



SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

INSPUR ELECTRONIC INFORMATION INDUSTRY CO. INC.
INSPUR AS5300G5

SPC-1 v3.9.1

SUBMISSION IDENTIFIER: A32017

SUBMITTED FOR REVIEW: SEPTEMBER 3, 2020

First Edition – September 2020

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Benchmark Specification and Glossary

The official SPC Benchmark 1™ (SPC-1™) specification is available on the website of the Storage Performance Council (SPC) at www.spcresults.org.

The SPC-1™ specification contains a glossary of the SPC-1™ terms used in this publication.

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AUDIT CERTIFICATION



Hao Sun
 Inspur Electronic Information Industry Co. Ltd.
 NO.1036, Inspur Road, Jinan
 People's Republic of China

September 2, 2020

I verified the SPC Benchmark 1™ (SPC-1™ v3.9.1) test execution and performance results of the following Tested Storage Product:

Inspur AS5300G5

The results were:

| | |
|-----------------------------|------------------------------|
| SPC-1 IOPS™ | 2,710,243 |
| SPC-1 Price-Performance | \$226.99/SPC-1 KIOPS™ |
| SPC-1 Total System Price | 615,192.25 |
| SPC-1 IOPS Response Time | 0.547 ms |
| SPC-1 Overall Response Time | 0.251 ms |
| SPC-1 ASU Capacity | 68,719 GB |
| SPC-1 ASU Price | \$8.96/GB |

In my opinion, these performance results were produced in compliance with the SPC requirements for the benchmark.

The testing was executed using the SPC-1 Toolkit Version v3.0.2-1-g823a. The audit process was conducted in accordance with the SPC Policies and met the requirements for the benchmark.

A Letter of Good Faith was issued by Inspur Electronic Information Industry Co. Inc., stating the accuracy and completeness of the documentation and testing data provided in support of the audit of this result.

A Full Disclosure Report for this result was prepared by InfoSizing, reviewed and approved by Inspur Electronic Information Industry Co. Inc., and can be found at www.spcresults.org under the Submission Identifier A32017.

Page 1 of 2

63 Lourdes Dr. | Leominster, MA 01453 | 978-343-6562 | www.sizing.com

A32017

Inspur AS5300G5

Page 2 of 2

The independent audit process conducted by InfoSizing included the verifications of the following items:

- The physical capacity of the data repository (192,000 GB).
- The total capacity of the Application Storage Unit (68,719 GB).
- The accuracy of the Benchmark Configuration diagram.
- The tuning parameters used to configure the Benchmark Configuration.
- The Workload Generator commands used to execute the testing.
- The validity and integrity of the test result files.
- The compliance of the results from each performance test.
- The compliance of the results from each persistence test.
- The compliance of the submitted pricing model.
- The differences between the tested and the priced configuration, if any.

The Full Disclosure Report for this result was prepared in accordance with the disclosure requirements set forth in the specification for the benchmark.

The following benchmark requirements, if any, were waived in accordance with the SPC Policies:

The SPC-1 data reduction tool sometimes exhibits a minor anomaly when grouping operations into the 1-minute buckets used when calculating and reporting statistics. As a by-product of this anomaly, minor differences (all less than 0.01%) exist between some of the values reported in the FDR and the corresponding values in the workbooks provided in the Supporting Files. In my opinion, this has no impact on the integrity of the result.

Respectfully Yours,



Doug Johnson, Certified SPC Auditor

63 Lourdes Dr. | Leominster, MA 01453 | 978-343-6562 | www.sizing.com

LETTER OF GOOD FAITH

September 2, 2020

To: Doug Johnson, SPC Auditor
PerfLabs, Inc. DBA InfoSizing
63 Lourdes Drive
Leominster, MA 01453-6709
USA

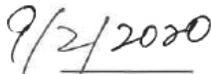
Subject: SPC-1 Letter of Good Faith for the AS5300G5

Inspur Electronic Information Industry Co. Ltd is the SPC-1 test sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 results and materials we have submitted for that product are complete, accurate, and in full compliance with version 3.9 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.

Sincerely,


Henry Li
GM of Storage Product Department
Inspur Electronic Information Industry Co. Ltd.


Date: September 2, 2020



SPC Benchmark 1™ *Executive Summary*



Inspur AS5300G5

| | | | |
|-----------------------------|------------------|---------------------------|------------------------------|
| SPC-1 IOPS™ | 2,710,243 | SPC-1 Price Performance | \$226.99/SPC-1 KIOPS™ |
| SPC-1 IOPS Response Time | 0.547 ms | SPC-1 Total System Price | \$615,192.25 |
| SPC-1 Overall Response Time | 0.251 ms | SPC-1 Overall Discount | 73.46% |
| | | Currency / Target Country | USD / China |
| | | Availability Date | August 31, 2020 |

Extensions

| | |
|---------------------------------|----|
| ☆ SPC-1 Data Reduction | NA |
| ☆ SPC-1 Encryption | NA |
| ☆ SPC-1 NDU | NA |
| ☆ SPC-1 Synchronous Replication | NA |
| ☆ SPC-1 Snapshot | NA |

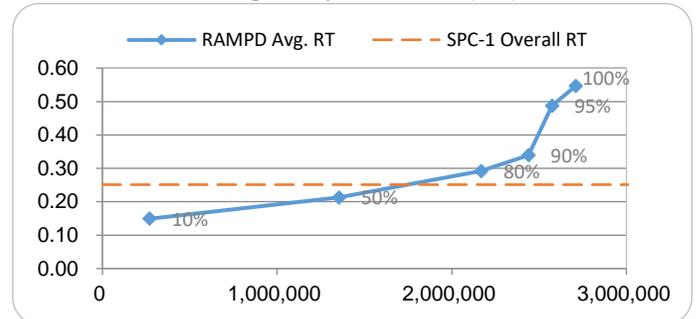
Storage Metrics

| | |
|---------------------------------|-------------|
| SPC-1 Data Protection Level | Protected 2 |
| SPC-1 Physical Storage Capacity | 192,000 GB |
| SPC-1 ASU Capacity | 68,719 GB |
| SPC-1 ASU Price | \$8.96/GB |

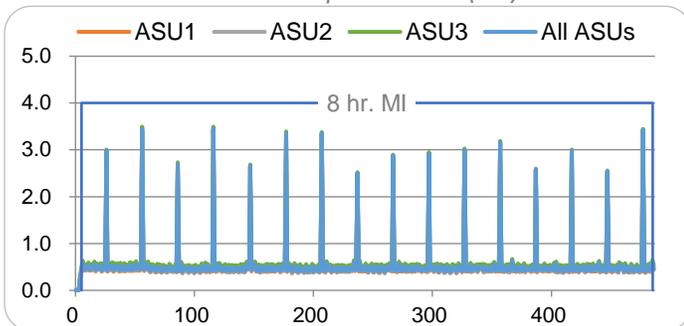
Priced Storage Configuration Summary

- 16 Emulex LPe16002 2-port FC HBAs
- 4 Inspur AS5300G5 Enclosures
- 8 Controllers (2 per Enclosure)
- 1,024 GB Total Cache
- 64 16Gb FC Ports (48 ports used)
- 200 960 GB SSDs
- 2 FS6700 16 Gb FC Switches
- 18 Total RUs

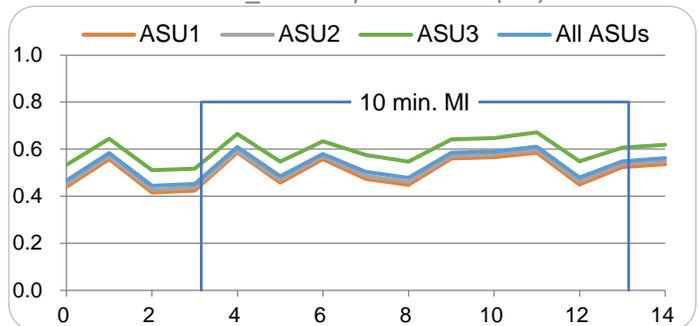
RAMPD Average Response Time (ms) vs. IOPS



SUSTAIN Response Time (ms)



RAMPD_100 Response Time (ms)



SPC Benchmark 1™ Specification Revision v3.9.1
 SPC Benchmark 1™ Workload Generator Revision v3.0.2-1-g823a

Submitted for Review September 3, 2020
 Submission Details www.storageperformance.org/r/A32017

PRICING DETAILS

| Part No. | Description | Source | Qty | Unit Price | Ext. Price | Disc. | Disc. Price |
|---|--|--------|-----|------------|--------------|-------|-------------------|
| Hardware & Software | | | | | | | |
| UAS5300G5001 | Inspur AS5300G5 Storage System Base Unit (2U,Dual Controllers,25*2.5",BBU+Flash,3Y 5x10xND Basic Svc&Warranty) | 1 | 4 | 30,124.93 | 120,499.72 | 70% | 36,149.92 |
| TMO053 | Inspur AS5300G5 Cache Module-256GB | 1 | 4 | 1,937.68 | 7,750.72 | 68% | 2,480.24 |
| THD068 | Inspur 960GB TLC SSD Enterprise Drive(2.5"), For AS5300G5 J012HG5、J025SG5、J048HG5 | 1 | 200 | 7,421.21 | 1,484,242.00 | 75% | 371,060.50 |
| UJ025SG50001 | Inspur J025SG5 JBOD (2U, 25*2.5" disks) | 1 | 4 | 9,899.72 | 39,598.88 | 70% | 11,879.67 |
| TSJ160 | Inspur AS5300G5 4*16Gbps FC Ports +SFP | 1 | 16 | 9,498.57 | 151,977.12 | 70% | 45,593.14 |
| THS530 | Inspur AS5300G5 Basic Software(InThin,InSnapshot,InClone,InBackup, InVdiskMirror,InQos,InRAID,InPath) | 1 | 4 | 2,847.86 | 11,391.44 | 90% | 1,139.15 |
| TWF003 | Inspur 3M LC-LC OM4 Fibre Channel Cable | 1 | 80 | 28.66 | 2,292.80 | 70% | 687.84 |
| TSJ203 | Inspur 2*Port 16Gbps Fibre Channel Adapter | 1 | 16 | 5,114.62 | 81,833.92 | 70% | 24,550.18 |
| 500326 | Inspur FS6700 SAN switch, Enable 16Gbps*48 Ports,+SFP | 1 | 2 | 206,303.73 | 412,607.46 | 72% | 115,530.09 |
| Hardware & Software Subtotal | | | | | | | 609,070.73 |
| Support & Maintenance | | | | | | | |
| F2H104 | Installation Service - Engineering | 1 | 4 | 1,027.94 | 4,111.76 | 0% | 4,111.76 |
| F2GD0030AS53G525 | UPgrade TO Onsite Premier 24x7x4H Engineer Onsite Service - 36Month(s) | 1 | 4 | 502.44 | 2,009.76 | 0% | 2,009.76 |
| Support & Maintenance Subtotal | | | | | | | 6,121.52 |
| SPC-1 Total System Price | | | | | | | 615,192.25 |
| SPC-1 IOPS™ | | | | | | | 2,710,243 |
| SPC-1 Price-Performance™ (\$/SPC-1 KIOPS™) | | | | | | | 226.99 |
| SPC-1 ASU Capacity (GB) | | | | | | | 68,719 |
| SPC-1 ASU Price (\$/GB) | | | | | | | 8.96 |

Discount Details: The discounts are based on the total purchase price.

Warranty: Provides 7x24x4H arrival service within designated city and distance. The service includes 7x24 contact to the Inspur call center with 4-hours on-site hardware replacement or troubleshooting, and online software support with access to all new software updates or troubleshooting.

Differences Between Tested and Priced Storage Configurations

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

PUBLICATION DETAILS

This section provides contact information for the test sponsor and auditor, a revision history of this document, and a description of any exceptions or waivers associated with this publication.

Contact Information

| Role | Name | Details |
|-------------------------------------|--|--|
| Test Sponsor Primary Contact | Inspur Electronic Information Industry Co. Inc. Hao Sun | http://en.inspur.com/ sunhaobj@inspur.com |
| SPC Auditor | InfoSizing Doug Johnson | www.sizing.com doug@sizing.com |

Revision Information

| Date | FDR Revision | Details |
|-------------------|---------------|---------------------|
| September 3, 2020 | First Edition | Initial Publication |

Exceptions and Waivers

The SPC-1 data reduction tool sometimes exhibits a minor anomaly when grouping operations into the 1-minute buckets used when calculating and reporting statistics. As a by-product of this anomaly, minor differences (all less than 0.01%) exist between some of the values reported in this FDR and the corresponding values in the workbooks provided in the Supporting Files.

CONFIGURATION INFORMATION

Tested Storage Product Description

Inspur AS5300G5 is a mid-end hybrid flash storage system for medium/large-sized enterprises and provides both SAN and NAS. With the storage operating system especially developed for cloud computing and big data, rich software features, and industry-leading hardware platform, AS5300G5 satisfies the data storage and disaster recovery requirement of various applications, such as medium/large-sized OLTP/OLAP databases, virtualization and file sharing.

Host System and Tested Storage Configuration Components

The following table lists the components of the Host System(s) and the TSC.

| Host Systems |
|---|
| 8 x Inspur NF5280M5, each with: 2 x Intel® Xeon® 6132 CPU (2.6 GHz, 14-Core, 20 MB L3) 128 GB Main Memory Red Hat Enterprise Linux 7.4 |
| Tested Storage Configuration |
| 16 x Emulex LPe16002 2-port FC HBAs |
| 4 x Inspur AS5300G5 Enclosures, each with: 2 x Storage Controller 128 GB cache (1,024 GB total) 2 x 4-port 16 Gbps FC I/O modules (48 ports used) 1 x 4-port 12 Gb SAS I/O module 200 x 960 GB SSDs (25 per enclosure) |
| 2 x INSPUR FS6700 16 Gb FC Switches |

Component Changes in Revised Full Disclosure Report

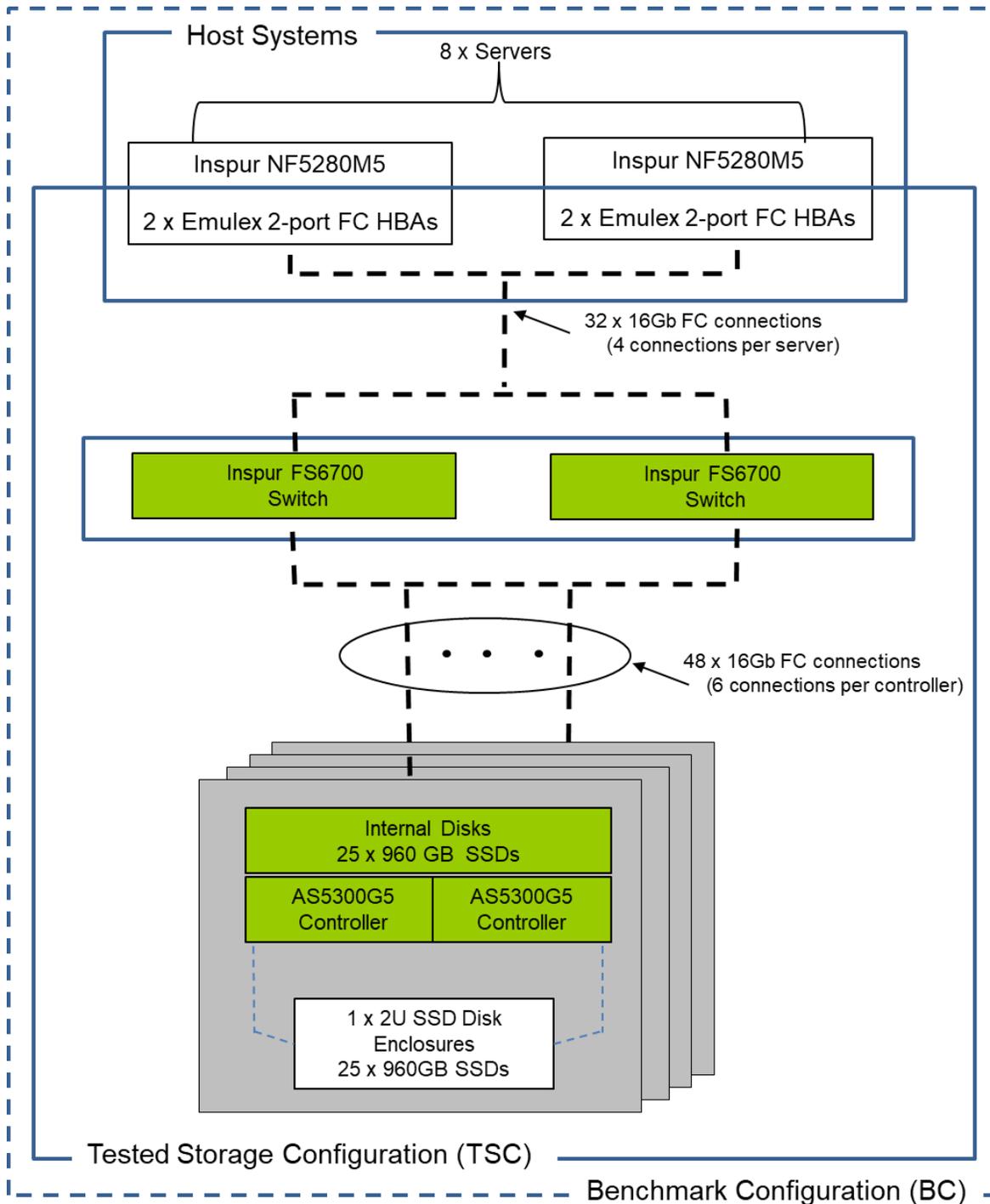
The following table outlines component changes that were made in revisions to this Full Disclosure Report.

| Original Component | Revised Component | Description of Change |
|--------------------|-------------------|-----------------------|
| n/a | n/a | Initial submission |

Configuration Diagrams

BC/TSC Configuration Diagram

The following diagram illustrates the Benchmark Configuration (BC), including the Tested Storage Configuration (TSC) and the Host System(s).



Storage Network Configuration

The TSC utilized an external storage subsystem consisting of eight Inspur AS5300G5 controllers driven by eight host systems (Inspur NF5280M5). Each NF5280M5 host system utilized two dual-port Fibre Channel HBAs to establish four connections to the FS6700 switches. Each HBA had one connection to each of the two switches. The AS5300G5 controllers were grouped in sets of two, forming four Inspur AS5300G5 Controller Enclosures. Each AS5300G5 controller had six connections to the FS6700 switches (three connections per switch). All Fibre Channel paths operated at 16 Gbps.

Benchmark Configuration Creation Process

Customer Tuning Parameters and Options

All the customer tuning parameters and options that have been altered from their default values for this benchmark are included in Appendix C and in the Supporting Files (see Appendix A).

Tested Storage Configuration Creation

A detailed description of how the logical representation of the TSC was created is included in Appendix D and in the Supporting Files (see Appendix A).

Tested Storage Configuration Inventory

An inventory of the components in the TSC, as seen by the Benchmark Configuration, is included in Appendix E and in the Supporting Files (see Appendix A).

Workload Generator Storage Configuration

The SPC-1 Workload Generator storage configuration commands and parameters used to invoke the execution of the tests are included in Appendix F and in the Supporting Files (see Appendix A).

Logical Volume Capacity and Application Storage Unit Mapping

The following table details the capacity of the Application Storage Units (ASUs) and how they are mapped to logical volumes (LVs). All capacities are reported in GB.

| | LV per ASU | LV Capacity | Used per LV | Total per ASU | % ASU Capacity | Optimized* |
|---------------------------|------------|-------------|-------------|---------------|--|------------|
| ASU-1 | 18 | 1,717.9 | 1,717.9 | 30,923.7 | 45.0% | No |
| ASU-2 | 18 | 1,717.9 | 1,717.9 | 30,923.7 | 45.0% | No |
| ASU-3 | 4 | 1,717.9 | 1,717.9 | 6,871.9 | 10.0% | No |
| SPC-1 ASU Capacity | | | | 68,719 | *See Space Optimization Techniques | |

Physical Storage Capacity and Utilization

The following table details the Physical Capacity of the storage devices and the Physical Capacity Utilization (percentage of Total Physical Capacity used) in support of hosting the ASUs. All capacities are reported in GB.

| Devices | Count | Physical Capacity | Total Capacity |
|--------------------------------------|-------|-------------------|----------------|
| SSD | 200 | 960.0 | 192,000.0 |
| Total Physical Capacity | | | 192,000 |
| Physical Capacity Utilization | | | 35.79% |

Data Protection

The data protection level used for all LVs was **Protected 2 (RAID-10)**, which was accomplished by configuring 80 LUNs over four storage pools comprising 16 RAID-10 arrays.

Space Optimization Information

Description of Utilized Techniques

The TSC did not use any space optimization techniques.

Physical Free Space Metrics

The following table lists the Physical Free Space as measured at each of the required points during test execution. If space optimization techniques were not used, "NA" is reported.

| Physical Free Space Measurement | Free Space (GB) |
|---------------------------------|-----------------|
| After Logical Volume Creation | NA |
| After ASU Pre-Fill | NA |
| After Repeatability Test Phase | NA |

Space Optimization Metrics

The following table lists the required space optimization metrics. If space optimization techniques were not used, "NA" is reported.

| Metric | Value |
|---------------------------------|-------|
| SPC-1 Space Optimization Ratio | NA |
| SPC-1 Space Effectiveness Ratio | NA |

BENCHMARK EXECUTION RESULTS

This portion of the Full Disclosure Report documents the results of the various SPC-1 Tests, Test Phases, and Test Runs.

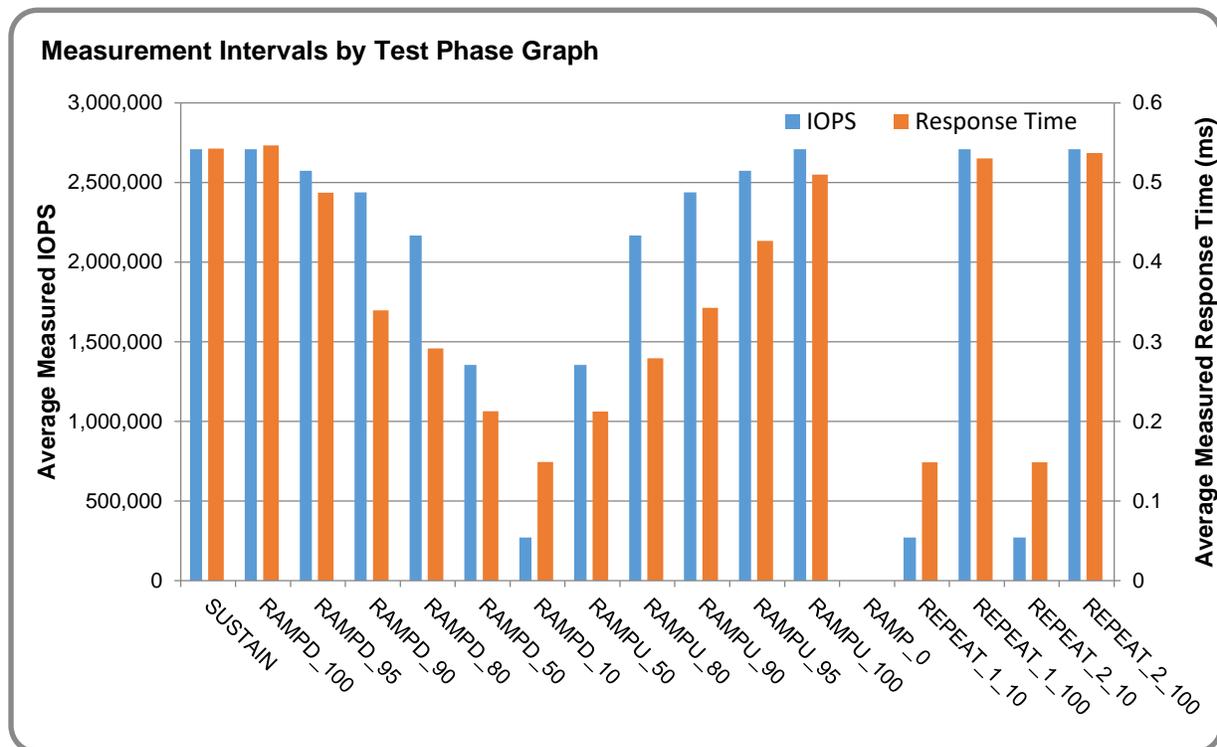
Benchmark Execution Overview

Workload Generator Input Parameters

The SPC-1 Workload Generator commands and input parameters for the Test Phases are presented in the Supporting Files (see Appendix A).

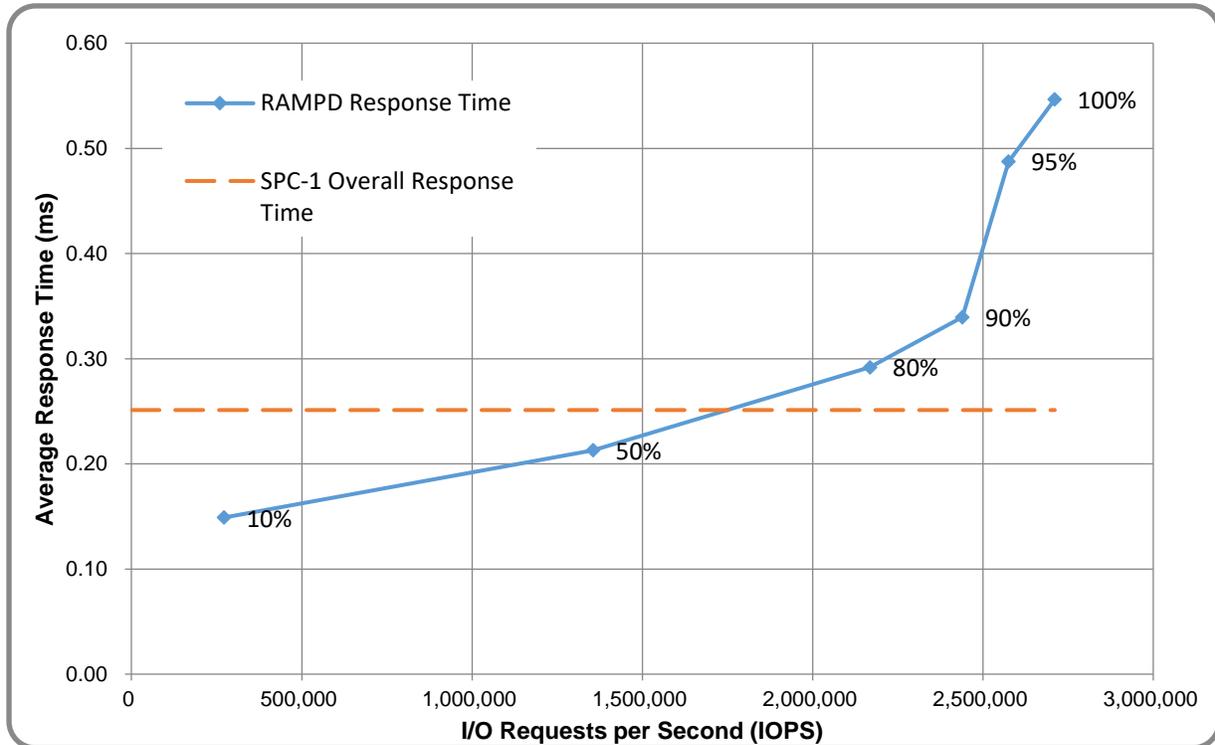
Measurement Intervals by Test Phase Graph

The following graph presents the average IOPS and the average Response Times measured over the MI of each Test Phase.



Response Time vs. Throughput Graph

The following graph presents the average Response Times versus the average IOPS for RAMPD_100 to RAMPD_10.



ASU Pre-Fill

The following table provides a summary of the Pre-Fill performed on the ASU prior to testing.

| ASU Pre-Fill Summary | | | |
|----------------------|--------------------|--|---------------|
| Start Time | 08-Aug-20 07:27:19 | Requested IOP Level | 10,000 MB/sec |
| End Time | 08-Aug-20 09:19:15 | Observed IOP Level | 10,232 MB/sec |
| Duration | 1:51:56 | For additional details see the Supporting Files. | |

SUSTAIN Test Phase

SUSTAIN – Results File

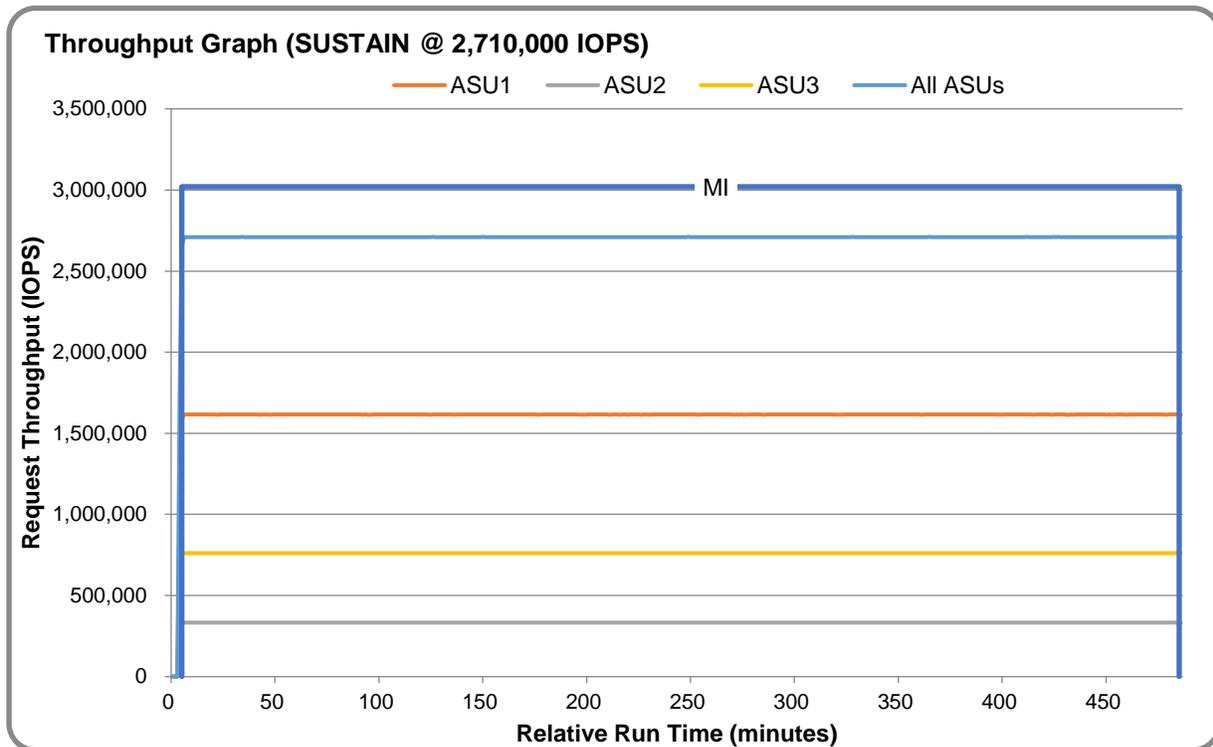
The results file generated during the execution of the SUSTAIN Test Phase is included in the Supporting Files (see Appendix A) as follows:

- SPC1_METRICS_0_Raw_Results.xlsx

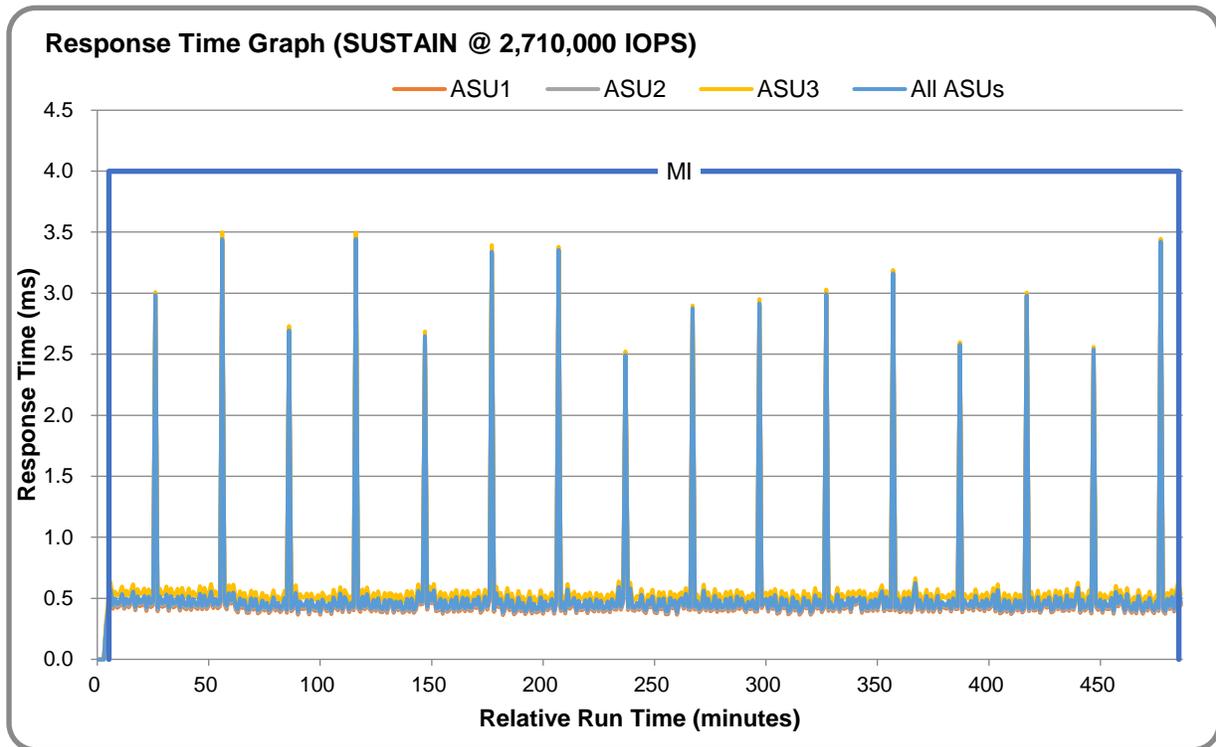
SUSTAIN – Execution Times

| Interval | Start Date & Time | End Date & Time | Duration |
|----------------------|--------------------|--------------------|----------|
| Transition Period | 08-Aug-20 09:27:56 | 08-Aug-20 09:30:56 | 0:03:00 |
| Measurement Interval | 08-Aug-20 09:30:56 | 08-Aug-20 17:30:57 | 8:00:01 |

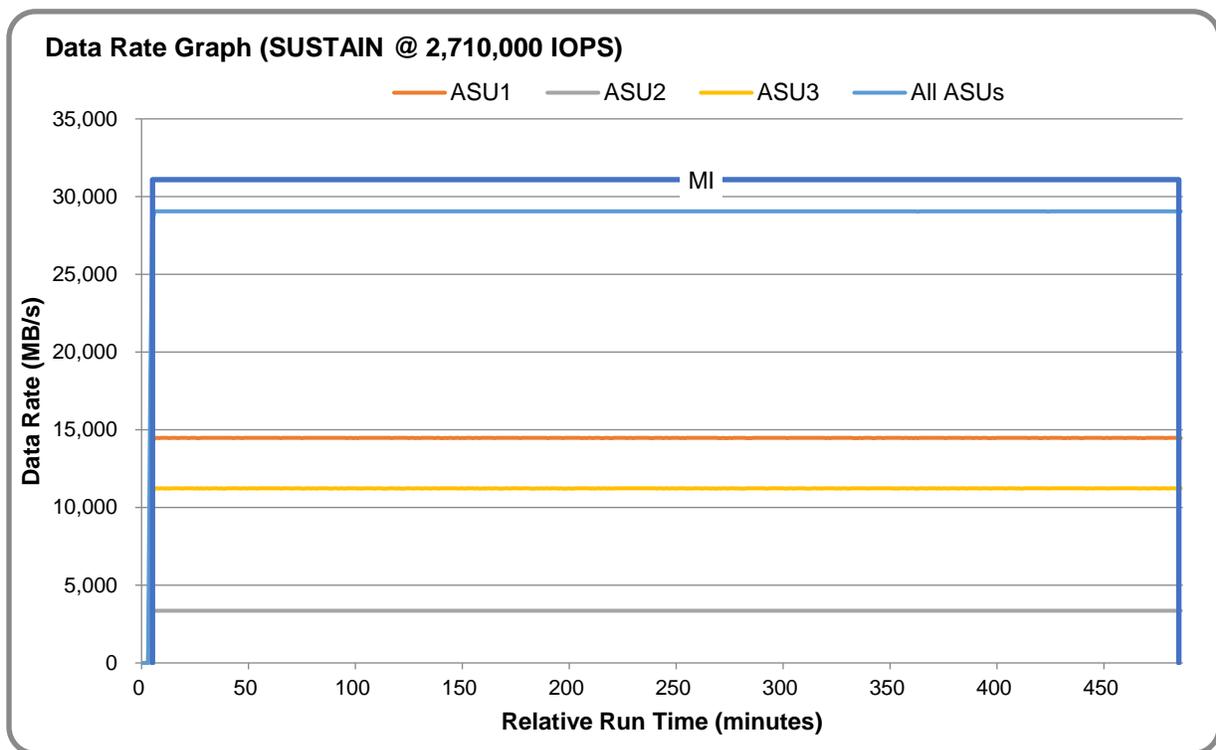
SUSTAIN – Throughput Graph



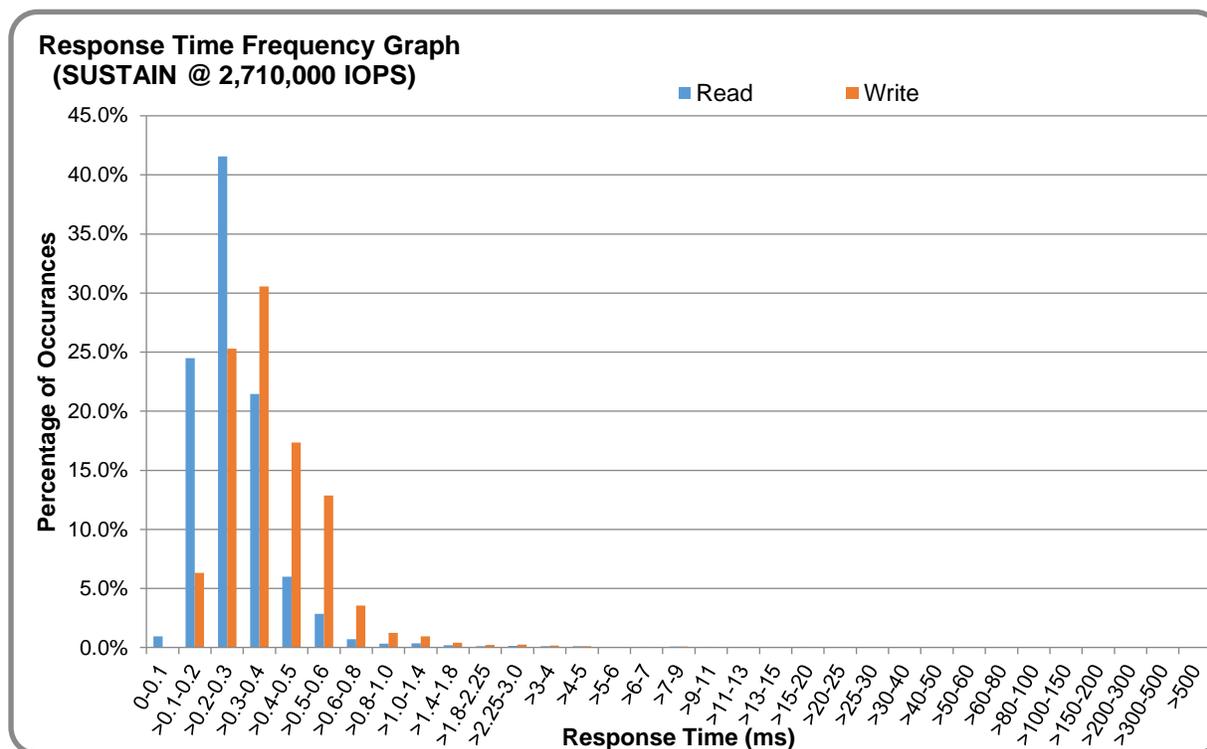
SUSTAIN – Response Time Graph



SUSTAIN – Data Rate Graph



SUSTAIN – Response Time Frequency Graph



SUSTAIN – Intensity Multiplier

The following table lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O stream, its coefficient of variation (Variation), and the percentage of difference (Difference) between Defined and Measured.

| | ASU1-1 | ASU1-2 | ASU1-3 | ASU1-4 | ASU2-1 | ASU2-2 | ASU2-3 | ASU3-1 |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Defined | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| Measured | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| Variation | 0.0004 | 0.0001 | 0.0003 | 0.0001 | 0.0006 | 0.0003 | 0.0004 | 0.0001 |
| Difference | 0.004% | 0.002% | 0.003% | 0.000% | 0.011% | 0.005% | 0.004% | 0.002% |

RAMPD_100 Test Phase

RAMPD 100 – Results File

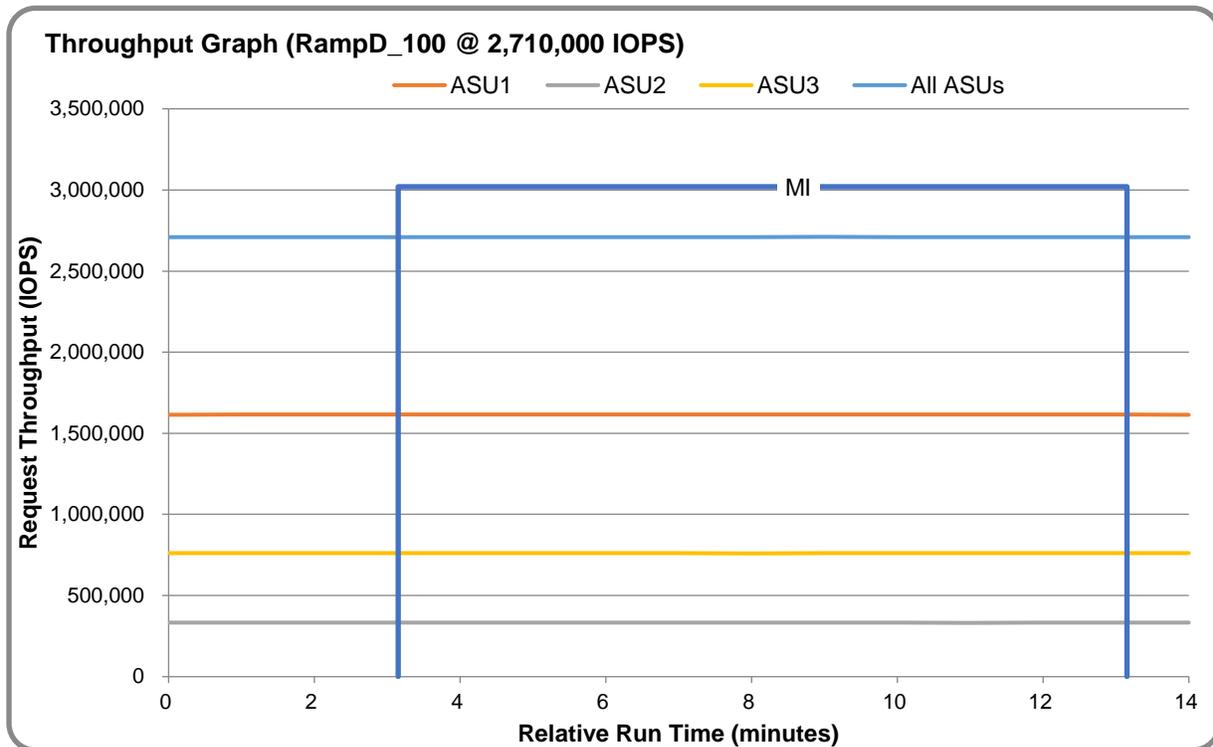
The results file generated during the execution of the RAMPD_100 Test Phase is included in the Supporting Files (see Appendix A) as follows:

- SPC1_METRICS_0_Raw_Results.xlsx

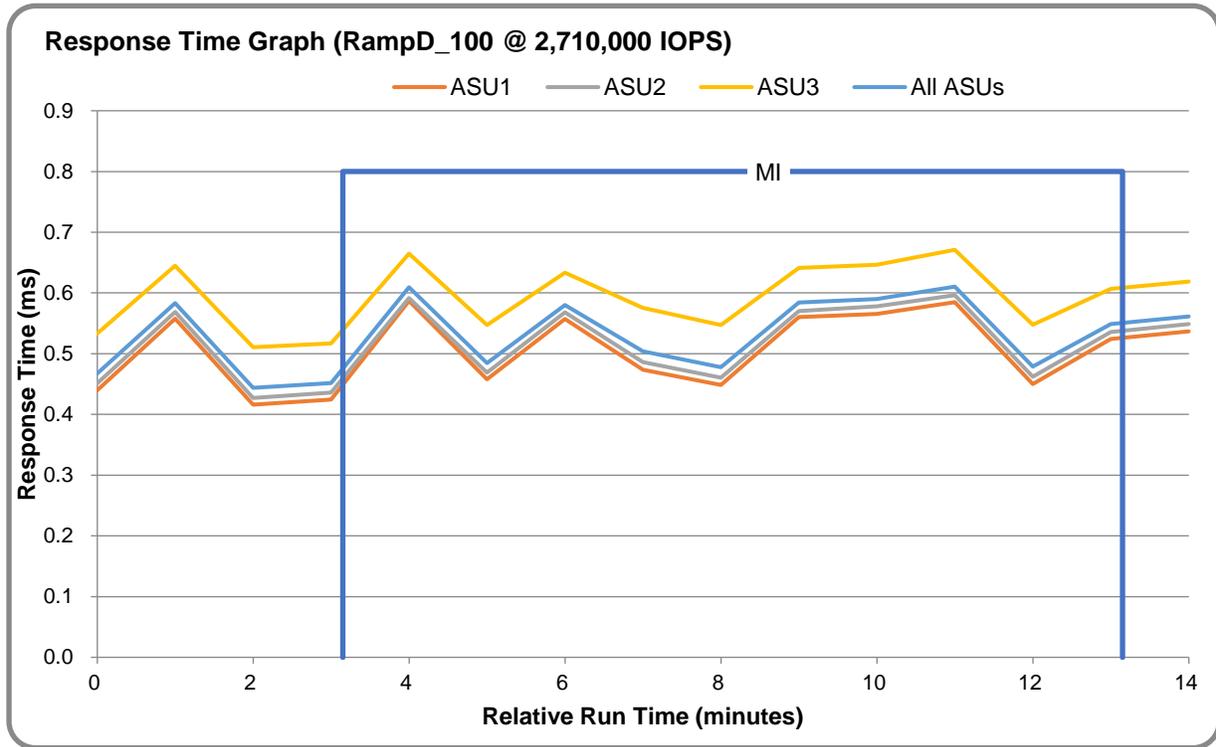
RAMPD 100 – Execution Times

| Interval | Start Date & Time | End Date & Time | Duration |
|----------------------|--------------------|--------------------|----------|
| Transition Period | 08-Aug-20 17:31:56 | 08-Aug-20 17:34:57 | 0:03:01 |
| Measurement Interval | 08-Aug-20 17:34:57 | 08-Aug-20 17:44:57 | 0:10:00 |

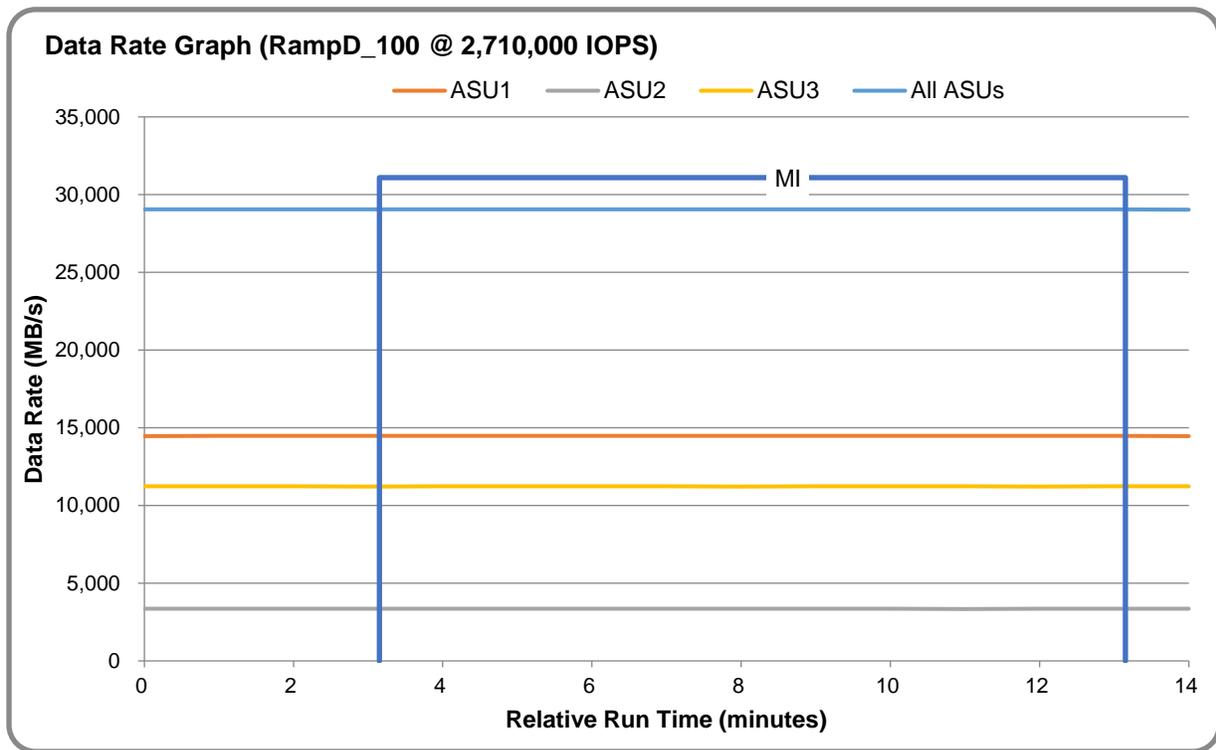
RAMPD 100 – Throughput Graph



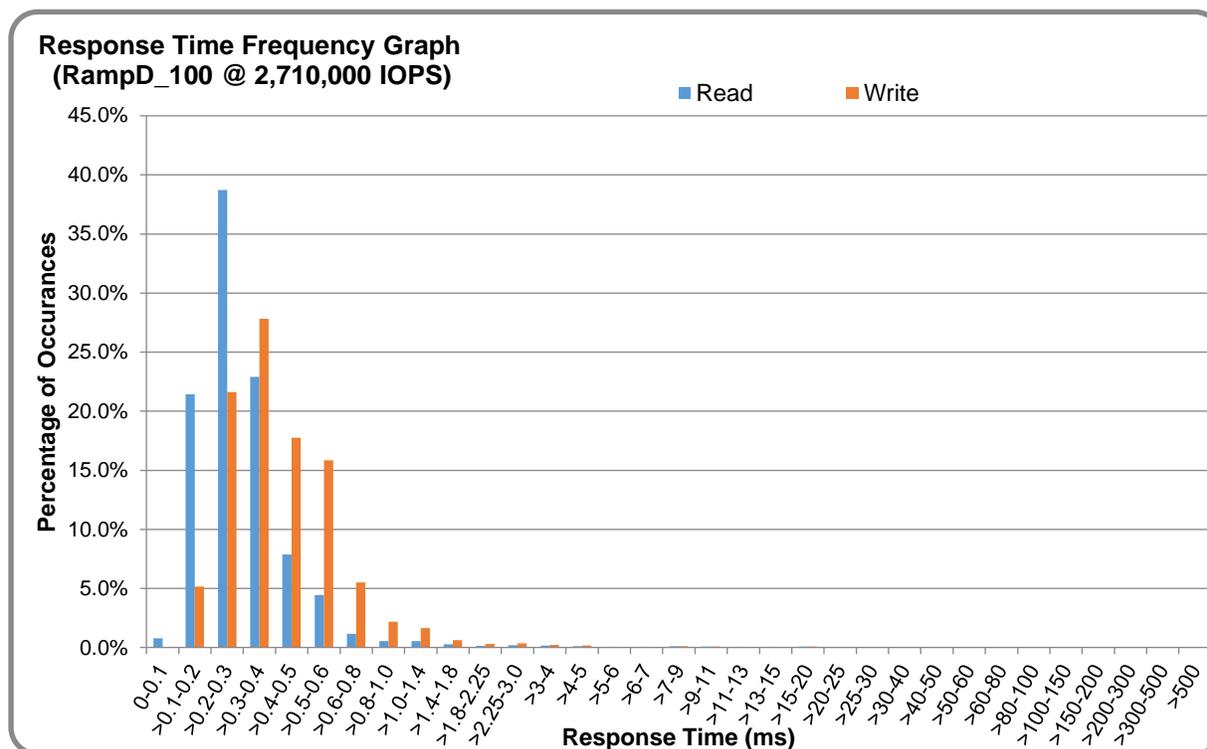
RAMPD 100 – Response Time Graph



RAMPD 100 – Data Rate Graph



RAMPD 100 – Response Time Frequency Graph



RAMPD 100 – Intensity Multiplier

The following table lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O stream, its coefficient of variation (Variation), and the percentage of difference (Difference) between Defined and Measured.

| | ASU1-1 | ASU1-2 | ASU1-3 | ASU1-4 | ASU2-1 | ASU2-2 | ASU2-3 | ASU3-1 |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Defined | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| Measured | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| Variation | 0.0003 | 0.0001 | 0.0003 | 0.0002 | 0.0007 | 0.0003 | 0.0005 | 0.0001 |
| Difference | 0.019% | 0.003% | 0.009% | 0.007% | 0.009% | 0.005% | 0.000% | 0.002% |

RAMPD 100 – I/O Request Summary

| | |
|--|---------------|
| I/O Requests Completed in the Measurement Interval | 1,626,128,728 |
| I/O Requests Completed with Response Time <= 30 ms | 1,624,583,469 |
| I/O Requests Completed with Response Time > 30 ms | 1,545,259 |

Response Time Ramp Test

Response Time Ramp Test – Results File

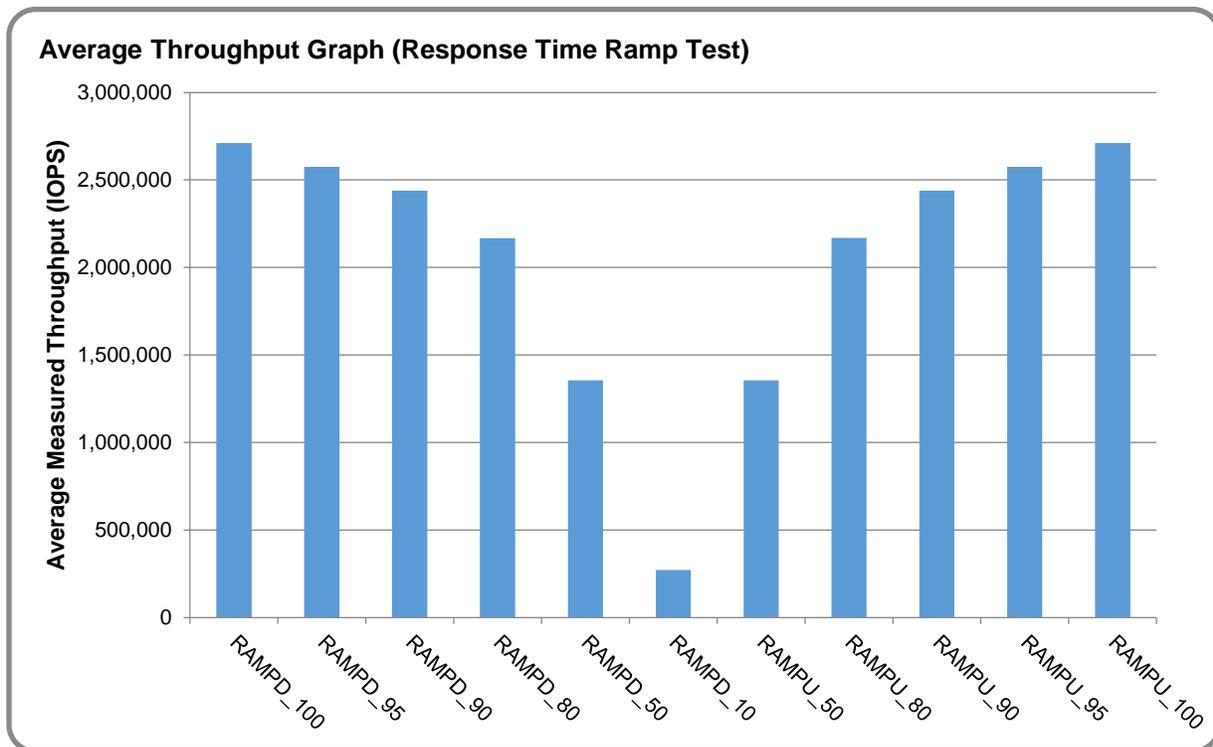
The results file generated during the execution of the Response Time Ramp Test is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

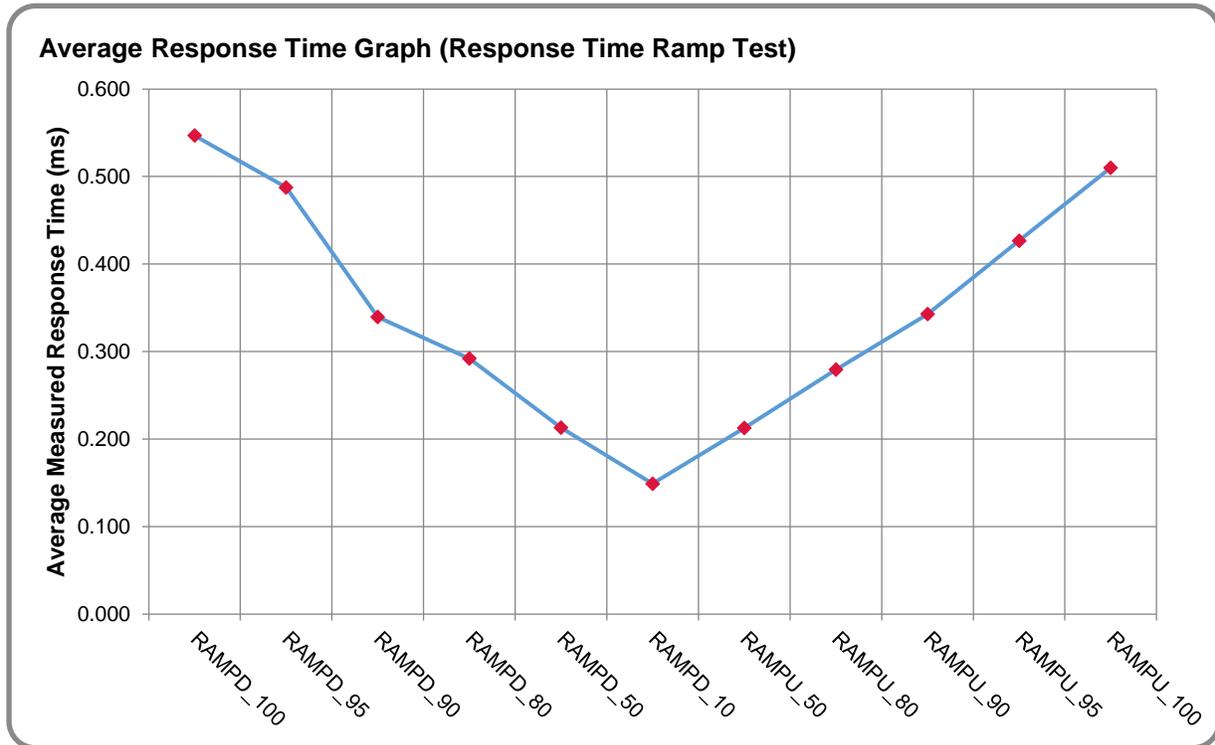
Response Time Ramp Test – Phases

The Response Time Ramp Test is comprised of 11 Test Phases, including six Ramp-Down Phases (executed at 100%, 95%, 90%, 80%, 50%, and 10% of the Business Scaling Unit) and five Ramp-Up Phases (executed at 50%, 80%, 90%, 95%, and 100% of the Business Scaling Unit).

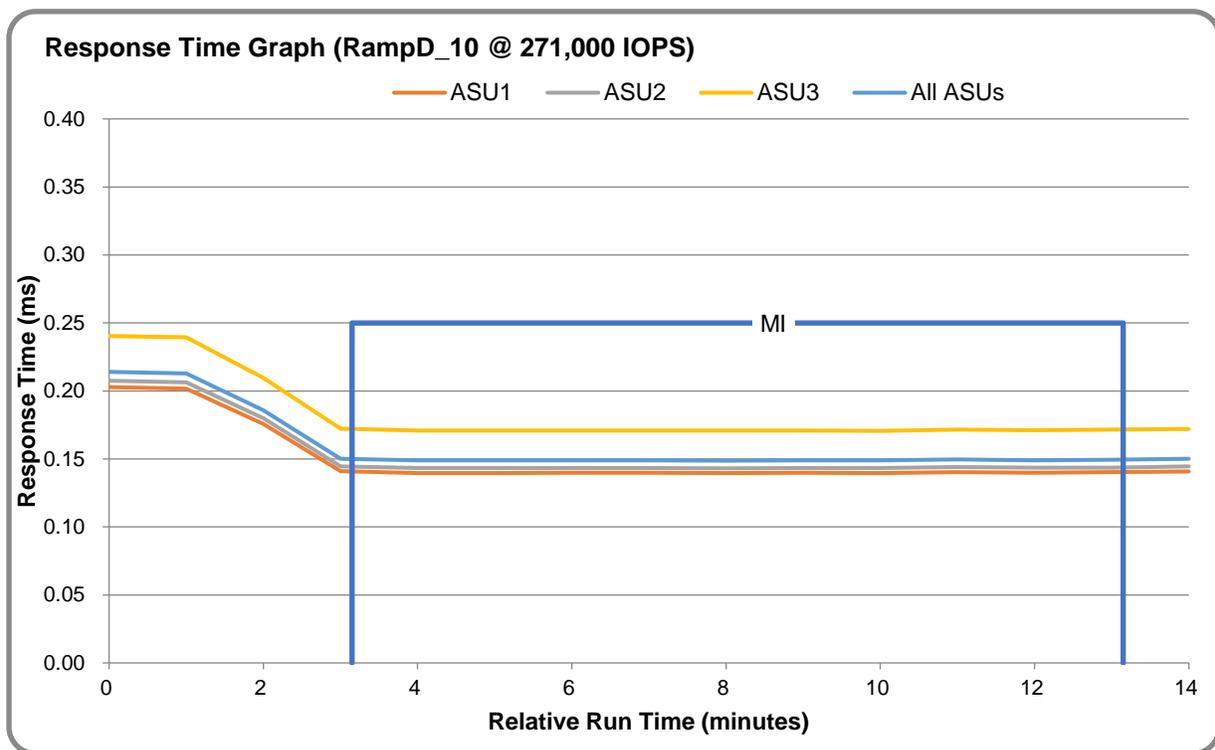
Response Time Ramp Test – Average Throughput Graph



Response Time Ramp Test – Average Response Time Graph



Response Time Ramp Test – RAMPD 10 Response Time Graph



Repeatability Test

Repeatability Test Results File

The results file generated during the execution of the Repeatability Test is included in the Supporting Files (see Appendix A) as follows:

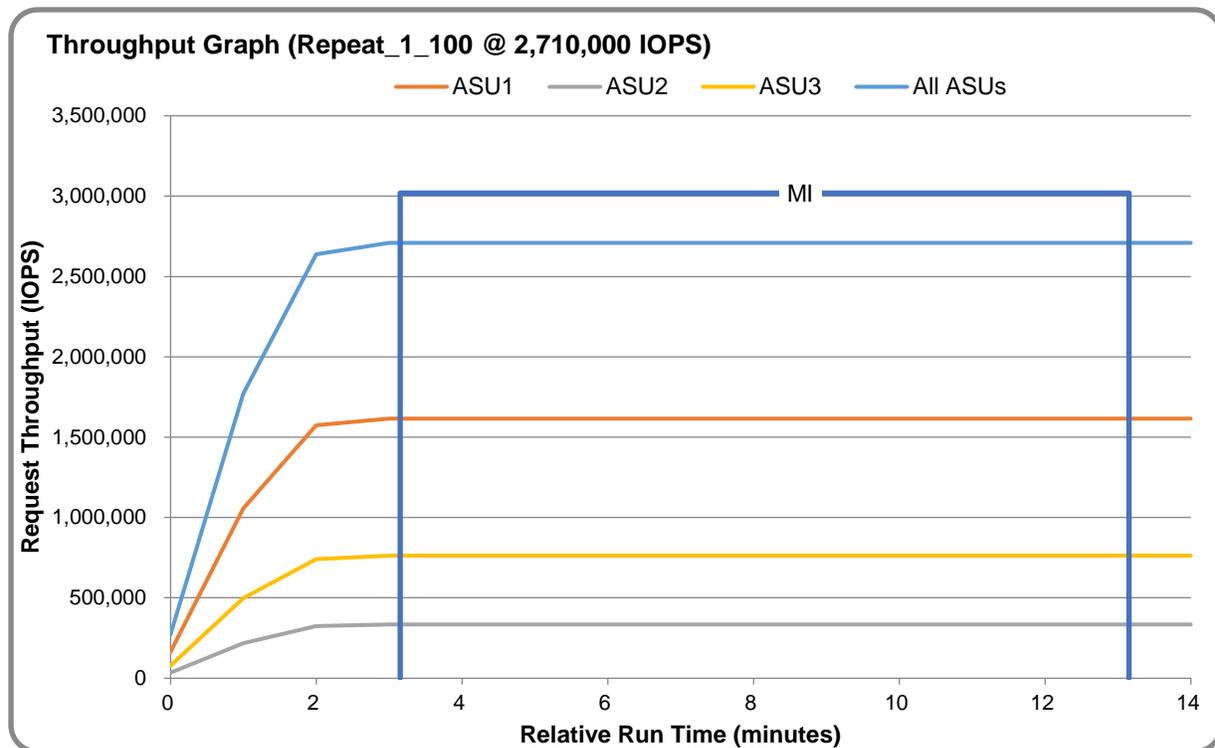
- **SPC1_METRICS_0_Raw_Results.xlsx**

Repeatability Test Results

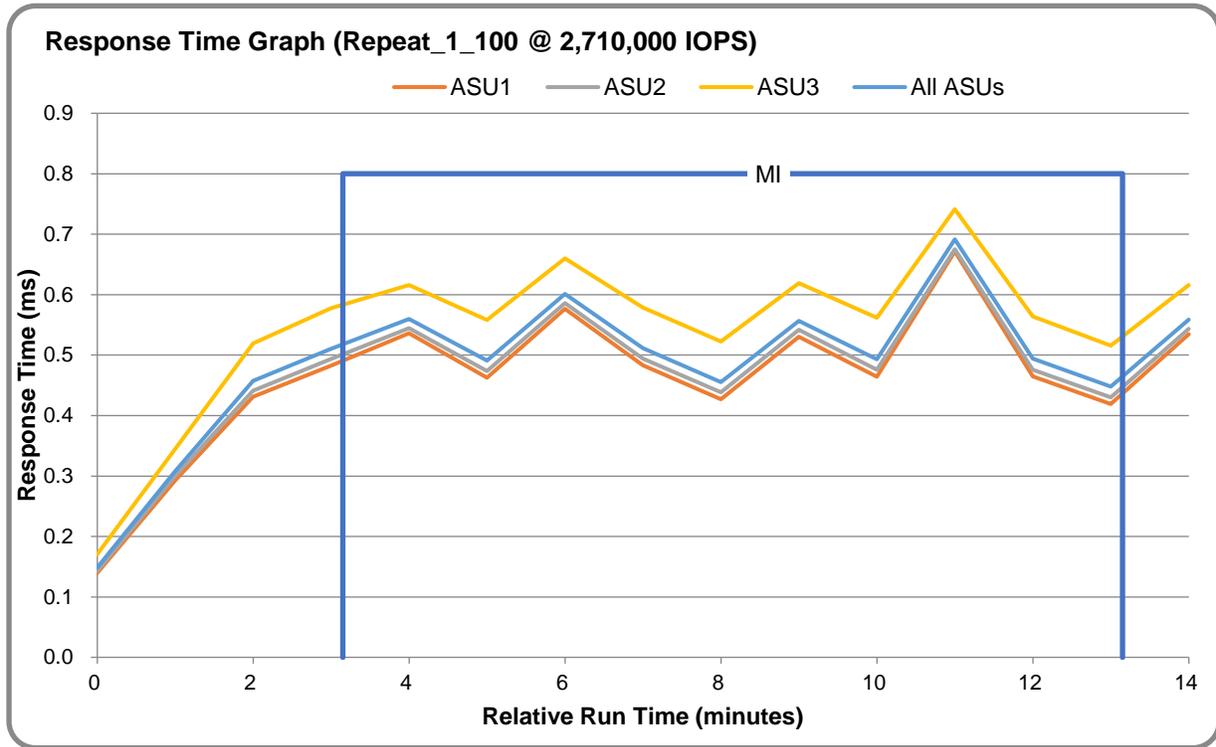
The throughput measurements for the Response Time Ramp Test (RAMPD) and the Repeatability Test Phases (REPEAT_1 and REPEAT_2) are listed in the table below.

| Test Phase | 100% IOPS | 10% IOPS |
|------------|-------------|-----------|
| RAMPD | 2,710,243.7 | 271,032.9 |
| REPEAT_1 | 2,710,105.1 | 271,031.3 |
| REPEAT_2 | 2,710,142.6 | 271,028.4 |

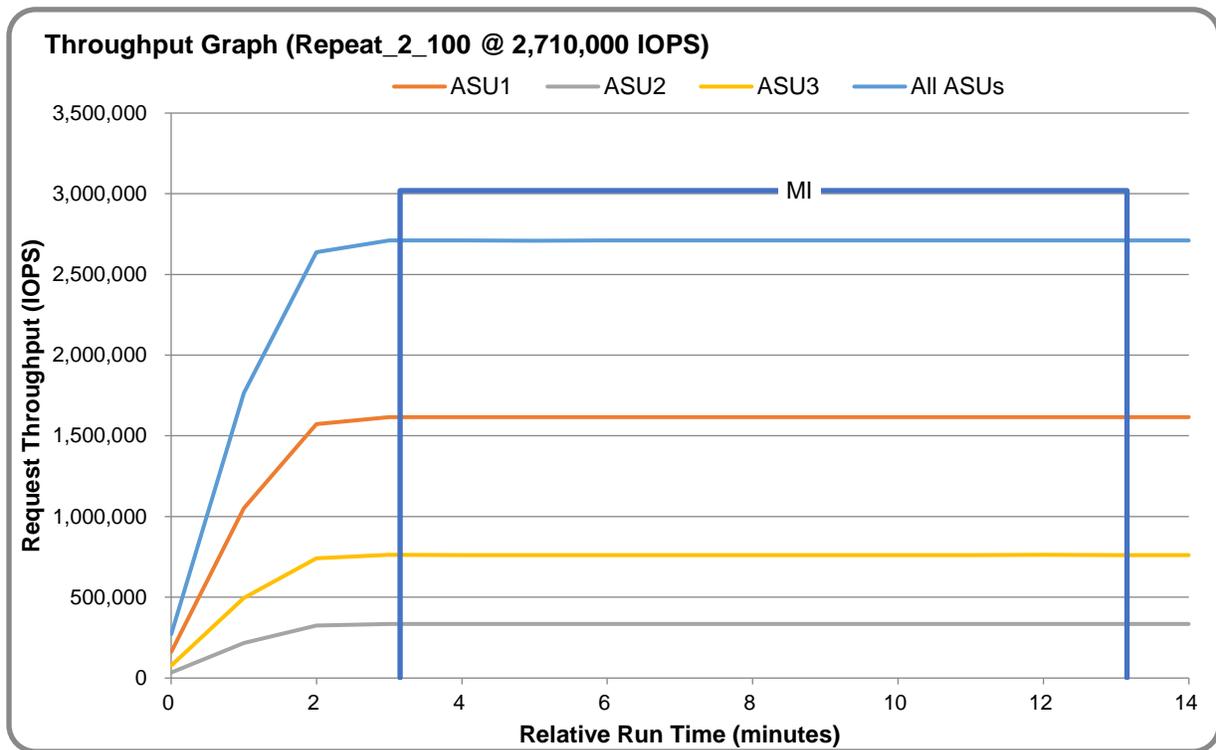
REPEAT 1 100 - Throughput Graph



REPEAT 1 100 – Response Time Graph



REPEAT 2 100 – Throughput Graph



REPEAT 2 100 – Response Time Graph



Repeatability Test – Intensity Multiplier

The following tables lists the targeted intensity multiplier (Defined), the measured intensity multiplier (Measured) for each I/O stream, its coefficient of variation (Variation), and the percent of difference (Difference) between Defined and Measured.

REPEAT_1_100 Test Phase

| | ASU1-1 | ASU1-2 | ASU1-3 | ASU1-4 | ASU2-1 | ASU2-2 | ASU2-3 | ASU3-1 |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Defined | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| Measured | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| Variation | 0.0004 | 0.0001 | 0.0002 | 0.0001 | 0.0006 | 0.0002 | 0.0004 | 0.0001 |
| Difference | 0.018% | 0.002% | 0.001% | 0.005% | 0.007% | 0.013% | 0.011% | 0.008% |

REPEAT_2_100 Test Phase

| | ASU1-1 | ASU1-2 | ASU1-3 | ASU1-4 | ASU2-1 | ASU2-2 | ASU2-3 | ASU3-1 |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Defined | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| Measured | 0.0350 | 0.2810 | 0.0700 | 0.2100 | 0.0180 | 0.0700 | 0.0350 | 0.2810 |
| Variation | 0.0003 | 0.0001 | 0.0003 | 0.0002 | 0.0009 | 0.0003 | 0.0003 | 0.0001 |
| Difference | 0.008% | 0.005% | 0.024% | 0.005% | 0.019% | 0.013% | 0.010% | 0.000% |

Data Persistence Test

Data Persistence Test Results File

The results files generated during the execution of the Data Persistence Test is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_PERSIST_1_0_Raw_Results.xlsx**
- **SPC1_PERSIST_2_0_Raw_Results.xlsx**

Data Persistence Test Execution

The Data Persistence Test was executed using the following sequence of steps:

- The PERSIST_1_0 Test Phase was executed to completion.
- The Benchmark Configuration was taken through an orderly shutdown process and powered off.
- The Benchmark Configuration was powered on and taken through an orderly startup process.
- The PERSIST_2_0 Test Phase was executed to completion.

Data Persistence Test Results

| Data Persistence Test Phase: Persist1 | |
|---|-------------|
| Total Number of Logical Blocks Written | 575,342,776 |
| Total Number of Logical Blocks Verified | 284,518,946 |
| Total Number of Logical Blocks Overwritten | 290,823,830 |
| Total Number of Logical Blocks that Failed Verification | 0 |
| Time Duration for Writing Test Logical Blocks (sec.) | 601 |
| Size in bytes of each Logical Block | 8,192 |
| Number of Failed I/O Requests in the process of the Test | 0 |

Committed Data Persistence Implementation

The TSC uses a BBU power-down protection mechanism. Each controller has two batteries and an SSD as the system disk. When an unexpected power-down occurs, the controller continues to be powered by the battery and refreshes the cache data to the SSD for permanent storage. When the power supply is restored, the data in the system disk SSD is automatically restored.

APPENDIX A: SUPPORTING FILES

The following table details the content of the Supporting Files provided as part of this Full Disclosure Report.

| File Name | Description | Location |
|-------------------------------------|--|-----------------|
| /SPC1_RESULTS | Data reduction worksheets | root |
| SPC1_INIT_0_Raw_Results.xlsx | Raw results for INIT Test Phase | /SPC1_RESULTS |
| SPC1_METRICS_0_Quick_Look.xlsx | Quick Look Test Run Overview | /SPC1_RESULTS |
| SPC1_METRICS_0_Raw_Results.xlsx | Raw results for Primary Metrics Test | /SPC1_RESULTS |
| SPC1_METRICS_0_Summary_Results.xlsx | Primary Metrics Summary | /SPC1_RESULTS |
| SPC1_PERSIST_1_0_Raw_Results.xlsx | Raw results for PERSIST1 Test Phase | /SPC1_RESULTS |
| SPC1_PERSIST_2_0_Raw_Results.xlsx | Raw results for PERSIST2 Test Phase | /SPC1_RESULTS |
| SPC1_Run_Set_Overview.xlsx | Run Set Overview Worksheet | /SPC1_RESULTS |
| SPC1_VERIFY_0_Raw_Results.xlsx | Raw results for first VERIFY Test Phase | /SPC1_RESULTS |
| SPC1_VERIFY_1_Raw_Results.xlsx | Raw results for second VERIFY Test Phase | /SPC1_RESULTS |
| /C_Tuning | Tuning parameters and options | root |
| set_nr_requests.sh | Set queue depth, max AIO and scheduler | /C_Tuning |
| /D_Creation | Storage configuration creation | root |
| init_as5300G5.sh | Create Pools, RAIDs, LUNs, and Hosts | /D_Creation |
| lv_scan.sh | Scan and activate logical volumes | /D_Creation |
| lvm.sh | Create logical volumes | /D_Creation |
| vg.sh | Create volume groups | /D_Creation |
| /E_Inventory | Configuration inventory | root |
| profile.sh | Captures profile of storage environment | /E_Inventory |
| profile_end_as5300g5.txt | Storage configuration after restart | /E_Inventory |
| profile_start_as5300g5.txt | Storage configuration before INIT | /E_Inventory |
| volume_list.sh | Captures logical volume environment | /E_Inventory |
| volume_listing_end.txt | List of logical volumes after restart | /E_Inventory |
| volume_listing_start.txt | List of logical volumes before INIT | /E_Inventory |
| /F_Generator | Workload generator | root |
| full_test_before_persist.sh | Executes all test phases before PERSIST1 | /F_generator |
| HOST8.HST | Host configuration file | /F_generator |
| SPC1.asu | Define LUNs hosting the ASUs | /F_generator |
| test_persist1.sh | Executes PERSIST1 | /F_generator |
| test_persist2.sh | Executes PERSIST2 | /F_generator |

APPENDIX B: THIRD PARTY QUOTATION

All components are available directly through the Test Sponsor (Inspur Electronic Information Industry Co. Inc.).

APPENDIX C: TUNING PARAMETERS AND OPTIONS

Change the Scheduler on each Host System. Execute the `set_nr_requests.sh` script on each Host System to complete the following settings:

- Change the maximum number of AIO operations to 1048576.
- Change the `nr_requests` from 128 to 1024 on each Host System for each device.
- Change the I/O scheduler from `cfq` to `noop` on each Host System.

APPENDIX D: STORAGE CONFIGURATION CREATION

Step 1: Create Storage Pools, RAIDs, LUNs, Hosts, Mapping and deploy LUNs.

Execute the `init_as5300g5.sh` script on a remote server which can login on AS5300G5 storage system to complete the following:

1. Create 4 storage pools: Pool0,Pool1,Pool2,Pool3
2. Create 16 RAID10
3. Create 80 LUNs(20 LUN per Pool, 850 GB per LUN)
4. Create 8 Hosts in storage cluster
5. Add the FC port's WWPN to the 8 hosts (4 WWPNs per Host)
6. Map LUNs to the 8 Hosts

Step 2: Create Volumes on the Master Host System

Execute the `vg.sh` script on the Master Host System to create 2 VGs ,and the excute the `lvm.sh` script to create 40 logical volumes as follows:

In addition, the script will make each logical volume available (activate).

1. Create Physical Volumes

Create 80 physical volumes using the `pvcreate` command.

2. Create Volumes Groups

Create 2 volume groups (`spc1vg1 spc1vg2`) using the `vgcreate` command as follows:

Create `spc1vg1` using 40 of 80 physical volumes,and create `spc1vg2` using 40 of 80 physical volumes

3. Create Logical Volumes

- Create 9 logical volumes ,every volume capacity is 1600 GB, on `spc1vg1` for ASU-1.
- Create 9 logical volumes ,every volume capacity is 1600 GB, on `spc1vg2` for ASU-1
- Create 9 logical volumes ,every volume capacity is 1600 GB, on `spc1vg1` for ASU-2.
- Create 9 logical volumes ,every volume capacity is 1600 GB, on `spc1vg2` for ASU-2.
- Create 2 logical volumes ,every volume capacity is 1600 GB, on `spc1vg1` for ASU-3.
- Create 2 logical volumes ,every volume capacity is 1600 GB, on `spc1vg2` for ASU-3.

Step 3: Change the Scheduler on each Host System.

1. Execute the `set_nr_requests.sh` script on each Host System to complete the following settings:

- Change the maximum number of AIO operations to 1048576
- Change the from 128 to 1024 on each Host System for each device.
- Change the I/O scheduler from `cfq` to `noop` on each Host System.

APPENDIX E: CONFIGURATION INVENTORY

An inventory of the configuration was collected by running the following scripts.

- profile.sh
- volume_list.sh

The following log files were generated by running the above scripts.

- profile_start_as5300g5.txt
- profile_end_as5300g5.txt
- volume_listing_start.txt
- volume_listing_end.txt

These files are all available in the Supporting Files (see Appendix A).

APPENDIX F: WORKLOAD GENERATOR

The ASUs accessed by the SPC-1 workload generator were defined using the script SPC1.ASU.

The hosts used to drive the SPC-1 workload were defined using the script HOST8.HST. The scripts used to execute the benchmark sequence were:

- full_run_before_persist.sh
- test_persist1.sh
- test_persist2.sh

These files are all available in the Supporting Files (see Appendix A).