# SPC BENCHMARK 1™
# FULL DISCLOSURE REPORT

## SUN MICROSYSTEMS, INC.
## SUN STOREDGE™ 6920 (20 TRAY)

**SPC-1 V1.8**

**Submitted for Review: August 16, 2004**
**Submission Identifier: A00033**
**Accepted: October 15, 2004**

**First Edition – August 2004**



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**Notes**

The following terms, used in this document, are defined as:

- Kilobyte (KB) is equal to 1,000 ($10^3$) bytes.
- Megabyte (MB) is equal to 1,000,000 ($10^6$) bytes.
- Gigabyte (GB) is equal to 1,000,000,000 ($10^9$) bytes.
- Terabyte (TB) is equal to 1,000,000,000,000 ($10^{12}$) bytes.

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# AUDIT CERTIFICATION



Leah Schoeb
Sun Microsystems, Inc.
5300 Riata Park Court AUS08
Austin, TX 78721

August 13, 2004

The SPC Benchmark 1™ results listed below for the Sun StorEdge™ 6920 (20 tray) were produced in compliance with the SPC Benchmark 1™ V1.8 Onsite Audit requirements.

| SPC Benchmark 1™ V1.8 Results | |
|---|---|
| **Tested Storage Configuration (TSC) Name:** Sun StorEdge™ 6920 (20 tray) | |
| **Metric** | **Reported Result** |
| SPC-1 IOPS™ | 48,646.62 |
| SPC-1 Price-Performance | $10.73/SPC-1 IOPS™ |
| Total ASU Capacity | 3,022.000 GB |
| Data Protection Level | Mirroring |
| Total TSC Price (including three-year maintenance) | $522,087 |

The following SPC Benchmark 1™ Onsite Audit requirements were reviewed and found compliant with V1.8 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 physical inspection and information supplied by Sun Microsystems, Inc.:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of each Application Storage Unit (ASU) and requirements.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Physical verification of the components to mach the above diagram.

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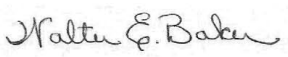
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters.
- Commands and parameters used to configure the SPC-1 Workload Generator.
- The following Host System requirements were verified by physical inspection and information supplied by Sun Microsystems, Inc.:
  - ✓ The type of Host System including the number of processors and main memory.
  - ✓ The presence and version number of the Workload Generator on the Host System.
  - ✓ The TSC boundary within the Host System.
- The execution of Test, Test Phase, and Test Run was observed and found compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification.
- The Test Results Files and resultant Summary Results Files received for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability Test
- There were no differences between the Tested Storage Configuration (TSC) used for the benchmark and Priced Storage Configuration.
- The final version of the pricing spreadsheet 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.

**Audit Notes:**

There were no additional audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

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# LETTER OF GOOD FAITH

Sun microsystems

Date: 7/26/03

From: Kathleen Holmgren

To: Walter Baker

Subject: SPC-1 Letter of Good Faith for the StorEdge™ 6920

Sun Microsystems Inc. is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with V1.8 of the SPC-1 benchmark specification.

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

Signed:

Kathleen Holmgren
Senior Vice President, Product Line Management Network Storage

# EXECUTIVE SUMMARY

## Test Sponsor and Contact Information

| Test Sponsor and Contact Information | |
|---|---|
| **Test Sponsor Primary Contact** | Sun Microsystems, Inc. – http://www.sun.com<br>Leah Schoeb – leah.schoeb@sun.com<br>5300 Riata Park Court AUS08<br>Austin, TX 78721<br>Phone: (512) 401-1227<br>FAX: (512) 266-2523 |
| **Test Sponsor Alternate Contact** | Sun Microsystems, Inc. – http://www.sun.com<br>Jason Schaffer – jason.schaffer@sun.com<br>7777 Gateway Blvd 7, UNWK16<br>Newark, CA<br>Phone: (510) 936-2979<br>FAX: (510) 936-2323 |
| **Auditor** | Storage Performance Council – http://www.StoragePerformance.org<br>Walter E. Baker – AuditService@StoragePerformance.org<br>643 Bair Island Road, Suite 103<br>Redwood City, CA 94063<br>Phone: (650) 556-9384<br>FAX: (650) 556-9385 |

## Revision Information and Key Dates

| Revision Information and Key Dates | |
|---|---|
| **SPC-1 Specification revision number** | V1.8 |
| **SPC-1 Workload Generator revision number** | V2.00.04a |
| **Date Results were first used publicly** | August 16, 2004 |
| **Date FDR was submitted to the SPC** | August 16, 2004 |
| **Date the TSC is/was available for shipment to customers** | July 23, 2004 |
| **Date the TSC completed audit certification** | August 13, 2004 |

## Summary of Results

| SPC-1 Results | |
|---|---|
| **Tested Storage Configuration (TSC) Name:** Sun StorEdge™ 6920 (20 tray) | |
| **Metric** | **Reported Result** |
| **SPC-1 IOPS™** | 48,646.62 |
| **SPC-1 Price-Performance** | $10.73/SPC-1 IOPS™ |
| **Total ASU Capacity** | 3,022.000 GB |
| **Data Protection Level** | Mirroring |
| **Total TSC Price (including three-year maintenance)** | $522,087 |

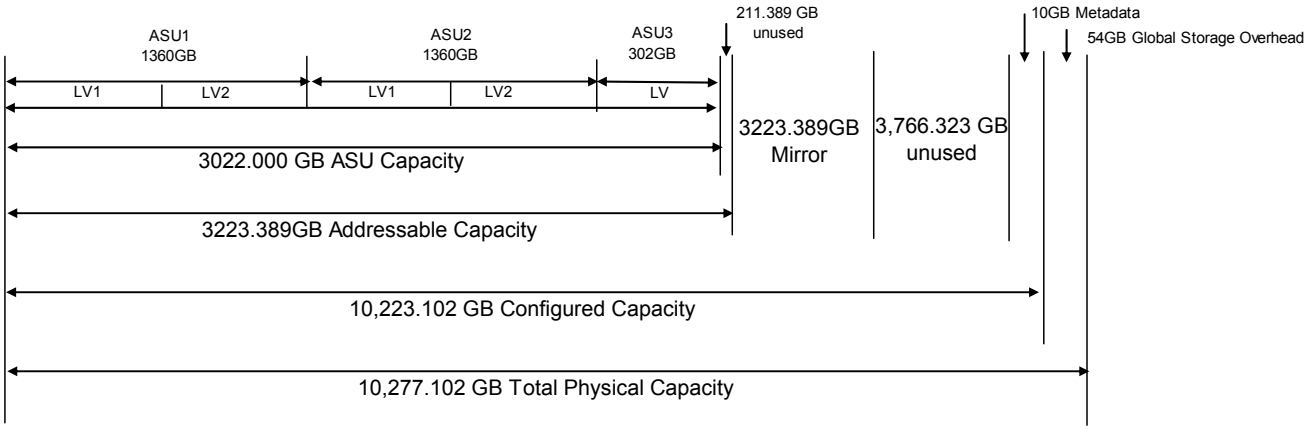
**SPC-1 IOPS™** represents the maximum I/O Request Throughput at the 100% load point.

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

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

## Storage Capacities and Relationships

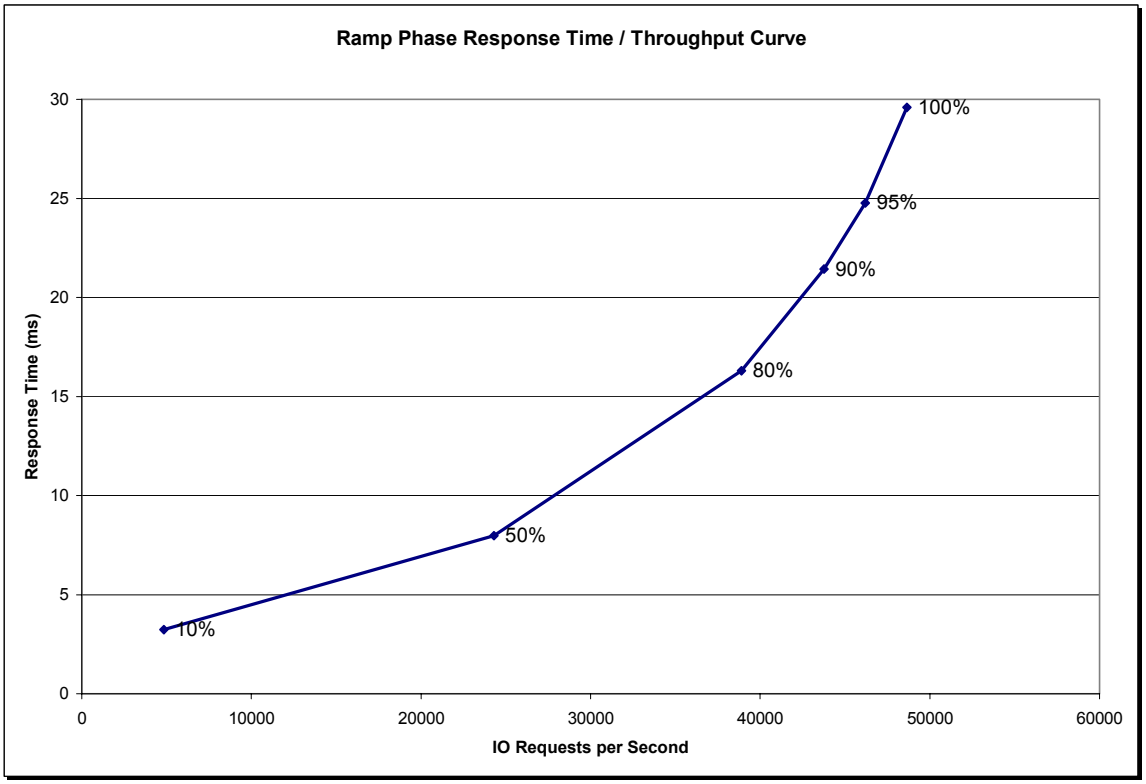
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



## Response Time – Throughput Curve

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

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




## Response Time – Throughput Data

| | 10% Load | 50% Load | 80% Load | 90% Load | 95% Load | 100% Load |
|---|---|---|---|---|---|---|
| **I/O Request Throughput** | 4,850.58 | 24,308.44 | 38,897.30 | 43,771.02 | 46,197.91 | 48,646.62 |
| ***Average Response Time (ms):*** | | | | | | |
| **All ASUs** | 3.24 | 7.98 | 16.29 | 21.42 | 24.76 | 29.59 |
| **ASU-1** | 3.66 | 8.39 | 16.34 | 21.23 | 24.35 | 29.24 |
| **ASU-2** | 3.25 | 7.76 | 15.92 | 20.92 | 24.18 | 28.53 |
| **ASU-3** | 2.34 | 7.20 | 16.37 | 22.05 | 25.88 | 30.80 |
| **Reads** | 5.11 | 10.20 | 17.90 | 22.40 | 25.21 | 29.60 |
| **Writes** | 2.02 | 6.53 | 15.25 | 20.79 | 24.47 | 29.58 |

## Tested Storage Configuration Pricing *(Priced Storage Configuration)*

| Part Number | Description | Quantity | US List | Total | % Discount | Ave. Price |
|---|---|---|---|---|---|---|
| TA6920-DSP-4F | Base Cabinet 32 ports | 1 | $69,995 | $69,995 | 32% | $47,597 |
| TA6020M22A1S1008 | Storage Partner Pair with 28 36GB 15k rpm | 10 | $66,890 | $668,900 | 32% | $454,852 |
| XTA6920-SPM-UNLTB | Storage Pool Manager | 1 | $9,200 | $9,200 | 32% | $6,256 |
| X6767A | 2Gb PCI Single FC HBA | 12 | $1,560 | $18,720 | 32% | $12,730 |
| X9733A | 5M LC to LC FC Optical Cable | 12 | $80 | $960 | 32% | $653 |
| **Total** | | | **$147,725** | **$767,775** | | **$522,087** |

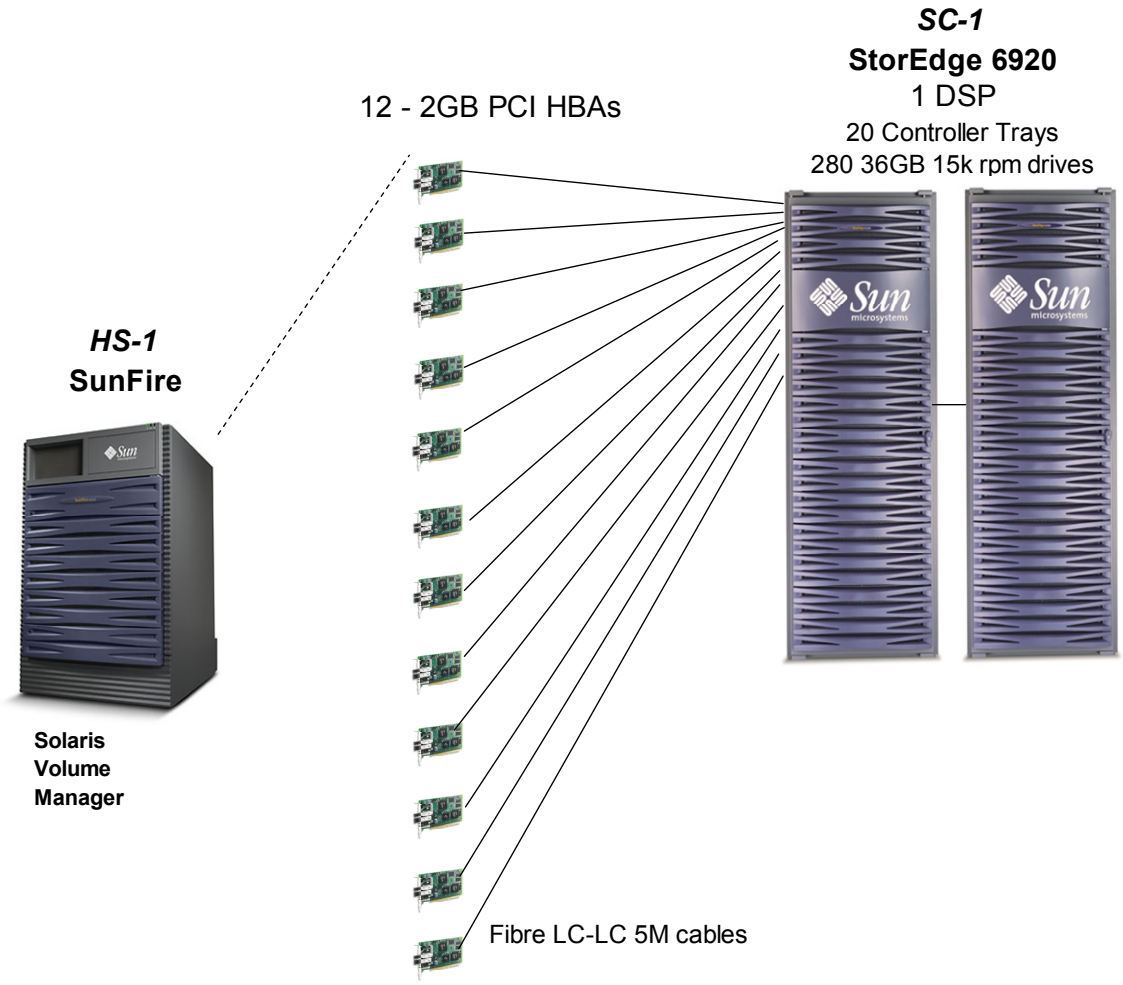
Three year "Gold Service" System Maintenance is included, which provides the following:

- 7 days per week, 24 hours per day coverage.
- Acknowledgement of new and existing problems within four hours.
- Onsite presence of a qualified maintenance engineer or provision of a customer replaceable part within four hours of the above acknowledgement for any hardware failure that results in an inoperative Priced Storage Configuration component. In either of the two cases, the remedy will result in resumption of operation.

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

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

## Benchmark Configuration/Tested Storage Configuration Diagram




| Host Systems: | Tested Storage Configuration (TSC): |
|---|---|
| ***UID=HS-1*** | 12 – 2 Gb Single port FC HBAs |
| SunFire 6800 | ***UID=SC-1:*** |
| 24 – UltraSPARC™ III 900MHz CPUs with 8MB EEC External cache per CPU | Sun StorEdge 6920:<br>20 Controllers each with 1 tray<br>1 GB of cache per controller<br>14 – 36 GB, 15 K RPM drives per tray |
| 48 GB main memory | |
| Solaris 9 update 6 | |
| Solaris Volume Manager (SVM) | 32 DSP FC Ports |
| PCI | 280 – 36 GB 15K RPM disk drives |
| WG | |

# CONFIGURATION INFORMATION

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

*Clause 9.2.4.4.1*

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

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 13 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

## Storage Network Configuration

*Clause 9.2.4.4.2*

*If a storage network is employed in the BC/TSC, the FDR shall contain a topology diagram… . This diagram should include, but is not limited to the following components:*

1. *Storage Controller and Domain Controllers (see Clause 9.2.4.4.1)*
2. *Host Systems (see Clause 9.2.4.4.1)*
3. *Routers and Bridges*
4. *Hubs and Switches*
5. *HBAs to Host Systems and Front End Port to Storage Controllers*

*Additionally the diagram shall:*

- *Illustrate the physical connection between components.*
- *Describe the type of each physical connection.*
- *Describe the network protocol used over each physical connection.*
- *The maximum theoretical transfer rate of each class of interconnect used in the configuration.*
- *Correlate with the BC Configuration Diagram in Clause 9.2.4.4.1.*

*The Test Sponsor shall additionally supply (referenced in an appendix) a wiring diagram of the physical connections and physical port assignments used in the storage network. The diagram should allow anyone to exactly replicate the physical configuration of the storage network.*

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

## Host System Configuration

*Clause 9.2.4.4.3*

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

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

The details of the Host System configuration may be found on page 13 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

## Customer Tunable Parameters and Options

*Clause 9.2.4.5.1*

*All Benchmark Configuration (BC) components with customer tunable parameter and options that have been altered from their default values must be listed in the FDR. The FDR entry for each of those components must include both the name of the component and the altered value of the parameter or option.*

"Appendix A: Customer Tunable Parameters and Options" on page 49 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

## Tested Storage Configuration (TSC) Description

*Clause 9.2.4.5.2*

*The FDR must include sufficient information to recreate the logical representation of the TSC. In addition to customer tunable parameters and options (Clause 4.2.4.5.3), that information must include, at a minimum, a diagram and/or description of the following:*

- *All physical components that comprise the TSC. Those components are also illustrated in the Benchmark Configuration (BC) diagram in Clause 9.2.4.4.1 and, if applicable, 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.*

*In addition the FDR may include listings of scripts and/or commands used to configure the physical components that comprise the TSC.*

"Appendix B: Tested Storage Configuration (TSC) Creation" on page 52 contains the detailed information that describes how to create and configure the logical TSC.

## SPC-1 Workload Generator Storage Configuration

*Clause 9.2.4.5.3*

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

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in "Appendix C: SPC-1 Workload Generator Storage Commands and Parameters" on page 63.

# 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 ECC 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.

## Storage Capacities and Relationships

*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) | 3,022.000 |
| Addressable Storage Capacity | Gigabytes (GB) | 3,233.389 |
| Configured Storage Capacity | Gigabytes (GB) | 10,223.102 |
| Physical Storage Capacity | Gigabytes (GB) | 10,277.102 |
| Data Protection Overhead (mirror) | Gigabytes (GB) | 3,233.389 |
| Required Storage | Gigabytes (GB) | 10.000 |
| Global Storage Overhead | Gigabytes (GB) | 54.000 |
| Total Unused Storage | Gigabytes (GB) | 4,400.490 |

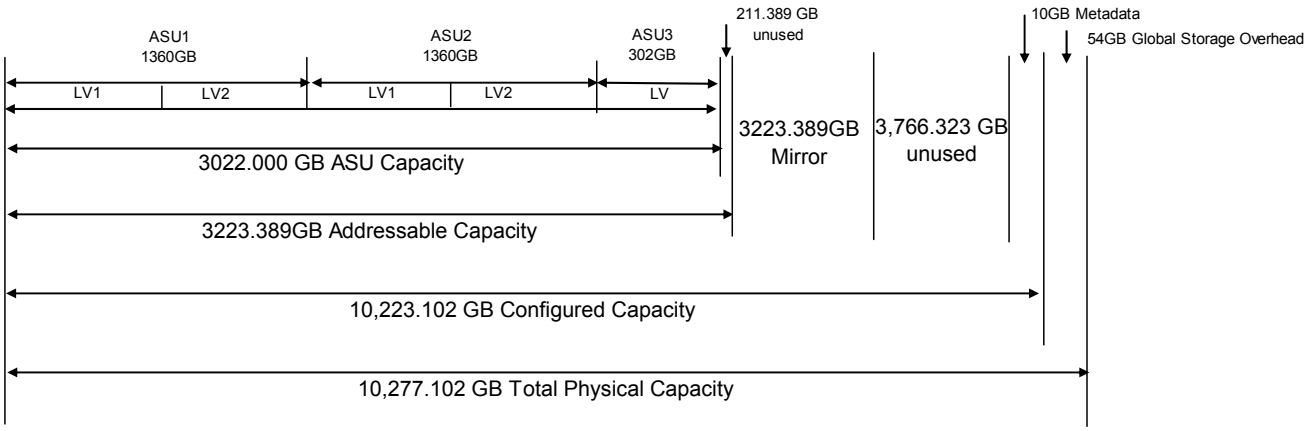
### SPC-1 Storage Hierarchy Ratios

| | Addressable Storage Capacity | Configured Storage Capacity | Physical Storage Capacity |
|---|---|---|---|
| **Total ASU Capacity** | 93.46% | 29.56% | 29.41% |
| **Required for Data Protection (Mirroring)** | | 31.63% | 31.46% |
| **Addressable Storage Capacity** | | 31.63% | 31.46% |
| **Required Storage** | | 0.10% | 0.10% |
| **Configured Storage Capacity** | | | 99.47% |
| **Global Storage Overhead** | | | 0.53% |
| **Unused Storage:** | | | |
| **Addressable** | 6.538% | | |
| **Configured** | | 40.977% | |
| **Physical** | | | 0.000% |

The Physical Storage Capacity consisted of 10,277.102 GB distributed over 280 disk drives each with a formatted capacity of 36.704 GB. There was 0.000 GB (0.00 %) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 54.000 GB (0.53 %) of Physical Storage Capacity. There was 4,189.101 GB (40.977 %) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 93.46 % of the Addressable Storage Capacity resulting in 211.389 GB (6.538 %) of Unused Storage within the Addressable Storage Capacity.

### SPC-1 Storage Capacities and Relationships Illustration

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




## Logical Volume Capacity and ASU Mapping

*Clause 9.2.4.6.2*

*A table illustrating the capacity of each ASU and the mapping of Logical Volumes to ASUs shall be provided in the FDR. Logical Volumes shall be sequenced in the table from top to bottom per its position in the contiguous address space of each ASU. The capacity of each Logical Volume shall be stated. … In conjunction with this table, the Test Sponsor shall provide a complete description of the type of data protection (see Clause 2.4.5) used on each Logical Volume.*

| Logical Volume Capacity and Mapping | | |
|---|---|---|
| **ASU-1 (1,360.000 GB)** | **ASU-2 (1,360.000 GB)** | **ASU-3 (302.000 GB)** |
| 1 Logical Volume<br>727.711 GB per Logical Volume<br>(680.000 GB used per Logical Volume)<br><br>1 Logical Volume<br>729.808 GB per Logical Volume<br>(680.000 GB used per Logical Volume) | 2 Logical Volumes<br>733.583 GB per Logical Volume<br>(680.000 GB used per Logical Volume) | 1 Logical Volume<br>308.700 GB per Logical Volume<br>(302.000 GB used per Logical Volume) |

The Data Protection Level used for all Logical Volumes was Mirroring as described on page 10. See "ASU Configuration" in the **IOPS Test Results File** for more detailed configuration information.

# SPC-1 BENCHMARK EXECUTION RESULTS

## 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.*

***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.*

***Measurement Interval:*** *The finite and contiguous time period, after the Tested Storage Configuration (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.*

***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. Comment: Steady Stated is achieved only after caches in the TSC have filled and as a result the I/O Request throughput of the TSC has stabilized.*

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

***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.*

***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 Figure 5-1 below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.*

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

- **Data Persistence Test**
  - Data Persistence Test Run 1
  - Data Persistence Test Run 2
- **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

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 Tests may be executed in any sequence.

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 5.4.2.1*

*The Sustainability Test Phase consists of one Test Run at the 100% load point with a Measurement Interval of three (3) hours. The intent is to demonstrate a sustained maximum I/O Request Throughput as well as insuring the Tested Storage Configuration (TSC) has reached steady state prior to measuring the maximum I/O Request Throughput (SPC-1™ IOPS).*

*The reported I/O Request Throughput of the Sustainability Test Run must be within 5% of the reported SPC-1™ IOPS primary metric. The Average Response Time measured in Sustainability Test Run cannot exceed thirty (30) milliseconds.*

*Clause 9.2.4.7.1*

*For the Sustainability Test Phase the FDR shall contain:*

1. *A Data Rate Distribution (data table and graph).*
2. *I/O Request Throughput Distribution (data table and graph).*
3. *The human readable Test Run Results File produced by the Workload Generator.*
4. *A listing or screen image of all input parameters supplied to the Workload Generator.*
5. *The Measured Intensity Multiplier for each I/O stream.*
6. *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, and Response Time Ramp Test Runs are documented in "Appendix D: SPC-1 Workload Generator Input Parameters" on Page 64.

### Sustainability Test Results File

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

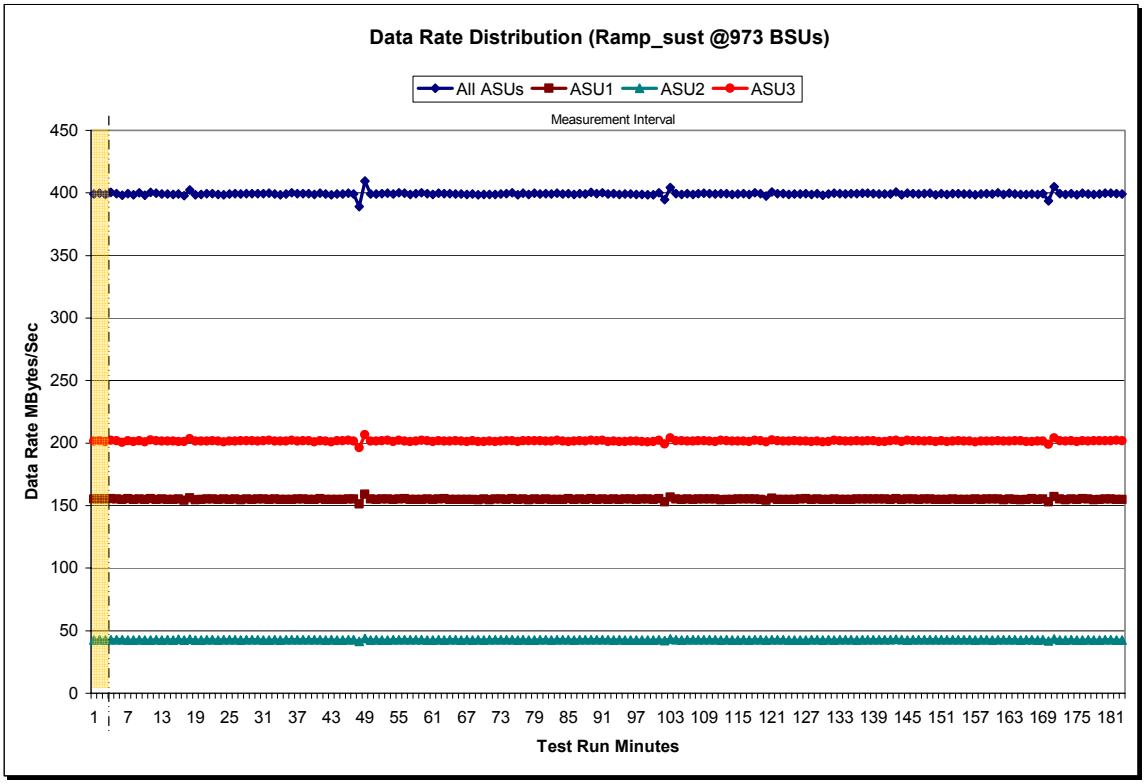
**Sustainability Test Results File**

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

| | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| **Ramp-Up/Start-Up** | 7:28:53 | 7:31:53 | 0-2 | 0:03:00 |
| **Measurement Interval** | 7:31:53 | 10:31:53 | 3-182 | 3:00:00 |

| Interval | All ASUs | ASU1 | ASU2 | ASU3 | Interval | All ASUs | ASU1 | ASU2 | ASU3 | Interval | All ASUs | ASU1 | ASU2 | ASU3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 399.25 | 155.08 | 42.60 | 201.57 | 63 | 399.30 | 154.85 | 42.84 | 201.61 | 126 | 399.41 | 155.35 | 42.50 | 201.56 |
| 1 | 399.67 | 155.29 | 42.62 | 201.77 | 64 | 399.24 | 154.79 | 42.67 | 201.77 | 127 | 398.86 | 154.91 | 42.60 | 201.34 |
| 2 | 398.83 | 155.03 | 42.50 | 201.31 | 65 | 399.07 | 155.01 | 42.57 | 201.48 | 128 | 399.36 | 155.11 | 42.65 | 201.60 |
| 3 | 400.38 | 155.38 | 42.79 | 202.21 | 66 | 398.79 | 154.76 | 42.85 | 201.18 | 129 | 398.18 | 154.75 | 42.51 | 200.92 |
| 4 | 399.50 | 155.03 | 42.75 | 201.73 | 67 | 399.12 | 154.95 | 42.42 | 201.75 | 130 | 399.03 | 155.00 | 42.74 | 201.29 |
| 5 | 398.05 | 154.86 | 42.73 | 200.46 | 68 | 398.54 | 154.52 | 42.67 | 201.35 | 131 | 399.83 | 155.17 | 42.54 | 202.13 |
| 6 | 399.54 | 155.35 | 42.43 | 201.76 | 69 | 398.82 | 155.03 | 42.54 | 201.25 | 132 | 399.31 | 154.93 | 42.65 | 201.72 |
| 7 | 398.64 | 154.87 | 42.54 | 201.24 | 70 | 398.96 | 154.66 | 42.64 | 201.67 | 133 | 399.29 | 154.93 | 42.88 | 201.47 |
| 8 | 399.95 | 155.30 | 42.70 | 201.95 | 71 | 398.89 | 155.14 | 42.71 | 201.04 | 134 | 399.30 | 155.00 | 42.84 | 201.47 |
| 9 | 398.15 | 155.00 | 42.28 | 200.86 | 72 | 399.23 | 155.15 | 42.72 | 201.36 | 135 | 399.61 | 155.03 | 42.59 | 201.98 |
| 10 | 400.36 | 155.35 | 42.50 | 202.50 | 73 | 399.37 | 154.95 | 42.61 | 201.81 | 136 | 399.70 | 155.27 | 42.84 | 201.58 |
| 11 | 399.68 | 154.96 | 42.81 | 201.91 | 74 | 400.09 | 155.41 | 42.68 | 202.00 | 137 | 399.89 | 155.19 | 42.74 | 201.97 |
| 12 | 399.20 | 155.09 | 42.51 | 201.60 | 75 | 398.58 | 154.85 | 42.53 | 201.20 | 138 | 399.51 | 155.03 | 42.68 | 201.81 |
| 13 | 399.09 | 154.87 | 42.69 | 201.53 | 76 | 399.73 | 155.18 | 42.76 | 201.79 | 139 | 399.21 | 155.09 | 42.79 | 201.33 |
| 14 | 398.85 | 154.78 | 42.53 | 201.53 | 77 | 398.89 | 154.68 | 42.43 | 201.78 | 140 | 399.28 | 155.23 | 42.86 | 201.19 |
| 15 | 399.23 | 155.10 | 43.00 | 201.13 | 78 | 399.64 | 155.10 | 42.54 | 202.00 | 141 | 399.28 | 154.95 | 42.65 | 201.68 |
| 16 | 397.95 | 154.34 | 42.54 | 201.07 | 79 | 399.24 | 154.82 | 42.73 | 201.69 | 142 | 400.70 | 155.45 | 42.94 | 202.31 |
| 17 | 402.43 | 156.05 | 43.07 | 203.31 | 80 | 399.51 | 155.17 | 42.74 | 201.60 | 143 | 398.54 | 154.84 | 42.62 | 201.08 |
| 18 | 398.37 | 154.41 | 42.44 | 201.53 | 81 | 399.07 | 154.97 | 42.45 | 201.65 | 144 | 399.75 | 155.12 | 42.45 | 202.18 |
| 19 | 398.93 | 154.90 | 42.47 | 201.57 | 82 | 399.63 | 154.91 | 42.68 | 202.03 | 145 | 399.39 | 155.04 | 42.63 | 201.72 |
| 20 | 399.33 | 155.03 | 42.64 | 201.66 | 83 | 399.12 | 154.85 | 42.66 | 201.62 | 146 | 399.18 | 154.78 | 42.72 | 201.68 |
| 21 | 399.45 | 155.10 | 42.67 | 201.68 | 84 | 399.37 | 155.47 | 42.68 | 201.22 | 147 | 399.50 | 155.19 | 42.72 | 201.59 |
| 22 | 398.92 | 154.77 | 42.57 | 201.57 | 85 | 398.74 | 154.91 | 42.45 | 201.38 | 148 | 399.64 | 155.08 | 42.72 | 201.84 |
| 23 | 398.56 | 155.08 | 42.65 | 200.83 | 86 | 399.39 | 155.07 | 42.63 | 201.68 | 149 | 398.64 | 154.86 | 42.70 | 201.08 |
| 24 | 399.26 | 154.97 | 42.76 | 201.54 | 87 | 399.00 | 154.77 | 42.62 | 201.61 | 150 | 399.30 | 154.90 | 42.65 | 201.75 |
| 25 | 399.50 | 155.21 | 42.78 | 201.51 | 88 | 400.35 | 155.48 | 42.79 | 202.08 | 151 | 398.81 | 154.94 | 42.63 | 201.23 |
| 26 | 399.14 | 154.65 | 42.51 | 201.97 | 89 | 399.60 | 154.95 | 42.77 | 201.89 | 152 | 399.57 | 155.30 | 42.74 | 201.53 |
| 27 | 399.58 | 155.04 | 42.71 | 201.83 | 90 | 399.99 | 155.34 | 42.62 | 202.02 | 153 | 399.62 | 155.01 | 42.70 | 201.91 |
| 28 | 399.51 | 154.90 | 42.63 | 201.98 | 91 | 399.11 | 154.97 | 42.82 | 201.32 | 154 | 399.05 | 154.81 | 42.70 | 201.54 |
| 29 | 399.44 | 155.06 | 42.80 | 201.57 | 92 | 399.55 | 155.34 | 42.57 | 201.63 | 155 | 399.16 | 154.97 | 42.69 | 201.50 |
| 30 | 399.44 | 155.04 | 42.58 | 201.82 | 93 | 398.70 | 154.79 | 42.66 | 201.25 | 156 | 398.58 | 155.17 | 42.40 | 201.02 |
| 31 | 399.67 | 154.90 | 42.50 | 202.27 | 94 | 399.03 | 155.13 | 42.56 | 201.34 | 157 | 399.04 | 154.87 | 42.70 | 201.48 |
| 32 | 399.27 | 155.08 | 42.67 | 201.52 | 95 | 399.23 | 155.18 | 42.59 | 201.46 | 158 | 399.33 | 155.16 | 42.68 | 201.50 |
| 33 | 398.58 | 154.75 | 42.46 | 201.37 | 96 | 398.92 | 154.84 | 42.50 | 201.58 | 159 | 398.98 | 155.04 | 42.49 | 201.45 |
| 34 | 399.25 | 154.95 | 42.62 | 201.67 | 97 | 398.91 | 155.04 | 42.54 | 201.33 | 160 | 399.95 | 155.25 | 42.86 | 201.84 |
| 35 | 400.02 | 155.02 | 42.88 | 202.12 | 98 | 398.49 | 155.23 | 42.52 | 200.74 | 161 | 398.94 | 154.64 | 42.67 | 201.63 |
| 36 | 399.57 | 155.32 | 42.65 | 201.61 | 99 | 398.35 | 154.88 | 42.43 | 201.04 | 162 | 399.76 | 155.27 | 42.89 | 201.61 |
| 37 | 399.59 | 155.08 | 42.67 | 201.83 | 100 | 400.18 | 155.48 | 42.63 | 202.07 | 163 | 399.17 | 154.72 | 42.73 | 201.72 |
| 38 | 399.50 | 154.94 | 42.63 | 201.93 | 101 | 394.49 | 153.07 | 42.15 | 199.26 | 164 | 398.93 | 154.64 | 42.60 | 201.69 |
| 39 | 398.69 | 154.92 | 42.80 | 200.96 | 102 | 404.18 | 156.82 | 43.27 | 204.09 | 165 | 398.82 | 154.90 | 42.63 | 201.29 |
| 40 | 399.85 | 155.37 | 42.65 | 201.83 | 103 | 399.56 | 155.06 | 42.71 | 201.78 | 166 | 399.19 | 155.38 | 42.71 | 201.10 |
| 41 | 399.19 | 154.97 | 42.57 | 201.66 | 104 | 398.93 | 154.86 | 42.37 | 201.70 | 167 | 398.92 | 154.83 | 42.60 | 201.49 |
| 42 | 398.49 | 154.88 | 42.64 | 200.97 | 105 | 399.36 | 155.05 | 42.86 | 201.44 | 168 | 399.31 | 155.21 | 42.73 | 201.36 |
| 43 | 399.21 | 154.76 | 42.57 | 201.88 | 106 | 398.91 | 154.82 | 42.66 | 201.42 | 169 | 393.70 | 152.98 | 41.94 | 198.78 |
| 44 | 399.22 | 155.02 | 42.46 | 201.74 | 107 | 399.49 | 155.06 | 42.64 | 201.78 | 170 | 405.01 | 157.28 | 43.48 | 204.24 |
| 45 | 399.93 | 155.22 | 42.61 | 202.11 | 108 | 399.65 | 155.22 | 42.72 | 201.71 | 171 | 399.61 | 155.09 | 42.57 | 201.95 |
| 46 | 399.22 | 155.15 | 42.65 | 201.42 | 109 | 399.49 | 155.03 | 42.82 | 201.64 | 172 | 398.72 | 154.63 | 42.53 | 201.56 |
| 47 | 389.23 | 151.31 | 41.49 | 196.44 | 110 | 399.08 | 155.10 | 42.70 | 201.29 | 173 | 399.53 | 155.18 | 42.61 | 201.75 |
| 48 | 409.62 | 159.04 | 43.78 | 206.80 | 111 | 399.33 | 154.65 | 42.60 | 202.07 | 174 | 398.44 | 154.73 | 42.60 | 201.11 |
| 49 | 399.10 | 155.11 | 42.51 | 201.48 | 112 | 399.38 | 154.97 | 42.73 | 201.67 | 175 | 399.71 | 155.35 | 42.54 | 201.82 |
| 50 | 399.10 | 154.82 | 42.64 | 201.64 | 113 | 398.89 | 154.98 | 42.54 | 201.36 | 176 | 399.15 | 155.07 | 42.68 | 201.40 |
| 51 | 399.39 | 155.03 | 42.49 | 201.87 | 114 | 399.08 | 155.03 | 42.43 | 201.62 | 177 | 398.93 | 154.69 | 42.52 | 201.71 |
| 52 | 399.72 | 155.08 | 42.58 | 202.06 | 115 | 399.50 | 155.33 | 42.73 | 201.43 | 178 | 399.17 | 154.88 | 42.59 | 201.69 |
| 53 | 399.02 | 155.00 | 42.85 | 201.17 | 116 | 398.92 | 155.20 | 42.40 | 201.33 | 179 | 399.78 | 155.30 | 42.62 | 201.85 |
| 54 | 400.08 | 155.02 | 42.77 | 202.29 | 117 | 399.99 | 155.28 | 42.65 | 202.06 | 180 | 399.79 | 155.30 | 42.62 | 201.87 |
| 55 | 399.77 | 155.48 | 42.74 | 201.55 | 118 | 399.43 | 154.84 | 42.62 | 201.97 | 181 | 399.60 | 154.98 | 42.50 | 202.12 |
| 56 | 398.67 | 154.80 | 42.67 | 201.20 | 119 | 397.67 | 154.37 | 42.45 | 200.85 | 182 | 399.13 | 154.95 | 42.50 | 201.69 |
| 57 | 399.34 | 155.01 | 42.75 | 201.58 | 120 | 400.90 | 155.74 | 42.64 | 202.52 | | | | | |
| 58 | 399.99 | 155.01 | 42.71 | 202.27 | 121 | 399.44 | 154.85 | 42.61 | 201.98 | | | | | |
| 59 | 399.56 | 155.21 | 42.60 | 201.75 | 122 | 399.32 | 154.97 | 42.78 | 201.57 | | | | | |
| 60 | 398.68 | 154.76 | 42.58 | 201.34 | 123 | 398.90 | 154.93 | 42.52 | 201.45 | | | | | |
| 61 | 399.85 | 155.18 | 42.73 | 201.94 | 124 | 399.26 | 154.88 | 42.59 | 201.79 | | | | | |
| 62 | 399.37 | 155.36 | 42.53 | 201.48 | 125 | 399.18 | 155.20 | 42.60 | 201.38 | | | | | |

## Sustainability – Data Rate Distribution Graph

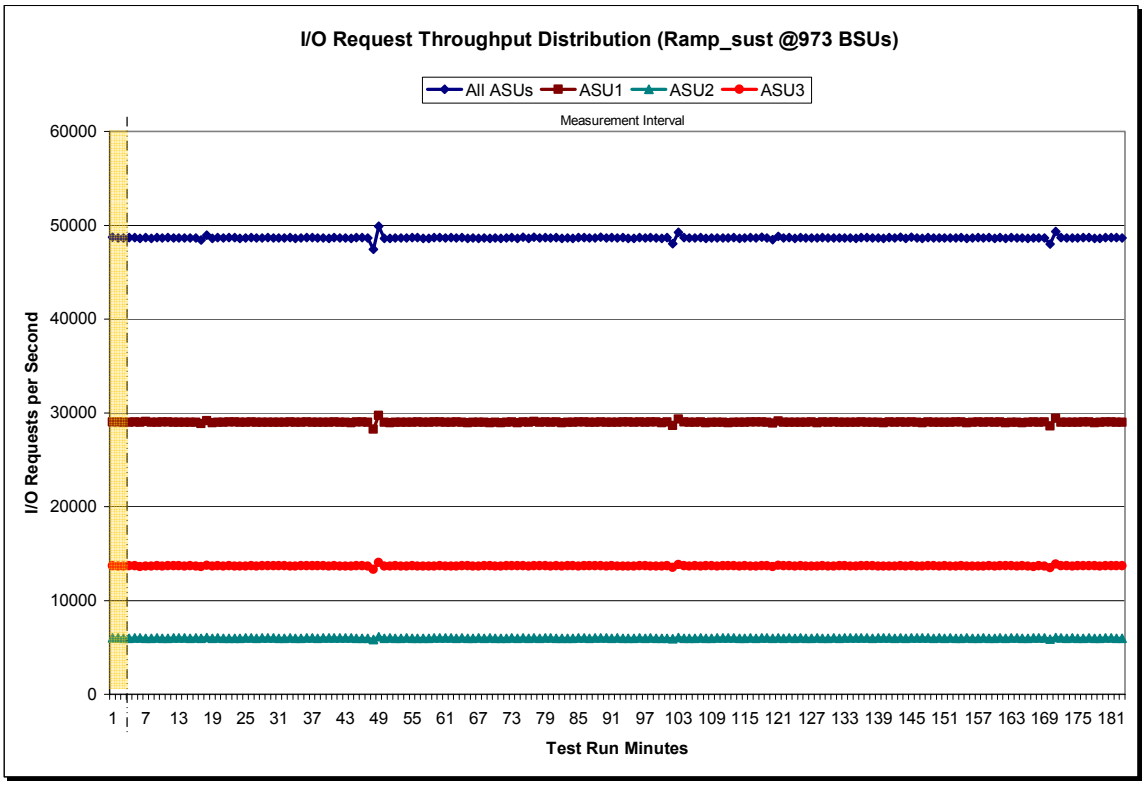


## Sustainability – I/O Request Throughput Distribution Data

| | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| **Ramp-Up/Start-Up** | 7:28:53 | 7:31:53 | 0-2 | 0:03:00 |
| **Measurement Interval** | 7:31:53 | 10:31:53 | 3-182 | 3:00:00 |

| Interval | All ASUs | ASU1 | ASU2 | ASU3 | Interval | All ASUs | ASU1 | ASU2 | ASU3 | Interval | All ASUs | ASU1 | ASU2 | ASU3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 48,725.25 | 29,027.20 | 5,990.22 | 13,707.83 | 63 | 48,663.37 | 28,985.18 | 5,993.63 | 13,684.55 | 126 | 48,653.15 | 29,016.75 | 5,970.40 | 13,666.00 |
| 1 | 48,660.33 | 29,011.32 | 5,987.92 | 13,661.10 | 64 | 48,609.68 | 28,957.75 | 5,968.22 | 13,683.72 | 127 | 48,625.63 | 28,962.18 | 5,993.53 | 13,669.92 |
| 2 | 48,642.33 | 29,006.05 | 5,974.68 | 13,661.60 | 65 | 48,624.85 | 29,000.25 | 5,970.15 | 13,654.45 | 128 | 48,663.50 | 29,012.07 | 5,977.17 | 13,674.27 |
| 3 | 48,682.50 | 28,995.33 | 5,978.88 | 13,708.28 | 66 | 48,612.20 | 28,976.78 | 5,995.05 | 13,640.37 | 129 | 48,621.98 | 28,981.90 | 5,982.67 | 13,657.42 |
| 4 | 48,698.70 | 29,032.50 | 5,989.30 | 13,676.90 | 67 | 48,635.73 | 28,983.88 | 5,977.58 | 13,674.27 | 130 | 48,660.15 | 29,006.92 | 5,985.53 | 13,667.70 |
| 5 | 48,579.03 | 28,968.42 | 5,984.12 | 13,626.50 | 68 | 48,611.12 | 28,947.58 | 5,987.33 | 13,676.20 | 131 | 48,643.27 | 28,992.03 | 5,975.65 | 13,675.58 |
| 6 | 48,699.92 | 29,056.47 | 5,977.68 | 13,665.77 | 69 | 48,631.57 | 28,989.55 | 5,978.75 | 13,663.27 | 132 | 48,640.93 | 28,982.03 | 5,986.58 | 13,672.32 |
| 7 | 48,612.02 | 28,980.33 | 5,975.63 | 13,656.05 | 70 | 48,575.90 | 28,934.20 | 5,979.75 | 13,661.95 | 133 | 48,633.07 | 28,973.97 | 6,006.90 | 13,652.20 |
| 8 | 48,678.52 | 29,002.78 | 5,987.20 | 13,688.53 | 71 | 48,654.28 | 29,004.00 | 5,976.02 | 13,674.27 | 134 | 48,614.15 | 28,974.47 | 5,990.48 | 13,649.20 |
| 9 | 48,635.40 | 29,015.22 | 5,972.73 | 13,647.45 | 72 | 48,699.38 | 29,030.70 | 5,984.55 | 13,684.13 | 135 | 48,687.77 | 29,011.03 | 5,989.53 | 13,687.20 |
| 10 | 48,700.27 | 29,027.22 | 5,978.63 | 13,694.42 | 73 | 48,612.70 | 28,957.00 | 5,976.38 | 13,679.32 | 136 | 48,675.17 | 28,996.02 | 5,997.30 | 13,681.85 |
| 11 | 48,656.50 | 28,996.97 | 5,983.03 | 13,676.50 | 74 | 48,705.88 | 29,042.30 | 5,987.15 | 13,676.43 | 137 | 48,648.28 | 28,986.52 | 5,978.22 | 13,683.55 |
| 12 | 48,658.33 | 28,997.53 | 5,985.65 | 13,675.15 | 75 | 48,593.05 | 28,965.87 | 5,982.50 | 13,644.68 | 138 | 48,658.92 | 28,996.17 | 5,991.58 | 13,671.17 |
| 13 | 48,625.42 | 28,982.35 | 5,985.82 | 13,657.25 | 76 | 48,739.65 | 29,060.92 | 5,998.53 | 13,680.20 | 139 | 48,601.00 | 28,955.90 | 5,994.80 | 13,650.30 |
| 14 | 48,634.20 | 28,986.82 | 5,972.38 | 13,675.00 | 77 | 48,627.78 | 28,983.83 | 5,961.00 | 13,682.95 | 140 | 48,682.13 | 29,024.42 | 5,990.78 | 13,666.93 |
| 15 | 48,625.97 | 28,992.65 | 5,986.55 | 13,646.77 | 78 | 48,684.45 | 29,015.87 | 5,990.52 | 13,678.07 | 141 | 48,641.25 | 29,002.07 | 5,980.63 | 13,658.55 |
| 16 | 48,425.42 | 28,847.57 | 5,969.97 | 13,607.88 | 79 | 48,630.63 | 28,979.93 | 5,983.98 | 13,666.72 | 142 | 48,738.50 | 29,043.58 | 6,003.43 | 13,691.48 |
| 17 | 48,932.47 | 29,145.48 | 6,036.85 | 13,750.13 | 80 | 48,683.00 | 29,014.13 | 5,978.05 | 13,690.82 | 143 | 48,582.95 | 28,971.73 | 5,971.18 | 13,640.03 |
| 18 | 48,596.50 | 28,962.33 | 5,978.55 | 13,655.62 | 81 | 48,597.18 | 28,960.82 | 5,967.13 | 13,669.23 | 144 | 48,726.23 | 29,034.25 | 5,988.18 | 13,703.80 |
| 19 | 48,661.68 | 28,995.28 | 5,989.20 | 13,677.20 | 82 | 48,635.32 | 28,972.07 | 5,977.57 | 13,685.68 | 145 | 48,637.32 | 28,976.13 | 5,990.38 | 13,670.80 |
| 20 | 48,649.07 | 29,003.45 | 5,977.87 | 13,667.75 | 83 | 48,616.72 | 28,963.52 | 5,978.70 | 13,674.50 | 146 | 48,617.05 | 28,961.57 | 5,995.50 | 13,659.98 |
| 21 | 48,686.28 | 29,013.77 | 5,978.28 | 13,694.23 | 84 | 48,701.65 | 29,041.58 | 5,990.00 | 13,670.07 | 147 | 48,693.18 | 29,013.97 | 5,989.80 | 13,689.42 |
| 22 | 48,662.70 | 29,019.68 | 5,974.95 | 13,668.07 | 85 | 48,703.03 | 29,013.55 | 5,998.52 | 13,690.97 | 148 | 48,657.45 | 29,003.08 | 5,979.60 | 13,674.77 |
| 23 | 48,589.43 | 28,967.97 | 5,975.22 | 13,646.25 | 86 | 48,653.78 | 28,987.08 | 5,974.40 | 13,692.30 | 149 | 48,636.58 | 28,978.93 | 5,987.15 | 13,670.50 |
| 24 | 48,628.40 | 28,984.38 | 5,991.77 | 13,652.25 | 87 | 48,652.80 | 28,992.48 | 5,983.70 | 13,676.62 | 150 | 48,648.23 | 28,987.13 | 5,979.62 | 13,681.48 |
| 25 | 48,688.98 | 29,022.28 | 5,988.10 | 13,678.60 | 88 | 48,729.95 | 29,046.97 | 5,990.25 | 13,692.73 | 151 | 48,656.47 | 28,997.85 | 5,990.72 | 13,667.90 |
| 26 | 48,627.00 | 28,990.57 | 5,973.98 | 13,662.45 | 89 | 48,655.78 | 28,999.12 | 5,986.25 | 13,670.42 | 152 | 48,659.35 | 29,017.65 | 5,979.53 | 13,662.17 |
| 27 | 48,653.28 | 28,992.37 | 5,985.68 | 13,675.23 | 90 | 48,666.13 | 29,005.38 | 5,974.25 | 13,686.50 | 153 | 48,683.58 | 29,007.10 | 5,978.50 | 13,697.98 |
| 28 | 48,663.57 | 28,981.00 | 5,991.88 | 13,690.68 | 91 | 48,647.32 | 29,004.23 | 5,990.03 | 13,653.05 | 154 | 48,580.22 | 28,945.63 | 5,988.57 | 13,646.02 |
| 29 | 48,659.00 | 28,994.17 | 5,990.00 | 13,674.83 | 92 | 48,669.95 | 29,031.22 | 5,971.20 | 13,667.53 | 155 | 48,622.58 | 28,980.03 | 5,978.25 | 13,664.30 |
| 30 | 48,630.58 | 28,973.80 | 5,981.35 | 13,675.43 | 93 | 48,609.20 | 29,007.98 | 5,959.15 | 13,642.07 | 156 | 48,678.43 | 29,032.75 | 5,981.32 | 13,664.37 |
| 31 | 48,637.80 | 28,985.00 | 5,975.45 | 13,677.35 | 94 | 48,614.72 | 28,966.48 | 5,977.65 | 13,670.58 | 157 | 48,632.33 | 28,974.60 | 5,994.47 | 13,663.27 |
| 32 | 48,673.40 | 29,016.80 | 5,990.37 | 13,666.23 | 95 | 48,679.98 | 29,012.55 | 5,987.30 | 13,680.13 | 158 | 48,690.80 | 29,030.73 | 5,975.32 | 13,684.75 |
| 33 | 48,588.67 | 28,970.78 | 5,970.52 | 13,647.37 | 96 | 48,632.43 | 28,979.02 | 5,974.82 | 13,678.60 | 159 | 48,606.32 | 28,984.75 | 5,968.10 | 13,653.47 |
| 34 | 48,648.78 | 28,987.37 | 5,980.87 | 13,680.55 | 97 | 48,662.02 | 29,011.32 | 5,992.05 | 13,658.65 | 160 | 48,696.82 | 29,015.35 | 6,000.48 | 13,680.98 |
| 35 | 48,683.80 | 29,021.95 | 5,984.17 | 13,677.68 | 98 | 48,644.68 | 29,022.78 | 5,976.10 | 13,645.80 | 161 | 48,608.63 | 28,957.63 | 5,976.02 | 13,674.98 |
| 36 | 48,669.78 | 28,990.55 | 5,998.52 | 13,680.72 | 99 | 48,578.10 | 28,953.05 | 5,969.65 | 13,655.40 | 162 | 48,674.70 | 28,999.70 | 5,988.03 | 13,686.97 |
| 37 | 48,645.55 | 28,990.22 | 5,978.15 | 13,677.18 | 100 | 48,668.85 | 29,011.28 | 5,982.17 | 13,675.40 | 163 | 48,618.95 | 28,976.65 | 5,989.18 | 13,653.12 |
| 38 | 48,648.97 | 28,987.25 | 5,984.50 | 13,677.22 | 101 | 48,052.17 | 28,638.80 | 5,907.78 | 13,505.58 | 164 | 48,620.42 | 28,959.62 | 5,981.32 | 13,679.48 |
| 39 | 48,612.83 | 28,972.40 | 5,994.83 | 13,645.60 | 102 | 49,237.38 | 29,332.40 | 6,066.57 | 13,838.42 | 165 | 48,610.97 | 28,972.82 | 5,980.30 | 13,657.85 |
| 40 | 48,689.13 | 29,027.20 | 5,987.45 | 13,674.48 | 103 | 48,669.20 | 29,013.05 | 5,976.63 | 13,679.52 | 166 | 48,627.83 | 29,012.93 | 5,986.73 | 13,628.17 |
| 41 | 48,637.37 | 28,978.67 | 5,987.35 | 13,671.35 | 104 | 48,626.80 | 28,986.72 | 5,976.70 | 13,663.38 | 167 | 48,645.90 | 28,970.38 | 5,991.10 | 13,684.42 |
| 42 | 48,618.90 | 28,979.68 | 5,984.55 | 13,654.67 | 105 | 48,659.42 | 28,994.40 | 5,973.27 | 13,691.75 | 168 | 48,659.27 | 29,009.07 | 6,009.57 | 13,640.63 |
| 43 | 48,611.73 | 28,955.77 | 5,986.75 | 13,669.22 | 106 | 48,668.53 | 29,013.67 | 5,985.63 | 13,669.23 | 169 | 47,971.30 | 28,610.78 | 5,895.60 | 13,464.92 |
| 44 | 48,700.32 | 29,019.35 | 5,981.62 | 13,699.35 | 107 | 48,612.27 | 28,962.15 | 5,965.72 | 13,684.40 | 170 | 49,318.12 | 29,405.78 | 6,066.88 | 13,845.45 |
| 45 | 48,684.20 | 29,015.08 | 5,979.73 | 13,689.38 | 108 | 48,621.82 | 28,967.92 | 5,977.10 | 13,676.80 | 171 | 48,669.50 | 28,985.15 | 5,988.33 | 13,696.02 |
| 46 | 48,632.20 | 29,003.90 | 5,970.55 | 13,657.75 | 109 | 48,633.95 | 28,984.73 | 5,985.63 | 13,663.58 | 172 | 48,626.72 | 28,969.05 | 5,980.67 | 13,677.00 |
| 47 | 47,408.37 | 28,258.78 | 5,827.88 | 13,321.70 | 110 | 48,645.33 | 28,980.47 | 5,986.23 | 13,678.63 | 173 | 48,651.40 | 29,002.95 | 5,984.85 | 13,663.60 |
| 48 | 49,892.75 | 29,732.83 | 6,134.78 | 14,025.13 | 111 | 48,625.28 | 28,961.45 | 5,983.20 | 13,680.63 | 174 | 48,650.38 | 28,999.63 | 5,978.65 | 13,672.10 |
| 49 | 48,610.57 | 28,991.55 | 5,974.40 | 13,644.62 | 112 | 48,676.68 | 29,000.43 | 5,996.28 | 13,679.97 | 175 | 48,682.57 | 29,016.42 | 5,972.15 | 13,694.00 |
| 50 | 48,579.52 | 28,937.90 | 5,983.12 | 13,658.50 | 113 | 48,605.93 | 28,985.62 | 5,967.83 | 13,652.48 | 176 | 48,693.58 | 29,020.98 | 6,000.33 | 13,672.27 |
| 51 | 48,640.63 | 28,988.28 | 5,964.98 | 13,687.37 | 114 | 48,646.98 | 28,999.92 | 5,971.33 | 13,675.73 | 177 | 48,594.17 | 28,956.62 | 5,961.45 | 13,676.10 |
| 52 | 48,651.02 | 28,999.78 | 5,979.60 | 13,671.63 | 115 | 48,677.88 | 29,033.88 | 5,985.38 | 13,658.62 | 178 | 48,615.02 | 28,986.82 | 5,978.32 | 13,649.88 |
| 53 | 48,631.25 | 28,988.15 | 5,991.83 | 13,651.27 | 116 | 48,638.75 | 29,014.08 | 5,953.85 | 13,670.82 | 179 | 48,695.65 | 29,008.00 | 6,000.43 | 13,687.22 |
| 54 | 48,662.32 | 28,991.90 | 5,979.90 | 13,690.52 | 117 | 48,734.07 | 29,046.45 | 5,991.13 | 13,696.48 | 180 | 48,681.80 | 29,017.05 | 5,986.58 | 13,678.17 |
| 55 | 48,689.80 | 29,040.17 | 5,980.15 | 13,669.48 | 118 | 48,649.08 | 28,977.18 | 5,988.17 | 13,683.73 | 181 | 48,673.52 | 28,996.62 | 5,977.65 | 13,699.25 |
| 56 | 48,608.62 | 28,963.78 | 5,976.63 | 13,668.20 | 119 | 48,455.13 | 28,889.98 | 5,954.42 | 13,610.73 | 182 | 48,648.23 | 28,993.65 | 5,974.78 | 13,679.80 |
| 57 | 48,616.62 | 28,992.63 | 5,976.10 | 13,647.88 | 120 | 48,823.15 | 29,096.83 | 6,007.57 | 13,718.75 | Average | 48,648.63 | 28,994.69 | 5,982.97 | 13,670.96 |
| 58 | 48,664.57 | 29,014.33 | 5,983.53 | 13,666.70 | 121 | 48,646.93 | 28,980.85 | 5,976.53 | 13,689.55 | | | | | |
| 59 | 48,675.82 | 29,013.82 | 5,986.78 | 13,675.22 | 122 | 48,678.45 | 29,006.35 | 5,995.45 | 13,676.65 | | | | | |
| 60 | 48,655.20 | 28,999.77 | 5,993.53 | 13,661.90 | 123 | 48,616.57 | 28,975.23 | 5,978.18 | 13,663.15 | | | | | |
| 61 | 48,661.65 | 28,996.32 | 6,003.08 | 13,662.25 | 124 | 48,664.27 | 28,986.15 | 5,995.83 | 13,682.28 | | | | | |
| 62 | 48,638.17 | 29,024.00 | 5,966.43 | 13,647.73 | 125 | 48,627.30 | 28,979.92 | 5,978.12 | 13,669.27 | | | | | |

## Sustainability – I/O Request Throughput Distribution Graph




## Sustainability – 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 | 0.0250. | 0.2810 |
| COV | 0.003 | 0.001 | 0.002 | 0.001 | 0.005 | 0.002 | 0.003 | 0.001 |

***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.*

***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%.*

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

## Primary Metrics Test – IOPS Test Phase

*Clause 5.4.2.2*

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

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

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

*Clause 9.2.4.7.2*

*For the IOPS Test Phase the FDR shall contain:*

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

### SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, and Response Time Ramp Test Runs are documented in "Appendix D: SPC-1 Workload Generator Input Parameters" on Page 64.

### IOPS Test Results File

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

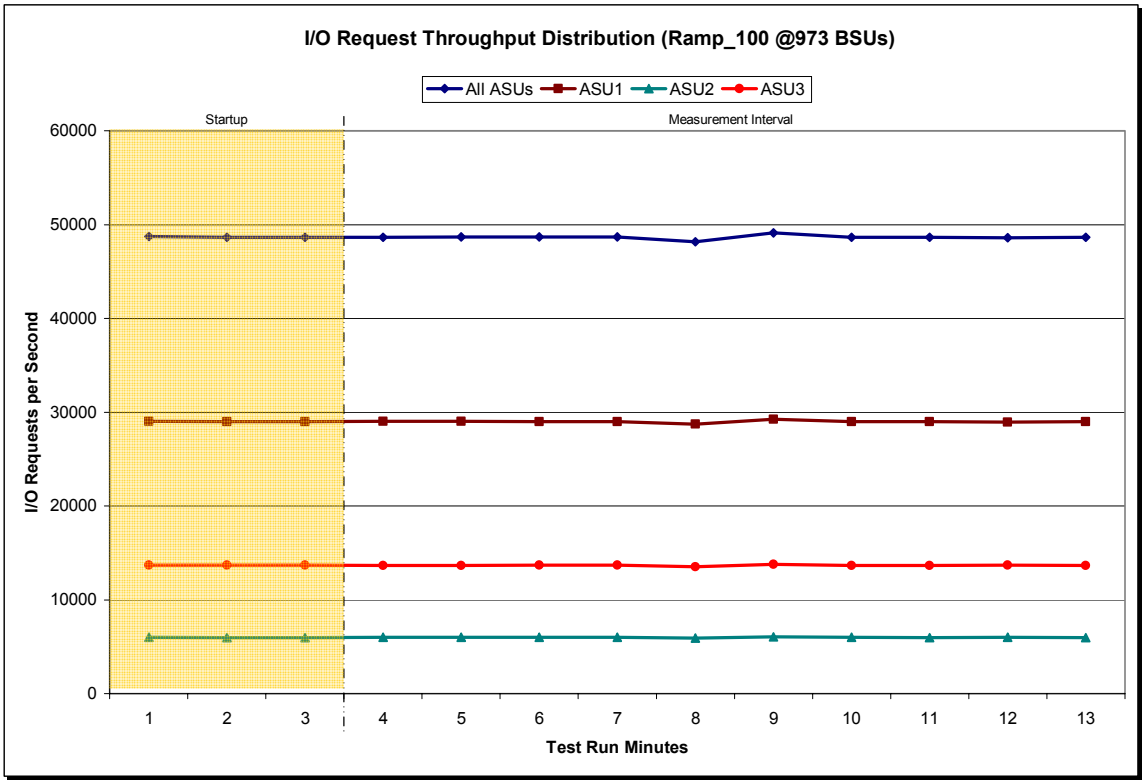
**IOPS Test Results File**

## IOPS Test Run – I/O Request Throughput Distribution Data

| 973 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 10:32:43 | 10:35:44 | 0-2 | 0:03:01 |
| *Measurement Interval* | 10:35:44 | 10:45:44 | 3-12 | 0:10:00 |

| 60 second intervals | All ASUs | ASU1 | ASU2 | ASU3 |
|---|---|---|---|---|
| 0 | 48,723.80 | 29,036.88 | 5,997.38 | 13,689.53 |
| 1 | 48,638.90 | 28,986.40 | 5,980.57 | 13,671.93 |
| 2 | 48,627.58 | 28,963.48 | 5,974.83 | 13,689.27 |
| 3 | 48,660.62 | 29,013.08 | 5,985.07 | 13,662.47 |
| 4 | 48,670.53 | 29,015.35 | 5,984.38 | 13,670.80 |
| 5 | 48,665.25 | 28,984.50 | 6,008.52 | 13,672.23 |
| 6 | 48,662.68 | 28,992.30 | 5,990.40 | 13,679.98 |
| 7 | 48,179.60 | 28,722.05 | 5,921.22 | 13,536.33 |
| 8 | 49,104.38 | 29,262.23 | 6,046.50 | 13,795.65 |
| 9 | 48,643.53 | 28,992.18 | 5,993.08 | 13,658.27 |
| 10 | 48,640.67 | 28,991.35 | 5,978.65 | 13,670.67 |
| 11 | 48,614.83 | 28,949.03 | 5,990.05 | 13,675.75 |
| 12 | 48,624.12 | 28,988.07 | 5,977.03 | 13,659.02 |
| Average | 48,646.62 | 28,991.02 | 5,987.49 | 13,668.12 |

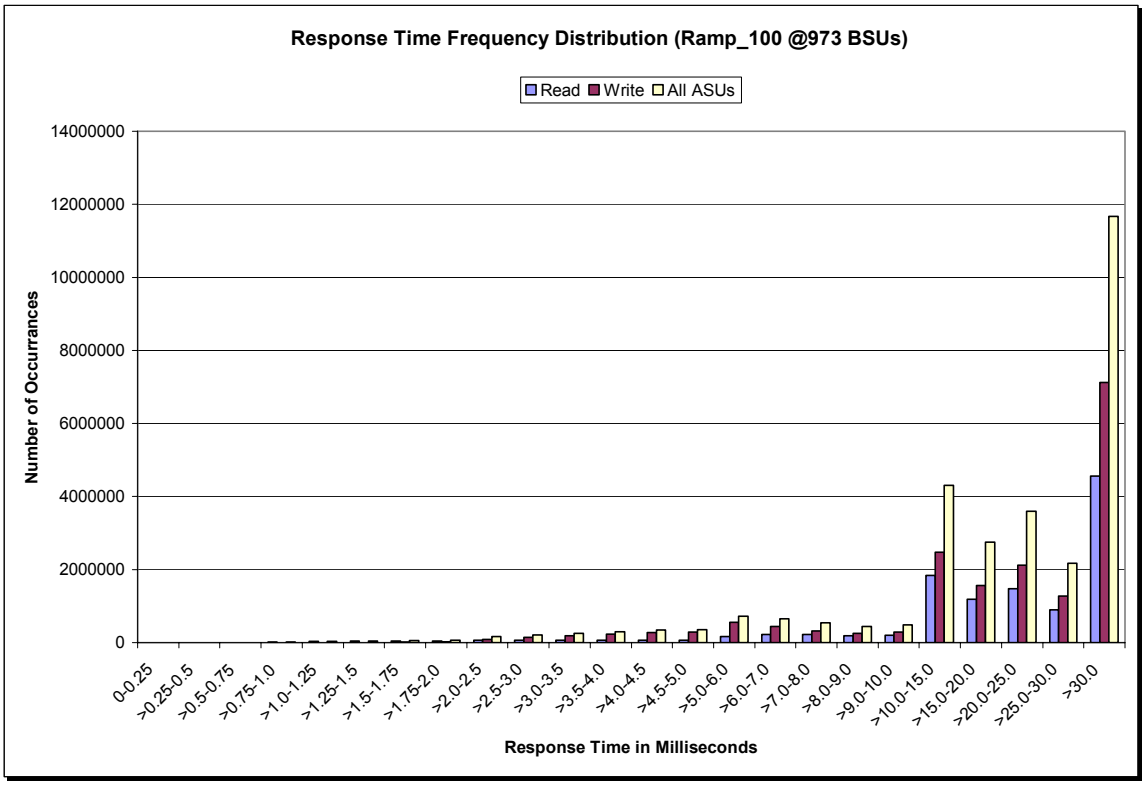
## IOPS Test Run – I/O Request Throughput Distribution Graph



## 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 | 0 | - | 310 | 10,312 | 32,217 | 41,719 | 41,786 | 39,202 |
| Write | 0 | - | - | - | 15 | 1,657 | 11,501 | 26,690 |
| All ASUs | 0 | - | 310 | 10,312 | 32,232 | 43,376 | 53,287 | 65,892 |
| ASU1 | 0 | - | 225 | 7,481 | 23,173 | 30,532 | 36,053 | 42,664 |
| ASU2 | 0 | - | 85 | 2,831 | 9,056 | 12,443 | 14,072 | 15,099 |
| ASU3 | 0 | - | - | - | 3 | 401 | 3,162 | 8,129 |
| **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 | 70,816 | 66,300 | 66,666 | 65,328 | 64,554 | 66,284 | 165,833 | 217,362 |
| Write | 94,277 | 143,404 | 191,234 | 237,249 | 274,227 | 292,683 | 552,938 | 438,340 |
| All ASUs | 165,093 | 209,704 | 257,900 | 302,577 | 338,781 | 358,967 | 718,771 | 655,702 |
| ASU1 | 100,884 | 122,192 | 146,246 | 168,304 | 186,025 | 196,525 | 403,729 | 390,335 |
| ASU2 | 33,549 | 37,881 | 43,519 | 48,346 | 51,100 | 51,269 | 94,478 | 80,530 |
| ASU3 | 30,660 | 49,631 | 68,135 | 85,927 | 101,656 | 111,173 | 220,564 | 184,837 |
| **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 | 220,465 | 187,230 | 196,603 | 1,837,557 | 1,181,668 | 1,477,151 | 901,762 | 4,556,863 |
| Write | 322,940 | 260,151 | 286,798 | 2,471,087 | 1,565,334 | 2,119,014 | 1,271,595 | 7,116,926 |
| All ASUs | 543,405 | 447,381 | 483,401 | 4,308,644 | 2,747,002 | 3,596,165 | 2,173,357 | 11,673,789 |
| ASU1 | 336,736 | 276,610 | 295,514 | 2,673,197 | 1,694,866 | 2,177,230 | 1,307,324 | 6,777,439 |
| ASU2 | 66,249 | 55,325 | 60,430 | 526,626 | 329,875 | 424,178 | 256,927 | 1,378,440 |
| ASU3 | 140,420 | 115,446 | 127,457 | 1,108,821 | 722,261 | 994,757 | 609,106 | 3,517,910 |

## IOPS Test Run –Response Time Frequency Distribution Graph

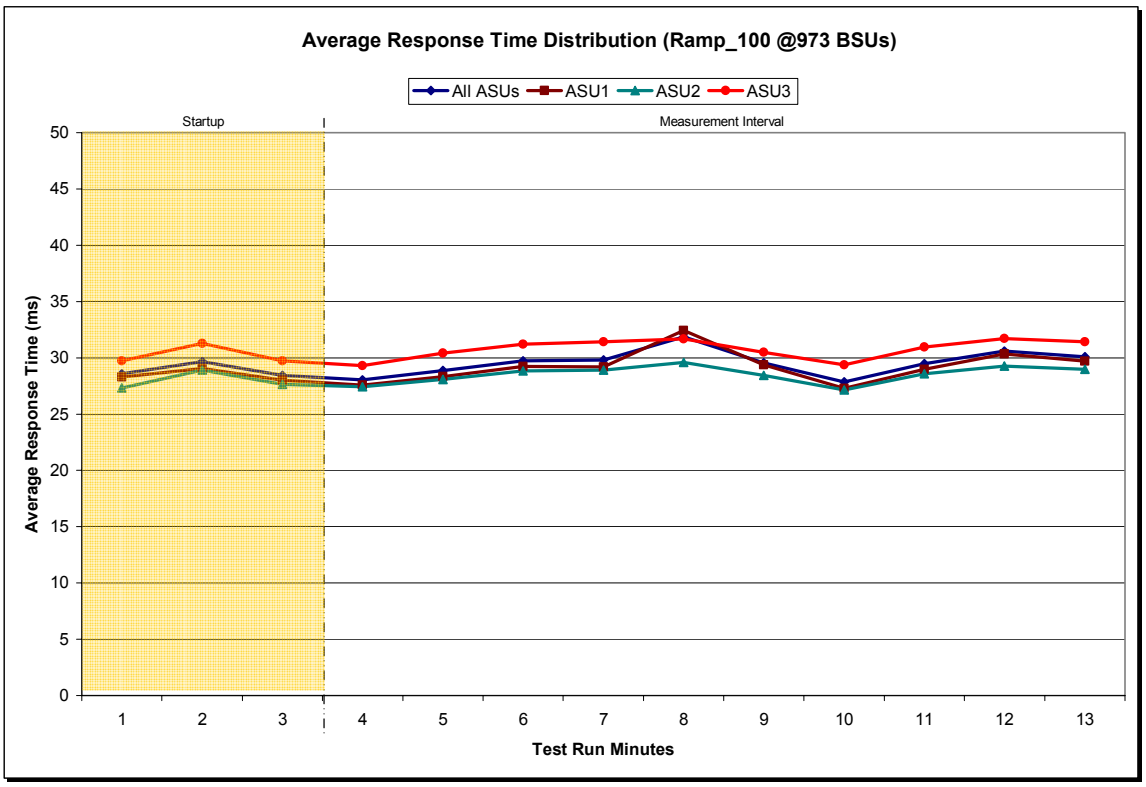


## IOPS Test Run – Average Response Time (ms) Distribution Data

| 973 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 10:32:43 | 10:35:44 | 0-2 | 0:03:01 |
| *Measurement Interval* | 10:35:44 | 10:45:44 | 3-12 | 0:10:00 |

| 60 second intervals | All ASUs | ASU1 | ASU2 | ASU3 |
|---|---|---|---|---|
| 0 | 28.59 | 28.30 | 27.34 | 29.75 |
| 1 | 29.67 | 29.06 | 28.92 | 31.29 |
| 2 | 28.44 | 28.00 | 27.63 | 29.72 |
| 3 | 28.05 | 27.58 | 27.43 | 29.31 |
| 4 | 28.87 | 28.31 | 28.07 | 30.41 |
| 5 | 29.74 | 29.23 | 28.85 | 31.21 |
| 6 | 29.79 | 29.20 | 28.92 | 31.42 |
| 7 | 31.87 | 32.42 | 29.60 | 31.67 |
| 8 | 29.57 | 29.36 | 28.44 | 30.51 |
| 9 | 27.86 | 27.28 | 27.15 | 29.39 |
| 10 | 29.49 | 28.98 | 28.59 | 30.95 |
| 11 | 30.60 | 30.35 | 29.26 | 31.73 |
| 12 | 30.08 | 29.68 | 28.96 | 31.41 |
| Average | 29.59 | 29.24 | 28.53 | 30.80 |

## IOPS Test Run – Average Response Time (ms) 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 |
|---|---|---|
| 29,186,048 | 17,512,259 | 29,186,048 |

## IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

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

***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.*

***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%.*

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

## Primary Metrics Test – Response Time Ramp Test Phase

*Clause 5.4.2.3*

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

*The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 11.*

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

*Clause 9.2.4.7.3*

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

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

### SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, and Response Time Ramp Test Runs are documented in "Appendix D: SPC-1 Workload Generator Input Parameters" on Page 64.

### 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 - 973 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| Start-Up/Ramp-Up | 10:32:43 | 10:35:44 | 0-2 | 0:03:01 |
| Measurement Interval | 10:35:44 | 10:45:44 | 3-12 | 0:10:00 |

| (60 second intervals) | All ASUs | ASU-1 | ASU-2 | ASU-3 |
|---|---|---|---|---|
| 0 | 48,723.80 | 29,036.88 | 5,997.38 | 13,689.53 |
| 1 | 48,638.90 | 28,986.40 | 5,980.57 | 13,671.93 |
| 2 | 48,627.58 | 28,963.48 | 5,974.83 | 13,689.27 |
| 3 | 48,660.62 | 29,013.08 | 5,985.07 | 13,662.47 |
| 4 | 48,670.53 | 29,015.35 | 5,984.38 | 13,670.80 |
| 5 | 48,665.25 | 28,984.50 | 6,008.52 | 13,672.23 |
| 6 | 48,662.68 | 28,992.30 | 5,990.40 | 13,679.98 |
| 7 | 48,179.60 | 28,722.05 | 5,921.22 | 13,536.33 |
| 8 | 49,104.38 | 29,262.23 | 6,046.50 | 13,795.65 |
| 9 | 48,643.53 | 28,992.18 | 5,993.08 | 13,658.27 |
| 10 | 48,640.67 | 28,991.35 | 5,978.65 | 13,670.67 |
| 11 | 48,614.83 | 28,949.03 | 5,990.05 | 13,675.75 |
| 12 | 48,624.12 | 28,988.07 | 5,977.03 | 13,659.02 |
| Average | 48,646.62 | 28,991.02 | 5,987.49 | 13,668.12 |

| 95% Load Level - 924 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| Start-Up/Ramp-Up | 10:46:13 | 10:49:14 | 0-2 | 0:03:01 |
| Measurement Interval | 10:49:14 | 10:59:14 | 3-12 | 0:10:00 |

| (60 second intervals) | All ASUs | ASU-1 | ASU-2 | ASU-3 |
|---|---|---|---|---|
| 0 | 46,148.68 | 27,488.20 | 5,679.93 | 12,980.55 |
| 1 | 46,196.98 | 27,554.92 | 5,677.68 | 12,964.38 |
| 2 | 46,178.03 | 27,547.37 | 5,676.23 | 12,954.43 |
| 3 | 46,211.78 | 27,534.40 | 5,689.43 | 12,987.95 |
| 4 | 46,190.98 | 27,532.62 | 5,680.10 | 12,978.27 |
| 5 | 46,241.13 | 27,549.83 | 5,677.07 | 13,014.23 |
| 6 | 46,164.97 | 27,513.27 | 5,681.28 | 12,970.42 |
| 7 | 46,180.40 | 27,532.72 | 5,670.40 | 12,977.28 |
| 8 | 46,238.40 | 27,528.15 | 5,692.00 | 13,018.25 |
| 9 | 46,175.45 | 27,491.55 | 5,688.37 | 12,995.53 |
| 10 | 46,176.72 | 27,526.80 | 5,677.65 | 12,972.27 |
| 11 | 46,235.02 | 27,568.87 | 5,693.95 | 12,972.20 |
| 12 | 46,164.20 | 27,499.72 | 5,690.72 | 12,973.77 |
| Average | 46,197.91 | 27,527.79 | 5,684.10 | 12,986.02 |

| 90% Load Level - 875 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| Start-Up/Ramp-Up | 10:59:41 | 11:02:42 | 0-2 | 0:03:01 |
| Measurement Interval | 11:02:42 | 11:12:42 | 3-12 | 0:10:00 |

| (60 second intervals) | All ASUs | ASU-1 | ASU-2 | ASU-3 |
|---|---|---|---|---|
| 0 | 43,807.50 | 26,117.20 | 5,373.28 | 12,317.02 |
| 1 | 43,726.32 | 26,051.40 | 5,381.17 | 12,293.75 |
| 2 | 43,771.32 | 26,096.78 | 5,394.22 | 12,280.32 |
| 3 | 43,807.18 | 26,101.75 | 5,378.60 | 12,326.83 |
| 4 | 43,756.42 | 26,057.47 | 5,383.92 | 12,315.03 |
| 5 | 43,779.88 | 26,110.10 | 5,390.50 | 12,279.28 |
| 6 | 43,787.92 | 26,097.70 | 5,384.70 | 12,305.52 |
| 7 | 43,770.03 | 26,075.02 | 5,394.48 | 12,300.53 |
| 8 | 43,737.00 | 26,071.38 | 5,384.25 | 12,281.37 |
| 9 | 43,770.13 | 26,081.43 | 5,378.28 | 12,310.42 |
| 10 | 43,775.68 | 26,088.50 | 5,395.35 | 12,291.83 |
| 11 | 43,800.92 | 26,090.78 | 5,388.33 | 12,321.80 |
| 12 | 43,725.07 | 26,068.00 | 5,377.03 | 12,280.03 |
| Average | 43,771.02 | 26,084.21 | 5,385.55 | 12,301.27 |

| 80% Load Level - 778 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| Start-Up/Ramp-Up | 11:13:02 | 11:16:03 | 0-2 | 0:03:01 |
| Measurement Interval | 11:16:03 | 11:26:03 | 3-12 | 0:10:00 |

| (60 second intervals) | All ASUs | ASU-1 | ASU-2 | ASU-3 |
|---|---|---|---|---|
| 0 | 38,967.65 | 23,217.27 | 4,796.78 | 10,953.60 |
| 1 | 38,864.68 | 23,164.28 | 4,788.40 | 10,912.00 |
| 2 | 38,911.95 | 23,200.18 | 4,796.62 | 10,915.15 |
| 3 | 38,926.72 | 23,166.03 | 4,800.88 | 10,959.80 |
| 4 | 38,910.95 | 23,231.53 | 4,789.55 | 10,889.87 |
| 5 | 38,873.77 | 23,180.65 | 4,778.67 | 10,914.45 |
| 6 | 38,882.93 | 23,179.53 | 4,779.57 | 10,923.83 |
| 7 | 38,878.42 | 23,172.10 | 4,777.08 | 10,929.23 |
| 8 | 38,830.27 | 23,155.30 | 4,776.57 | 10,898.40 |
| 9 | 38,943.25 | 23,215.85 | 4,790.03 | 10,937.37 |
| 10 | 38,916.13 | 23,185.90 | 4,793.48 | 10,936.75 |
| 11 | 38,957.00 | 23,217.28 | 4,804.40 | 10,935.32 |
| 12 | 38,853.57 | 23,145.88 | 4,790.02 | 10,917.67 |
| Average | 38,897.30 | 23,185.01 | 4,788.03 | 10,924.27 |

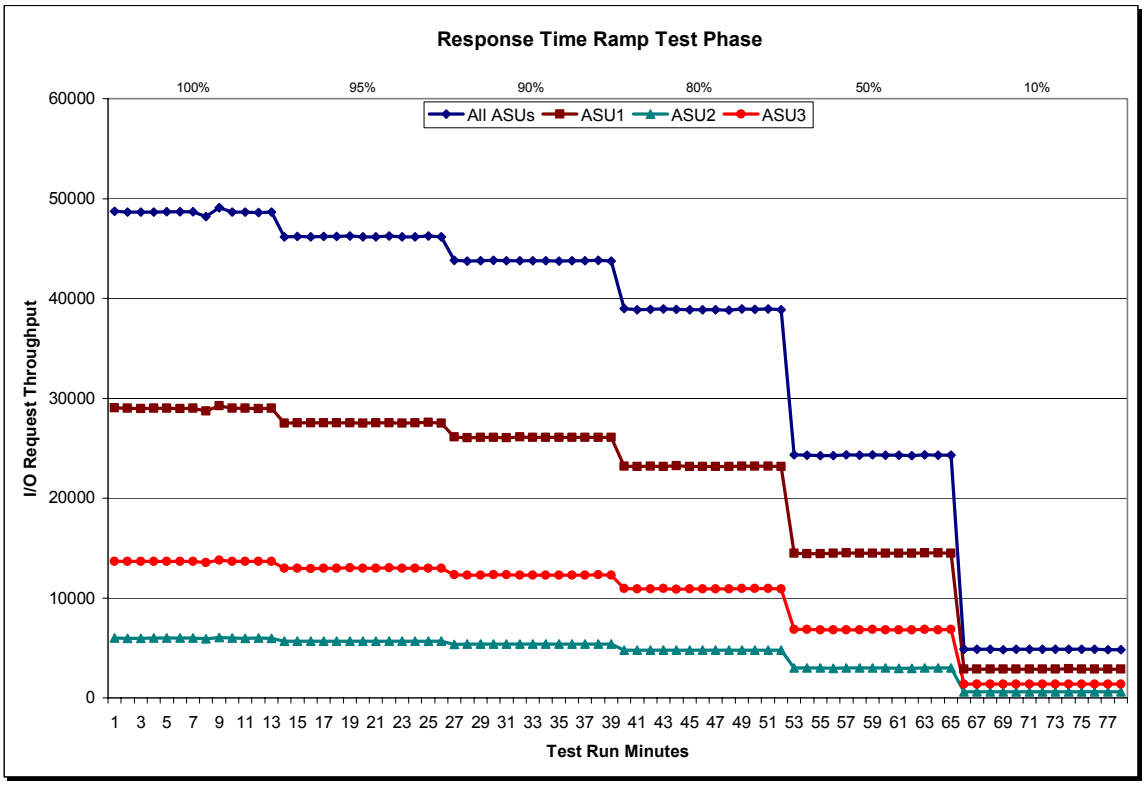
| 50% Load Level - 486 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| Start-Up/Ramp-Up | 11:26:21 | 11:29:22 | 0-2 | 0:03:01 |
| Measurement Interval | 11:29:22 | 11:39:22 | 3-12 | 0:10:00 |

| (60 second intervals) | All ASUs | ASU-1 | ASU-2 | ASU-3 |
|---|---|---|---|---|
| 0 | 24,324.57 | 14,494.03 | 2,991.28 | 6,839.25 |
| 1 | 24,295.92 | 14,459.50 | 2,985.95 | 6,850.47 |
| 2 | 24,276.98 | 14,455.08 | 2,999.90 | 6,822.00 |
| 3 | 24,273.33 | 14,482.17 | 2,977.13 | 6,814.03 |
| 4 | 24,334.73 | 14,509.17 | 2,990.67 | 6,834.90 |
| 5 | 24,306.50 | 14,477.05 | 2,996.78 | 6,832.67 |
| 6 | 24,326.70 | 14,475.38 | 3,002.90 | 6,848.42 |
| 7 | 24,315.67 | 14,486.98 | 2,999.40 | 6,829.28 |
| 8 | 24,291.38 | 14,488.98 | 2,976.23 | 6,826.17 |
| 9 | 24,250.97 | 14,466.12 | 2,973.73 | 6,811.12 |
| 10 | 24,350.40 | 14,511.52 | 3,003.13 | 6,835.75 |
| 11 | 24,314.42 | 14,503.48 | 2,996.03 | 6,814.90 |
| 12 | 24,320.25 | 14,493.95 | 2,988.52 | 6,837.78 |
| Average | 24,308.44 | 14,489.48 | 2,990.45 | 6,828.50 |

| 10% Load Level - 97 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| Start-Up/Ramp-Up | 11:39:33 | 11:42:34 | 0-2 | 0:03:01 |
| Measurement Interval | 11:42:34 | 11:52:34 | 3-12 | 0:10:00 |

| (60 second intervals) | All ASUs | ASU-1 | ASU-2 | ASU-3 |
|---|---|---|---|---|
| 0 | 4,866.02 | 2,895.10 | 602.33 | 1,368.58 |
| 1 | 4,858.33 | 2,898.02 | 595.27 | 1,365.05 |
| 2 | 4,849.08 | 2,892.60 | 592.78 | 1,363.70 |
| 3 | 4,845.85 | 2,890.85 | 592.10 | 1,362.90 |
| 4 | 4,848.58 | 2,881.73 | 598.90 | 1,367.95 |
| 5 | 4,849.97 | 2,894.40 | 595.72 | 1,359.85 |
| 6 | 4,848.63 | 2,883.32 | 595.88 | 1,369.43 |
| 7 | 4,861.07 | 2,898.20 | 600.40 | 1,362.47 |
| 8 | 4,871.88 | 2,907.37 | 597.32 | 1,367.20 |
| 9 | 4,848.82 | 2,891.27 | 595.27 | 1,362.28 |
| 10 | 4,850.37 | 2,887.33 | 596.63 | 1,366.40 |
| 11 | 4,847.30 | 2,894.12 | 593.88 | 1,359.30 |
| 12 | 4,833.37 | 2,875.87 | 596.35 | 1,361.15 |
| Average | 4,850.58 | 2,890.45 | 596.25 | 1,363.89 |

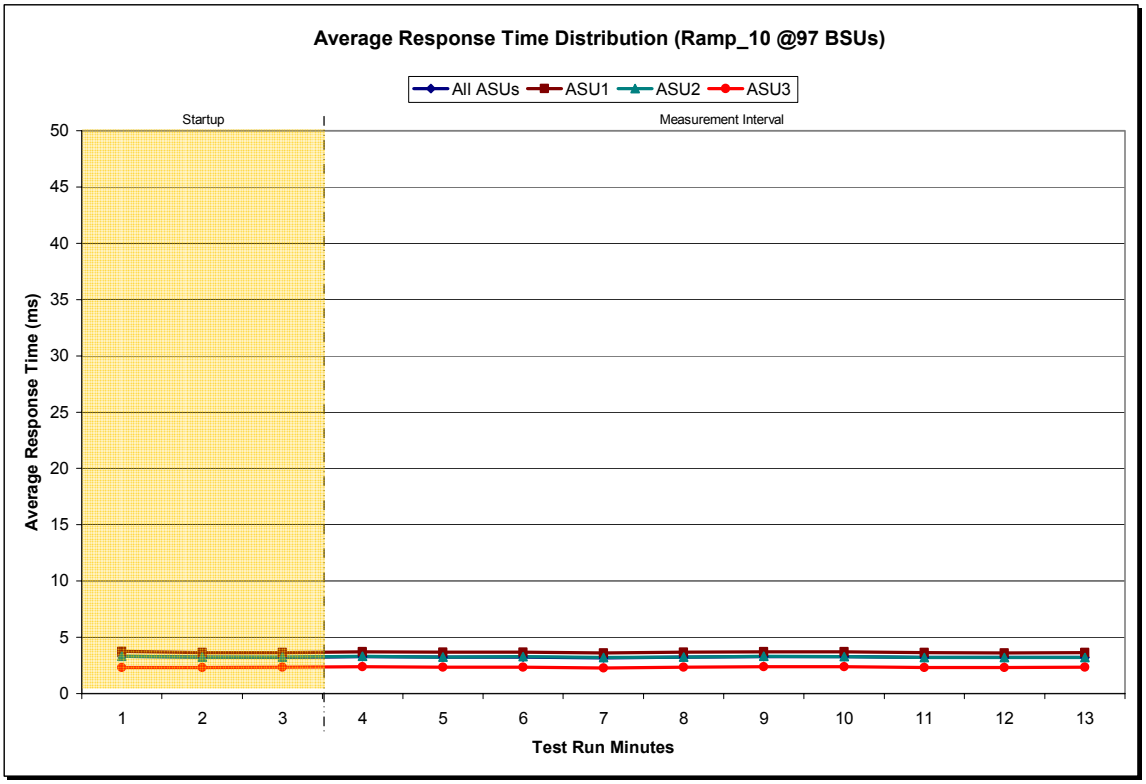
## Response Time Ramp Distribution (IOPS) Graph



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

| 97 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 11:39:33 | 11:42:34 | 0-2 | 0:03:01 |
| *Measurement Interval* | 11:42:34 | 11:52:34 | 3-12 | 0:10:00 |
| **60 second intervals** | **All ASUs** | **ASU1** | **ASU2** | **ASU3** |
| **0** | 3.30 | 3.76 | 3.31 | 2.31 |
| **1** | 3.23 | 3.65 | 3.25 | 2.31 |
| **2** | 3.22 | 3.64 | 3.25 | 2.32 |
| **3** | 3.29 | 3.71 | 3.30 | 2.38 |
| **4** | 3.25 | 3.67 | 3.25 | 2.35 |
| **5** | 3.24 | 3.66 | 3.26 | 2.33 |
| **6** | 3.18 | 3.60 | 3.21 | 2.28 |
| **7** | 3.24 | 3.67 | 3.25 | 2.33 |
| **8** | 3.28 | 3.70 | 3.31 | 2.37 |
| **9** | 3.29 | 3.71 | 3.28 | 2.39 |
| **10** | 3.21 | 3.64 | 3.22 | 2.31 |
| **11** | 3.19 | 3.61 | 3.19 | 2.30 |
| **12** | 3.21 | 3.63 | 3.22 | 2.33 |
| **Average** | 3.24 | 3.66 | 3.25 | 2.34 |

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



### SPC-1 LRT™ (10%) – 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 | 0.2808 | 0.0703 | 0.2098 | 0.0180 | 0.0699 | 0.0351 | 0.2812 |
| COV | 0.016 | 0.003 | 0.007 | 0.005 | 0.001 | 0.005 | 0.007 | 0.003 |

***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.*

***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%.*

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

## Repeatability Test

*Clause 5.4.3*

*The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ and SPC-1 LRT™ primary metrics 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™ primary metric. Each Average Response Time value must be less than the SPC-1 LRT™ primary metric plus 5%.*

*The second Test Run in each Test Phase is executed at the 100% load point. The I/O Request Throughput from the Test Runs is compared to the SPC-1 IOPS™ primary metric. Each I/O Request Throughput value must be greater than the SPC-1 IOPS™ primary metric minus 5%. In addition, the Average Response Time for each Test Run cannot exceed 30 milliseconds.*

*If any of the above constraints are not met, the benchmark measurement is invalid.*

*Clause 9.2.4.7.3*

*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 two Repeatability Test Phases. The content, appearance, and format of the table are specified in Table 9-11.*
2. *An I/O Request Throughput Distribution (data and graph).*
3. *An Average Response Time Distribution (data and graph).*
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 Repeatability Test Runs are documented in "Appendix D: SPC-1 Workload Generator Input Parameters" on Page 64.

### Repeatability Test Results File

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

| | SPC-1 IOPS™ | SPC-1 LRT™ |
|---|---|---|
| ***Primary Metrics*** | *48,646.62* | *3.24* |
| **Repeatability Test Phase 1** | 48,627.57 | 3.25 |
| **Repeatability Test Phase 2** | 48,641.01 | 3.23 |

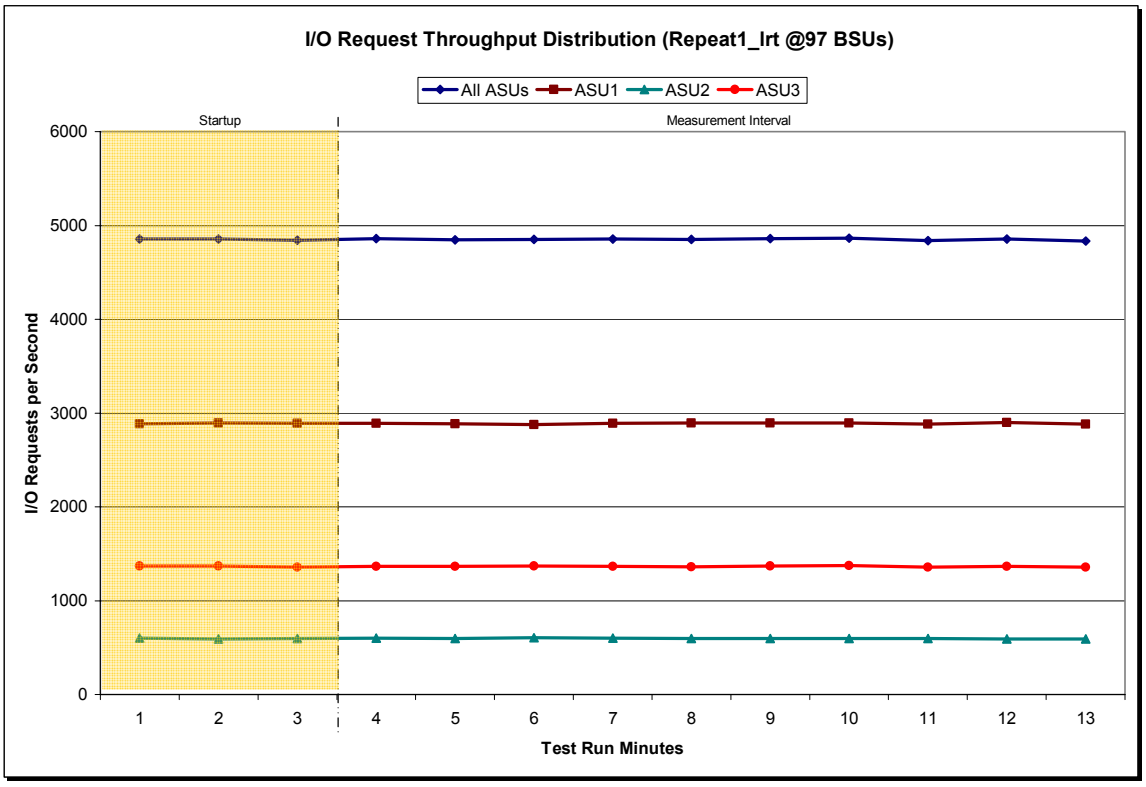
A link to the test result file generated from each Repeatability Test Run list is listed below.

**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

| 97 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 11:52:56 | 11:55:56 | 0-2 | 0:03:00 |
| *Measurement Interval* | 11:55:56 | 12:05:56 | 3-12 | 0:10:00 |
| **60 second intervals** | **All ASUs** | **ASU1** | **ASU2** | **ASU3** |
| **0** | 4,853.55 | 2,887.35 | 598.55 | 1,367.65 |
| **1** | 4,856.27 | 2,893.70 | 593.37 | 1,369.20 |
| **2** | 4,842.15 | 2,888.23 | 597.50 | 1,356.42 |
| **3** | 4,858.07 | 2,891.82 | 601.62 | 1,364.63 |
| **4** | 4,848.38 | 2,886.13 | 597.02 | 1,365.23 |
| **5** | 4,850.08 | 2,875.73 | 603.78 | 1,370.57 |
| **6** | 4,855.87 | 2,890.65 | 598.50 | 1,366.72 |
| **7** | 4,851.35 | 2,893.15 | 596.92 | 1,361.28 |
| **8** | 4,857.82 | 2,895.48 | 594.97 | 1,367.37 |
| **9** | 4,862.15 | 2,892.53 | 597.55 | 1,372.07 |
| **10** | 4,837.67 | 2,883.33 | 595.87 | 1,358.47 |
| **11** | 4,856.07 | 2,899.78 | 591.58 | 1,364.70 |
| **12** | 4,831.92 | 2,880.22 | 593.43 | 1,358.27 |
| **Average** | 4,850.94 | 2,888.88 | 597.12 | 1,364.93 |

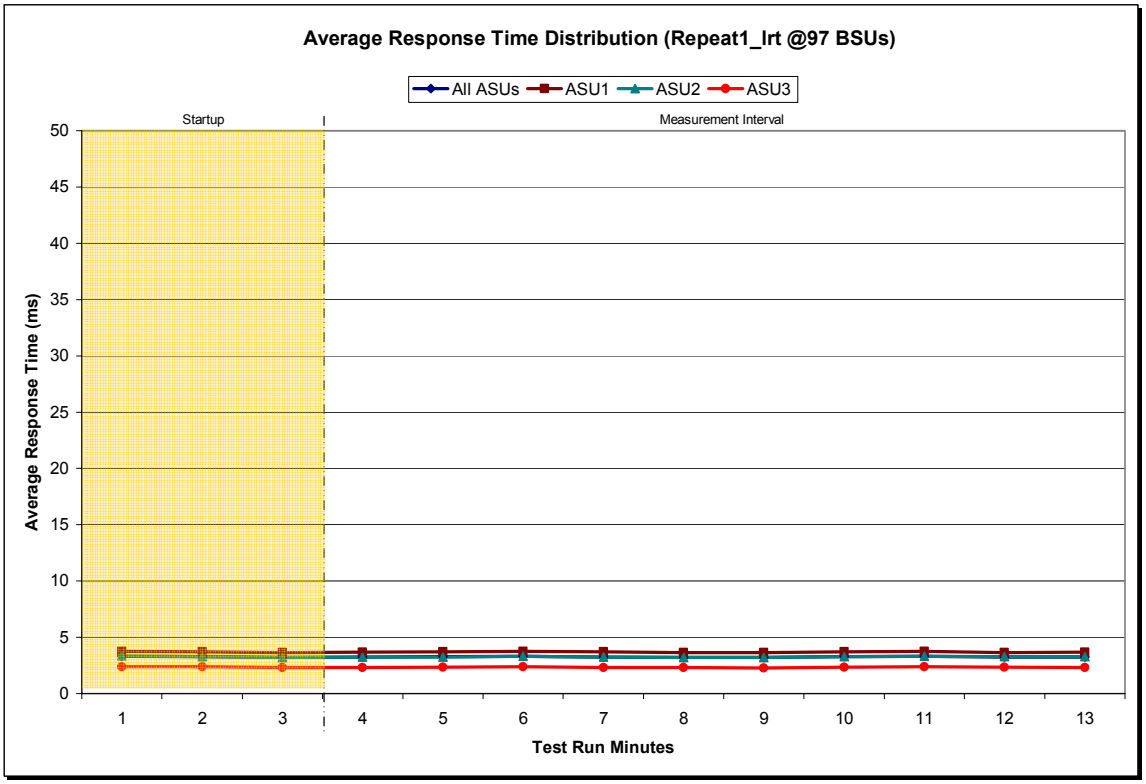
## Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

| 97 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 11:52:56 | 11:55:56 | 0-2 | 0:03:00 |
| *Measurement Interval* | 11:55:56 | 12:05:56 | 3-12 | 0:10:00 |
| **60 second intervals** | **All ASUs** | **ASU1** | **ASU2** | **ASU3** |
| **0** | 3.31 | 3.75 | 3.34 | 2.36 |
| **1** | 3.28 | 3.71 | 3.28 | 2.37 |
| **2** | 3.21 | 3.63 | 3.22 | 2.29 |
| **3** | 3.23 | 3.66 | 3.25 | 2.32 |
| **4** | 3.26 | 3.70 | 3.23 | 2.35 |
| **5** | 3.31 | 3.74 | 3.32 | 2.39 |
| **6** | 3.25 | 3.70 | 3.24 | 2.32 |
| **7** | 3.22 | 3.64 | 3.21 | 2.32 |
| **8** | 3.21 | 3.65 | 3.22 | 2.29 |
| **9** | 3.26 | 3.69 | 3.27 | 2.35 |
| **10** | 3.30 | 3.74 | 3.31 | 2.36 |
| **11** | 3.23 | 3.64 | 3.26 | 2.33 |
| **12** | 3.23 | 3.66 | 3.26 | 2.31 |
| **Average** | 3.25 | 3.68 | 3.26 | 2.33 |

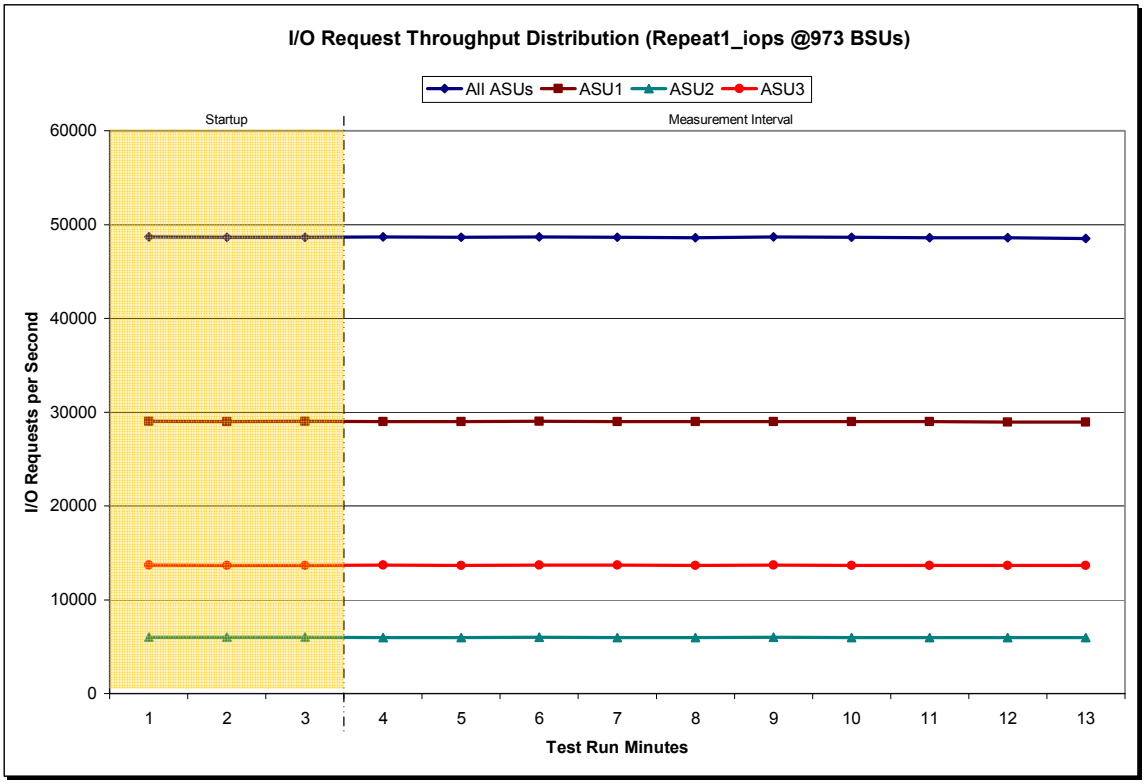
## Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



## Repeatability 1 IOPS – I/O Request Throughput Distribution Data

| 973 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 12:06:26 | 12:09:27 | 0-2 | 0:03:01 |
| *Measurement Interval* | 12:09:27 | 12:19:27 | 3-12 | 0:10:00 |
| **60 second intervals** | **All ASUs** | **ASU1** | **ASU2** | **ASU3** |
| **0** | 48,689.77 | 29,011.18 | 5,998.55 | 13,680.03 |
| **1** | 48,650.43 | 28,993.80 | 5,985.48 | 13,671.15 |
| **2** | 48,647.48 | 29,008.42 | 5,990.08 | 13,648.98 |
| **3** | 48,670.93 | 29,006.00 | 5,978.72 | 13,686.22 |
| **4** | 48,638.63 | 28,997.00 | 5,981.65 | 13,659.98 |
| **5** | 48,687.93 | 29,011.02 | 5,999.87 | 13,677.05 |
| **6** | 48,649.12 | 28,980.98 | 5,981.97 | 13,686.17 |
| **7** | 48,608.43 | 28,968.03 | 5,980.90 | 13,659.50 |
| **8** | 48,661.55 | 28,990.58 | 5,997.87 | 13,673.10 |
| **9** | 48,627.70 | 28,998.97 | 5,972.78 | 13,655.95 |
| **10** | 48,610.03 | 28,983.00 | 5,963.52 | 13,663.52 |
| **11** | 48,591.75 | 28,962.70 | 5,980.62 | 13,648.43 |
| **12** | 48,529.60 | 28,938.95 | 5,960.03 | 13,630.62 |
| **Average** | 48,627.57 | 28,983.72 | 5,979.79 | 13,664.05 |

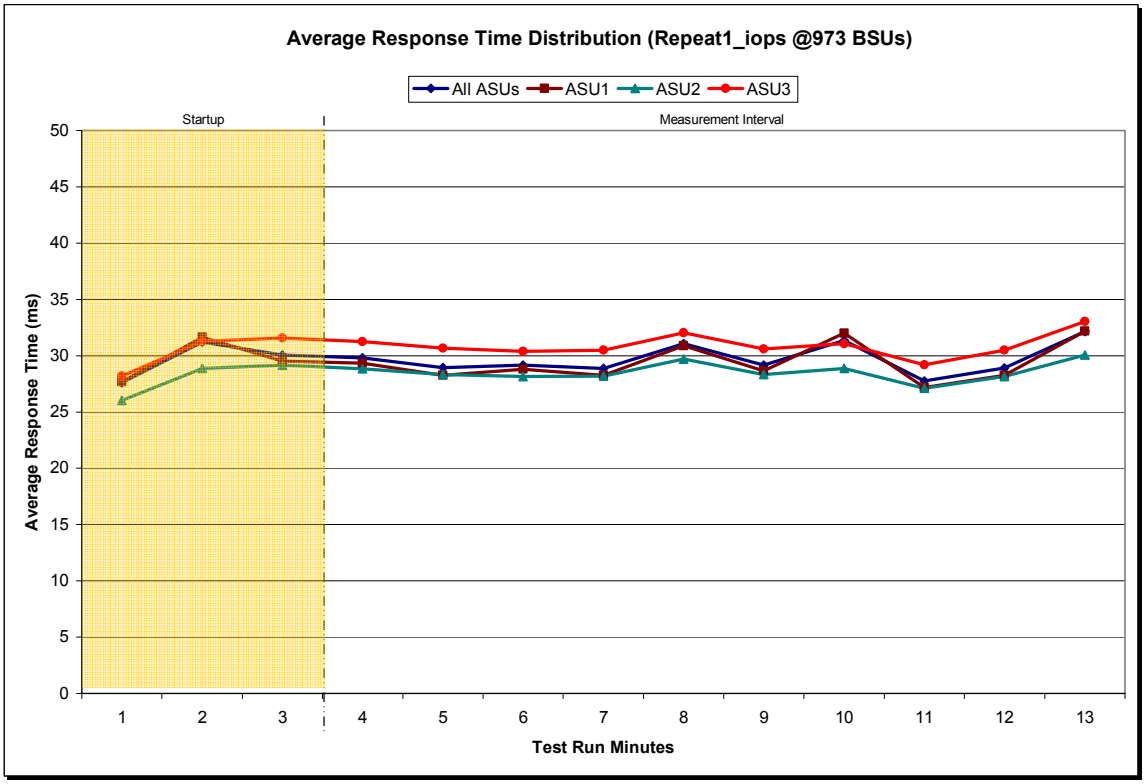
## Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

| 973 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 12:06:26 | 12:09:27 | 0-2 | 0:03:01 |
| *Measurement Interval* | 12:09:27 | 12:19:27 | 3-12 | 0:10:00 |
| **60 second intervals** | **All ASUs** | **ASU1** | **ASU2** | **ASU3** |
| **0** | 27.61 | 27.67 | 26.02 | 28.17 |
| **1** | 31.20 | 31.65 | 28.85 | 31.27 |
| **2** | 30.05 | 29.52 | 29.16 | 31.55 |
| **3** | 29.80 | 29.32 | 28.85 | 31.24 |
| **4** | 28.95 | 28.26 | 28.34 | 30.68 |
| **5** | 29.17 | 28.81 | 28.14 | 30.39 |
| **6** | 28.88 | 28.25 | 28.19 | 30.49 |
| **7** | 31.06 | 30.88 | 29.68 | 32.03 |
| **8** | 29.16 | 28.65 | 28.32 | 30.60 |
| **9** | 31.35 | 31.99 | 28.87 | 31.06 |
| **10** | 27.74 | 27.20 | 27.11 | 29.18 |
| **11** | 28.89 | 28.28 | 28.16 | 30.51 |
| **12** | 32.15 | 32.18 | 30.05 | 33.03 |
| **Average** | 29.71 | 29.38 | 28.57 | 30.92 |

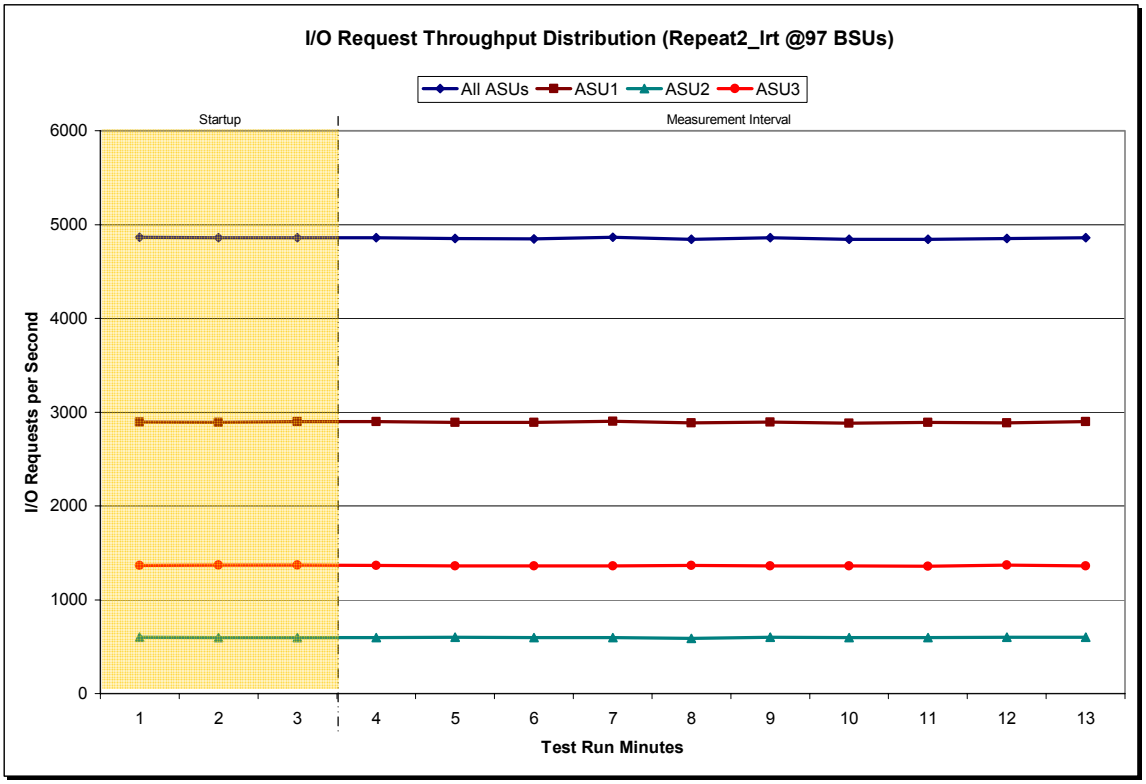
## Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



## Repeatability 2 LRT – I/O Request Throughput Distribution Data

| 97 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 12:19:50 | 12:22:50 | 0-2 | 0:03:00 |
| *Measurement Interval* | 12:22:50 | 12:32:50 | 3-12 | 0:10:00 |
| **60 second intervals** | **All ASUs** | **ASU1** | **ASU2** | **ASU3** |
| **0** | 4,862.57 | 2,896.23 | 600.15 | 1,366.18 |
| **1** | 4,858.13 | 2,891.42 | 597.62 | 1,369.10 |
| **2** | 4,859.48 | 2,896.92 | 593.97 | 1,368.60 |
| **3** | 4,859.28 | 2,896.50 | 597.95 | 1,364.83 |
| **4** | 4,852.18 | 2,891.93 | 598.37 | 1,361.88 |
| **5** | 4,847.37 | 2,888.83 | 597.62 | 1,360.92 |
| **6** | 4,861.98 | 2,903.30 | 597.93 | 1,360.75 |
| **7** | 4,841.37 | 2,887.45 | 588.10 | 1,365.82 |
| **8** | 4,857.90 | 2,896.00 | 599.82 | 1,362.08 |
| **9** | 4,841.80 | 2,881.35 | 598.17 | 1,362.28 |
| **10** | 4,843.40 | 2,890.48 | 595.12 | 1,357.80 |
| **11** | 4,852.70 | 2,886.15 | 598.30 | 1,368.25 |
| **12** | 4,860.68 | 2,897.82 | 600.58 | 1,362.28 |
| **Average** | 4,851.87 | 2,891.98 | 597.20 | 1,362.69 |

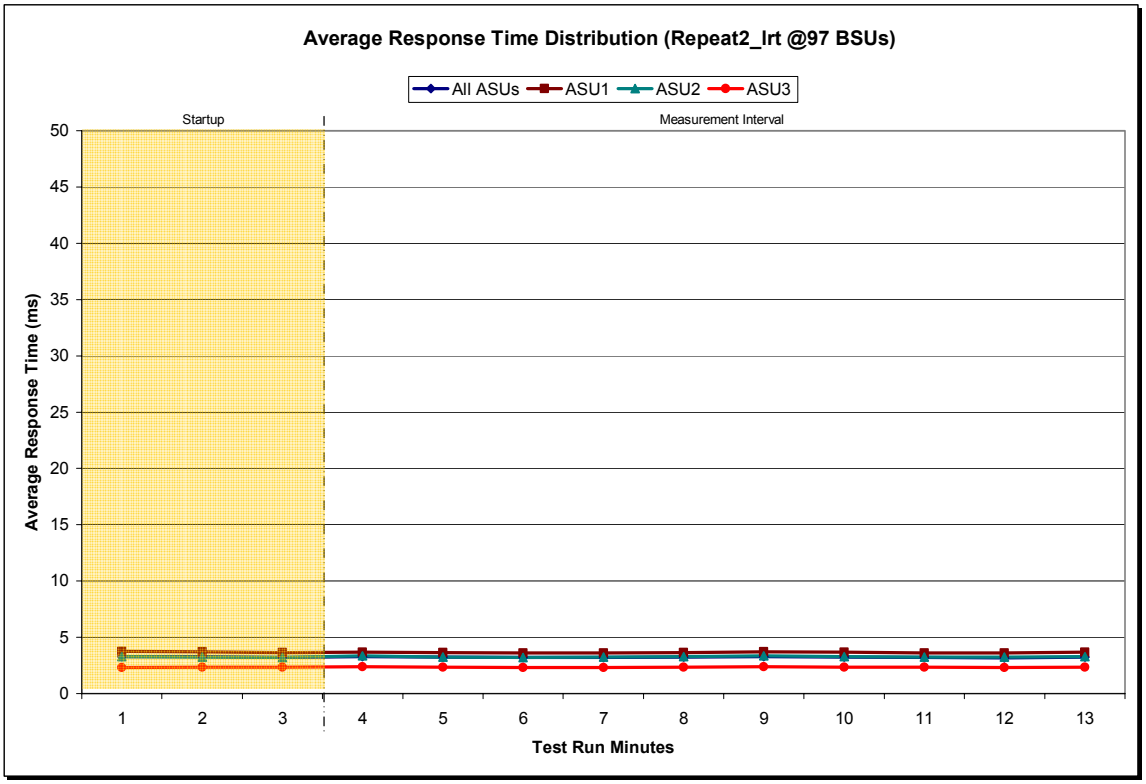
## Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

| 97 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 12:19:50 | 12:22:50 | 0-2 | 0:03:00 |
| *Measurement Interval* | 12:22:50 | 12:32:50 | 3-12 | 0:10:00 |
| **60 second intervals** | **All ASUs** | **ASU1** | **ASU2** | **ASU3** |
| **0** | 3.28 | 3.74 | 3.28 | 2.29 |
| **1** | 3.26 | 3.70 | 3.25 | 2.34 |
| **2** | 3.22 | 3.65 | 3.20 | 2.33 |
| **3** | 3.28 | 3.69 | 3.34 | 2.38 |
| **4** | 3.23 | 3.64 | 3.25 | 2.34 |
| **5** | 3.19 | 3.59 | 3.21 | 2.31 |
| **6** | 3.19 | 3.60 | 3.24 | 2.30 |
| **7** | 3.23 | 3.64 | 3.28 | 2.34 |
| **8** | 3.28 | 3.70 | 3.33 | 2.38 |
| **9** | 3.24 | 3.66 | 3.27 | 2.35 |
| **10** | 3.20 | 3.61 | 3.23 | 2.32 |
| **11** | 3.18 | 3.58 | 3.24 | 2.29 |
| **12** | 3.25 | 3.66 | 3.29 | 2.36 |
| **Average** | 3.23 | 3.64 | 3.27 | 2.34 |

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

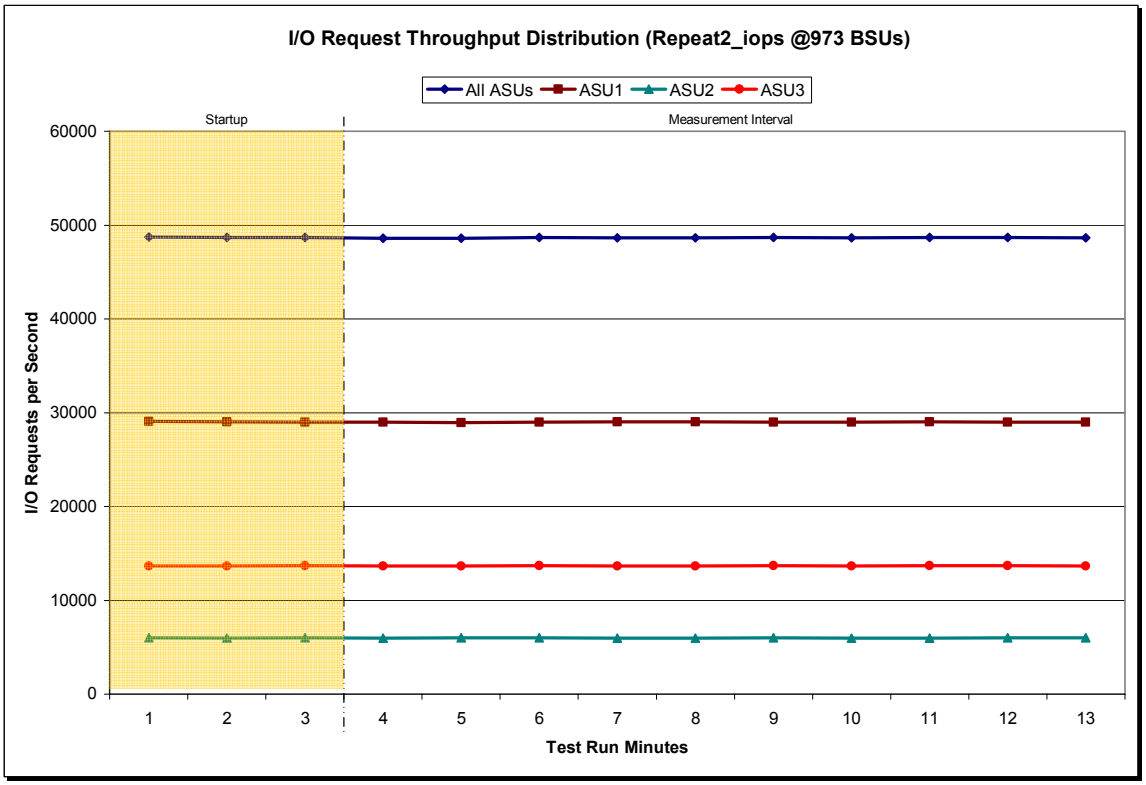


## Repeatability 2 IOPS – I/O Request Throughput Distribution Data

| 973 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 12:33:20 | 12:36:21 | 0-2 | 0:03:01 |
| *Measurement Interval* | 12:36:21 | 12:46:21 | 3-12 | 0:10:00 |

| 60 second intervals | All ASUs | ASU1 | ASU2 | ASU3 |
|---|---|---|---|---|
| 0 | 48,708.47 | 29,050.82 | 5,993.87 | 13,663.78 |
| 1 | 48,678.62 | 29,035.03 | 5,980.95 | 13,662.63 |
| 2 | 48,684.52 | 29,001.80 | 5,997.55 | 13,685.17 |
| 3 | 48,589.82 | 28,968.98 | 5,962.77 | 13,658.07 |
| 4 | 48,582.42 | 28,952.73 | 5,982.73 | 13,646.95 |
| 5 | 48,666.27 | 28,994.57 | 5,992.37 | 13,679.33 |
| 6 | 48,650.12 | 29,008.18 | 5,973.62 | 13,668.32 |
| 7 | 48,653.45 | 29,015.35 | 5,969.00 | 13,669.10 |
| 8 | 48,664.42 | 28,981.55 | 6,000.08 | 13,682.78 |
| 9 | 48,633.67 | 28,986.18 | 5,978.30 | 13,669.18 |
| 10 | 48,662.62 | 29,012.78 | 5,976.40 | 13,673.43 |
| 11 | 48,675.22 | 28,996.95 | 5,991.00 | 13,687.27 |
| 12 | 48,632.15 | 28,982.97 | 5,994.70 | 13,654.48 |
| Average | 48,641.01 | 28,990.03 | 5,982.10 | 13,668.89 |

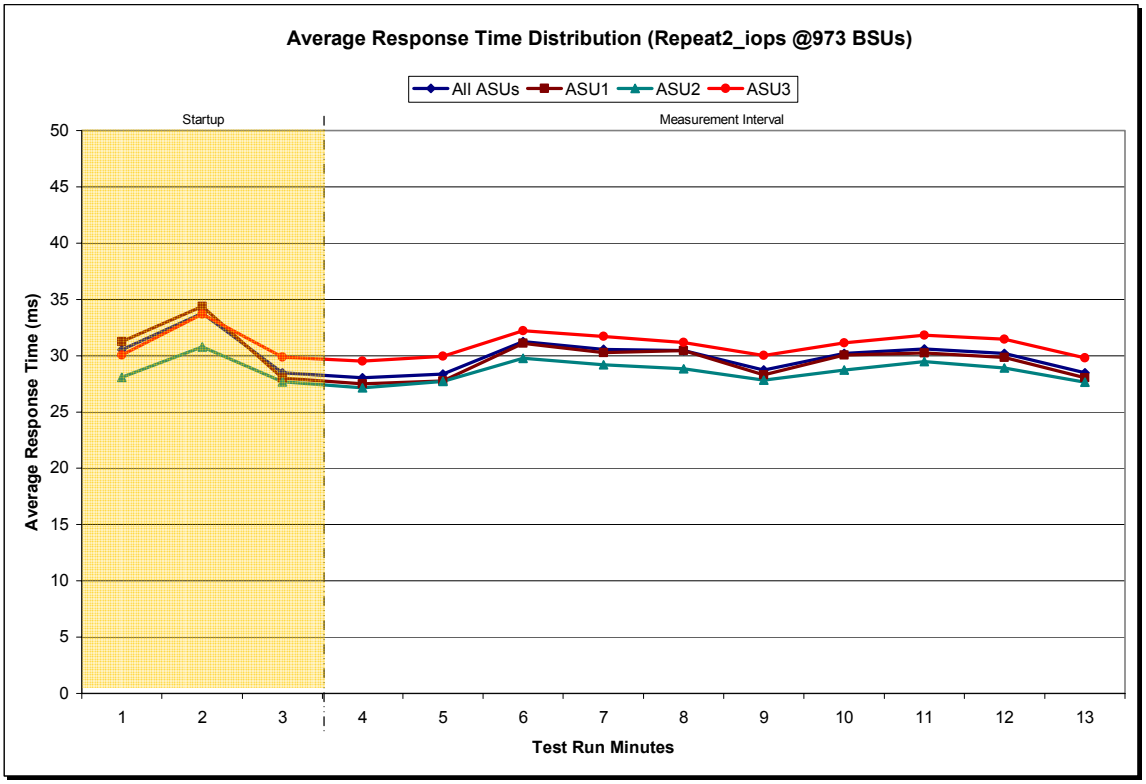
## Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

| 973 BSUs | Start | Stop | Interval | Duration |
|---|---|---|---|---|
| *Start-Up/Ramp-Up* | 12:33:20 | 12:36:21 | 0-2 | 0:03:01 |
| *Measurement Interval* | 12:36:21 | 12:46:21 | 3-12 | 0:10:00 |
| **60 second intervals** | **All ASUs** | **ASU1** | **ASU2** | **ASU3** |
| **0** | 30.51 | 31.23 | 28.06 | 30.07 |
| **1** | 33.75 | 34.38 | 30.77 | 33.70 |
| **2** | 28.49 | 27.99 | 27.67 | 29.89 |
| **3** | 28.03 | 27.52 | 27.16 | 29.51 |
| **4** | 28.37 | 27.76 | 27.73 | 29.96 |
| **5** | 31.25 | 31.09 | 29.79 | 32.23 |
| **6** | 30.55 | 30.29 | 29.20 | 31.71 |
| **7** | 30.45 | 30.44 | 28.83 | 31.18 |
| **8** | 28.71 | 28.28 | 27.81 | 30.03 |
| **9** | 30.21 | 30.07 | 28.72 | 31.15 |
| **10** | 30.59 | 30.25 | 29.48 | 31.80 |
| **11** | 30.20 | 29.86 | 28.91 | 31.48 |
| **12** | 28.48 | 28.04 | 27.66 | 29.80 |
| **Average** | 29.68 | 29.36 | 28.53 | 30.88 |

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



**Repeatability 1 (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 | 0.0348 | 0.2809 | 0.0700 | 0.2098 | 0.0180 | 0.0700 | 0.03510 | 0.2814 |
| COV | 0.009 | 0.003 | 0.006 | 0.005 | 0.013 | 0.003 | 0.013 | 0.002 |

***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.*

***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%.*

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

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

| | ASU1-1 | ASU1-2 | ASU1-3 | ASU1-4 | ASU2-1 | ASU2-2 | ASU2-3 | ASU3-1 |
|---|---|---|---|---|---|---|---|---|
| *IM* | *0.0350* | *0.2810* | *0.0700* | *0.2100* | *0.0180* | *0.0700* | *0.0350* | *0.2810* |
| MIM | 0.0350 | 0.2810 | 0.0699 | 0.2101 | 0.0180 | 0.0699 | 0.0350 | 0.2810 |
| COV | 0.002 | 0.001 | 0.002 | 0.001 | 0.003 | 0.003 | 0.003 | 0.001 |

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

| | ASU1-1 | ASU1-2 | ASU1-3 | ASU1-4 | ASU2-1 | ASU2-2 | ASU2-3 | ASU3-1 |
|---|---|---|---|---|---|---|---|---|
| *IM* | *0.0350* | *0.2810* | *0.0700* | *0.2100* | *0.0180* | *0.0700* | *0.0350* | *0.2810* |
| MIM | 0.0350 | 0.2808 | 0.0699 | 0.2103 | 0.0180 | 0.0700 | 0.0351 | 0.2809 |
| COV | 0.012 | 0.003 | 0.005 | 0.003 | 0.013 | 0.007 | 0.008 | 0.003 |

**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 | 0.002 | 0.001 | 0.003 | 0.001 | 0.004 | 0.002 | 0.003 | 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 IOP™ primary metric. The bit pattern selected to be written to each block as well as the address of the block will be retained in a log file.*

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

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

*Clause 9.2.4.8*

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

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

### SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Persistence Test Runs are documented in "Appendix D: SPC-1 Workload Generator Input Parameters" on Page 64.

**java –Xmx512m persist1 –b 973**
**java –Xmx512m persist2**

### 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 | 116,631,712 |
| Total Number of Logical Blocks Verified | 91,747,296 |
| Total Number of Logical Blocks that Failed Verification | 0 |
| Time Duration for Writing Test Logical Blocks | 10 minutes |
| Size in Bytes of each Logical Block | 512 |
| Number of Failed I/O Requests in the process of the Test | 0 |

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

## PRICED STORAGE CONFIGURATION AVAILABILITY DATE

*Clause 9.2.4.9*

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

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

The Sun StorEdge™ 6920 (20 tray), as documented in this Full Disclosure Report became available for customer purchase and shipment on July 23, 2004.

## PRICING INFORMATION

*Clause 9.2.4.11*

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

Pricing information may found in the Tested Storage Configuration Pricing section on page 12.

## ANOMALIES OR IRREGULARITIES

*Clause 9.2.4.10*

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

There were no anomalies or irregularities encountered during the SPC-1 Onsite Audit of the Sun StorEdge™ 6920 (20 tray).

# APPENDIX A: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

The following settings were made in the Solaris "/etc/system" control file information for execution of the SPC-1 Workload Generator on the SunFire 6800:

```
spc@bigdog:/spc/spc1 $ cat /etc/system
*ident  "@(#)system     1.18    97/06/27 SMI" /* SVR4 1.5 */
*
* SYSTEM SPECIFICATION FILE
*

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



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



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



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

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



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

* ITOps add
set noexec_user_stack = 1
set noexec_user_stack_log = 1
* end ITOps add
*** IPC semaphores
set semsys:seminfo_semmap=4096
set semsys:seminfo_semmni=4096
set semsys:seminfo_semmns=4096
set semsys:seminfo_semmnu=4096
set semsys:seminfo_semume=64
set semsys:seminfo_semmsl=256

* IPC messages
set msgsys:msginfo_msgmap=4096
set msgsys:msginfo_msgmni=4096
set msgsys:msginfo_msgssz=64
set msgsys:msginfo_msgtql=40000

* pt_cnt : pseudo terminals are allocated dynamically
* set hard limit on file descriptors
* set rlim_fd_max = 8192
* set soft limit on file descriptors
set rlim_fd_cur = 1024

* buffer high water mark: limits the amount of RAM devoted to headers cache.
set bufhwm = 8000

* increase capability to do 1Mb IOs to *raw* devices, 32MB max.
*set maxphys = 1048576
set maxphys = 4194304

* Memory allocation parameters
set vxio:voliomem_chunk_size = 1048576
set vxio:voliomem_maxpool_sz = 134217728
* I/O related parameters
set vxio:vol_default_iodelay = 10
set vxio:vol_maxkiocount = 32768
set vxio:vol_maxioctl = 131072
```

```
set vxio:vol_maxio = 8192
set vxio:vol_maxspecialio = 10240
* VM related
* scanner I/Os per second page-outs.(default 65536 for E10000)
* set maxpgio = 16384
* # of pages the scanned when freelist falls below lotsfree.
* set to 1/16 to 1/4 RAM up to 1Gb/sec (131072) *set fastscan = 65536 **Fri Mar 31 16:07:32 PST 2000
* R. McDougall: increase maxpgio to prevent the scanner from limiting writes set maxpgio = 65536
* R. McDougall: increase fastscan to limit the effect the page scanner
* has on file system throughput
set fastscan = 65536


* UFS related
* filesystem write throttling high/low watermark
* R. McDougall: set the write throttle higher for large systems > 1GB of RAM
*
set ufs:ufs_HW = 20971520
set ufs:ufs_LW = 15728640

* cool fsflushr on big memory memory machines set autoup = 1024 set tune_t_fsflushr = 1

* TCP related
* decrease potential connection backlog by:
* 1. increase connection hash table size, increase if connections are high.
set tcp:tcp_conn_hash_size = 32768
* 2. depth of destination queue (# of messages outbound streams can hold)
* NOTE: sq_max_size = 0 is unlimited, but uses more kernel memory.
set sq_max_size = 100
```

# APPENDIX B: TESTED STORAGE CONFIGURATION (TSC) CREATION

The following steps document the operations necessary to configure and access the SPC-1 Tested Storage Configuration (TSC) for the Sun StorEdge 9620 system.

- Access the storage interface
- Create a Secure Virtual Storage Domain (SVSD)
- Create virtual pools and Vdisks using the MailSpooling profile
- Create virtual volumes from the pools
- Map the volumes to the initiators (Host System HBAs)

Each of the above steps is described in further detail below.

## Access the storage interface

The Web-UI is a browser based interface that manages the Storage Service Processor. To start the Web-UI, open a browser and enter the following URL: https://SP_WAN_IPADDRESS:6789. A username and password will be required to access the Web-UI.

## Create a Secure Virtual Storage Domain (SVSD)

From the Web-UI Console Window select the ***SE6920 Configuration Service*** link. Use the Storage Domains link to display the Storage Domain Summary window. To begin creating a new SVSD click on the "New" link. In the New Storage Domain window enter **spc** as the name *(description is always optional)* Select all the initiators displayed, which will finish creating the SVSD.

## Create virtual pools and Vdisks using the MailSpooling profile
## Create virtual volumes from the pools
## Map the volumes to the initiators (Host System HBAs)

The last three steps are completed using the script listed below. The script must be created on the service processor at **/opt/se6x20/cli/bin**. The command **/opt/se6x20/cli/bin/ssce login –u storage –f –h localhost** is used to login to the CLI interface of the StorEdge 6920. A password will be required for the login. The script can then be executed from the CLI interface, which will create the virtual volumes and map them to the HBAs. That process will be approximately ten hours in duration.

```
#!/sbin/sh
#
# Copyright (c) 2001 by Sun Microsystems, Inc.
# All rights reserved.
#
#
# UnMap volumes
PATH=/opt/se6x20/cli/bin:$PATH
set -x
#
```

```
############################################################
# Create Storage pools
#
sscs create -p MailSpooling -S spc -d pool-1 pool pool-1
sscs create -p MailSpooling -S spc -d pool-2 pool pool-2
sscs create -p MailSpooling -S spc -d pool-3 pool pool-3
sscs create -p MailSpooling -S spc -d pool-4 pool pool-4
#
############################################################
# Create Vdisks in all pools
#
sscs create -p pool-1 -t 0 -a array00 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-1 -t 0 -a array01 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-1 -t 0 -a array02 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-1 -t 0 -a array03 -S spc -d 7 vdisk
sleep 120
#
sscs create -p pool-2 -t 1 -a array00 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-2 -t 1 -a array01 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-2 -t 1 -a array02 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-2 -t 1 -a array03 -S spc -d 7 vdisk
sleep 120

sscs create -p pool-3 -t 0 -a array00 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-3 -t 0 -a array01 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-3 -t 0 -a array02 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-3 -t 0 -a array03 -S spc -d 7 vdisk
sleep 120
###
sscs create -p pool-4 -t 1 -a array00 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-4 -t 1 -a array01 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-4 -t 1 -a array02 -S spc -d 7 vdisk
sleep 120
sscs create -p pool-4 -t 1 -a array03 -S spc -d 7 vdisk
sleep 120
##
##
echo Verifying all vdisks are created
VDisk=`sscs list -S spc vdisk | wc -l`
while (test "$VDisk" -lt "16")
do
        sscs list -S spc vdisk
        sleep 180
VDisk=`sscs list -S spc vdisk | wc -l`
done
echo Lets move on

#
# Create ASU3 volumes on pool-1
set -x
StartTime=`date`
```

```
echo Creating asu3 volumes on pool-1
counter=1
while (test "$counter" -lt "5")
do
        echo Creating asu3 volumes on pool-1
  /opt/se6x20/cli/bin/sscs create -p pool-1 -s 18g -S spc -t volume p1-asu3-s$counter
  counter=`expr $counter + 1`
done

# Create ASU3 volumes on pool-2
date
echo Creating asu3 volumes on pool-2
counter=1
while (test "$counter" -lt "5")
do
        echo Creating asu3 volumes on pool-2
  /opt/se6x20/cli/bin/sscs create -p pool-2 -s 18g -S spc -t volume p2-asu3-s$counter
  counter=`expr $counter + 1`
done
#
# Create volumes on pool-3
set -x
date
echo Creating asu3 volumes on pool-3
counter=1
while (test "$counter" -lt "5")
do
        echo Creating asu3 volumes on pool-3
  /opt/se6x20/cli/bin/sscs create -p pool-3 -s 18g -S spc -t volume p3-asu3-s$counter
  counter=`expr $counter + 1`
done
#
# Create volumes on pool-4
date
echo Creating asu3 volumes on pool-4
counter=1
while (test "$counter" -lt "5")
do
        echo Creating asu3 volumes on pool-4
  /opt/se6x20/cli/bin/sscs create -p pool-4 -s 18g -S spc -t volume p4-asu3-s$counter
  counter=`expr $counter + 1`
done
echo $StartTime

#
# Create ASU1 volumes on pool-1
date
echo Creating asu1 volumes on pool-1
counter=1
while (test "$counter" -lt "6")
do
        echo Creating asu1 volumes on pool-1
  /opt/se6x20/cli/bin/sscs create -p pool-1 -s 68g -S spc -t volume p1-asu1-s$counter
  counter=`expr $counter + 1`
done

# Create volumes on pool-2
date
echo Creating asu1 volumes on pool-2
counter=1
while (test "$counter" -lt "6")
do
```

```
        echo Creating asu1 volumes on pool-2
    /opt/se6x20/cli/bin/sscs create -p pool-2 -s 68g -S spc -t volume p2-asu1-s$counter
    counter=`expr $counter + 1`
  done
  #
  # Create volumes on pool-3
  date
  echo Creating asu1 volumes on pool-3
  counter=1
  while (test "$counter" -lt "6")
  do
        echo Creating asu1 volumes on pool-3
    /opt/se6x20/cli/bin/sscs create -p pool-3 -s 68g -S spc -t volume p3-asu1-s$counter
    counter=`expr $counter + 1`
  done
  #
  # Create volumes on pool-4
  date
  echo Creating asu1 volumes on pool-4
  counter=1
  while (test "$counter" -lt "6")
  do
        echo Creating asu1 volumes on pool-4
    /opt/se6x20/cli/bin/sscs create -p pool-4 -s 68g -S spc -t volume p4-asu1-s$counter
    counter=`expr $counter + 1`
  done

  #
  # Create ASU2 volumes on pool-1
  date
  echo Creating asu2 volumes on pool-1
  counter=1
  while (test "$counter" -lt "4")
  do
        echo Creating asu2 volumes on pool-1
    /opt/se6x20/cli/bin/sscs create -p pool-1 -s 114g -S spc -t volume p1-asu2-s$counter
    counter=`expr $counter + 1`
  done

  # Create volumes on pool-2
  date
  echo Creating asu2 volumes on pool-2
  counter=1
  while (test "$counter" -lt "4")
  do
        echo Creating asu2 volumes on pool-2
    /opt/se6x20/cli/bin/sscs create -p pool-2 -s 114g -S spc -t volume p2-asu2-s$counter
    counter=`expr $counter + 1`
  done
  #
  # Create volumes on pool-3
  date
  echo Creating asu2 volumes on pool-3
  counter=1
  while (test "$counter" -lt "4")
  do
        echo Creating asu2 volumes on pool-3
    /opt/se6x20/cli/bin/sscs create -p pool-3 -s 114g -S spc -t volume p3-asu2-s$counter
    counter=`expr $counter + 1`
  done
  #
  #
```

```
# Create volumes on pool-4
date
echo Creating asu2 volumes on pool-4
counter=1
while (test "$counter" -lt "4")
do
        echo Creating asu2 volumes on pool-4
    /opt/se6x20/cli/bin/sscs create -p pool-4 -s 114g -S spc -t volume p4-asu2-s$counter
    counter=`expr $counter + 1`
done
#
#
#
# Map volumes
set -x
echo
startTime=`date`
counter=1
while (test "$counter" -lt "5")
do
target=`expr $counter + 0`
        echo Mapping p1-asu3-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server12
echo Mapping server13
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server13
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server14
echo Mapping server15
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server19
echo Mapping server20
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server20
echo Mapping server3
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server3
echo Mapping server6
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu3-s$counter -P readwrite -l $target initiator server6
   counter=`expr $counter + 1`
 sleep 10
done

counter=1
while (test "$counter" -lt "5")
do
target=`expr $counter + 4`
        echo Mapping p2-asu3-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server12
echo Mapping server13
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server13
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server14
echo Mapping server15
```

```
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server19
echo Mapping server20
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server20
echo Mapping server3
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server3
echo Mapping server6
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu3-s$counter -P readwrite -l $target initiator server6
  counter=`expr $counter + 1`
 sleep 10
done
#
date
counter=1
while (test "$counter" -lt "5")
do
target=`expr $counter + 8`
       echo Mapping p3-asu3-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server12
echo Mapping server13
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server13
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server14
echo Mapping server15
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server19
echo Mapping server20
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server20
echo Mapping server3
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server3
echo Mapping server6
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu3-s$counter -P readwrite -l $target initiator server6
  counter=`expr $counter + 1`
 sleep 10
done
#
counter=1
while (test "$counter" -lt "5")
do
target=`expr $counter + 12`
       echo Mapping p4-asu3-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server12
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server13
```

```
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server14
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server19
echo Mapping server20
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server20
echo Mapping server3
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server3
echo Mapping server6
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu3-s$counter -P readwrite -l $target initiator server6
   counter=`expr $counter + 1`
 sleep 10
done
#
#
# Map volumes
set -x
echo
date
counter=1
while (test "$counter" -lt "6")
do
target=`expr $counter + 16`
       echo Mapping p1-asu1-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server12
echo Mapping server13
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server13
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server14
echo Mapping server15
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server19
echo Mapping server20
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server20
echo Mapping server3
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server3
echo Mapping server6
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu1-s$counter -P readwrite -l $target initiator server6
   counter=`expr $counter + 1`
 sleep 10
done

counter=1
while (test "$counter" -lt "6")
do
```

```
target=`expr $counter + 21`
        echo Mapping p2-asu1-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server12
echo Mapping server13
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server13
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server14
echo Mapping server15
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server19
echo Mapping server20
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server20
echo Mapping server3
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server3
echo Mapping server6
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu1-s$counter -P readwrite -l $target initiator server6
   counter=`expr $counter + 1`
 sleep 10
done
#
date
counter=1
while (test "$counter" -lt "6")
do
target=`expr $counter + 26`
        echo Mapping p3-asu1-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server12
echo Mapping server13
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server13
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server14
echo Mapping server15
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server19
echo Mapping server20
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server20
echo Mapping server3
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server3
echo Mapping server6
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu1-s$counter -P readwrite -l $target initiator server6
   counter=`expr $counter + 1`
 sleep 10
done
#
```

```
counter=1
while (test "$counter" -lt "6")
do
target=`expr $counter + 31`
        echo Mapping p4-asu1-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server12
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server13
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server14
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server19
echo Mapping server20
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server20
echo Mapping server3
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server3
echo Mapping server6
 /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu1-s$counter -P readwrite -l $target initiator server6
   counter=`expr $counter + 1`
 sleep 10
done
#
#
# Map volumes
set -x
echo
date
counter=1
while (test "$counter" -lt "4")
do
target=`expr $counter + 36`
        echo Mapping p1-asu2-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server12
echo Mapping server13
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server13
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server14
echo Mapping server15
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server19
echo Mapping server20
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server20
echo Mapping server3
```

```
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server3
echo Mapping server6
 /opt/se6x20/cli/bin/sscs map -S spc -v p1-asu2-s$counter -P readwrite -l $target initiator server6
  counter=`expr $counter + 1`
 sleep 10
done

counter=1
while (test "$counter" -lt "4")
do
target=`expr $counter + 39`
       echo Mapping p2-asu2-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server12
echo Mapping server13
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server13
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server14
echo Mapping server15
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server19
echo Mapping server20
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server20
echo Mapping server3
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server3
echo Mapping server6
 /opt/se6x20/cli/bin/sscs map -S spc -v p2-asu2-s$counter -P readwrite -l $target initiator server6
  counter=`expr $counter + 1`
 sleep 10
done
#
date
counter=1
while (test "$counter" -lt "4")
do
target=`expr $counter + 42`
       echo Mapping p3-asu2-s$counter to all Initiators
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server11
echo Mapping server12
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server12
echo Mapping server13
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server13
echo Mapping server14
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server14
echo Mapping server15
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server15
echo Mapping server16
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server16
echo Mapping server17
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server17
echo Mapping server18
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server18
echo Mapping server19
 /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server19
```

```
 echo Mapping server20
  /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server20
 echo Mapping server3
  /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server3
 echo Mapping server6
  /opt/se6x20/cli/bin/sscs map -S spc -v p3-asu2-s$counter -P readwrite -l $target initiator server6
    counter=`expr $counter + 1`
  sleep 10
 done
 #
 counter=1
 while (test "$counter" -lt "4")
 do
 target=`expr $counter + 45`
        echo Mapping p4-asu2-s$counter to all Initiators
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server11
 echo Mapping server12
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server12
 echo Mapping server14
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server13
 echo Mapping server14
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server14
 echo Mapping server14
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server15
 echo Mapping server16
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server16
 echo Mapping server17
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server17
 echo Mapping server18
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server18
 echo Mapping server19
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server19
 echo Mapping server20
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server20
 echo Mapping server3
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server3
 echo Mapping server6
  /opt/se6x20/cli/bin/sscs map -S spc -v p4-asu2-s$counter -P readwrite -l $target initiator server6
    counter=`expr $counter + 1`
  sleep 10
 done
 echo $StartTime
```

# APPENDIX C: SPC-1 WORKLOAD GENERATOR STORAGE COMMANDS AND PARAMETERS

The contents of the SPC-1 Workload Generator command and parameter file is listed below.

```
sd=default
sd=asu1_1,lun=/dev/md/rdsk/d10,size=680g
sd=asu1_2,lun=/dev/md/rdsk/d11,size=680g
sd=asu2_1,lun=/dev/md/rdsk/d20,size=680g
sd=asu2_2,lun=/dev/md/rdsk/d21,size=680g
sd=asu3_1,lun=/dev/md/rdsk/d3,size=302g
```

# APPENDIX D: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

The script used to execute Persistence Test Run 2, the Metrics Test (Sustainability, IOPS, and Response Time Ramp), and the Repeatability Test is listed below.

```
#!/usr/bin/ksh
bsu=973
STEP=5
startup=180
while [[ $bsu -le 973 ]]
do
outdir=/spc/nfs-spc/output/Audit/${bsu}
mkdir -p $outdir
iostat -xnzT d 60 60 > /tmp/6920-iostat.out &
java -Xmx512m persist2
mv persistence1 $outdir
mv persistence2 $outdir
metastat > $outdir/metastat
java -Xmx2048m -Xss1024k metrics -b $bsu -s $startup
mv metrics $outdir
java -Xmx2048m -Xss1024k repeat1 -b $bsu -s $startup
mv repeatability1 $outdir
java -Xmx2048m -Xss1024k repeat2 -b $bsu -s $startup
mv repeatability2 $outdir
mv SPCOut $outdir
cp /tmp/6920-iostat.out $outdir
#zip -r money/${bsu}_vx_9980_dir_archive $outdir
bsu=`expr $bsu + $STEP`
echo "All done .... sleeping for 5 minutes"
sleep 300
done
```