



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

**IBM CORPORATION
IBM SYSTEM STORAGE™ EXP 12S**

SPC-1C/E™ V1.3

**Submitted for Review: June 3, 2009
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EXECUTIVE SUMMARY

Test Sponsor and Contact Information

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Revision Information and Key Dates

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SPC-1C/E Specification revision number	V1.3
SPC-1C Workload Generator revision number	V1.0
Date Results were first used publicly	June 3, 2009
Date the FDR was submitted to the SPC	June 3, 2009
Date the TSC is available for shipment to customers	May 22, 2009
Date the TSC completed audit certification	June 2, 2009

Tested Storage Product (TSP) Description

The IBM System Storage EXP 12S is a high-density 2U, 19-inch rack-mountable disk drive enclosure which expands disk capacity on a POWER6 processor-based server. It offers:

- Modular SAS disk expansion drawer.
- Up to twelve hot-swappable 3.5 inch SAS disk drives.
- A variety of supported connection options.
- Redundant hot-plug power and cooling.
- Redundant and hot-swappable SAS expanders.

This SPC-1C/E Result demonstrates the new ability of the IBM System Storage™ EXP 12S, available as of May 22, 2009, to incorporate up to 8 solid state devices.

Summary of Results

SPC-1C Results	
Tested Storage Product: IBM System Storage™ EXP 12S	
Metric	Reported Result
SPC-1C IOPS™	45,000.20
Total ASU Capacity	547.608 GB
Data Protection Level	Unprotected
Total Price – Priced Storage Configuration	\$87,468.35

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

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

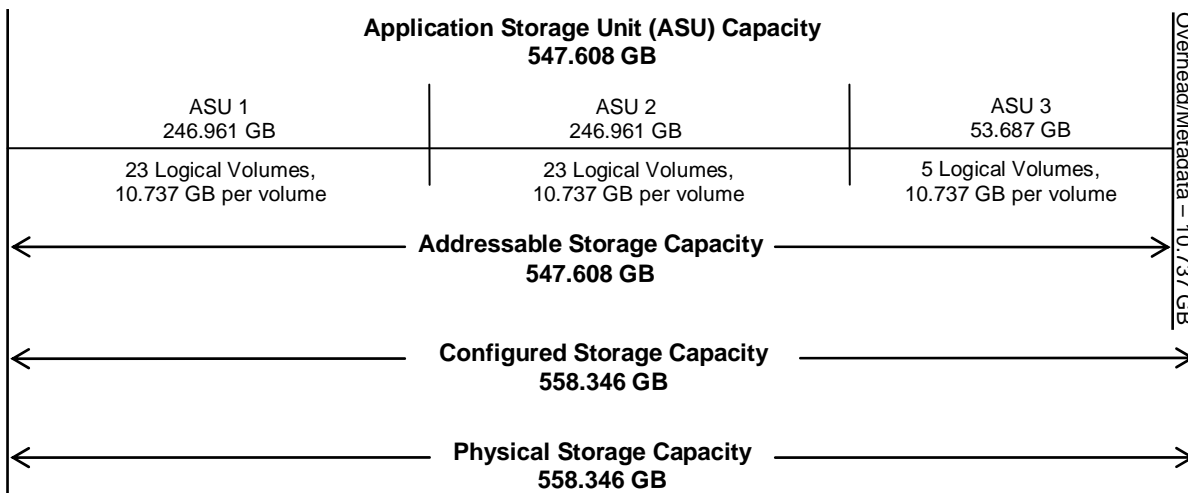
A **Data Protection Level** of **UNPROTECTED** makes no claim of data protection in the event of a single point of failure.

Storage Capacities and Relationships

The Tested Storage Configuration (TSC) must be configured so that there is either no Unused Storage or that the sum of Total ASU Capacity and storage required for data protection equals 50% (+-1 GiB) of the Physical Storage Capacity. This configuration meets the “no Unused Storage” requirement as documented below:

$$\begin{aligned}
 &558.346 \text{ GB (Physical Storage Capacity)} \\
 &547.608 \text{ GB (Total ASU Capacity)} + 0.000 \text{ GB (data protection)} \\
 &\quad + 10.737 \text{ GB (metadata/overhead)} = 558.346 \text{ GB}
 \end{aligned}$$

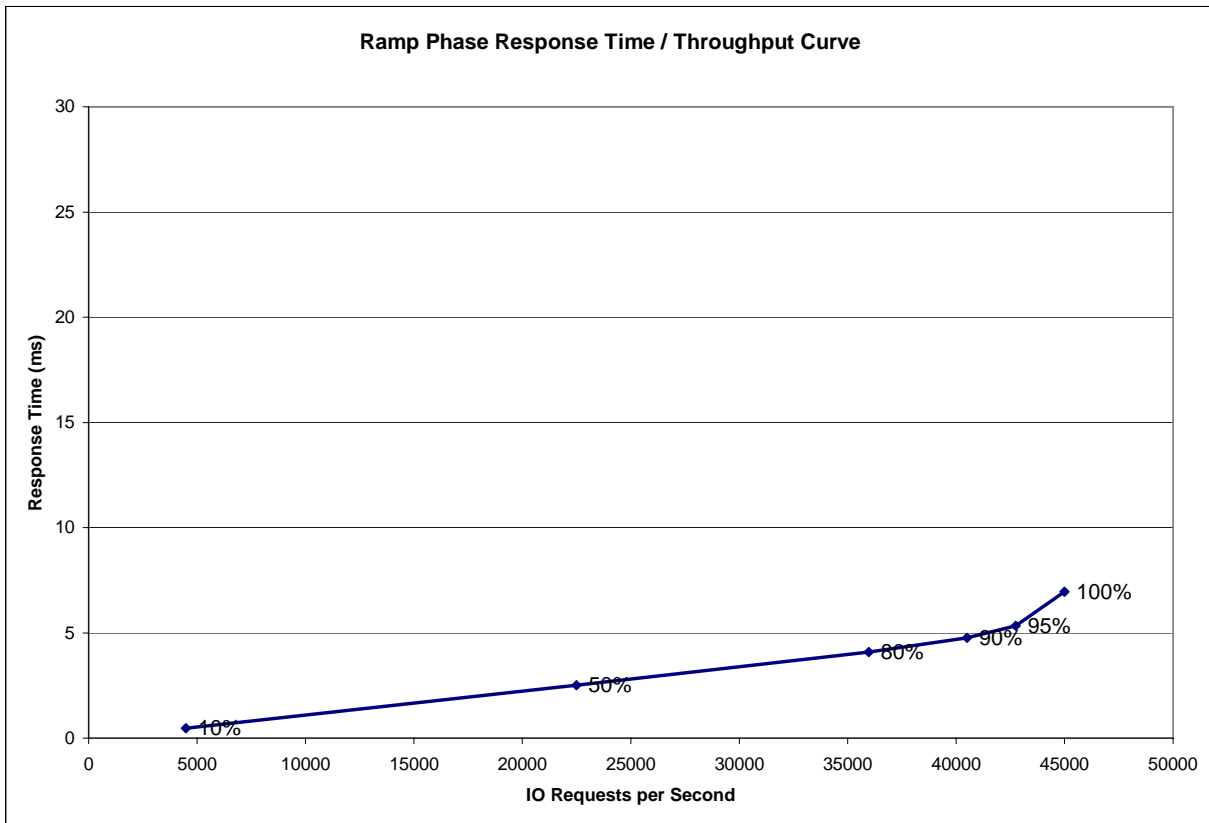
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



Response Time – Throughput Curve

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

The Average Response Time measured at 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
I/O Request Throughput	4,497.09	22,496.89	35,969.55	40,491.46	42,745.04	45,000.20
Average Response Time (ms):						
All ASUs	0.46	2.51	4.10	4.76	5.33	6.95
ASU-1	0.52	2.69	4.37	5.07	5.65	7.23
ASU-2	0.54	2.81	4.49	5.17	5.74	7.34
ASU-3	0.31	1.99	3.33	3.92	4.47	6.16
Reads	0.75	3.41	5.43	6.26	6.89	8.53
Writes	0.28	1.93	3.22	3.79	4.31	5.91

SPC-1C/E Reported Data

	Usage Profile					
	Hours of Use per Day			Nominal Power, W	Nominal Traffic, IOPS	Nominal IOPS/W
	Heavy	Moderate	Idle			
Low Daily Usage:	0	8	16	161.50	7498.96	46.43
Medium Daily Usage:	4	14	6	162.64	19118.11	117.55
High Daily Usage:	18	6	0	164.01	32601.39	198.77
Composite Metrics:				162.72	19,739.49	121.31
Annual Energy Use, kWh:	1,425.41					
Energy Cost, \$/kWh:	\$ 0.12			Annual Energy Cost, \$:	\$ 171.05	

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-1C Workload: 164.37W at 80% of maximum reported performance (*35,969.55 SPC-1C IOPS*).

MODERATE SPC-1C Workload: 162.94W at 50% of maximum reported performance (*22,496.89 SPC-1C IOPS*).

IDLE SPC-1C Workload: 160.78W at 0% of maximum reported performance (*0.00 SPC-1C IOPS*).

LOW DAILY USAGE: Zero (0) hours of **HEAVY** SPC-1C Workload, eight (8) hours of **MODERATE** SPC-1C Workload, and sixteen (16) hours of **IDLE** SPC-1C Workload.

MEDIUM DAILY USAGE: Four (4) hours of **HEAVY** SPC-1C Workload, fourteen (14) hours of **MODERATE** SPC-1C Workload, and six (6) hours of **IDLE** SPC-1C Workload.

HIGH DAILY USAGE: Eighteen (18) hours of **HEAVY** SPC-1C Workload, six (6) hours of **MODERATE** SPC-1C Workload, and zero (0) hours of **IDLE** SPC-1C Workload.

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**.

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

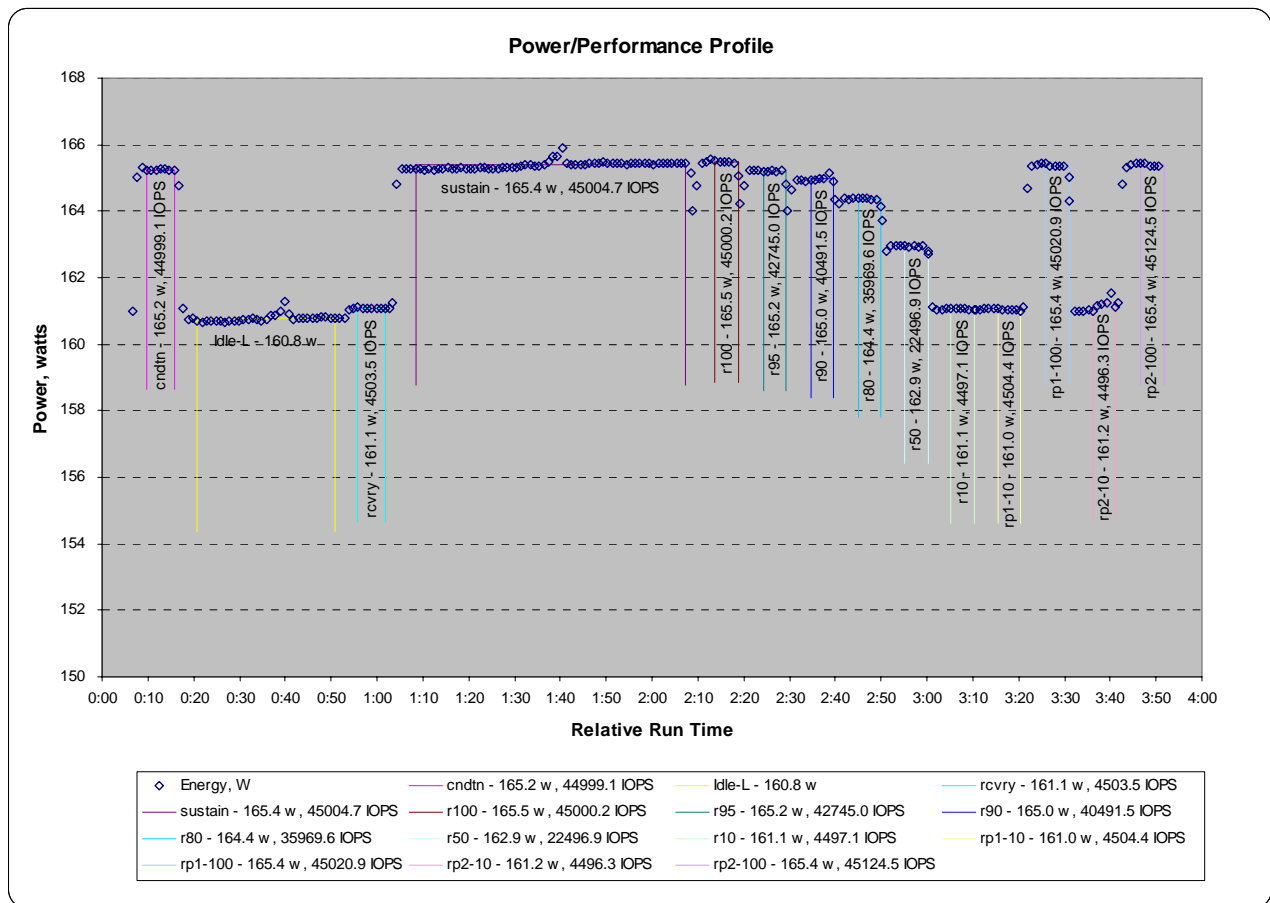
ANNUAL ENERGY USE, kWh: An estimate of the average energy use across the three environments over the course of a year and computed as (**NOMINAL POWER** * 24 * 0.365).

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-1C/E Power/Performance Profile

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



Tested Storage Configuration Pricing (*Priced Storage Configuration*)

Product	Description	quantity	Unit Price	Unit Maint per month	Extended Price	Extended Maint
9117-MMA	Power 570 host processor					
5886	EXP12S expansion drawer	1	4,500.00	200.00	4,500.00	\$4,800.00
3586	69 GB 3.5in SAS Solid State Drive	8	10,000.00	90.00	80,000.00	\$17,280.00
5904	PCI-X DDR 1.5 GB cache SAS RAID Adapter	1	8,500.00		8,500.00	\$0.00
6671	Power cord (drawer to IBM PDU), 250V/10A	1	28.00		28.00	\$0.00
3692	SAS Cable (YO), Adapter to SAS Enclosure	1	110.00		110.00	\$0.00
	Total Extended				93,138.00	\$22,080.00
	Discount				28.00%	7.57%
	Total Price w/ maintenance					\$87,468.35

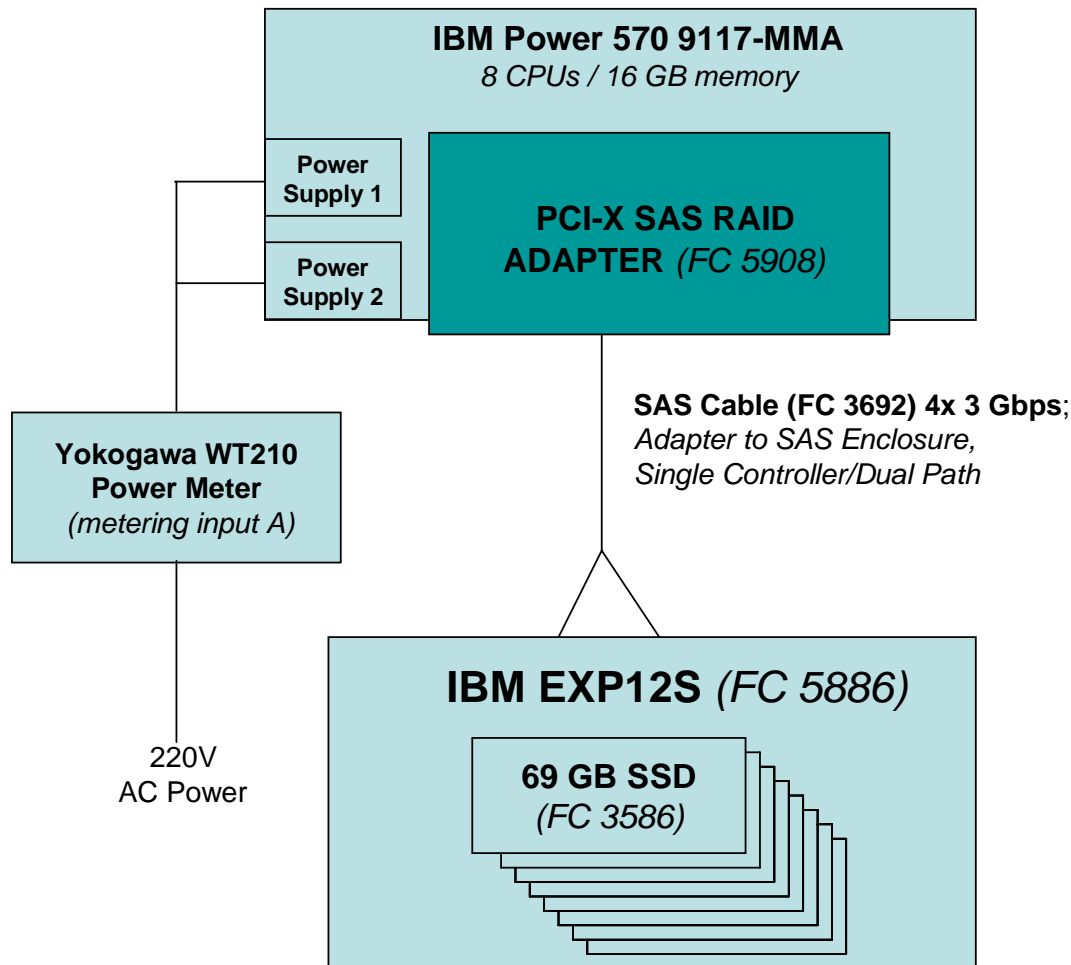
The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- Acknowledgement of new and existing problems with four (4) hours.
- Onsite present 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 Price Storage Configuration that can be remedied by the repair or replacement of a Priced Storage Configuration component.

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

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

Benchmark Configuration/Tested Storage Configuration Diagram



Benchmark Configuration/Tested Storage Configuration Components

Host System:	Tested Storage Configuration (TSC):
IBM Power 570 9117 MMA 8 – 4.2 GHz Power 6 CPUs 8 MB L2 cache per 2 CPUs 32 MB L3 cache per 2 CPUs	1 – PCI-X SAS RAID adapter with 1.5 GB cache
16 GB main memory	1 – SAS cable that provides one adapter connection and two drive enclosure connections
AIX 6.2 TL02	1 – EXP12S expansion drawer
PCI-X	8 – 69 GB 3.5" SAS Solid State Drive (SSD)
Other BC Components	
1 – Yokogawa WT210 Digital Power Meter	