



**SPC BENCHMARK 1/ENERGY™  
EXECUTIVE SUMMARY**

**IBM CORPORATION  
IBM FLASHSYSTEM 820**

**SPC-1/E V1.14**

**Submitted for Review: August 16, 2013  
Submission Identifier: AE00006**

## EXECUTIVE SUMMARY

### Test Sponsor and Contact Information

Test Sponsor and Contact Information	
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<b>Auditor</b>	Storage Performance Council – <a href="http://www.storageperformance.org">http://www.storageperformance.org</a> Walter E. Baker – <a href="mailto:AuditService@StoragePerformance.org">AuditService@StoragePerformance.org</a> 643 Bair Island Road, Suite 103 Redwood City, CA 94063 Phone: (650) 556-9384 FAX: (650) 556-9385

### Revision Information and Key Dates

Revision Information and Key Dates	
<b>SPC-1 Specification revision number</b>	V1.14
<b>SPC-1 Workload Generator revision number</b>	V2.3.0
<b>Date Results were first used publicly</b>	August 16, 2013
<b>Date the FDR was submitted to the SPC</b>	August 16, 2013
<b>Date the Priced Storage Configuration is available for shipment to customers</b>	currently available
<b>Date the TSC completed audit certification</b>	August 15, 2013

### Tested Storage Product (TSP) Description

IBM FlashSystem 720 and FlashSystem 820 storage systems are external, shared flash solid state storage devices that provide high performance, density, and efficiency in small integrated rackmount footprints. FlashSystem 720 and FlashSystem 820 have a unique combination of extremely low latency and high performance that offers customers scalable usable capacity points from 5 up to 20 TB (fully protected) using either SLC or eMLC flash storage media. FlashSystem 720 and FlashSystem 820 products also incorporate advanced reliability technology, including 2D Flash RAID and Variable Stripe RAID self-healing data protection.

## Summary of Results

SPC-1 Reported Data	
Tested Storage Product (TSP) Name: IBM FlashSystem 820	
Metric	Reported Result
SPC-1 IOPS™	195,021.70
SPC-1 Price-Performance™	\$1.55/SPC-1 IOPS™
Total ASU Capacity	12,283.606 GB
Data Protection Level	Protected 1 (RAID-5)
Total Price	\$302,028.00
Currency Used	U.S. Dollars
Target Country for availability, sales and support	USA

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

SPC-1 Price-Performance™ is the ratio of **Total Price** to SPC-1 IOPS™.

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

A **Data Protection Level** of **Protected 1** using **RAID-5**, which distributes check data corresponding to user data across multiple disks in the form of bit-by-bit parity.

***Protected 2:** The single point of failure of any **storage device** in the configuration will not result in permanent loss of access to or integrity of the SPC-1 Data Repository.*

**Total Price** includes the cost of the Priced Storage Configuration plus three years of hardware maintenance and software support as detailed on page 8.

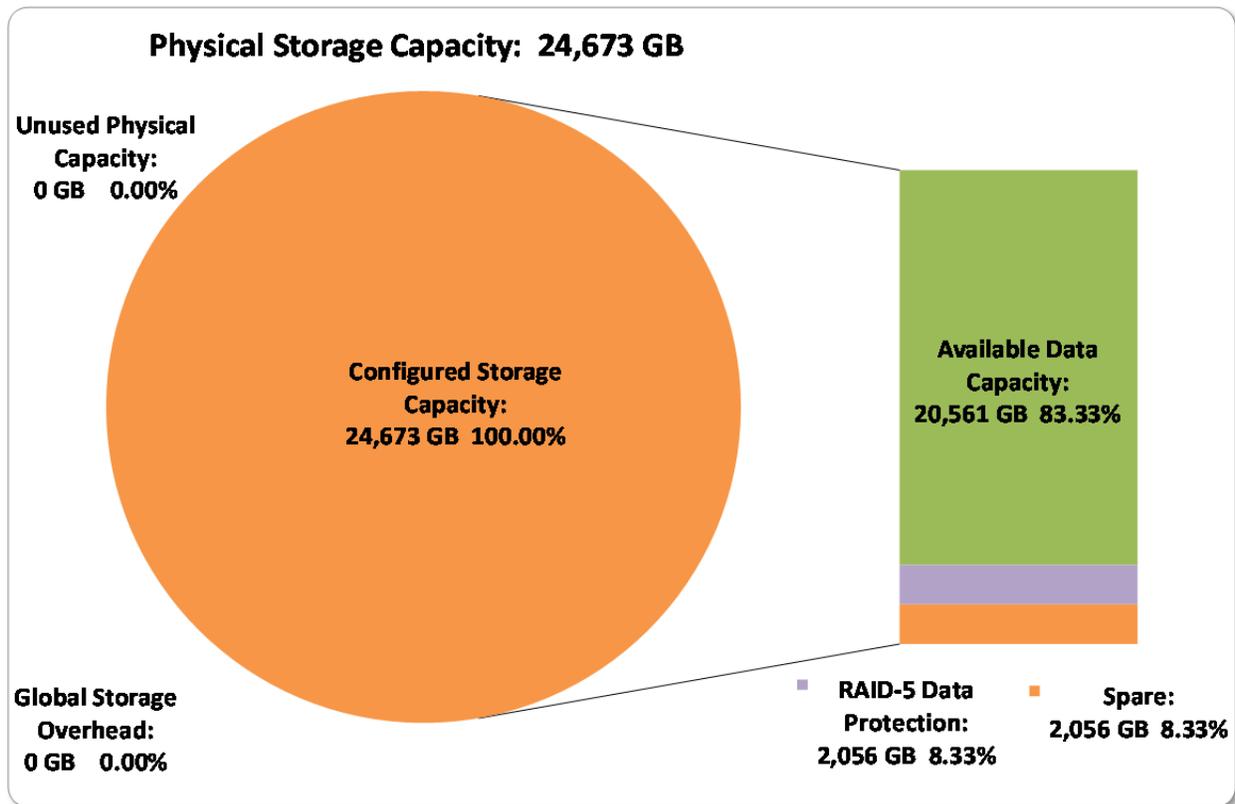
**Currency Used** is formal name for the currency used in calculating the **Total Price** and **SPC-1 Price-Performance™**. That currency may be the local currency of the **Target Country** or the currency of a difference country (*non-local currency*).

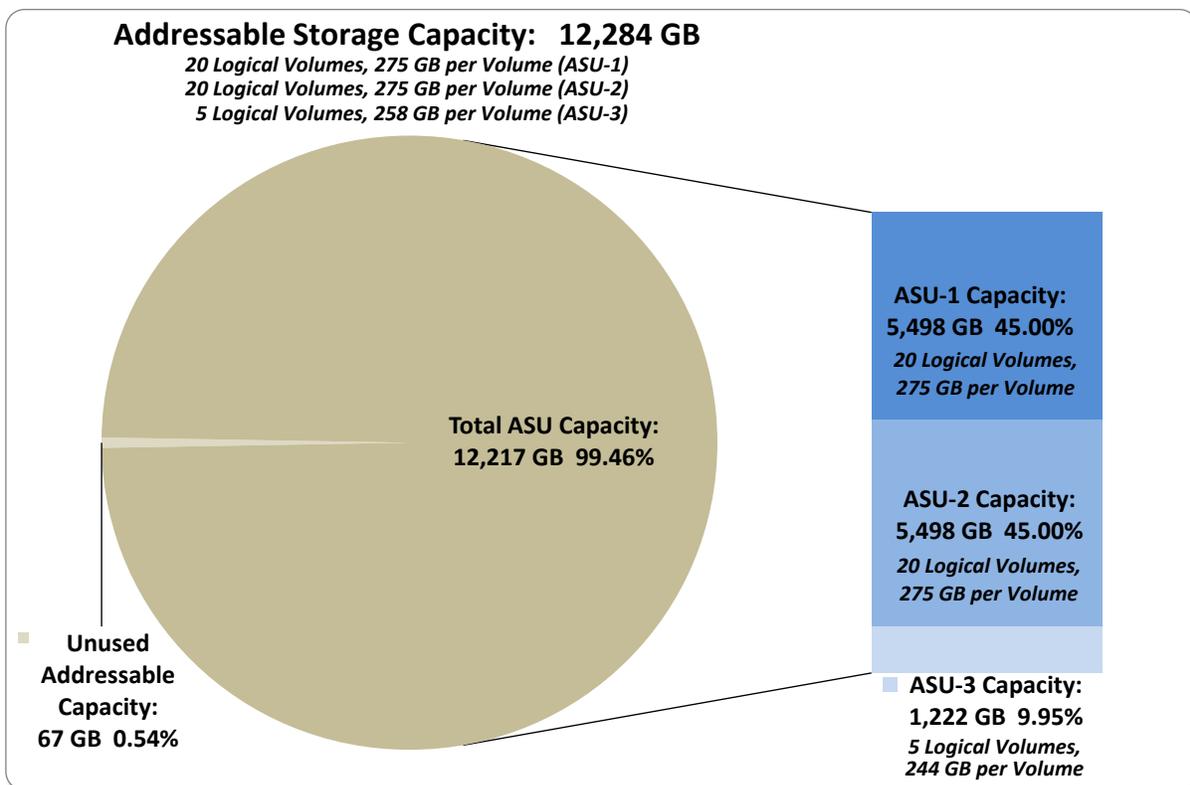
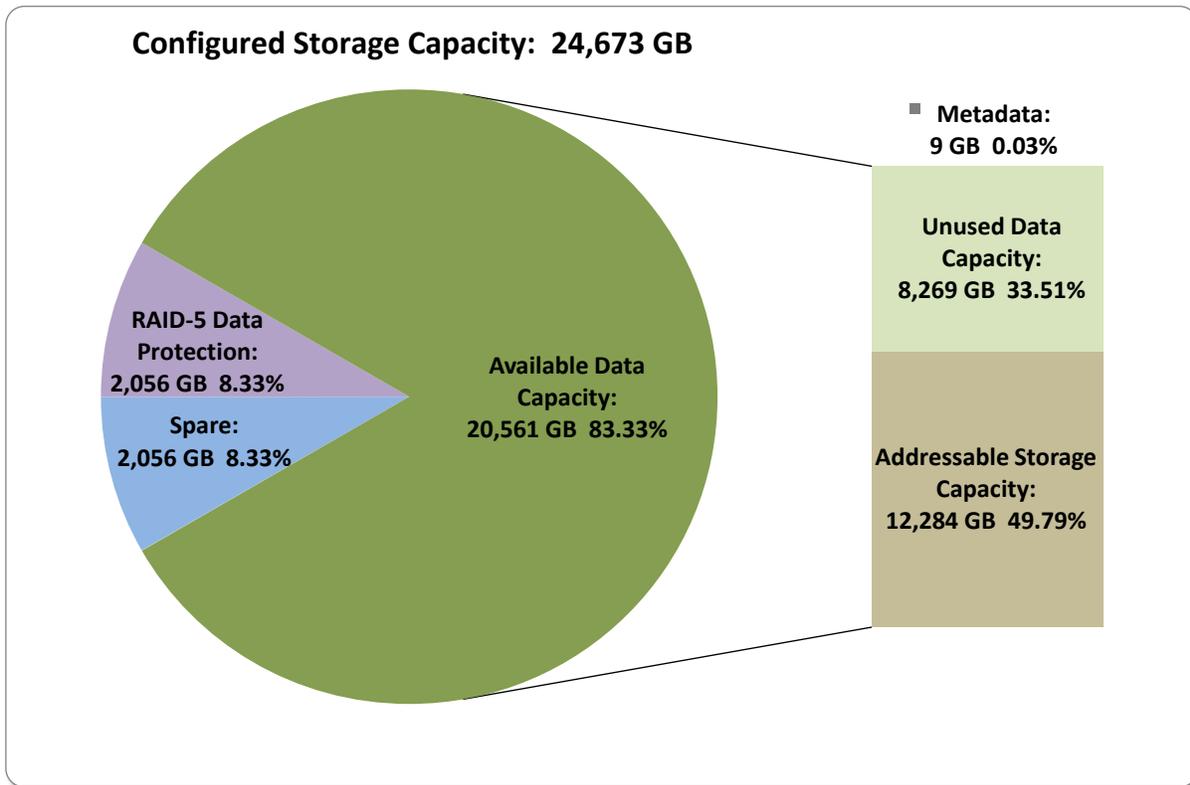
The **Target Country** is the country in which the Priced Storage Configuration is available for sale and in which the required hardware maintenance and software support is provided either directly from the Test Sponsor or indirectly via a third-party supplier.

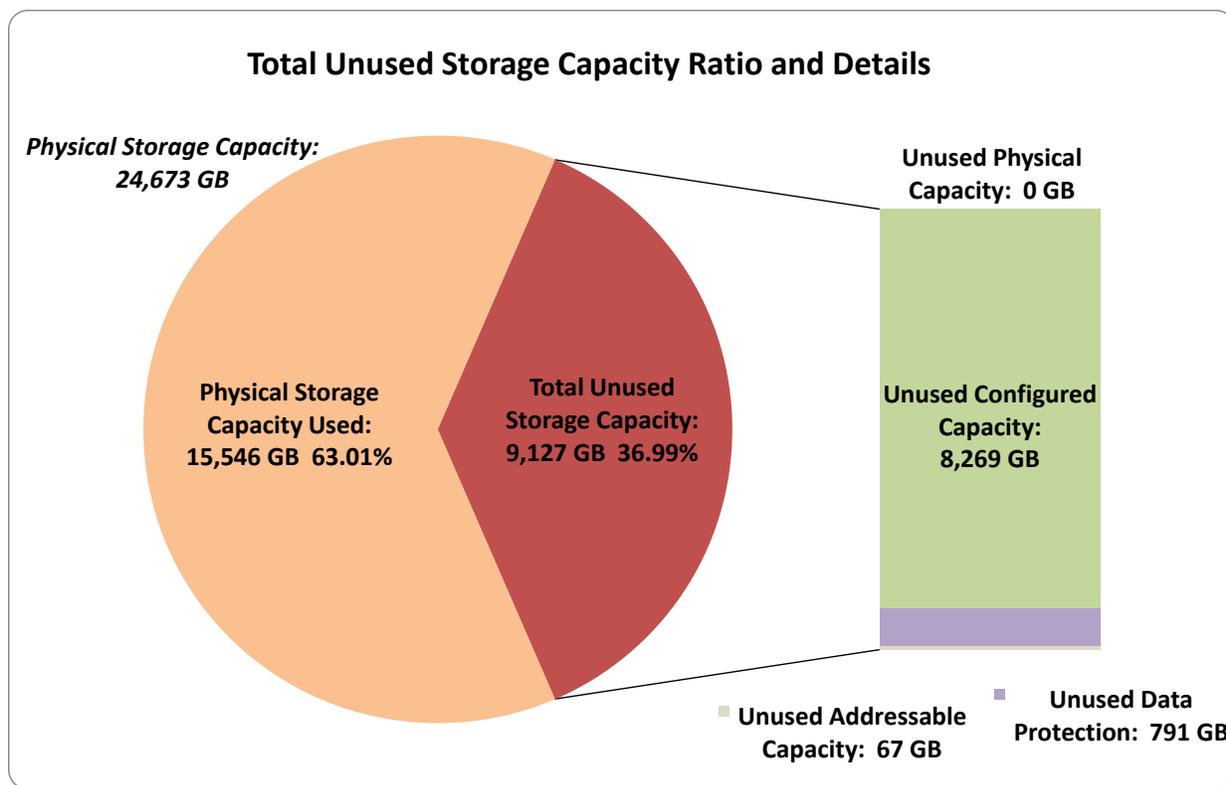
### Storage Capacities, Relationships, and Utilization

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

The capacity values in each of the following four charts are listed as integer values, for readability, rather than the decimal values listed elsewhere in this document.







SPC-1 Storage Capacity Utilization	
Application Utilization	49.51%
Protected Application Utilization	54.64%
Unused Storage Ratio	36.99%

**Application Utilization:** Total ASU Capacity (12,216.796 GB) divided by Physical Storage Capacity (24,673.041 GB)

**Protected Application Utilization:** Total ASU Capacity (12,216.796 GB) plus total Data Protection Capacity (2,056.087 GB) minus unused Data Protection Capacity (791.457 GB) divided by Physical Storage Capacity (24,673.041 GB)

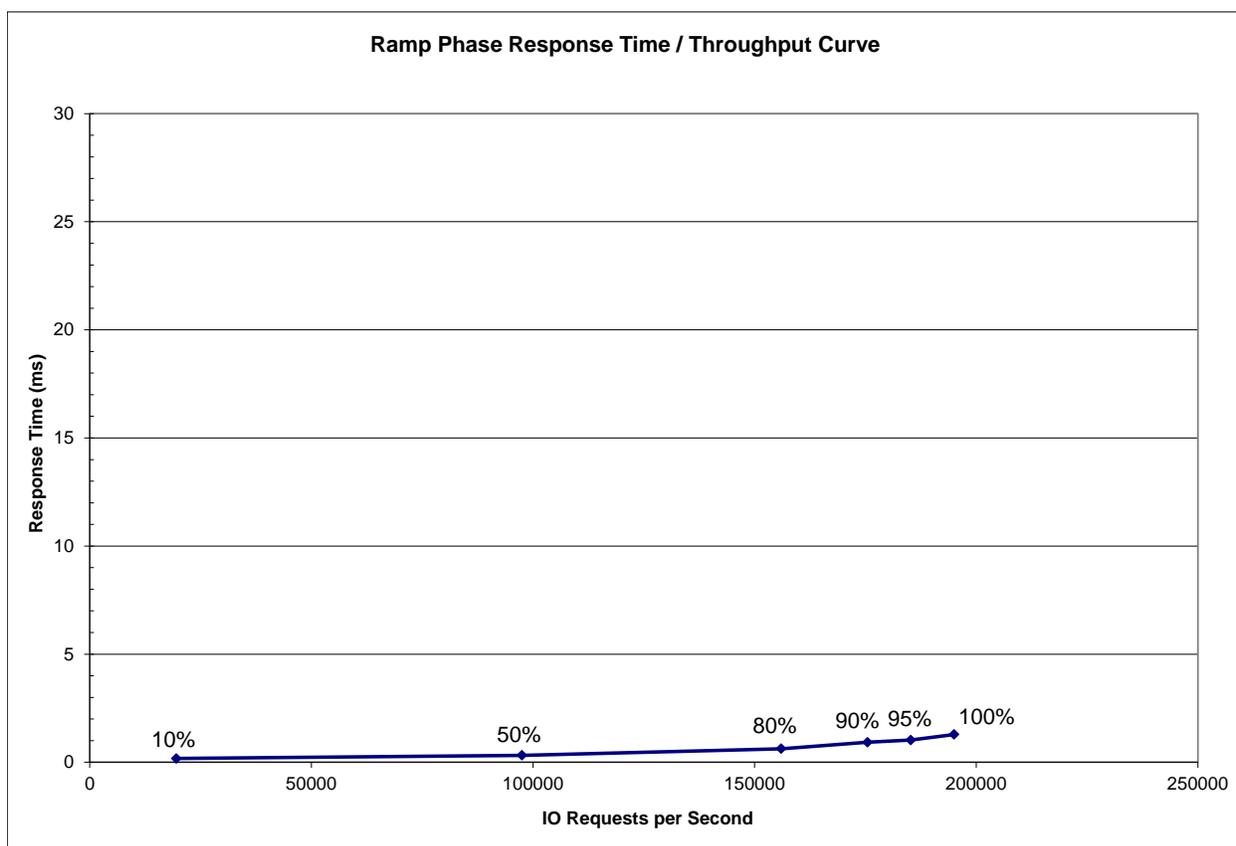
**Unused Storage Ratio:** Total Unused Capacity (9,126.939 GB) divided by Physical Storage Capacity (24,673.041 GB) and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 22-23 in the Full Disclosure Report.

## Response Time – Throughput Curve

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

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



## Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
<b>I/O Request Throughput</b>	19,512.06	97,504.04	156,026.23	175,489.82	185,250.57	195,021.70
<b>Average Response Time (ms):</b>						
<b>All ASUs</b>	0.18	0.32	0.63	0.92	1.02	1.29
<b>ASU-1</b>	0.19	0.36	0.69	0.96	1.04	1.22
<b>ASU-2</b>	0.19	0.35	0.64	0.89	0.98	1.17
<b>ASU-3</b>	0.15	0.22	0.48	0.86	1.02	1.48
<b>Reads</b>	0.24	0.50	0.94	1.20	1.27	1.39
<b>Writes</b>	0.13	0.20	0.42	0.74	0.86	1.22

## SPC-1/E Reported Data

The initial SPC-1/E energy extension temperature, recorded during the first one minute of the Idle Test was 72F. The final SPC-1/E energy extension temperature, recorded during the last one minute of the Primary Metrics Test was 71F.

Power Environment							
Average RMS Voltage:				Average Power Factor:			
199.71				0.968			
Usage Profile							
	Hours of Use per Day			Nominal Power, W	Nominal Traffic, IOPS	Nominal IOPS/W	Nominal Heat, BTU/hr
	Heavy	Moderate	Idle				
Low Daily Usage:	0	8	16	330.81	32501.35	98.25	1,128.76
Medium Daily Usage:	4	14	6	346.94	82881.73	238.90	1,183.78
High Daily Usage:	18	6	0	365.77	141395.68	386.57	1,248.05
Composite Metrics:				347.84	85,592.92	246.07	
Annual Energy Use, kWh:				3,047.07			
Energy Cost, \$/kWh:				\$ 0.12			
				Annual Energy Cost, \$: \$ 365.65			

The above usage profile describes conditions in environments that respectively impose light (“low”), moderate (“medium”), and extensive (“high”) demands on the Tested Storage Configuration (TSC).

**HEAVY SPC-1 Workload:** 370.51W at 80% of maximum reported performance (*156,026.23 SPC-1 IOPS*).

**MODERATE SPC-1 Workload:** 351.56W at 50% of maximum reported performance (*97,504.04 SPC-1 IOPS*).

**IDLE SPC-1 Workload:** 320.44W at 0% of maximum reported performance (*0.00 SPC-1 IOPS*).

**AVERAGE RMS VOLTAGE:** The average supply voltage applied to the Tested Storage Product (TSP) as measured during the Measurement Intervals of the SPC-1/E Tests.

**AVERAGE POWER FACTOR:** The ratio of average real power, in watts, to the average apparent power, in volt-amperes flowing into the Tested Storage Product (TSP) during the Measurement Intervals of the SPC-1/E Tests.

**NOMINAL POWER, W:** The average power consumption over the course of a day (*24 hours*), taking into account hourly load variations.

**NOMINAL TRAFFIC, IOPS:** The average level of I/O requests over the course of a day (*24 hours*), taking into account hourly load variations.

**NOMINAL IOPS/W:** The overall efficiency with which I/O requests can be supported, reflected by the ratio of **NOMINAL TRAFFIC** versus the **NOMINAL POWER**.

**NOMINAL HEAT, BTU/HR:** The average amount of heat required to be dissipated over the course of a day (*24 hours*), taking into account hourly load variations. (*1 watt = 3.412 BTU/hr*)

**COMPOSITE METRICS:** The aggregated **NOMINAL POWER**, **NOMINAL TRAFFIC**, and **NOMINAL IOPS/W** for all three environments: **LOW**, **MEDIUM**, and **HIGH DAILY USAGE**.

**ANNUAL ENERGY USE, KWH:** An estimate of the average energy use across the three environments over the course of a year and computed as (**NOMINAL POWER** \* 24 \* 0.365).

**ENERGY COST, \$/KWH:** A standardized energy cost per kilowatt hour.

**ANNUAL ENERGY COST:** An estimate of the annual energy use across the three environments over the course of a year and computed as (**ANNUAL ENERGY USE** \* **ENERGY COST**).

## SPC-1/E Power/Performance Profile

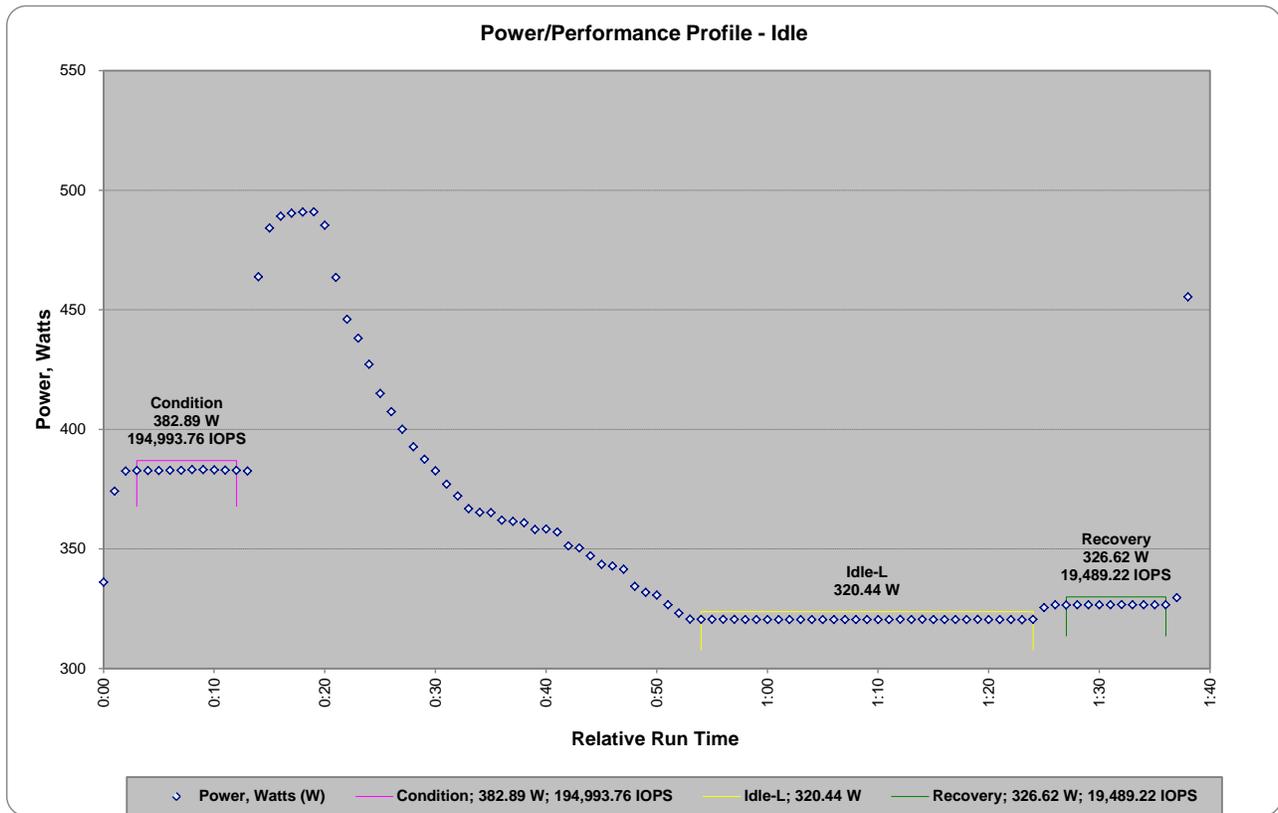
The following four SPC-1/E Power/Performance Profile charts provide a complete “at a glance” illustration and report for each SPC-1/E execution component. The power consumption at each step is reported and, where appropriate the measured SPC-1 performance (*SPC-1 IOPS™*) is also reported.

The **Load Level** value in the table represents the percentage of the maximum, specified offered load that was used for a specific execution component. Each **Execution Component** entry includes the acronym, in parenthesis, which is used in the corresponding chart to identify the execution component.

### SPC-1/E Power/Performance Profile Data

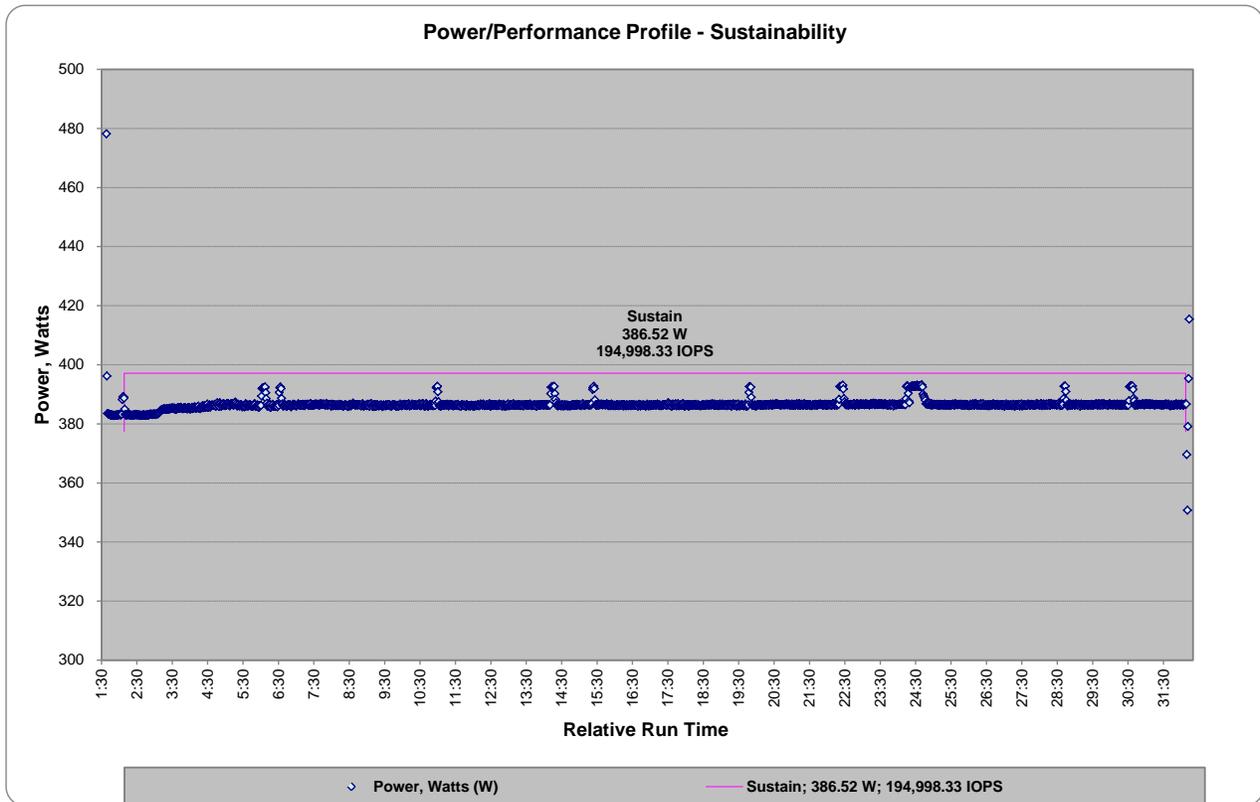
Execution Component	Load Level	SPC-1 IOPS™	Power (W)
Idle – Conditioning ( <i>Condition</i> )	100%	194,993.76	382.89
Idle ( <i>Idle-L</i> )	0%		320.44
Idle - Recovery ( <i>Recovery</i> )	10%	19,489.22	326.62
Sustainability ( <i>Sustain</i> )	100%	194,998.33	386.52
IOPS ( <i>100%</i> )	100%	195,021.70	382.82
Ramp95 ( <i>95%</i> )	95%	185,250.57	379.58
Ramp90 ( <i>90%</i> )	90%	175,489.82	379.00
Ramp80 ( <i>80%</i> )	80%	156,026.23	370.51
Ramp50 ( <i>50%</i> )	50%	97,504.04	351.56
Ramp10 ( <i>10%</i> )	10%	19,512.06	216.98
Repeat1 LRT ( <i>10%</i> )	10%	19,502.67	327.07
Repeat1 IOPS ( <i>100%</i> )	100%	194,990.44	382.61
Repeat2 LRT ( <i>10%</i> )	10%	19,499.14	327.05
Repeat2 IOPS ( <i>100%</i> )	100%	194,933.08	382.87

### Power/Performance Profile – Idle Test



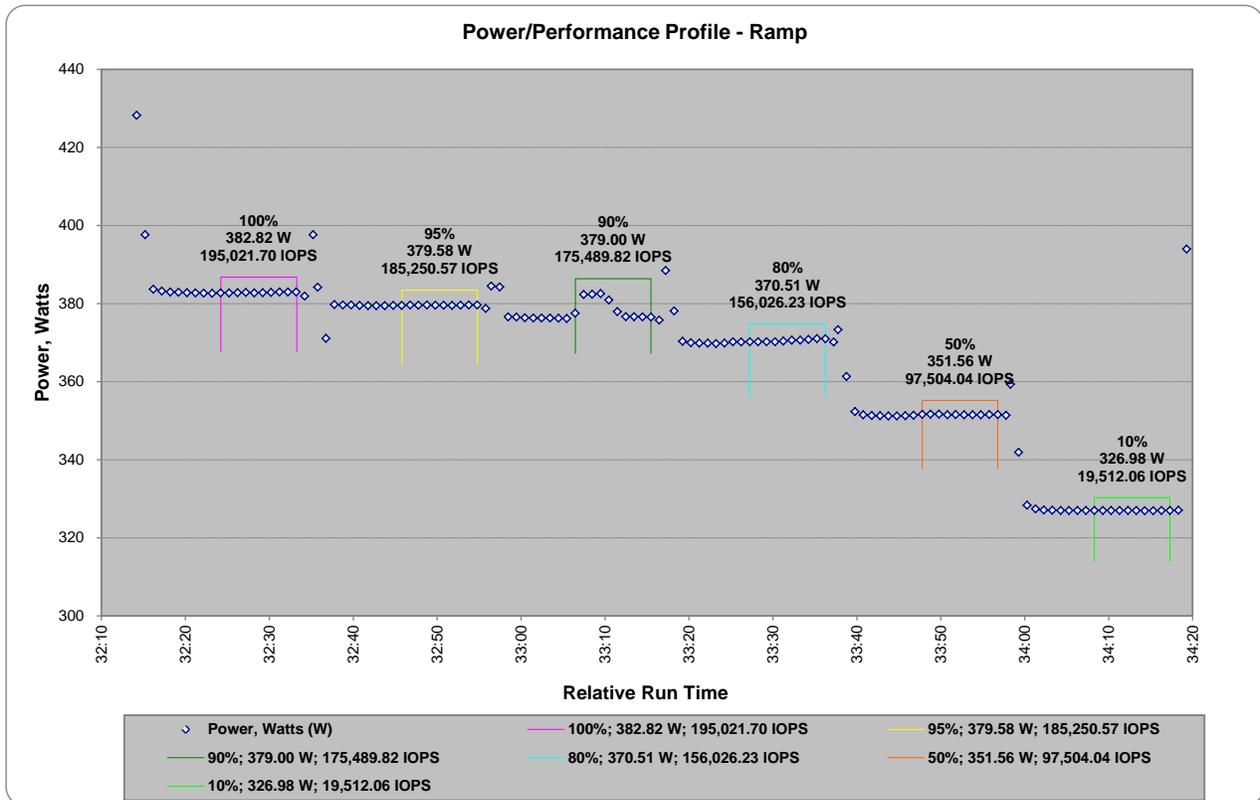
Execution Component	Load Level	SPC-1 IOPS™	Power (W)
Idle – Conditioning ( <b>Condition</b> )	100%	194,993.76	382.89
Idle ( <b>Idle-L</b> )	0%	0.00	320.44
Idle - Recovery ( <b>Recovery</b> )	10%	19,489.22	326.62

**Power/Performance Profile – Sustainability Test Run**



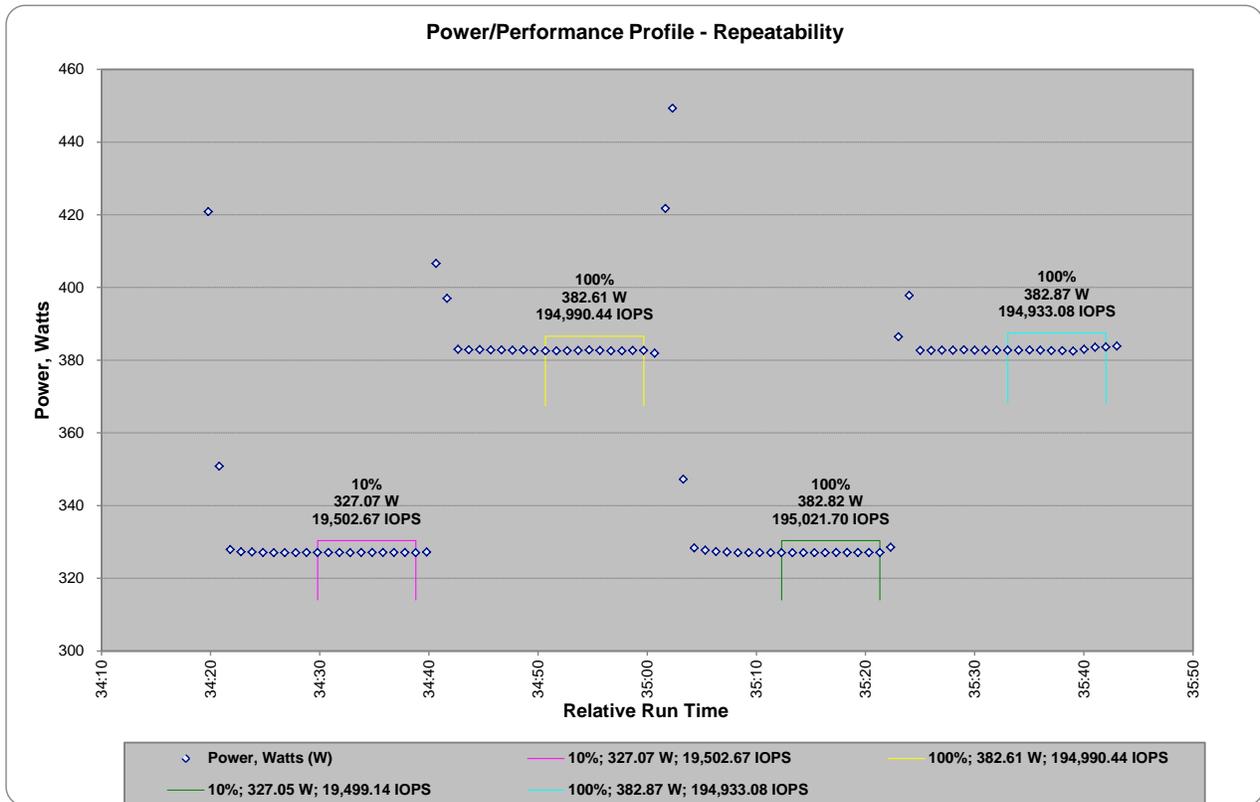
Execution Component	Load Level	SPC-1 IOPS™	Power (W)
Sustainability ( <i>Sustain</i> )	100%	194,998.33	386.52

**Power/Performance Profile – IOPS and Response Time Ramp Test Runs**



Execution Component	Load Level	SPC-1 IOPS™	Power (W)
IOPS (100%)	100%	195,021.70	382.82
Ramp95 (95%)	95%	185,250.57	379.58
Ramp90 (90%)	90%	175,489.82	379.00
Ramp80 (80%)	80%	156,026.23	370.51
Ramp50 (50%)	50%	97,504.04	351.56
Ramp10 (10%)	10%	19,512.06	216.98

**Power/Performance Profile – Repeatability Test (two phases)**



Execution Component	Load Level	SPC-1 IOPS™	Power (W)
Repeat1 LRT (10%)	10%	19,502.67	327.07
Repeat1 IOPS (100%)	100%	194,990.44	382.61
Repeat2 LRT (10%)	10%	19,499.14	327.05
Repeat2 IOPS (100%)	100%	194,933.08	382.87

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

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

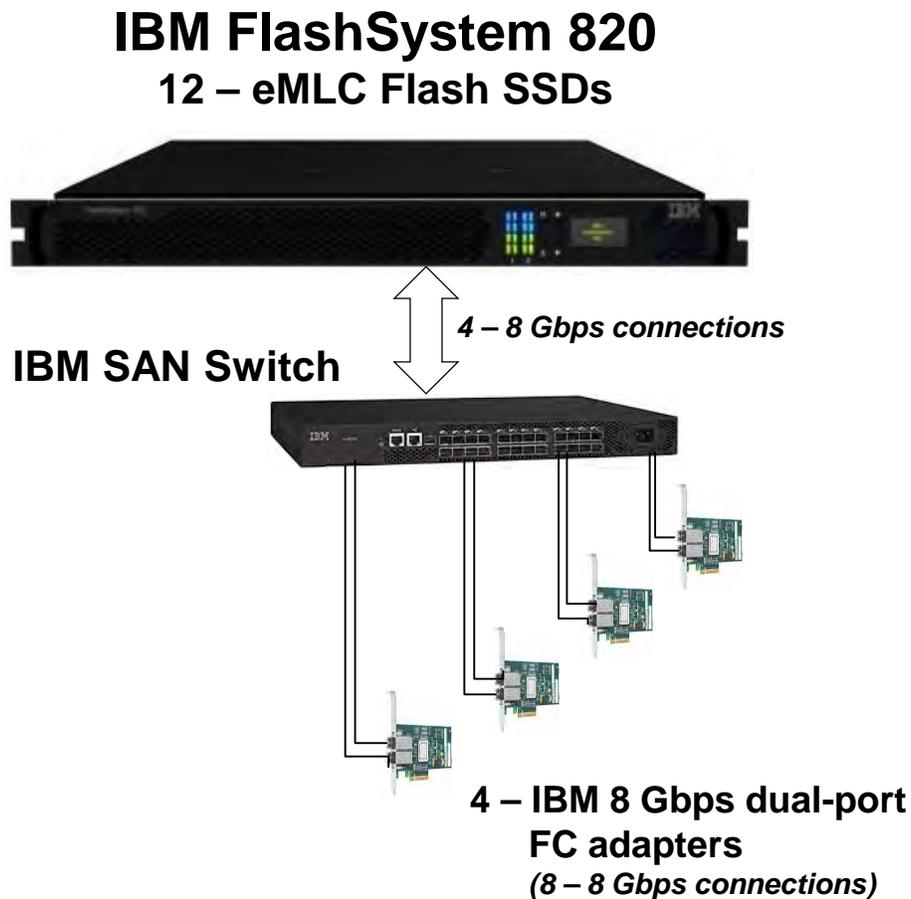
## Priced Storage Configuration Pricing

Component	Quantity	Unit Price	Unit Maint	List w/ Maint	% discount	Total Price
FlashSystem 820 (9831-AE2) w/ 4 SFPs, 1 year warranty included	1	16,000.00	40,608.00	56,608.00	30	39,625.60
eMLC 12-pack (9831-AF0F) 12 max capacity flash cards	1	331,000.00	0.00	331,000.00	30	231,700.00
24 port fibre channel switch (2498-B24) w/ 16 SFPs, 16 ports enabled	1	10,750.00	10,800.00	21,550.00	20	17,240.00
5m fibre channel cable (9831-3701)	12	75.00	0.00	900.00	30	630.00
8 Gbps dual port FC adapter (9117-5735)	4	4,583.00	0.00	18,332.00	30	12,832.40
<b>Total Price</b>						<b>302,028.00</b>

The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- Acknowledgement of new and existing problems with four (4) hours.
- Onsite presence of a qualified maintenance engineer or provision of a customer replaceable part within four (4) hours of the above acknowledgement for any hardware failure that results in an inoperative Priced Storage Configuration that can be remedied by the repair or replacement of a Priced Storage Configuration component.

**Priced Storage Configuration Diagram**



**Priced Storage Configuration Components**

<b>Priced Storage Configuration</b>
4 – IBM 8 Gbps dual-port FC adapters
1 – IBM SAN 24 port switch <i>(16 ports enabled w/16 SFPs)</i>
<b>IBM FlashSystem 820</b>
Dual controllers
4 – 8 Gbps FC front-end connections <i>(w/4 SFPs)</i> <i>(4 connections used)</i>
40 – SAMNet backend lanes available and used <i>(proprietary interconnect similar to PCIe)</i>
12 – eMLC Flash SSDs