

Index	Topic	Subtopic	Stakeholder Comment	EPA Response
1	Definitions	Product Types	A stakeholder suggested changes to add clarity to the product types definition. It was recommended that the term "storage media" be defined or replaced with "storage device" and that a more detailed description of "other devices" be used. Another stakeholder questioned the use of the term storage device in certain definitions (ex: NAS and SAN) and suggested referring to the 2012 SNIA Dictionary.	EPA will maintain the current definition using the term storage device as the term provides sufficient clarity. Also, the definition will remain open to "other devices" to prevent an unnecessary constraint on technologies.
2	Definitions	COMs	A stakeholder requested that the list of COMs be increased to include Automatic Tiering and other similar functions since product documentation can verify their availability. They suggested that an appropriate requirement would be that the documentation of these products be under some form of engineering control.	There is currently no test to detect auto-tiering in the SNIA V2.0 Emerald™ specification, so EPA is not able to recognize this as a COM at this time. EPA hopes that auto-tiering can be included in a future version of the Emerald specification, and notes that nothing prohibits manufacturers from enabling it in their systems.
3	Definitions	Thin Provisioning	A stakeholder suggested that the term "reallocating" be changed to "allocating" in the thin provisioning definition.	EPA has incorporated this change into Draft 4 of the specification.
4	Definitions	Storage Taxonomy	A stakeholder suggested that the term "moderate response time" and "moderate and long term" be further defined. They also suggested removing the optical disk reference in the removable media library and virtual media library definitions because this is a specific product. Also, they requested that "SAN" be deleted from the interconnect element definition because there are many types of switches.	The terms "Moderate response time" and "moderate to long response time" are defined in the definitions where the terms are used. The optical disk and SAN references are meant as examples to provide further clarity for the definition and are not intended to distinguish any product.
5	Definitions	Capacity	A stakeholder recommended adding the base + exponent to capacity examples (i.e. 1 MiB = 2 ²⁰ = 1,048,576 Bytes, 1 MB = 10 ⁶ = 1,000,000 Bytes). A stakeholder requested that references to raw capacity be used as is the standard in the SNIA Emerald™ Power Efficiency Specification.	MB and MiB are defined in the Capacity definition. Raw capacity is defined in Section F.5 of the definitions. The storage specification ties its requirements to storage device count and does not need to reference specific capacity amounts. The raw capacity definition is included for reference only.
6	Definitions	Operational States	One stakeholder suggested the addition of a definition of MaxTTFD and also a reference to avoid confusion. Another stakeholder recommended adding "user settable" to the mention of deep idle in the online storage definition.	The definition of Max TTFD is defined in the specification under Section J.6 in the definitions. The Deep Idle definition states that this capability must be a user-selected, optional feature of the storage product.
7	Definitions	Product Family - Cache	Several stakeholders had questions on the SSD storage device limit for cache and recommended that the manufacturers state cache size for each tested configuration within a product family. Stakeholders stated that the quantity of cache is somewhat dependent on the number of storage devices in a system. A different stakeholder agreed that a range of cache be allowed but suggested that it be a configuration variable instead of a qualification criterion because it is defined by the performance envelope and configuration. Two additional commenters stated that the allowable cache should be greater than or equal to the qualifying configuration. Another stakeholder supported the product family approach but believed that the amount of cache should be limited to the amount of the corresponding qualified configuration to prevent certain configurations from consuming more than the registered product.	EPA will maintain the current approach that a storage product may be qualified with any amount of cache (DRAM, SSD, etc.) that the manufacturer chooses to use in the qualified optimal configuration and that the qualified family of storage products may contain that amount of cache or larger without retesting. This enables manufacturers to define a floor for their products' cache performance, letting them scale cache upward from a minimum level of their choosing. This approach removes a possible confounding variable in understanding system behavior--namely, the possibility of system performance decreasing due to a smaller cache size.

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8	Definitions	Product Family - Configurations	<p>Stakeholders agreed with the definition of optimal configuration but pointed out that there is no requirement for homogeneous configurations. Another commenter suggested that vendors derive optimal configurations to show the best power performance ratio.</p> <p>A stakeholder believed that optimal configuration should be renamed Optimal Performance/Power Configuration (OPPC) because "optimal configuration" is used in regards to performance when communicating with customers.</p> <p>Several stakeholders stated that the terms maximum and minimum configuration were confusing because products could be configured outside of these terms. One stakeholder pointed out that these terms refer to a system with the minimum/maximum number of storage media to deliver an acceptable workload capability. A recommended change for these configuration terms was 'Maximum/Minimum Qualified Configuration'.</p> <p>Two commenters suggested that the -20% to +5% range for qualified systems is restrictive. One recommended that it be expanded to -40% to +15% or it should be allowed as a sliding bar.</p>	<p>EPA has provided additional clarification in Sections 1.1.2 and 1.1.7 that only single storage device configurations may be tested in the Draft 4 specification.</p> <p>EPA has maintained the Optimal Configuration definition, but has revised and renamed the Minimum and Maximum Qualified Configuration definitions to clarify that they are not the same as the minimum and maximum configurations offered by the manufacturer.</p> <p>EPA will maintain the current range for qualified storage products, but has added an Expanded Maximum Qualified Configuration in addition to the existing Expanded Minimum Qualified Configuration to provide more flexibility for products whose performance/watt remains within 15% of the Optimal Configuration outside the default qualified range.</p>
9	Definitions	Product Family - Mixed Configurations	<p>Several stakeholders offered cooperation and urged EPA to consider qualifications for heterogeneous configurations for several reasons:</p> <ul style="list-style-type: none"> • Optimum systems could result in configurations that would never be sold; which would be potentially confusing for customers • Test burden could be significant for qualifying a new product since it would require approximately 2 days to test each configuration for each device type • Predicted performance of heterogeneous systems would not be representative of real world situations <p>Another stakeholder suggested that limiting the optimal configuration to only homogeneous drives might be best for consistency. One stakeholder questioned how a mixed configuration would go through the qualification process.</p>	<p>While EPA agrees that heterogeneous testing would be ideal for reducing test burden, EPA maintains its concern that the current V2.0 SNIA Emerald specification does not provide sufficient insight into heterogeneous configuration performance and that applying it to such systems will not produce consistent results. The current homogeneous device testing proposal provides purchasers with targeted information that highlights how a given system will handle particular workloads and allows for estimation of how a heterogeneous system would behave, even if it does not directly test a heterogeneous device system.</p>

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10	Definitions	Product Family - Drawer Boundary	<p>Another point of concern for stakeholders was drawer rounding. Two stakeholders recommended that the requirement to round to the nearest shelf for minimum and maximum configurations be optional. Another stakeholder proposed that drawer rounding be applied to systems of any device count because a drawer that is not full, is not fully amortized. Another stakeholder pointed out that the quanta of less than one shelf reduces energy efficiency and all systems should be rounded to the nearest non-zero shelf boundary, independent of number of drives.</p> <p>A stakeholder stated that a 1-drawer allowance is not useful and it doesn't make sense to be liberal about size decreases and size increases because size increases are favored since they amortize the power used by the controller. A commenter recommended allowing product variance in either direction because testing a product at several levels can be expensive.</p> <p>A suggested strategy for drawer rounding from a stakeholder is as follows:</p> <ul style="list-style-type: none"> • Allow rounding of drawers for Online 3 and 4 systems • Allow maximum qualified configurations to be a full drawer above the optimal in order to simplify the maximum configuration designation • Allow the minimum configuration to be set at the nearest full drawer multiple below the 20% optimal drive count • Require workload metrics to be reported for the minimum/maximum systems after the rounding has been completed 	<p>EPA thanks stakeholders for their comments on this issue.</p> <p>If indeed drawer boundaries are the most efficient operational point, EPA would expect vendors to center submissions around those points. The current Draft 4 specification has included language stating that manufacturers may choose to round up (in Maximum Configuration) or down (in Minimum Configuration) to the nearest drawer boundary, and excludes Online 2 systems. In this way, EPA feels vendors whose systems are most optimal around drawer boundaries have the ability to test and submit results showcasing that, while at the same time not imposing architectural restrictions for developments which might be able to deliver energy efficiency at configuration points not aligned with full drawers.</p> <p>While only size increases may appear to be favored, EPA believes that rounding up to a larger drawer count (rather than down) in a Minimum Configuration will result in a smaller range of qualified product, as the space between Minimum and Maximum Configurations will be smaller. Many stakeholders have argued that scale-up systems are sold small and built up over time. EPA believes that rounding down allows smaller systems to qualify and provides purchasers with more relevant information for the systems they will likely be buying.</p>
11	Definitions	Product Family - Expanded Configuration	<p>A stakeholder requested expansion of the percentage differences required for comparison to the optimal configuration. The commenter also suggested that the comparisons be performed between each individual workload test score instead of creating a single score.</p>	<p>The Expanded Maximum and Minimum Qualified Configuration's performance difference requirement has been expanded to within 15% of the Optimal Configuration performance (performance/watt) based on stakeholder feedback. EPA agrees that this expansion will allow a more representative range of product sizes to qualify while maintaining the rigor of ENERGY STAR requirements for storage products.</p>

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12	Definitions	Product Family - Combinations of Optimal Configurations	<p>A commenter stated that the description for creating combined storage media systems from transaction and streaming systems is confusing and offered some additional clarifications and suggestions:</p> <ul style="list-style-type: none"> • Allow validated storage replacement options to be included in the combined systems • "lines 366 to 367: Reword this section to read: "The combined system does not contain any storage device, or its validated replacement storage device, at a greater percentage of total devices than that found in the OPPC (Optimal Performance/Power Configuration), Minimum Qualified, or Extended Minimum Qualified configurations." • "lines 374 to 375: This sub-section should be reworded to read: "When rounding to a drawer, Storage Devices should be added or removed (as appropriate) to maintain disk percentages in roughly the same proportion as the proportion used in the configuration before drawer rounding is initiated." " • Sub-section 1.I.iv should be removed because it restricts the percentages of storage devices in smaller configurations to the maximum percentage of the optimal or tested configurations. <p>Another stakeholder appreciated the idea of qualifying combinations of optimal configurations but stated that the algorithm would need to be rethought if optimal configurations were allowed to be heterogeneous. Another suggestion was to eliminate the complex criteria and state that all devices are required to be from one or more of the accepted configurations.</p>	<p>EPA has revised Section 1.I.7 to provide more clarity on the replacement of storage devices as well as providing drawer rounding guidance when multiple Optimal Configurations are combined. EPA welcomes stakeholder feedback on these changes.</p> <p>EPA is open to discussions on the algorithm for combining optimal configurations.</p>
13	Definitions	Product Family - Capacity Optimization	<p>A stakeholder supported the position that a capacity optimization configuration should be submitted in conjunction with a transaction or streaming optimized system.</p>	<p>EPA thanks this stakeholder for their feedback.</p>
14	Definitions	Scale-Out/Scale-Up	<p>A stakeholder stated that the definition for "Scale-Out Storage Product" doesn't reflect what is available on the market because there are products with controllers that have the ability to work in tandem and to add additional storage devices. For "Scale-Up Storage Products", they suggested the definition exclude products that have the ability to scale-out. The suggested definitions are:</p> <ul style="list-style-type: none"> • "Scale-Out Storage Product: A storage product in which independent functional nodes have the ability to work in tandem with additional nodes." • "Scale-Up Storage Product: A storage product in which additional storage devices can be added to the original controller(s) configuration as capacity needs increase, and in which all functional nodes operate independently from other functional nodes." <p>Another commenter noted that differences in scale-up and scale-out systems are blurring as technology advances. For example, most large systems can scale up to some defined number of storage devices and then scale out with additional controllers. They stressed the importance of not precluding recognition of either type in the definitions and that further discussion would be beneficial. A stakeholder recommended that the definition of scale-out products account for a node that contains a variable number of storage devices.</p>	<p>The definitions for scale-out and scale-up storage products have been removed and new definitions have been added to provide clarity. The new terms, "centralized controller storage" and "distributed controller storage", were added to Section J of the definitions. The Draft 4 specification contains requirements for both centralized controller storage as well as distributed controller storage. EPA looks forward to discussing these new definitions with stakeholders.</p>
15	Definitions	Maximum Sustainable Performance	<p>A stakeholder requested a reference to the Emerald™ specification stability criteria for sustainable performance.</p>	<p>EPA has removed the Maximum Sustainable Performance definition as it is not used in the most recent drafts of the V1.0 Storage specification or test method.</p>

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16	Definitions	Physical/Modeled Data	A stakeholder agreed with the physical and modeled data definitions.	EPA thanks this stakeholder for their feedback.
17	Qualifying Products		<p>A stakeholder questioned the inclusion of only online data storage products and recommended that more products are considered because of their role in efficient tiered storage concepts and can provide options for efficient storage management (e.g. MAIDS). However, excluding adjunct storage products, interconnect elements, and tape base long term storage products is appropriate.</p> <p>Another stakeholder expressed their need to evaluate the risk of having a small range of qualified systems compared to what is required to be tested although they understand why EPA has chosen a smaller range for qualified systems. This commenter expressed a need for industry to find a balance between testing systems and minimizing risk to ENERGY STAR.</p> <p>A stakeholder suggested that a product should only be in one online category for qualification purposes to ensure compatibility between Version 1.0 and 2.0.</p>	<p>While the addition of Near Online may be considered in future versions of the storage specification, it is too large of an alteration to the Version 1.0 specification at this time. Additional data or supporting information on Near Online systems is welcomed to support future development.</p> <p>The Online category definitions have been altered to clarify that a storage product should only exist in one category.</p>
18	Qualifying Products	RAID	A stakeholder requested that the requirement for a RAID capable storage controller be changed to "contains a controller with advanced data recovery capability such as RAID, mirroring/grid technology, or other comparable advanced error detection and recovery system." Some systems use mirroring/grid technology that is comparable to the functionality of RAID and can even improve performance. Another commenter suggested 'parity' as a better term than RAID and JBOD be used instead of Direct Attached Storage products.	Based on stakeholder feedback, EPA has clarified that all products submitted for qualification must include a controller with advanced data recovery capability, including but not limited to RAID. Based on stakeholder feedback, EPA believes the RAID requirement in Draft 3 was too restrictive for newer storage architectures.
19	Qualifying Products	Scale-Out/Scale-Up	<p>There were some concerns regarding scale-out and scale-up systems. One stakeholder encouraged communication regarding the exclusion of scale-out products that support a block interface. Another stakeholder expressed the need for "node" to be defined and data obtained to show the impacts of additional nodes. A different stakeholder recommended that scale-out products be excluded until a definition is agreed upon.</p> <p>One stakeholder suggested that only scale-out storage products beyond the first controller node where the system consists of more than 200 drives be excluded because the total scale-out system is greater than the sum of individual parts. Though these products are excluded, the stakeholder recommended that EPA allow companies to submit data for larger scale-out systems to determine if it should be included in Version 2.0.</p> <p>Another stakeholder agreed that scale-out systems be excluded only if the definition is changed to state that it is a storage product with independent functional nodes that have the ability to work in tandem with additional nodes. This commenter noted that products that scale-out but do not scale-up can compete with products that scale-out and scale-up so these products need to be on a level playing field to avoid a competitive advantage.</p>	See Index #14. EPA looks forward to discussing scale-up and scale-out systems with stakeholders when reviewing Draft 4.

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20	Power Supply Requirements	Efficiency Requirements	<p>Several stakeholders supported a consistency with CSCI Silver requirements and encouraged the removal of the 10% load point and the increase for efficiency requirements unless data can support. Commenters said that it would be confusing if the target efficiencies did not correlate with CSCI Silver and selecting levels between two recognized PSU performance categories makes comparison difficult when comparing qualified and non-qualified products.</p> <p>One stakeholder stated that correct sizing of power supplies is crucial to high overall efficiency which can lead to a larger saving potential than by striving to strengthen the power supply efficiency. Thus, the commenter suggested that this be referenced and requirements be established to provide online power calculation tools to help buyers choose the right power supply. Also, the supplier should offer several power supply models to serve different loads and configuration levels. The products equipped with redundant power supplies should include the option to switch this power supply into standby when not used.</p> <p>Another stakeholder requested that the power supply units section reference Rev 6.6 of EPRI Internal Power Supply Efficiency Test Protocol to be consistent with the Computer Server Requirement Version 2.0 and to include the most current version of the protocol.</p>	<p>Based on stakeholder feedback and additional research, EPA has removed the 10% load point from the power supply efficiency and power factor requirements in storage products.</p> <p>EPA will display the presence of power supply resizing functionality on the ENERGY STAR website, and will add the topic for consideration in future specification revisions.</p> <p>EPA has updated Section 3.2.1 to reference Rev 6.6 of the EPRI Internal Power Supply Efficiency Test Protocol to harmonize with the requirements in the V2.0 Computer Servers Program Requirements.</p>
21	Power Supply Requirements	Embedded Equipment	<p>A stakeholder supported requirements for efficiency of embedded PSUs that power primary components of a DC storage product but believed it necessary to include a requirement that all equipment in a storage system that falls under another ENERGY STAR specification (ex: servers, computers) also be qualified. The reason for this requirement being that a customer would expect all equipment in a labeled storage system be compliant. A stakeholder believed that it was not appropriate to require individual qualification of embedded products that are used as components in a storage system. A storage controller, for instance, will fit the definition of a server but is designed specifically to operate a storage system and will likely not perform well under ENERGY STAR server criteria.</p> <p>Several stakeholders agreed with the embedded equipment requirements because it keeps the focus on elements that require the most power in online storage products. One stakeholder stated that the amount of embedded power supplies and regulators can vary from product to product and testing and validating the efficiency of these components will be difficult. It is suggested that the efficiency should be assessed through performance of the product on the performance/power metrics.</p>	<p>EPA thanks the stakeholders for their comments and will maintain the current requirements of Section 3.2.1.iii that only embedded power supplies that power primary components of the storage product must meet the power supplies requirements in Table 1 and Table 2 of the Draft 4 specification. This issue has been discussed in the past and was deemed to introduce a high level of complexity with respect to component sourcing and coordination between unconnected and shifting updates of other ENERGY STAR specifications.</p>

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22	Active/Idle State Criteria		<p>One stakeholder agreed with the active and idle state disclosure but requested a ready idle and deep sleep requirement for the specification. The commenter stated that removing the idle requirements will create difficulty in identifying the most efficient products.</p> <p>Two stakeholders supported the proposal for collecting active metric data for transaction, streaming, and capacity optimized systems before setting qualifying criteria because there is insufficient data currently. One commenter stated that the lack of SNIA metric results, cost of obtaining systems and performing testing has created difficulty in providing the EPA with a broad data set. This commenter recommended that EPA publish the data received without references for two years to give manufacturers a better understanding of the test data for a range of system configurations.</p> <p>Another stakeholder stated that the 24-hour idle test is excessive but gave support for EPA's position on user-settable deep idle. This commenter requested the opportunity to work with the EPA to define a test for COM technology.</p>	<p>EPA will provide Ready Idle information for all configurations on the ENERGY STAR website in Version 1.0. Creating requirements for Ready Idle in Version 1.0 would lead to systems being optimized for Ready Idle, which produces non-representative data for transaction and streaming optimized systems. EPA cannot require a deep idle option as there is currently no test method to validate it.</p> <p>EPA will publish all active and idle data at the effective date of the Version 1.0 Storage specification.</p> <p>Based on stakeholder feedback, EPA has removed the 24 hour idle test requirement from the test method and now requires that testers follow the idle testing criteria presented in the V2.0 SNIA Emerald™ specification. The 24 hour period was suggested to help capture system behaviors that occur infrequently but which could have a significant impact on long-run power consumption. However, it is not clear at this time that 24 hours would capture all of these, so the gains from lengthier testing would not outweigh the additional burden. EPA will pursue the topic of idle power activities in future revisions of the Storage specification to better understand what an ideal idle test time would be.</p>
23	Power Management Requirements		<p>Several stakeholders appreciated the removal of the requirement for a power modeling presale tools warranty. One of these stakeholders requested clarification on the interest in power-performance modeling tools, validation of model data, and the process for using these models for qualification. A commenter encouraged using modeling data as an optional requirement because this information is confidential and not as well developed as it is for server products.</p> <p>Three stakeholders questioned whether this requirement regarded power calculators (customer tool to determine power required for a potential configuration) or a power-performance modeling tool that would predict performance/Watt for a configuration and workload. The power-performance modeling tool is viewed as experimental and additional information would need to be provided regarding the expected accuracy and calibration. One stakeholder proposed to ask for modeled data between three measured points and allow a vendor to chose a range for testing.</p> <p>Another stakeholder supported the availability of power modeling presale tools for online 4 systems and believed that performance per Watt is an easy metric for customers to understand.</p>	<p>EPA would like to clarify that for Online 4 systems that use modeled performance/watt data for qualification, EPA expects that a power modeling tool characterizing the storage product will be made available to manufacturer qualified purchasers of the product. EPA has made minor revisions to Section 3.3.1 to provide additional clarity on what this requirement is asking. Online 4 systems that do not use modeled data to qualify will not be subject to this requirement.</p>
24	Energy Efficiency Feature Requirements	Adaptive Cooling	<p>One stakeholder pointed out that some devices or units in a storage product do not require active cooling and requested that this requirement clarify that adaptive cooling is not necessary for these devices.</p>	<p>EPA has revised Section 3.5.1 to state that adaptive cooling requirements are not applicable to devices that employ passive cooling.</p>

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25	Energy Efficiency Feature Requirements	COMs	<p>A stakeholder requested that the COMs in Table 4 be defined. They stated it was regrettable that the list of energy efficiency features was reduced from the previous draft and additional features could be added. Exceptional cases where COMs would not be required should be defined rather than reducing the overall requirement.</p> <p>Other stakeholders wanted to further reduce the minimum number of required COMs. Several commenters suggested one COM be required for Online 3 and 4 systems because these systems may not have COMs initially designed into the system to meet a customer's needs. Two stakeholders requested 1 COM for Online 3 and 2 COMs for Online 4 be the requirement because Online 4 products demand performance rather than capacity optimization.</p> <p>Stakeholders gave the following reasons to not require that a number of COM functions be available for all qualified systems but the COMs available should only be listed on a PPDS:</p> <ul style="list-style-type: none"> • Many COMs require a higher level of power consumption and can degrade system performance (customers may choose to improve system utilization and accept performance degradation in some applications due to COM use) • A growing trend of COMs being managed by hardware appliance added to the system as opposed to being on system hardware • COMs functionality can be embedded into a product where that functionality brings benefits to a specific workload type and it is not possible to turn the COMs off 	<p>EPA will not add additional COMs to the energy efficiency feature list that can not be validated by an existing test. EPA encourages stakeholders to develop additional validation tools for COMs they would like to be considered in future revisions.</p> <p>Based on stakeholder feedback and a survey of products available on the market, EPA has revised the COMs requirements for Online 3 and Online 4 products in Table 4 of the Draft 4 specification.</p> <p>EPA would like to clarify that all COMs that are offered for a qualified product will be listed on the ENERGY STAR website.</p>
26	Energy Efficiency Feature Requirements	Proposed COMs	<p>Stakeholders requested an expansion of the list of available COMs. One requested that MAID, a feature that stops a spinning disk and enables power saving, and auto-tiering, which is a feature that allocates hot data to SSD and cold data to HDD, be included in the recognized COMs. Another stakeholder supported an opportunity to declare additional energy saving software and use these or SNIA defined COMs for the requirements of Table 4 (ex: Data Migration).</p>	<p>See Index #25</p>
27	Information Reporting Requirements		<p>A stakeholder expressed concern with publishing data and how it will be displayed. The data collected by EPA will never have been reviewed by industry for consistency, configuration errors, or interpretation discrepancies. They requested that this data remain anonymous for at least 2 years to allow stakeholders to understand its implications.</p> <p>A stakeholder was opposed to disclosing active performance and efficiency because active performance can be obtained from multiplying power by active state efficiency. Since storage systems are tailored to specific needs, each system would have its own performance parameters which could cause confusion for customers. If the data is published, they asked that it be anonymous.</p>	<p>EPA has revised Section 3.5.7 to clarify that all active and idle test results will be made available on the ENERGY STAR website as part of the qualification process.</p>

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28	Information Reporting Requirements	Active/Idle State Disclosure	<p>One stakeholder suggested changing the "Optional" requirement for transaction, streaming, and capacity optimization in Table 5 (Public Disclosure Requirements for Active and Idle State Efficiency) to "Not required".</p> <p>SNIA's "Hotband Workload" test should be finalized in October 2012 and two stakeholders believed that it should be incorporated into the Version 1.0 metrics collection process.</p>	<p>EPA will maintain the current use of "optional" in Table 5. EPA would like to clarify that all testing data shall be submitted via Certification Bodies, but only the required workloads in Table 5 will be shown on the ENERGY STAR website.</p> <p>EPA has incorporated the V2.0 SNIA Emerald™ specification into the Draft 4 specification and Draft 2 test method, with the hopes that the V2.0 Emerald specification will be finalized and fully functional prior the release of the Final Draft of the ENERGY STAR Storage specification. If the V2.0 Emerald specification does not meet this expectation, EPA will revert to referencing the V1.0 Emerald specification for the Final Draft of the specification and test method.</p>
29	Information Reporting Requirements	Workload Weighting	<p>Several stakeholders expressed confusion regarding the requirements listed in Table 6 (Workload Weighting Requirements) and some suggested its removal from the specification. Reasons for removing this requirement include:</p> <ul style="list-style-type: none"> • Flexibility is needed to develop storage systems for different markets • SNIA is working to improve the test methodology to show performance power improvement of cache and ENERGY STAR should wait to include this method to collect correct data for storage systems that utilize cache and caching algorithms • The requirements represent a blended score for transactional, streaming and capacity optimized workloads and there is little data on typical workloads to determine an appropriate proxy • Requirement improperly weighs metrics that have higher ranges over metrics with lower ranges • The results for "Mixed Workload 2" are not used for any purpose and should be removed. <p>One stakeholder supported the inclusion of Table 6 to ensure a level of commonality in different manufacturer's approach to defining Optimal Configuration but believed the table needed to be simplified as appropriate.</p>	<p>EPA has simplified the approach in Table 6 of the Draft 4 specification, while maintaining the goal of ensuring a level of commonality in different manufacturer's approach to defining optimal configurations. EPA welcomes stakeholder feedback on these revisions.</p>

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30	Information Reporting Requirements	Workload Weighting Proposals	<p>Two stakeholders offered an alternative approach to require comparison between individual workload test scores for a workload type, with the majority of the scores (3 for transaction, 2 scores for streaming and 1 for capacity optimization workload). The requirement would be that these majority scores have to be within 15% of the scores for the OPPC (Optimal Performance/Power Configuration) and the remaining scores within 20% of the OPPC scores (2 for transaction workload and 1 for the streaming workload). Also, they believed that 10% is too narrow of a band for comparison, and this range should be expanded to enable qualification of systems with a lower number of storage media. If this approach is adopted, it is also recommended that Table 6 be removed and a section for Extended Minimum Configurations be added to account for this method.</p> <p>A stakeholder also suggested that EPA collect metric results for different systems to assess their relative values and determine overall criteria for the different workloads. If there are significant differences in the data, then additional investigation will be required to create specific weighting criteria. Another stakeholder recommendation was to simplify the table with the following criteria:</p> <ul style="list-style-type: none"> • Transaction Optimization: 80/10/10 of the transaction workloads and eliminate the Mixed Workload 2 since it does not count in the weighting, or add it in as a 10% factor • Streaming Optimization: 50/50 of the sequential workloads • Capacity Optimization: 100: Ready Idle 	See Index #29. EPA looks forward to discussing this issue with stakeholder when reviewing Draft 4.
31	Information Reporting Requirements	Online 2/3 Storage Products	<p>The request for data at +15% and -40% of optimal configuration, while the qualification range is from -25% and +5%, will require interpolation so one commenter suggested that the required data submission bounds be the same as the maximum and minimum configurations. Also, one stakeholder stated that expansion in either direction for product size should be optional because some manufacturers have configuration limits. Another stakeholder requested that these requirement point to Table 5 instead of Table 6 (Workload Weighting Requirements).</p> <p>A commenter wanted clarification on why class 2 or 3 systems have more stringent testing requirements than class 4 products and believed that they should have the same treatment. They also stated that the 3-configuration test is onerous and a sliding bar percentage range should be used instead. This commenter pointed out that 15% of a 288-disk system is only 43.2 drives and rounding that is 0 shelves thus having the same as the optimal configuration. They recommended rounding up would be more appropriate in addition to not setting a limit on the size of the larger configuration, except to specify that it has more drawers than the optimal configuration. A stakeholder also suggested that Online 2 and 3 be allowed to provide modeled data.</p>	<p>EPA will maintain the current default ranges of system size for both qualification and testing, and would like to clarify that the range of qualification is a subset within the range of testing in most cases. The two ranges may be equal depending on how the system fits into the optional Expanded Minimum and Maximum Qualified Configuration provisions in Sections 1.1.3 and 1.1.4.</p> <p>EPA agrees that rounding to the nearest drawer boundary when testing larger systems can provide more energy efficient systems, and has revised Section 3.5.3 to allow rounding to the nearest drawer.</p> <p>EPA is allowing modeled data for O-4 systems only because of their large size, and the associated testing burden that comes with these systems.</p>

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32	Information Reporting Requirements	Online 4 Storage Products	<p>A stakeholder was confused by the fact that data is required to be submitted for the optimal configuration and for configurations at least 40% smaller and at least 15% larger, while the standard qualification range is only -20% and +5%. They assumed that there was an implication to calculate this envelope assuming linearity. This commenter recommended that the minimum and maximum configurations be measured directly and allowing manufacturers the option of submitting additional data for configurations outside of this range. Another suggestion was to set the minimum configuration at -25% to reflect typical configurations of purchasers. A commenter requested that the EPA state the allowable % difference between the model and actual measured data.</p>	See Index #31
33	Information Reporting Requirements	PPDS	<p>One stakeholder supported the development of the PPDS to better inform buyers. Another stakeholder recommended that the PPDS only include performance per Watt data without any raw performance numbers or raw power consumption data because this would contradict long-standing operating norms of the industry and will not add value for consumers. One additional commenter stated that the data should be anonymous or only the performance/power ratio be published. They also noted that the ASHRAE chart reference was not necessary.</p>	See Index #27
34	Storage Device Replacement Requirements		<p>Several stakeholders appreciated the attempt to reduce test burden with allowing substitutions outlined in the storage device replacement requirements. However, stakeholders had the following comments and suggestions regarding the requirements:</p> <ul style="list-style-type: none"> • Rotational media requirements are too narrow for significant testing reduction because there will be variance greater than 5% (alternative: use the requirements for non-rotational storage devices for rotating media while specifying that the rotational speed be equal) • Rotational speed should be removed from the "no change" requirements because rotational storage devices with optimized motor speed don't have rotational speed values in manufacturer's specification sheets • Cache size requirement for rotational speed be changed from "no change" to "equal or greater" because successor devices often have larger cache memory • Performance requirements for rotational devices be changed from "within +/- 5%" to "equal or improved" performance • Testing is not reduced by including the requirement that performance be impacted by less than 20% (some stakeholders suggested the removal of this section because there are limited means to assess if this is the case and current modelers have accuracies of +/- 15% to +/-20%) • A stakeholder suggested reversing net performance impacts for qualification ranges and device substitution (device substitution should have no greater than 10% impact on performance/Watt and qualified configuration range should be expanded to -20%) • Another stakeholder recommended changes in parameters is permitted within the limits stated for each item, where "equal" has a +/- 5% tolerance 	Based on stakeholder feedback, EPA has simplified Section 3.6 and revised several of the requirements within the section. EPA welcomes stakeholder feedback on these changes.

Index	Topic	Subtopic	Stakeholder Comment	EPA Response
35	Standard Performance Data Measurement and Output Requirements		Three stakeholders recommended that Online 2 storage products be exempt from the Standard Performance Data Measurement and Reporting requirement because of their limited capacity and non-expandable nature. Their proliferation in a data center is limited and the cost of the product is disproportional to the cost of the required infrastructure.	EPA agrees with these statements and has revised Section 3.7 to apply only to Online 3 and Online 4 storage products.
36	Standard Performance Data Measurement and Output Requirements	Data Elements	<p>A stakeholder supported the inclusion of the air inlet temperature measurement but suggested that since there are many unknowns related to this measurement, the vendor should define the main inlet point, recording where it is and how it is measure and then reporting this information on the PPDS.</p> <p>Three stakeholders agreed with the proposal to make this requirement optional. One stated that in terms of operational management, collecting temperature data via wireless LAN from multiple thermal sensors distributed in a data center is more suitable for unified management in a data center. They also stated that there is little demand for embedded thermal sensors in a storage product and the placement of the sensors is spatially challenging because the air inlet is usually where drives are densely packed.</p> <p>Another stakeholder stated that temperature is a facilities-side concern and would prefer to allow the market to decide whether external or embedded devices is the best solution.</p>	<p>EPA will maintain the current optional air inlet requirements proposed in Draft 3, but welcomes additional feedback from stakeholders on which temperature data is important for collection during qualification. EPA does not currently specify where these measurements take place, allowing manufacturers to choose as needed.</p> <p>EPA thanks stakeholders for their support and is open to further discussions on appropriate forms of mandatory temperature data collection in Storage Products for future specification revisions.</p>
37	Standard Performance Data Measurement and Output Requirements	Reporting Implementation	A stakeholder believed that limiting the implementation of data reporting stifles innovation of storage products and requested that add-in devices be allowed in Version 2.0.	See Index #36
38	Standard Performance Data Measurement and Output Requirements	Sampling Requirement	<p>A stakeholder requested allowing a 30 second frequency where the data is provided with a time stamp, in addition to reporting on a 10 second frequency. The time stamp will allow the collection system to match up multiple readings to get a constant view of the data center power profile while enabling the collection system to poll less frequently.</p> <p>In terms of input power sampling, one stakeholder believed it would be appropriate to state that the data be provided only via a pull mechanism by external software. This commenter requested further discussion on the value of providing a rolling average of 3 samples rather than the software that is using the data provide its own rolling average. However, a new trend in data center management software, provides its own information that is likely to use actual rather than averaged data. Also, they believed that the sampling accuracy should have a range of +/- 5% because this is the capability of the available parts to perform this work. An alternative approach to the sampling requirement would be to require that the supplied data be less than 30 seconds old, allowing implementation to be up to each manufacturer.</p>	EPA has revised Section 3.7.3 to harmonize with the V2.0 Computer Servers Program Requirements, which includes provisions for time stamping and updated language on data sampling requirements. EPA welcomes stakeholder feedback on these changes.

Index	Topic	Subtopic	Stakeholder Comment	EPA Response
39	Timeline		<p>A stakeholder indicated that there is an inadequate amount of time to allow certification bodies and labs to implement the specification. These bodies usually have not dealt with products of this size and complexity. One stakeholder referenced the UPS specification as support of their argument and stated that at least six months would be necessary after the publication of the final draft.</p> <p>One stakeholder supported the effective date and stated that the specification will become active in the European Union three to six months after the January 2013 date.</p>	<p>EPA understands stakeholder concerns regarding the size and complexity of these products. The CBs and labs that EPA has worked with on other complex products such as servers have shown that they are capable of learning quickly and handling complexity. EPA acknowledges that storage is even more complex than servers, and is therefore proposing a three month window between publication of the final specification and the effective date (where typically for new products there would be no window). EPA is also coordinating with SNIA to ensure adequate hands-on training for CBs and labs and will monitor the situation to ensure that everyone is ready by the effective date.</p>
40	Proof of Concept		<p>Another stakeholder offered support by performing an assessment of the potential complexities associated with product family and replacement storage device processes by testing the qualification process on two or more actual products.</p>	<p>EPA thanks the stakeholder for this offer and has been working with stakeholders during the development of the Draft 4 specification to evaluate any complexities with the specification methodology, as well as test methodology (V2.0 SNIA Emerald specification). EPA is appreciative of the considerable stakeholder resources that have been provided during this effort and sees this as an excellent indicator of the future success of this specification.</p>
41	Considerations for Future Revisions		<p>A stakeholder suggested several considerations for future specification revisions:</p> <ul style="list-style-type: none"> • Addition of energy efficiency requirements (ex: step-wise reduction of disk speed, parking of disk heads, batching requests and intelliseek) • Widening qualifying products to include more than online storage products because other types can play a role in efficient tiered storage concepts (ex: MAIDS) • Criteria for active and idle state efficiency by possibly categorizing data storage technologies and defining more than one set of requirements (ex: SSD technology may have higher efficiency) <p>It is also recommended that work on version 2 will begin soon after the effective date to make the lifetime of version 1 short.</p>	<p>EPA will consider these and any other suggestions for future revision considerations and will finalize the list in the Final Draft specification. EPA welcomes additional feedback on potential future considerations for Storage Products in the Version 2.0 Storage specification. Clearly highlighting future concerns now will help EPA and stakeholders to make preparations to address them prior to future Storage Version 2.0 development.</p>