



SPC Benchmark 1C/Energy™ (SPC-1C/E™)

Storage Component Benchmark with Energy Use Extension

<http://www.StoragePerformance.org>

SPCadmin@StoragePerformance.org



SPC Benchmark 1C/Energy™

- SPC Benchmark 1C/Energy™ (*SPC-1C/E™*) is an extension to the first storage component benchmark, SPC Benchmark 1C™ (*SPC-1C™*).
- SPC-1C/E was publicly announced on June 3, 2009. IBM and Seagate were the first SPC member companies to submit results at that time.
- SPC-1C/E consists of the complete set of SPC-1C performance measurements and reporting, combined with the measurement and reporting of energy use.



SPC Benchmark 1C (SPC-1C)

- SPC-1C is based on the SPC-1 specification and utilizes the SPC-1 workload.
- SPC-1C reporting requirements are similar to SPC-1.
- Storage component vendors comprise the primary producer audience for SPC-1C.
- Storage solution providers (*vendors, resellers, etc.*), as well as end users, are the primary consumer audiences for SPC-1C.



SPC-1C Configurations

- SPC-1C configurations consist of the following two components:
 - One or more HBAs/Controllers (single/dual/quad...).
 - One of the following storage device configurations:
 - One, two, or four storage devices in a “standalone” configuration.
 - » An external enclosure may be used but only to provide power and/or connectivity for the storage devices.
 - A Small Storage Subsystem may include a maximum of forty-eight (48) storage devices in no larger than a 4U enclosure profile (*1 – 4U, 2 – 2U, 4 – 1U, etc.*)



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- SPC Benchmark 1C/Energy (*SPC-1C/E*) is the first SPC benchmark to include measurement and reporting of energy use in addition to storage performance.
- The SPC-1C/E is only applicable to Small Storage Subsystem configurations as previously described on page 4.



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- In addition to the “core” SPC-1C performance measurement and reporting requirements, SPC-1C/E defines:
 - Configuration and instrumentation requirements for energy usage measurement
 - Execution requirements for application idle state measurements and the transition into active (*performance*) state measurements
 - Data collection requirements for energy use measurements
 - Expanded disclosure and audit requirements



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- The storage configuration's energy use is measured and reported.
 - Measurements are taken during both application idle and active states of the benchmark execution.
 - Multiple application idle phases are allowed.
 - The active (*performance*) state consists of performance Test Runs, identical to SPC-1C.
- SPC-1C/E energy use results cannot be reported without the corresponding SPC-1C/E performance results.



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□ SPC-1C/E execution profile:

- A 10 minute “precondition” phase at 100% of the specified performance offered load.
- An application idle phase lasting at least 30 minutes with one or more distinct phases.
- Each application idle phase may be preceded by an optional transition period not to exceed 3 minutes.
- A second 10 minute “precondition” phase at 10% of the specified performance offered load.
- Execution of the current SPC-1C Tests:
*Metrics (Sustainability, IOPS, Response Time Ramp),
Repeatability, and Persistence (energy use measurements are
not taken during the Persistence Test)*



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□ SPC-1C/E application idle phases:

- More than one idle phase is allowed as long as transitions between idle phases do not require manual intervention.

Idle Phase 0, Idle Phase 1...Idle Phase L-1, Idle Phase L

- Idle Phase 0 thru Idle Phase L-1 must have the same duration, selected by the Test Sponsor, up to a maximum of 10 minutes.
- Idle Phase L (“deepest” idle state) duration is selected by the Test Sponsor with a minimum of 30 minutes.
- The simplest Idle Test consists of a single idle phase with a duration of 30 minutes.



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- SPC-1C/E Reported Data includes multiple energy use metrics:
 - Across several selected environments
 - Taking into account hourly variations in I/O load
- This reported data will allow an estimate of average annual energy use.
- The SPC-1C/E required table and graph lists and illustrates storage performance and energy use for each performance test.



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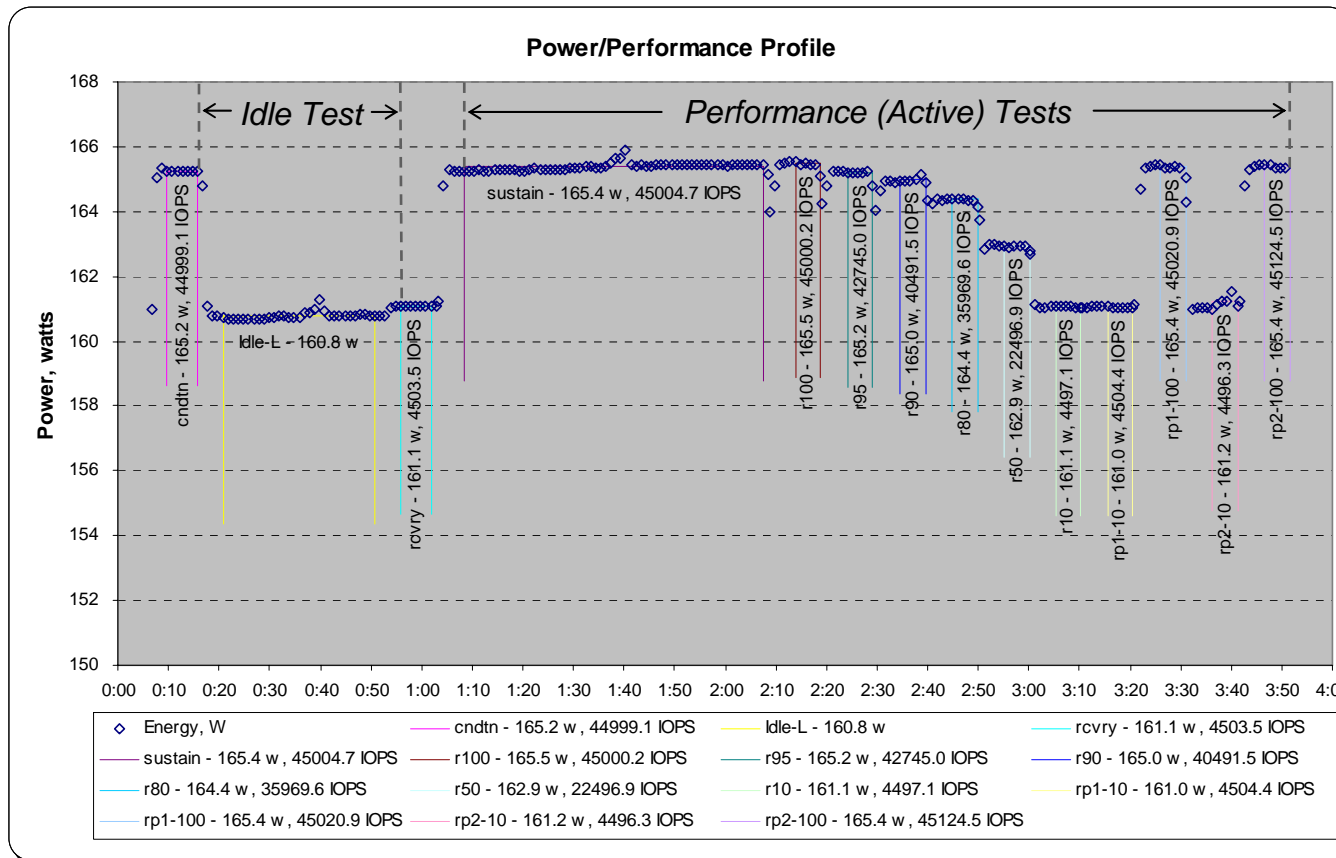
- An example of SPC-1C/E Reported Data:

	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	



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- Example of SPC-1C/E required graph (corresponds to the earlier Reported Data example):





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□ Example of SPC-1C/E required table (used for the earlier SPC-1C/E required graph example):

Relative Time	Time	Run Name	Energy, W	Voltage, V	Current, A							
0:06:44	16:46:44	Conditioning	160.97	202.52	0.9057	0:52:51	17:32:51	Recovery	160.80	203.46	0.9019	
0:07:44	16:47:44	Conditioning	165.02	202.51	0.9246	0:53:51	17:33:51	Recovery	161.04	203.39	0.9033	
0:08:44	16:48:44	Conditioning	165.33	202.67	0.9255	0:54:51	17:34:51	Recovery	161.09	203.36	0.9036	
0:09:44	16:49:44	Conditioning	165.25	202.67	0.9251	0:55:51	17:35:51	Recovery	161.11	203.34	0.9036	
0:10:44	16:50:44	Conditioning	165.23	202.58	0.9253	0:56:51	17:36:51	Recovery	161.09	203.35	0.9036	
0:11:44	16:51:44	Conditioning	165.25	202.57	0.9255	0:57:51	17:37:51	Recovery	161.09	203.38	0.9036	
0:12:44	16:52:44	Conditioning	165.26	202.63	0.9254	0:58:51	17:38:51	Recovery	161.08	203.37	0.9035	
0:13:44	16:53:44	Conditioning	165.26	202.60	0.9254	0:59:51	17:39:51	Recovery	161.06	203.33	0.9035	
0:14:44	16:54:44	Conditioning	165.24	202.62	0.9252	1:00:51	17:40:51	Recovery	161.08	203.26	0.9038	
0:15:44	16:55:44	Conditioning	165.23	202.65	0.9251	1:01:51	17:41:51	Recovery	161.08	203.17	0.9041	
0:16:44	16:56:44	Startup Idle-L	164.77	202.72	0.9228	1:02:51	17:42:51	RunOut	161.06	203.12	0.9041	
0:17:44	16:57:44	Startup Idle-L	161.06	202.77	0.9056	1:03:24	17:43:24	Startup Sustainabiliy	161.24	203.12	0.9049	
0:18:44	16:58:44	Startup Idle-L	160.76	202.65	0.9046	1:04:24	17:44:24	Startup Sustainabiliy	164.80	203.18	0.9213	
0:19:44	16:59:44	Startup Idle-L	160.77	202.43	0.9052	1:05:24	17:45:24	Startup Sustainabiliy	165.29	203.27	0.9234	
0:20:51	17:00:51	Idle-L	160.72	203.50	0.9016	1:06:24	17:46:24	Startup Sustainabiliy	165.26	203.22	0.9233	
0:21:51	17:01:51	Idle-L	160.67	203.84	0.9002	1:07:24	17:47:24	Startup Sustainabiliy	165.26	203.13	0.9235	
0:22:51	17:02:51	Idle-L	160.69	203.81	0.9003	1:08:24	17:48:24	Sustainability	165.26	203.19	0.9233	
0:23:51	17:03:51	Idle-L	160.68	203.74	0.9005	1:09:24	17:49:24	Sustainability	165.25	203.27	0.9232	
0:24:51	17:04:51	Idle-L	160.69	203.70	0.9006	1:10:24	17:50:24	Sustainability	165.23	203.31	0.9230	
0:25:51	17:05:51	Idle-L	160.70	203.64	0.9007	1:11:24	17:51:24	Sustainability	165.28	203.27	0.9233	
0:26:51	17:06:51	Idle-L	160.67	203.59	0.9006	1:12:24	17:52:24	Sustainability	165.25	203.28	0.9232	
0:27:51	17:07:51	Idle-L	160.70	203.60	0.9007	1:13:24	17:53:24	Sustainability	165.26	203.30	0.9233	
0:28:51	17:08:51	Idle-L	160.70	203.66	0.9005	1:14:24	17:54:24	Sustainability	165.29	203.24	0.9236	
0:29:51	17:09:51	Idle-L	160.72	203.77	0.9003	1:15:24	17:55:24	Sustainability	165.30	203.20	0.9237	
0:30:51	17:10:51	Idle-L	160.73	203.76	0.9005	1:16:24	17:56:24	Sustainability	165.29	203.17	0.9237	
0:31:51	17:11:51	Idle-L	160.76	203.68	0.9008	1:17:24	17:57:24	Sustainability	165.28	203.17	0.9236	
0:32:51	17:12:51	Idle-L	160.76	203.68	0.9008	1:18:24	17:58:24	Sustainability	165.31	203.11	0.9238	
0:33:51	17:13:51	Idle-L	160.75	203.63	0.9009	1:19:24	17:59:24	Sustainability	165.26	203.10	0.9235	
0:34:51	17:14:51	Idle-L	160.72	203.66	0.9007	1:20:24	18:00:24	Sustainability	165.26	203.25	0.9232	
0:35:51	17:15:51	Idle-L	160.75	203.69	0.9008	1:21:24	18:01:24	Sustainability	165.29	203.45	0.9229	
0:36:51	17:16:51	Idle-L	160.86	203.66	0.9013	1:22:24	18:02:24	Sustainability	165.32	203.42	0.9232	
0:37:51	17:17:51	Idle-L	160.89	203.65	0.9015	1:23:24	18:03:24	Sustainability	165.31	203.43	0.9232	
0:38:51	17:18:51	Idle-L	161.00	203.72	0.9020	1:24:24	18:04:24	Sustainability	165.29	203.47	0.9230	
0:39:51	17:19:51	Idle-L	161.28	203.78	0.9031	1:25:24	18:05:24	Sustainability	165.29	203.48	0.9229	
0:40:51	17:20:51	Idle-L	160.92	203.70	0.9017	1:26:24	18:06:24	Sustainability	165.29	203.47	0.9229	
0:41:51	17:21:51	Idle-L	160.76	203.64	0.9011	1:27:24	18:07:24	Sustainability	165.31	203.54	0.9228	
0:42:51	17:22:51	Idle-L	160.77	203.60	0.9012	1:28:24	18:08:24	Sustainability	165.31	203.56	0.9228	
0:43:51	17:23:51	Idle-L	160.78	203.55	0.9013	1:29:24	18:09:24	Sustainability	165.33	203.51	0.9230	
0:44:51	17:24:51	Idle-L	160.80	203.56	0.9015	1:30:24	18:10:24	Sustainability	165.33	203.52	0.9230	
0:45:51	17:25:51	Idle-L	160.79	203.63	0.9015	1:31:24	18:11:24	Sustainability	165.35	203.48	0.9232	
0:46:51	17:26:51	Idle-L	160.79	203.58	0.9015	1:32:24	18:12:24	Sustainability	165.38	203.48	0.9234	
0:47:51	17:27:51	Idle-L	160.82	203.55	0.9018	1:33:24	18:13:24	Sustainability	165.38	203.52	0.9233	
0:48:51	17:28:51	Idle-L	160.82	203.52	0.9019	1:34:24	18:14:24	Sustainability	165.35	203.53	0.9230	
0:49:51	17:29:51	Idle-L	160.78	203.44	0.9019	1:35:24	18:15:24	Sustainability	165.36	203.53	0.9230	
						1:36:24	18:16:24	Sustainability	165.39	203.59	0.9231	



SPC Benchmark 1C/Energy™

- SPC-1C/E future investigations and development activity under consideration:
 - Energy use extension for SPC-2C
 - Extending energy use measurement and reporting to SPC-1/SPC-2 (*larger configurations*)
 - An end-user tool to 'customize/localize' SPC-1C/E Reported Data to specific end user environments



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□ SPC-1C/E future investigations/development:

- Energy use extension for SPC-2C
 - Will begin testing in 3-4 weeks to determine which of the three SPC-2C workloads (Large File Processing, Large Database Query, and Video on Demand) would be appropriate for inclusion in an energy use extension.
- Extending energy use measurement and reporting to SPC-1/SPC-2 (*larger configurations*)
 - Initial direction under discussion: SPC-1 configurations that can be measured with a single power meter, which may include multiple power inputs.



SPC-1C/E End-User Tool

- An SPC-1C/E end-user tool is under investigation, which would allow “customization/localization” of SPC-1C/E Reported Data by:
 - Allowing the end-user to change values in the “Hours of Use per Day” matrix to reflect actual or projected values..
 - Use local energy cost for calculating “Annual Energy Use (*kWh*).



SPC-1C/E End-User Tool

- The end-user may only change the values highlighted in **red**, which will reflect actual or projected usage values. All other values are either calculated by the tool or extracted by the tool from the SPC-1C/E Result of interest.

	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
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Annual Energy Use, kWh:	1,425.41					
Energy Cost, \$/kWh:	\$ 0.12			Annual Energy Cost, \$:	\$ 171.05	