SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

IBM CORPORATION
IBM SYSTEM STORAGE DS8870

SPC-1 V1.12

Submitted for Review: October 3, 2012
Submission Identifier: A00120
Revised: October 15, 2012

First Edition – October 2012

Trademarks

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AUDIT CERTIFICATION

Bruce McNutt
IBM Corporation (ARC)
650 Harry Road
San Jose, CA 95120

September 28, 2012

The SPC Benchmark 1™ Reported Data listed below for the IBM System Storage DS8870 was produced in compliance with the SPC Benchmark 1™ v1.12 Remote Audit requirements.

SPC Benchmark 1™ v1.12 Reported Data	
Tested Storage Product (TSP) Name: IBM System Storage DS8870	
Metric	**Reported Result**
SPC-1 IOPS™	451,082.27
SPC-1 Price-Performance	$10.81/SPC-1 IOPS™
Total ASU Capacity	56,232.000 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$4,876,005.70

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with 1.12 of the SPC Benchmark 1™ specification:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified by information supplied by IBM Corporation:
  - ✓ 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.
- The total Application Storage Unit (ASU) Capacity was filled with random data, using an auditor approved tool, prior to execution of the SPC-1 Tests.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).

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

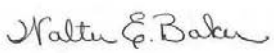
AUDIT CERTIFICATION *(CONT.)*

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

Audit Notes:

There were no audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

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LETTER OF GOOD FAITH

IBM

Vice President and Disk Storage Business Line Executive

IBM Technology & Systems Group
650 Harry Road, Almaden Research Center
San Jose CA 95120-6099

Phone: 1-408-927-0623

September 12, 2012

Mr. Walter E. Baker, SPC Auditor
Gradient Systems, Inc.
643 Bair Island Road, Suite 103
Redwood City, CA 94063

Subject: SPC-1 Letter of Good Faith for the IBM System Storage DS8870.

IBM Corporation is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with Version 1.12 of the SPC-1 benchmark specification.

Our disclosure of the Benchmark configuration and execution of the benchmark includes all items that, to the best of our knowledge and belief, materially affect the reported results, regardless of whether such items are explicitly required to be disclosed by the SPC-1 benchmark specification.

Sincerely,

Laura Guio
Vice President, Business Line Executive Storage Systems
IBM Systems and Technology Group

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	IBM Corporation – http://www.ibm.com Bruce McNutt – bmcnutt@us.ibm.com IBM ARC 650 Harry Road San Jose, CA 95120 Phone: (408) 927-2717 FAX: (408) 927-2050
Test Sponsor Alternate Contact	IBM Corporation – http://www.ibm.com David Whitworth –davidw@us.ibm.com 11501 Burnet Rd. Austin, TX 78758 Phone: (512) 286-9218
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	V2.3.0
Date Results were first used publicly	October 3, 2012
Date the FDR was submitted to the SPC	October 3, 2012
Date the revised FDR was submitted to the SPC Revised chart scaling on pages 30, 35, 48 and 52 of the Full Disclosure Report to provide a more clear illustration of various response time values.	October 15, 2012
Date the Priced Storage Configuration is available for shipment to customers	October 19, 2012
Date the TSC completed audit certification	September 28, 2012

Tested Storage Product (TSP) Description

The DS8870 represents the latest in this series of enterprise disk storage systems designed for high-performance, high-capacity and resiliency. New with the 8870 are a major upgrade of the processing complex and system bandwidth.

Summary of Results

SPC-1 Reported Data	
Tested Storage Product (TSP) Name: IBM System Storage DS8870	
Metric	**Reported Result**
SPC-1 IOPS™	451,082.27
SPC-1 Price-Performance™	$10.81/SPC-1 IOPS™
Total ASU Capacity	56,232.000GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$4,875,005.70

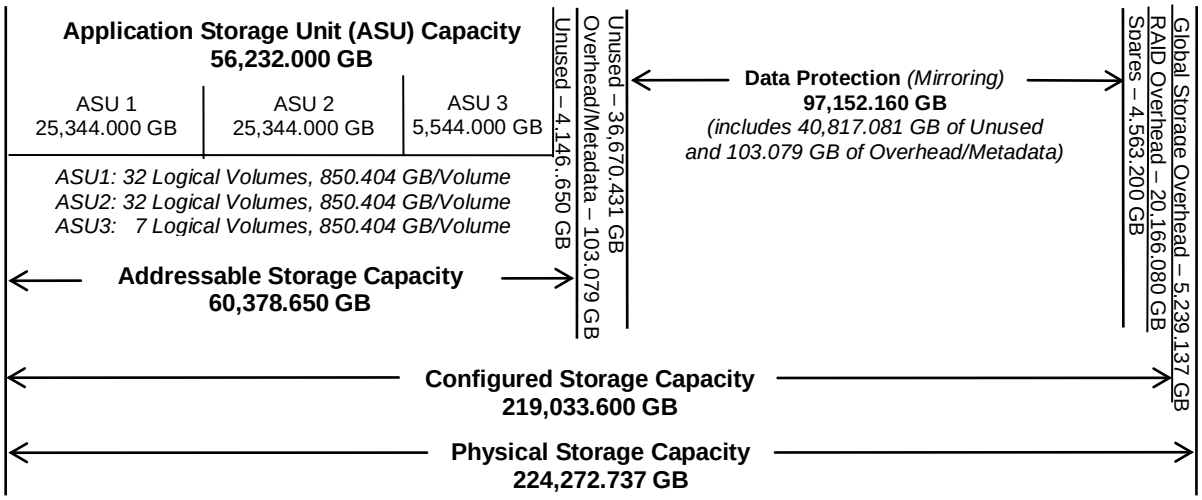
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

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

Storage Capacities, Relationships, and Utilization

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



SPC-1 Storage Capacity Utilization	
Application Utilization	25.07%
Protected Application Utilization	50.19%
Unused Storage Ratio	36.40%

Application Utilization: Total ASU Capacity *(56,232.000 GB)* divided by Physical Storage Capacity *(224,272.737 GB)*

Protected Application Utilization: Total ASU Capacity *(56,232.000 GB)* plus total Data Protection Capacity *(97.152.160 GB)* minus unused Data Protection Capacity *(40,817.081 GB)* divided by Physical Storage Capacity *(224,272.737 GB)*

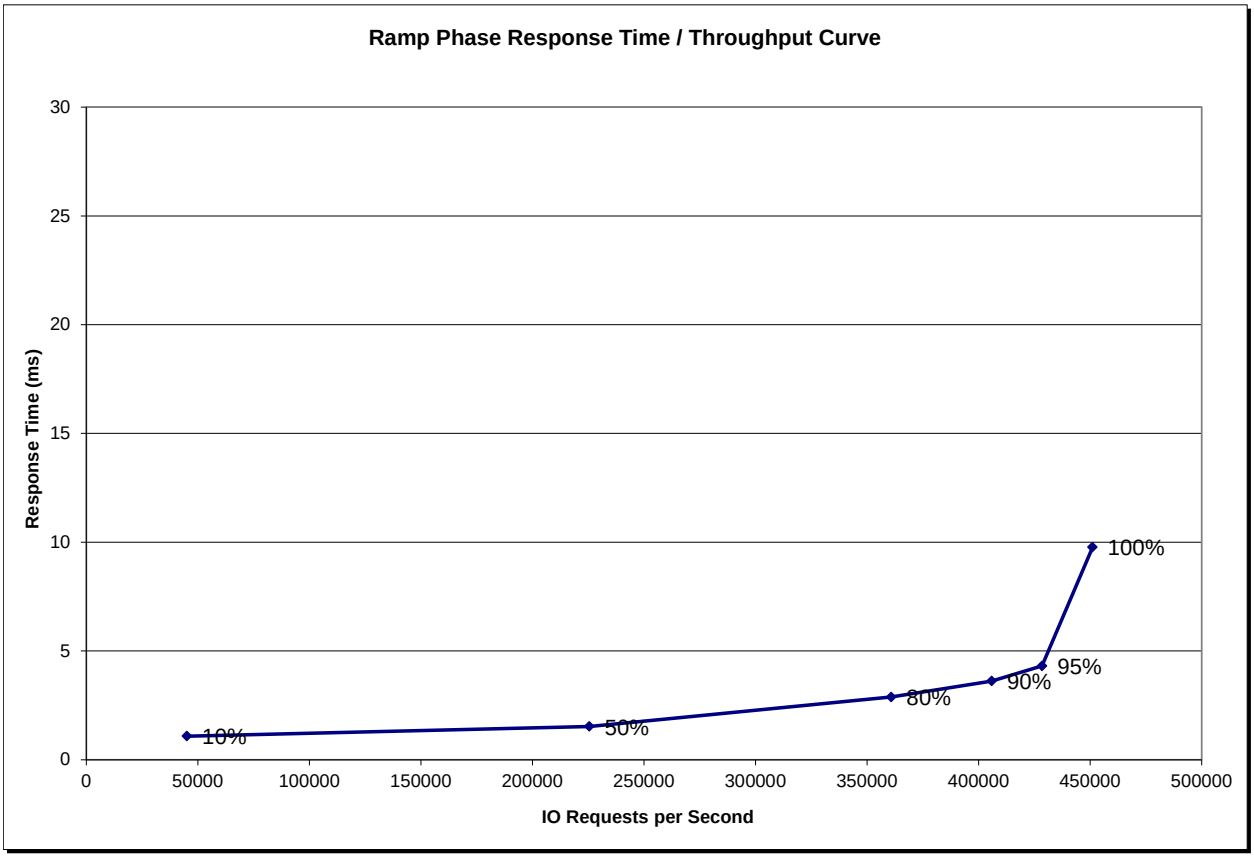
Unused Storage Ratio: Total Unused Capacity *(81,634.162 GB)* divided by Physical Storage Capacity *(224,272.737 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 23-24.

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	45,089.86	225,493.94	360,839.78	405,899.16	428,462.79	451,082.27
Average Response Time (ms):						
All ASUs	1.08	1.53	2.88	3.61	4.31	9.77
ASU-1	1.43	1.95	2.85	3.49	4.12	5.18
ASU-2	1.17	1.62	2.51	3.14	3.79	4.86
ASU-3	0.31	0.60	3.11	4.09	4.95	21.65
Reads	2.31	3.04	4.27	5.05	5.74	6.89
Writes	0.29	0.54	1.98	2.68	3.38	11.64

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

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

Priced Storage Configuration Pricing

Product	Description	Qty	Unit Price	List Price	% disc't	Ext'd Price
2423-961	IBM System Storage DS8870	1	$ 72,419.00	$ 72,419.00	50%	$ 36,209.50
1	9xE factory merge	3	$ -	$ -	50%	$ -
100	Eligible for EU Shipment	1	$ -	$ -	50%	$ -
201	Storage Enclosure Infrastructure	1	$ -	$ -	50%	$ -
351	961 - 96E Position 1	1	$ -	$ -	50%	$ -
352	961 - 96E Position 2	1	$ -	$ -	50%	$ -
353	961 - 96E Position 3	1	$ -	$ -	50%	$ -
700	OEL Indicator	1	$ -	$ -	50%	$ -
713	IBM System Storage Easy Tier Indicator	1	$ -	$ -	50%	$ -
840	200.1 to 250.0 TB capacity	1	$ -	$ -	50%	$ -
900	Non-Standby CoD	1	$ -	$ -	50%	$ -
1051	Battery Assembly	2	$ 16,200.00	$ 32,400.00	50%	$ 16,200.00
1082	Line Cord (US/LA/AP/Canada)	1	$ 7,000.00	$ 7,000.00	50%	$ 3,500.00
1120	Management Console - English Laptop Internal	1	$ 9,160.00	$ 9,160.00	50%	$ 4,580.00
1241	Disk Enclosure Pair	5	$ 20,000.00	$ 100,000.00	50%	$ 50,000.00
1242	HD STD Enclosure Indicator	5	$ -	$ -	50%	$ -
1246	HD Disk Drive Cable Group 1	1	$ 7,000.00	$ 7,000.00	50%	$ 3,500.00
1301	I/O Enclosure Pair PCIE	2	$ 11,780.00	$ 23,560.00	50%	$ 11,780.00
1321	PCI-E Cable Group 2	1	$ 4,100.00	$ 4,100.00	50%	$ 2,050.00
1731	DS8000 LMC R7.0	1	$ 40,000.00	$ 40,000.00	50%	$ 20,000.00
5108	146 GB 15K Drive Set FDE	15	$ 53,909.00	$ 808,635.00	50%	$ 404,317.50
3053	Device Adapter Pair I	4	$ 15,000.00	$ 60,000.00	50%	$ 30,000.00
3153	8 Gb 4 port SW FCP/FICON Adapter PCIE	8	$ 37,312.00	$ 298,496.00	50%	$ 149,248.00
4317	1TB Processor Memory (16-core)	1	$ 926,280.00	$ 926,280.00	50%	$ 463,140.00
4404	16-core Processor Card	1	$ 333,820.00	$ 333,820.00	50%	$ 166,910.00
7034	OEL - 25 TB	1	$ -	$ -	50%	$ -
7045	OEL - 200 TB	1	$ -	$ -	50%	$ -
7051	OEL - 1 Value Unit	1	$ -	$ -	50%	$ -
7053	OEL - 10 Value Unit	1	$ -	$ -	50%	$ -
7055	OEL - 50 Value Unit	1	$ -	$ -	50%	$ -
7065	OEL - 200 Value Unit	2	$ -	$ -	50%	$ -
7083	IBM System Storage Easy Tier indicator	1	$ -	$ -	50%	$ -
2398-LFA	DS8000 Function Authorization	1	$ -	$ -	40%	$ -
7034	OEL - 25 TB	1	$ -	$ -	40%	$ -
7045	OEL - 200 TB	1	$ -	$ -	40%	$ -
7051	OEL - 1 Value Unit	1	$ 6,666.00	$ 6,666.00	40%	$ 3,999.60
7053	OEL - 10 Value Unit	1	$ 53,659.00	$ 53,659.00	40%	$ 32,195.40
7055	OEL - 50 Value Unit	1	$ 140,794.00	$ 140,794.00	40%	$ 84,476.40
7065	OEL - 200 Value Unit	2	$ 429,677.00	$ 859,354.00	40%	$ 515,612.40
7083	IBM System Storage Easy Tier	1	$ -	$ -	40%	$ -

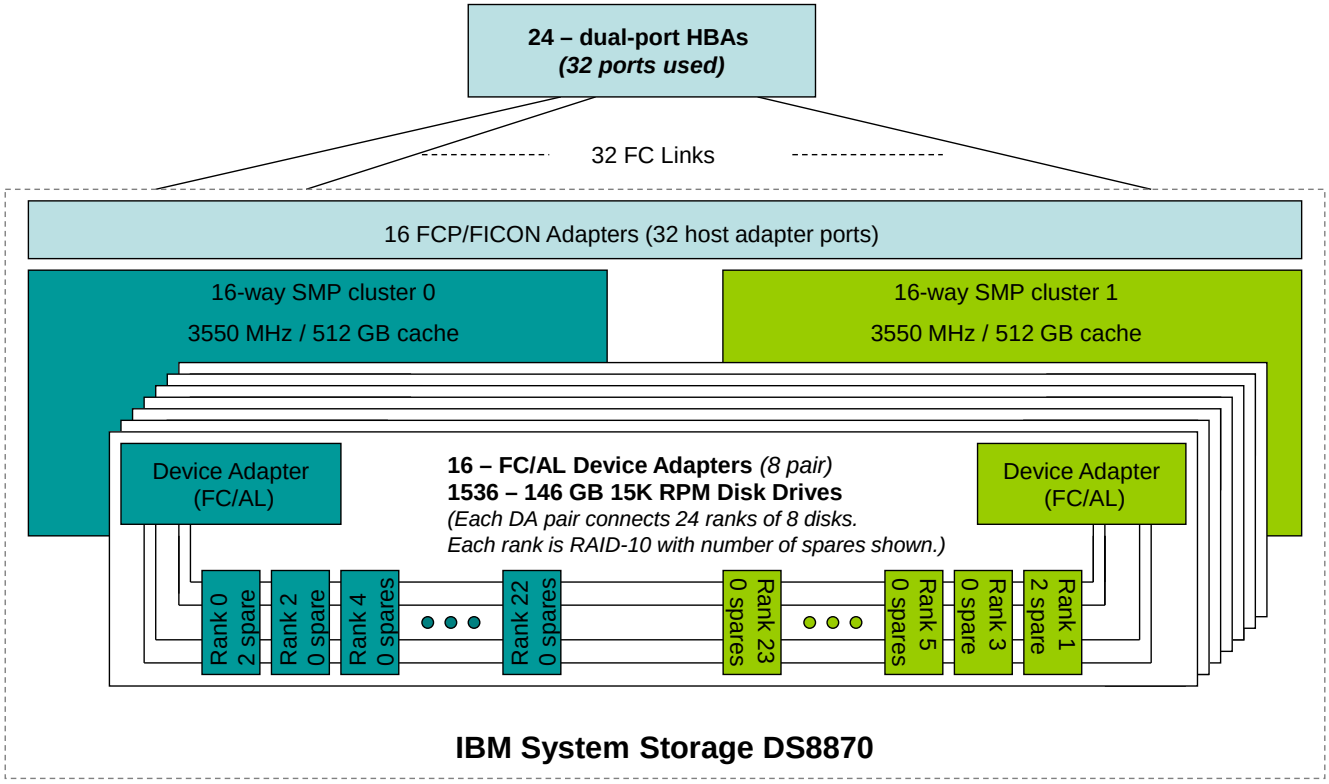
Priced Storage Configuration Pricing *(continued)*

Product	Description	Qty	Unit Price	List Price	% disc't	Ext'd Price
2423-96E	IBM System Storage DS8870 Expansion Unit	1	$ 73,500.00	$ 73,500.00	50%	$ 36,750.00
1	9xE factory merge	1	$ -	$ -	50%	$ -
100	Eligible for EU Shipment	1	$ -	$ -	50%	$ -
201	Storage Enclosure Infrastructure	1	$ -	$ -	50%	$ -
353	961 - 96E Position 3	1	$ -	$ -	50%	$ -
840	200.1 to 250.0 TB capacity	1	$ -	$ -	50%	$ -
1082	Line Cord (US/LA/AP/Canada)	1	$ 7,000.00	$ 7,000.00	50%	$ 3,500.00
1241	Disk Enclosure Pair	10	$ 20,000.00	$ 200,000.00	50%	$ 100,000.00
1242	HD STD Enclosure Indicator	10	$ -	$ -	50%	$ -
1249	HD Disk Drive Cable Group 5	1	$ 12,000.00	$ 12,000.00	50%	$ 6,000.00
1831	DS8000 LMC R7.0 indicator	1	$ -	$ -	50%	$ -
5108	146 GB 15K Drive Set FDE	30	$ 53,909.00	$ 1,617,270.00	50%	$ 808,635.00
2423-96E	IBM System Storage DS8870 Expansion Unit	1	$ 73,500.00	$ 73,500.00	50%	$ 36,750.00
1	9xE factory merge	1	$ -	$ -	50%	$ -
100	Eligible for EU Shipment	1	$ -	$ -	50%	$ -
201	Storage Enclosure Infrastructure	1	$ -	$ -	50%	$ -
352	961 - 96E Position 2	1	$ -	$ -	50%	$ -
840	200.1 to 250.0 TB capacity	1	$ -	$ -	50%	$ -
1082	Line Cord (US/LA/AP/Canada)	1	$ 7,000.00	$ 7,000.00	50%	$ 3,500.00
1241	Disk Enclosure Pair	10	$ 20,000.00	$ 200,000.00	50%	$ 100,000.00
1242	HD STD Enclosure Indicator	10	$ -	$ -	50%	$ -
1248	HD Disk Drive Cable Group 4	1	$ 12,000.00	$ 12,000.00	50%	$ 6,000.00
1831	DS8000 LMC R7.0 indicator	1	$ -	$ -	50%	$ -
5108	146 GB 15K Drive Set FDE	30	$ 53,909.00	$ 1,617,270.00	50%	$ 808,635.00
2423-96E	IBM System Storage DS8870 Expansion Unit	1	$ 73,500.00	$ 73,500.00	50%	$ 36,750.00
1	9xE factory merge	1	$ -	$ -	50%	$ -
100	Eligible for EU Shipment	1	$ -	$ -	50%	$ -
201	Storage Enclosure Infrastructure	1	$ -	$ -	50%	$ -
351	961 - 96E Position 1	1	$ -	$ -	50%	$ -
840	200.1 to 250.0 TB capacity	1	$ -	$ -	50%	$ -
1051	Battery Assembly	2	$ 16,200.00	$ 32,400.00	50%	$ 16,200.00
1082	Line Cord (US/LA/AP/Canada)	1	$ 7,000.00	$ 7,000.00	50%	$ 3,500.00
1241	Disk Enclosure Pair	7	$ 20,000.00	$ 140,000.00	50%	$ 70,000.00
1242	HD STD Enclosure Indicator	7	$ -	$ -	50%	$ -
1247	HD Disk Drive Cable Group 2	1	$ 9,000.00	$ 9,000.00	50%	$ 4,500.00
1301	I/O Enclosure Pair PCIE	2	$ 11,780.00	$ 23,560.00	50%	$ 11,780.00
1322	PCIE Cable Group 3	1	$ 5,000.00	$ 5,000.00	50%	$ 2,500.00
1831	DS8000 LMC R7.0 indicator	1	$ -	$ -	50%	$ -
5108	146 GB 15K Drive Set FDE	21	$ 53,909.00	$ 1,132,089.00	50%	$ 566,044.50
3053	Device Adapter Pair I	4	$ 15,000.00	$ 60,000.00	50%	$ 30,000.00
3153	8 Gb 4 port SW FCP/FICON Adapter PCIE	8	$ 37,312.00	$ 298,496.00	50%	$ 149,248.00
9117-5735	8 Gbps dual port FC adapter	24	$ 4,583.00	$ 109,992.00	30%	$ 76,994.40
	TOTAL					**$ 4,875,005.70**

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 presence 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.

Priced Storage Configuration Diagram



Priced Storage Configuration Components

Priced Storage Configuration:
24 – 8 Gbps dual port FC HBAs
IBM System Storage DS8870 2 –SMP processing clusters Each cluster contains: 16 – processor cores 512 GB – processor memory (1024 GB total)
16 – 8 Gb, 4 port SW FCP/FICON adapter pairs *(128 host port front-end connections, 32 used)*
8 – 8 Gb, 4 port FC-AL device adapter pairs *(4 adapter pair/cluster)* *(64 backend connections, 64 used)*
1 – Management Console *(internal laptop)*
3 – DS8870 Expansion Units
32 – Disk Enclosure pairs *(48 disk drives per enclosure pair)*
1,536 – 146 GB, 15K RPM, 2.5” disk drives

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

Storage Network Configuration

Clause 9.4.3.4.1

…

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

Clause 9.4.3.4.2

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

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

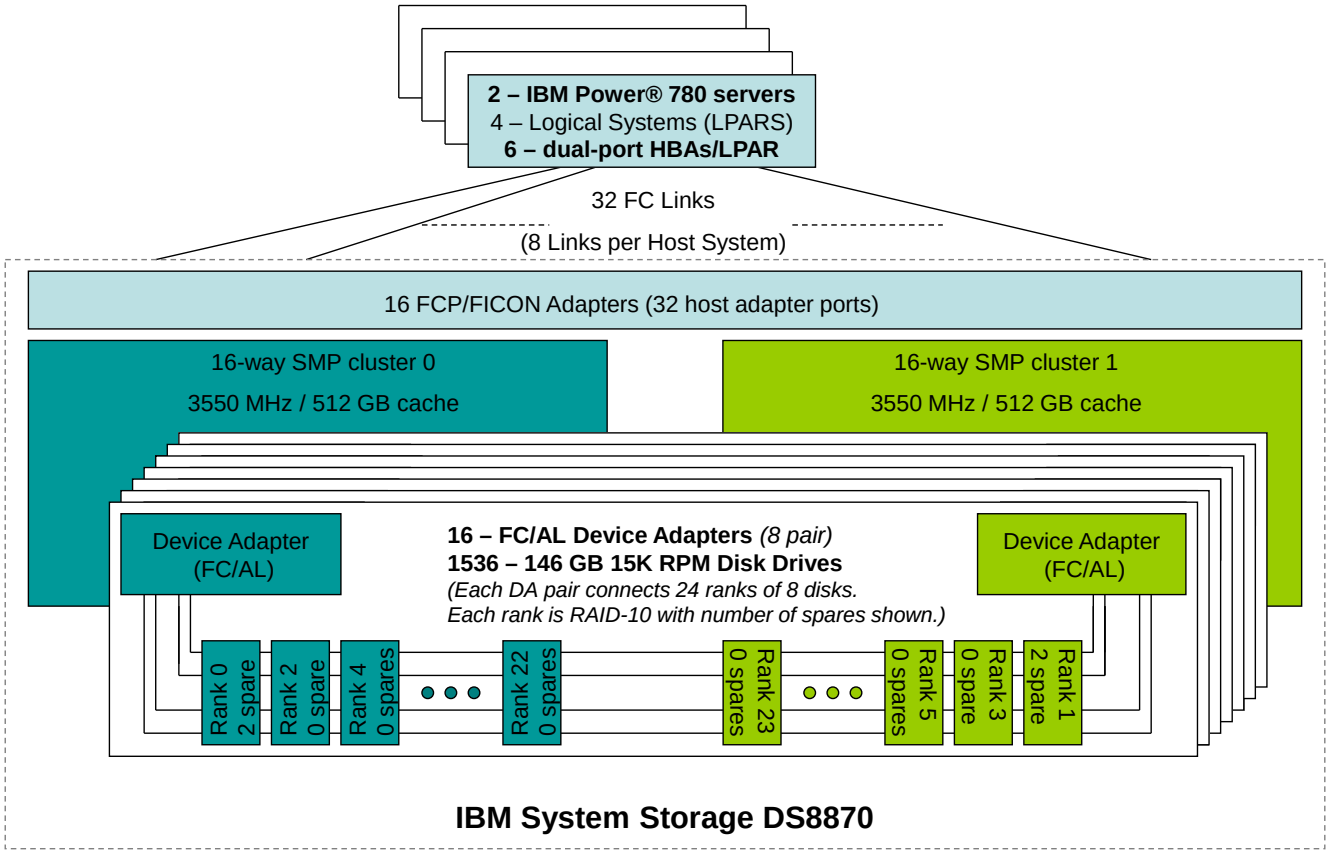
Host System and Tested Storage Configuration (TSC) Table of Components

Clause 9.4.3.4.3

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

The Host System and TSC table of components may be found on page 21 *(Host Systems and Tested Storage Configuration Components).*

Benchmark Configuration/Tested Storage Configuration Diagram



Host Systems and Tested Storage Configuration Components

Host Systems:	Tested Storage Configuration (TSC)
2 – IBM Power® 780 servers Each server with: 64 CPUs (cores) each core: 3.92 GHz, 256 KB L2 cache 4 MiB L3 cache 512 GiB main memory AIX 7.1 PCIe AIX Logical Volume Manager (used for striping) Each physical server was partitioned into 2 logical servers (LPARS) for a total of 4 logical servers, each with 32 cores.	24 – 8 Gbps dual port FC HBAs
	IBM System Storage DS8870 2 –SMP processing clusters Each cluster contains: 16 – processor cores 512 GB – processor memory *(1024 GB total)*
	16 – 8 Gb, 4 port SW FCP/FICON adapter pairs *(128 host port front-end connection, 32 used)*
	8 – 8 Gb, 4 port, FC-AL device adapter pairs *(4 adapter pair/cluster)* *(64 backend connections, 64 used)*
	1 – Management Console *(internal laptop)*
	3 – DS8870 Expansion Units
	32 – Disk Enclosure pairs *(48 disk drives per enclosure pair)*
	1,536 – 146 GB, 15K RPM, 2.5” disk drives

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 62 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 63 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 77.

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 58 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)	56,232.000
Addressable Storage Capacity	Gigabytes (GB)	60,378.650
Configured Storage Capacity	Gigabytes (GB)	219,033.600
Physical Storage Capacity	Gigabytes (GB)	224,272.737
Data Protection *(Mirrored)*	Gigabytes (GB)	97,152.160
Required Storage *(overhead/metadata/spares)*	Gigabytes (GB)	29,935.438
Global Storage Overhead	Gigabytes (GB)	5,239.137
Total Unused Storage	Gigabytes (GB)	81,634.162

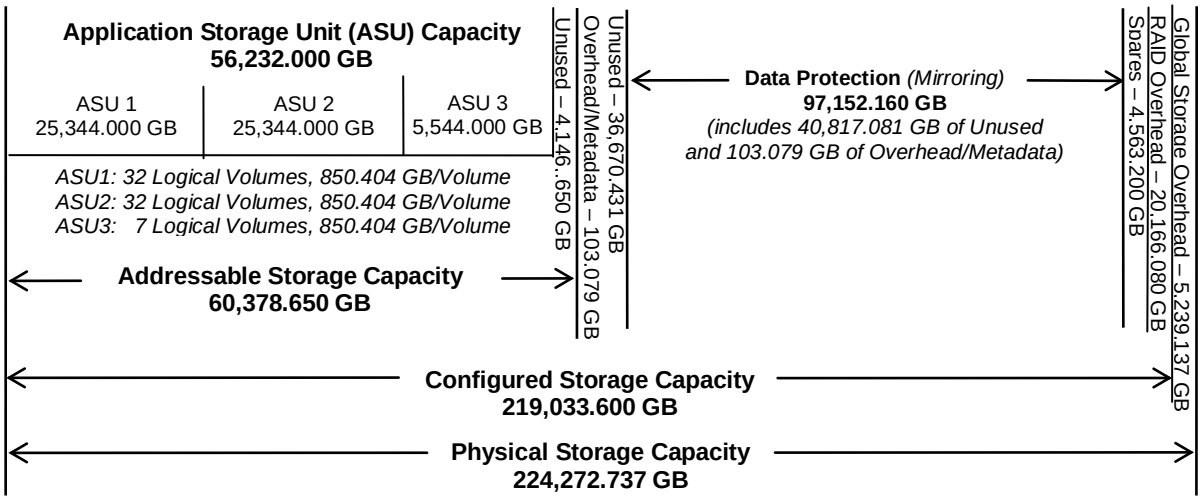
SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	**Configured Storage Capacity**	**Physical Storage Capacity**
Total ASU Capacity	93.13%	25.67%	25.07%
Required for Data Protection *(Mirrored)*		44.35%	43.32%
Addressable Storage Capacity		27.57%	26.92%
Required Storage *(overhead/metadata/spares)*		11.38%	11.12%
Configured Storage Capacity			97.66%
Global Storage Overhead			2.34%
Unused Storage:			
Addressable	6.87%		
Configured		33.48%	
Physical			0.00%

The Physical Storage Capacity consisted of 224,272.737 GB distributed over 1,536 disk drives, each with a formatted capacity of 146.011 GB. There was 0.000 GB (0.00%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 5,239.137 GB (2.34%) of the Physical Storage Capacity. There was 73.340.862 GB (33.48%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 93.13% of the Addressable Storage Capacity resulting in 4,146.650 GB (6.87%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(Mirroring)* capacity was 97,152.160 GB of which 56,335.079 GB was utilized. The total Unused Storage capacity was 81,634.162 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 (25,344.000 GB)	**ASU-2 (25,344.000 GB)**	**ASU-3 (5,952.825 GB)**
32 Logical Volumes 850.404 GB per Logical Volume (792.000 GB used per Logical Volume)	32 Logical Volumes 850.404 GB per Logical Volume (792.000 GB used per Logical Volume)	7 Logical Volumes 850.404 GB per Logical Volume (792.000 GB used per Logical Volume)

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

Storage Capacity Utilization

Clause 9.4.3.6.2

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

Clause 2.8.1

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

Clause 2.8.2

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

Clause 2.8.3

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

SPC-1 Storage Capacity Utilization	
Application Utilization	25.07%
Protected Application Utilization	50.19%
Unused Storage Ratio	36.40%

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 59 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 86.

Sustainability Test Results File

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

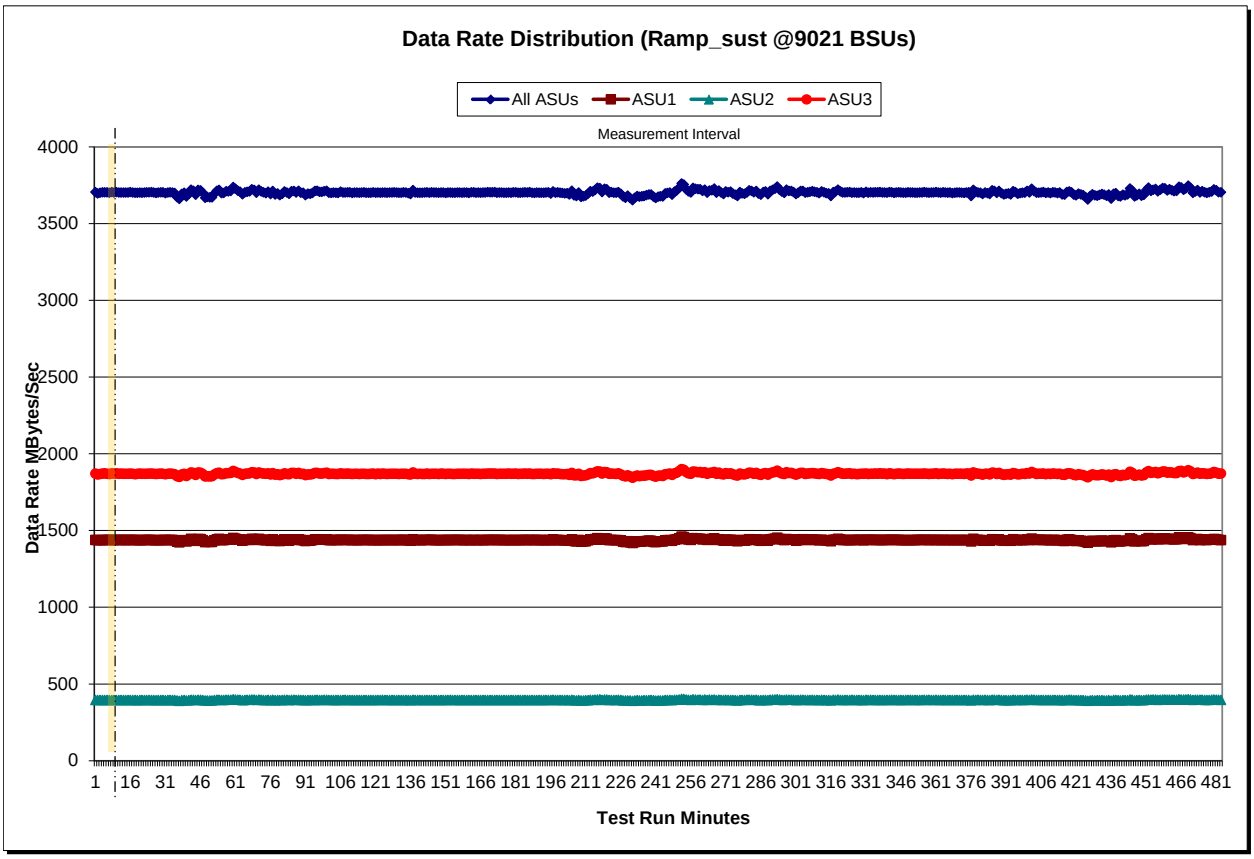
Sustainability Test Results File

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

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

Sustainability Data Rate Table

Sustainability – Data Rate Distribution Graph

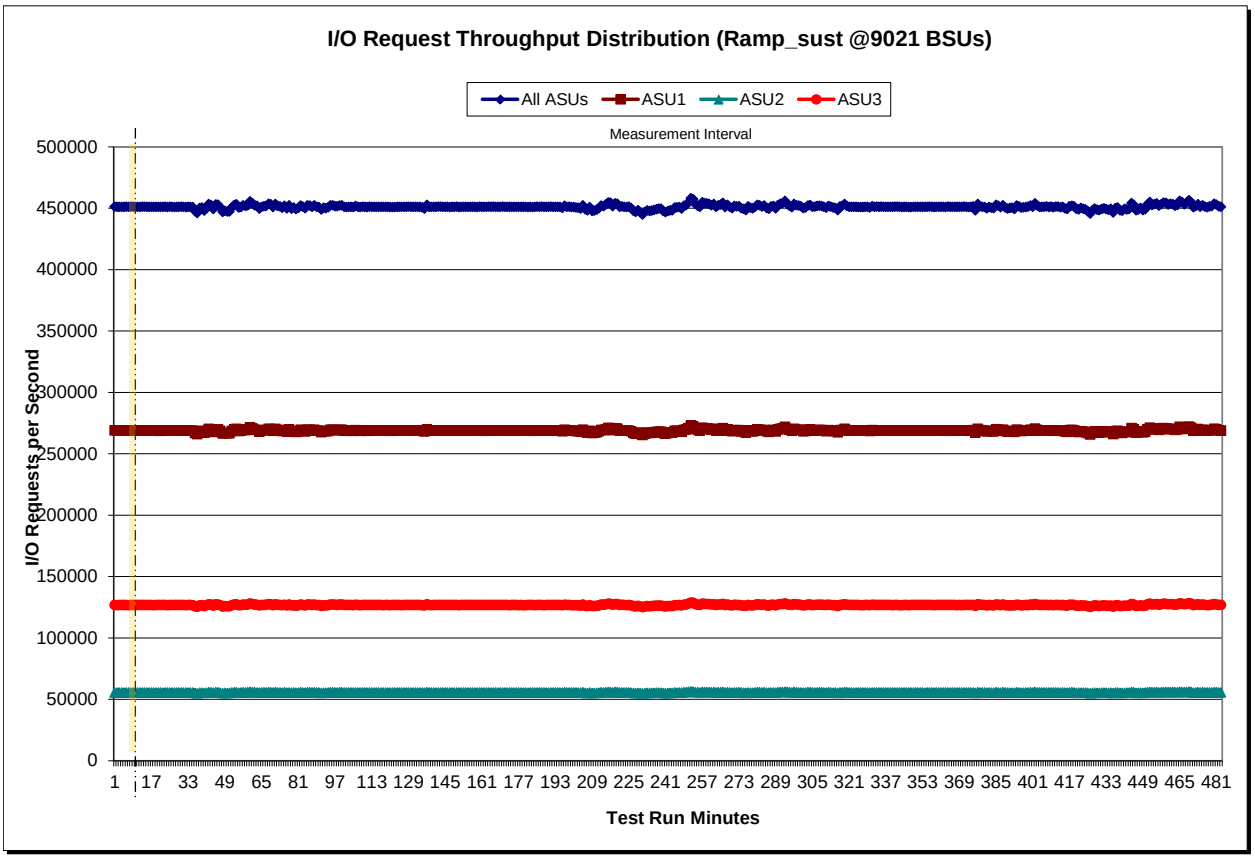


Sustainability – I/O Request Throughput Distribution Data

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

Sustainability I/O Request Throughput Table

Sustainability – I/O Request Throughput Distribution Graph

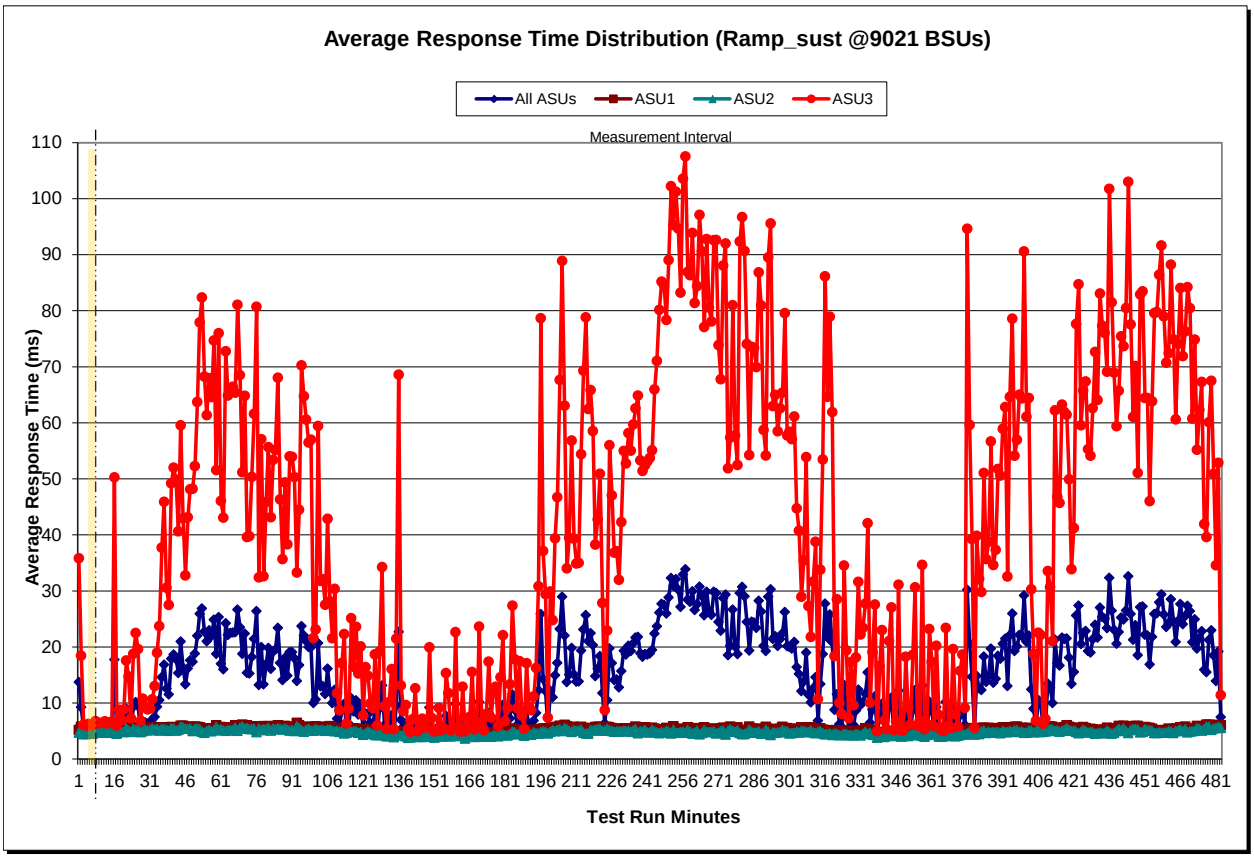


Sustainability – Average Response Time (ms) Distribution Data

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

Sustainability Average Response Time Table

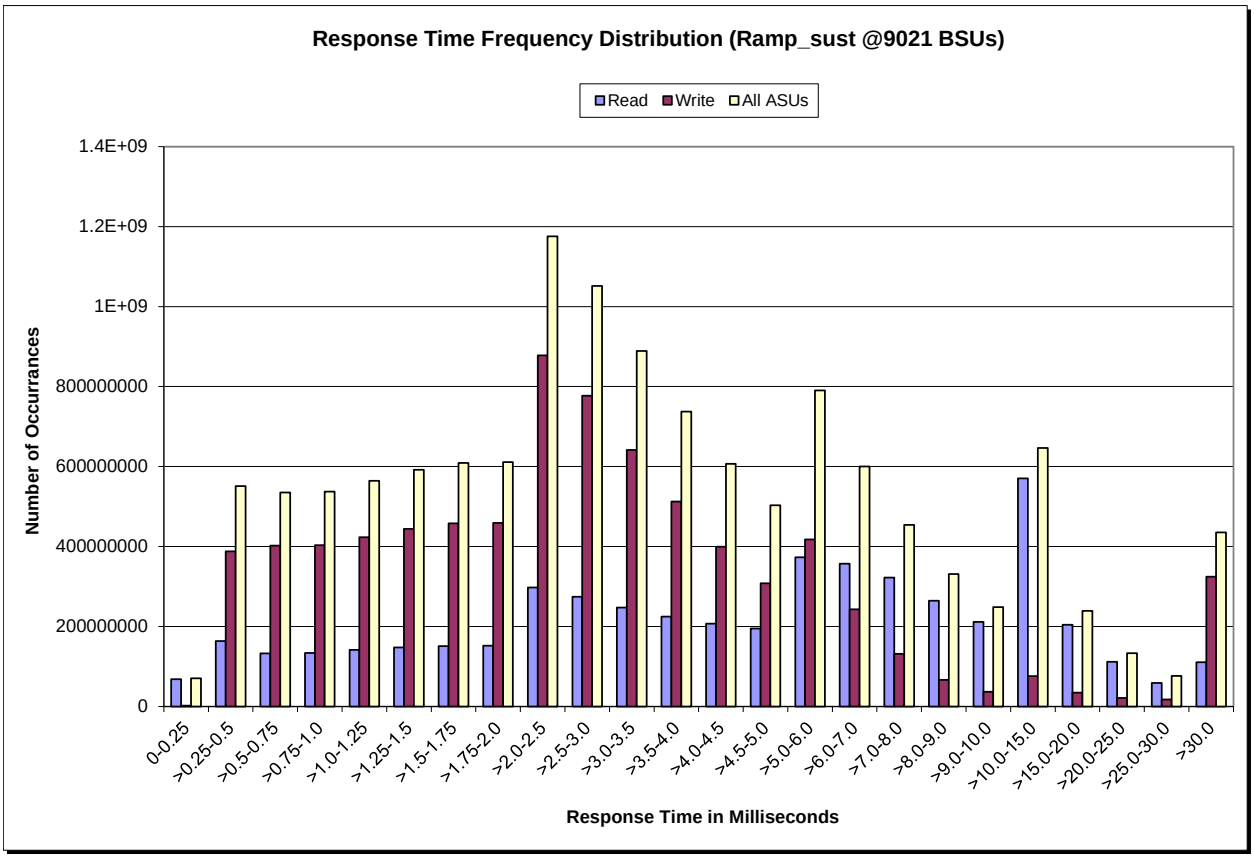
Sustainability – Average Response Time (ms) Distribution Graph



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	68,245,445	163,488,802	132,712,776	134,030,792	141,390,559	147,784,275	151,223,543	152,233,712
Write	2,122,498	387,885,877	402,285,658	403,381,459	423,107,447	444,151,112	458,005,151	458,920,354
All ASUs	70,367,943	551,374,679	534,998,434	537,412,251	564,498,006	591,935,387	609,228,694	611,154,066
ASU1	57,446,431	317,288,205	287,063,715	289,928,974	305,394,549	321,120,800	331,466,338	334,087,790
ASU2	12,436,194	76,938,200	69,698,794	70,328,886	74,035,238	77,727,151	80,106,379	80,531,268
ASU3	485,318	157,148,274	178,235,925	177,154,391	185,068,219	193,087,436	197,655,977	196,535,008
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	297,682,833	274,569,511	247,326,425	224,733,464	207,214,284	195,100,928	372,869,722	357,407,754
Write	877,988,767	776,931,621	641,540,864	512,450,031	399,509,625	308,026,978	417,669,988	242,873,336
All ASUs	1,175,671,600	1,051,501,132	888,867,289	737,183,495	606,723,909	503,127,906	790,539,710	600,281,090
ASU1	649,918,228	592,207,864	513,655,081	438,972,868	372,120,804	317,680,081	521,066,079	417,133,436
ASU2	155,438,280	139,217,119	117,031,730	95,558,565	76,637,714	61,109,714	88,849,439	62,079,898
ASU3	370,315,092	320,076,149	258,180,478	202,652,062	157,965,391	124,338,111	180,624,192	121,067,756
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	322,245,011	264,479,325	211,721,750	570,588,750	204,217,720	111,878,669	59,246,481	110,724,559
Write	131,675,953	66,754,031	37,062,903	76,020,345	34,993,840	21,685,126	17,392,631	324,580,742
All ASUs	453,920,964	331,233,356	248,784,653	646,609,095	239,211,560	133,563,795	76,639,112	435,305,301
ASU1	327,946,380	247,542,630	190,247,620	499,866,763	175,978,230	95,042,904	49,612,482	89,337,447
ASU2	46,614,871	34,628,843	26,890,578	74,274,547	28,619,651	16,978,033	9,738,100	22,340,639
ASU3	79,359,713	49,061,883	31,646,455	72,467,785	34,613,679	21,542,858	17,288,530	323,627,215

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	0.001	0.000	0.001	0.000	0.001	0.001	0.001	0.000

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 to the Workload Generator.*
6. *The total number of I/O Requests completed in the Measurement Interval as well as the number of I/O Requests with a Response Time less than or equal to 30 milliseconds and the number of I/O Requests with a Response Time greater than 30 milliseconds.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 86.

IOPS Test Results File

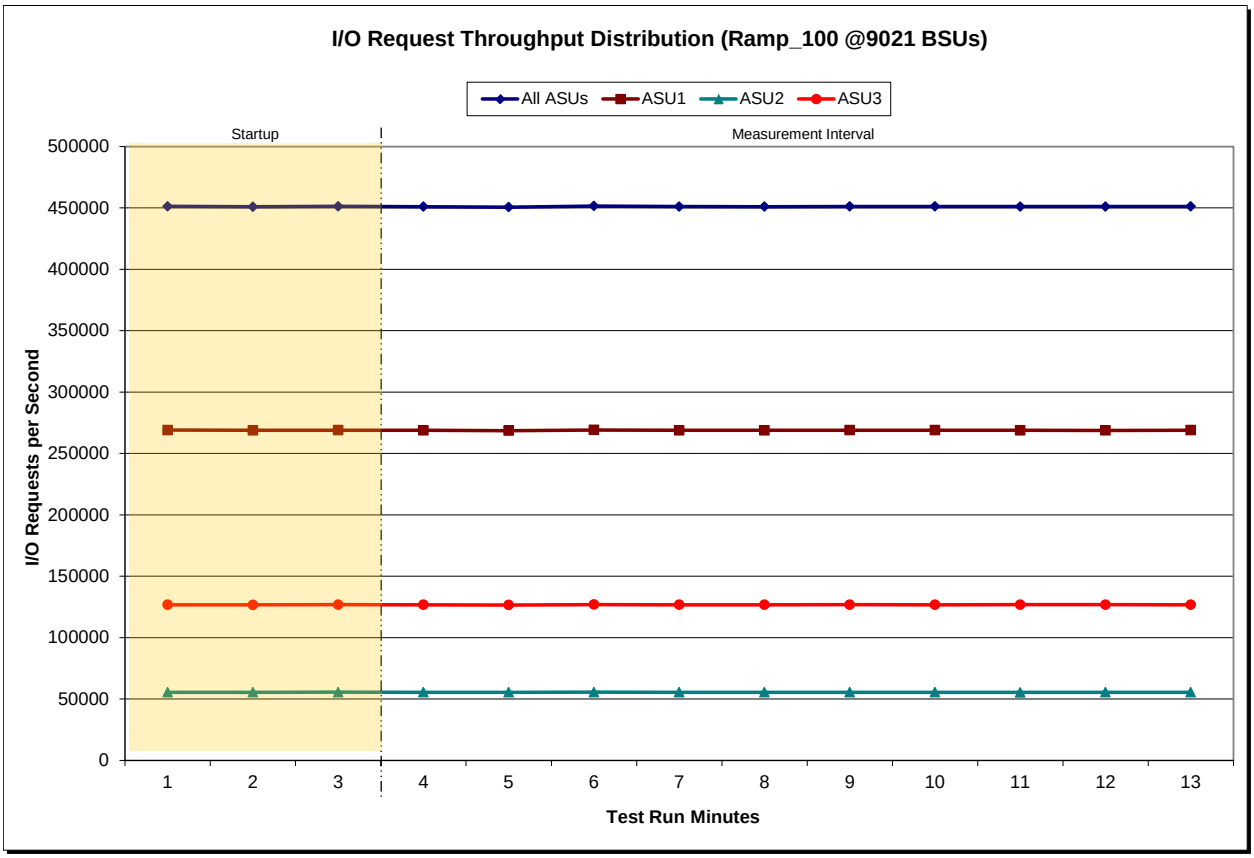
A link to the test results file generated from the IOPS Test Run is listed below.

IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

9,021 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:54:23	10:57:23	0-2	0:03:00
Measurement Interval	10:57:23	11:07:24	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	451,258.22	269,045.53	55,466.50	126,746.18
1	450,920.83	268,856.62	55,440.93	126,623.28
2	451,256.33	268,908.68	55,548.70	126,798.95
3	450,950.07	268,799.23	55,430.62	126,720.22
4	450,586.62	268,558.40	55,452.53	126,575.68
5	451,558.08	269,099.67	55,572.68	126,885.73
6	451,106.88	268,875.05	55,474.03	126,757.80
7	451,027.90	268,866.85	55,430.05	126,731.00
8	451,202.00	268,945.67	55,472.48	126,783.85
9	451,126.22	268,923.25	55,441.77	126,761.20
10	451,098.48	268,881.13	55,406.53	126,810.82
11	451,036.42	268,746.98	55,497.20	126,792.23
12	451,130.02	268,899.77	55,487.52	126,742.73
Average	***451,082.27***	***268,859.60***	***55,466.54***	***126,756.13***

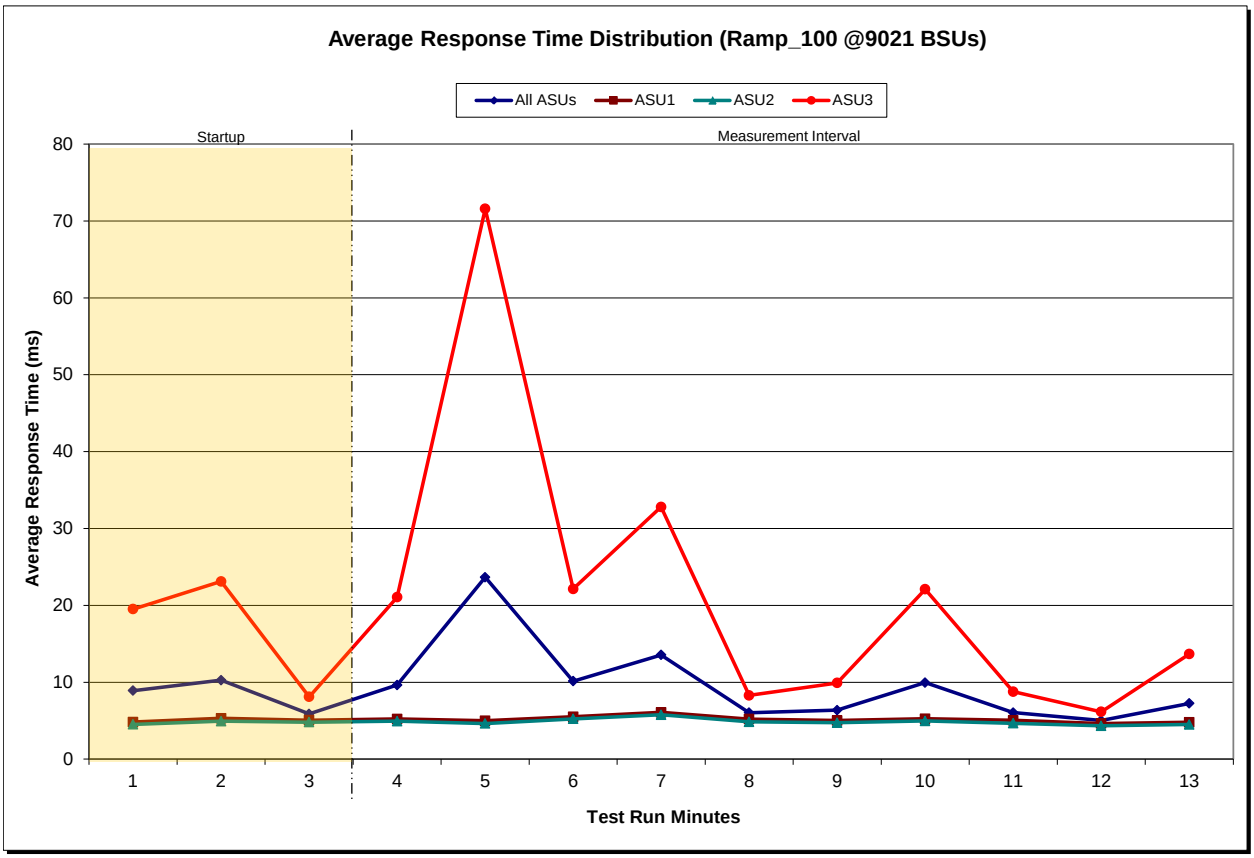
IOPS Test Run – I/O Request Throughput Distribution Graph



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

9,021 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:54:23	10:57:23	0-2	0:03:00
Measurement Interval	10:57:23	11:07:24	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	8.91	4.82	4.52	19.51
1	10.27	5.32	4.94	23.12
2	5.88	5.06	4.80	8.10
3	9.64	5.23	4.94	21.07
4	23.66	5.00	4.64	71.59
5	10.14	5.50	5.23	22.14
6	13.55	6.08	5.76	32.80
7	6.03	5.21	4.85	8.29
8	6.36	5.03	4.73	9.92
9	9.95	5.25	4.97	22.10
10	6.05	5.05	4.66	8.77
11	5.02	4.64	4.33	6.15
12	7.25	4.79	4.50	13.67
Average	***9.77***	***5.18***	***4.86***	***21.65***

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



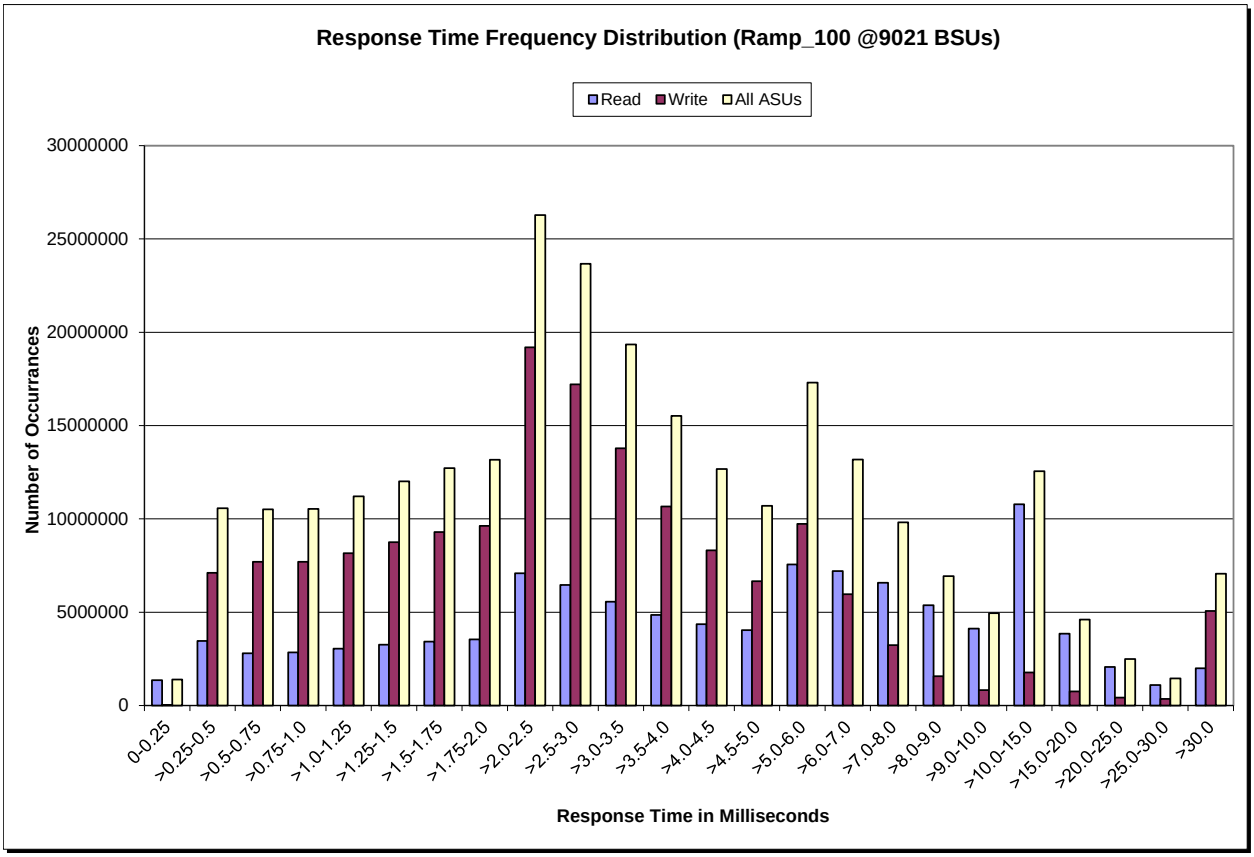
IOPS Test Run – Response Time Frequency Distribution Data

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	1,358,772	3,459,601	2,802,657	2,843,641	3,051,065	3,259,304	3,423,346	3,538,606
Write	29,461	7,110,050	7,702,528	7,695,940	8,155,632	8,753,171	9,297,624	9,626,831
All ASUs	1,388,233	10,569,651	10,505,185	10,539,581	11,206,697	12,012,475	12,720,970	13,165,437
ASU1	1,157,060	6,242,022	5,738,380	5,789,832	6,187,212	6,654,009	7,064,055	7,344,479
ASU2	224,626	1,451,138	1,342,283	1,353,353	1,443,222	1,551,599	1,649,727	1,710,529
ASU3	6,547	2,876,491	3,424,522	3,396,396	3,576,263	3,806,867	4,007,188	4,110,429

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	7,088,227	6,462,635	5,564,965	4,853,430	4,362,406	4,043,126	7,563,991	7,209,749
Write	19,187,898	17,210,270	13,777,831	10,666,478	8,312,673	6,655,277	9,731,979	5,965,470
All ASUs	26,276,125	23,672,905	19,342,796	15,519,908	12,675,079	10,698,403	17,295,970	13,175,219
ASU1	14,769,687	13,464,096	11,214,314	9,231,702	7,711,613	6,625,457	10,985,233	8,734,444
ASU2	3,426,823	3,082,550	2,499,897	1,972,637	1,571,330	1,281,393	1,937,460	1,377,078
ASU3	8,079,615	7,126,259	5,628,585	4,315,569	3,392,136	2,791,553	4,373,277	3,063,697

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	6,580,249	5,371,317	4,122,713	10,783,331	3,852,262	2,063,954	1,101,130	1,993,212
Write	3,238,825	1,566,785	831,334	1,768,766	758,480	428,116	350,715	5,070,905
All ASUs	9,819,074	6,938,102	4,954,047	12,552,097	4,610,742	2,492,070	1,451,845	7,064,117
ASU1	6,803,346	5,015,651	3,669,118	9,348,461	3,282,126	1,732,383	912,238	1,637,320
ASU2	1,031,529	755,407	568,028	1,517,494	581,586	337,394	193,350	419,213
ASU3	1,984,199	1,167,044	716,901	1,686,142	747,030	422,293	346,257	5,007,584

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
270,646,728	263,582,611	7,064,117

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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

Clauses 5.1.10 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2810	0.0700	0.2101	0.0180	0.0700	0.0350	0.2810
COV	0.002	0.000	0.001	0.000	0.001	0.001	0.001	0l000

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.4.3

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

The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 13.

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

Clause 9.4.3.7.3

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

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 86.

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 - 9,021 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	10:54:23	10:57:23	0-2	0:03:00
Measurement Interval	10:57:23	11:07:24	3-12	0:10:01

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	451,258.22	269,045.53	55,466.50	126,746.18
1	450,920.83	268,856.62	55,440.93	126,623.28
2	451,256.33	268,908.68	55,548.70	126,798.95
3	450,950.07	268,799.23	55,430.62	126,720.22
4	450,586.62	268,558.40	55,452.53	126,575.68
5	451,558.08	269,099.67	55,572.68	126,885.73
6	451,106.88	268,875.05	55,474.03	126,757.80
7	451,027.90	268,866.85	55,430.05	126,731.00
8	451,202.00	268,945.67	55,472.48	126,783.85
9	451,126.22	268,923.25	55,441.77	126,761.20
10	451,098.48	268,881.13	55,406.53	126,810.82
11	451,036.42	268,746.98	55,497.20	126,792.23
12	451,130.02	268,899.77	55,487.52	126,742.73
Average	***451,082.27***	***268,859.60***	***55,466.54***	***126,756.13***

95% Load Level - 8,569 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:12:34	11:15:34	0-2	0:03:00
Measurement Interval	11:15:34	11:25:35	3-12	0:10:01

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	428,768.90	255,584.08	52,714.47	120,470.35
1	428,533.57	255,371.75	52,705.73	120,456.08
2	428,546.38	255,436.05	52,756.38	120,353.95
3	428,437.80	255,342.58	52,700.97	120,394.25
4	428,580.87	255,401.92	52,723.03	120,455.92
5	428,450.63	255,419.00	52,719.92	120,311.72
6	428,353.67	255,290.30	52,686.50	120,376.87
7	428,630.55	255,414.17	52,742.67	120,473.72
8	428,263.33	255,180.15	52,713.05	120,370.13
9	428,436.58	255,312.98	52,738.23	120,385.37
10	428,378.50	255,274.65	52,710.95	120,392.90
11	428,518.45	255,360.97	52,739.38	120,418.10
12	428,577.50	255,442.90	52,707.52	120,427.08
Average	***428,462.79***	***255,343.96***	***52,718.22***	***120,400.61***

90% Load Level - 8,118 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:30:39	11:33:39	0-2	0:03:00
Measurement Interval	11:33:39	11:43:40	3-12	0:10:01

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	405,981.68	241,932.58	49,992.85	114,056.25
1	406,030.30	241,889.02	49,985.67	114,155.62
2	405,811.42	241,833.23	49,941.67	114,036.52
3	405,880.28	241,883.87	49,959.18	114,037.23
4	406,004.65	241,987.72	49,954.52	114,062.42
5	405,856.88	241,865.18	49,931.42	114,060.28
6	405,801.87	241,880.17	49,906.12	114,015.58
7	405,924.53	241,936.48	49,901.60	114,086.45
8	405,967.95	241,994.78	49,912.90	114,060.27
9	405,898.78	241,965.65	49,894.42	114,038.72
10	405,884.40	241,935.20	49,902.08	114,047.12
11	405,793.72	241,872.92	49,920.78	114,000.02
12	405,978.52	241,933.50	49,962.02	114,083.00
Average	***405,899.16***	***241,925.55***	***49,924.50***	***114,049.11***

80% Load Level - 7,210 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	11:48:30	11:51:30	0-2	0:03:00
Measurement Interval	11:51:30	12:01:31	3-12	0:10:01

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	361,001.07	215,123.65	44,402.68	101,474.73
1	360,835.13	215,113.00	44,384.00	101,338.13
2	360,929.15	215,090.38	44,357.60	101,481.17
3	360,740.83	214,937.35	44,416.55	101,386.93
4	360,963.78	215,171.23	44,376.70	101,415.85
5	360,792.10	215,045.45	44,419.55	101,327.10
6	360,841.47	215,027.32	44,410.37	101,403.78
7	360,868.90	215,090.35	44,381.75	101,396.80
8	360,756.97	215,038.57	44,366.03	101,352.37
9	360,743.65	214,904.00	44,407.75	101,431.90
10	360,867.07	215,072.20	44,366.37	101,428.50
11	360,879.75	215,066.50	44,381.15	101,432.10
12	360,943.30	215,087.73	44,431.62	101,423.95
Average	***360,839.78***	***215,044.07***	***44,395.78***	***101,399.93***

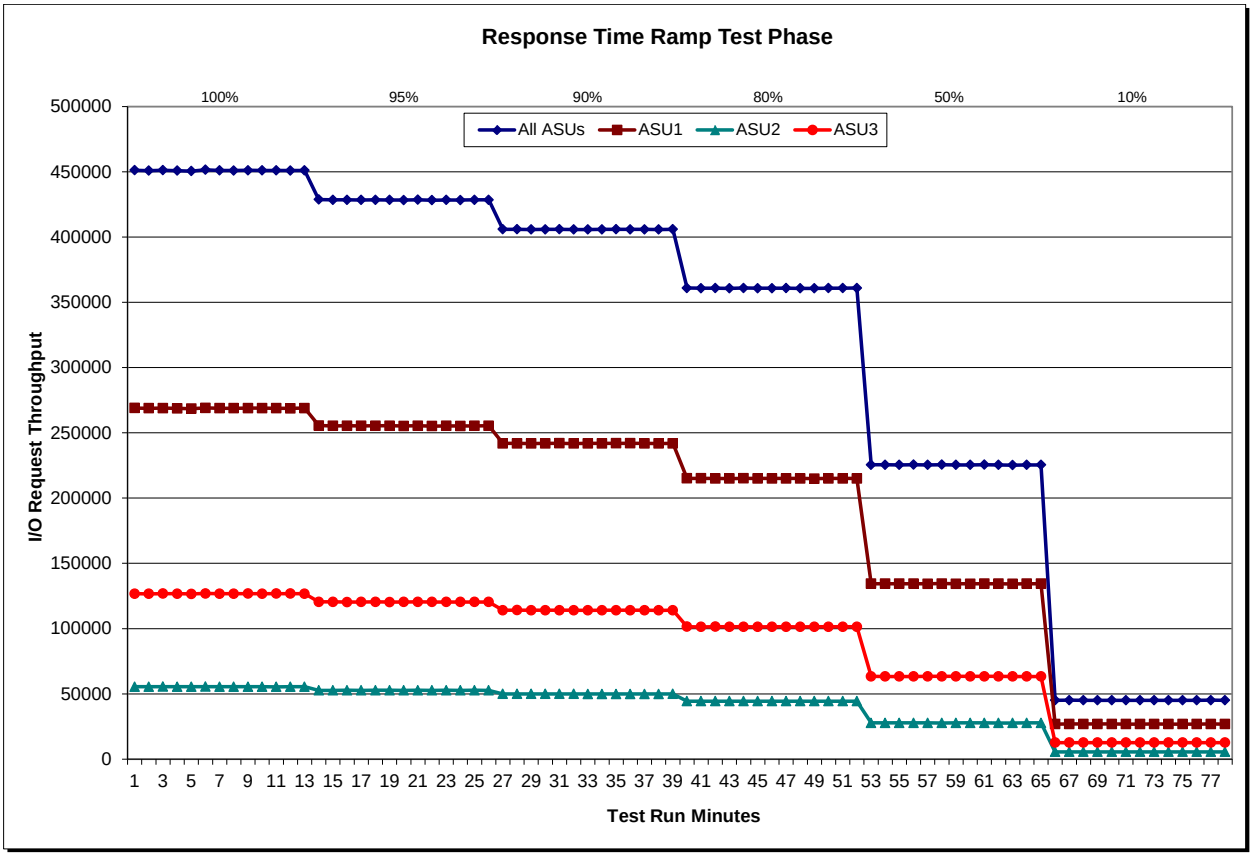
50% Load Level - 4,510 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:05:37	12:05:37	0-2	0:00:00
Measurement Interval	12:05:37	12:05:37	3-12	0:00:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	225,553.02	134,427.78	27,741.30	63,383.93
1	225,519.78	134,436.88	27,741.32	63,341.58
2	225,473.08	134,442.95	27,724.92	63,305.22
3	225,590.55	134,456.75	27,776.30	63,357.50
4	225,483.28	134,352.17	27,767.55	63,363.57
5	225,595.58	134,469.07	27,714.72	63,411.80
6	225,488.60	134,364.58	27,737.40	63,386.62
7	225,458.85	134,353.33	27,743.03	63,362.48
8	225,584.25	134,423.95	27,730.50	63,429.80
9	225,474.72	134,390.00	27,714.87	63,369.85
10	225,314.92	134,260.78	27,719.12	63,335.02
11	225,492.42	134,411.22	27,735.32	63,345.88
12	225,456.18	134,428.88	27,724.65	63,302.65
Average	***225,493.94***	***134,391.07***	***27,736.35***	***63,366.52***

10% Load Level - 902 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:21:54	12:24:54	0-2	0:03:00
Measurement Interval	12:24:54	12:34:55	3-12	0:10:01

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	45,098.18	26,861.93	5,549.50	12,686.75
1	45,131.40	26,907.77	5,551.57	12,672.07
2	45,100.78	26,879.73	5,546.42	12,674.63
3	45,112.50	26,888.72	5,557.68	12,666.10
4	45,104.22	26,880.38	5,545.33	12,678.50
5	45,052.40	26,841.87	5,528.53	12,682.00
6	45,095.33	26,868.32	5,540.47	12,686.55
7	45,069.08	26,888.20	5,544.92	12,635.97
8	45,065.98	26,842.40	5,548.70	12,674.88
9	45,080.45	26,854.63	5,543.08	12,682.73
10	45,099.55	26,869.88	5,550.72	12,678.95
11	45,123.33	26,903.67	5,550.00	12,669.67
12	45,095.73	26,867.92	5,551.17	12,676.65
Average	***45,089.86***	***26,870.60***	***5,546.06***	***12,673.20***

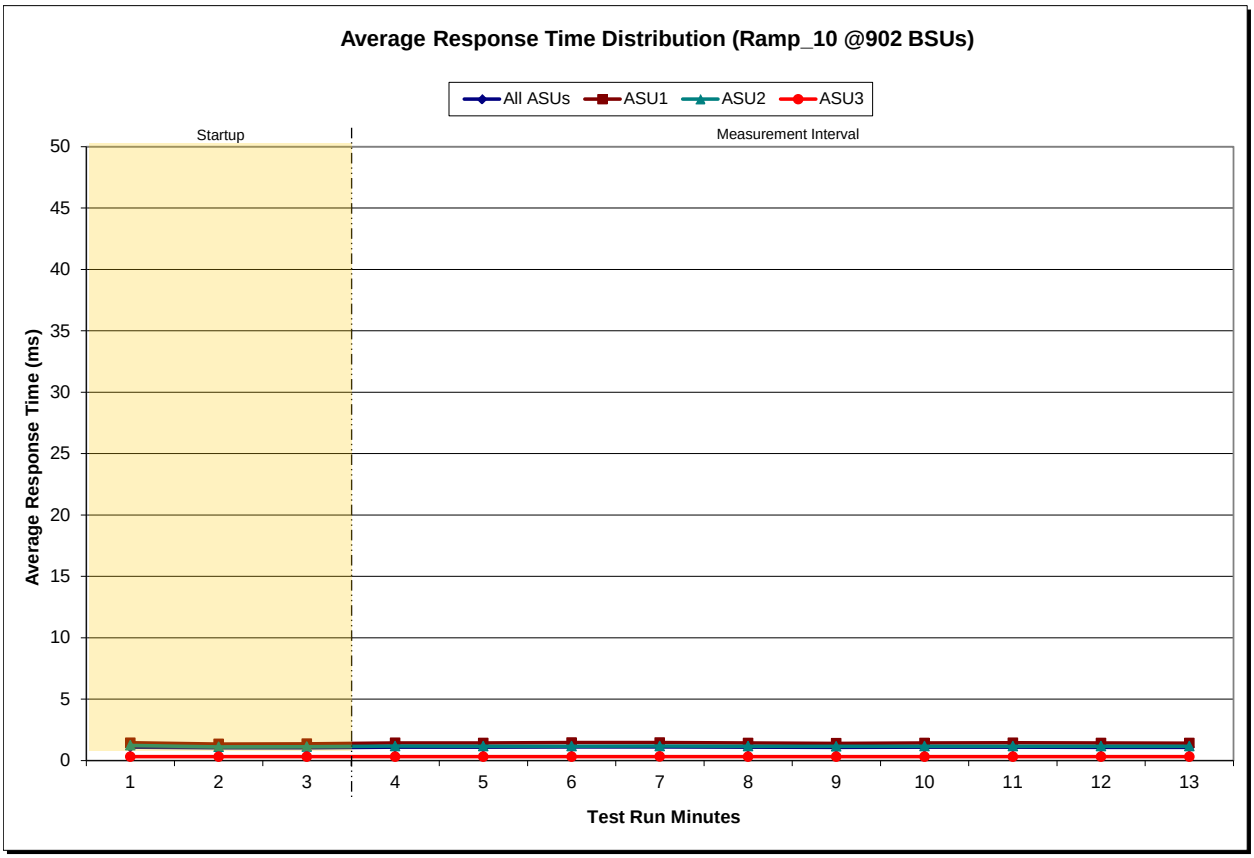
Response Time Ramp Distribution (IOPS) Graph



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

902 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:21:54	12:24:54	0-2	0:03:00
Measurement Interval	12:24:54	12:34:55	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
Minutes of Test Run	All ASUs	ASU1	ASU2	ASU3
0	1.10	1.44	1.23	0.31
1	1.03	1.35	1.11	0.31
2	1.04	1.36	1.13	0.31
3	1.09	1.43	1.18	0.31
4	1.08	1.43	1.16	0.31
5	1.10	1.46	1.17	0.31
6	1.11	1.47	1.17	0.32
7	1.08	1.42	1.16	0.31
8	1.06	1.40	1.16	0.31
9	1.08	1.43	1.17	0.32
10	1.09	1.44	1.16	0.31
11	1.08	1.42	1.17	0.31
12	***1.08***	***1.42***	***1.17***	***0.31***

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



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

Clause 3.4.3

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

Clauses 5.1.10 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0351	0.2810	0.0699	0.2099	0.0180	0.0700	0.0350	0.2811
COV	0.003	0.001	0.002	0.001	0.003	0.002	0.003	0.001

Repeatability Test

Clause 5.4.5

The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ primary metric and the 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 86.

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	***451,082.27***
Repeatability Test Phase 1	451,020.47
Repeatability Test Phase 2	451,037.49

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	***1.08 ms***
Repeatability Test Phase 1	1.09 ms
Repeatability Test Phase 2	1.07 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).

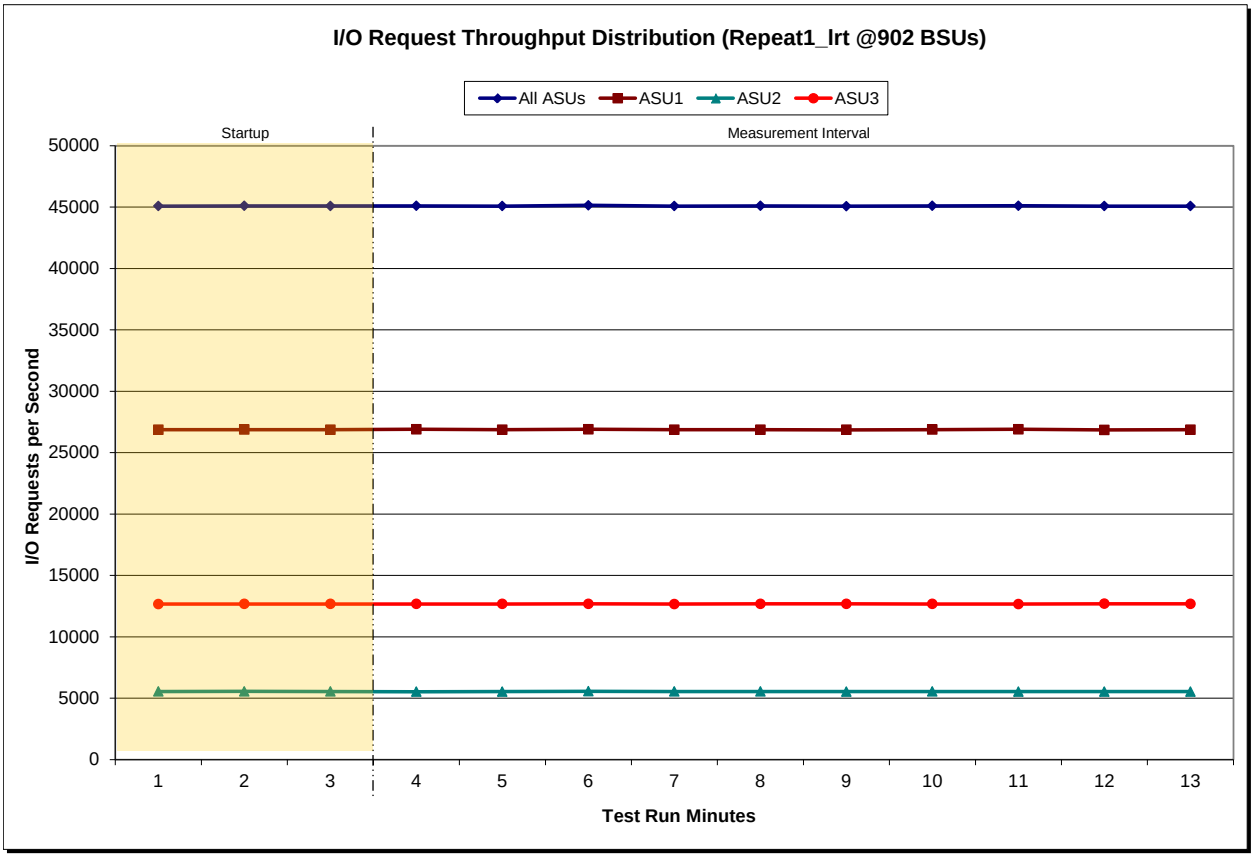
A link to the test result file generated from each Repeatability Test Run is listed below.

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

902 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:38:09	12:41:09	0-2	0:03:00
Measurement Interval	12:41:09	12:51:10	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	45,079.85	26,864.15	5,549.90	12,665.80
1	45,101.47	26,875.93	5,550.45	12,675.08
2	45,092.13	26,870.87	5,549.07	12,672.20
3	45,102.40	26,900.97	5,531.45	12,669.98
4	45,077.13	26,863.18	5,540.70	12,673.25
5	45,146.00	26,906.38	5,560.10	12,679.52
6	45,079.53	26,866.53	5,549.30	12,663.70
7	45,097.98	26,865.68	5,549.20	12,683.10
8	45,074.92	26,857.73	5,537.20	12,679.98
9	45,096.30	26,873.82	5,549.35	12,673.13
10	45,110.98	26,901.93	5,541.07	12,667.98
11	45,079.15	26,852.55	5,535.15	12,691.45
12	45,083.45	26,866.55	5,537.00	12,679.90
Average	***45,094.79***	***26,875.53***	***5,543.05***	***12,676.20***

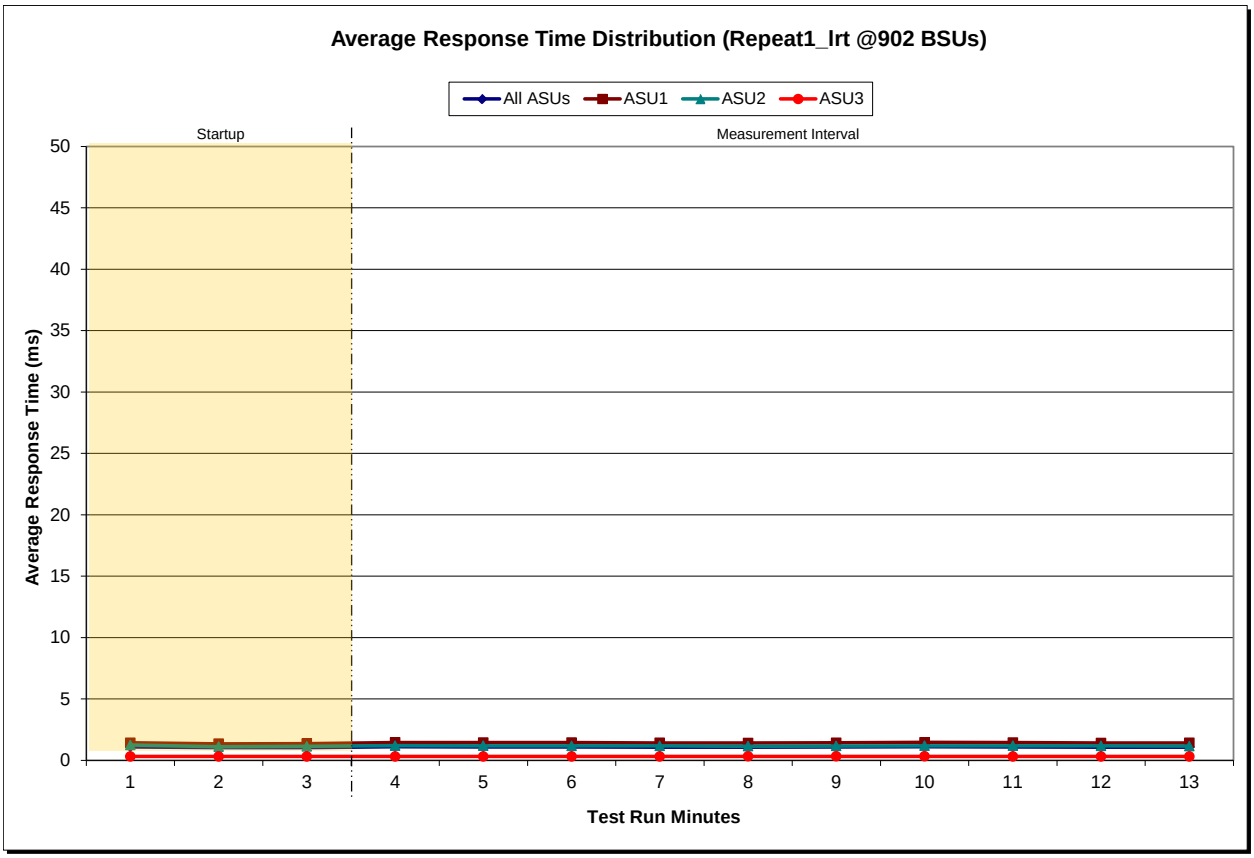
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

902 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:38:09	12:41:09	0-2	0:03:00
Measurement Interval	12:41:09	12:51:10	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.09	1.42	1.24	0.31
1	1.03	1.35	1.11	0.31
2	1.04	1.36	1.14	0.31
3	1.10	1.46	1.19	0.32
4	1.09	1.44	1.18	0.32
5	1.09	1.44	1.17	0.31
6	1.08	1.42	1.17	0.31
7	1.07	1.41	1.15	0.32
8	1.08	1.43	1.17	0.32
9	1.11	1.46	1.18	0.32
10	1.09	1.44	1.18	0.32
11	1.07	1.41	1.17	0.32
12	1.08	1.42	1.16	0.32
Average	***1.09***	***1.43***	***1.17***	***0.32***

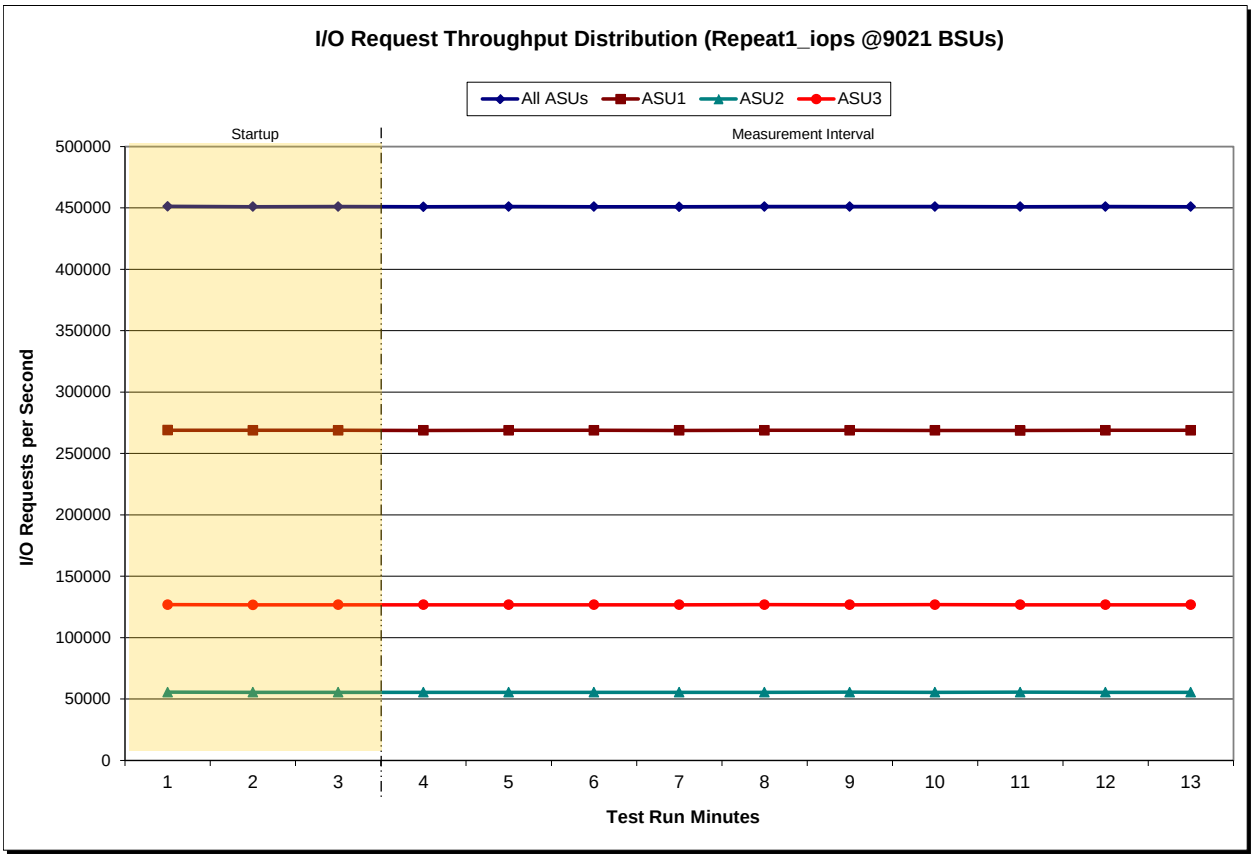
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

9,021 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:55:26	12:58:27	0-2	0:03:01
Measurement Interval	12:58:27	13:08:28	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	451,245.10	268,892.35	55,510.28	126,842.47
1	451,000.90	268,825.85	55,487.98	126,687.07
2	451,080.22	268,857.85	55,492.10	126,730.27
3	450,936.97	268,784.32	55,455.78	126,696.87
4	451,090.93	268,845.22	55,490.97	126,754.75
5	450,991.43	268,854.15	55,418.00	126,719.28
6	450,942.50	268,760.30	55,438.77	126,743.43
7	451,087.57	268,826.93	55,473.95	126,786.68
8	451,089.48	268,839.80	55,520.55	126,729.13
9	451,036.52	268,766.38	55,487.58	126,782.55
10	450,950.27	268,668.83	55,510.53	126,770.90
11	451,053.08	268,812.22	55,478.20	126,762.67
12	451,025.98	268,831.65	55,488.63	126,705.70
Average	***451,020.47***	***268,798.98***	***55,476.30***	***126,745.20***

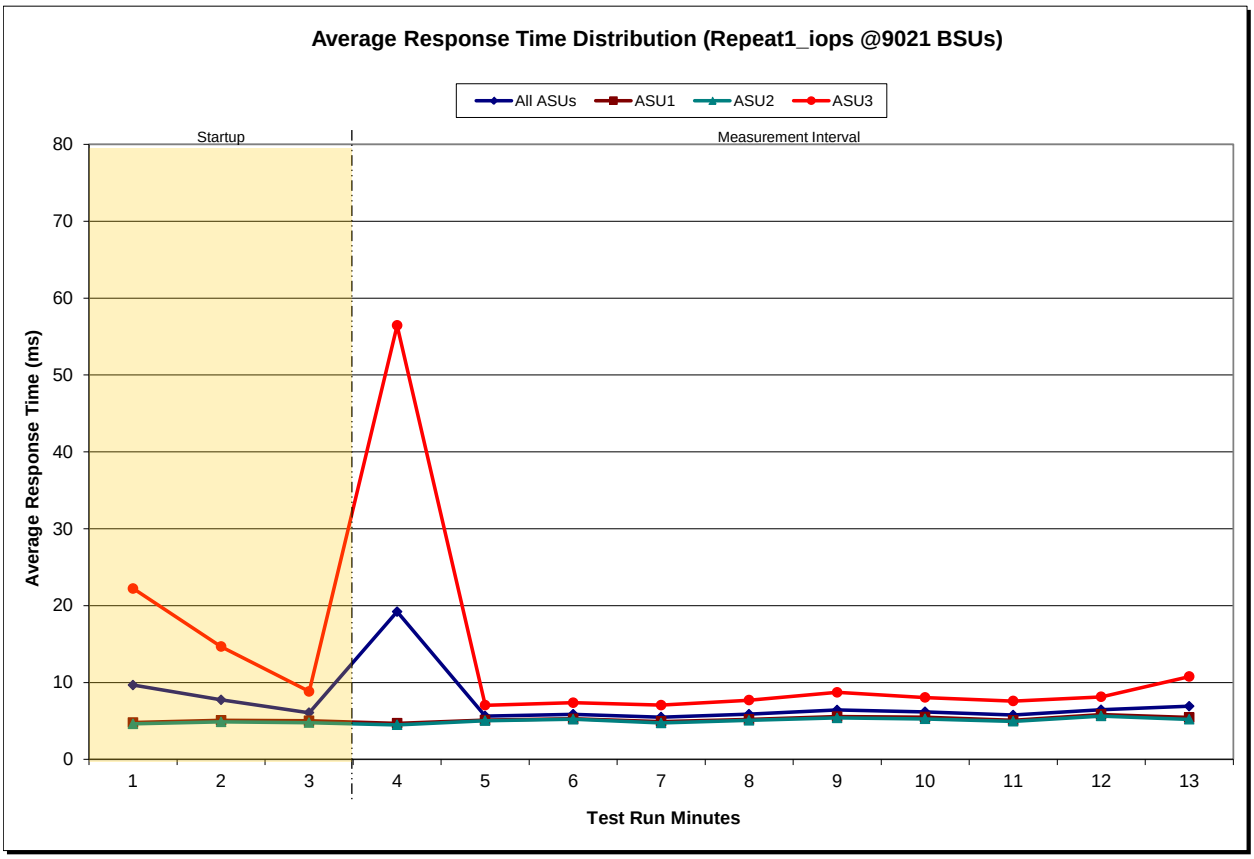
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

9,021 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	12:55:26	12:58:27	0-2	0:03:01
Measurement Interval	12:58:27	13:08:28	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	9.67	4.79	4.62	22.22
1	7.75	5.08	4.88	14.67
2	6.06	5.02	4.78	8.83
3	19.21	4.70	4.50	56.44
4	5.64	5.11	5.04	7.04
5	5.86	5.28	5.23	7.37
6	5.49	4.92	4.74	7.05
7	5.88	5.19	5.08	7.70
8	6.43	5.56	5.39	8.72
9	6.18	5.49	5.27	8.05
10	5.77	5.08	4.95	7.59
11	6.46	5.84	5.64	8.13
12	6.91	5.45	5.21	10.77
Average	***7.39***	***5.26***	***5.11***	***12.89***

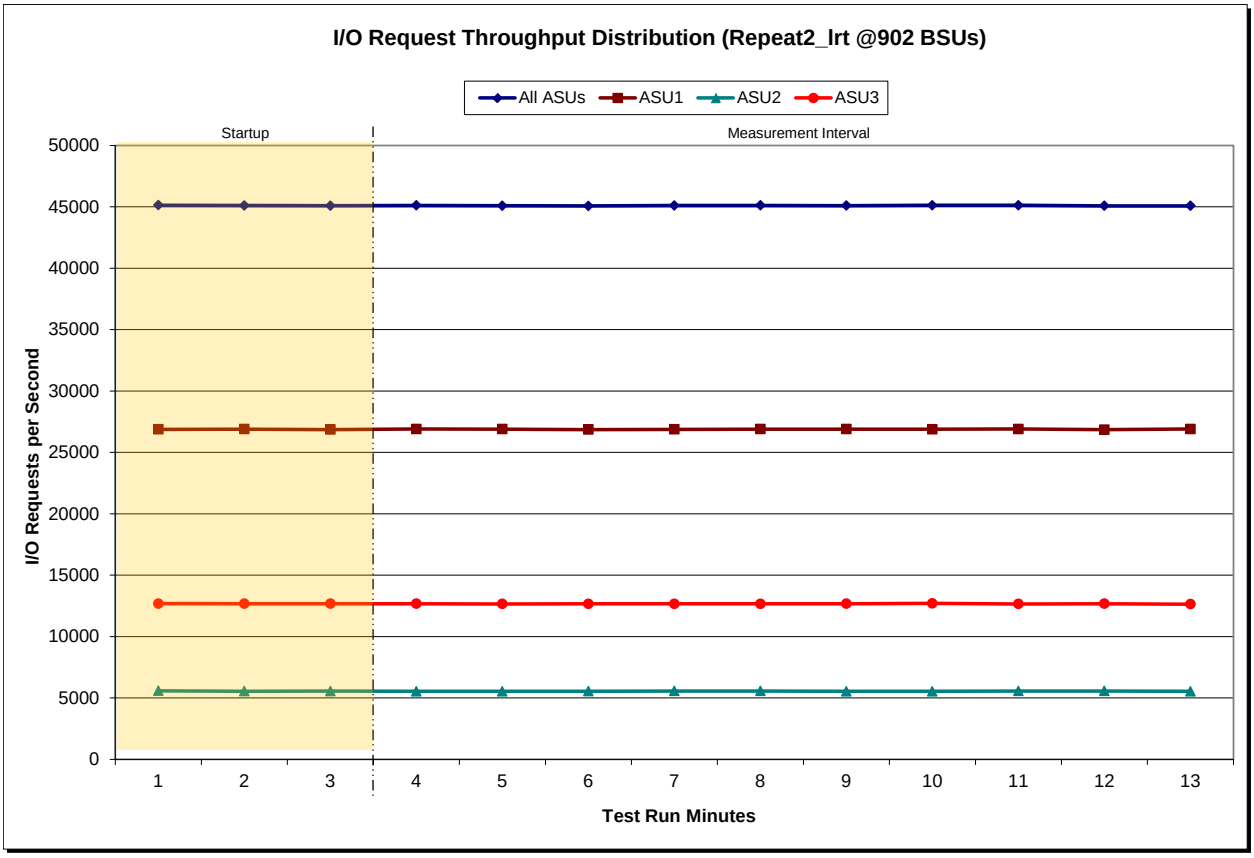
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

902 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:11:42	13:14:42	0-2	0:03:00
Measurement Interval	13:14:42	13:24:43	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	45,136.07	26,879.63	5,577.78	12,678.65
1	45,110.77	26,895.68	5,543.15	12,671.93
2	45,088.40	26,858.27	5,553.38	12,676.75
3	45,113.50	26,902.30	5,538.70	12,672.50
4	45,090.35	26,893.12	5,539.25	12,657.98
5	45,070.10	26,858.93	5,542.20	12,668.97
6	45,104.77	26,878.68	5,563.30	12,662.78
7	45,119.75	26,896.22	5,559.70	12,663.83
8	45,098.08	26,889.25	5,533.92	12,674.92
9	45,122.70	26,882.80	5,540.62	12,699.28
10	45,123.37	26,904.03	5,560.20	12,659.13
11	45,076.57	26,844.60	5,559.37	12,672.60
12	45,076.70	26,903.43	5,539.48	12,633.78
Average	***45,099.59***	***26,885.34***	***5,547.67***	***12,666.58***

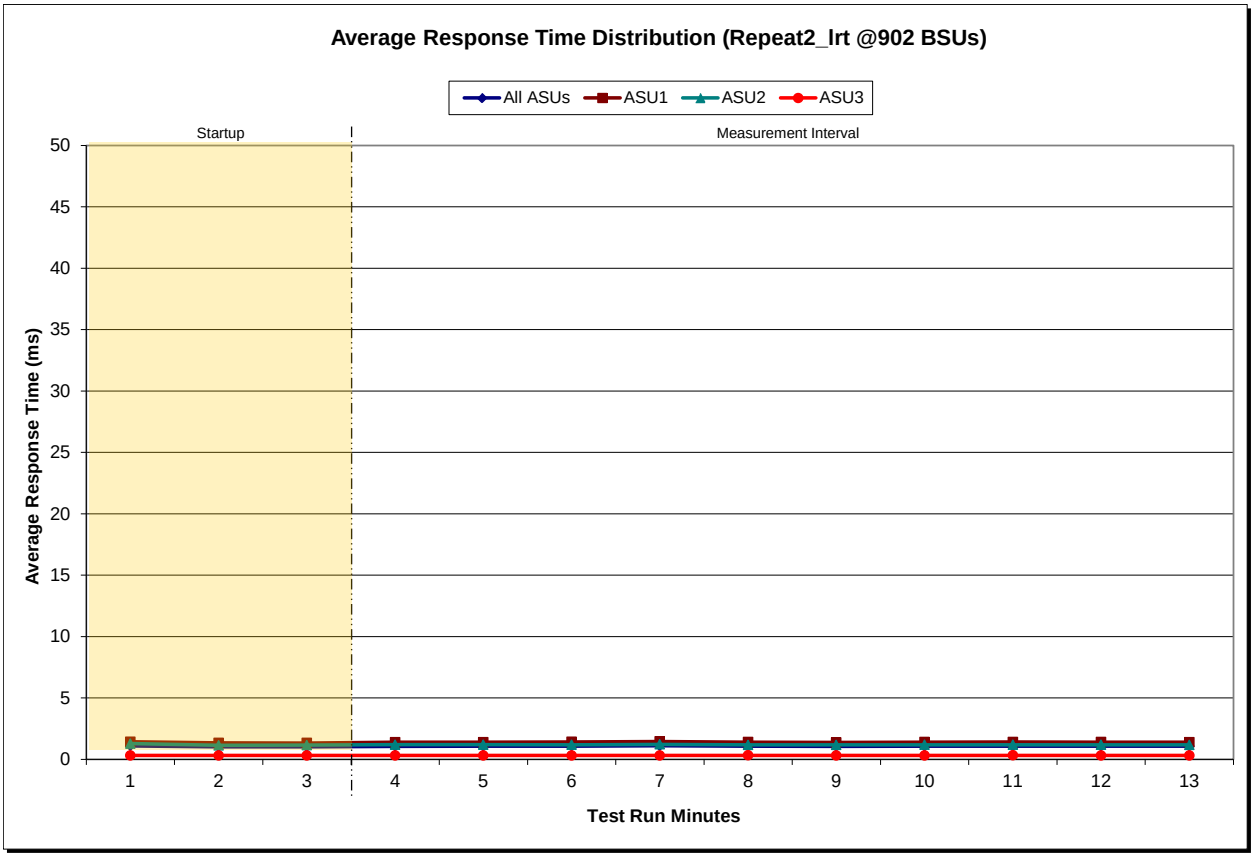
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

902 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:11:42	13:14:42	0-2	0:03:00
Measurement Interval	13:14:42	13:24:43	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.09	1.42	1.28	0.31
1	1.02	1.34	1.14	0.31
2	1.02	1.33	1.16	0.31
3	1.06	1.39	1.19	0.32
4	1.06	1.39	1.19	0.32
5	1.08	1.42	1.18	0.31
6	1.11	1.45	1.22	0.31
7	1.07	1.40	1.18	0.32
8	1.05	1.37	1.17	0.31
9	1.07	1.40	1.18	0.31
10	1.07	1.41	1.18	0.32
11	1.07	1.40	1.18	0.32
12	1.06	1.39	1.17	0.32
Average	***1.07***	***1.40***	***1.18***	***0.32***

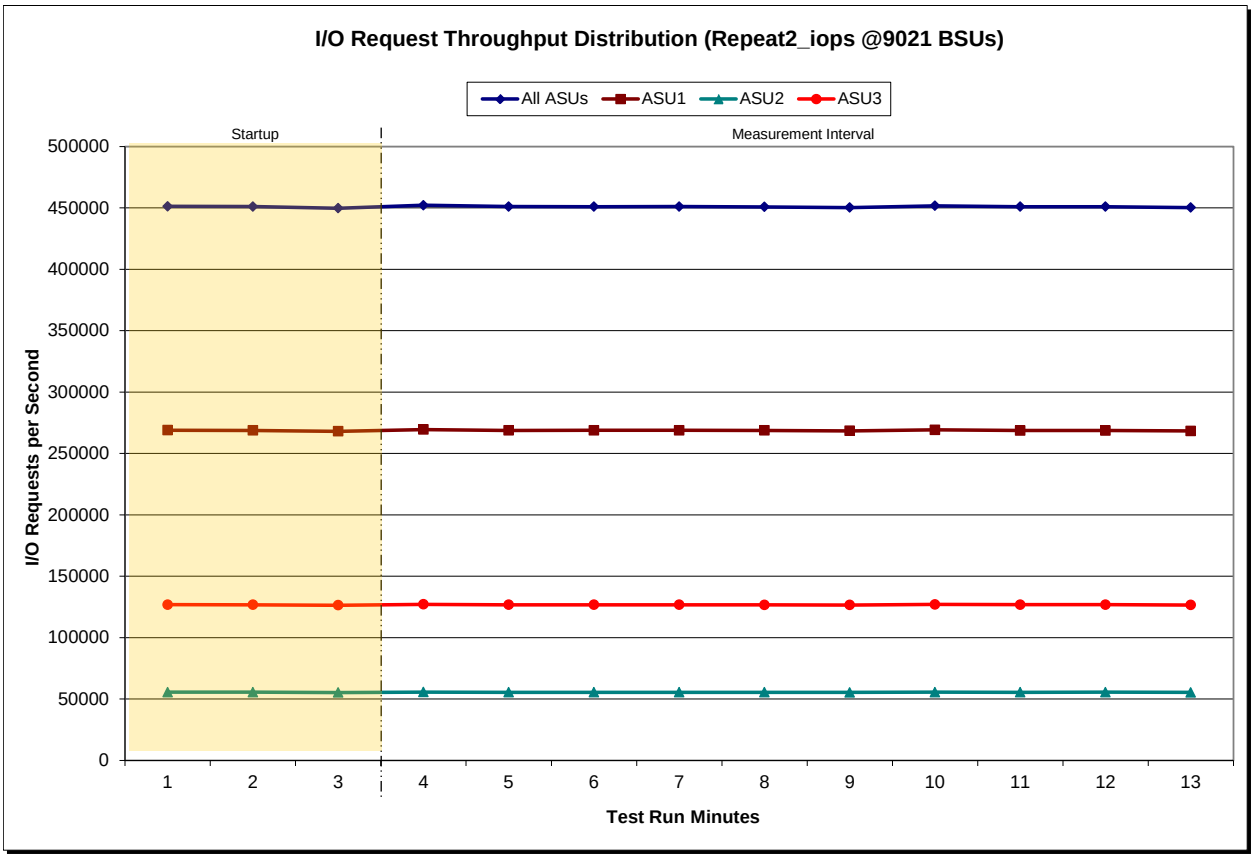
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

9,021 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:29:01	13:32:02	0-2	0:03:01
Measurement Interval	13:32:02	13:42:03	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	451,255.52	268,905.35	55,509.50	126,840.67
1	451,040.08	268,771.92	55,504.55	126,763.62
2	449,745.08	268,065.95	55,296.25	126,382.88
3	452,182.00	269,471.30	55,655.63	127,055.07
4	451,056.00	268,785.15	55,499.23	126,771.62
5	450,997.82	268,820.37	55,442.48	126,734.97
6	451,066.38	268,848.33	55,498.17	126,719.88
7	450,818.42	268,710.78	55,480.10	126,627.53
8	450,238.12	268,356.62	55,353.05	126,528.45
9	451,744.08	269,245.87	55,530.98	126,967.23
10	450,983.65	268,703.55	55,493.10	126,787.00
11	450,998.23	268,679.17	55,530.72	126,788.35
12	450,290.17	268,301.50	55,388.18	126,600.48
Average	***451,037.49***	***268,792.26***	***55,487.17***	***126,758.06***

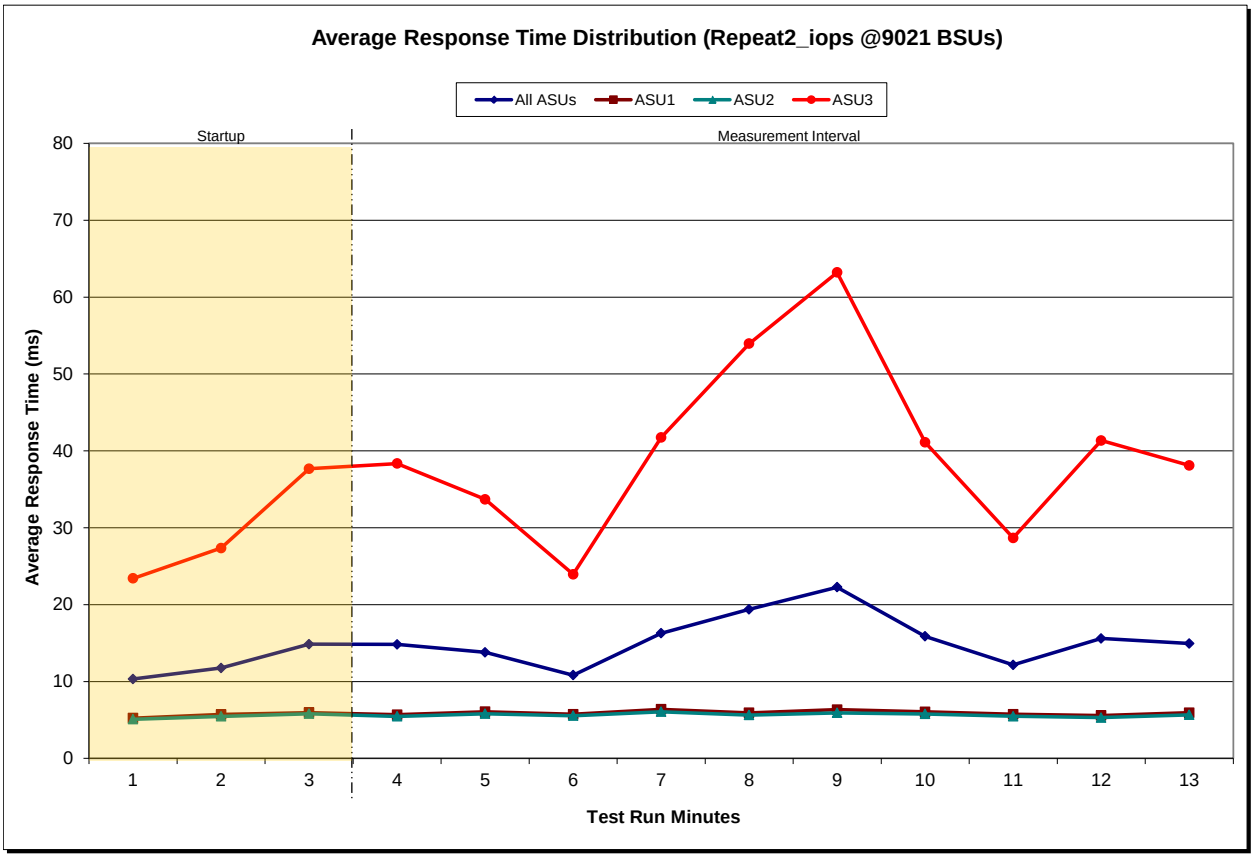
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

9,021 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:29:01	13:32:02	0-2	0:03:01
Measurement Interval	13:32:02	13:42:03	3-12	0:10:01
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	10.33	5.24	5.10	23.41
1	11.76	5.71	5.47	27.35
2	14.85	5.95	5.81	37.68
3	14.83	5.68	5.47	38.34
4	13.80	6.07	5.81	33.69
5	10.83	5.74	5.55	23.94
6	16.27	6.38	6.06	41.73
7	19.38	5.93	5.64	53.95
8	22.27	6.34	5.92	63.21
9	15.87	6.05	5.78	41.10
10	12.16	5.74	5.48	28.67
11	15.60	5.58	5.30	41.34
12	14.95	5.93	5.67	38.11
Average	***15.60***	***5.94***	***5.67***	***40.41***

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



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

Clause 3.4.3

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

Clauses 5.1.10 and 5.3.13.2

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

Clause 5.3.13.3

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2809	0.0701	0.2100	0.0180	0.0700	0.0350	0.2811
COV	0.004	0.001	0.003	0.001	0.004	0.002	0.002	0.001

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	0.2809	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.001	0.000	0.001	0.000	0.002	0.001	0.001	0.000

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

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	***0.0350***	***0.2810***	***0.0700***	***0.2100***	***0.0180***	***0.0700***	***0.0350***	***0.2810***
MIM	0.0350	0.2811	0.0700	0.2100	0.0180	0.0700	0.0350	0.2809
COV	0.004	0.001	0.001	0.001	0.004	0.002	0.003	0.001

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

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

Data Persistence Test

Clause 6

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

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

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

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

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

Clause 9.4.3.8

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

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in "Appendix E: SPC-1 Workload Generator Input Parameters" on Page 86.

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	2,727,400
Total Number of Logical Blocks Verified	2,658,331
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks	5 minutes
Size in bytes of each Logical Block	1024
Number of Failed I/O Requests in the process of the Test	0

If approved by the SPC Auditor, the SPC-2 Persistence Test may be used to meet the SPC-1 persistence requirements. Both the SPC-1 and SPC-2 Persistence Tests provide the same level of functionality and verification of data integrity. The SPC-2 Persistence Test may be easily configured to address an SPC-1 storage configuration. The SPC-2 Persistence Test extends the size of storage configurations that may be tested and significantly reduces the test duration of such configurations.

The SPC-2 Persistence Test was approved for use in this set of audited measurements.

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 IBM System Storage DS8870 as documented in this Full Disclosure Report will become available on October 19, 2012 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 be found in the Priced Storage Configuration Pricing section on page 14.

TESTED STORAGE CONFIGURATION (TSC) AND PRICED STORAGE CONFIGURATION DIFFERENCES

Clause 9.4.3.3.7

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

A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration may be found in the Executive Summary portion of this document on page 14.

ANOMALIES OR IRREGULARITIES

Clause 9.4.3.10

The FDR shall include a clear and complete description of any anomalies or irregularities encountered in the course of executing the SPC-1 benchmark that may in any way call into question the accuracy, verifiability, or authenticity of information published in this FDR.

There were no anomalies or irregularities encountered during the SPC-1 Remote Audit of the IBM System Storage DS8870.

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.

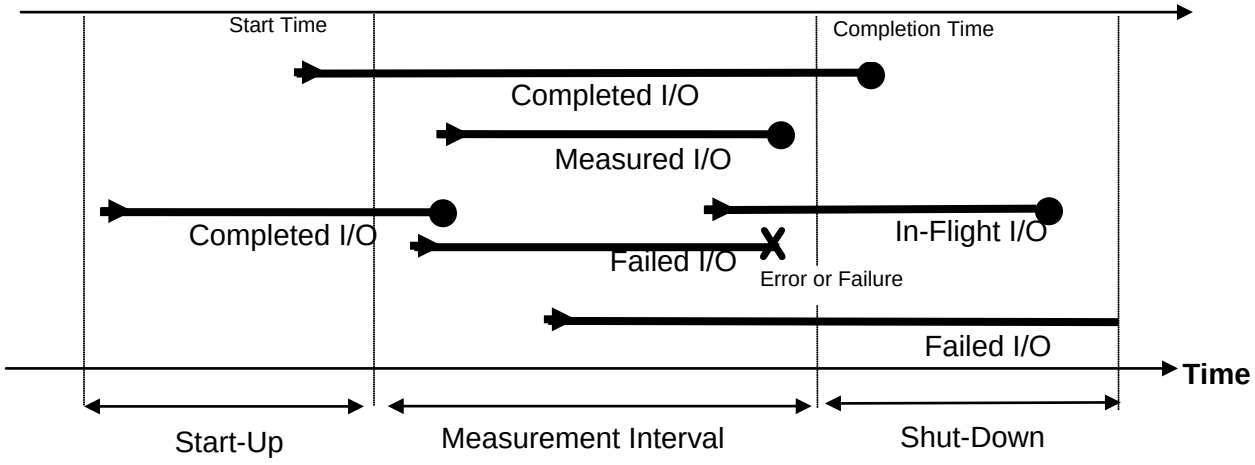
Test: A collection of Test Phases and or Test Runs sharing a common objective.

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

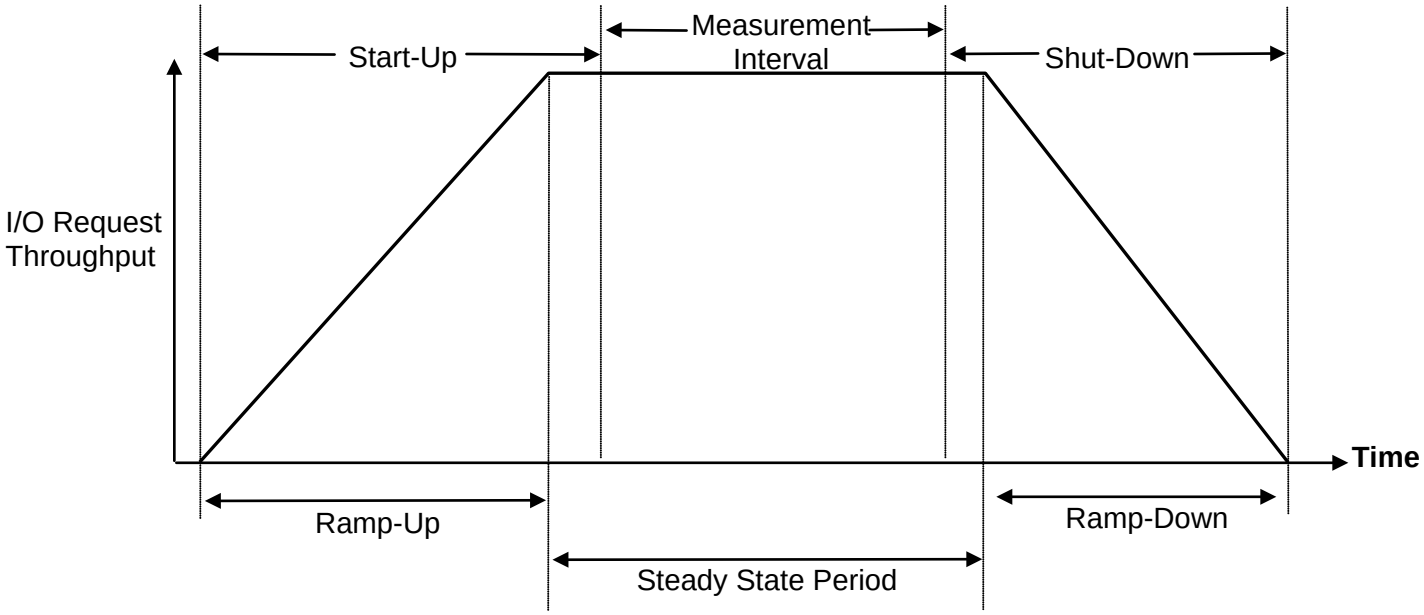
period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.

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

There were no customer tunable parameters or options changed from default values for the benchmark measurement.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

Each script referenced in the following sections appears in the Referenced Scripts section.

- The **step1_makearray.txt**, **step2_mkranks.txt**, **step3_makevols.txt** and **step4_define_paths.txt** scripts are scripts written in the DSCLI command language and executed on one of the Host Systems. DSCI was installed and configured to allow management of the DS8870.
- The **step5_discover.sh** script, listed below, is a shell script executed from an AIX command window on each of the four Host Systems.
- The **step6_create_lvs.sh** script is a Shell script executed from an AIX command window on one of the Host Systems.
- The **step7_importvg.sh** script is a Shell script executed from an AIX command window on each of the four Host Systems.

Create the RAID-10 ranks

The first script, **step1_makearray.txt**, groups the physical volumes into 192 RAID-10 arrays and the system automatically generates a set of array names, A0-A191. A predefined set of 8 physical disks is associated with each array in a specified "array site". Each "array site" is associated with a pair of Device Adapters (DA), as shown on page 17.

During the execution of the **step1_makearray.txt** script, two of the 8 disks are reserved as spares in the first two "array sites" of a DA pair, as also illustrated on page 17.

The **step1_makearray.txt** script configures all "array site" disks other than the spares into a RAID-10 array. Thus, the effect of the script is to produce a mixture of 3+3+2S and 4+4 arrays, for a total of 192 RAID-10 arrays.

The next script **step2_mkranks.txt**, defines the arrays, A0-A191, as 192 open system ranks, R0-R191 . As in the previous script, the rank names are assigned by the system. Step 2 also defines the ranks R0-R191 to comprise a set of 192 'extentpools" (pools of available storage) with the names P0-P191.

Create the LUNs

The **step3_makevols.txt** script defines 192 LUNs on the set of 192 RAID-10 ranks. Each LUN in the 3+3 arrays has a capacity of 353 GiB and each LUN in the 4+4 arrays has a capacity of 482GiB. All LUNs were used in the SPC-1 measurements. Each LUN is assigned to one of 8 volume groups, V1-V8, so that paths can be assigned by groups of volumes.

Define the LUN access path

The next step is to define the paths by which each LUN can be accessed by AIX. Four AIX Host Systems are used in this test; each Host System has 8 connections to the DS8870. The path definitions are created by the **step4_define_paths.txt** script. Each host WWPN (total of 32) is assigned to one of the eight volume groups, V1-V8.

Discover the LUNs and create multi-path "hdisks"

The **step5_discover.sh** script performs discovery on each of the 8 Host System paths on each Host System. In this configuration, AIX MPIO capability is utilized, creating one multi-path hdisk that corresponds to each LUN.

Create volume groups and striped logical volumes on the "hdisks"

The **step6_create_lvs.sh** script creates volume groups and striped logical volumes on the hdisks. The volume group "stripevg" contains all of the hdisks on 4+4 arrays while the "stripevg_3p3" volume group contains all of the hdisks on 3+3 arrays.

The "stripevg" volume group contains 71 logical volumes named "fat*" that are striped across all of the 4+4 arrays. The "stripevg_3p3" volume group contains 7 logical volumes named "3p3_*" that are striped across all of the 3+3 arrays. The SPC-1 Test Runs used just 66 of the "fat*" logical volumes and 5 of the "3p3*" logical volumes.

Import volume groups on all four Host Systems

The **step7_importvg.sh** script imports the volume groups as shared volume groups on all four Host Systems.

Referenced Scripts

step1_makearray.txt

```
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S19
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S20
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S21
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S22
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S23
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S24
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S25
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S26
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S27
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S28
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S29
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S30
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S31
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S32
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S33
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S34
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S35
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S132
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S133
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S134
```

```
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S135
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S136
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S137
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S138

mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S42
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S43
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S44
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S45
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S46
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S47
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S48
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S49
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S50
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S51
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S52
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S53
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S139
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S141
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S142
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S144
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S145
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S146
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S147
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S148
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S149
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S150

mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S1
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S2
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S3
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S4
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S5
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S6
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S7
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S8
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S9
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S10
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S155
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S156

mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S36
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S38
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S41
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S54
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S55
```

```
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S57
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S60
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S61
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S159
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S160
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S161
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S162

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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S86
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S88
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S89
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S90
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S91
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S92
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S93
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S94
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S95
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S96
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S98
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S101
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S165
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S166
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S167
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S168

mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S120
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S121
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S122
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S123
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S126
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S127
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S128
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S129
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S130
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S131
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S169
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S170
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S171
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S172
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S175
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S176
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S177
```

```
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S179
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S180

mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S66
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S67
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S68
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S69
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S70
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S71
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S72
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S73
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S74
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S75
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S76
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S77
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S78
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S79
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S80
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S81
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S82
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S83
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S181
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S182
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S183
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S184
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S185
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S186

mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S102
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S103
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S104
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S106
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S107
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S108
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mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S110
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S111
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S112
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S113
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S114
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S115
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S116
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S117
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S118
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S119
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S187
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S188
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S189
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S190
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S191
mkarray -dev IBM.2107-75RA321 -raidtype 10 -arsite S192
```

step2_makeranks.txt

```
mkrank -dev IBM.2107-75RA321 -array A0 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A1 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A2 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A3 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A4 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A5 -stgtype fb
```

```
mkrank -dev IBM.2107-75RA321 -array A6 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A7 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A8 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A9 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A10 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A11 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A12 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A13 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A14 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A15 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A16 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A17 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A18 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A19 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A20 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A21 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A22 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A23 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A24 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A26 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A27 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A28 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A29 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A40 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A41 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A67 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A68 -stgtype fb
```

```
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mkrank -dev IBM.2107-75RA321 -array A70 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A71 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A73 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A77 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A102 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A103 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A109 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A128 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A129 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A130 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A131 -stgtype fb
```

```
mkrank -dev IBM.2107-75RA321 -array A132 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A133 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A135 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A180 -stgtype fb
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mkrank -dev IBM.2107-75RA321 -array A183 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A184 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A185 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A186 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A187 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A188 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A189 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A190 -stgtype fb
mkrank -dev IBM.2107-75RA321 -array A191 -stgtype fb
```

step3_makevols.txt

```
mkfbvol -dev IBM.2107-75RA321 -extpool P0  -type ds -cap 353 -name da0r0_#h  1000
mkfbvol -dev IBM.2107-75RA321 -extpool P2  -type ds -cap 482 -name da0r2_#h  1001
mkfbvol -dev IBM.2107-75RA321 -extpool P4  -type ds -cap 482 -name da0r4_#h  1002
mkfbvol -dev IBM.2107-75RA321 -extpool P6  -type ds -cap 482 -name da0r6_#h  1003
mkfbvol -dev IBM.2107-75RA321 -extpool P8  -type ds -cap 482 -name da0r8_#h  1004
mkfbvol -dev IBM.2107-75RA321 -extpool P10 -type ds -cap 482 -name da0r10_#h 1005
mkfbvol -dev IBM.2107-75RA321 -extpool P12 -type ds -cap 482 -name da0r12_#h 1006
mkfbvol -dev IBM.2107-75RA321 -extpool P14 -type ds -cap 482 -name da0r14_#h 1007
mkfbvol -dev IBM.2107-75RA321 -extpool P16 -type ds -cap 482 -name da0r16_#h 1008
mkfbvol -dev IBM.2107-75RA321 -extpool P18 -type ds -cap 482 -name da0r18_#h 1009
mkfbvol -dev IBM.2107-75RA321 -extpool P20 -type ds -cap 482 -name da0r20_#h 1010
mkfbvol -dev IBM.2107-75RA321 -extpool P22 -type ds -cap 482 -name da0r22_#h 1011
mkfbvol -dev IBM.2107-75RA321 -extpool P1  -type ds -cap 353 -name da0r1_#h  1100
mkfbvol -dev IBM.2107-75RA321 -extpool P3  -type ds -cap 482 -name da0r3_#h  1101
mkfbvol -dev IBM.2107-75RA321 -extpool P5  -type ds -cap 482 -name da0r5_#h  1102
mkfbvol -dev IBM.2107-75RA321 -extpool P7  -type ds -cap 482 -name da0r7_#h  1103
mkfbvol -dev IBM.2107-75RA321 -extpool P9  -type ds -cap 482 -name da0r9_#h  1104
mkfbvol -dev IBM.2107-75RA321 -extpool P11 -type ds -cap 482 -name da0r11_#h 1105
mkfbvol -dev IBM.2107-75RA321 -extpool P13 -type ds -cap 482 -name da0r13_#h 1106
mkfbvol -dev IBM.2107-75RA321 -extpool P15 -type ds -cap 482 -name da0r15_#h 1107
mkfbvol -dev IBM.2107-75RA321 -extpool P17 -type ds -cap 482 -name da0r17_#h 1108
mkfbvol -dev IBM.2107-75RA321 -extpool P19 -type ds -cap 482 -name da0r19_#h 1109
mkfbvol -dev IBM.2107-75RA321 -extpool P21 -type ds -cap 482 -name da0r21_#h 1110
mkfbvol -dev IBM.2107-75RA321 -extpool P23 -type ds -cap 482 -name da0r23_#h 1111

mkfbvol -dev IBM.2107-75RA321 -extpool P24 -type ds -cap 353 -name da1r0_#h  1200
mkfbvol -dev IBM.2107-75RA321 -extpool P26 -type ds -cap 482 -name da1r2_#h  1201
mkfbvol -dev IBM.2107-75RA321 -extpool P28 -type ds -cap 482 -name da1r4_#h  1202
mkfbvol -dev IBM.2107-75RA321 -extpool P30 -type ds -cap 482 -name da1r6_#h  1203
mkfbvol -dev IBM.2107-75RA321 -extpool P32 -type ds -cap 482 -name da1r8_#h  1204
mkfbvol -dev IBM.2107-75RA321 -extpool P34 -type ds -cap 482 -name da1r10_#h 1205
mkfbvol -dev IBM.2107-75RA321 -extpool P36 -type ds -cap 482 -name da1r12_#h 1206
mkfbvol -dev IBM.2107-75RA321 -extpool P38 -type ds -cap 482 -name da1r14_#h 1207
mkfbvol -dev IBM.2107-75RA321 -extpool P40 -type ds -cap 482 -name da1r16_#h 1208
mkfbvol -dev IBM.2107-75RA321 -extpool P42 -type ds -cap 482 -name da1r18_#h 1209
mkfbvol -dev IBM.2107-75RA321 -extpool P44 -type ds -cap 482 -name da1r20_#h 1210
mkfbvol -dev IBM.2107-75RA321 -extpool P46 -type ds -cap 482 -name da1r22_#h 1211
mkfbvol -dev IBM.2107-75RA321 -extpool P25 -type ds -cap 353 -name da1r1_#h  1300
mkfbvol -dev IBM.2107-75RA321 -extpool P27 -type ds -cap 482 -name da1r3_#h  1301
mkfbvol -dev IBM.2107-75RA321 -extpool P29 -type ds -cap 482 -name da1r5_#h  1302
mkfbvol -dev IBM.2107-75RA321 -extpool P31 -type ds -cap 482 -name da1r7_#h  1303
mkfbvol -dev IBM.2107-75RA321 -extpool P33 -type ds -cap 482 -name da1r9_#h  1304
mkfbvol -dev IBM.2107-75RA321 -extpool P35 -type ds -cap 482 -name da1r11_#h 1305
mkfbvol -dev IBM.2107-75RA321 -extpool P37 -type ds -cap 482 -name da1r13_#h 1306
mkfbvol -dev IBM.2107-75RA321 -extpool P39 -type ds -cap 482 -name da1r15_#h 1307
mkfbvol -dev IBM.2107-75RA321 -extpool P41 -type ds -cap 482 -name da1r17_#h 1308
mkfbvol -dev IBM.2107-75RA321 -extpool P43 -type ds -cap 482 -name da1r19_#h 1309
mkfbvol -dev IBM.2107-75RA321 -extpool P45 -type ds -cap 482 -name da1r21_#h 1310
mkfbvol -dev IBM.2107-75RA321 -extpool P47 -type ds -cap 482 -name da1r23_#h 1311

mkfbvol -dev IBM.2107-75RA321 -extpool P48 -type ds -cap 353 -name da2r0_#h  1400
mkfbvol -dev IBM.2107-75RA321 -extpool P50 -type ds -cap 482 -name da2r2_#h  1401
mkfbvol -dev IBM.2107-75RA321 -extpool P52 -type ds -cap 482 -name da2r4_#h  1402
mkfbvol -dev IBM.2107-75RA321 -extpool P54 -type ds -cap 482 -name da2r6_#h  1403
mkfbvol -dev IBM.2107-75RA321 -extpool P56 -type ds -cap 482 -name da2r8_#h  1404
mkfbvol -dev IBM.2107-75RA321 -extpool P58 -type ds -cap 482 -name da2r10_#h 1405
mkfbvol -dev IBM.2107-75RA321 -extpool P60 -type ds -cap 482 -name da2r12_#h 1406
mkfbvol -dev IBM.2107-75RA321 -extpool P62 -type ds -cap 482 -name da2r14_#h 1407
mkfbvol -dev IBM.2107-75RA321 -extpool P64 -type ds -cap 482 -name da2r16_#h 1408
mkfbvol -dev IBM.2107-75RA321 -extpool P66 -type ds -cap 482 -name da2r18_#h 1409
mkfbvol -dev IBM.2107-75RA321 -extpool P68 -type ds -cap 482 -name da2r20_#h 1410
```

```
mkfbvol -dev IBM.2107-75RA321 -extpool P70 -type ds -cap 482 -name da2r22_#h 1411
mkfbvol -dev IBM.2107-75RA321 -extpool P49 -type ds -cap 353 -name da2r1_#h  1500
mkfbvol -dev IBM.2107-75RA321 -extpool P51 -type ds -cap 482 -name da2r3_#h  1501
mkfbvol -dev IBM.2107-75RA321 -extpool P53 -type ds -cap 482 -name da2r5_#h  1502
mkfbvol -dev IBM.2107-75RA321 -extpool P55 -type ds -cap 482 -name da2r7_#h  1503
mkfbvol -dev IBM.2107-75RA321 -extpool P57 -type ds -cap 482 -name da2r9_#h  1504
mkfbvol -dev IBM.2107-75RA321 -extpool P59 -type ds -cap 482 -name da2r11_#h 1505
mkfbvol -dev IBM.2107-75RA321 -extpool P61 -type ds -cap 482 -name da2r13_#h 1506
mkfbvol -dev IBM.2107-75RA321 -extpool P63 -type ds -cap 482 -name da2r15_#h 1507
mkfbvol -dev IBM.2107-75RA321 -extpool P65 -type ds -cap 482 -name da2r17_#h 1508
mkfbvol -dev IBM.2107-75RA321 -extpool P67 -type ds -cap 482 -name da2r19_#h 1509
mkfbvol -dev IBM.2107-75RA321 -extpool P69 -type ds -cap 482 -name da2r21_#h 1510
mkfbvol -dev IBM.2107-75RA321 -extpool P71 -type ds -cap 482 -name da2r23_#h 1511

mkfbvol -dev IBM.2107-75RA321 -extpool P72 -type ds -cap 353 -name da3r0_#h  1600
mkfbvol -dev IBM.2107-75RA321 -extpool P74 -type ds -cap 482 -name da3r2_#h  1601
mkfbvol -dev IBM.2107-75RA321 -extpool P76 -type ds -cap 482 -name da3r4_#h  1602
mkfbvol -dev IBM.2107-75RA321 -extpool P78 -type ds -cap 482 -name da3r6_#h  1603
mkfbvol -dev IBM.2107-75RA321 -extpool P80 -type ds -cap 482 -name da3r8_#h  1604
mkfbvol -dev IBM.2107-75RA321 -extpool P82 -type ds -cap 482 -name da3r10_#h 1605
mkfbvol -dev IBM.2107-75RA321 -extpool P84 -type ds -cap 482 -name da3r12_#h 1606
mkfbvol -dev IBM.2107-75RA321 -extpool P86 -type ds -cap 482 -name da3r14_#h 1607
mkfbvol -dev IBM.2107-75RA321 -extpool P88 -type ds -cap 482 -name da3r16_#h 1608
mkfbvol -dev IBM.2107-75RA321 -extpool P90 -type ds -cap 482 -name da3r18_#h 1609
mkfbvol -dev IBM.2107-75RA321 -extpool P92 -type ds -cap 482 -name da3r20_#h 1610
mkfbvol -dev IBM.2107-75RA321 -extpool P94 -type ds -cap 482 -name da3r22_#h 1611
mkfbvol -dev IBM.2107-75RA321 -extpool P73 -type ds -cap 353 -name da3r1_#h  1700
mkfbvol -dev IBM.2107-75RA321 -extpool P75 -type ds -cap 482 -name da3r3_#h  1701
mkfbvol -dev IBM.2107-75RA321 -extpool P77 -type ds -cap 482 -name da3r5_#h  1702
mkfbvol -dev IBM.2107-75RA321 -extpool P79 -type ds -cap 482 -name da3r7_#h  1703
mkfbvol -dev IBM.2107-75RA321 -extpool P81 -type ds -cap 482 -name da3r9_#h  1704
mkfbvol -dev IBM.2107-75RA321 -extpool P83 -type ds -cap 482 -name da3r11_#h 1705
mkfbvol -dev IBM.2107-75RA321 -extpool P85 -type ds -cap 482 -name da3r13_#h 1706
mkfbvol -dev IBM.2107-75RA321 -extpool P87 -type ds -cap 482 -name da3r15_#h 1707
mkfbvol -dev IBM.2107-75RA321 -extpool P89 -type ds -cap 482 -name da3r17_#h 1708
mkfbvol -dev IBM.2107-75RA321 -extpool P91 -type ds -cap 482 -name da3r19_#h 1709
mkfbvol -dev IBM.2107-75RA321 -extpool P93 -type ds -cap 482 -name da3r21_#h 1710
mkfbvol -dev IBM.2107-75RA321 -extpool P95 -type ds -cap 482 -name da3r23_#h 1711

mkfbvol -dev IBM.2107-75RA321 -extpool P96 -type ds -cap 353 -name da4r0_#h  1800
mkfbvol -dev IBM.2107-75RA321 -extpool P98 -type ds -cap 482 -name da4r2_#h  1801
mkfbvol -dev IBM.2107-75RA321 -extpool P100 -type ds -cap 482 -name da4r4_#h  1802
mkfbvol -dev IBM.2107-75RA321 -extpool P102 -type ds -cap 482 -name da4r6_#h  1803
mkfbvol -dev IBM.2107-75RA321 -extpool P104 -type ds -cap 482 -name da4r8_#h  1804
mkfbvol -dev IBM.2107-75RA321 -extpool P106 -type ds -cap 482 -name da4r10_#h 1805
mkfbvol -dev IBM.2107-75RA321 -extpool P108 -type ds -cap 482 -name da4r12_#h 1806
mkfbvol -dev IBM.2107-75RA321 -extpool P110 -type ds -cap 482 -name da4r14_#h 1807
mkfbvol -dev IBM.2107-75RA321 -extpool P112 -type ds -cap 482 -name da4r16_#h 1808
mkfbvol -dev IBM.2107-75RA321 -extpool P114 -type ds -cap 482 -name da4r18_#h 1809
mkfbvol -dev IBM.2107-75RA321 -extpool P116 -type ds -cap 482 -name da4r20_#h 1810
mkfbvol -dev IBM.2107-75RA321 -extpool P118 -type ds -cap 482 -name da4r22_#h 1811
mkfbvol -dev IBM.2107-75RA321 -extpool P97 -type ds -cap 353 -name da4r1_#h  1900
mkfbvol -dev IBM.2107-75RA321 -extpool P99 -type ds -cap 482 -name da4r3_#h  1901
mkfbvol -dev IBM.2107-75RA321 -extpool P101 -type ds -cap 482 -name da4r5_#h  1902
mkfbvol -dev IBM.2107-75RA321 -extpool P103 -type ds -cap 482 -name da4r7_#h  1903
mkfbvol -dev IBM.2107-75RA321 -extpool P105 -type ds -cap 482 -name da4r9_#h  1904
mkfbvol -dev IBM.2107-75RA321 -extpool P107 -type ds -cap 482 -name da4r11_#h 1905
mkfbvol -dev IBM.2107-75RA321 -extpool P109 -type ds -cap 482 -name da4r13_#h 1906
mkfbvol -dev IBM.2107-75RA321 -extpool P111 -type ds -cap 482 -name da4r15_#h 1907
mkfbvol -dev IBM.2107-75RA321 -extpool P113 -type ds -cap 482 -name da4r17_#h 1908
mkfbvol -dev IBM.2107-75RA321 -extpool P115 -type ds -cap 482 -name da4r19_#h 1909
mkfbvol -dev IBM.2107-75RA321 -extpool P117 -type ds -cap 482 -name da4r21_#h 1910
mkfbvol -dev IBM.2107-75RA321 -extpool P119 -type ds -cap 482 -name da4r23_#h 1911
```

```
mkfbvol -dev IBM.2107-75RA321 -extpool P120 -type ds -cap 353 -name da5r0_#h  1A00
mkfbvol -dev IBM.2107-75RA321 -extpool P122 -type ds -cap 482 -name da5r2_#h  1A01
mkfbvol -dev IBM.2107-75RA321 -extpool P124 -type ds -cap 482 -name da5r4_#h  1A02
mkfbvol -dev IBM.2107-75RA321 -extpool P126 -type ds -cap 482 -name da5r6_#h  1A03
mkfbvol -dev IBM.2107-75RA321 -extpool P128 -type ds -cap 482 -name da5r8_#h  1A04
mkfbvol -dev IBM.2107-75RA321 -extpool P130 -type ds -cap 482 -name da5r10_#h 1A05
mkfbvol -dev IBM.2107-75RA321 -extpool P132 -type ds -cap 482 -name da5r12_#h 1A06
mkfbvol -dev IBM.2107-75RA321 -extpool P134 -type ds -cap 482 -name da5r14_#h 1A07
mkfbvol -dev IBM.2107-75RA321 -extpool P136 -type ds -cap 482 -name da5r16_#h 1A08
mkfbvol -dev IBM.2107-75RA321 -extpool P138 -type ds -cap 482 -name da5r18_#h 1A09
mkfbvol -dev IBM.2107-75RA321 -extpool P140 -type ds -cap 482 -name da5r20_#h 1A10
mkfbvol -dev IBM.2107-75RA321 -extpool P142 -type ds -cap 482 -name da5r22_#h 1A11
mkfbvol -dev IBM.2107-75RA321 -extpool P121 -type ds -cap 353 -name da5r1_#h  1B00
mkfbvol -dev IBM.2107-75RA321 -extpool P123 -type ds -cap 482 -name da5r3_#h  1B01
mkfbvol -dev IBM.2107-75RA321 -extpool P125 -type ds -cap 482 -name da5r5_#h  1B02
mkfbvol -dev IBM.2107-75RA321 -extpool P127 -type ds -cap 482 -name da5r7_#h  1B03
mkfbvol -dev IBM.2107-75RA321 -extpool P129 -type ds -cap 482 -name da5r9_#h  1B04
mkfbvol -dev IBM.2107-75RA321 -extpool P131 -type ds -cap 482 -name da5r11_#h 1B05
mkfbvol -dev IBM.2107-75RA321 -extpool P133 -type ds -cap 482 -name da5r13_#h 1B06
mkfbvol -dev IBM.2107-75RA321 -extpool P135 -type ds -cap 482 -name da5r15_#h 1B07
mkfbvol -dev IBM.2107-75RA321 -extpool P137 -type ds -cap 482 -name da5r17_#h 1B08
mkfbvol -dev IBM.2107-75RA321 -extpool P139 -type ds -cap 482 -name da5r19_#h 1B09
mkfbvol -dev IBM.2107-75RA321 -extpool P141 -type ds -cap 482 -name da5r21_#h 1B10
mkfbvol -dev IBM.2107-75RA321 -extpool P143 -type ds -cap 482 -name da5r23_#h 1B11

mkfbvol -dev IBM.2107-75RA321 -extpool P144 -type ds -cap 353 -name da6r0_#h  1C00
mkfbvol -dev IBM.2107-75RA321 -extpool P146 -type ds -cap 482 -name da6r2_#h  1C01
mkfbvol -dev IBM.2107-75RA321 -extpool P148 -type ds -cap 482 -name da6r4_#h  1C02
mkfbvol -dev IBM.2107-75RA321 -extpool P150 -type ds -cap 482 -name da6r6_#h  1C03
mkfbvol -dev IBM.2107-75RA321 -extpool P152 -type ds -cap 482 -name da6r8_#h  1C04
mkfbvol -dev IBM.2107-75RA321 -extpool P154 -type ds -cap 482 -name da6r10_#h 1C05
mkfbvol -dev IBM.2107-75RA321 -extpool P156 -type ds -cap 482 -name da6r12_#h 1C06
mkfbvol -dev IBM.2107-75RA321 -extpool P158 -type ds -cap 482 -name da6r14_#h 1C07
mkfbvol -dev IBM.2107-75RA321 -extpool P160 -type ds -cap 482 -name da6r16_#h 1C08
mkfbvol -dev IBM.2107-75RA321 -extpool P162 -type ds -cap 482 -name da6r18_#h 1C09
mkfbvol -dev IBM.2107-75RA321 -extpool P164 -type ds -cap 482 -name da6r20_#h 1C10
mkfbvol -dev IBM.2107-75RA321 -extpool P166 -type ds -cap 482 -name da6r22_#h 1C11
mkfbvol -dev IBM.2107-75RA321 -extpool P145 -type ds -cap 353 -name da6r1_#h  1D00
mkfbvol -dev IBM.2107-75RA321 -extpool P147 -type ds -cap 482 -name da6r3_#h  1D01
mkfbvol -dev IBM.2107-75RA321 -extpool P149 -type ds -cap 482 -name da6r5_#h  1D02
mkfbvol -dev IBM.2107-75RA321 -extpool P151 -type ds -cap 482 -name da6r7_#h  1D03
mkfbvol -dev IBM.2107-75RA321 -extpool P153 -type ds -cap 482 -name da6r9_#h  1D04
mkfbvol -dev IBM.2107-75RA321 -extpool P155 -type ds -cap 482 -name da6r11_#h 1D05
mkfbvol -dev IBM.2107-75RA321 -extpool P157 -type ds -cap 482 -name da6r13_#h 1D06
mkfbvol -dev IBM.2107-75RA321 -extpool P159 -type ds -cap 482 -name da6r15_#h 1D07
mkfbvol -dev IBM.2107-75RA321 -extpool P161 -type ds -cap 482 -name da6r17_#h 1D08
mkfbvol -dev IBM.2107-75RA321 -extpool P163 -type ds -cap 482 -name da6r19_#h 1D09
mkfbvol -dev IBM.2107-75RA321 -extpool P165 -type ds -cap 482 -name da6r21_#h 1D10
mkfbvol -dev IBM.2107-75RA321 -extpool P167 -type ds -cap 482 -name da6r23_#h 1D11

mkfbvol -dev IBM.2107-75RA321 -extpool P168 -type ds -cap 353 -name da7r0_#h  1E00
mkfbvol -dev IBM.2107-75RA321 -extpool P170 -type ds -cap 482 -name da7r2_#h  1E01
mkfbvol -dev IBM.2107-75RA321 -extpool P172 -type ds -cap 482 -name da7r4_#h  1E02
mkfbvol -dev IBM.2107-75RA321 -extpool P174 -type ds -cap 482 -name da7r6_#h  1E03
mkfbvol -dev IBM.2107-75RA321 -extpool P176 -type ds -cap 482 -name da7r8_#h  1E04
mkfbvol -dev IBM.2107-75RA321 -extpool P178 -type ds -cap 482 -name da7r10_#h 1E05
mkfbvol -dev IBM.2107-75RA321 -extpool P180 -type ds -cap 482 -name da7r12_#h 1E06
mkfbvol -dev IBM.2107-75RA321 -extpool P182 -type ds -cap 482 -name da7r14_#h 1E07
mkfbvol -dev IBM.2107-75RA321 -extpool P184 -type ds -cap 482 -name da7r16_#h 1E08
mkfbvol -dev IBM.2107-75RA321 -extpool P186 -type ds -cap 482 -name da7r18_#h 1E09
mkfbvol -dev IBM.2107-75RA321 -extpool P188 -type ds -cap 482 -name da7r20_#h 1E10
mkfbvol -dev IBM.2107-75RA321 -extpool P190 -type ds -cap 482 -name da7r22_#h 1E11
```

```
mkfbvol -dev IBM.2107-75RA321 -extpool P169 -type ds -cap 353 -name da7r1_#h  1F00
mkfbvol -dev IBM.2107-75RA321 -extpool P171 -type ds -cap 482 -name da7r3_#h  1F01
mkfbvol -dev IBM.2107-75RA321 -extpool P173 -type ds -cap 482 -name da7r5_#h  1F02
mkfbvol -dev IBM.2107-75RA321 -extpool P175 -type ds -cap 482 -name da7r7_#h  1F03
mkfbvol -dev IBM.2107-75RA321 -extpool P177 -type ds -cap 482 -name da7r9_#h  1F04
mkfbvol -dev IBM.2107-75RA321 -extpool P179 -type ds -cap 482 -name da7r11_#h 1F05
mkfbvol -dev IBM.2107-75RA321 -extpool P181 -type ds -cap 482 -name da7r13_#h 1F06
mkfbvol -dev IBM.2107-75RA321 -extpool P183 -type ds -cap 482 -name da7r15_#h 1F07
mkfbvol -dev IBM.2107-75RA321 -extpool P185 -type ds -cap 482 -name da7r17_#h 1F08
mkfbvol -dev IBM.2107-75RA321 -extpool P187 -type ds -cap 482 -name da7r19_#h 1F09
mkfbvol -dev IBM.2107-75RA321 -extpool P189 -type ds -cap 482 -name da7r21_#h 1F10
mkfbvol -dev IBM.2107-75RA321 -extpool P191 -type ds -cap 482 -name da7r23_#h 1F11

mkvolgrp -dev IBM.2107-75RA321 -hosttype pSeries -volume 1000-1009,1010,1011,1300-
1309,1310,1311 bay_0_volumes
mkvolgrp -dev IBM.2107-75RA321 -hosttype pSeries -volume 1100-1109,1110,1111,1200-
1209,1210,1211 bay_1_volumes
mkvolgrp -dev IBM.2107-75RA321 -hosttype pSeries -volume 1400-1409,1410,1411,1700-
1709,1710,1711 bay_2_volumes
mkvolgrp -dev IBM.2107-75RA321 -hosttype pSeries -volume 1500-1509,1510,1511,1600-
1609,1610,1611 bay_3_volumes
mkvolgrp -dev IBM.2107-75RA321 -hosttype pSeries -volume 1800-1809,1810,1811,1B00-
1B09,1B10,1B11 bay_4_volumes
mkvolgrp -dev IBM.2107-75RA321 -hosttype pSeries -volume 1900-1909,1910,1911,1A00-
1A09,1A10,1A11 bay_5_volumes
mkvolgrp -dev IBM.2107-75RA321 -hosttype pSeries -volume 1C00-1C09,1C10,1C11,1F00-
1F09,1F10,1F11 bay_6_volumes
mkvolgrp -dev IBM.2107-75RA321 -hosttype pSeries -volume 1D00-1D09,1D10,1D11,1E00-
1E09,1E10,1E11 bay_7_volumes
```

step4_define_paths.txt

```
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA04FAFC  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V2 FCS2
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA05026C  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V3 FCS4
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA0506CE  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V4 FCS0

MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FD1CC6  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V1 FCS18
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FCC222  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V2 FCS14
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FD00A8  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V3 FCS16
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FD06EA  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V4 FCS12

MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FD08CF  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V5 FCS33
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FCF474  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V6 FCS34
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FCF475  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V7 FCS35
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FD08CE  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V8 FCS32

MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FD2053  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V5 FCS45
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FD0D2C  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V6 FCS46
```

```
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FD0D2D  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V7 FCS47
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000000C9FD2052  -PROFILE "IBM PSERIES
- AIX" -VOLGRP V8 FCS44

MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA050280 -PROFILE "IBM PSERIES -
AIX" -VOLGRP V5 perfsh3a_FCS10
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA04FADB -PROFILE "IBM PSERIES -
AIX" -VOLGRP V6 perfsh3a_FCS9
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA04FADA -PROFILE "IBM PSERIES -
AIX" -VOLGRP V7 perfsh3a_FCS8
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA050281 -PROFILE "IBM PSERIES -
AIX" -VOLGRP V8 perfsh3a_FCS11

MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA05031C -PROFILE "IBM PSERIES -
AIX" -VOLGRP V5 perfsh3a_FCS22
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA05014B -PROFILE "IBM PSERIES -
AIX" -VOLGRP V6 perfsh3a_FCS21
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA05014A -PROFILE "IBM PSERIES -
AIX" -VOLGRP V7 perfsh3a_FCS20
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA05031D -PROFILE "IBM PSERIES -
AIX" -VOLGRP V8 perfsh3a_FCS23

MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA0503D4 -PROFILE "IBM PSERIES -
AIX" -VOLGRP V1 perfsh3a_FCS26
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA05039C -PROFILE "IBM PSERIES -
AIX" -VOLGRP V2 perfsh3a_FCS30
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA0504C4 -PROFILE "IBM PSERIES -
AIX" -VOLGRP V3 perfsh3a_FCS24
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA04FA96 -PROFILE "IBM PSERIES -
AIX" -VOLGRP V4 perfsh3a_FCS28

MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA04FA90 -PROFILE "IBM PSERIES -
AIX" -VOLGRP V1 perfsh3a_FCS38
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA04FA9C -PROFILE "IBM PSERIES -
AIX" -VOLGRP V2 perfsh3a_FCS42
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA050266 -PROFILE "IBM PSERIES -
AIX" -VOLGRP V3 perfsh3a_FCS36
MKHOSTCONNECT -DEV IBM.2107-75RA321 -WWNAME 10000090FA050248 -PROFILE "IBM PSERIES -
AIX" -VOLGRP V4 perfsh3a_FCS40
```

step5_discover.sh

```
cfgmgr
```

step6_createlvs.sh

```
for i in 5 6 7 8 9 10 11 12 13 14 15 17 18 19 20 21 22 23 24 25 26 27 29 30 31 32 33
34 35 36 37 38 39 41 42 43 44 45 46 47 48 49 50 51 53 54 55 56 57 58 59 60 61 62 63
65 66 67 68 69 70 71 72 73 74 75 77 78 79 80 81 82 83 84 85 86 87 89 90 91 92 93 94
95 96 97 98 99 101 102 103 104 105 106 107 108 109 110 111 113 114 115 116 117 118
119 120 121 122 123 125 126 127 128 129 130 131 132 133 134 135 137 138 139 140 141
142 143 144 145 146 147 149 150 151 152 153 154 155 156 157 158 159 161 162 163 164
165 166 167 168 169 170 171 173 174 175 176 177 178 179 180 181 182 183 185 186 187
188 189 190 191 192 193 194 195
do
        hdisks="$hdisks hdisk$i"
done

mkvg -S -f -y stripevg -s 512 $hdisks

i=1
```

```
while [[ i -le 71 ]]
do
       mklv -a e -y fat$i -x 5000 -u 176 -S 128M stripevg 1584
       (( i=i+1 ))
done

for i in 4 16 28 40 52 64 76 88 100 112 124 136 148 160 172 184
do
        hdisks="$hdisks hdisk$i"
done

mkvg -S -f -y stripevg_3p3 -s 512 $hdisks

i=1
while [[ i -le 7 ]]
do
       mklv -a e -y 3p3_$i -x 5000 -u 16 -S 128M stripevg_3p3 1584
       (( i=i+1 ))
Done

varyoffvg stripevg; exportvg stripevg
varyoffvg stripevg_3p3; exportvg stripevg_3p3
```

step7_importvg.sh

```
importvg -ny stripevg hdisk4;  varyonvg -bu stripevg
importvg -ny stripevg_3p3 hdisk4;  varyonvg -bu stripevg_3p3
```

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

ASU Pre-Fill

The content of command and parameter file, used in this benchmark to execute the required ASU pre-fill, is listed below.

```
*
* This will produce a random data pattern of the entire LBA range using LSFR 32bit
*
compratio=1
sd=default,threads=1,size=792000000000
sd=sd1,lun=/dev/rfat1
sd=sd2,lun=/dev/rfat2
sd=sd3,lun=/dev/rfat3
sd=sd4,lun=/dev/rfat4
sd=sd5,lun=/dev/rfat5
sd=sd6,lun=/dev/rfat6
sd=sd7,lun=/dev/rfat7
sd=sd8,lun=/dev/rfat8
sd=sd9,lun=/dev/rfat9
sd=sd10,lun=/dev/rfat10
sd=sd11,lun=/dev/rfat11
sd=sd12,lun=/dev/rfat12
sd=sd13,lun=/dev/rfat13
sd=sd14,lun=/dev/rfat14
sd=sd15,lun=/dev/rfat15
sd=sd16,lun=/dev/rfat16
sd=sd17,lun=/dev/rfat17
sd=sd18,lun=/dev/rfat18
sd=sd19,lun=/dev/rfat19
sd=sd20,lun=/dev/rfat20
sd=sd21,lun=/dev/rfat21
sd=sd22,lun=/dev/rfat22
sd=sd23,lun=/dev/rfat23
sd=sd24,lun=/dev/rfat24
sd=sd25,lun=/dev/rfat25
sd=sd26,lun=/dev/rfat26
sd=sd27,lun=/dev/rfat27
sd=sd28,lun=/dev/rfat28
sd=sd29,lun=/dev/rfat29
sd=sd30,lun=/dev/rfat30
sd=sd31,lun=/dev/rfat31
sd=sd32,lun=/dev/rfat32
sd=sd33,lun=/dev/rfat33
sd=sd34,lun=/dev/rfat34
sd=sd35,lun=/dev/rfat35
sd=sd36,lun=/dev/rfat36
sd=sd37,lun=/dev/rfat37
sd=sd38,lun=/dev/rfat38
sd=sd39,lun=/dev/rfat39
sd=sd40,lun=/dev/rfat40
sd=sd41,lun=/dev/rfat41
sd=sd42,lun=/dev/rfat42
sd=sd43,lun=/dev/rfat43
sd=sd44,lun=/dev/rfat44
sd=sd45,lun=/dev/rfat45
sd=sd46,lun=/dev/rfat46
sd=sd47,lun=/dev/rfat47
```

```
sd=sd48,lun=/dev/rfat48
sd=sd49,lun=/dev/rfat49
sd=sd50,lun=/dev/rfat50
sd=sd51,lun=/dev/rfat51
sd=sd52,lun=/dev/rfat52
sd=sd53,lun=/dev/rfat53
sd=sd54,lun=/dev/rfat54
sd=sd55,lun=/dev/rfat55
sd=sd56,lun=/dev/rfat56
sd=sd57,lun=/dev/rfat57
sd=sd58,lun=/dev/rfat58
sd=sd59,lun=/dev/rfat59
sd=sd60,lun=/dev/rfat60
sd=sd61,lun=/dev/rfat61
sd=sd62,lun=/dev/rfat62
sd=sd63,lun=/dev/rfat63
sd=sd64,lun=/dev/rfat64
sd=sd65,lun=/dev/r3p3_1
sd=sd66,lun=/dev/r3p3_2
sd=sd67,lun=/dev/r3p3_3
sd=sd68,lun=/dev/r3p3_4
sd=sd69,lun=/dev/r3p3_5
sd=sd70,lun=/dev/rfat65
sd=sd71,lun=/dev/rfat66

wd=default,rdpct=0,seek=-1,xfersize=256K
wd=wd1,sd=sd1
wd=wd2,sd=sd2
wd=wd3,sd=sd3
wd=wd4,sd=sd4
wd=wd5,sd=sd5
wd=wd6,sd=sd6
wd=wd7,sd=sd7
wd=wd8,sd=sd8
wd=wd9,sd=sd9
wd=wd10,sd=sd10
wd=wd11,sd=sd11
wd=wd12,sd=sd12
wd=wd13,sd=sd13
wd=wd14,sd=sd14
wd=wd15,sd=sd15
wd=wd16,sd=sd16
wd=wd17,sd=sd17
wd=wd18,sd=sd18
wd=wd19,sd=sd19
wd=wd20,sd=sd20
wd=wd21,sd=sd21
wd=wd22,sd=sd22
wd=wd23,sd=sd23
wd=wd24,sd=sd24
wd=wd25,sd=sd25
wd=wd26,sd=sd26
wd=wd27,sd=sd27
wd=wd28,sd=sd28
wd=wd29,sd=sd29
wd=wd30,sd=sd30
wd=wd31,sd=sd31
wd=wd32,sd=sd32
wd=wd33,sd=sd33
wd=wd34,sd=sd34
wd=wd35,sd=sd35
wd=wd36,sd=sd36
wd=wd37,sd=sd37
```

```
wd=wd38,sd=sd38
wd=wd39,sd=sd39
wd=wd40,sd=sd40
wd=wd41,sd=sd41
wd=wd42,sd=sd42
wd=wd43,sd=sd43
wd=wd44,sd=sd44
wd=wd45,sd=sd45
wd=wd46,sd=sd46
wd=wd47,sd=sd47
wd=wd48,sd=sd48
wd=wd49,sd=sd49
wd=wd50,sd=sd50
wd=wd51,sd=sd51
wd=wd52,sd=sd52
wd=wd53,sd=sd53
wd=wd54,sd=sd54
wd=wd55,sd=sd55
wd=wd56,sd=sd56
wd=wd57,sd=sd57
wd=wd58,sd=sd58
wd=wd59,sd=sd59
wd=wd60,sd=sd60
wd=wd61,sd=sd61
wd=wd62,sd=sd62
wd=wd63,sd=sd63
wd=wd64,sd=sd64
wd=wd65,sd=sd65
wd=wd66,sd=sd66
wd=wd67,sd=sd67
wd=wd68,sd=sd68
wd=wd69,sd=sd69
wd=wd70,sd=sd70
wd=wd71,sd=sd71

*===================================
* Use 10 hours as a maximum elapsed time,
* which should ensure the entire LBA range
* will be written before the time elapses
*===================================
*
rd=FILLIT,wd=wd*,iorate=max,elapsed=999990,interval=10
```

Primary Metrics and Repeatability Tests

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

The content of the SPC-2 Workload Generator command and parameter files, used for the SPC-2 Persistence Test, is also listed below.

Common Command Lines – Primary Metrics and Repeatability Tests

The following command lines appear at the beginning of each command and parameter file for the Primary Metrics and Repeatability Test. The command lines are only listed below to eliminate redundancy.

```
host=master
slaves=(slav1,slav2,slav3,slav4,slav5,slav6,slav7,slav8,slav9,slav10,slav11,slav12,s
lav13,slav14,slav15,slav16,slav17,slav18,slav19,slav20,slav21,slav22,slav23,slav24,s
lav25,slav26,slav27,slav28,slav29,slav30,slav31,slav32,slav33,slav34,slav35,slav36,s
lav37,slav38,slav39,slav40,slav41,slav42,slav43,slav44,slav45,slav46,slav47,slav48,s
lav49,slav50,slav51,slav52,slav53,slav54,slav55,slav56,slav57,slav58,slav59,slav60,s
lav61,slav62,slav63,slav64,slav65,slav66,slav67,slav68,slav69,slav70,slav71,slav72,s
lav73,slav74,slav75,slav76,slav77,slav78,slav79,slav80,slav81,slav82,slav83,slav84,s
lav85,slav86,slav87,slav88,slav89,slav90,slav91,slav92)
javaparms="-Xms1280m -Xmx1280m -Xss128k -Xgcpolicy:optavgpause"
sd=default,size=792g
sd=asu1_1,lun=/dev/rfat1
sd=asu1_2,lun=/dev/rfat2
sd=asu1_3,lun=/dev/rfat3
sd=asu1_4,lun=/dev/rfat4
sd=asu1_5,lun=/dev/rfat5
sd=asu1_6,lun=/dev/rfat6
sd=asu1_7,lun=/dev/rfat7
sd=asu1_8,lun=/dev/rfat8
sd=asu1_9,lun=/dev/rfat9
sd=asu1_10,lun=/dev/rfat10
sd=asu1_11,lun=/dev/rfat11
sd=asu1_12,lun=/dev/rfat12
sd=asu1_13,lun=/dev/rfat13
sd=asu1_14,lun=/dev/rfat14
sd=asu1_15,lun=/dev/rfat15
sd=asu1_16,lun=/dev/rfat16
sd=asu1_17,lun=/dev/rfat17
sd=asu1_18,lun=/dev/rfat18
sd=asu1_19,lun=/dev/rfat19
sd=asu1_20,lun=/dev/rfat20
sd=asu1_21,lun=/dev/rfat21
sd=asu1_22,lun=/dev/rfat22
sd=asu1_23,lun=/dev/rfat23
sd=asu1_24,lun=/dev/rfat24
sd=asu1_25,lun=/dev/rfat25
sd=asu1_26,lun=/dev/rfat26
sd=asu1_27,lun=/dev/rfat27
sd=asu1_28,lun=/dev/rfat28
sd=asu1_29,lun=/dev/rfat29
sd=asu1_30,lun=/dev/rfat30
sd=asu1_31,lun=/dev/rfat31
sd=asu1_32,lun=/dev/rfat32
sd=asu2_1,lun=/dev/rfat33
sd=asu2_2,lun=/dev/rfat34
```

```
sd=asu2_3,lun=/dev/rfat35
sd=asu2_4,lun=/dev/rfat36
sd=asu2_5,lun=/dev/rfat37
sd=asu2_6,lun=/dev/rfat38
sd=asu2_7,lun=/dev/rfat39
sd=asu2_8,lun=/dev/rfat40
sd=asu2_9,lun=/dev/rfat41
sd=asu2_10,lun=/dev/rfat42
sd=asu2_11,lun=/dev/rfat43
sd=asu2_12,lun=/dev/rfat44
sd=asu2_13,lun=/dev/rfat45
sd=asu2_14,lun=/dev/rfat46
sd=asu2_15,lun=/dev/rfat47
sd=asu2_16,lun=/dev/rfat48
sd=asu2_17,lun=/dev/rfat49
sd=asu2_18,lun=/dev/rfat50
sd=asu2_19,lun=/dev/rfat51
sd=asu2_20,lun=/dev/rfat52
sd=asu2_21,lun=/dev/rfat53
sd=asu2_22,lun=/dev/rfat54
sd=asu2_23,lun=/dev/rfat55
sd=asu2_24,lun=/dev/rfat56
sd=asu2_25,lun=/dev/rfat57
sd=asu2_26,lun=/dev/rfat58
sd=asu2_27,lun=/dev/rfat59
sd=asu2_28,lun=/dev/rfat60
sd=asu2_29,lun=/dev/rfat61
sd=asu2_30,lun=/dev/rfat62
sd=asu2_31,lun=/dev/rfat63
sd=asu2_32,lun=/dev/rfat64
sd=asu3_1,lun=/dev/r3p3_1
sd=asu3_2,lun=/dev/r3p3_2
sd=asu3_3,lun=/dev/r3p3_3
sd=asu3_4,lun=/dev/r3p3_4
sd=asu3_5,lun=/dev/r3p3_5
sd=asu3_6,lun=/dev/rfat65
sd=asu3_7,lun=/dev/rfat66
```

Primary Metrics Test: Sustainability Test Phase/Test Run

common command lines

```
rd=sustain,bsus=9021,startup=180,elapsed=28800,interval=60
```

Primary Metrics Test: IOPS Test Phase *(100% Test Run)*

common command lines

```
rd=ramp_100,bsus=9021,startup=180,elapsed=600,interval=60
```

Primary Metrics Test: Response Time Ramp Test Phase *(95% Test Run)*

common command lines

```
rd=ramp_95,bsus=8569,startup=180,elapsed=600,interval=60
```

Primary Metrics Test: Response Time Ramp Test Phase *(90% Test Run)*

common command lines

```
rd=ramp_90,bsus=8118,startup=180,elapsed=600,interval=60
```

Primary Metrics Test: Response Time Ramp Test Phase *(80% Test Run)*

common command lines

```
rd=ramp_80,bsus=7216,startup=180,elapsed=600,interval=60
```

Primary Metrics Test: Response Time Ramp Test Phase *(50% Test Run)*

common command lines

```
rd=ramp_50,bsus=4510,startup=180,elapsed=600,interval=60
```

Primary Metrics Test: Response Time Ramp Test Phase *(10% Test Run)*

common command lines

```
rd=ramp_10,bsus=902,startup=180,elapsed=600,interval=60
```

Repeatability Test: Repeatability Test Phase 1 *(10% and 100% Test Runs)*

common command lines

```
rd=repeat1_lrt,bsus=902,startup=180,elapsed=600,interval=60
rd=repeat1_iops,bsus=9021,startup=180,elapsed=600,interval=60
```

Repeatability Test: Repeatability Test Phase 2 *(10% and 100% Test Runs)*

common command lines

```
rd=repeat2_lrt,bsus=902,startup=180,elapsed=600,interval=60
rd=repeat2_iops,bsus=9021,startup=180,elapsed=600,interval=60
```

SPC-2 Persistence Test

Common Command Lines – SPC-2 Persistence Test

The following command lines appear at the beginning of each command and parameter file for the two SPC-2 Persistence Test Runs. The command lines are only listed below to eliminate redundancy.

```
host=localhost,jvms=8,maxstreams=200

sd=default,host=localhost,size=792000000000
sd=sd1,lun=/dev/rfat1
sd=sd2,lun=/dev/rfat2
sd=sd3,lun=/dev/rfat3
sd=sd4,lun=/dev/rfat4
sd=sd5,lun=/dev/rfat5
sd=sd6,lun=/dev/rfat6
sd=sd7,lun=/dev/rfat7
sd=sd8,lun=/dev/rfat8
sd=sd9,lun=/dev/rfat9
sd=sd10,lun=/dev/rfat10
sd=sd11,lun=/dev/rfat11
sd=sd12,lun=/dev/rfat12
sd=sd13,lun=/dev/rfat13
sd=sd14,lun=/dev/rfat14
sd=sd15,lun=/dev/rfat15
sd=sd16,lun=/dev/rfat16
sd=sd17,lun=/dev/rfat17
```

```
sd=sd18,lun=/dev/rfat18
sd=sd19,lun=/dev/rfat19
sd=sd20,lun=/dev/rfat20
sd=sd21,lun=/dev/rfat21
sd=sd22,lun=/dev/rfat22
sd=sd23,lun=/dev/rfat23
sd=sd24,lun=/dev/rfat24
sd=sd25,lun=/dev/rfat25
sd=sd26,lun=/dev/rfat26
sd=sd27,lun=/dev/rfat27
sd=sd28,lun=/dev/rfat28
sd=sd29,lun=/dev/rfat29
sd=sd30,lun=/dev/rfat30
sd=sd31,lun=/dev/rfat31
sd=sd32,lun=/dev/rfat32
sd=sd33,lun=/dev/rfat33
sd=sd34,lun=/dev/rfat34
sd=sd35,lun=/dev/rfat35
sd=sd36,lun=/dev/rfat36
sd=sd37,lun=/dev/rfat37
sd=sd38,lun=/dev/rfat38
sd=sd39,lun=/dev/rfat39
sd=sd40,lun=/dev/rfat40
sd=sd41,lun=/dev/rfat41
sd=sd42,lun=/dev/rfat42
sd=sd43,lun=/dev/rfat43
sd=sd44,lun=/dev/rfat44
sd=sd45,lun=/dev/rfat45
sd=sd46,lun=/dev/rfat46
sd=sd47,lun=/dev/rfat47
sd=sd48,lun=/dev/rfat48
sd=sd49,lun=/dev/rfat49
sd=sd50,lun=/dev/rfat50
sd=sd51,lun=/dev/rfat51
sd=sd52,lun=/dev/rfat52
sd=sd53,lun=/dev/rfat53
sd=sd54,lun=/dev/rfat54
sd=sd55,lun=/dev/rfat55
sd=sd56,lun=/dev/rfat56
sd=sd57,lun=/dev/rfat57
sd=sd58,lun=/dev/rfat58
sd=sd59,lun=/dev/rfat59
sd=sd60,lun=/dev/rfat60
sd=sd61,lun=/dev/rfat61
sd=sd62,lun=/dev/rfat62
sd=sd63,lun=/dev/rfat63
sd=sd64,lun=/dev/rfat64
sd=sd65,lun=/dev/r3p3_1
sd=sd66,lun=/dev/r3p3_2
sd=sd67,lun=/dev/r3p3_3
sd=sd68,lun=/dev/r3p3_4
sd=sd69,lun=/dev/r3p3_5
sd=sd70,lun=/dev/rfat65
sd=sd71,lun=/dev/rfat66


maxlatestart=1
reportinginterval=5
segmentlength=512m
```

SPC-2 Persistence Test Run 1 *(write phase)*

common command lines

```
rd=default,rampup=180,periods=90,measurement=300,runout=0,rampdown=0,buffers=1

rd=default,rdpct=0,xfersize=1024k
rd=TR1-5s_SPC-2-persist-w,streams=384
```

SPC-2 Persistence Test Run 1 *(read phase)*

common command lines

```
maxpersistenceerrors=10

rd=default,buffers=1,rdpct=100,xfersize=1024k
rd=TR1-5s_SPC-2-persist-r
```

Slave JVMs

Each Slave JVM was invoked with a command and parameter file similar to the example listed below. The only difference in each file was "host" parameter value, which was unique to each Slave JVM, e.g. **slav1**, **slav2**, **slav3**… .

```
master=perfsh3a
host=slav1
sd=default,size=792g
sd=asu1_1,lun=/dev/rfat1
sd=asu1_2,lun=/dev/rfat2
sd=asu1_3,lun=/dev/rfat3
sd=asu1_4,lun=/dev/rfat4
sd=asu1_5,lun=/dev/rfat5
sd=asu1_6,lun=/dev/rfat6
sd=asu1_7,lun=/dev/rfat7
sd=asu1_8,lun=/dev/rfat8
sd=asu1_9,lun=/dev/rfat9
sd=asu1_10,lun=/dev/rfat10
sd=asu1_11,lun=/dev/rfat11
sd=asu1_12,lun=/dev/rfat12
sd=asu1_13,lun=/dev/rfat13
sd=asu1_14,lun=/dev/rfat14
sd=asu1_15,lun=/dev/rfat15
sd=asu1_16,lun=/dev/rfat16
sd=asu1_17,lun=/dev/rfat17
sd=asu1_18,lun=/dev/rfat18
sd=asu1_19,lun=/dev/rfat19
sd=asu1_20,lun=/dev/rfat20
sd=asu1_21,lun=/dev/rfat21
sd=asu1_22,lun=/dev/rfat22
sd=asu1_23,lun=/dev/rfat23
sd=asu1_24,lun=/dev/rfat24
sd=asu1_25,lun=/dev/rfat25
sd=asu1_26,lun=/dev/rfat26
sd=asu1_27,lun=/dev/rfat27
sd=asu1_28,lun=/dev/rfat28
sd=asu1_29,lun=/dev/rfat29
sd=asu1_30,lun=/dev/rfat30
sd=asu1_31,lun=/dev/rfat31
sd=asu1_32,lun=/dev/rfat32
sd=asu2_1,lun=/dev/rfat33
sd=asu2_2,lun=/dev/rfat34
```

```
sd=asu2_3,lun=/dev/rfat35
sd=asu2_4,lun=/dev/rfat36
sd=asu2_5,lun=/dev/rfat37
sd=asu2_6,lun=/dev/rfat38
sd=asu2_7,lun=/dev/rfat39
sd=asu2_8,lun=/dev/rfat40
sd=asu2_9,lun=/dev/rfat41
sd=asu2_10,lun=/dev/rfat42
sd=asu2_11,lun=/dev/rfat43
sd=asu2_12,lun=/dev/rfat44
sd=asu2_13,lun=/dev/rfat45
sd=asu2_14,lun=/dev/rfat46
sd=asu2_15,lun=/dev/rfat47
sd=asu2_16,lun=/dev/rfat48
sd=asu2_17,lun=/dev/rfat49
sd=asu2_18,lun=/dev/rfat50
sd=asu2_19,lun=/dev/rfat51
sd=asu2_20,lun=/dev/rfat52
sd=asu2_21,lun=/dev/rfat53
sd=asu2_22,lun=/dev/rfat54
sd=asu2_23,lun=/dev/rfat55
sd=asu2_24,lun=/dev/rfat56
sd=asu2_25,lun=/dev/rfat57
sd=asu2_26,lun=/dev/rfat58
sd=asu2_27,lun=/dev/rfat59
sd=asu2_28,lun=/dev/rfat60
sd=asu2_29,lun=/dev/rfat61
sd=asu2_30,lun=/dev/rfat62
sd=asu2_31,lun=/dev/rfat63
sd=asu2_32,lun=/dev/rfat64
sd=asu3_1,lun=/dev/r3p3_1
sd=asu3_2,lun=/dev/r3p3_2
sd=asu3_3,lun=/dev/r3p3_3
sd=asu3_4,lun=/dev/r3p3_4
sd=asu3_5,lun=/dev/r3p3_5
sd=asu3_6,lun=/dev/rfat65
sd=asu3_7,lun=/dev/rfat66
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

ASU Pre-Fill, Primary Metrics Test, Repeatability Test, Persistence Test Run 1 and Persistence Test Run 2

The **runall.sh** script was used to execute the required ASU pre-fill (**runfill.sh**), 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.

Between each Test Run, the **runall.sh** script terminates (**allhost_jvmstop.sh**) and then starts (**allhost_jvmstart.sh**) the required Slave JVMs

runall.sh

```
cd ../fill
./runfill.sh
cd $rundir


allhost_jvmstop.sh

allhost_jvmstart.sh
java -Xoptionsfile=javaopts.cfg spc1 -w SPC1 -fmetrics1.txt -ometrics1 SPCOut
allhost_jvmstop.sh

allhost_jvmstart.sh
java -Xoptionsfile=javaopts.cfg spc1 -w SPC1 -fmetrics2.txt -ometrics2 SPCOut
allhost_jvmstop.sh

allhost_jvmstart.sh
java -Xoptionsfile=javaopts.cfg spc1 -w SPC1 -fmetrics3.txt -ometrics3 SPCOut
allhost_jvmstop.sh

allhost_jvmstart.sh
java -Xoptionsfile=javaopts.cfg spc1 -w SPC1 -fmetrics4.txt -ometrics4 SPCOut
allhost_jvmstop.sh

allhost_jvmstart.sh
java -Xoptionsfile=javaopts.cfg spc1 -w SPC1 -fmetrics5.txt -ometrics5 SPCOut
allhost_jvmstop.sh

allhost_jvmstart.sh
java -Xoptionsfile=javaopts.cfg spc1 -w SPC1 -fmetrics6.txt -ometrics6 SPCOut
allhost_jvmstop.sh

allhost_jvmstart.sh
java -Xoptionsfile=javaopts.cfg spc1 -w SPC1 -fmetrics7.txt -ometrics7 SPCOut
allhost_jvmstop.sh

allhost_jvmstart.sh
java -Xoptionsfile=javaopts.cfg spc1 -w SPC1 -frepeat1.txt -orepeat1 SPCOut
allhost_jvmstop.sh

allhost_jvmstart.sh
java -Xoptionsfile=javaopts.cfg spc1 -w SPC1 -frepeat2.txt -orepeat2 SPCOut
allhost_jvmstop.sh

rundir=`pwd`
```

```
cd ../persistrun
rm -fr persistw
./runpersist1.sh
cd $rundir

#java -Xoptionsfile=javaoptsp.cfg persist1 -b 1000

date > capdata.out
./capdata.sh >> capdata.out
```

runfill.sh

```
#!/usr/bin/ksh
export PATH=$PATH:/usr/java6/bin:/perform/vdbench503
export VDBHOME=/perform/vdbench503
export CLASSPATH=$VDBHOME
export LIBPATH=$VDBHOME/aix
export IBM_JAVADUMP_OUTOFMEMORY=false
export IBM_HEAPDUMP_OUTOFMEMORY=false
rm -fr fill_output
vdbench -f fill.cfg -o fill_output
```

allhost_jvmstop.sh

This script invokes **rmslaves.sh** to terminate the Slave JVM on all Host Systems.

```
#use SSH commands to stop JVMs on all hosts
HERE=`pwd`
$HERE/rmslaves.sh
ssh perfsh3b $HERE/rmslaves.sh
ssh perfsh3c $HERE/rmslaves.sh
ssh perfsh3d $HERE/rmslaves.sh
```

rmslaves.sh

```
proc_num=$(ps -ef |grep slav|grep -v "grep"|grep -v "rmslaves"|awk '{print $2}')
if [[ -n $proc_num ]];then
kill -9 $proc_num
fi
```

allhost_jvmstart.sh

This script invokes **refreshslaves.sh** to start the Slave JVM on all Host Systems.

```
#use SSH commands to start JVMs on all hosts
export HERE=`pwd`
refreshslaves.sh 1 23 $HERE
ssh perfsh3b $HERE/refreshslaves.sh 24 46 $HERE
ssh perfsh3c $HERE/refreshslaves.sh 47 69 $HERE
ssh perfsh3d $HERE/refreshslaves.sh 70 92 $HERE
```

refreshslaves.sh

```
if [ $# -lt 3 ]
then
   echo "usage: refreshslaves.sh first last directory"
   return
fi
export PATH=/usr/java6/bin:$PATH
export SPC1HOME=/perform/spc1install
export CLASSPATH=$SPC1HOME
export LIBPATH=$SPC1HOME/aix
```

```
export IBM_JAVADUMP_OUTOFMEMORY=false
export IBM_HEAPDUMP_OUTOFMEMORY=false
i=$1
run_dir=$3
while [[ $i -le $2 ]]
do
ps -ef | grep  slav$i | grep -v grep > /dev/null
if [ $? -ne 0 ]
then
   nohup java -Xoptionsfile=$run_dir/javaopts.cfg spc1 -f $run_dir/slav$i.txt >
$run_dir/slav$i.out &
fi
let i="i+1"
done
```