SNIA Green Storage Power Measurement Technical Specification

WORKING DRAFT

Version 0.0.18

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Publication of this Working Draft for review and comment has been approved by the Green TWG. This draft represents a "best effort" attempt by the Green TWG to reach preliminary consensus, and it may be updated, replaced, or made obsolete at any time. This document should not be used as reference material or cited as other than a "work in progress."

Revision History

Suggestion for changes or modifications to this document should be sent to the SNIA Green Storage Technical Working Group at http://www.snia.org/feedback/.

Revision	Release Date	Changes
0.0.1	9 April 2008	Initial Document Outline
0.0.16	3 November 2008	TWG Technical Proposal Ballot Draft
0.0.17	15 December 2008	TC Technical Proposal Ballot Draft
0.0.18	20 January 2009	Minor editorial cleanup

Intended Audience

This document is intended for use by individuals and companies engaged in assessing the power utilization of storage products.

Disclaimer

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This Working Draft is an internal document of the SNIA Green Storage Technical Working Group (TWG) that has not been approved for release outside of the membership of the SNIA. This draft does not represent the position of the SNIA.

Suggestions for revisions should be directed to http://www.snia.org/feedback/.

Changes to the Specification

Each publication of this specification is uniquely identified by a three-level identifier, comprised of a version number, a release number and an update number. The current identifier for this specification is version 0.0.18. Future publications of this specification are subject to specific constraints on the scope of change that is permissible from one publication to the next and the degree of interoperability and backward compatibility that should be assumed between products designed to different publications of this standard. The SNIA has defined three levels of change to a specification:

- Major Revision: A major revision of the specification represents a substantial change to the underlying scope or architecture of the specification A major revision results in an increase in the version number of the version identifier (e.g., from version 1.x.x to version 2.x x). There is no assurance of interoperability or backward compatibility between releases with different version numbers.
- Minor Revision: A minor revision of the specification represents a technical change to existing content or an adjustment to the scope of the specification. A minor revision results in an increase in the release number of the specification's identifier (e.g., from x.1.x to x.2.x). Minor revisions with the same version number preserve interoperability and backward compatibility.
- Update: An update to the specification is limited to minor corrections or clarifications of existing specification content. An update will result in an increase in the third component of the release identifier (e.g., from x.x.1 to x.x.2). Updates with the same version and minor release levels preserve interoperability and backward compatibility.

Usage

Table of Contents

List of Tables

Clause 1 Overview

1.1 Preamble

There is a growing awareness of the environmental impact of IT equipment use. This impact takes several forms: the energy expended in equipment manufacture and distribution; the impact of materials reclamation, and the power consumed in operation and cooling of the equipment. IT equipment users of all kinds now wish to make their IT operations as energy efficient as possible. This new priority can be driven by one or more of several requirements:

- Rising energy costs have made power and cooling expenses a more significant percentage of total cost of ownership of server and storage equipment.
- Some data centers are physically unable to add more power and cooling load, which means that new applications and data can only be brought on if old ones are retired or consolidated onto new, more efficient storage.
- Increased regulatory and societal pressures provide incentives for companies to lower their total energy footprints. For many companies, IT is a significant portion of overall power consumption, and corporate Green goals can only be achieved by reducing IT or by making it more efficient.

IT equipment users will seek advice on the most power efficient approach to getting their work done. It is not practical for customers to test a wide range of storage products and architectures for themselves. A more efficient approach is to create a collection of metrics that allow IT architects to objectively compare a range of approaches to a storage problem. This objective, metric-based approach has a dual impact:

- Users can select the mode of storage usage that accomplishes their work objectives with the lowest overall energy consumption
- Companies will be driven to innovate and compete in the development of energy efficient products as measured by the standard yardsticks.

1.2 General Assumptions

The purpose of a SNIA Green Storage Power Measurement is to provide an accurate assessment of the power consumption of commercial storage systems. Tested systems shall:

1. Be comprised of commercially released products and components;
2. Employ settings, parameters, and configurations that would allow end-users to achieve power levels equivalent to the published result.

A SNIA Green Storage Power Measurement is assumed to be a good faith effort by the TEST SPONSOR to accurately characterize the power requirements of the tested system. The precise configuration used in a SNIA Green Storage Power Measurement is left to the TEST SPONSOR. Any commercially released components may be used, and a focus on new or emerging components or technologies is encouraged.

1.3 Measurement Guidelines

SNIA Green Storage Power Measurement benchmark results are expected to be accurate representations of storage system power requirements. Therefore, stringent measurement, auditing, and reporting guidelines are defined by this specification. In general, the TEST SPONSOR shall provide a level of completeness and accuracy in their disclosures sufficient to reproduce the reported results even if the items are not explicitly required to be disclosed by the SNIA Green Storage Power Measurement specification.

More detailed measurement, evaluation and disclosure requirements can be found in the body of the specification.

1.4 Disclaimer

A SNIA Green Storage Power Measurement provides a high-level assessment of the power consumption profile of the tested system. It is not an attempt to precisely model or reproduce any specific installation.

Actual power consumption is highly dependent upon precise workload, environmental and usage parameters. While SNIA Green Storage Power Measurement results are intended to provide a realistic and reproducible assessment of the relative power needs across a broad range of system configurations and usages, it cannot completely match the precise power needs of any one specific installation.

Clause 2 Normative references

2.1 Overview

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.2 Approved references

Table 2-1 lists the standards, specifications and other documents that have been finalized and are referenced in this specification.

Table 2-1 Approved References

Author/Owner	Title	Revision	URL
ASHRAE	*Thermal Guidelines for Data Processing Environments*	ISBN/ISSN: 1-931862-43-5	http://resourcecenter.ashrae.org/store/ashrae/newstore.cgi?itemid=21074&view=item&categoryid=174&categoryparent=174&page=1&loginid=595434

2.3 References under development

None defined for this revision of the specification.

2.4 Other references

None defined for this revision of the specification.

Clause 3 Scope

The *SNIA Green Storage Power Measurement Specification* defines methodologies and metrics for the evaluation of the energy impact of storage networking products.

This revision of the specification addresses only the power consumption of idle equipment. Future revisions will include the additional scope listed below. The submission of externally-initiated, application-level requests for data transfer between a host and a storage system differentiates an active storage system from an idle storage system. Storage systems and components are said to be idle when

they are configured, powered up, connected to host systems, and capable of satisfying I/O requests from those systems, but no I/O requests are being submitted from the host systems.

This specification includes:

1. a generalized taxonomy for storage networking products (Clause 5);
2. measurement and data collections guidelines for idle storage systems (Clause 6);
3. metrics for product comparison of idle storage systems (Clause 7);
4. a framework for the disclosure of measurement data (Clause 8);
5. methodologies for audit and verification of results (Clause 9);
6. guidance for proper publication of results (Clause 10);
7. a structure for the continued maintenance and management of past submissions (Clause 11).

The SNIA has identified opportunities for refinement of existing material and expansion of scope that will be addressed in future revisions of the specification, including:

1. measurement, data collection guidelines and metrics for active storage systems;
2. measurement, data collection guidelines and metrics for storage appliances and interconnect elements;
3. characterization of power supply efficiency;
4. expansion of audit and disclosure requirements;
5. revision and expansion of taxonomy to address additional products and market segments;
6. assessment of power-related system functionalities and features.

Clause 4 Definitions, symbols, abbreviations, and conventions

4.1 Definitions, Acronyms and abbreviations

4.1.1 Capacity

The sum of the raw unformatted, uncompressed capacity of each STORAGE DEVICE in the SUT.

4.1.2 Count Key Data (CKD)

A disk data organization model in which the disk is assumed to consist of a fixed number of tracks, each having a maximum data capacity. The CKD architecture derives its name from the record format, which consists of a field containing the number of bytes of data and a record address, an optional key field by which particular records can be easily recognized, and the data itself.

4.1.3 Direct-connected

Storage designed to be under the control of a single host, or multiple hosts in a non-shared environment.

4.1.4 Fixed Block Architecture (FBA)

A model of disks in which storage space is organized as linear, dense address spaces of blocks of a fixed size. Fixed block architecture is the disk model on which SCSI is predicated.

4.1.5 Maximum Configuration

Specifies the lower bound on the maximum number of storage devices in the PRODUCT, either as part of original configuration or through field upgrades.

4.1.6 Maximum Time to Data (MaxTTD)
The maximum time before an entire data object is accessible within the constraints imposed by its storage media. For random-access media, a data object is accessible when any byte may be accessed. For sequential-access media, a data object is accessible when the requested object has begun streaming from a previously inactive drive.

4.1.7 Network-connected
Storage designed to be connected to a host via a network protocol (e.g., TCP/IP, IB, and FC).

4.1.8 Non-disruptive serviceability
Support for continued availability of data during all FRU service operations, including break/fix, code patches, software/firmware upgrades, configuration changes, data migrations, and system expansion. Service operations may result in performance impacts to data availability, but shall not result in a loss of access.

4.1.9 Sequential write
An I/O load consisting of consecutively issued write requests to adjacently located data.

4.1.10 Single Point of Failure (SPOF)
One component or path in a system, the failure of which would make the system inoperable or data inaccessible.

4.1.11 Storage Device
A collective term for disk drives, tapes cartridges, and any other mechanisms providing non-volatile data storage. This definition is specifically intended to exclude aggregating storage elements such as RAID array subsystems, robotic tape libraries, filers, and file servers.

4.1.12 Storage Product
The customer-orderable system or component that is the focal point of a SNIA Green Storage Power Measurement; a central component of the SUT.

4.1.13 Storage Protection
A combination of RAID, NVRAM and sparing that assures that all IO operations will be preserved in the event of power loss or STORAGE DEVICE failure.

4.1.14 System under Test (SUT)
The specific configuration of hardware and software used during a given SNIA Green Storage Power Measurement.

4.1.15 Test Sponsor
The individual or company that submits a SNIA Green Storage Power Measurement to SNIA.

4.2 Acronyms and Abbreviations

CKD	Count Key Data
FBA	Fixed Block Architecture
FRU	Field-replaceable Unit
IT	Information Technology
MaxTTD	Maximum Time to Data
PDU	Power Distribution Unit
SCSI	Small Computer System Interface
SNIA	Storage Network Industry Association
SPOF	Single Point of Failure
SUT	System under Test

UPS Uninterruptible Power Supply

4.3 Keywords

4.3.1 expected
A keyword used to describe the behavior of the hardware or software in the design models presumed by this standard. Other hardware and software design models may also be implemented.

4.3.2 mandatory
A keyword indicating an item that is required to be implemented as defined in this specification to claim compliance with this specification.

4.3.3 may
A keyword that indicates flexibility of choice with no implied preference.

4.3.4 may not
Keywords that indicates flexibility of choice with no implied preference.

4.3.5 obsolete
A keyword indicating that an item was defined in prior revisions to this specification but has been removed from this revision.

4.3.6 optional
A keyword that describes features that are not required to be operational during the test. However, if any optional feature is operational during the test, it shall be implemented as defined in this specification.

4.3.7 prohibited
A keyword used to describe a feature or behavior that is not allowed to be present in the SUT.

4.3.8 required
A keyword used to describe a behavior that shall be operational during of the test.

4.3.9 shall
A keyword indicating a mandatory requirement. TEST SPONSORS are required to implement all such requirements.

4.3.10 should
A keyword indicating flexibility of choice with a preferred alternative; equivalent to the phrase “it is recommended”.

4.4 Conventions

Certain words and terms used in this specification have a specific meaning beyond their normal English meaning. These words and terms are defined either in Clause 4 or in the text where they first appear. When used in this specification, these terms will appear in SMALLCAPS.

Numbers that are not immediately followed by lower-case b or h are decimal values.

Numbers immediately followed by lower-case b (xxb) are binary values.

Numbers immediately followed by lower-case h (xxh) are hexadecimal values.

Hexadecimal digits that are alphabetic characters are upper case (i.e., ABCDEF, not abcdef).

Hexadecimal numbers may be separated into groups of four digits by spaces. If the number is not a multiple of four digits, the first group may have fewer than four digits (e.g., AB CDEF 1234 5678h)

Storage capacities shall be reported in base-10. IO transfer sizes and offsets shall be reported in base-2. The associated units and abbreviations used in this specification are:

- A kilobyte (KB) is equal to 1,000 (10^3) bytes.
- A megabyte (MB) is equal to 1,000,000 (10^6) bytes.

- A gigabyte (GB) is equal to 1,000,000,000 (10^9) bytes.
- A terabyte (TB) is equal to 1,000,000,000,000 (10^{12}) bytes.
- A petabyte (PB) is equal to 1,000,000,000,000,000 (10^{15}) bytes
- A kibibyte (KiB) is equal to 2^{10} bytes.
- A mebibyte (MiB) is equal to 2^{20} bytes.
- A gibibyte (GiB) is equal to 2^{30} bytes.
- A tebibyte (TiB) is equal to 2^{40} bytes.
- A pebibyte (PiB) is equal to 2^{50} bytes

Clause 5 Taxonomy

5.1 Introduction

This clause defines a market taxonomy that classifies storage products or subsystems in terms of operational profile and supported features.

5.2 Taxonomy Assumptions

5.2.1 Taxonomy categories define broad market segments that can be used to group products that share common functionality or performance requirements, and within which meaningful product comparison can be undertaken. This specification defines six broad taxonomy categories:

- Online, defined in 5.3;
- Near-Online, defined in 5.4;
- Removable-Media Library, defined in 5.5;
- Virtual Media Library, defined in 5.6;
- Infrastructure Appliance, defined in 5.7;
- Infrastructure Interconnect Elements, defined in 5.8.

While this taxonomy is broad, it is not intended to address all storage devices. For example, this specification does not address storage devices that rely on a Universal Serial Bus (USB) connection for their power.

5.2.2 Within a taxonomy category, a specific model or release of a product will support different feature sets, whether focused on capacity, reliability, functionality or another differentiator. Feature and functionality differences within a category are addressed with attributes. Each taxonomy category defines a set of attributes that are common to all products within the category.

Where a taxonomy category requires a specific fixed, setting or range for a given attribute, that setting is summarized in Table 5-1 to assist a test sponsor in initial category selection. The full set of attributes for each category is provided in the following sections.

Table 5-1 Common Category Attributes

Attribute	Category					
	Online	**Near online**	**Removable Media**	**Virtual Media Library**	**Appliance**	**Interconnect**
Access Pattern	Random	Random	Sequential write	Sequential write		
MaxTTD (t)[1]	t < 80 ms	t > 80 ms	t > 80 ms t < 5 min	t < 80 ms	t < 80 ms	t < 80 ms
User accessible data	Required	Required	Required	Required	Prohibited	Prohibited

5.2.3 CLASSIFICATIONS define combinations of settings or values for the attributes within a category. A product shall satisfy all the attributes for its designated CLASSIFICATION.

5.2.4 Maximum Configuration bounds the number of STORAGE DEVICES that the SUT is capable of supporting.

[1] For the Appliance and Interconnect categories, MaxTTD measures the maximum additional latency introduced by the product.

5.3 Online Taxonomy Category

This category defines the features and functionalities for an online, random-access storage product. Products in this profile may provide any combination of block, file or object interfaces. Table 5-2 defines the requirements for this taxonomy classifications defined in this category.

Table 5-2 Online Taxonomy Classifications

Attribute	Classification				
	Online 1	Online 2	Online 3	Online 4	Online 5
Access Pattern	Random	Random	Random	Random	Random
Connectivity	Not specified	Connected to single or multiple hosts, but not shared	Network-connected	Network-connected	Network-connected
Storage Protection	Optional	Optional	Required	Required	Required
FBA/CKD Support	Optional	Optional	Optional	Optional	Required
Maximum Configuration [1]	4	> 4	> 20	> 100	> 1000
MaxTTD (t)	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms
No SPOF	Optional	Optional	Optional	Required	Required
Integrated PDU and UPS	Optional	Optional	Optional	Optional	Required
Rackmount	No	Yes	Yes	Yes	Yes
Non-Disruptive Serviceability	Optional	Optional	Optional	Optional	Required
User-Accessible Data	Required	Required	Required	Required	Required

5.4 Near Online Taxonomy Category

This category defines the features and functionalities for a near-online, random-access storage product. Products in this profile employ MAID or FCAS architectures. Table 5-3 defines the requirements for this taxonomy classifications defined in this category.

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[1] Specifies the lower bound on the maximum number of storage devices in the PRODUCT, either as part of original configuration or through field upgrades.

Table 5-3 Near-Online Taxonomy Classifications

Attribute	Classification		
	Near Online 1	Near Online 2	Near Online 3
Access Pattern	Random	Random	Random
Connectivity	Network connected	Network connected	Network connected
Maximum Configuration [1]	4	> 4	> 100
MaxTTD (t)	t > 80 ms	t > 80 ms	t > 80 ms
No SPOF	Optional	Optional	Required
Non-Disruptive Serviceability	Optional	Optional	Required
User-accessible Data	Required	Required	Required

5.5 Removable-Media Library Category

This category defines the features and functionalities for storage products that rely on automated or manual media loaders (e.g., tape or optical libraries). Table 5-4 defines the requirements for the taxonomy classifications defined in this category.

Table 5-4 Removable-Media Library Classifications

Attribute	Classification				
	Removable 1	Removable 2	Removable 3	Removable 4	Removable 5
Access Pattern	Sequential write	Sequential write	Sequential write	Sequential write	Sequential write
MaxTTD (t)	80 ms < t < 5 m	80 ms < t < 5 m	80 ms < t < 5 m	80 ms < t < 5 m	80 ms < t < 5 m
No SPOF	Optional	Optional	Optional	Optional	Required
Robotics	Prohibited	Required	Required	Required	Required
Maximum Drive Count	Not specified	≤ 4	≥ 5	≥ 25	≥ 12
User-accessible Data	Required	Required	Required	Required	Required

[1] Specifies the lower bound on the maximum number of storage devices in the PRODUCT, either as part of original configuration or through field upgrades.

5.6 Virtual Media Library Category

This operational profile defines the features and functionalities for sequential-access storage products that rely on optical or disk-based storage media to provide a Virtual Tape Library. Table 5-5 defines the requirements for the taxonomy classifications defined in this category.

Table 5-5 Virtual Media Library Classifications

Attribute	Classification		
	Virtual 1	Virtual 2	Virtual 3
Access Pattern	Sequential write	Sequential write	Sequential write
Connectivity	Network connected	Network connected	Network connected
FICON Support	Optional	Optional	Required
Maximum Configuration [1]	100	> 100	> 100
MaxTTD (t)	t < 80 ms	t < 80 ms	t < 80 ms
No SPOF	Optional	Required	Required
Non-Disruptive Serviceability	Optional	Optional	Required
User-accessible Data	Required	Required	Required

5.7 Infrastructure Appliance

This operational profile defines the features and functionalities for storage appliances that support a storage area network and provide advanced management capabilities. Products in this category rely on a closed environment to typically support a single-purpose, dedicated storage-oriented service or application (e.g., virtualization, de-duplication, NAS gateways). No end-user accessible data is stored in the appliance. Devices in this category are part of the data path from a host to a storage device, and are responding to IO requests in real time. Storage appliances that are outside the data path (e.g., backup servers) are not addressed by this category. Table 5-6 defines the requirements for the taxonomy classifications defined in this category.

[1] Specifies the lower bound on the maximum number of storage devices in the SUT, either as part of original configuration or through field upgrades.

Table 5-6 Infrastructure Appliance Classifications

Attribute	Classification		
	Appliance 1	**Appliance 2**	**Appliance 3**
Connectivity	Direct or Network connected	Direct or Network connected	Network connected
Maximum Configuration [1]	20	> 20	≥ 100
MaxTTD (t)	t < 80 ms	t < 80 ms	t < 80 ms
No SPOF	Optional	Optional	Required
Non-Disruptive Serviceability	Optional	Optional	Required
User-accessible Data	Prohibited	Prohibited	Prohibited

5.8 Infrastructure Interconnect Element

This operational profile defines the features and functionalities for managed inter-connect elements within a storage area network (e.g., switches, extenders). Table 5-7 defines the requirements for the taxonomy classifications defined in this category.

Table 5-7 Infrastructure Interconnect Classifications

Attribute	Classification		
	Interconnect 1	**Interconnect 2**	**Interconnect 3**
Maximum Port Count (n)	Switch: n ≤ 32	Router: n ≤ 4 Switch: 32 ≤ n ≤ 128 Extender: ≤ 4	Router: > 4 Switch: > 128
No SPOF	Optional	Optional	Required
User-accessible Data	Prohibited	Prohibited	Prohibited

[1] Specifies the lower bound on the maximum number of storage devices accessible to the appliance, either as part of original configuration or through field upgrades.

Clause 6 Test Execution

6.1 Overview

This clause defines the data collection and testing methodology used to produce a valid SNIA Green Storage Power Measurement.

6.2 General Assumptions

6.2.1 Benchmark Driver

A SNIA Green Storage Power Measurement result should be produced using a recommended SNIA Green Storage Power Measurement benchmark driver. See Appendix C for a list of recommended benchmark drivers.

6.2.2 SUT Consistency

The physical and logical configuration of the SUT, including its configuration and tuning parameters, shall not be changed between or during a test or test phase unless explicitly allowed in the definition of the test or test phase.

6.2.3 No Non-Test Activity

Other than booting/starting the systems, storage or network infrastructure employed during the benchmark, no substantive work shall be performed on the SUT between the Tests or Test Phases defined in this specification unless explicitly allowed in the definition of the test or test phase.

6.2.4 IO Modes

All IO requests on a SUT shall be classified as either:

- Foreground IO, a externally-initiated, application-level request for data transfer between the benchmark driver and the storage system being tested, or
- Background IO, a system-initiated request for data transfer within the storage system being tested.

6.3 SUT Configuration Requirements

6.3.1 Storage Requirements

6.3.1.1 The TEST SPONSOR shall identify one taxonomy classification for the SUT (see Clause 5).

6.3.1.2 The availability date of the SUT is date by which all components of the SUT are generally available. For this specification, generally available is defined as available for purchase by any customer in a market where a given component is offered for sale. General availability shall not be predicated on prior sales to the customer or other special relationships between the vendor and the customer.

6.3.1.3 The availability date shall not be more than ninety (90) days from the acceptance date of the test result (see 11.1.3).

6.3.1.4 The SUT shall contain at least one (1) STORAGE DEVICE.

6.3.1.5 The capacity of the SUT is defined to be the sum of the raw unformatted, uncompressed capacity of each STORAGE DEVICE in the SUT.

6.3.2 Power Requirements

6.3.2.1 The power supplied to the SUT shall match one of the power profiles outlined in Table 6-1.

Table 6-1 Power Profiles

INPUT VOLTAGE RANGE	Phases	AC INPUT FREQUENCY RANGE
100-120 VAC RMS	1	47 – 63 Hz
180 – 240 VAC RMS	3	47 – 63 Hz
200 – 240 VAC RMS	1	47 – 63 Hz
380 – 508 VAC RMS	3	47 – 63 Hz

6.3.2.2 The power supplied to the SUT shall conform to the selected profile throughout test execution.

6.3.3 Environmental Requirements

6.3.3.1 All measurements shall be conducted in a climate controlled facility.

6.3.3.2 Environmental conditions that satisfy ASHRAE Class I standards for data centers shall be maintained throughout test execution.

6.3.3.3 The non-condensing relative humidity shall be disclosed at the beginning and end of each test execution.

6.3.4 Instrumentation Requirements

6.3.4.1 The benchmark configuration shall include a recommended power monitor. See Appendix A for a list of recommended monitors.

6.3.4.2 If the selected power monitor does not gather environmental data, the benchmark configuration shall include an environmental monitor. See Appendix A for a list of recommended monitors.

6.3.4.3 The power monitor shall be active throughout all tests and test phases of the benchmark and shall provide:

- Input voltage to the SUT, to an accuracy of 1%;
- Power consumption by the SUT, to the accuracy summarized in Table 6-2.

The power and voltage measurements shall be recorded to durable media using a period of not more than 5 second and shall use a timestamp that is synchronized with the other components of the SUT to a resolution of at least 1 second.

Table 6-2 Power Meter Accuracy

Power Consumption (p)	Minimum Accuracy
p ≤ 10 W	± 0.01 W
10 < p ≤ 100 W	± 0.1 W
p > 100 W	± 1.0 W

6.3.4.4 The temperature, measured in degrees C, to a resolution of 0.1 degree, as measured at the primary air inlet port for the SUT shall be recorded to durable media using a period of not more than 1 minute, and

shall use a timestamp that is synchronized with the other components of the SUT to a resolution of at least 1 second.

6.4 Idle Test Execution Overview

The Idle Power Test is composed of two test phases, which shall be executed in sequence:

1. Conditioning of the SUT;
2. Idle measurement

The conditioning phase of the Idle Power test is intended to provide a uniform foundation for the idle power measurement(s) and to:

- Demonstrate the SUT ability to process IO requests;
- Assure that each STORAGE DEVICE, tape drive, appliance or interconnect element in the SUT is activated. For the purposes of this specification, a device is deemed activated when it is fully operational and capable of satisfying all supported requests within the constraints of the taxonomy classification identified for the SUT.

6.5 Idle Test Conditioning Requirements

6.5.1 General Requirements

6.5.1.1 Each IO stream shall issue each IO request synchronously, with each subsequent IO request issued immediately following the completion of its predecessor.

6.5.1.2 Storage Conditioning shall begin when the first request from the IO streams is issued by the benchmark driver and shall last for a minimum of 15 minutes. The duration of storage conditioning shall be disclosed.

6.5.1.3 The benchmark driver shall uniformly distribute the required IO requests among the IO streams, such that the difference between the maximum number of IO requests serviced by an IO stream is no more than 10% greater than minimum number of IO requests serviced by an IO stream.

6.5.1.4 If the SUT includes functionality that requires changes to the IO profile defined for the conditioning phase of the selected taxonomy category in order to meet the intent stated in 6.4, the changes shall be disclosed.

6.5.2 Online Category Conditioning

6.5.2.1 The TEST SPONSOR shall assure that all STORAGE DEVICES are accessed at some time during the conditioning phase.

6.5.2.2 The benchmark driver shall initiate a number of independent IO streams equal to or greater than the number of LUNS made available to the benchmark driver by the SUT, for all other taxonomy categories.

6.5.2.3 Each IO stream shall issue a sequence of IO requests with the following profile, unless the SUT includes functionality that requires changes to the IO profile to satisfy the intent of conditioning (see 6.5.1.4):

- Transfer size: 8 KiB (8 192 bytes)
- Operations Mix: 70% read, 30% write
- Transfer Alignment: 8 KiB (8 192 bytes)
- Transfer Offset: Randomly distributed throughout the address range provided to the benchmark driver (see Appendix C), and rounded down to satisfy Transfer Alignment.

6.5.3 Near Online Category Conditioning

6.5.3.1 The TEST SPONSOR shall assure that all tape drives are accessed at some time during the conditioning phase.

6.5.3.2 The benchmark driver shall initiate a number of independent IO streams equal to or greater than the number of tape drives present in the SUT.

6.5.3.3 Each IO stream shall issue a sequence of IO requests with the following profile, unless the SUT includes functionality that requires changes to the IO profile to satisfy the intent of conditioning (see 6.5.1.4):

- Transfer size: 8 KiB (8 192 bytes)
- Operations Mix: 70% read, 30% write
- Transfer Alignment: 8 KiB (8 192 bytes)
- Transfer Offset: Randomly distributed throughout the address range provided to the benchmark driver (Appendix C), and rounded down to satisfy Transfer Alignment.

6.5.4 Removable Media Category Conditioning

6.5.4.1 The TEST SPONSOR shall assure that all tape drives are accessed at some time during the conditioning phase.

6.5.4.2 Each IO stream shall issue a sequence of IO requests with the following profile, unless the SUT includes functionality that requires changes to the IO profile to satisfy the intent of conditioning (see 6.5.1.4):

- Transfer size: 128 KiB (131 072 bytes)
- Operations Mix: 100% write for the first half of the conditioning phase, followed by a rewind request; 100%read for the second half of the conditioning phase.

6.5.5 Virtual Media Library Category Conditioning

6.5.5.1 The TEST SPONSOR shall assure that all STORAGE DEVICES are accessed at some time during the conditioning phase.

6.5.5.2 Each IO stream shall issue a sequence of IO requests with the following profile, unless the SUT includes functionality that requires changes to the IO profile to satisfy the intent of conditioning (see 6.5.1.4):

- Transfer size: 128 KiB (131 072 bytes)
- Operations Mix: 100% write for the first half of the conditioning phase, followed by a rewind request; 100%read for the second half of the conditioning phase.

6.5.6 Appliance Category Conditioning

Not defined in this specification revision.

6.5.7 Interconnect Category Conditioning

Not defined in this specification revision.

Equation 6-1: Average Idle Power

$$P_i = \frac{\sum W_s}{n}$$

Where:

- *P_i is average idle power*
- *W_s is power in watts measured in each sampling interval s*
- *n is the number of samples gathered by the power meter during the measurement interval.*

6.6 Idle Measurement Requirements

6.6.1 General Requirements

6.6.1.1 The Idle Measurement phase shall begin immediately following Storage Conditioning.

6.6.1.2 No User IO shall be initiated on the SUT during the Idle Measurement phase other than that required to satisfy the instrumentation requirements in 6.3.4.

6.6.1.3 AVERAGE IDLE POWER is the average power consumption measured during the idle measurement phase, as shown in **Error! Reference source not found.**.

6.6.2 Online Category Idle Measurement Requirements

6.6.2.1 The Idle Measurement Phase shall last for twenty-four (24) hours.

6.6.2.2 The AVERAGE IDLE POWER, as defined in 6.6.1.3, shall be disclosed.

6.6.3 Near Online Category Idle Measurement Requirements

6.6.3.1 The Idle Measurement Phase shall last for twenty-four (24) hours.

6.6.3.2 The AVERAGE IDLE POWER, as defined in 6.6.1.3, shall be disclosed.

6.6.4 Removable Media Category Idle Measurement Requirements

6.6.4.1 The Idle Measurement Phase shall last for two (2) hours.

6.6.4.2 The Idle Measurement Phase shall begin after any loaded STORAGE DEVICES have been unloaded from the tape drives and any robotics activity has completed.

6.6.4.3 The AVERAGE IDLE POWER, as defined in 6.6.1.3, shall be disclosed.

6.6.5 Virtual Tape Library Category Idle Measurement Requirements

6.6.5.1 The Idle Measurement Phase shall last for twenty-four (24) hours.

6.6.5.2 The AVERAGE IDLE POWER, as defined in 6.6.1.3, shall be disclosed.

6.6.6 Appliance Category Measurement Requirements

Not defined in this specification revision.

6.6.7 Interconnect Category Measurement Requirements

Not defined in this specification revision

Clause 7 Metrics

Equation 7-1 SNIA Idle Power Metric

$$P = \frac{C}{P_i}$$

Where:

- *P is the SNIA Idle Power Metric*
- *C is the total capacity of the SUT*
- *P_i is the average idle power*

7.1 Taxonomy Considerations

This revision of the specification defines metrics for the Online and Near-Online taxonomy categories only. Metrics for additional taxonomy categories will be defined in future revisions of the specification.

7.2 Primary Metrics

7.2.1 This revision of the specification defines one primary metric, SNIA Idle Power, which represents the amount of raw capacity supported per watt of power consumed by the SUT. It is calculated as shown in Equation 7-1as the ratio of

- the total CAPACITY of the SUT, measured in GB (see 6.3.1.5);
- the AVERAGE IDLE POWER, measured in watts (see 6.6.1.3).

7.2.2 SNIA Idle Power Metric shall be reported to three significant digits.

Clause 8 Disclosure Requirements

8.1 General Requirements

8.1.1 This clause defines the format and content of a SNIA Green Storage Power Measurement disclosure report. The disclosure report is intended to document the configuration, procedures and outcomes of a SNIA Green Storage Power Measurement execution.

8.1.2 The content of the disclosure report shall remain confidential between the SNIA and the test sponsor. See Clause 10 for a discussion of the publication of material from the disclosure report.

8.1.3 While the precise formatting is left to the test sponsor, all items detailed in Clause 8 shall be present in the disclosure, and the disclosure itself shall be as a PDF document.

8.2 Administrative Items

The administrative section of the disclosure report shall include:

- The date of the report;
- The name of the TEST SPONSOR;
- Contact information for the liaison between the TEST SPONSOR and the SNIA for this submission;
- The availability date, if it is later than the acceptance date (see 11.1.3); "released" if not.

8.3 Configuration Items

The configuration section of the disclosure report shall include a summary of the physical configuration of the SUT, including:

- The input voltage and frequency of the power supplied to the SUT;
- The number, raw capacity, RPM and interface of each type of STORAGE DEVICE;
- The number of enclosures;
- The STORAGE PROTECTION provided by the SUT for systems in the online taxonomy category;
- The number of tape drives for systems in the removable-media library taxonomy category;
- The CAPACITY, reported in GB;
- The CLASSIFICATION of the SUT.

8.4 Measurement Items

The measurement section of the disclosure report shall include:

- The power profile of the SUT as defined in Table 6-1;
- The environmental conditions at the start and end of each test as detailed in 6.3.3.3;
- The power and environmental monitors used in the test execution;
- A graph of the power and environmental data recorded during the tests as required in 6.3.4.3 and 6.3.4.4. The TEST SPONSOR shall make the raw data available to the SNIA upon request;
- The name of each LUN made available to the benchmark driver by the SUT;
- The name and version of the selected benchmark driver, along with all scripts, commands or configuration files used to execute the test measurement;
- The beginning and ending timestamp of each test and test phase;

- A description of any changes to the conditioning phase as defined in 6.5.1.4.

8.5 Reported Metrics

The metrics section of the disclosure report shall include:

- The calculated raw capacity of the SUT;
- The idle power measured during the idle power test, as defined in 6.6;
- The SNIA Green Storage Power Measurement Idle Power calculated for this result submission.

Clause 9 Audit Requirements

9.1 Audit

This specification does not define an audit procedure for SNIA Green Storage Power Measurement results. Future revisions of this specification may include additional requirements in this area.

9.2 Peer Review

This specification does not define a peer review process for SNIA Green Storage Power Measurement results. Future revisions of this specification may include additional requirements in this area.

9.3 Certification

This specification does not define a process for the certification of SNIA Green Storage Power Measurement results. Future revisions of this specification may include additional requirements in this area.

Clause 10 Fair Use Requirements

10.1 TEST SPONSORS shall not publicly promote, disseminate, publish or reproduce SNIA Green Storage Power Measurement results, either directly or by providing information to a third party, without the expressed, written consent of the SNIA. Future revisions of this specification may substantially modify this requirement.

10.2 TEST SPONSORS shall not compare or promote results that they have published without the expressed, written consent of the SNIA.

10.3 Any results published in accordance with this revision of the specification shall be fully anonymized. Any information that might identify the test sponsor shall be shared solely with SNIA in accordance with Clause 8, and shall not be publicly disseminated, published or reproduced either directly or by providing information to a third party.

Clause 11 Results Management

11.1 Submission

11.1.1 A SNIA Green Storage Power Measurement result is not official until it has been accepted by the SNIA as a valid submission.

11.1.2 A SNIA Green Storage Power Measurement submission is not complete until the following items shall be submitted to the SNIA by the TEST SPONSOR:

1. A completed disclosure report (see Clause 8)
2. A letter of good faith, signed by the TEST SPONSOR (see Appendix A)

3. Any required filing fees, as specified by the SNIA.

11.1.3 Once a SNIA Green Storage Power Measurement submission is complete, the TEST SPONSOR will be notified of its acceptance by the SNIA. The date of that notification is known as the acceptance date for the submission.

11.2 Revision

This specification does not define the process for revising an accepted SNIA Green Storage Power Measurement result.

11.3 Withdrawal

11.3.1 An accepted SNIA Green Storage Power Measurement results shall be withdrawn upon receipt by SNIA of a written request from the TEST SPONSOR.

11.3.2 A withdrawn SNIA Green Storage Power Measurement result shall not be used in any form of marketing, publication or comparison, regardless of prior consent granted by the SNIA.

Appendix A Recommended Power and Environmental Meters

The devices recommended for use in SNIA Green Storage Power Measurements at the time of the publication of this revision of the specification are summarized in Table A-1 and Table A-2. This list expands on the list of devices approved for use with the SPEC power benchmark (http://www.spec.org/power_ssj2008/).

For the most up-to-date list of recommended power meters, please refer to the SNIA web site.

Table A-1: Recommended Power Meters

Manufacturer	Model
Infratek	107A-1 (1-channel)
	GPM-8212
Yokogawa	WT210
	WT230 (3 phase)
	WT1600 (3 phase)
ZES Zimmer	LMG450 (1-channel)
	LMG95
	LMG500 (1-channel)
Xitron	2802 (1-channel)

Table A-2: Recommended Environmental Meters

Manufacturer	Model
Digi	WatchPort/H
Temperature@lert	TM-STD30

For more information on the appropriate use of a power meter in a SNIA Green Storage Power Measurement see 6.3.4. For more information on the selection criteria for power meters and the approval process for adding a new meter to this list, please contact the SNIA.

Appendix B Sample Letter of Good Faith

Joe Smith
Director, Environmental Evaluation
XYZ, Corp.
123 Main Street
High Tech Town, CA 12345

Bill Jones
GSI Results Coordinator
SNIA
500 Sansome St, Suite 504
San Francisco, CA 94111

20 January 2009

Re: XYZ 2000 Submission for SNIA Green Storage Power Measurement

Dear Sir:

On behalf of XYZ Corporation, I request acceptance of a SNIA Green Storage Power Measurement submission for the XYZ 2000 against the 0.0.18 revision of the SNIA Green Storage Power Measurement specification.

The measurements for this submission were completed on Monday, August 11, 2008 and are accurately summarized in the attached disclosure report. To the best of our knowledge, the results and measurements were:

- Accurate,
- Complete,
- Representative,
- Reproducible,
- Compliant with the 0.0.18 revision of the SNIA Green Storage Power Measurement specification and
- In accordance with the SNIA Green Storage Initiative's stated goal of providing meaningful power consumption information to aid in the purchase decisions of consumers.

Regards,

Joe Smith
Director, Environmental Evaluation

Appendix C Recommended Benchmark Drivers

The benchmark drivers recommended for use in SNIA Green Storage Power Measurements at the time of the publication of this revision of the specification are summarized in Table C-1. For the most up-to-date list of recommended benchmark drivers, please refer to the SNIA web site.

TEST SPONSORs interested in using a benchmark driver that does not appear in the current list of recommended drivers are encouraged to contact the SNIA.

Table C-1: Recommended Benchmark Drivers

Driver	Revision
IOMETER	2006.07.27