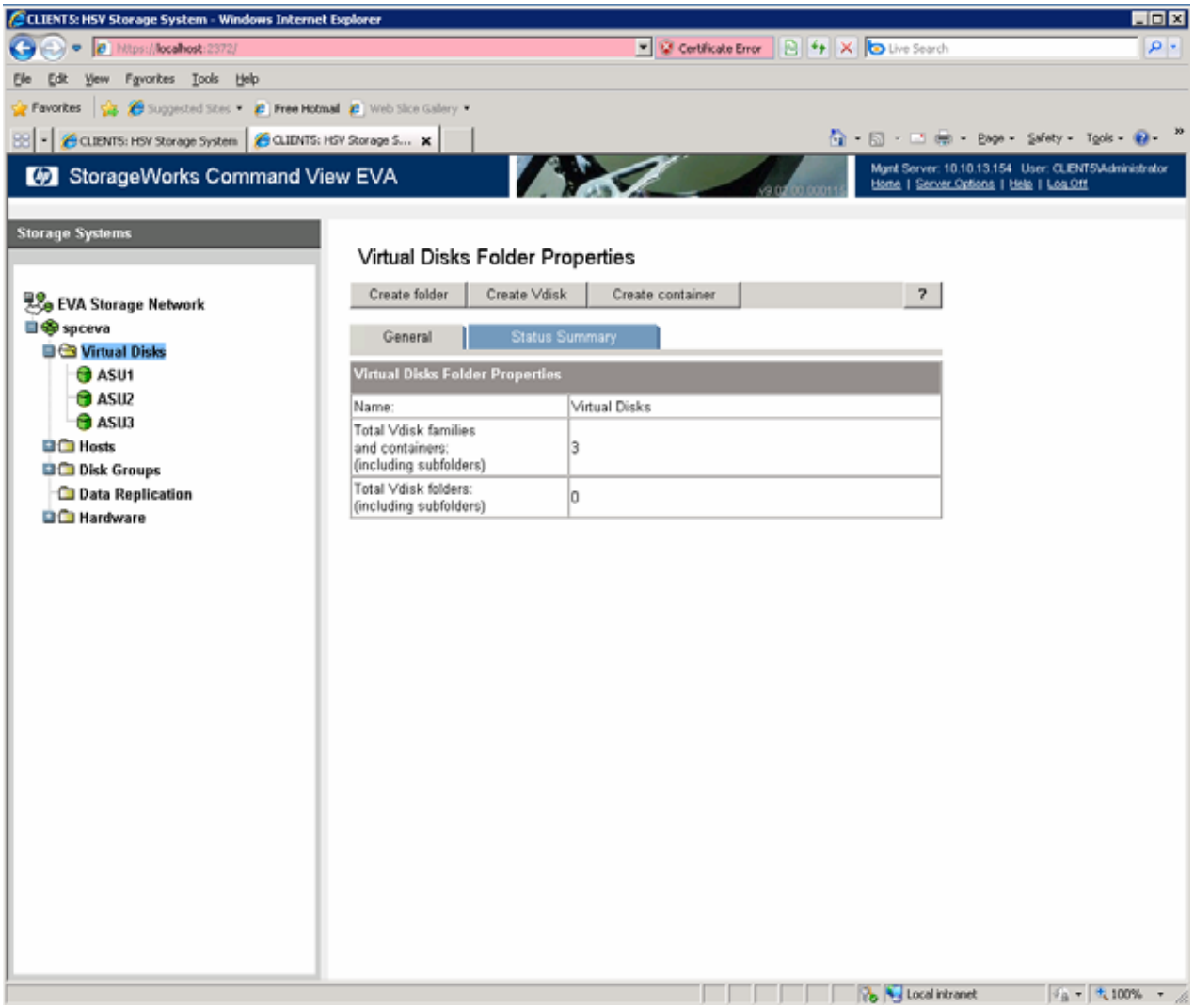
45% of the total Disk Group Capacity as ASU2 at 146GiB.

10% of the total Disk Group Capacity as ASU3 at 32GiB.

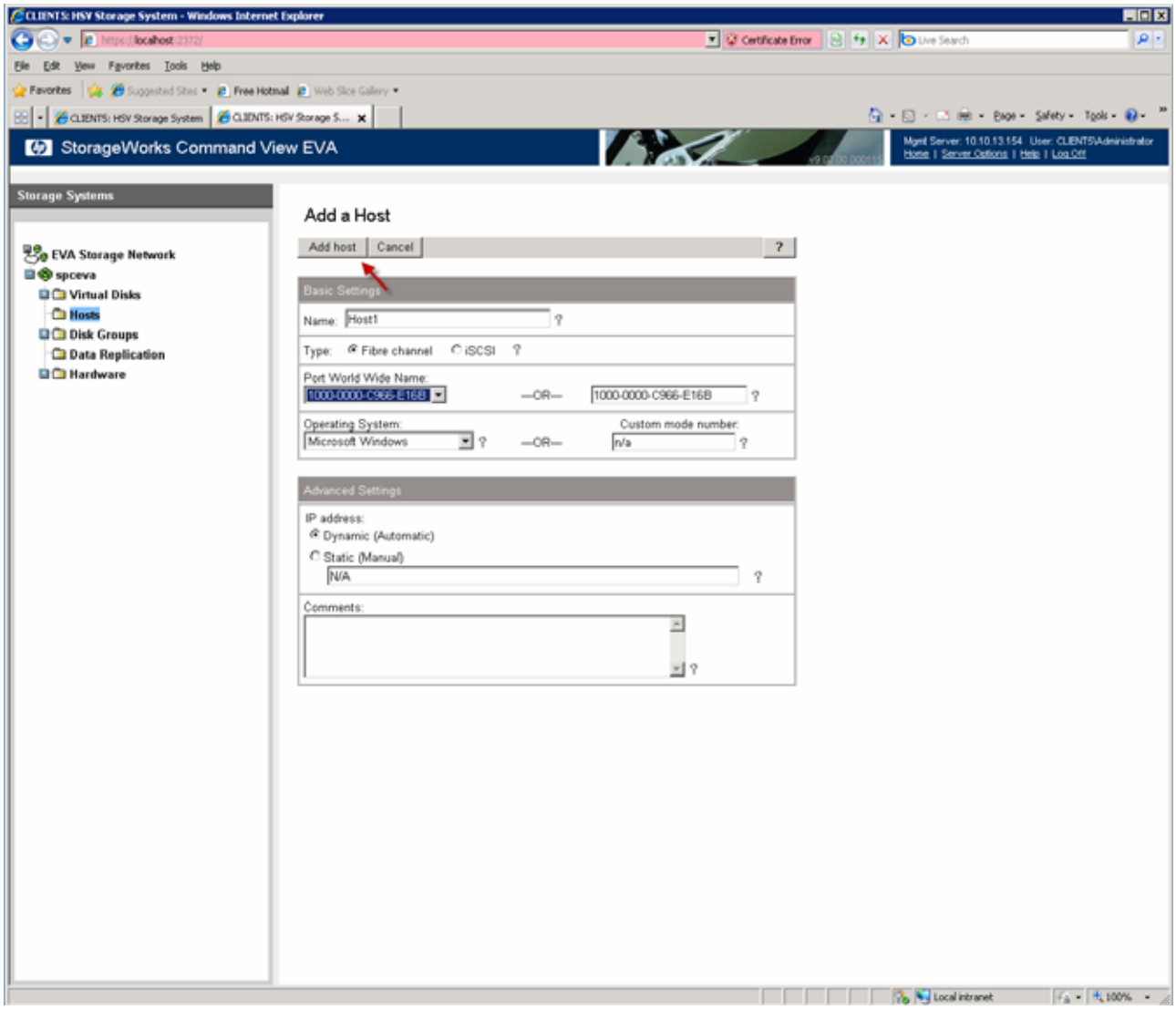
Creation of the Vdisk that comprised ASU-1 on the TSC is illustrated below.



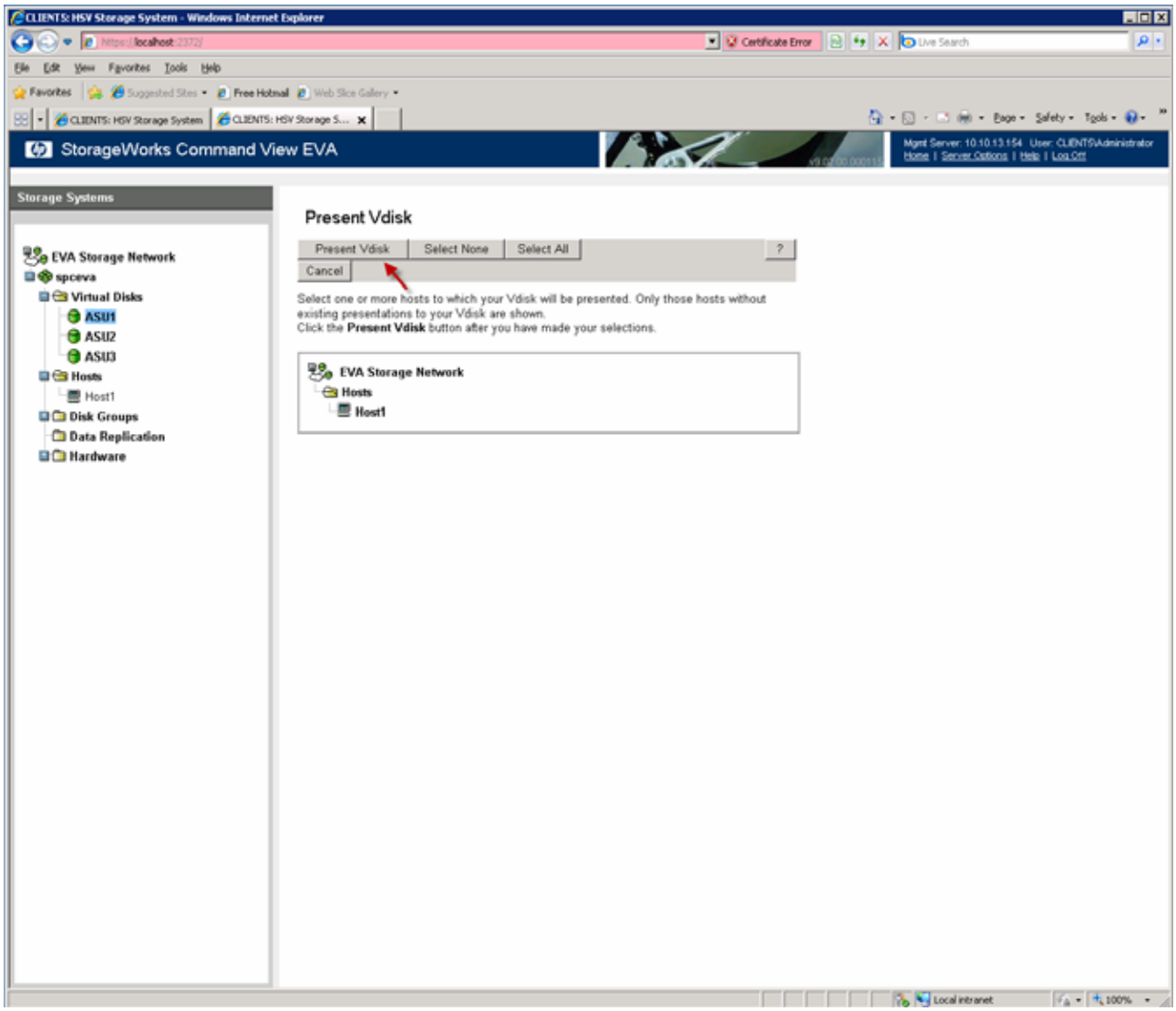
After all 3 ASU Vdisks (LUNS) have been created, the next step is to add the Host System and present it to each ASU LUN. This Host System will be running the SPC-1/E Workload Generator.



To add a Host System, select the Hosts folder, specify the name of the Host System along with WWN and OS, as illustrated below. Once all the information for the Host System has been added select the Add host button.



To present the Host System to each ASU Vdisk (LUN), select the Vdisk, for example ASU1, click Presentation then Present and select the Host System to be added to the Vdisk and select Present Vdisk.



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

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

```
sd=asu1_1,lun=\\.\PhysicalDrive1
sd=asu2_1,lun=\\.\PhysicalDrive2
sd=asu3_1,lun=\\.\PhysicalDrive3
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

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

The following script was used to execute the Idle Test *(Conditioning Phase, Application Idle Phase, and Recovery Phase)* 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.

```
java range -b 335
rename rangetest conditioning
choice /T 2100 /D Y
java range -b 34
rename rangetest recovery
java metrics -b 335
java repeat1 -b 335
java repeat2 -b 335
java persist1 -b 335
```

Persistence Test Run 2

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

```
java persist2
```