ENERGY STAR
Data Center Storage
Version 1.0 Specification Overview

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Agenda

Topic
Meeting Introduction
Definitions and Product Scope
Power Supply and Power Modeling Requirements
Energy Efficiency Feature Requirements
Information Reporting Requirements
Testing Data Requirements
Data Displayed on ENERGY STAR Website
Storage Product Family Variation Allowances
Standard Performance Data Measurement and Output
Test Method and Remaining Version 1.0 Timeline

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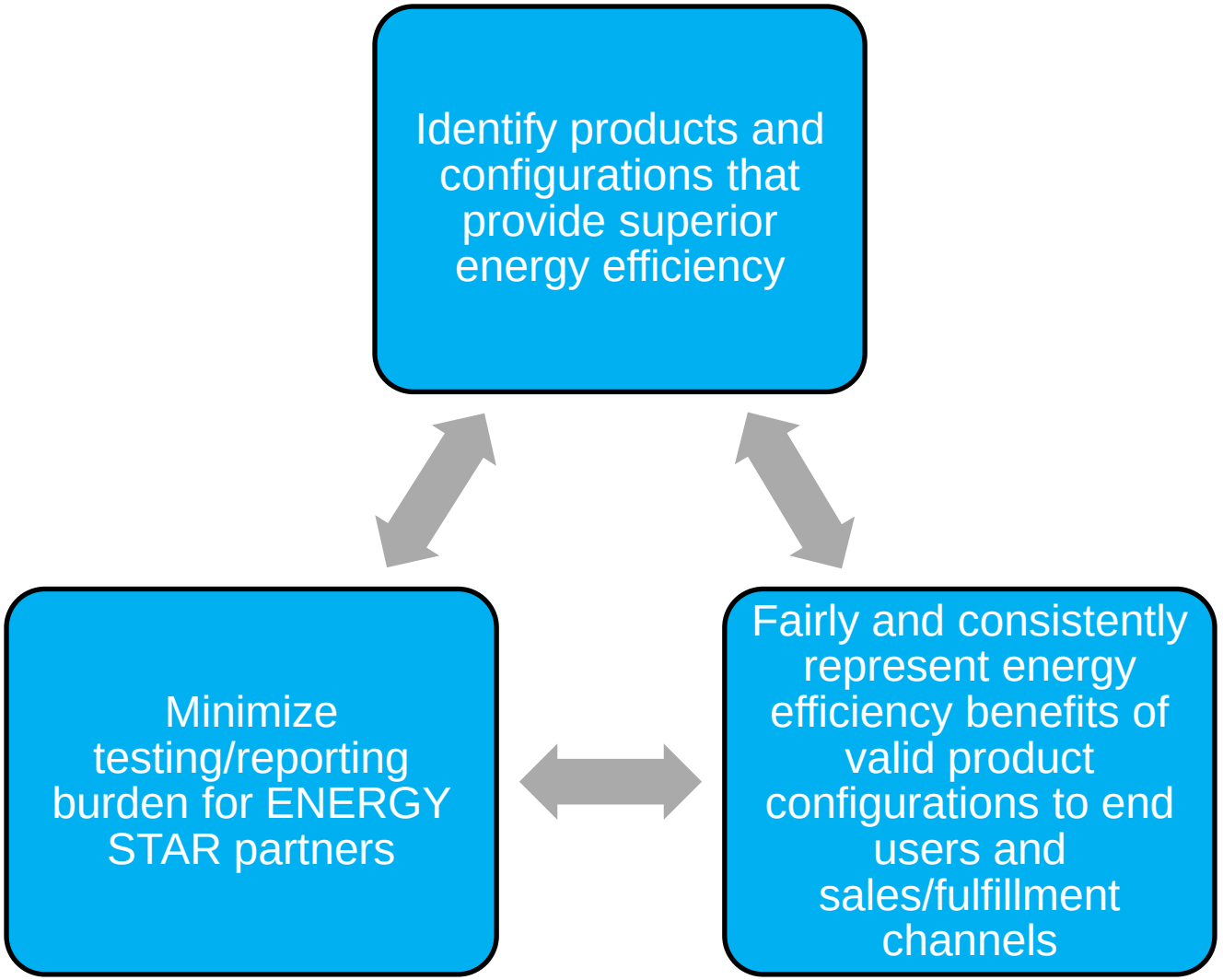
Goals and Notes

- High-level review of the ENERGY STAR Version 1.0 Data Center Storage Specification and Test Method
- Note: All slides will be posted to ENERGY STAR Data Center Storage website

Review of ENERGY STAR Goals



Adoption of Version 2.0.1 SNIA Emerald™ Specification

- EPA adopted V2.0.0 Emerald specification in the ENERGY STAR Final Draft Storage specification and test method.
- EPA is looking forward to the upcoming release of the V2.0.1 Emerald specification which provides additional guidance for testing storage products with automated storage tiering technology. This version will be referenced in the final ENERGY STAR Storage program requirements.

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Definitions

- Align with the SNIA dictionary whenever possible
- Product family is defined in Section I, and provides guidance on:
  - Defining the range of system sizes that fall within a product family
  - How to create configurations for certification using multiple storage device types and/or workload types

Definitions

- Other important concepts covered in the definition section include:
  - Product Types
  - Storage Taxonomy
  - Capacity Optimizing Methods (COMs)
  - Scale-up and Scale-out Storage
  - Automated Storage Tiering
  - Advanced Data Recovery Capability

Storage Taxonomy Review

Attribute	Classification					
	Online 1	Online 2	Online 3	Online 4	Online 5	Online 6
Access Pattern	Random/ Sequential	Random/ Sequential	Random/ Sequential	Random/ Sequential	Random/ Sequential	Random/ Sequential
MaxTTFD (t)	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms	t < 80 ms
User-Accessible Data	Required	Required	Required	Required	Required	Required
Connectivity	Not specified	Connected to single or multiple hosts	Network-connected	Network-connected	Network-connected	Network-connected
Consumer/ Component	Yes	No	No	No	No	No
Integrated Storage Controller	Optional	Optional	Required	Required	Required	Required
Storage Protection	Optional	Optional	Required	Required	Required	Required
No SPOF	Optional	Optional	Optional	Required	Required	Required
Non-Disruptive Serviceability	Optional	Optional	Optional	Optional	Required	Required
FBA/CKD Support	Optional	Optional	Optional	Optional	Optional	Required
Maximum Supported Configuration	≥1	≥ 4	≥ 12	> 100	>400	>400

In Scope

- Characterized within the Online 2, 3, or 4 Storage Taxonomy with the following additional criteria:
  1. Contain a controller with advanced data recovery capability (no JBODs allowed)
  2. Support Block I/O storage functionality
  3. Implement either scale-up or scale-out storage

Out of Scope

- Storage devices in the following categories of the Storage Taxonomy:
  - Near-online
  - Removable Media Library
  - Virtual Media Library
  - Adjunct Storage Products
  - Interconnect Elements

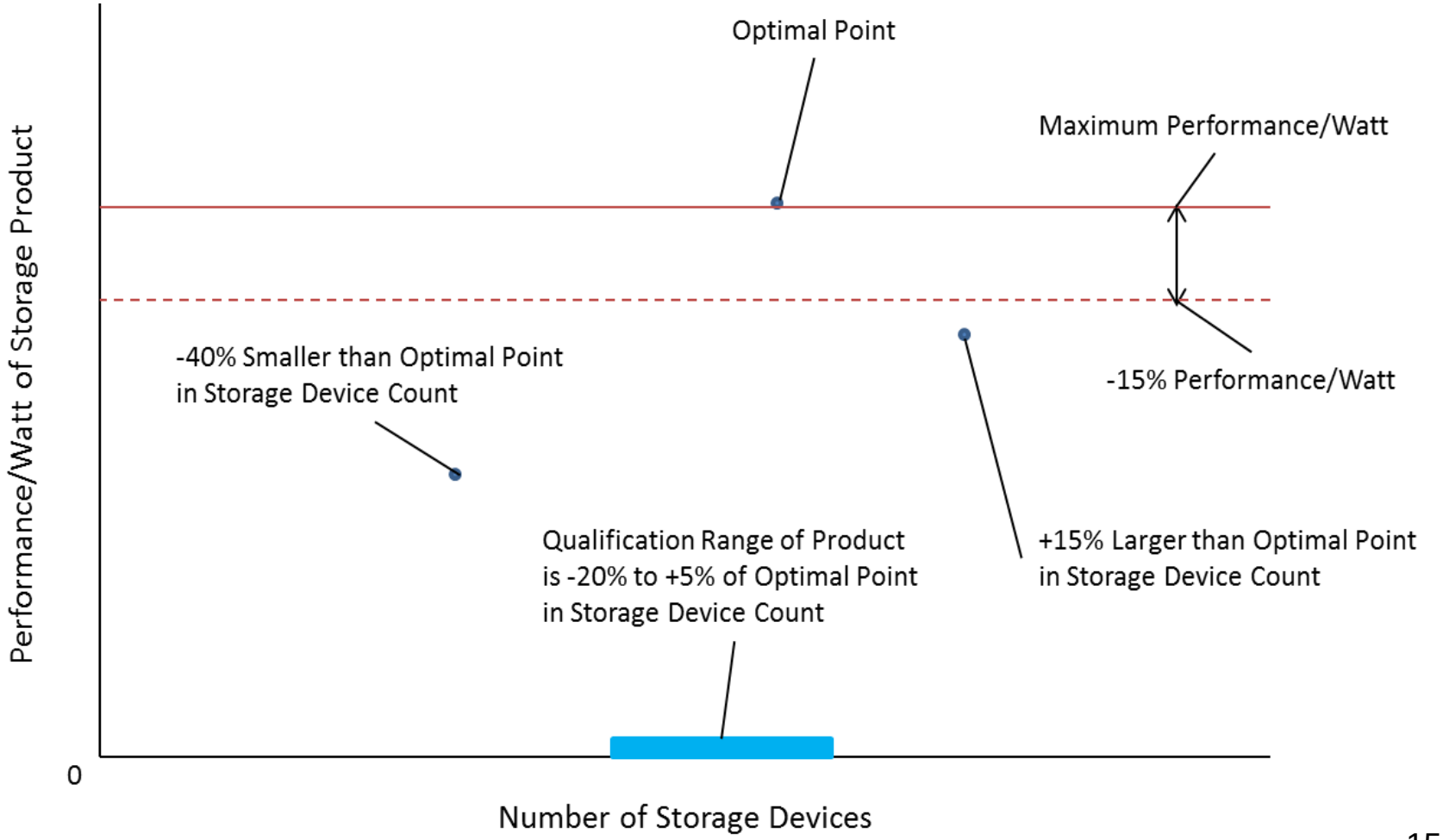
Out of Scope

- Personal / Portable Data Storage Products
- Computer Servers
- Blade Storage Products
- Direct Attached Storage Products
- Network Attached Storage products that cannot perform Block I/O
- Storage Products capable of object based storage

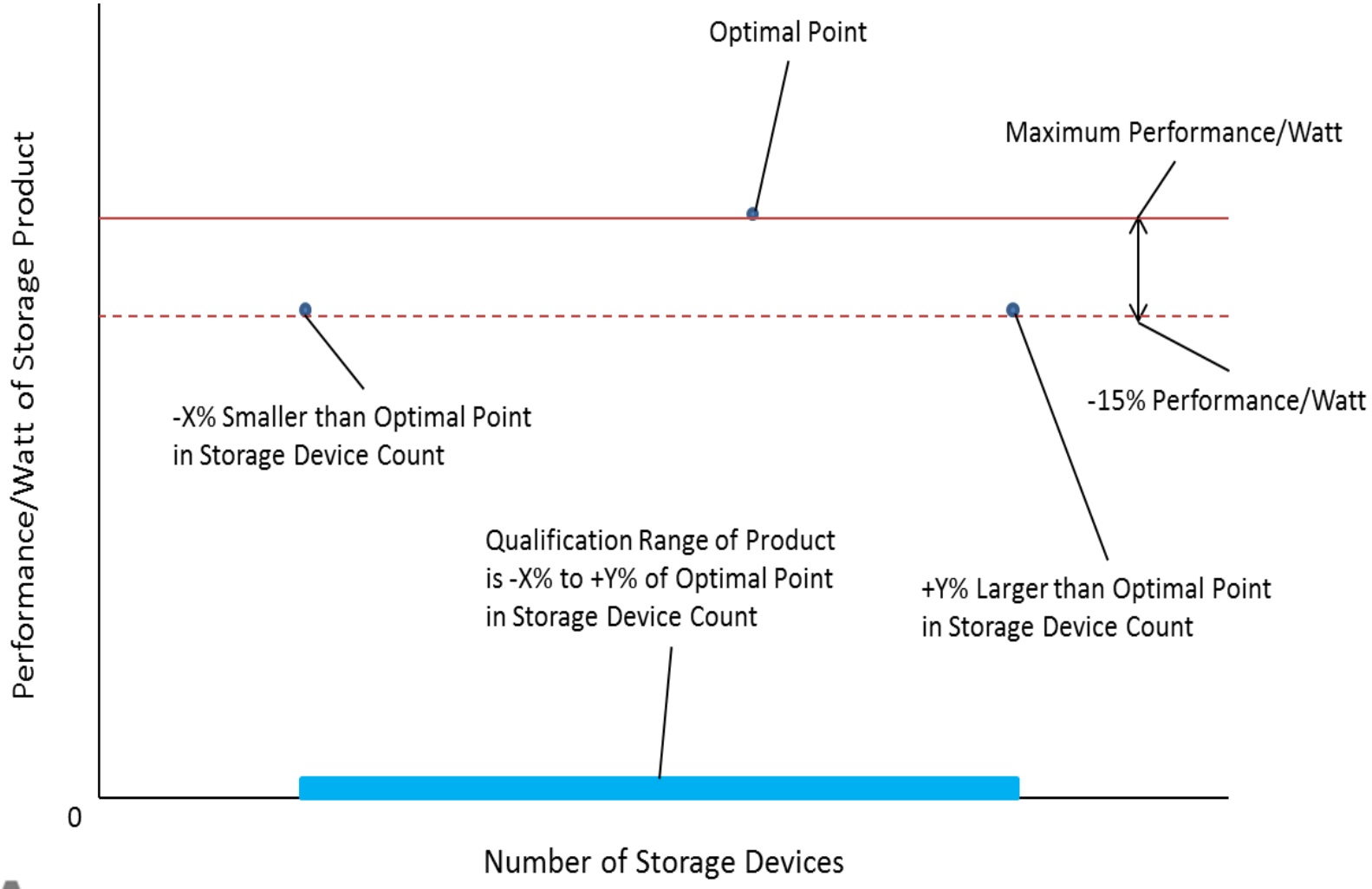
Qualified Range

- For all ranges, must test optimal point
- Fixed:
  - Test -40%, +15% device counts from optimal
  - Qualify -20%, +5%
- Flexible:
  - Test manufacturer-defined points, no more than 15% performance/watt drop off
  - Qualify out to manufacturer-defined points
- Mixed
  - Use Fixed for one side of the optimal, Flexible for the other.

In Pictures: Fixed



In Pictures: Flexible



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Power Supply Requirements

- 80 Plus Silver
  - PSUs for primary components
  - i.e. PSUs for controllers, drawers
- All other power supplies excluded from this requirement.

Power Modeling Requirements

- Use of a power/performance modeler is allowed for certification
  - Subject to criteria outlined later
- If modeled data is used for certification:
  - Partner is expected to make power modeling tools that can characterize the system, available to purchasers of the storage product.
  - Should provide performance/watt data for user-selected configuration characteristics

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Energy Efficiency Feature Requirements

- Adaptive Active Cooling:
  - Must utilize adaptive cooling tech that scales cooling to the current needs of the product.
- COMs:
  - Make available in quantities greater or equal to those listed in Table 4.

Energy Efficiency Feature Requirements - COMs

Table 3: Recognized COM Features

Feature	Verification Requirement
COM: Thin Provisioning	SNIA verification test
COM: Data Deduplication	SNIA verification test
COM: Compression	SNIA verification test
COM: Delta Snapshots	SNIA verification test[3]

Table 4: COM Requirements for Online 2, 3, and 4 Systems

Storage Product Category	Minimum number of COMs required to be made available
Online 2	0
Online 3	1
Online 4	1

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Information Reporting Requirements

- For every required testing point in system size, submit:

Workload Test
Hot Band
Random Read
Random Write
Sequential Read
Sequential Write
Ready Idle

Workload Weighting Requirements

- Manufacturers should use Table 6 to guide the creation of Optimal Configurations:

Table 6: Workload Weighting Requirements

Workload Test	Transaction Optimization	Streaming Optimization	Capacity Optimization
Hot Band	100%	0%	0%
Sequential Read	0%	70%	0%
Sequential Write	0%	30%	0%
Ready Idle	0%	0%	100%

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Testing Data Requirements

- Strongly encourage review of Sections:
  - 3.5.3
  - 3.5.4
  - 3.5.5
- Contain detailed instructions for designing, testing product families plus data points recorded.

Test Data for Scale-up, Physical Data only

- For a given workload type (e.g. transaction):
  - Physically test the optimal configuration point and applicable qualification range endpoints for the most commonly sold storage device
  - For additional storage devices in this workload type, only the optimal configuration points for those storage devices are required to be physically tested

Test Data for Scale-up, both Modeled and Physical Data

- For a given workload type (e.g. transaction):
  - Physically test the optimal configuration point and applicable qualification range endpoints for the most commonly sold storage device
  - Verify that modeled data for that configuration (using the same storage device) is within ±5% of the physical data collected above.
    - If within 5%, additional storage devices for the same workload type may submit modeled data for the optimal configuration point and additional points.
    - If not, follow Physical Data Only instructions on last slide.

Test Data for Scale-out Storage Products

- Same as for scale-up systems, but with following change to qualification range:
  - Only test the smallest marketed quantity of storage controllers / nodes available
  - Additional systems with a larger quantity of storage controllers may be optionally submitted

Testing Data General Rules

- Section 3.5.3.vii
- Configurations consisting of exclusively SSDs are not required to submit physical data, unless the SSD device is representative of the most commonly sold drive for that workload type.
- Verification of COM features is only required on testing of one storage device
- If automated storage tiering is enabled during testing, multi-storage device groups necessary for tiering may be counted as single storage devices when determining testing and qualification ranges, so long as the ratio of each device within a group remains as constant as possible

Testing Data General Rules

- If a product is not marketed with a storage device configurability or scalability that can achieve either the smaller or larger test points in system size required, then these points are not required
- Product families may not be based solely on Capacity workloads
  - Capacity must be submitted in addition to one or more other optimizations (transaction and/or streaming)

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Data Displayed on ENERGY STAR Website

- Product model name, model number, and SKU or other configuration identification number;
- A list of important product characteristics, including;
  - System configuration;
  - Storage controller details (e.g. model name and number);
  - Software configuration;
  - Storage controller power supply information;
  - Storage device drawer power supply information;
  - Storage devices used per optimization points
  - Input power and environmental characteristics during testing;
  - System power optimization capabilities;
  - Inlet air temperature and power consumption reporting capabilities.

Data Displayed on ENERGY STAR Website

- A list of qualified configurations within a family, including performance/watt data for the applicable workloads in Table 7:

Table 7: Active and Idle State Efficiency Test Results Displayed on the ENERGY STAR Website

Workload Test	Transaction Optimization	Streaming Optimization	Capacity Optimization
Hot Band	Yes	No	No
Random Read	Yes	No	No
Random Write	Yes	No	No
Sequential Read	No	Yes	No
Sequential Write	No	Yes	No
Ready Idle	Yes	Yes	Yes

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Storage Product Variation Allowances

- Once a product is qualified, system performance/watt may not change by more than 20%
- If >20%, must test new optimal configuration
  - Added to the existing product family
  - Expands scope of product family

Storage Product Variation Allowances

- To replace storage devices in a storage product without retesting, the following rules apply:
  - No change in:
    - Interface type, quantity, and transfer speed
  - Only an increase in the following:
    - Data capabilities, power management features, capacity, and cache size
  - Limited ±% variations of change in the following:
    - Average seek time, average latency, average power consumption, rotational speed and sustained transfer rate

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Standard Performance Data Measurement and Output Requirements

- Report input power at system level
  - Online 3 and Online 4 only
  - Optionally report inlet air temperature too
- Implementation shall follow the reporting and sampling requirements in Sections 3.7.2 and 3.7.3 of the specification.
- iPDUs may be used to fulfill these requirements if the storage product cannot
  - iPDUs must be made available for purchase with the storage product

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Test Method

- Provides guidance on input power and frequency requirements for the following product types:
  - Products with Ac-dc single output PSUs
  - Products with Ac-dc multi-output PSUs
  - Products with Ac-dc for Japanese markets
  - Three-phase products for North American market
  - Three-phase products for European market

Test Method

- Guidance on environmental test variables including:
  - Ambient temperature
  - Relative humidity
- Guidance on power meter and temperature sensor accuracy requirements

Test Method – Deviations from SNIA Emerald™ Specification

- Online 2 storage products must contain a controller with advanced data recovery capability
- Storage products shipped with COMs must disable all COMs that are capable of being disabled during the following tests:
  - SUT Pre-fill Test
  - SUT Conditioning Test
  - Active State Test
  - Ready State Idle Test

Test Method – Deviations from SNIA Emerald™ Specification

- Network Attached Storage (NAS) products that ship with Block I/O capability shall be tested under the following additional requirements:
  1. All usable storage devices not needed for minimal NAS capability shall be allocated to Block I/O for all testing
  2. NAS functionality shall be enabled for all testing
  3. No external NAS storage requests shall be presented to a product during testing

Remaining Version 1.0 Timeline

- June 20: Final Draft specification and test method released
- June 24 – 26:
  - SNIA Emerald test training for CBs, labs.
  - ENERGY STAR specification training for CBs, labs
- July 9: Final Draft stakeholder webinar
- July 15: Final Draft written comments due
- Late July:
  - Draft QPX form released for stakeholder review
  - Comments due +3 weeks later
- Early August:
  - Final Storage Program Requirements released
- Late August:
  - QPX system finalized
  - CB can start submitting applications
  - Submit test QPX data
- September 15: Deadline for first batch of CB applications
- October 1: EPA announces recognized CBs
- Early November: Version 1.0 Storage is effective
  - Note this is a three month delay until effective date
  - Due to unique complexity of this product category

References and resources

- ENERGY STAR Data Center Storage specification revision:
  - www.energystar.gov/NewSpecs
  - Select “Data Center Storage”

Questions?

Please send any questions to:
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Thank You!

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