



SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

FUJITSU LIMITED
ETERNUS DX600 S4

SPC-1 V3.6.0

SUBMISSION IDENTIFIER: A32005

SUBMITTED FOR REVIEW: APRIL 4, 2018

First Edition – April 2018

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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

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

April 3, 2018

I verified the SPC Benchmark 1™ (SPC-1™ V3.6.0) test execution and performance results of the following Tested Storage Product:

ETERNUS DX600 S4

The results were:

SPC-1 IOPS™	560,037
SPC-1 Price-Performance™	\$295.68/SPC-1 KIOPS™
SPC-1 IOPS™ Response Time	0.478 ms
SPC-1 Overall Response Time	0.297 ms
SPC-1 ASU Capacity	6,251 GB
SPC-1 ASU Price	\$26.49/GB
SPC-1 Total System Price	\$165,586.70

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 v03.00.2551. 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.storageperformance.org under the Submission Identifier A32005.

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

LETTER OF GOOD FAITH



Kanagawa-ken, Kawasaki-shi, Nakahara-ku, Kamikodanaka, 4-1-1, JAPAN 211-8588
Phone: 044-754-3423

April 3, 2018
From: Yoshinori Terao, 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.

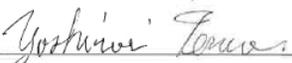
Subject: SPC-1 Letter of Good Faith for the FUJITSU Storage ETERNUS DX600 S4

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 V3.6 of the SPC-1 benchmark specification.

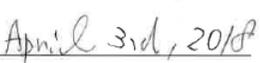
In addition, we have reported any items in the benchmark configuration and execution of the benchmark necessary to reproduce the reported results even if the items are not explicitly required to be disclosed by the SPC-1 benchmark specification.

Signed:

Date:



Yoshinori Terao
Vice President, System Development Div.



April 3rd, 2018



SPC BENCHMARK 1™

EXECUTIVE SUMMARY

FUJITSU LIMITED ETERNUS DX600 S4

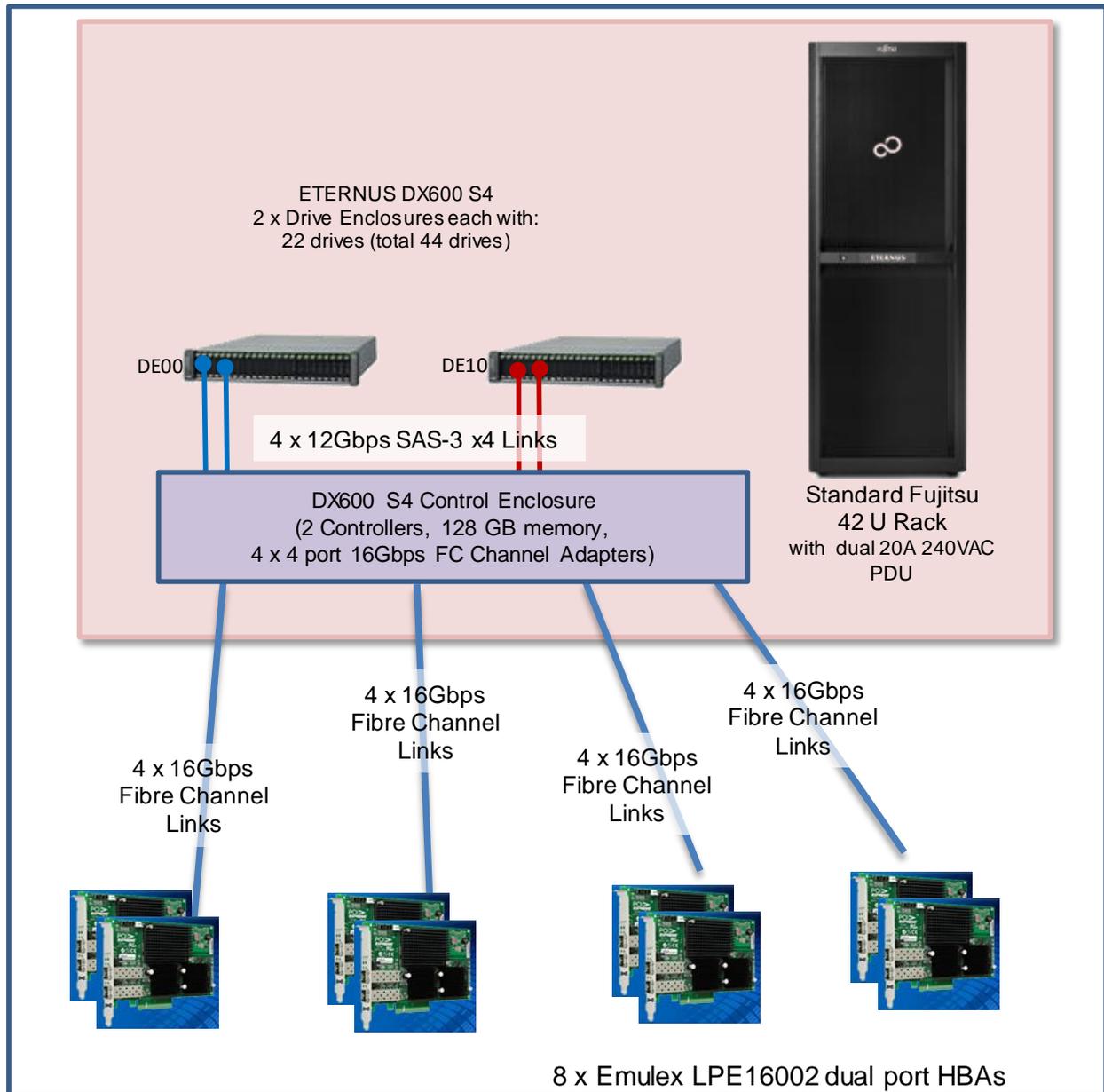
SPC-1 IOPS™	560,037
SPC-1 Price-Performance™	\$295.68/SPC-1 KIOPS™
SPC-1 IOPS™ Response Time	0.478 ms
SPC-1 Overall Response Time	0.297 ms
SPC-1 ASU Capacity	6,251 GB
SPC-1 ASU Price	\$26.49/GB
SPC-1 Total System Price	\$165,586.70
Data Protection Level	Protected 2 (RAID1)
Physical Storage Capacity	17,600 GB
Pricing Currency / Target Country	U.S. Dollars / USA

SPC-1 V3.6.0

SUBMISSION IDENTIFIER: A32005

SUBMITTED FOR REVIEW: APRIL 4, 2018

Benchmark Configuration Diagram



Tested Storage Product Description

The ETERNUS DX600 S4 is the ideal choice for application scenarios with demanding data and performance requirements. The system delivers impressive IOPS performance with lowest latency even at full load. Thus, it offers a solution that resolves all performance issues in critical applications – such as real-time business analytics or VDI environments - without requiring any complicated tuning. It also fits best as general-purpose storage for all Tier-1 applications in small and mid-sized companies.

Priced Storage Configuration Components

8 x Emulex LPE16002 dual port 16 Gb Fibre Channel HBAs
1 x DX600 S4, with: 2 x Controller Modules (CM) each with: 64 GB cache (128 GB total) 2 x Channel Adapter (CA) each with: 4 x 16Gbps Fibre Channel Host Ports 44 x 400GB SSD Storage Devices (without Hot Spare)

Storage Configuration Pricing

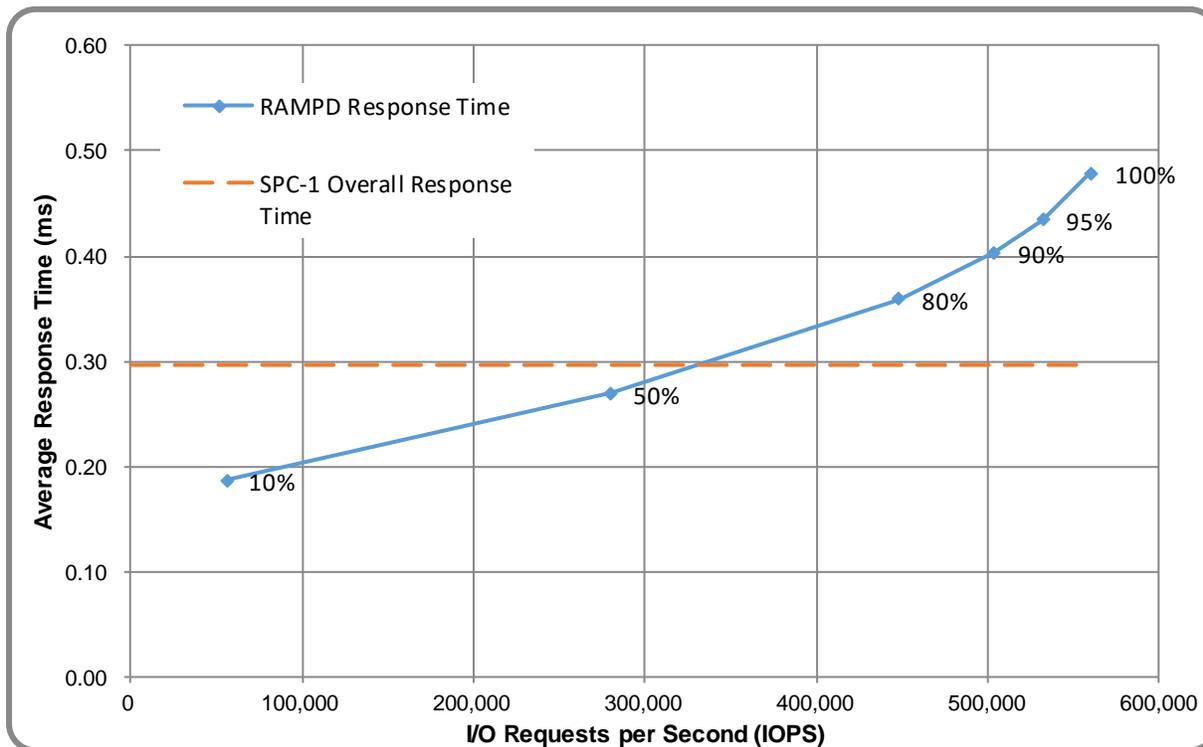
Part No.	Description	Source	Qty	Unit Price	Ext. Price	Disc.	Disc. Price
Hardware & Software							
ET604SAU	ETERNUS DX600 S4	1	1	47,220.00	47,220.00	50%	23,610.00
ETQM8H	128GB cache memory for DX600	1	1	8,770.00	8,770.00	50%	4,385.00
ETQEADU	Drive enclosure for DX500/DX600(2.5inch)	1	2	4,470.00	8,940.00	50%	4,470.00
ETQHH8E	Host interface for DX500/DX600(16Gbit/s, FC, 8port)	1	2	6,080.00	12,160.00	50%	6,080.00
ETQSAF	Value SSD(2.5inch) 400GB x1 for DX500/DX600	1	30	3,060.00	91,800.00	50%	45,900.00
ETQSA4A	SSD(2.5inch) 400GB x1 for DX500/DX600	1	14	5,880.00	82,320.00	50%	41,160.00
S26361-F4994-L502	PFC EP LPe16002	1	8	1,373.00	10,984.00	50%	5,492.00
ETPKC10U	AC100/200V Power Cable for DX500 S3/DX600 S3(IEC60320 C14, 1.0m)	1	3	130.00	390.00	50%	195.00
ETPP12U-L	Power distribution unit for DX500 S3/DX600 S3 (AC200-240V, 2U, 12Outlets)	1	1	2,170.00	2,170.00	50%	1,085.00
PYRACK_S26361-K827-V340_206528-02	PRIMECENTER M1 RACK 642S (42U, 1050x600mm) with Front & Rear Doors, side panels	1	1	3,157.00	3,157.00	50%	1,578.50
61-343827-003	LC-LC 10 GIGABIT MULTIMODE OM3 LASER OPTIMIZED DUPLEX 50/125 FIBER PATCH CABLE RISER RATED AQUA - 5M	1	16	140.00	2,240.00	50%	1,120.00
Hardware & Software Subtotal							135,075.50
Support & Maintenance							
	Provide 24 hour per day / 7days per week 4 hour response maintenance for 36 months						
ETD600-W059360-ATR	ETERNUS DX600 S4 Warranty, 36 Months, Basic Level, 12x5 Phone Support, 9x5 NBD Onsite	1	1	0.00	0.00	20%	0.00
ETD600-U004361-ATR	ETERNUS DX600 S4 Warranty Uplift, 36 Months, Enhanced Plus Level, 24x7 4hr Onsite, Prepaid billing	1	1	38,139.00	38,139.00	20%	30,511.20
Support & Maintenance Subtotal							30,511.20
SPC-1 Total System Price							165,586.70
SPC-1 IOPS™							560,037
SPC-1 Price-Performance™ (\$/SPC-1 KIOPS™)							295.68
SPC-1 ASU Capacity (GB)							6,251
SPC-1 ASU Price (\$/GB)							26.49

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: Currently available.

Response Time and Throughput Graph



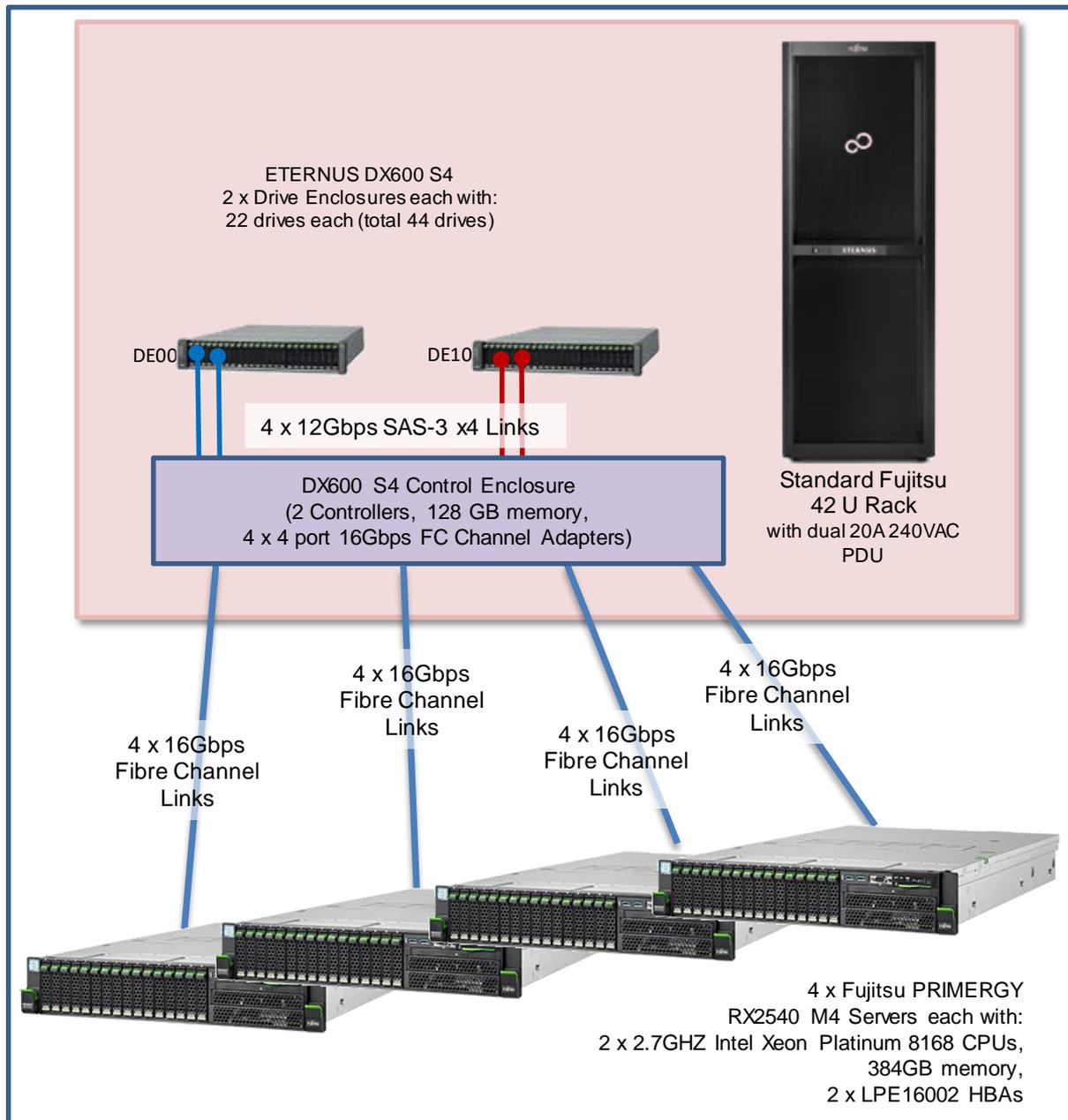
Contact Information	
Test Sponsor Primary Contact	Fujitsu Limited – http://www.fujitsu.com/services/computing/storage/ Kun Katsumata – kkatsumata@us.fujitsu.com
SPC Auditor	InfoSizing – www.sizing.com Doug Johnson – doug@sizing.com

Revision Information	
SPC Benchmark 1™ Revision	V3.6.0
SPC-1 Workload Generator Revision	V 03.00.2551
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).



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 Tested Storage Configuration (TSC).

Host Systems
4 x Fujitsu PRIMERGY RX2540 M4 Servers, each with: 2 x Intel Xeon Platinum 8168 (2.7GHz, 24 Cores, 33 MB L3) 384 GB Main Memory Red Hat Enterprise Linux Server release 6.9
Tested Storage Configuration
8 x Emulex LPE16002 dual port 16 Gb Fibre Channel HBAs
1 x DX600 S4, with: 2 x Controller Modules (CM) each with: 64 GB cache (128 GB total) 2 x Channel Adapter (CA) each with: 4 x 16Gbps Fibre Channel Host Ports 44 x 400GB SSD Storage Devices (without Hot Spare)

Differences Between Tested and Priced Storage Configurations

The TSC was configured with a Fujitsu Standard 42 U Rack. The PSC has a Standard PRIMECENTER 42 U Rack. If the TSC had been configured with a Standard PRIMECENTER 42 U Rack there would not have been a difference in the reported SPC-1 performance.

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

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 ASU Mapping

The following table details the capacity of each ASU and how they are mapped to logical volumes (LV).

	LV per ASU	LV Capacity	Used per LV	Total per ASU	% ASU Capacity	Optimized
ASU-1	1	3,887	2,813	2,813	45.0%	No
ASU-2	1	3,887	2,813	2,813	45.0%	No
ASU-3	1	863	625	625	10.0%	No
SPC-1 ASU Capacity				6,251		

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.

Devices	Count	Physical Capacity	Total Capacity
400GB Value SSD	30	400.0	12,000.0
400GB SSD	14	400.0	5,600.0
Total Physical Capacity			17,600
Physical Capacity Utilization			35.52%

Data Protection

The data protection level used for all logical volumes was **Protected 2 (RAID1)**, which was accomplished by configuring 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).

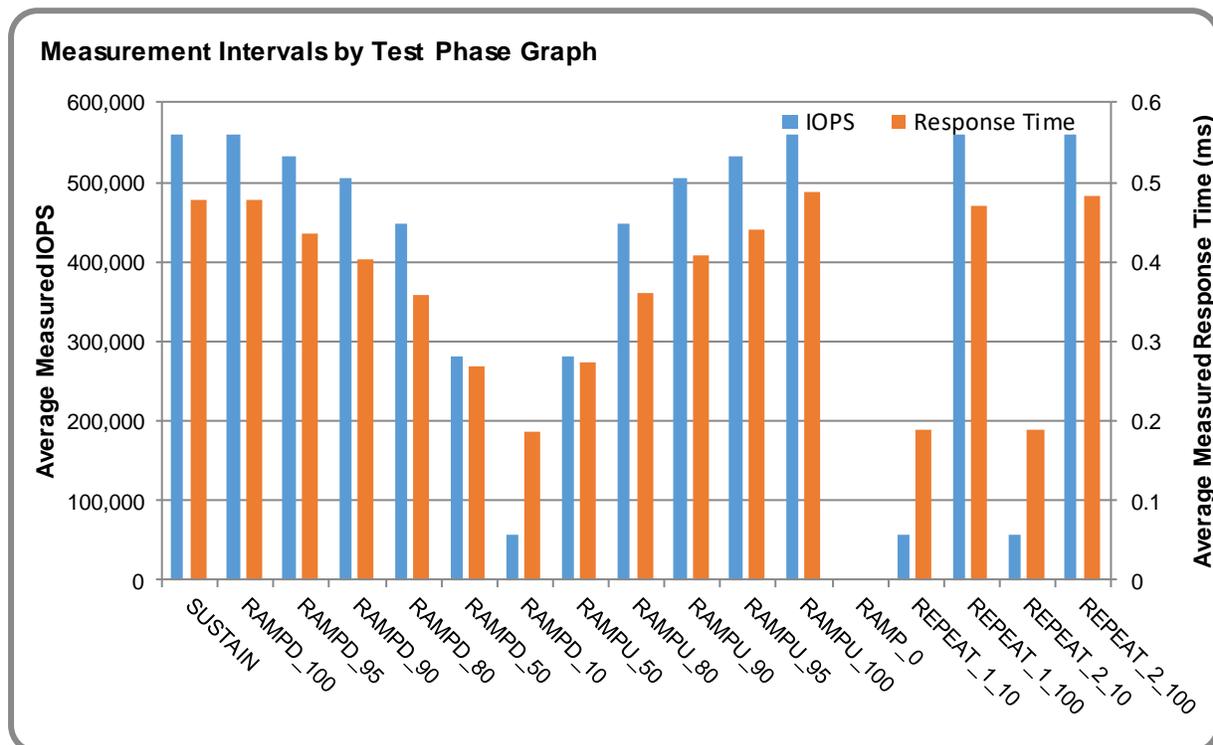
Primary Metrics Test Phases

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.

Measurement Intervals by Test Phase Graph

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



Exception and Waiver

None.

SUSTAIN Test Phase

SUSTAIN – Results File

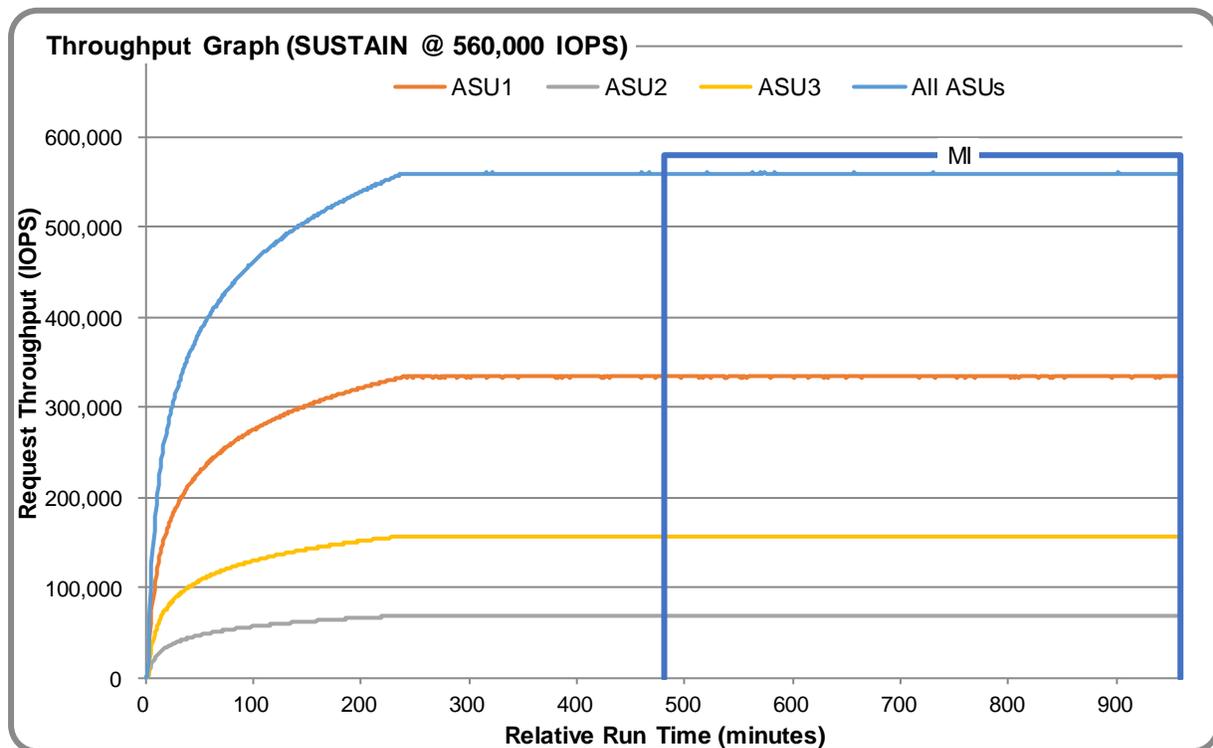
The results file generated during the execution of the SUSTAIN Test Phase is included in the Supporting Files (see Appendix A) as follows:

- SPC1_METRICS_0_Raw_Results.xlsx

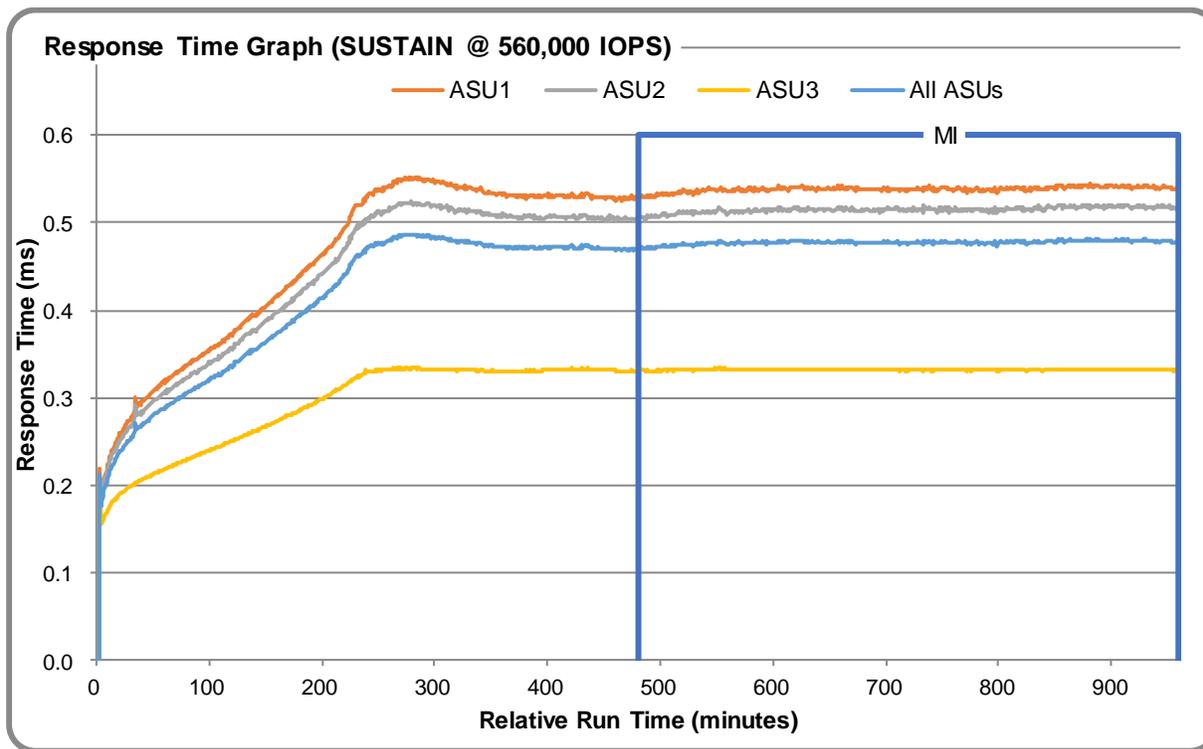
SUSTAIN – Execution Times

Interval	Start Date & Time	End Date & Time	Duration
Transition Period	16-Mar-18 21:12:10	17-Mar-18 05:12:10	8:00:00
Measurement Interval	17-Mar-18 05:12:10	17-Mar-18 13:12:12	8:00:02

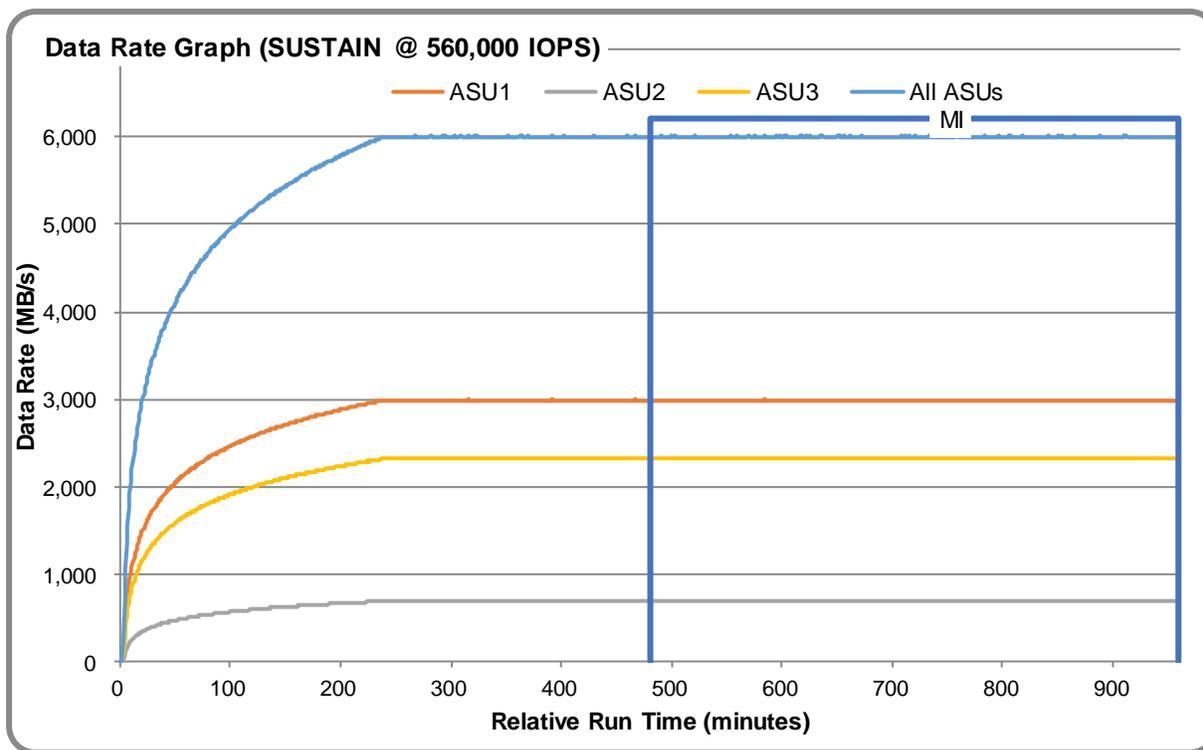
SUSTAIN – Throughput Graph



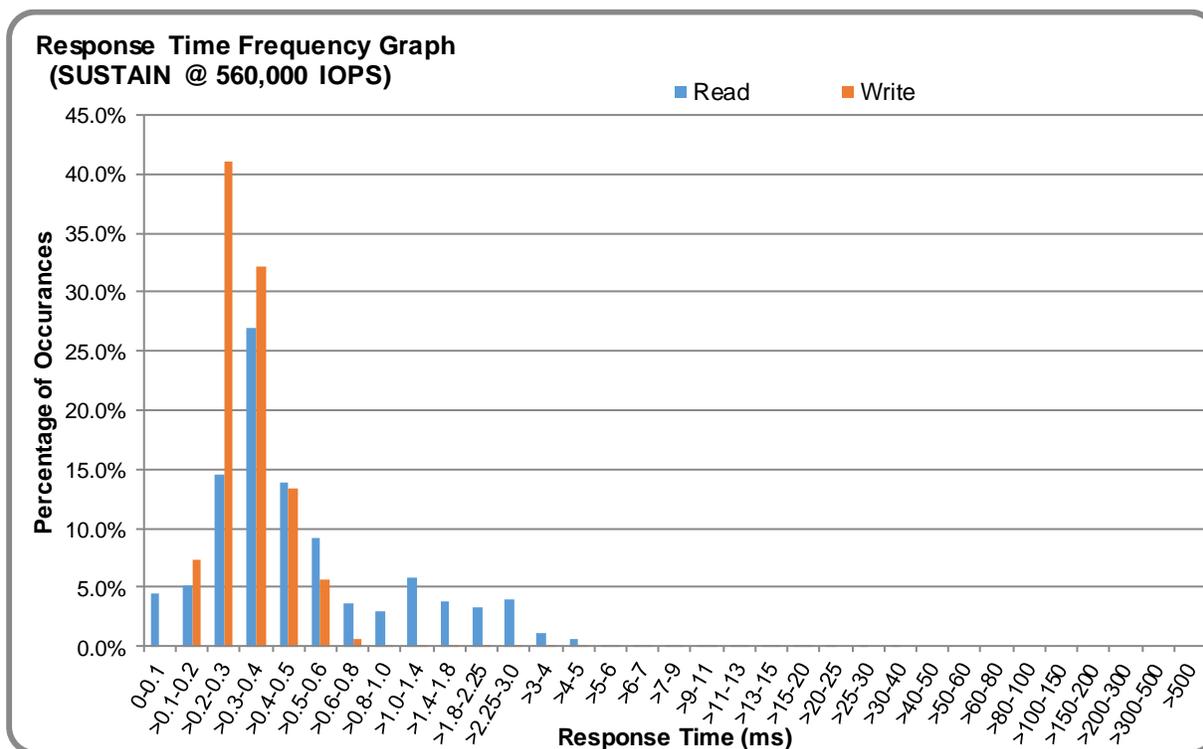
SUSTAIN – Response Time Graph



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 Target 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	0.0010	0.0003	0.0006	0.0003	0.0013	0.0006	0.0009	0.0003
Difference	0.000%	0.003%	0.001%	0.001%	0.007%	0.006%	0.009%	0.001%

RAMPD_100 Test Phase

RAMPD 100 – Results File

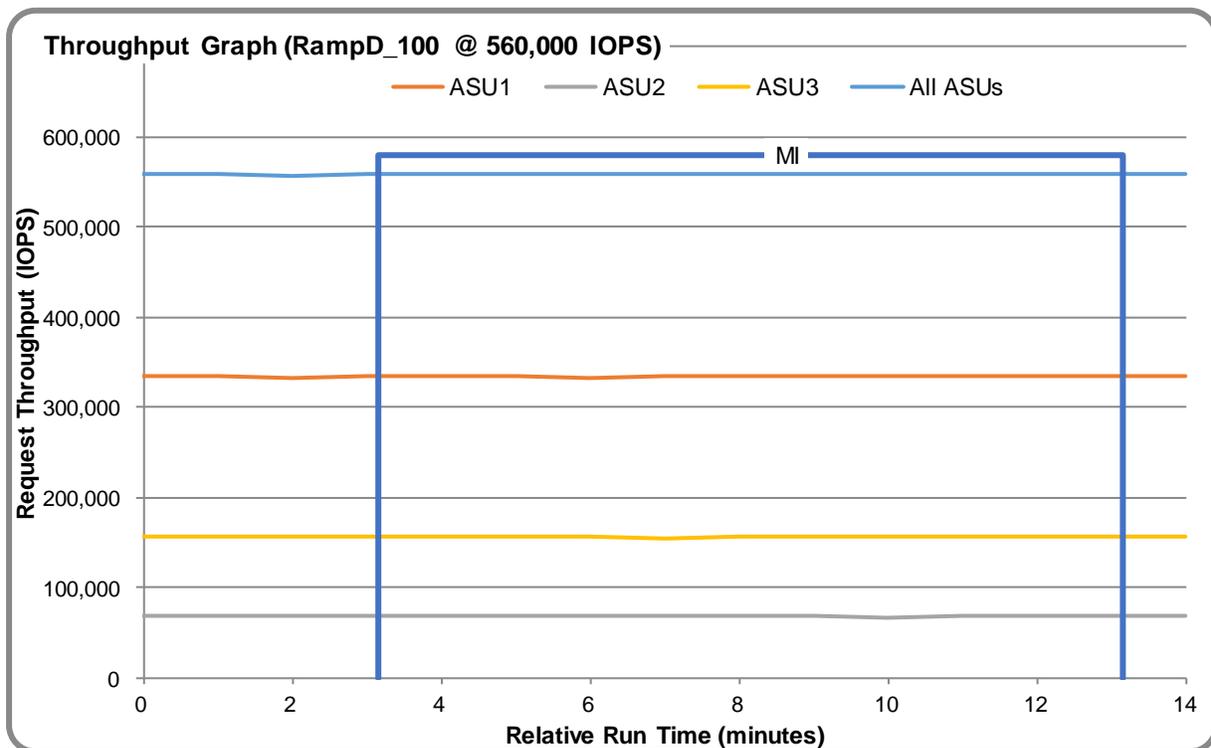
The results file generated during the execution of the RAMPD_100 Test Phase is included in the Supporting Files (see Appendix A) as follows:

- SPC1_METRICS_0_Raw_Results.xlsx

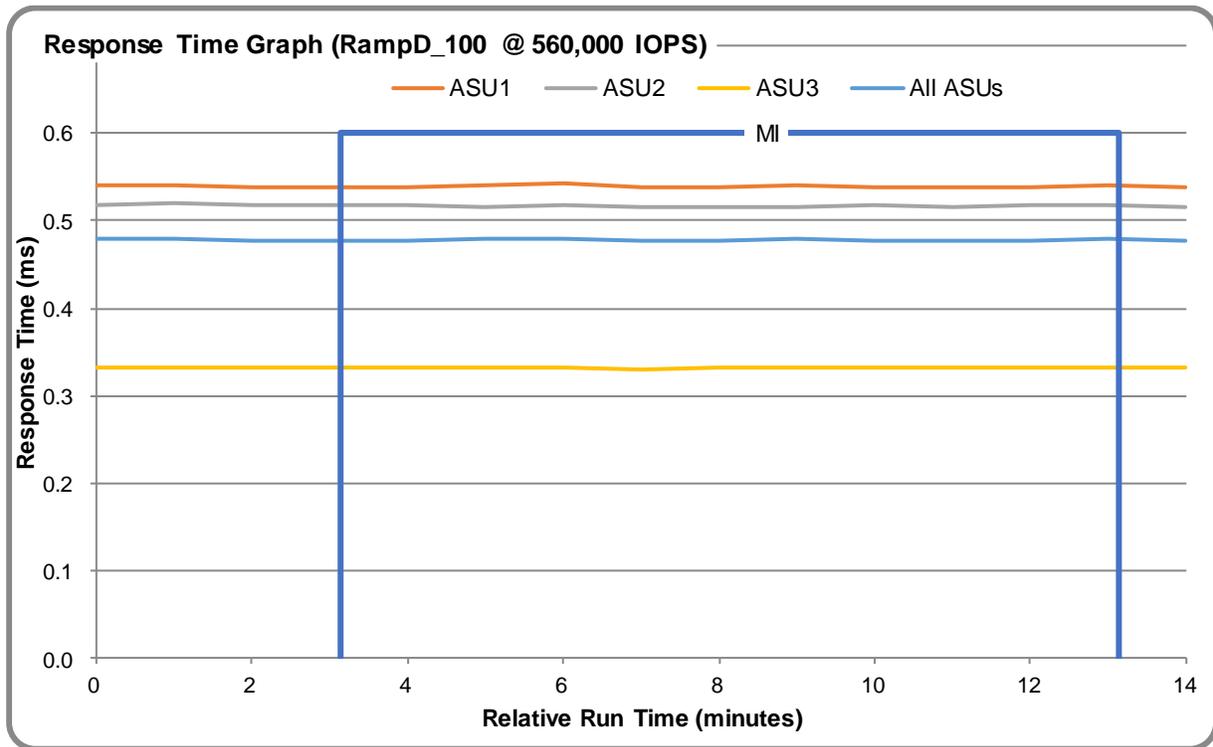
RAMPD 100 – Execution Times

Interval	Start Date & Time	End Date & Time	Duration
Transition Period	17-Mar-18 13:13:10	17-Mar-18 13:16:10	0:03:00
Measurement Interval	17-Mar-18 13:16:10	17-Mar-18 13:26:12	0:10:02

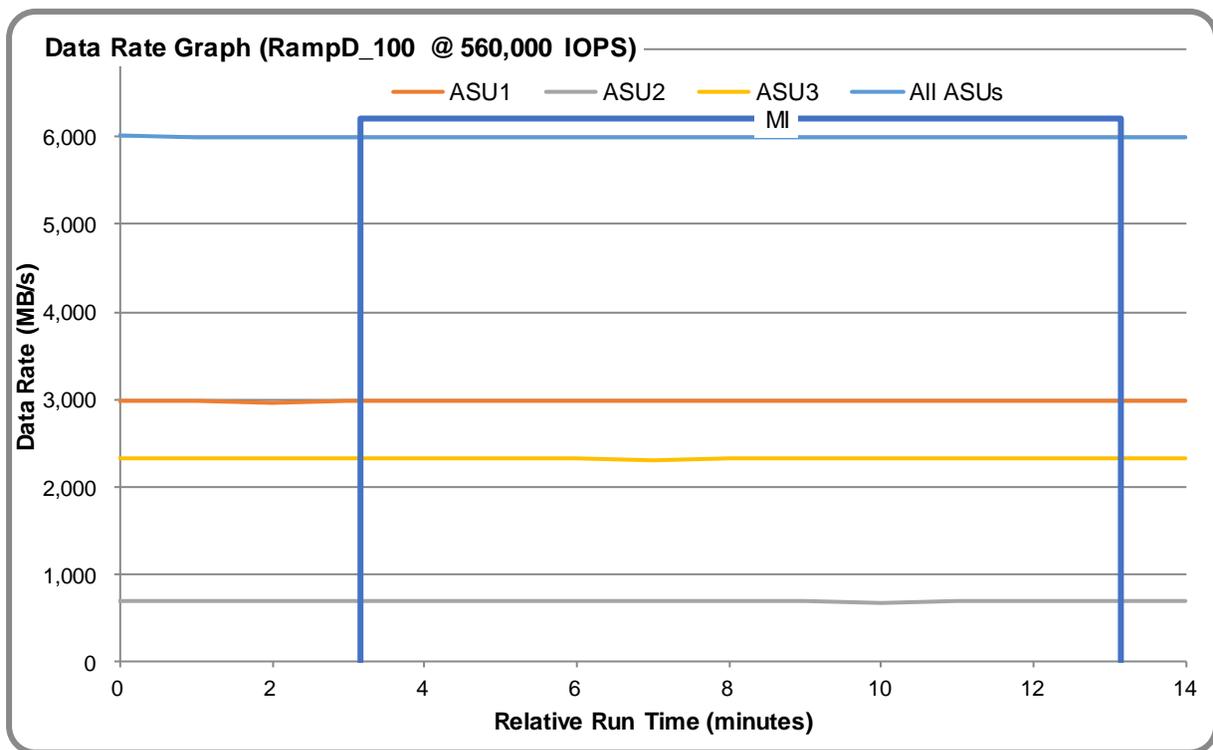
RAMPD 100 – Throughput Graph



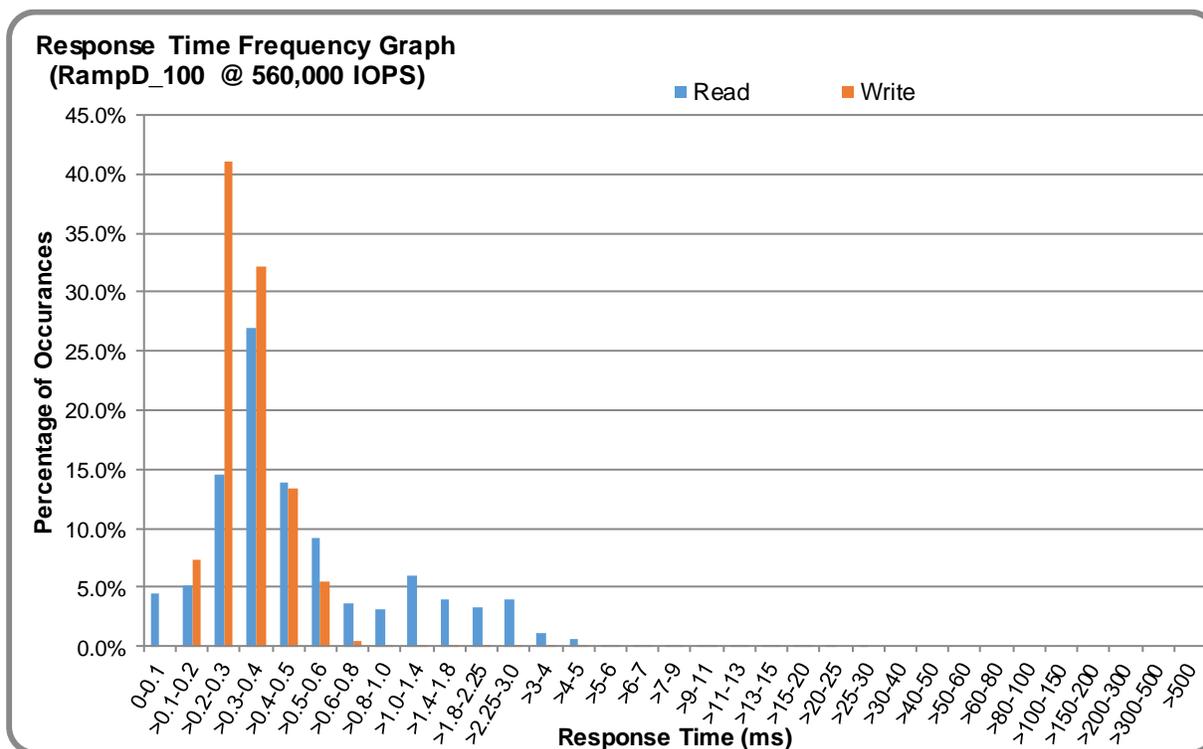
RAMPD 100 – Response Time Graph



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 Target 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	0.0006	0.0002	0.0007	0.0002	0.0012	0.0009	0.0008	0.0003
Difference	0.040%	0.009%	0.008%	0.006%	0.013%	0.005%	0.013%	0.006%

RAMPD 100 – I/O Request Summary

I/O Requests Completed in the Measurement Interval	336,027,565
I/O Requests Completed with Response Time <= 30 ms	336,027,559
I/O Requests Completed with Response Time > 30 ms	6

Response Time Ramp Test

Response Time Ramp Test – Results File

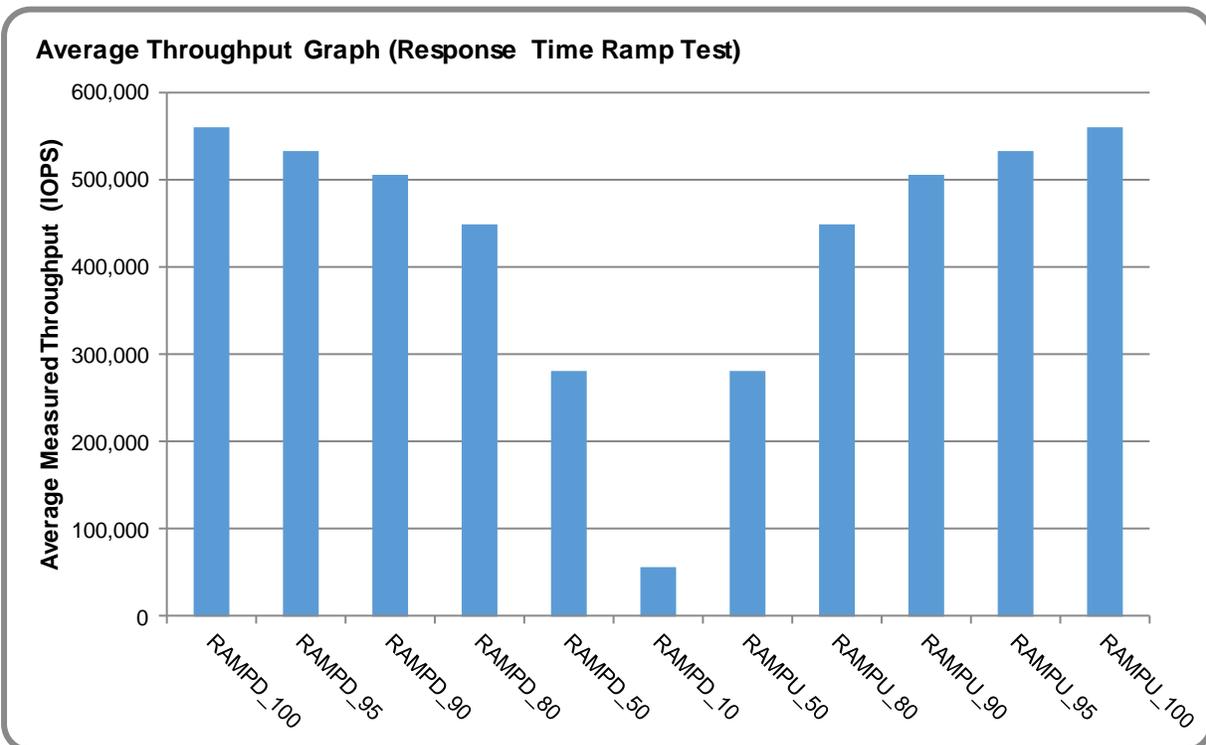
The results file generated during the execution of the Response Time Ramp Test is included in the Supporting Files (see Appendix A) as follows:

- **SPC1_METRICS_0_Raw_Results.xlsx**

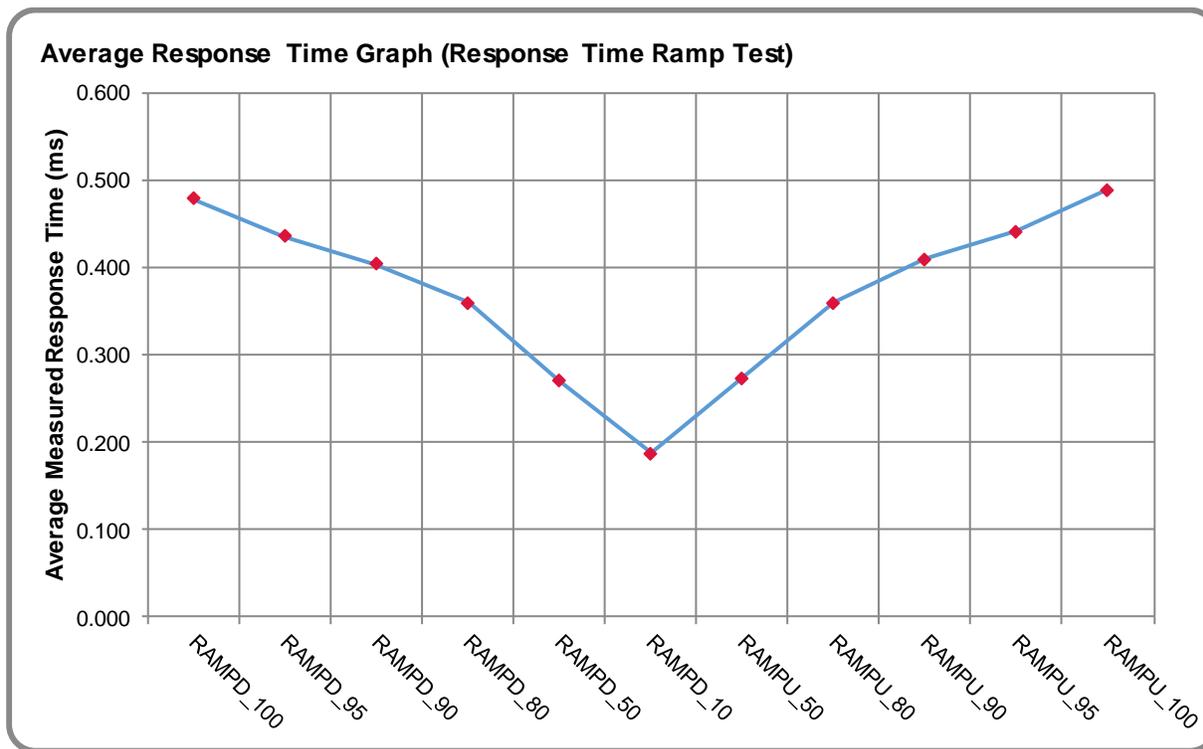
Response Time Ramp Test – Phases

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).

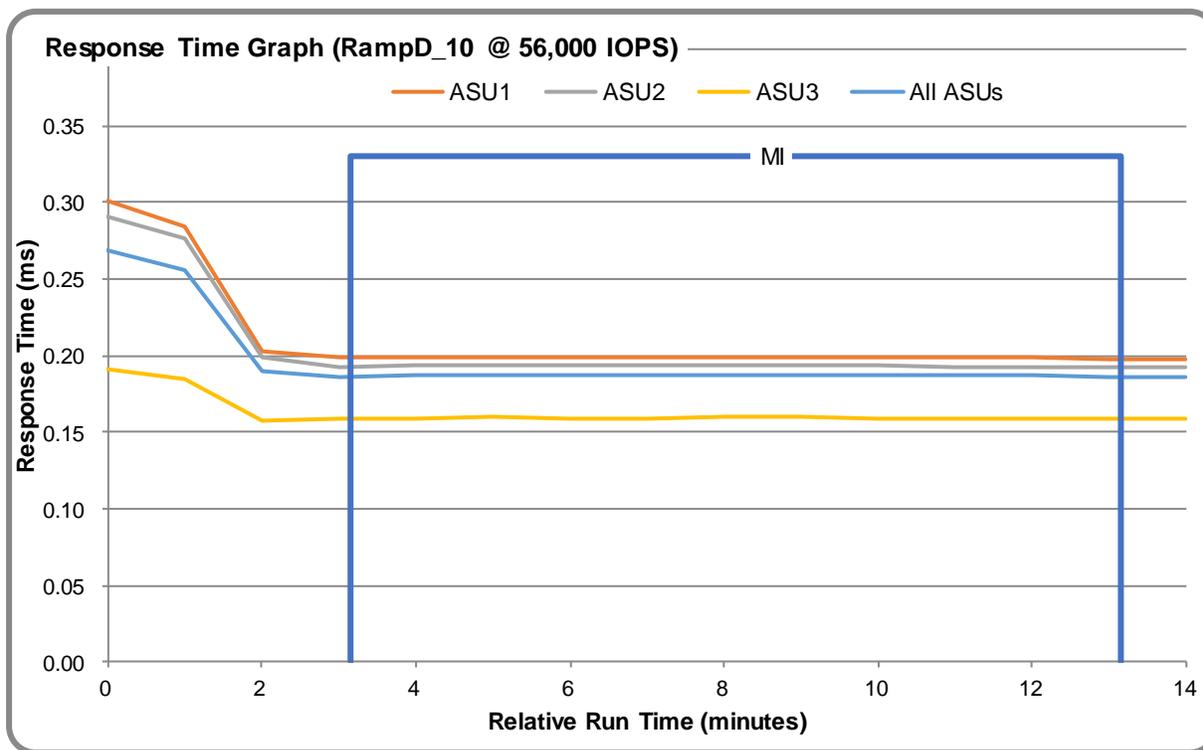
Response Time Ramp Test – Average Throughput Graph



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:

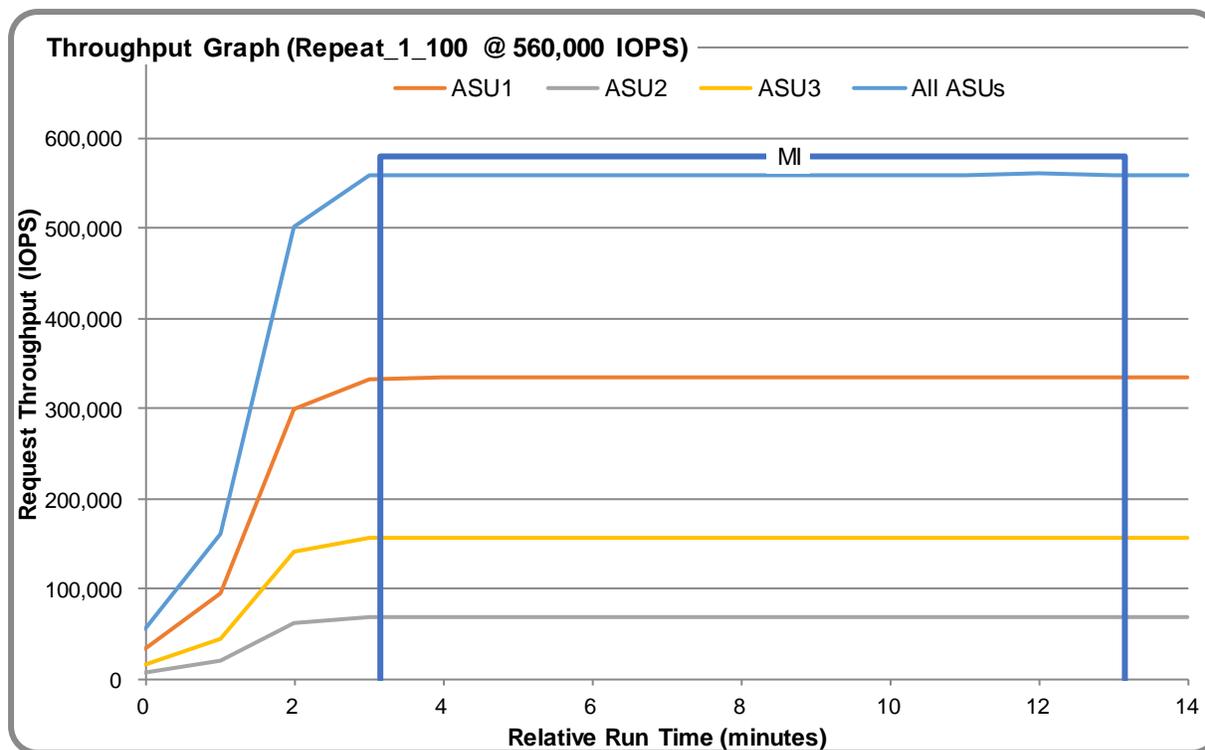
- **SPC1_METRICS_0_Raw_Results.xlsx**

Repeatability Test Results

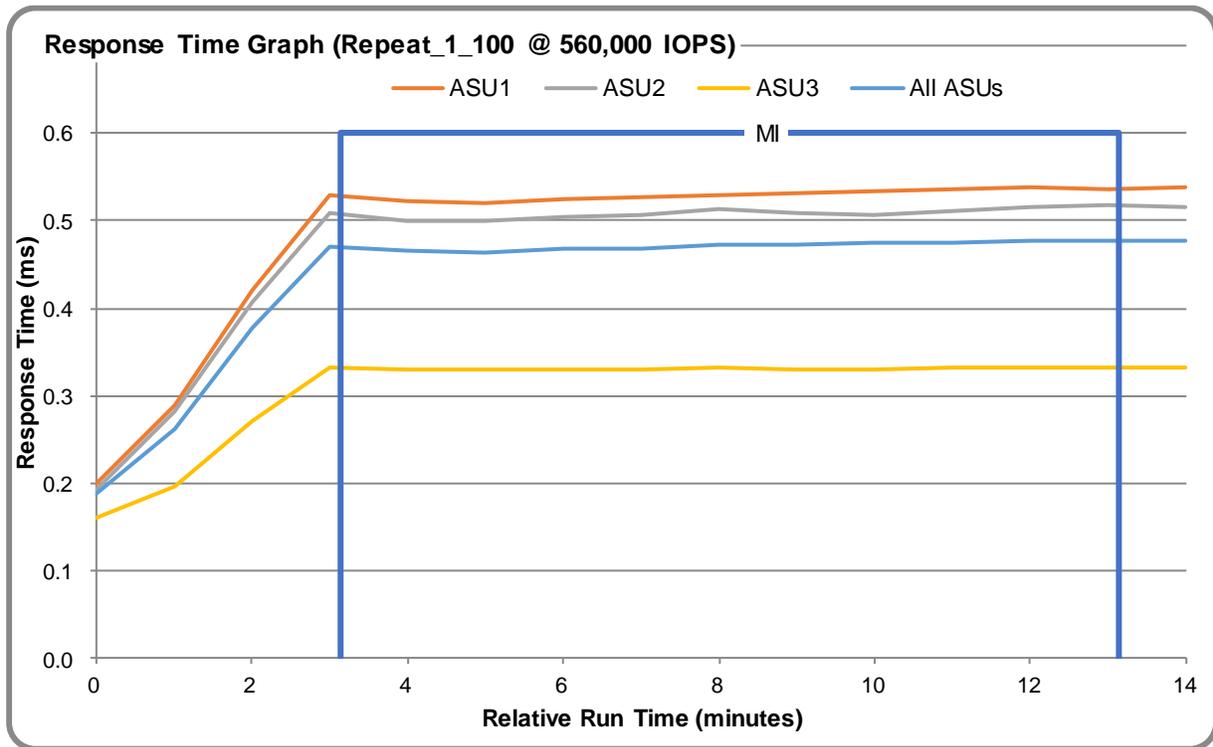
The throughput measurements for the Response Time Ramp Test (RAMPD) and the Repeatability Test Phases (REPEAT_1 and REPEAT_2) are listed in the tables below.

Test Phase	100% IOPS	10% IOPS
RAMPD	560,037.8	56,010.6
REPEAT_1	560,086.8	56,003.2
REPEAT_2	560,027.2	55,984.8

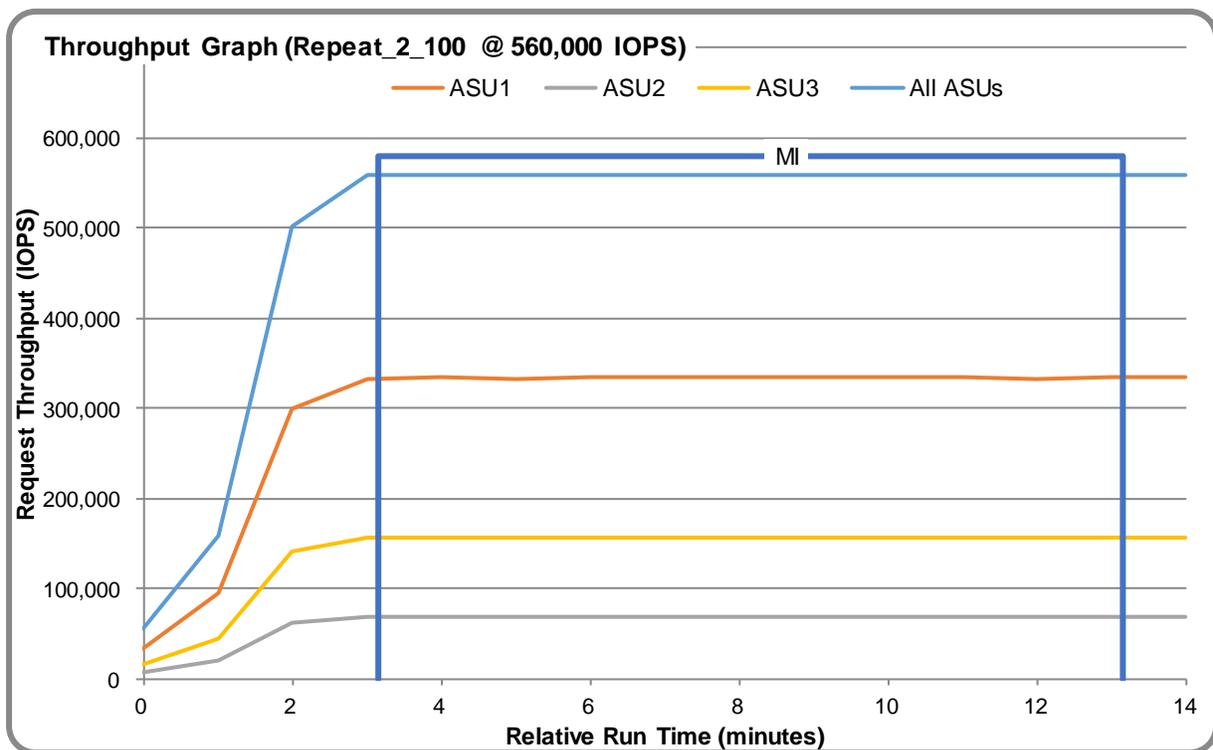
REPEAT 1 100 – Throughput Graph



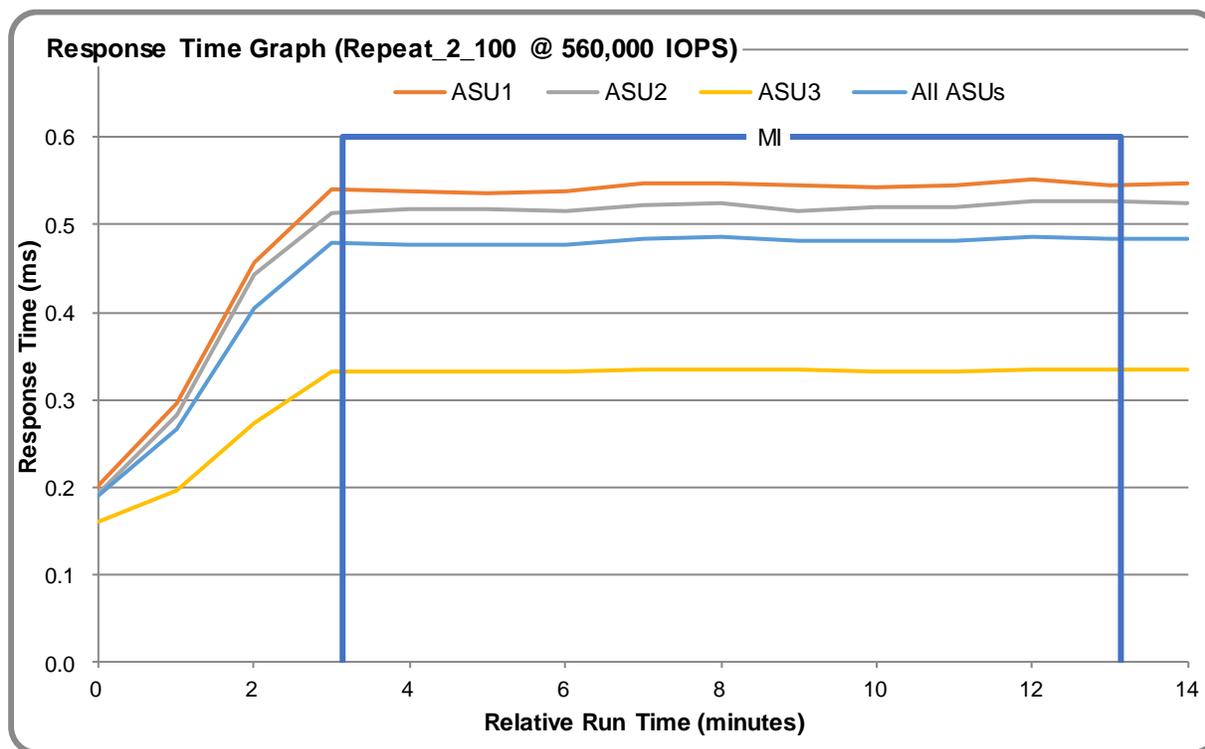
REPEAT 1 100 – Response Time Graph



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 Target 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	0.0010	0.0002	0.0006	0.0003	0.0009	0.0006	0.0008	0.0002
Difference	0.045%	0.001%	0.025%	0.016%	0.006%	0.014%	0.019%	0.003%

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	0.0008	0.0003	0.0008	0.0005	0.0014	0.0006	0.0011	0.0003
Difference	0.022%	0.007%	0.026%	0.002%	0.013%	0.003%	0.035%	0.002%

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	111,263,226
Total Number of Logical Blocks Verified	56,188,000
Total Number of Logical Blocks Overwritten	55,075,226
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

Redundantly configured batteries inside the ETERNUS DX600S4 storage system allows 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
doFDRcfg.sh	Shell script to configure the array	/D_Creation
definitions.exp	Procedure definitions	/D_Creation
DX600S4_20180222.exp	Configure CLI expect script	/D_Creation
showFormatStatus.exp	Check for physical format progress	/D_Creation
DX600S4_20180222makeLV.sh	Linux LVM configuration script	/D_Creation
/E_Inventory	Configuration inventory	root
log_BeforeF_JX180316204454.zlg_001.txt	Configuration details before the run	/E_Inventory
log_AfterJ_JX180316204454.zlg_001.txt	Configuration details after the run	/E_Inventory
/F_Generator	Workload generator	root
SPC1.DX600S4_20180222.asu	ASU configuration file	/F_generator
SPC1.DX600S4_20180222.hst	Host configuration file	/F_generator
doFDRall_1XV.sh	Master run file 1	/F_generator
doFDRall_2H.sh	Master run file 2	/F_generator
exportLog.exp	Storage array log export	/F_generator

APPENDIX B: THIRD PARTY QUOTATION

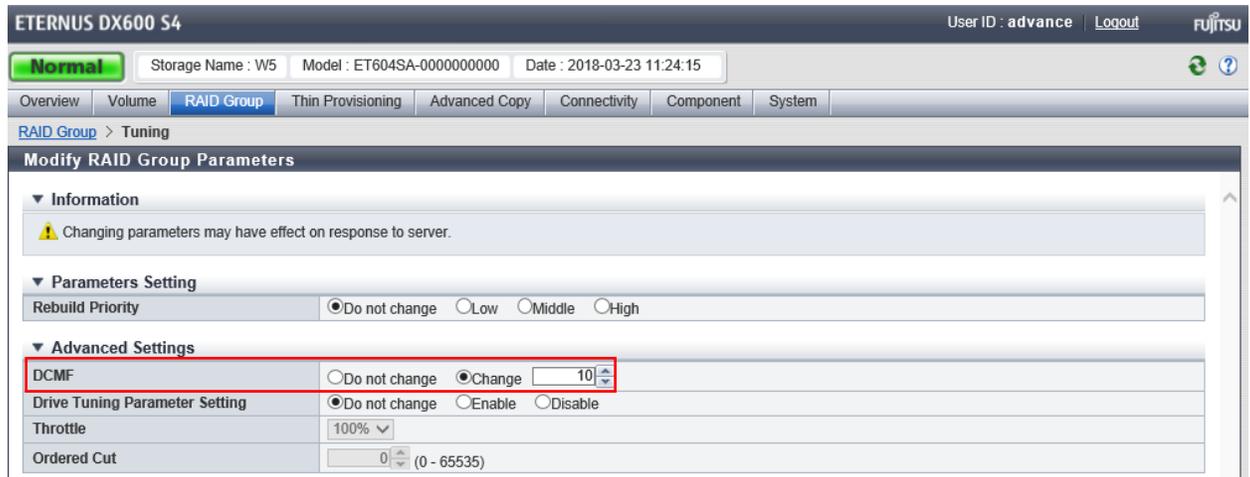
All components are directly available through the Test Sponsor.

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.

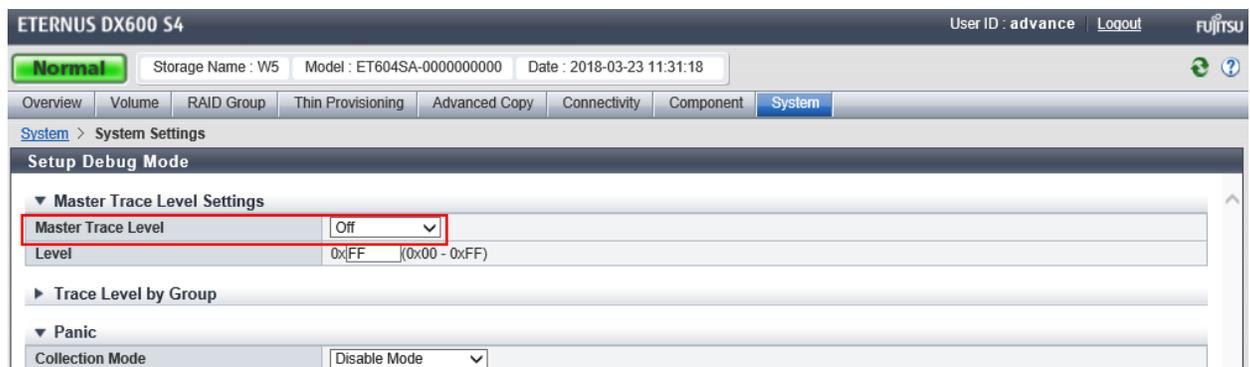
The following GUI screen (RAID Group -> Tuning -> Modify RAID Group Parameter) is used for each RAID Group and the DCMF parameter is changed to 10 as highlighted in the red frame below:



3. Disable Debug Trace

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
Following GUI setting was applied.

System-> System Settings -> Setup Subsystem Parameters:

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

The screenshot shows the ETERNUS DX600 S4 management interface. At the top, it displays 'User ID : advance' and 'Logout'. Below the navigation tabs (Overview, Volume, RAID Group, Thin Provisioning, Advanced Copy, Connectivity, Component, System), the 'System' tab is selected, leading to 'System Settings' > 'Setup Subsystem Parameters'. The page contains several sections: 'Information' with a warning about restarts, 'Display Critical System Mode' with 'Multipath CSM Order' set to '(Not Received)', 'Setup Subsystem Parameters' with a table of settings, and 'Setup Host' with 'Load Balance' set to 'Enable'. The 'Read Sequential' and 'Write Sequential' settings in the 'Setup Subsystem Parameters' table are highlighted with a red box, both set to 'Disable'.

Setup Subsystem Parameters	
1CM Write Through	<input type="radio"/> Enable <input checked="" type="radio"/> Disable
Highland Mode	<input type="radio"/> Enable <input checked="" type="radio"/> Disable
Auto power OFF/ON to fix "Not Ready 14"	<input checked="" type="radio"/> Enable <input type="radio"/> Disable
Flexible Write Through	<input type="radio"/> Enable <input checked="" type="radio"/> Disable
Ignore CM-CM Communication Error	<input type="radio"/> Enable <input checked="" type="radio"/> Disable
Read Sequential	<input type="radio"/> Enable <input checked="" type="radio"/> Disable
Write Sequential	<input type="radio"/> Enable <input checked="" type="radio"/> Disable
Turbo Mode	<input checked="" type="radio"/> Enable <input type="radio"/> Disable
Writeback Limit Count	512 ▼

APPENDIX D: STORAGE CONFIGURATION CREATION

The standard Fujitsu Command Line tool (CLI) was used to create the ETERNUS DX600 S4 SPC-1 configuration.

The 'master' script, **doFDRcfg.sh**, was executed, which in turn, invoked the script, **DX600S4_20180222.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 **DX600S4_20180222.exp** script completed steps 1-4, described below for the 16 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 22 RAID Groups were created, according to the configuration plan, **ConfigurationDesign_DX600S4_20180222.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 RG21.

Step 2 – Creation of the Logical Volumes

Wide striped logical volumes were created across 2 sets of RAID Groups (each with 11 RAID Groups). Three volumes were created on each of the RAID Groups, one for each of the three ASUs, for a total of 6 logical volumes. The sizes of two volumes created on the 2 sets for ASU-1 and ASU-2 were set to 1810 GiB each. The sizes of the volume on the 2 sets for ASU-3 were set to 402 GiB each.

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 **DX600S4_20180222.exp** script provided mapping to 16 host ports.

The port LUN mapping was assigned for each of the Logical Volumes using four ports on each of the two Channel Adapters (CA) in each of the two Controller Modules (CM). Each of the volumes, which were defined on RAID Groups owned by CM-0, were assigned LUN numbers on the active ports on the two CAs installed on CM-0. Each of the volumes, which were defined on RAID Groups owned by CM-1, were assigned LUN numbers on the active ports on the two CAs installed on CM-1.

Step 5 – Creation of the two way striped logical volumes.

Built in logical volume manager in Linux is used to stripe each pair of LUNs presented by DX600 S4 array.

This is done in 3 steps included in the **DX600S4_20180222makeLV.sh** script.

1. **Create Physical Volumes (PV) for each LUN presented from DX600 S4.**
pvcreate /dev/disk/by-id/scsi-3600000e00d2a0000002a000000000000
pvcreate /dev/disk/by-id/scsi-3600000e00d2a0000002a000000010000
pvcreate /dev/disk/by-id/scsi-3600000e00d2a0000002a000000020000
pvcreate /dev/disk/by-id/scsi-3600000e00d2a0000002a000000030000
pvcreate /dev/disk/by-id/scsi-3600000e00d2a0000002a000000040000
pvcreate /dev/disk/by-id/scsi-3600000e00d2a0000002a000000050000
2. **Create Three Volume Groups with physical extent size of 32MiB**
vgcreate -s32m asu1vg /dev/disk/by-id/scsi-
3600000e00d2a0000002a000000000000 /dev/disk/by-id/scsi-
3600000e00d2a0000002a000000030000
vgcreate -s32m asu2vg /dev/disk/by-id/scsi-
3600000e00d2a0000002a000000020000 /dev/disk/by-id/scsi-
3600000e00d2a0000002a000000050000
vgcreate -s32m asu3vg /dev/disk/by-id/scsi-
3600000e00d2a0000002a000000010000 /dev/disk/by-id/scsi-
3600000e00d2a0000002a000000040000
3. **Create Three Logical Volumes for each ASU with 32MiB Stripe size**
lvcreate -l 100%VG -i2 -I32768 -n asu1 asu1vg
lvcreate -l 100%VG -i2 -I32768 -n asu2 asu2vg
lvcreate -l 100%VG -i2 -I32768 -n asu3 asu3vg

Referenced Scripts

doFDRcfg.sh

definitions.exp

DX600S4_20180222.exp

showFormatStatus.exp

DX600S4_20180222makeLV.sh

APPENDIX E: CONFIGURATION INVENTORY

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

- log_BeforeF_JX180316204454.zlg_001.txt
- log_AfterJ_JX180316204454.zlg_001.txt

APPENDIX F: WORKLOAD GENERATOR

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

- SPC1.DX600S4_20180222.asu

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

- SPC1.DX600S4_20180222.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_1XV.sh and doFDRall_2H.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_1XV.sh
- doFDRall_2H.sh

Referenced Scripts

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

- exportLog.exp