SPC BENCHMARK 1™

FULL DISCLOSURE REPORT

FUJITSU LIMITED
ETERNUS AF150 S3

SPC-1 V3.8.0

SUBMISSION IDENTIFIER: A32011

SUBMITTED FOR REVIEW: NOVEMBER 5, 2019

First Edition – November 2019

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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

InfoSizing
The Right Metric For Sizing IT

Storage Performance Council

Mr. Kun Katsumata
Fujitsu Limited
1250 East Arques Ave.
PO box 3470
Sunnyvale, CA 94088-3470

November 1, 2019

I verified the SPC Benchmark 1™ (SPC-1 ™ V3.8) test execution and performance results of the
following Tested Storage Product:

ETERNUS AF150 S3

The results were:

SPC-1 IOPS™	**280,016**
SPC-1 Price-Performance™	**$89.40/SPC-1 KIOPS™**
SPC-1 IOPS™ Response Time	0.451 ms
SPC-1 Overall Response Time	0.231 ms
SPC-1 ASU Capacity	5,461 GB
SPC-1 ASU Price	$4.59/GB
SPC-1 Total System Price	$25,033.16

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 the Test Sponsor, 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 the Test
Sponsor, and can be found at www.spcresults.org under the Submission Identifier A32011.

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

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

- The physical capacity of the data repository;
- The total capacity of the Application Storage Unit (ASU);
- 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; and
- 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:

    None.

Respectfully Yours,

Doug Johnson, Certified SPC Auditor

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

LETTER OF GOOD FAITH

FUJITSU

Kanagawa-ken,Kawasaki-shi,Nakahara-ku,Kamikodanaka,4-1-1,JAPAN211-8588
Phone: 044-754-3423

October 23, 2019
From: Koji Uchida, Fujitsu Limited

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

Contact Information: Kun Katsumata
                                     Fujitsu America, Inc.
                                     1250 East Arques Ave. PO Box 3470
                                     Sunnyvale, CA 94088, U.S.A.

Subject: SPC-1 Letter of Good Faith for the FUJITSU Storage ETERNUS AF150 S3

Fujitsu Limited is the SPC-1 Test Sponsor for the above listed product. To the best of our
knowledge and belief, the required SPC-1 benchmark results and materials we have
submitted for that product are complete, accurate, and in full compliance with V3.8 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: Date:

Koji Uchida   Oct 23, 2019

Koji Uchida
Vice President, Storage System Business Div.

SPC BENCHMARK 1™

EXECUTIVE SUMMARY

FUJITSU LIMITED
ETERNUS AF150 S3

SPC-1 IOPS™	**280,016**
SPC-1 Price-Performance™	**$89.40/SPC-1 KIOPS™**
SPC-1 IOPS™ Response Time	0.451 ms
SPC-1 Overall Response Time	0.231 ms
SPC-1 ASU Capacity	5,461 GB
SPC-1 Space Effectiveness Ratio	NA
SPC-1 ASU Price	$4.59/GB
SPC-1 Total System Price	$25,033.16
Data Protection Level	Protected 2 (RAID1)
Physical Storage Capacity	15,360 GB
Pricing Currency / Target Country	U.S. Dollars / USA

SPC-1 V3.8.0

SUBMISSION IDENTIFIER: A32011

SUBMITTED FOR REVIEW: NOVEMBER 5, 2019

Benchmark Configuration Diagram

ETERNUS AF150 S3

1x ET AF150S3 Base System	16x SSD(2.5inch) 960GB x1 for AF150	2x AC Power Cords (125V - IEC320-C14, 0.5m)

2x
Host interface for AF150（FC, 2port）

4x FC16Gbps connection

PRIMERGY Server

2x
PRIMERGY RX2540 M4, each with:
 - 2x Intel(R) Xeon(R) Platinum 8168 CPU, 24 cores,33MB Cache,2.7GHz
 - 384GB Main Memory
 - 1x PPFC EP LPe16002
 - Red Hat Enterprise Linux Server 6.9
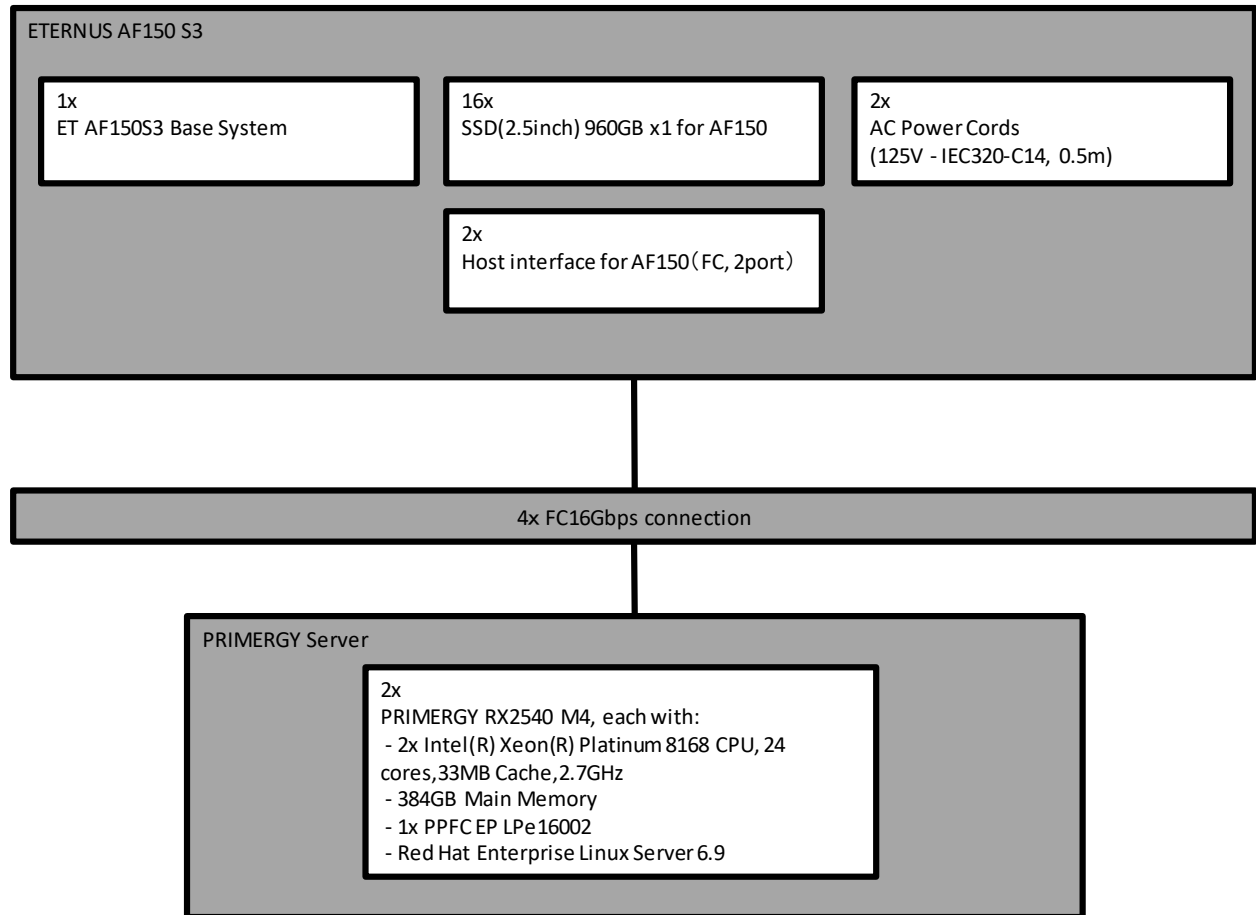
Tested Storage Product Description

The Fujitsu Storage ETERNUS AF150 S3 is an affordable, entry-level all-flash storage for SMBs. This easy to deploy and manage storage system can efficiently work with large data volumes and deliver exceptional price/performance ratio and offers comprehensive data services. It meets various business requirements with leading storage performance, seamless scalability and comprehensive data services – all at an affordable price.

For additional details, please visit:

https://www.fujitsu.com/global/products/computing/storage/all-flash-arrays/eternus-af150-s3/

Priced Storage Configuration Components

2x Emulex LPe16002B-M6-F 16Gb 2-port PCIe Fibre Channel Adapter

1x ETERNUS AF150 S3 with:
      1x Controller Enclosure Module with:
            2x Control Module, each with:
                  16 GB cache (32 GB total)
                  2x 16 Gbps Fibre Channel Host Ports
            16x 960 GB SSD Storage Devices

Storage Configuration Pricing

| Part No.	Description	Source	Qty	Unit Price	Ext. Price	Disc.	Disc. Price
	Hardware & Software						
ET153SAU	ETERNUS AF150 S3	1	1	11,680.00	11,680.00	39%	7,124.80
ETAHH4B	Host interface for AF150 S3(16Gbit/s, FC, 4ports)	1	1	2,360.00	2,360.00	39%	1,439.60
ETASA93	Value SSD(2.5inch) 960GB x1 for AF150 S3	1	16	1,340.00	21,440.00	39%	13,078.40
S26361-F4994-L502	PFC EP LPe16002	1	2	1,368.00	2,736.00	39%	1,668.96
ETAKC15U	AC100/200V Power Cord for AF150/AF250 S3, DX60/DX100/DX200 S5(IEC60320 C14, 1.5m)	1	2	110.00	220.00	39%	134.20
13-61-343827-003	Custom Fibre Host interface cable 3m LC-LC Crossed Polarity Duplex MM-50/125um; 3.0mm; Riser rated; OM3; Aqua Jacket	1	4	80.00	320.00	39%	195.20
					Hardware & Software Subtotal		23,641.16
	Support & Maintenance						
	Provide 24 hour per day / 7days per week 4 hour response maintenance for 36 months	1	0	0.00	0.00	0%	0.00
	Warranty Service, 36 monthsStandard, 9x5 phone, NBD response	1	1	0.00	0.00	0%	0.00
	Warranty Uplift, 36 monthsEnhanced plus, 24x7 4hr Onsite	1	1	1,740.00	1,740.00	20%	1,392.00
					Support & Maintenance Subtotal		1,392.00
	SPC-1 Total System Price						25,033.16
	SPC-1 IOPS™						280,016
	SPC-1 Price-Performance™ ($/SPC-1 KIOPS™)						**89.40**
	SPC-1 ASU Capacity (GB)						5,461
	SPC-1 ASU Price ($/GB)						**4.59**

Pricing Sources: 1 = Fujitsu

Discount Details: The discounts shown are based on the storage capacity purchased and are generally available.

Warranty: The 3-year maintenance and support included in the above pricing meets or exceeds a 24x7 coverage with a 4-hour response time.

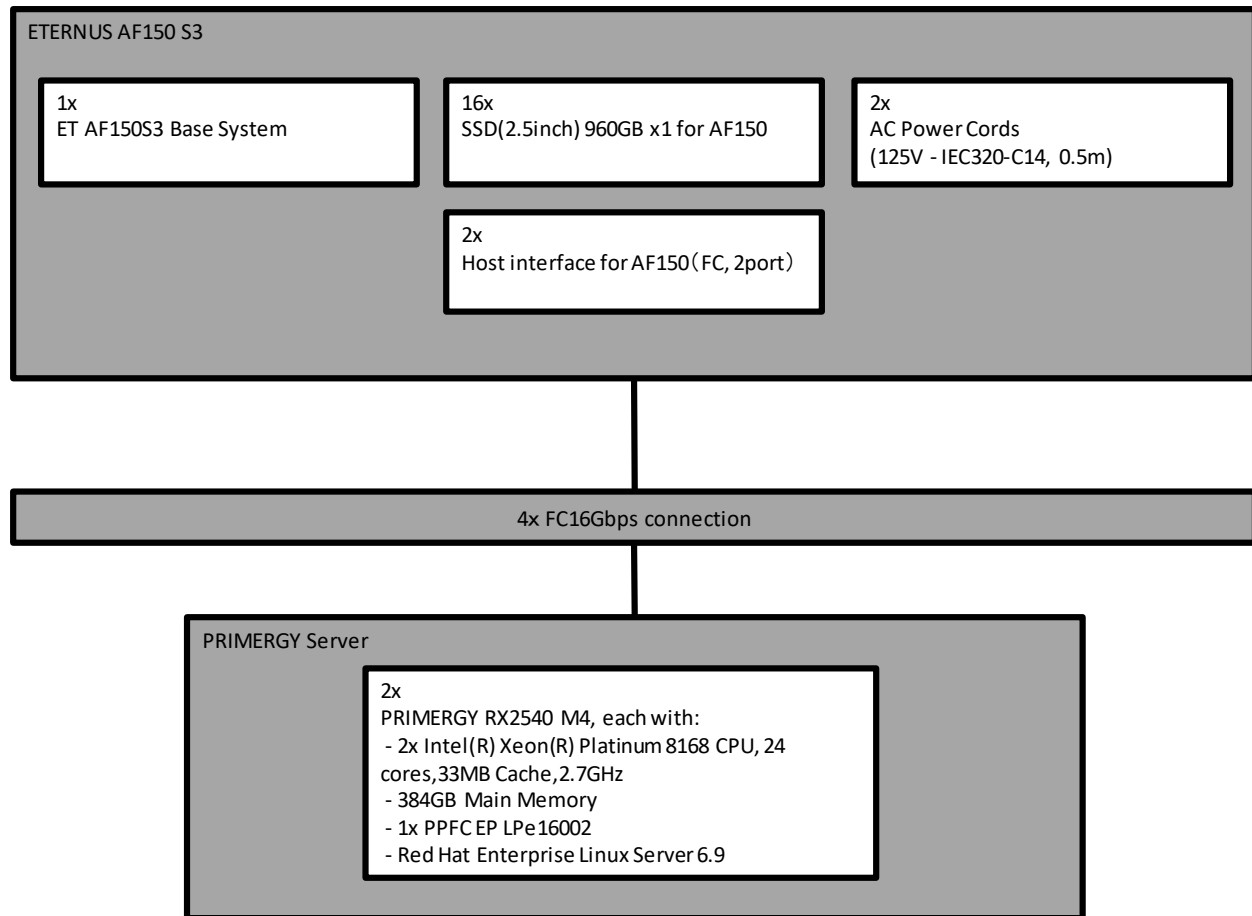**Availability Date**: November 5, 2019.

Response Time and Throughput Graph
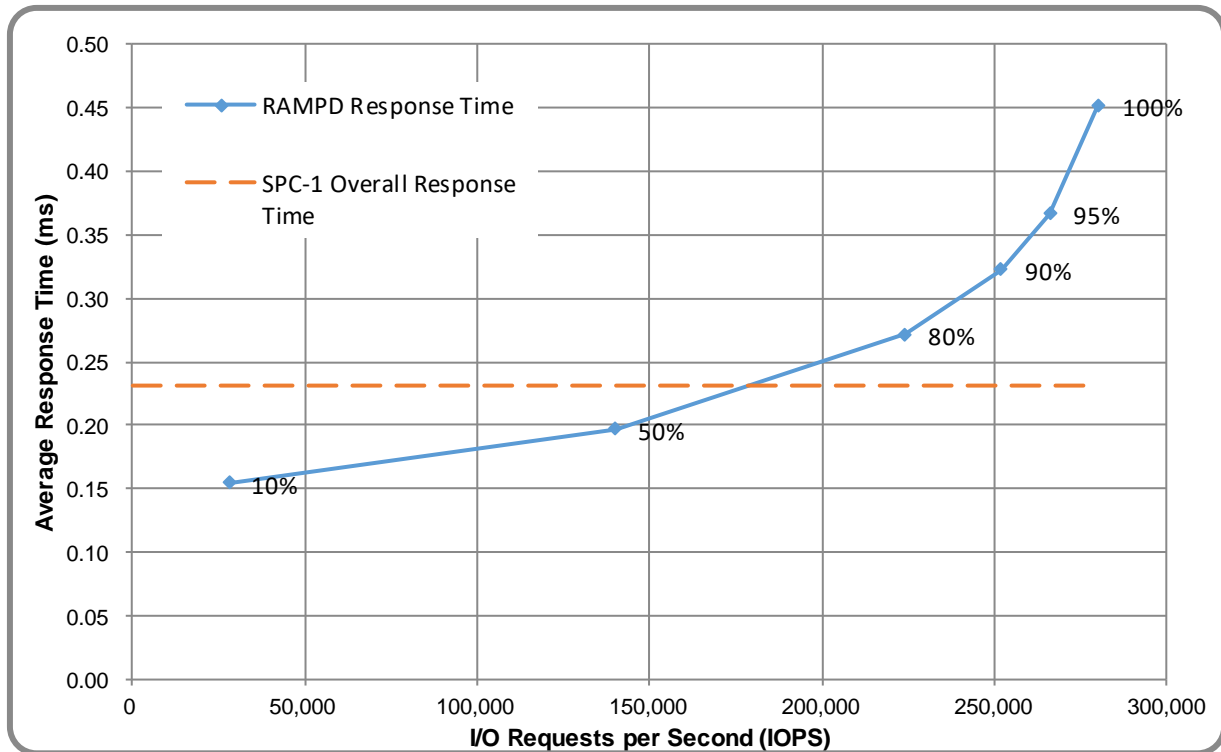
Contact Information	
Test Sponsor Primary Contact	Fujitsu Limited – http://www.fujitsu.com/services/computing/storage/ Kun Katsumata – kkatsumata@us.fujitsu.com
SPC Auditor	InfoSizing – www.sizing.com Doug Johnson – doug@sizing.com

Revision Information	
SPC Benchmark 1™ Revision	V3.8.0
SPC-1 Workload Generator Revision	v3.0.2-1-g823a
Publication Revision History	Initial Publication

CONFIGURATION INFORMATION

Benchmark Configuration and Tested Storage Configuration

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

ETERNUS AF150 S3

1x	16x	2x
ET AF150S3 Base System	SSD(2.5inch) 960GB x1 for AF150	AC Power Cords (125V - IEC320-C14, 0.5m)

2x
Host interface for AF150（FC, 2port）

4x FC16Gbps connection

PRIMERGY Server

2x
PRIMERGY RX2540 M4, each with:
 - 2x Intel(R) Xeon(R) Platinum 8168 CPU, 24 cores,33MB Cache,2.7GHz
 - 384GB Main Memory
 - 1x PPFC EP LPe 16002
 - Red Hat Enterprise Linux Server 6.9

Storage Network Configuration

The Benchmark Configuration utilized direct-attached storage.

Host System and Tested Storage Configuration Components

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

Host Systems
2x Fujitsu PRIMERGY RX2540 M4 Servers, each with:
2x Intel® Xeon® Platinum 8168 (2.7 GHz, 24-Core, 33 MB L3)
384 GB Main Memory
Red Hat Enterprise Linux Server 6.9
Tested Storage Configuration
2x Emulex LPe16002B-M6-F 16Gb 2-port PCIe Fibre Channel Adapter
1x ETERNUS AF150 S3 with:
1x Controller Enclosure Module with:
2x Control Module, each with:
16 GB cache (32 GB total)
2x 16 Gbps Fibre Channel Host Ports
16x 960 GB SSD Storage Devices

Differences Between Tested and Priced Storage Configurations

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

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

SPC Benchmark 1™ V3.8.0   Full disclosure Report   Submission Identifier: A32011
Fujitsu Limited   Submitted for Review: November 5, 2019
ETERNUS AF150 S3

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	9	273.0	273.0	2,457.5	45.0%	No
ASU-2	9	273.0	273.0	2,457.5	45.0%	No
ASU-3	2	273.0	273.0	546.1	10.0%	No
SPC-1 ASU Capacity				5,461	*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	16	960.0	15,360.0
	Total Physical Capacity		**15,360**
	Physical Capacity Utilization		**35.55%**

Data Protection

The data protection level used for all LVs was **Protected 2 (RAID1)**, which was accomplished by configurating multiple FC paths, dual controllers, dual power, dual fans, and RAID1 device protection.

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).

Primary Metrics Test Phases

The benchmark execution consists of the Primary Metrics Test Phases, including the Test Phases SUSTAIN, RAMPD_100 to RAMPD_10, RAMPU_50 to RAMPU_100, RAMP_0, REPEAT_1 and REPEAT_2.

Each Test Phase starts with a transition period followed by a Measurement Interval (MI).

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.
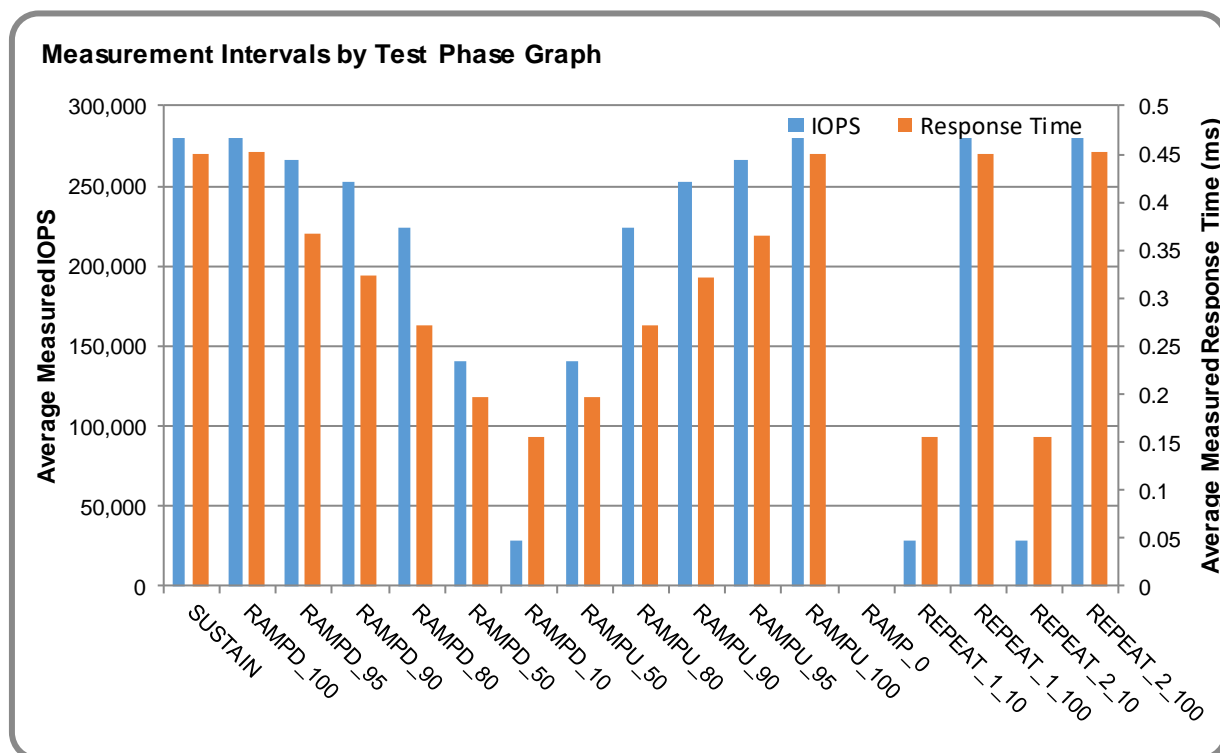
Exception and Waiver

None.

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:
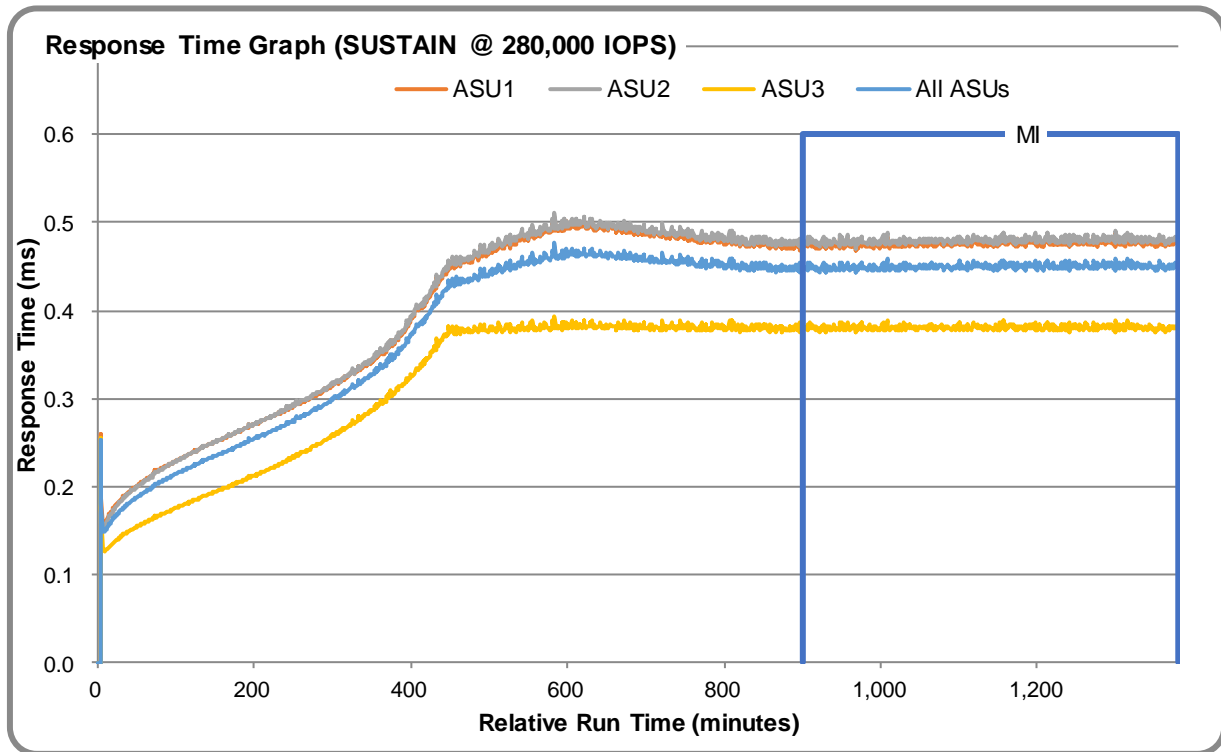
- **SPC1_METRICS_0_Raw_Results.xlsx**

SUSTAIN – Execution Times

| Interval	Start Date & Time	End Date & Time	Duration
Transition Period	15-Oct-19 17:29:46	16-Oct-19 08:29:46	15:00:00
Measurement Interval	16-Oct-19 08:29:46	16-Oct-19 16:29:47	8:00:01

SUSTAIN – Throughput Graph
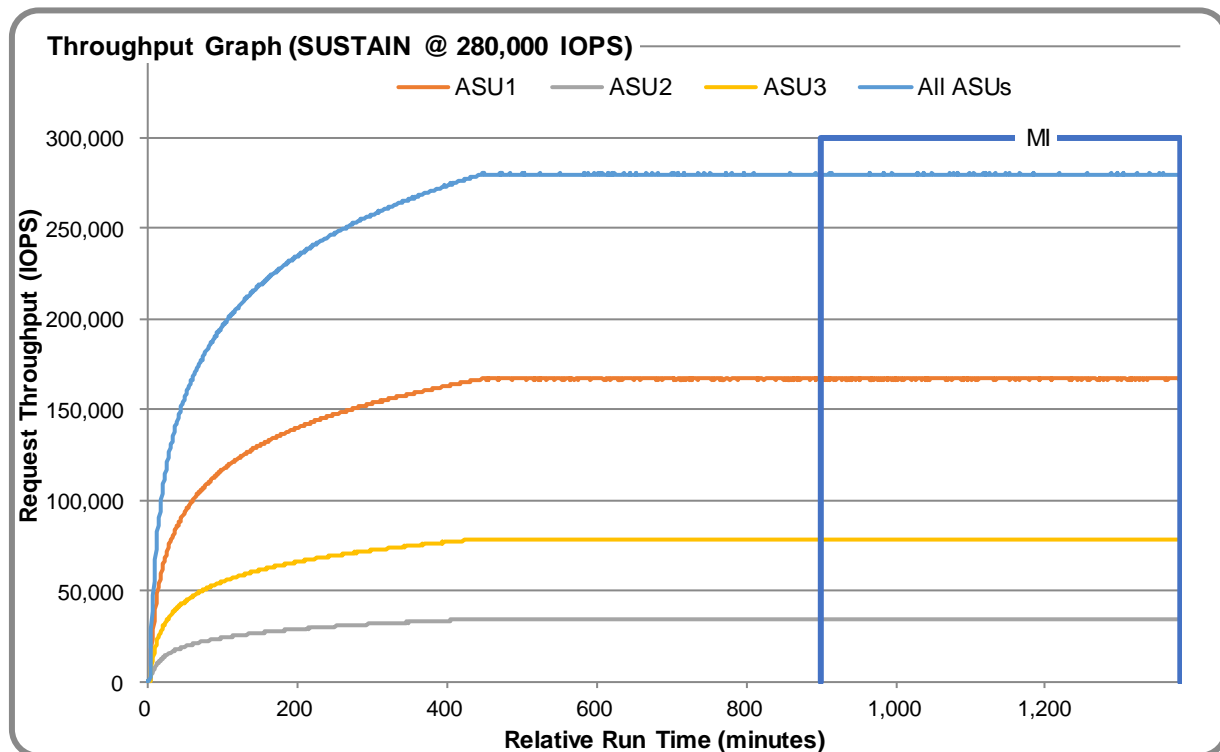
SUSTAIN – Response Time Graph

Response Time Graph (SUSTAIN @ 280,000 IOPS)

SUSTAIN – Data Rate Graph

Data Rate Graph (SUSTAIN @ 280,000 IOPS)

SUSTAIN – Response Time Frequency Graph
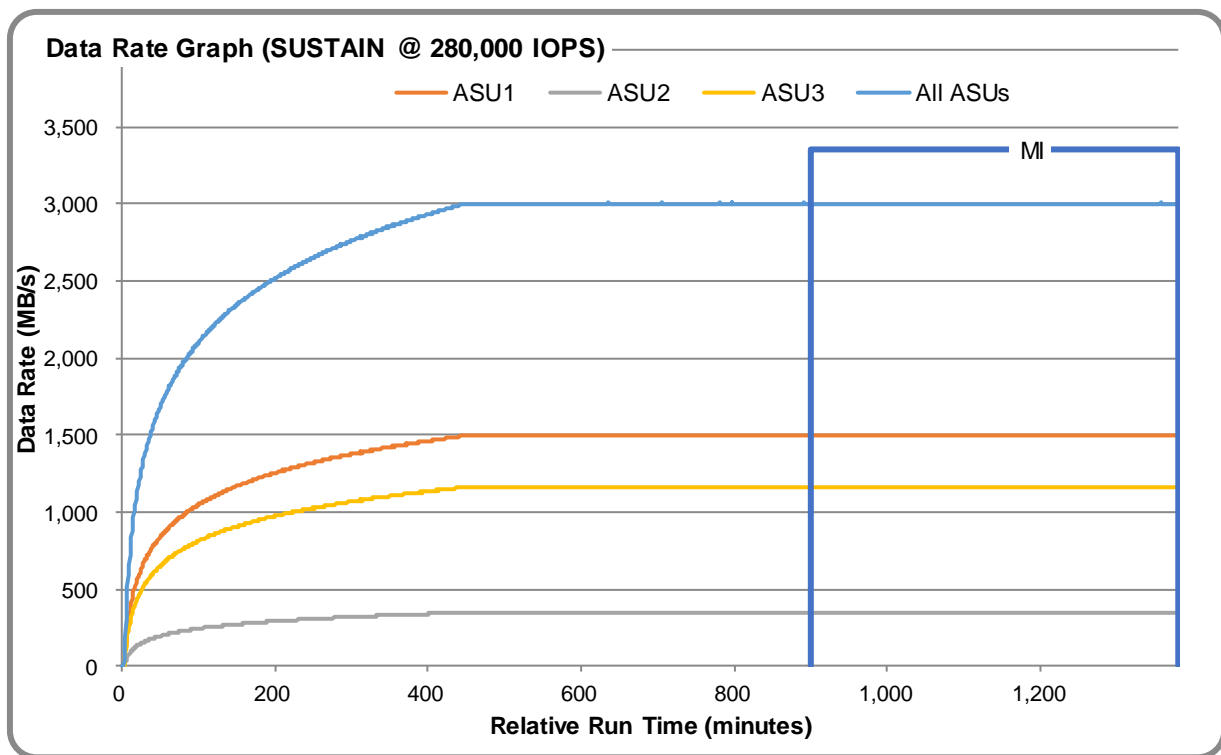
Response Time Frequency Graph (SUSTAIN @ 280,000 IOPS)
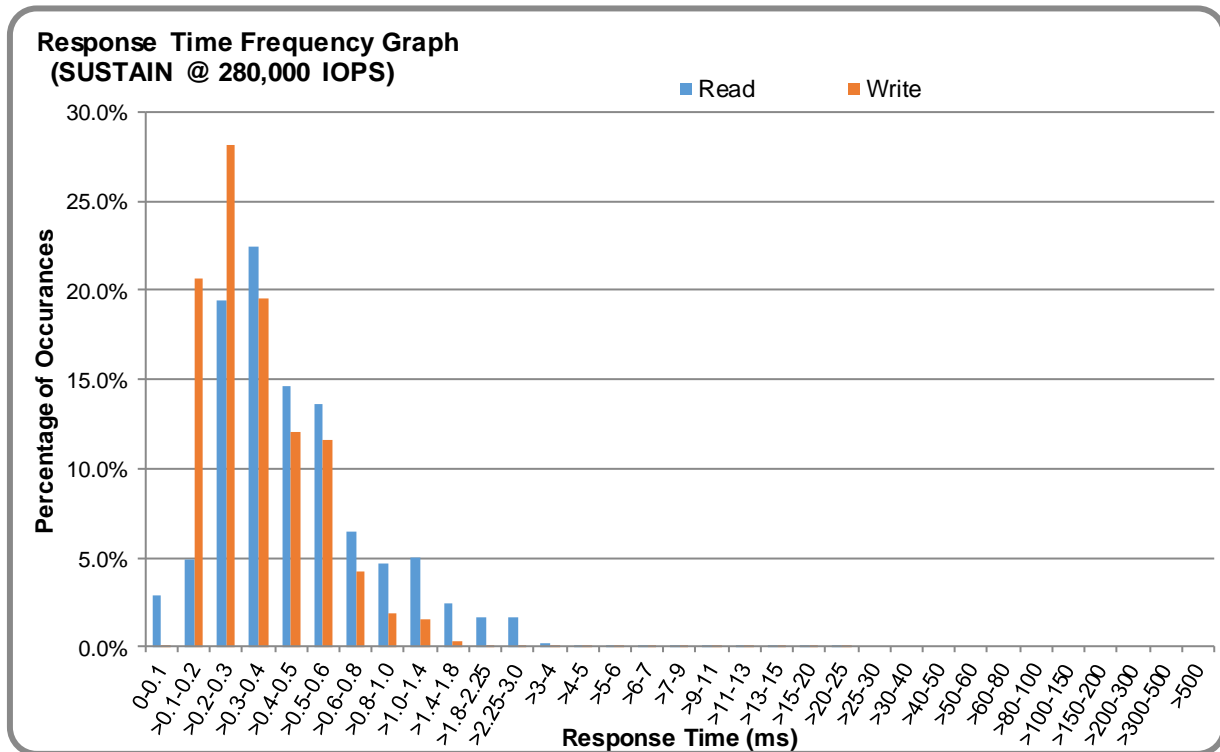
SUSTAIN – Intensity Multiplier

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	0.0012	0.0004	0.0009	0.0005	0.0017	0.0009	0.0012	0.0004
Difference	0.010%	0.003%	0.011%	0.000%	0.006%	0.002%	0.010%	0.003%

SPC Benchmark 1™ V3.8.0
Fujitsu Limited
ETERNUS AF150 S3

Full disclosure Report

Submission Identifier: A32011
Submitted for Review: November 5, 2019

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:
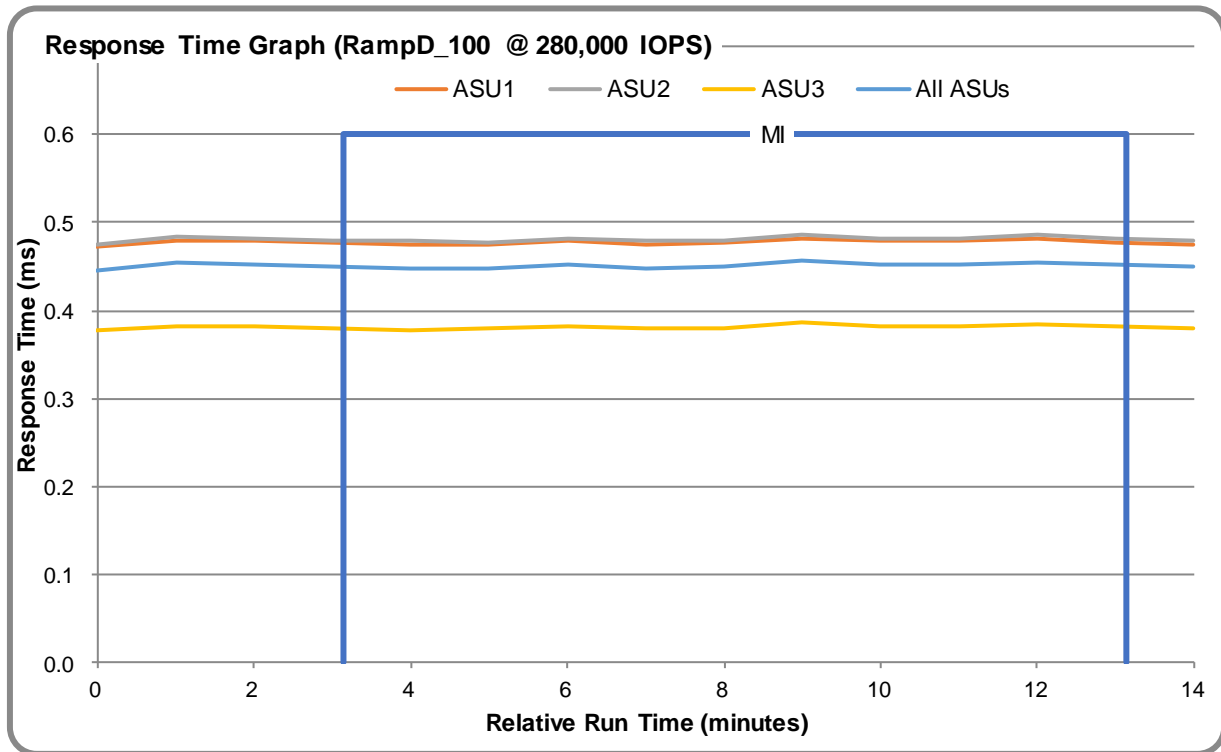
- **SPC1_METRICS_0_Raw_Results.xlsx**

RAMPD_100 – Execution Times

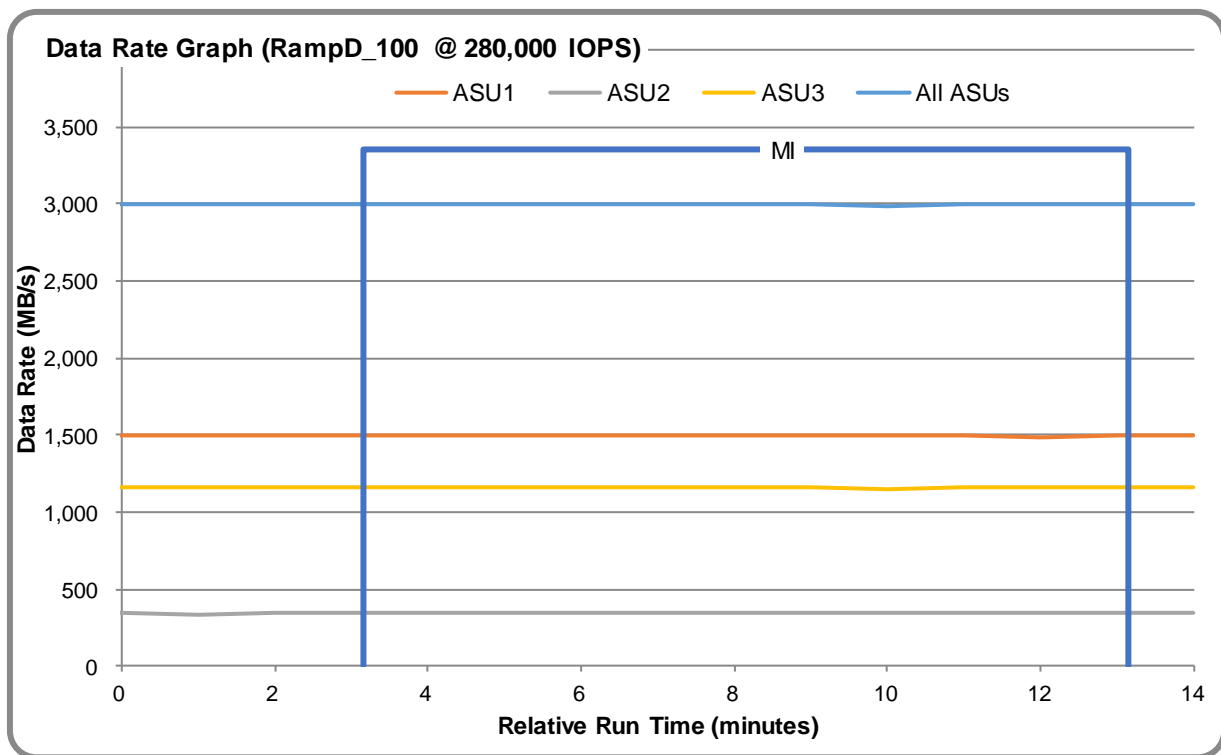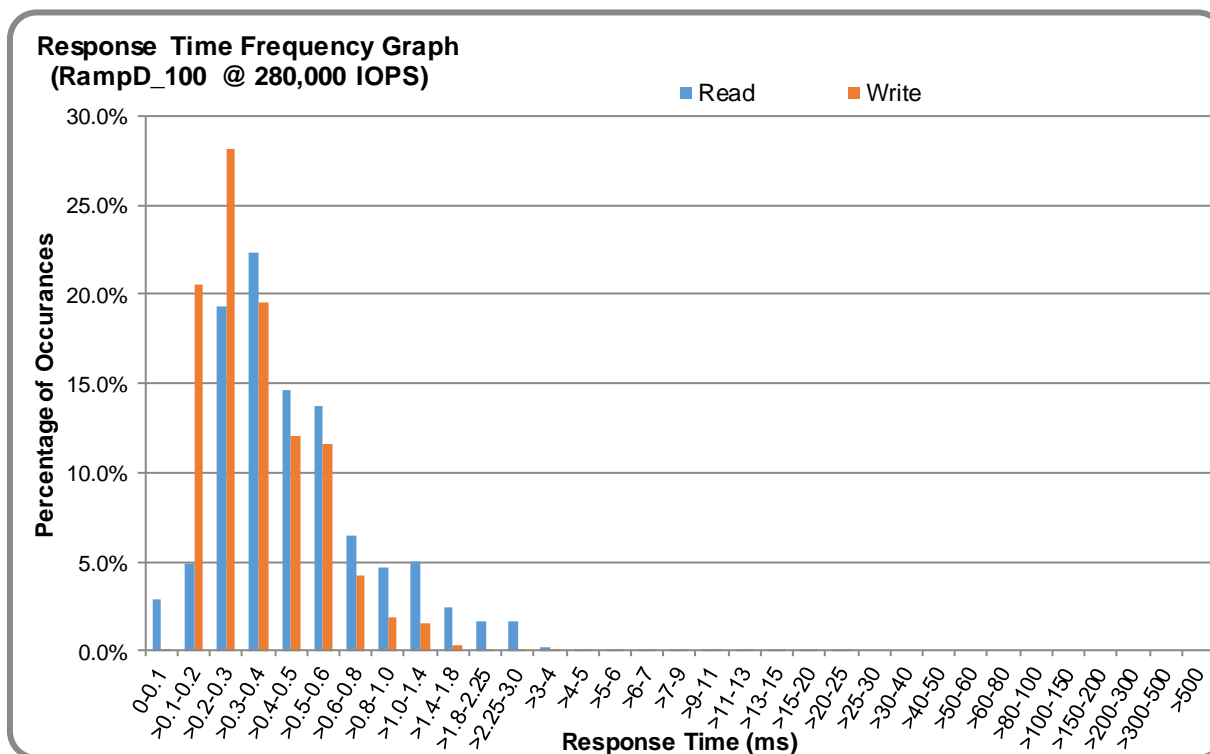| Interval	Start Date & Time	End Date & Time	Duration
Transition Period	16-Oct-19 16:30:46	16-Oct-19 16:33:46	0:03:00
Measurement Interval	16-Oct-19 16:33:46	16-Oct-19 16:43:47	0:10:01

RAMPD_100 – Throughput Graph
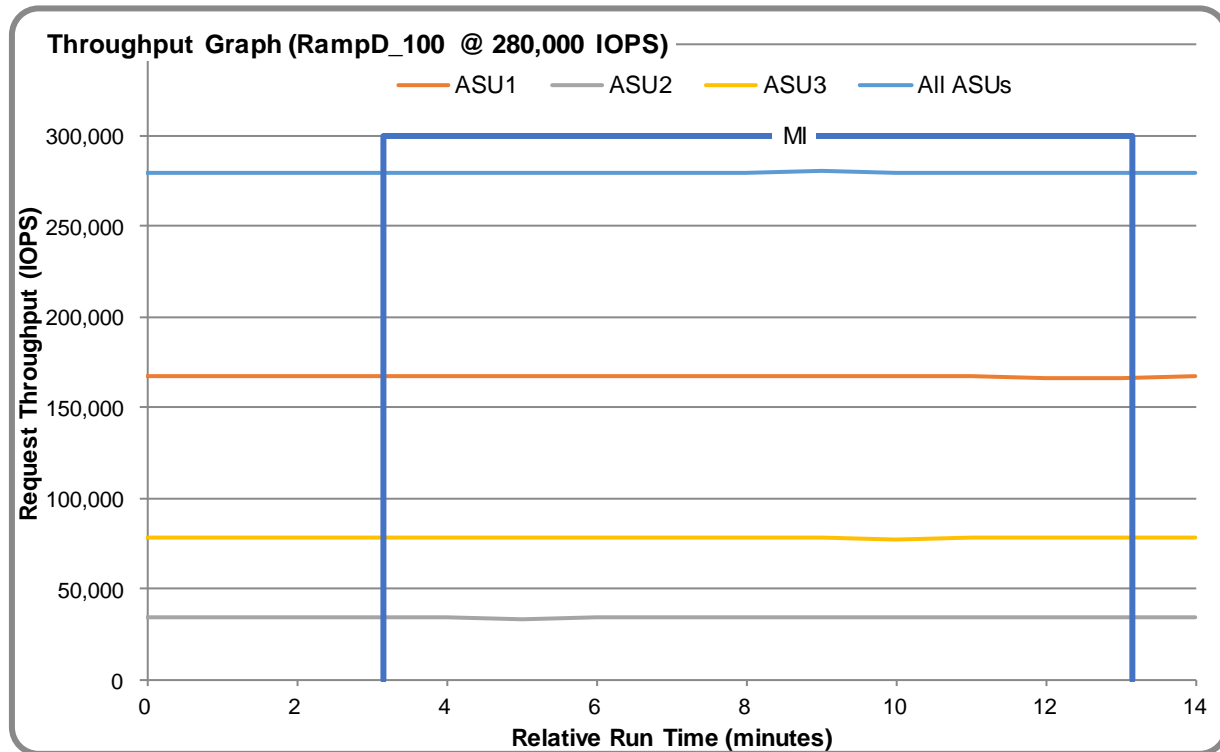
RAMPD_100 – Response Time Graph

RAMPD_100 – Data Rate Graph

RAMPD_100 – Response Time Frequency Graph

**Response Time Frequency Graph
(RampD_100 @ 280,000 IOPS)**

■ Read ■ Write

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	0.0013	0.0005	0.0010	0.0004	0.0022	0.0006	0.0014	0.0004
Difference	0.075%	0.007%	0.057%	0.014%	0.004%	0.051%	0.072%	0.009%

RAMPD_100 – I/O Request Summary

I/O Requests Completed in the Measurement Interval	168,012,092
I/O Requests Completed with Response Time <= 30 ms	168,012,092
I/O Requests Completed with Response Time > 30 ms	0

Response Time Ramp Test
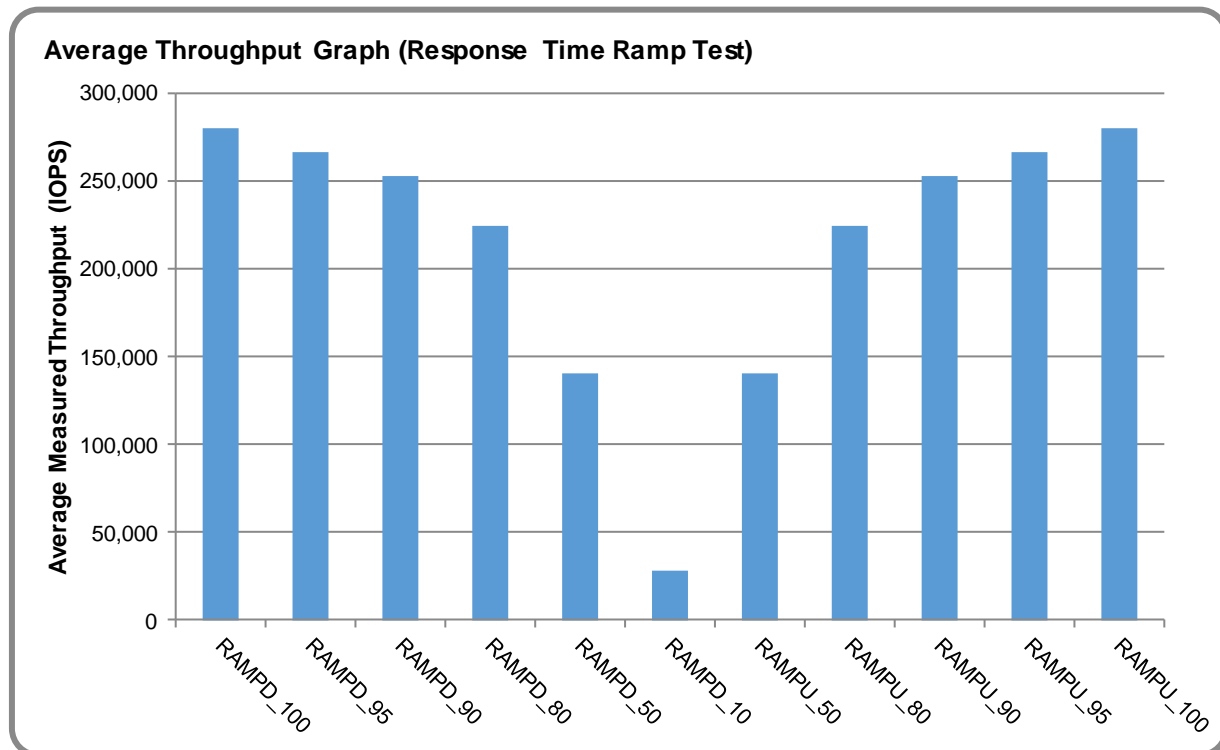
Response Time Ramp Test – Results File

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).
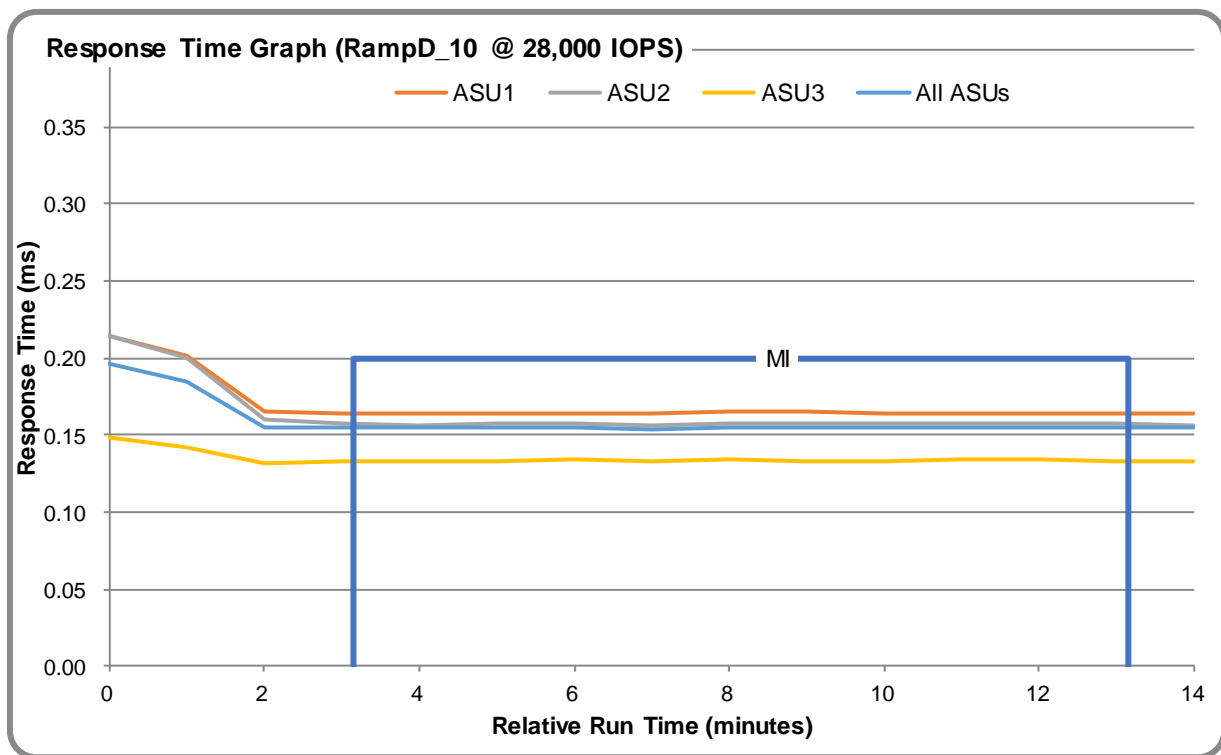
Response Time Ramp Test – Average Throughput Graph

Response Time Ramp Test – Average Response Time Graph

Average Response Time Graph (Response Time Ramp Test)
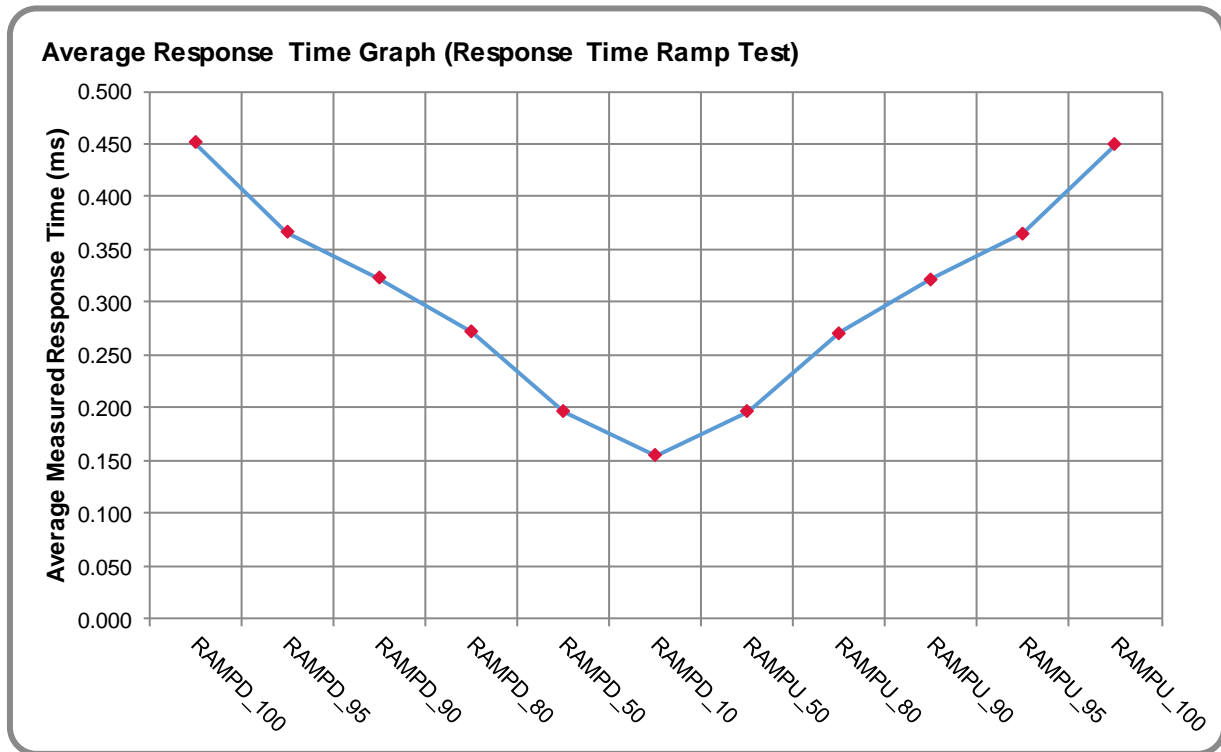
Response Time Ramp Test – RAMPD_10 Response Time Graph

Response Time Graph (RampD_10 @ 28,000 IOPS)

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:
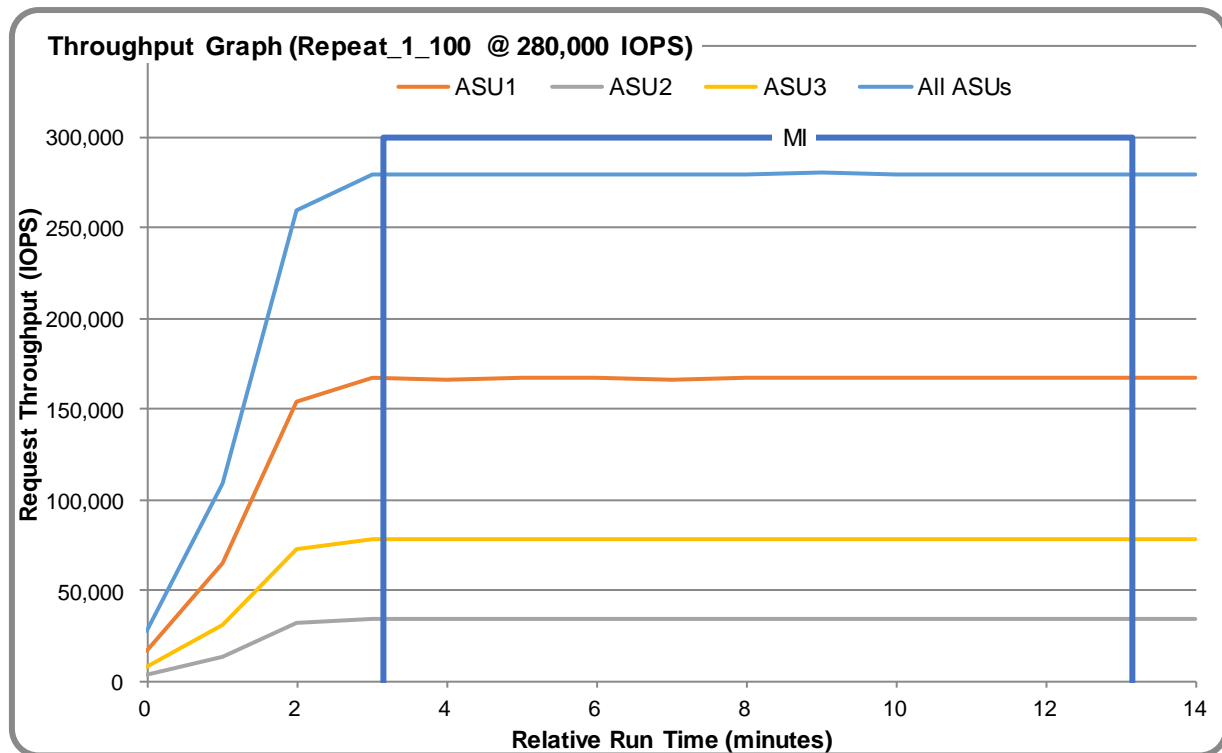
- **SPC1_METRICS_0_Raw_Results.xlsx**

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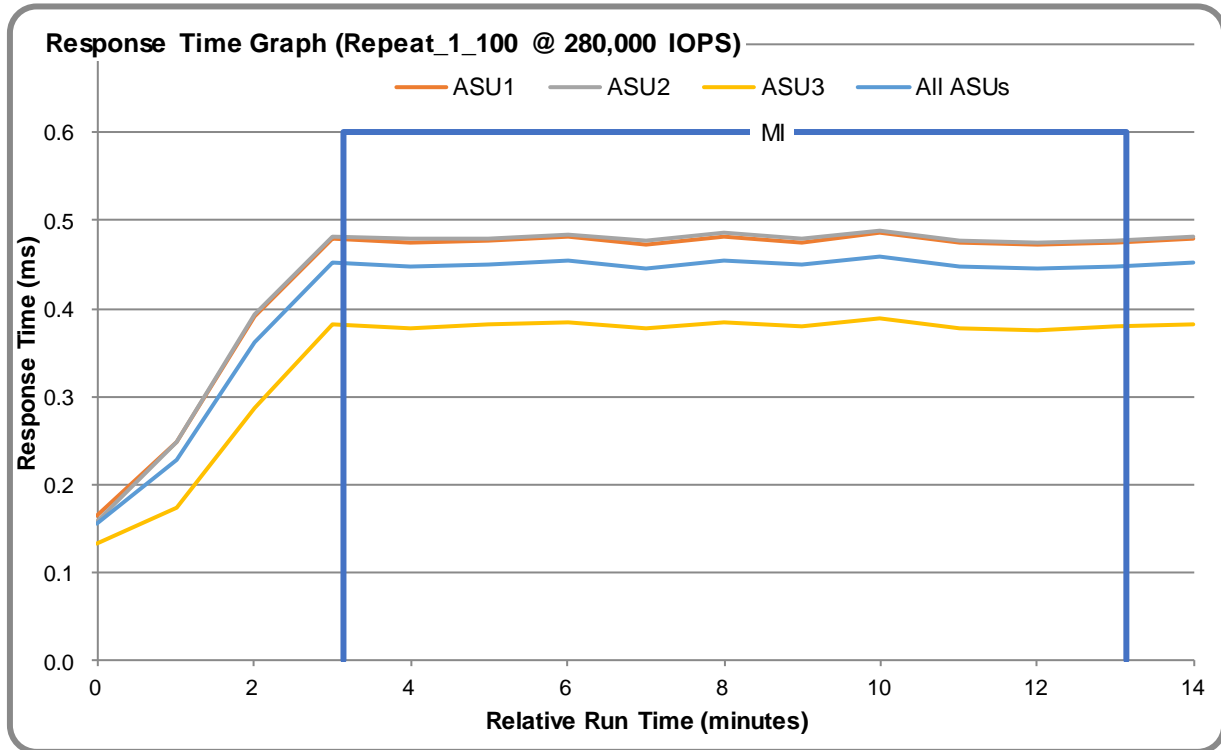
The throughput measurements for the Response Time Ramp Test (RAMPD) and the Repeatability Test Phases (REPEAT_1 and REPEAT_2) are listed in the table below.

Test Phase	100% IOPS	10% IOPS
RAMPD	280,016.4	28,001.8
REPEAT_1	280,028.2	28,002.3
REPEAT_2	280,051.1	28,002.6

REPEAT_1_100 – Throughput Graph

REPEAT_1_100 – Response Time Graph

Response Time Graph (Repeat_1_100 @ 280,000 IOPS)

REPEAT_2_100 – Throughput Graph

Throughput Graph (Repeat_2_100 @ 280,000 IOPS)
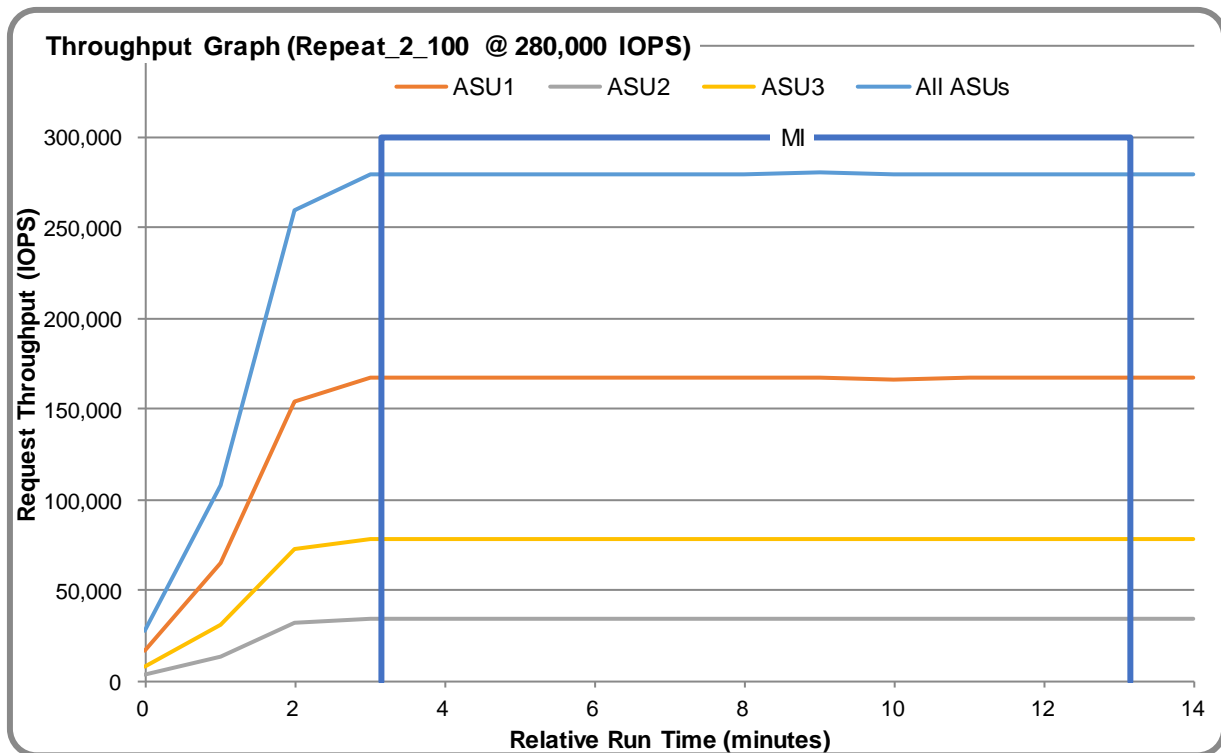
REPEAT_2_100 – Response Time Graph

Response Time Graph (Repeat_2_100 @ 280,000 IOPS)
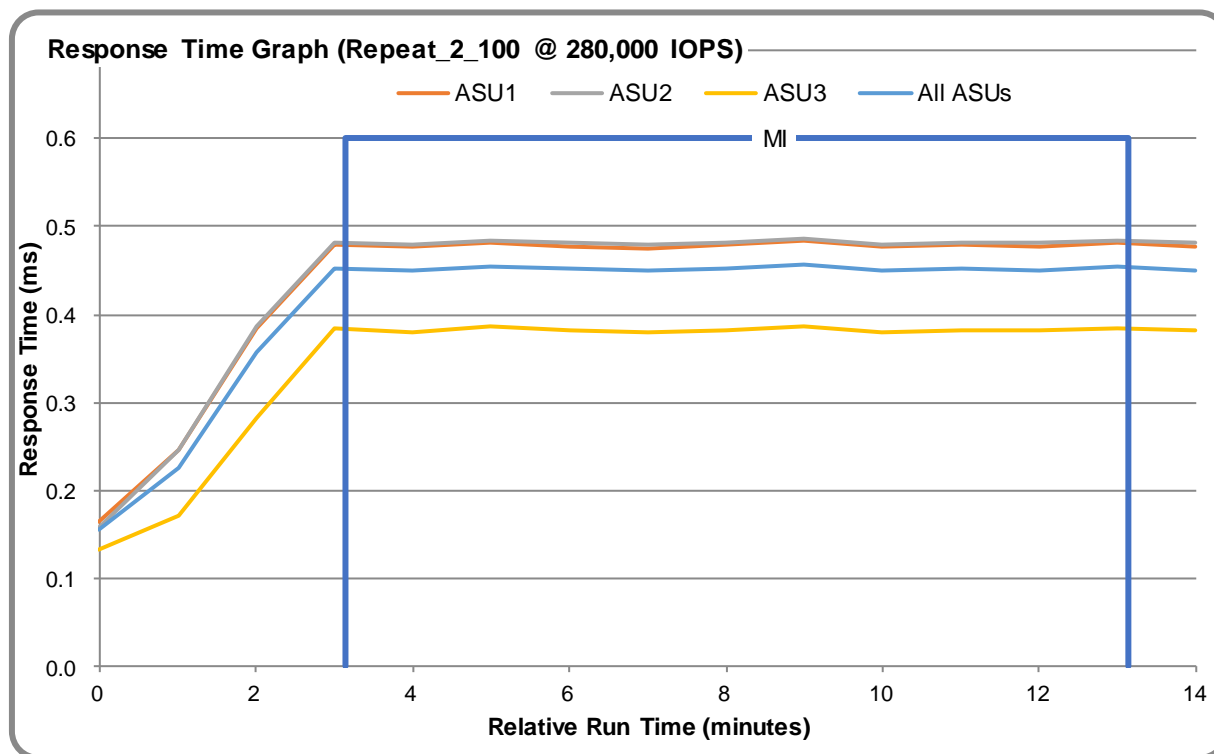
Repeatability Test – Intensity Multiplier

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	0.0016	0.0003	0.0010	0.0005	0.0022	0.0011	0.0017	0.0004
Difference	0.077%	0.006%	0.069%	0.015%	0.051%	0.008%	0.002%	0.004%

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	0.0019	0.0003	0.0012	0.0005	0.0018	0.0009	0.0012	0.0004
Difference	0.002%	0.007%	0.037%	0.010%	0.031%	0.030%	0.058%	0.012%

SPC Benchmark 1™ V3.8.0
Fujitsu Limited
ETERNUS AF150 S3

Full disclosure Report

Submission Identifier: A32011
Submitted for Review: November 5, 2019

Space Optimization Techniques

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

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	57,528,536
Total Number of Logical Blocks Verified	34,031,589
Total Number of Logical Blocks Overwritten	23,496,947
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks (sec.)	600
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

Redundantly configured batteries inside the ETERNUS AF150 S3 storage system allow data in cache memory to be moved to non-volatile memory or to physical disk drives in the event of a power outage. This secured data can then be maintained in that state indefinitely until the power is 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**
All tuning done via GUI (see Appendix C)		
/D_Creation	**Storage configuration creation**	**root**
AF150S3_20190917.exp	Configure CLI expect script	/D_Creation
AF150S3_20190917makeLV.sh	Linux LVM configuration script	/D_Creation
definitions.exp	Procedure definitions	/D_Creation
doFDRcfg.sh	Shell script to configure the array	/D_Creation
showFormatStatus.exp	Check for physical format progress	/D_Creation
/E_Inventory	**Configuration inventory**	**root**
log_BeforeF_AL191015170139.zlg_001.txt	Configuration details before the run	/E_Inventory
log_AfterJ_AL191015170139.zlg_001.txt	Configuration details after the run	/E_Inventory
/F_Generator	**Workload generator**	**root**
doFDRall_01.sh	Master run file 1	/F_generator
doFDRall_02.sh	Master run file 2	/F_generator
exportLog.exp	Storage array log export	/F_generator
SPC1_AF150S3_20190917.asu	ASU configuration file	/F_generator
SPC1_AF150S3_20190917.hst	Host configuration file	/F_generator

APPENDIX B: THIRD PARTY QUOTATION

All components are available directly through the Test Sponsor (Fujitsu Limited).

APPENDIX C: TUNING PARAMETERS AND OPTIONS

The standard Fujitsu GUI was used to apply the Tuning options for this test.

1. In order to execute some of the commands listed below it is necessary to create a user account with maintainer role. Please create such user account and login with the new account.

2. Change DCMF (Disk Command Multiplication Factor) value from the default (1) to (10) for all RAID Groups.
   The following GUI screen (RAID Group -> Tuning -> Modify RAID Group Parameter is used for each RAID Group and the DCMF parameter is changed to 10 as highlighted in red frame below:

3. Disable Debug Trace
   The following GUI setting was applied.
   System-> System Settings -> Setup Debug Mode: The Master Trace Level was set to Off (Default: Standard)
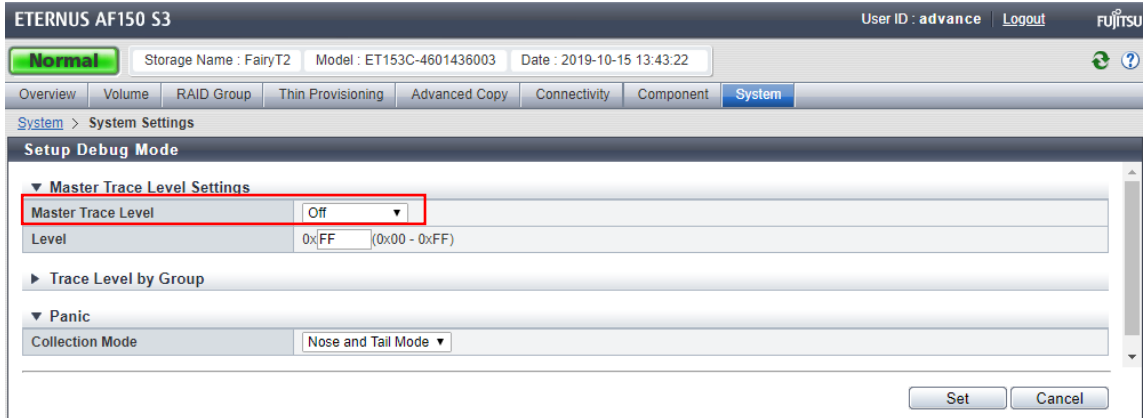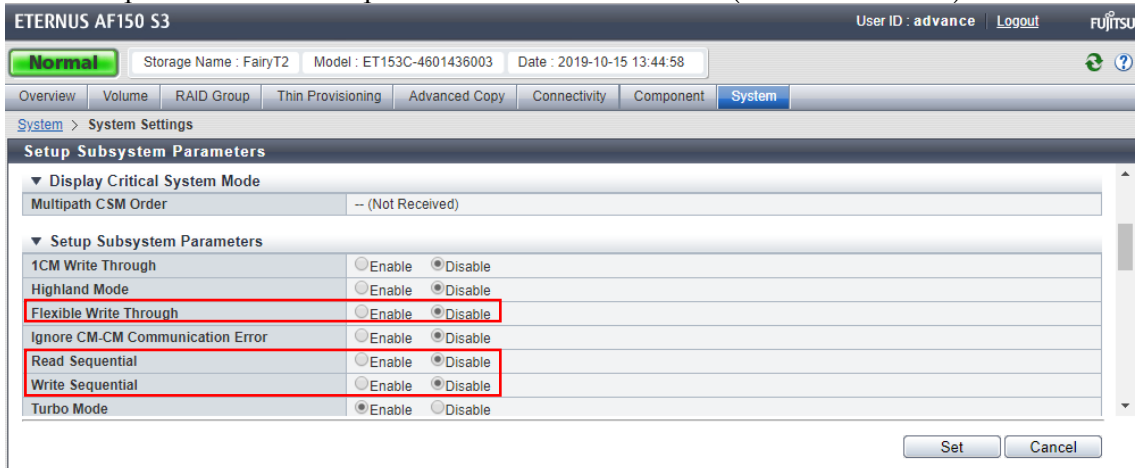
4. Disable Read Sequential/Write Sequential
   The following GUI setting was applied.
   System-> System Settings -> Setup Subsystem Parameters:

   Flexible Write Through was set to Disable (Default: Enable)

   Read Sequential/Write Sequential was set to Disable (Default: Enable)

APPENDIX D: STORAGE CONFIGURATION CREATION

The standard Fujitsu Command Line tool (CLI) was used to create the ETERNUS AF150 S3 SPC-1 configuration.

The 'master' script, **doFDRcfg.sh**, was executed, which in turn, invoked the script, **AF150S3_20190917.exp**. The 'master' script included shell commands to monitor the progress as the physical formatting proceeded, which used the **expect** script **showFormatStatus.exp** to pick up the status information from the array.

The **AF150S3_20190917.exp** script completed steps 1-4, described below for the 4-host port configuration.

Each **expect** script included the **docli** procedure, which was used to issue the CLI commands to the array. That procedure used **ssh** for communication with the array. A second procedure in the script, **doexit**, was used to conclude the execution sequence at the end of the script.

Step 1 – Creation of RAID Groups

A total of 8 RAID Groups were created, according to the configuration plan, **ConfigurationDesign_AF150S3_20190917.xlsx**, which is typically prepared in concert with a Fujitsu SE. Each RAID Group was made up of 2 disk drives in a RAID1(1+1) configuration and assigned to a specific CM for operational control. The RAID Groups were named RG00 through RG07.

Step 2 – Creation of the Logical Volumes

4 wide striped volumes were created across 4 RAID Groups assigned to the same CM.

Total of 8 wide striped logical volumes were created

Step 3 – Creation of the Global Hot Spares

No drives were designated as the Global Hot Spare.

Step 4 – Assignment of LUN Mapping to the Linux Host Systems

The **AF150S3_20190917.exp** script provided mapping to 4 host ports.

The port LUN mapping was assigned for each of the Logical Volumes using 2 ports on Channel Adapters (CA) in each of the 2 Controller Modules (CM). Each of the volumes, which were defined on RAID Groups owned by a CM, were assigned LUN numbers on the active ports on the CAs installed on same CM.

Step 5 – Creation of striped logical volumes.

Built in logical volume manager in Linux is used to stripe each LUN presented by ETERNUS AF150 S3 array.

This is done in 3 steps included in the **AF150S3_20190917**makeLV.sh script.

1. Create Physical Volumes (PV) for each LUN presented from AF150 S3.

    pvcreate /dev/disk/by-id/scsi-3600000e00d28000000283c2c00000000
    pvcreate /dev/disk/by-id/scsi-3600000e00d28000000283c2c00010000
    pvcreate /dev/disk/by-id/scsi-3600000e00d28000000283c2c00020000
    pvcreate /dev/disk/by-id/scsi-3600000e00d28000000283c2c00030000
    pvcreate /dev/disk/by-id/scsi-3600000e00d28000000283c2c00040000
    pvcreate /dev/disk/by-id/scsi-3600000e00d28000000283c2c00050000
    pvcreate /dev/disk/by-id/scsi-3600000e00d28000000283c2c00060000
    pvcreate /dev/disk/by-id/scsi-3600000e00d28000000283c2c00070000

2. Create one Volume Group with physical extent size of 512KiB

    vgcreate asu_vg1 /dev/disk/by-id/scsi-3600000e00d28000000283c2c00040000

    vgextend asu_vg1 /dev/disk/by-id/scsi-3600000e00d28000000283c2c00010000

    vgextend asu_vg1 /dev/disk/by-id/scsi-3600000e00d28000000283c2c00000000

    vgextend asu_vg1 /dev/disk/by-id/scsi-3600000e00d28000000283c2c00050000

    vgextend asu_vg1 /dev/disk/by-id/scsi-3600000e00d28000000283c2c00060000

    vgextend asu_vg1 /dev/disk/by-id/scsi-3600000e00d28000000283c2c00020000

    vgextend asu_vg1 /dev/disk/by-id/scsi-3600000e00d28000000283c2c00070000

    vgextend asu_vg1 /dev/disk/by-id/scsi-3600000e00d28000000283c2c00030000

3. Create 20 Logical Volumes for each ASU with 512KiB Stripe size

    lvcreate -n asu101 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu102 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu103 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu104 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu105 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu106 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu107 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu108 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu109 -i 8 -I 512 -C y -L 260416MiB asu_vg1

    lvcreate -n asu201 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu202 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu203 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu204 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu205 -i 8 -I 512 -C y -L 260416MiB asu_vg1
    lvcreate -n asu206 -i 8 -I 512 -C y -L 260416MiB asu_vg1

```
lvcreate -n asu207 -i 8 -I 512 -C y -L 260416MiB asu_vg1
lvcreate -n asu208 -i 8 -I 512 -C y -L 260416MiB asu_vg1
lvcreate -n asu209 -i 8 -I 512 -C y -L 260416MiB asu_vg1


lvcreate -n asu301 -i 8 -I 512 -C y -L 260416MiB asu_vg1
lvcreate -n asu302 -i 8 -I 512 -C y -L 260416MiB asu_vg1
```

Referenced Scripts

- doFDRcfg.sh
- AF150S3_20190917.exp
- showFormatStatus.exp
- AF150S3_20190917makeLV.sh

APPENDIX E: CONFIGURATION INVENTORY

The following files (included in the Supporting Files) capture the configuration before and after the test run.

- log_BeforeF_AL191015170139.zlg_001.txt

- log_AfterJ_AL191015170139.zlg_001.txt

APPENDIX F: WORKLOAD GENERATOR

The ASU configuration file can be found in the Supporting Files.

- SPC1_AF150S3_20190917.asu

The Host configuration file can be found in the Supporting Files.

- SPC1_AF150S3_20190917.hst

The following 'master' script was used to execute the required ASU pre-fill, Primary Metrics Test (Sustainability Test Phase, IOPS Test Phase, and Response Time Ramp Test Phase), Repeatability Test (Repeatability Test Phase 1 and Repeatability Test Phase 2), the SPC-1 Persistence Test Run 1 and the SPC-2 Persistence Test in an uninterrupted sequence with doFDRall_01.sh and doFDRall_02.sh.

The 'master' script invokes various other scripts which appear below in the **Referenced Scripts** section with a brief description of each referenced script.

- doFDRall_01.sh
- doFDRall_02.sh

Referenced Scripts

The 'master' script invokes the following script in order to export the log file from the storage array.

- exportLog.exp