

Ref. #	Topic	Subtopic	Stakeholder Comments	EPA Response
1	Definitions	General	Several stakeholders requested that all definitions in the specification align with the SNIA dictionary.	EPA will continue to harmonize with definitions in the SNIA dictionary whenever possible. In some instances, definitions differ to more accurately fit the context of the ENERGY STAR Data Center Storage specification.
2	Definitions	Thin Provisioning	Stakeholders supported the revisions to the Thin Provisioning definition.	EPA thanks stakeholders for these comments.
3	Definitions	Cache	Stakeholders agreed with the change from the term 'media' to 'devices' in the Cache definition.	EPA thanks stakeholders for these comments.
4	Definitions	Single-output Power Supply	Two stakeholders recommended this definition state that the total rated power output from all additional PSU outputs that are not primary and standby outputs should be less than <u>or equal to</u> 20 Watts. Also, they requested that EPA clarify that not primary means standby or standbys.	EPA has made minor revisions to the single output power supply definition, including allowing the total rated output from all additional PSU outputs that are not primary or standby outputs to equal up to 20 watts, rather than less than 20 watts as proposed in the Draft 4.
5	Definitions	Optimal Configuration	Two stakeholders asked if the unit for performance for the Optimal Configuration should be expressed in GB/s or GB or GB/W. One of these stakeholders requested consistency with Emerald by using units of MiB as opposed to MB. Also, a stakeholder stated that the definition of Optimal Configuration should use the term 'peak performance point' in place of 'maximum sellable energy efficiency performance' because the configuration being described represents the maximum energy efficiency performance for a specific device type using a designated workload. Many models may offer multiple device types in different combinations and the customer would choose one of the tested configurations, thus the term should be focused on what it represents to the purchaser.	EPA has clarified that MiB is the metric to be used for transfer rates, and GB for capacity, in the Final Draft specification. EPA has also changed the previous term "maximum sellable energy efficiency performance point" to "peak energy efficiency performance point".
6	Definitions	Drawer Rounding	Several stakeholders supported Draft 4's approach to drawer rounding for the Maximum and Minimum Qualified Configurations. Another stakeholder recommended differentiating between standard (typically 2U) versus dense drawers when drawer rounding is applied.	EPA does not have enough information on high density drawers to alter the current rounding guidance. Stakeholders shall follow the requirements listed in qualification and testing range sections of the Final Draft.
7	Definitions	Expanded Min/Max	A stakeholder supported the increase of allowable performance per watt range to 15% for the Expanded Minimum and Maximum systems.	EPA thanks the stakeholder for this comment.
8	Definitions	Systems Composed of Combinations of Single Device Optimal Configurations	Various stakeholders requested examples on the procedure for combinations of single device optimal configurations. A few stakeholders stated that the reference to NAS functionality in this definition is confusing because the Emerald specification does not cover NAS.	EPA has distributed a set of PowerPoint slides outlining the procedure for combining drives and hopes that they answer stakeholder questions. EPA looks forward to further stakeholder discussions as needed on this topic.
9	Definitions	Capacity Optimization Family Restriction	Stakeholders asked about the motivation for requiring high throughput or I/O efficiency from a system designed to hold data in the Capacity Optimization Family Restriction because 80% of the world's data is only stored and not read.	EPA has clarified that since the scope of Version 1.0 only includes Online systems, which are expected to have responses times of < 80ms, that it is important to collect energy efficiency performance data on the product's ability to write and read data, whether that be random and/or sequential.

10	Definitions	Centralized/ Distributed Controller Storage	<p>One stakeholder recommended that the definitions for 'Scale Up' and 'Scale Out' be maintained from Draft 3 because they are industry recognized terms. They also requested that EPA allow instances of 'Scale Out' systems to be qualified to the specification but not require that it be qualified with multiple nodes because the test method is not proven. They believed that the definition for Distributed Storage Controller be as follows:</p> <ul style="list-style-type: none"> • 'A storage product for which each drawer can contain up to a defined number of storage devices and a dedicated controller and the storage product consists of a minimum to a maximum number of drawers integrated as individual nodes on a single rack.' <p>A stakeholder stated that industry could not agree on definitions for Centralized and Distributed Controllers. Another stakeholder noted that the definitions were acceptable but seem unnecessary. They stated that the approach seems to assume Distributed architectures are always composed of free-standing modules with fully replicated infrastructure, however this is not correct of all products that fit this definition.</p>	<p>EPA has renamed the centralized and distributed controller definitions "Scale-up storage" and "Scale-out storage". The centralized and distributed controller storage definition names were introduced in Draft 4 to provide additional clarity, but stakeholders have since stated that scale-up and scale-out are common industry accepted terms and should remain as initially proposed in the Draft 3.</p> <p>These definitions have been revised slightly to clarify how redundant controllers are accounted for when categorizing a system as scale-up or scale-out.</p>
11	Definitions	Parity RAID	<p>Three stakeholders noted that since the specification now supports an expanded set of technologies for error detection/correction, it would be more appropriate to replace the terms 'Parity RAID' and 'grid technology' with a more generic term such as 'error detection/correction' in order to avoid unnecessary restrictions on these technologies. One of these stakeholders pointed out that the phrase "included RAID controller" should be changed to "included storage controller" accordingly.</p>	<p>EPA has removed the previous Parity RAID definition and replaced it with a more general Advanced Data Recovery Capability definition. This definition aligns with the description of Parity RAID requirement found in Draft 4. The definition supports scope inclusion terminology found in Section 2.1.1.iv.a, which was introduced in Draft 4.</p>
12	Scope	Included Products	<p>A stakeholder noted that it was unnecessary to state that object based storage is an exception to the Included products in the specification because this type of storage is listed specifically in the Excluded products.</p> <p>One stakeholder requested that Scale-up or Distributed Controller Storage be implemented in the scope of Version 1.0. However, another stakeholder believed that it was too late in the Version 1.0 specification development process to include Distributed Controller architectures in the scope and recommended that EPA focus only on Centralized designs for Version 1.0.</p>	<p>EPA has clarified that storage products capable of any level of object based storage are excluded from scope in Version 1.0.</p> <p>Both scale-up and scale-out storage products will continue to be in scope for Version 1.0.</p>
13	Scope	Excluded Products	<p>Two stakeholders requested that a section be added to state an exemption from ENERGY STAR requirements for embedded components (e.g., switches, displays, etc.) in a storage system. Another stakeholder supported the exclusion of Network Attached Storage (NAS) that cannot perform block function because the Emerald™ Specification is not capable of testing these systems. They also requested an exclusion be added for Multi-node Scale-out storage products.</p>	<p>There is an automatic exemption for such products as they are covered separately by other ENERGY STAR product specifications. Embedded components in a storage product is considered part of the storage product for testing and certification purposes. Only primary embedded components (controllers, drawers) are subject to power supply requirements in Section 3.2.</p> <p>EPA will maintain the current NAS requirements.</p> <p>EPA will maintain the current scope on scale-up and scale-out systems. Multi-node scale-out systems fall under the scale-out definition in Version 1.0.</p>
14	Power Supply Requirements		<p>Several stakeholders supported the removal of the 10% load point for power supply testing. A stakeholder requested that the requirements for PSUs in Table 2 (Power Factor Requirements for PSUs) be collapsed into a single row for simplicity. Another commenter requested that the requirement for Efficiency and Power Factor in Embedded Equipment be clarified to state that embedded products that do not power primary components of the storage product are not subject to PSU requirements and are also not required to be individually ENERGY STAR qualified.</p>	<p>EPA has consolidated Table 1 and Table 2 in Section 3.2 into a single row each, as the requirements are the same for all PSUs</p>

15	Power Modeling Requirements	Presale Tool	A stakeholder recommended that the language requiring that a power modeling tool be made available to manufacturer qualified purchasers of the product should be changed to "will be made available to purchasers of an ENERGY STAR Qualified storage product" to add clarity. Another stakeholder requested this requirement explicitly state that a power modeling tool must be made available to purchasers in order for manufacturers to comply.	EPA thanks stakeholders for these comments, but will maintain the current language in Section 3.3.
16	Energy Efficiency Feature Requirements	Adaptive Active Cooling	Several stakeholders requested clarity on the Adaptive Active Cooling requirements: <ul style="list-style-type: none"> • Is an inlet ambient air sensor required for reporting or for controlling fan speed? Is this only for primary components? • Is the requirement for direct inlet air temperature measurement to be made and entered into the fan speed control algorithm? How will this be verified? • This requirement should refer to the "associated cooling needs" to relate the behavior back to ambient temperature. 	EPA has removed the reference to ambient air temperature conditions in proximity to the storage product as to not exclude other types of potential cooling (e.g. liquid cooling).
17	Energy Efficiency Feature Requirements	COMs	Several stakeholders agreed with the reduction in the number of available COMs required to qualify a system as the Draft 3 levels would disqualify systems that would otherwise meet the specification requirements. However, another stakeholder noted that COMs assist in reducing the overall energy consumption of the system and believed that more stringent COM requirements should be implemented.	EPA and industry agree that COMs are complicated, and the energy they save is highly dependent on the data being handled and particular workloads. At this time, we believe they are best handled on a case-by-case basis for users. EPA will work with industry to educate users on the potential benefits of COMs, but an across the board requirement is difficult to support at this time.
18	Information Reporting Requirements	Mixed Drive Testing	Several stakeholders expressed concern over the clarifications in the "Proposed Path to Final Draft Data Center Storage Version 1.0" document not being clearly spelled out in the specification. This document states that pure SSD or Storage Class Media can be utilized in a system without physical testing however the requirements do not clearly delineate if/how a company can combine SSD and HDD storage devices to create physical configurations for testing. They recommended that the specification include language to state that combined systems can include SSDs as one of the storage devices in the system without testing of a system configuration fully or partially populated with SSD drives. Another stakeholder recommended that 3 data points (peak performance, device count of vendor's choosing above peak, and device count of 80% below peak) be provided for the most popular drive for an optimization type. All other device types would subsequently be tested only at their peak/optimal point and up to 10% of the device count could be supplied by SSDs configured as user-addressable storage without testing of an optimal SSD drive count. If this approach is not acceptable, they recommended that EPA obtain measurements from a wide range of devices chosen by the manufacturer and the -40% and +15% points would still be collected as currently outlined. A commenter noted that there is no qualification method for heterogeneous drive configurations and recommended that a method be provided to incentive to show the benefit of tiered systems. Another stakeholder requested the following language be added to clearly include the requirement for testing only the Optimal Configuration for additional drive types: "The manufacturer determined optimal configuration point for each additional drive type tested beyond the drive type tested in 3.5.3.i.a-c (or 3.5.4.i.a-c)."	EPA has simplified and clarified the existing qualification and testing range language in Sections 1.1, 3.5.3 and 3.5.4. For more detail please reference the Final Draft.
19	Information Reporting Requirements	Active/Idle Disclosure	A stakeholder requested clarification if at least 3 sets of Best Foot Forward (BFF) data (drive types of manufacturer's choice) are required and additional sets of BFF data (other drive types) are optional.	See Index #18

20	Information Reporting Requirements	PPDS	<p>Stakeholders asked if the PPDS or a Data Reporting Template will be used to collect data for the storage specification. They also requested that EPA publish a proposed data collection template as soon as possible. Several questions regarding data collection are listed below:</p> <ul style="list-style-type: none"> • What details about the storage controller are required? • What is meant by system power optimization capabilities? Also, how is this different from a list of power management and additional power saving features available and enabled by default? • What ASHRAE Thermal Report is being request and what is the selected data? • How should the vendor provide a list of qualified products if products in a family are differentiated only by the need to supply test points for each qualified drive type? These products will have the same model number and the synthesized heterogeneous configurations are the objects that the customer will be purchasing. 	<p>EPA no longer intends to use a standardized PPDS for Data Center Storage. EPA is currently developing the Qualified Product eXchange (QPX) document which will be used to collect all reported test data for ENERGY STAR certification. Manufacturers, CBs, and labs will have an opportunity to review this document prior to finalization. All data the EPA intends to publish will be displayed on the Qualified Product List (QPL) on the ENERGY STAR website. A subset of high level purchaser-oriented information will be presented in the new ENERGY STAR Product Finder Tool, which can be found at: http://www.energystar.gov/productfinder/</p>
21	Information Reporting Requirements	Table 5: Active and Idle State Efficiency Test Results Displayed in PPDS	<p>A stakeholder noted that the relationship between Table 5 and the various places in which it is referenced is confusing. They recommended that the table be moved to Section 3.5.7 and that all references to it should state that the 6 data points shall be submitted to EPA on the document that the Certification Bodies provide to EPA.</p> <p>Another stakeholder asked if the items in Table 5 listed as optional are truly optional because language in the specification appears to mandate all test results. If the intent was to state which results are mandatory to submit but optional to report publicly, they recommended a clarification.</p>	<p>EPA has created a new Table 7 to clarify which active and idle state test results will be displayed on the ENERGY STAR website. This table is similar to the previous Table 5 in Draft 4, but replaces the terms “required” and “optional” and with “yes” and “no” to further clarify which data will be displayed. EPA will no longer provide the option of displaying information that is not required in this Version 1.0 specification. .</p>
22	Information Reporting Requirements	Table 6: Workload Weighting Requirements	<p>A stakeholder pointed out that Random Read and Random Write were no longer presented on Table 6. Another stakeholder believed that setting workload weightings to assess the workload types is premature however stated that the current approach is acceptable if EPA collects a sufficient sample of SNIA Emerald™ tests to assess which workload test provides a representative metric. They also requested that only the performance/power scores be reported on the PPDS and not the response time data.</p>	<p>The hot band workload test in Table 6 is a combination of random and sequential workloads, developed off a series of real world end-user workloads collected by industry. The hot band workload is skewed towards random workloads, and therefore will represent random workloads in transaction based configurations when calculating workload weightings. Random workloads will still be tested and submitted as required by Table 5.</p>
23	Information Reporting Requirements	Online 2/3 Testing	<p>A stakeholder stated that it may not be possible for all storage systems to be resized in one direction or another and a reference to item (f) would be useful to indicate this. Two stakeholders requested clarification on what an all-SSD system should report and if these configurations can be ENERGY STAR qualified without submitting physical test points. Also, they questioned if these configurations are eligible by only providing the supporting PPDS information.</p>	<p>EPA has clarified that the exclusion on physical testing for SSDs does not apply to configurations consisting of mixed storage devices where one of the devices is a SSD or when a SSD storage device is representative of the highest deployed volume by the manufacturer.</p>
24	Information Reporting Requirements	Online 4 Testing	<p>A stakeholder recommended that the discussion of testing Online 4 products focus solely on the procedures used if modeled data is provided because the direct measurement of Online 4 systems is otherwise identical to the methods and requirements for Online 2 and 3 systems. Several stakeholders stated that accuracy requirements for modeling tools should be discussed in more detail because a 10-15% accuracy level in a modeler could allow disparity between different vendors thus the level of accuracy, how it would be validated, and what level of detail would be required need to be provided.</p> <p>One stakeholder asked if the model can be used to qualify Expanded Minimum or Maximum configurations. Another commenter noted that disk drawers may perform sub-optimally when not full and so the requested date may not be helpful. They suggested asking for modeled data point on each shelf boundary to a maximum of 6 points required in each direction.</p>	<p>EPA has revised the approach on modeled data in Section 3.5.4. Provisions for modeling now apply to all storage products in the scope of Version 1.0. The accuracy required to use modeled data has been set at ±5%.</p>

25	Storage Device Replacement Requirements		<p>Stakeholders had the following comments, questions, and recommendations on the Storage Device Replacement Requirements:</p> <ul style="list-style-type: none"> • Specific details on the specifications of capacity, rotational speed, and bus interface/transfer speeds are confidential between disk vendors and system vendors and may not be posted publicly or shared. This information should not be required to be submitted to EPA. • The limit on the degree that performance/watt is degraded by a substitution is understandable however, the need to limit the degree that a substitution can improve performance/watt is not clear. Capacity increases through technology improvements may deliver increased transfer speed from the device. Also, this may limit vendor's ability to respond to changing parts availability in a timely manner. • The requirement that replacement drives have the same interface type should be removed because there are some interfaces (e.g., SAS, Fibre Channel, etc.) which will have the same speed and may appear in the same quantity. Also, what is wrong with a faster interface? <p>One stakeholder proposed the +/-5% requirements be changed to within +/-10% because some successor storage devices with the same physical capacity have greater values than 5%, such as sustained transfer rate.</p>	<p>EPA has further simplified Section 3.6 and made the following significant changes to this section:</p> <ul style="list-style-type: none"> - The 20% performance/watt improvement cap now applies to all changes in the system. - The form factor requirement has been removed. - Variables that previously were allowed a tolerance of ±5% are now allowed a variance of ±10%. - The sustained transfer rate has been given a higher allowable variance. <p>Please see the Final Draft specification for more details.</p>
26	Measurement and Output Requirements		<p>A commenter stated that the input power measurement requirements should say 'as demonstrating a tolerance of less than or equal to 5% of the actual value for measurements greater than 200 W' because it is more accurate.</p> <p>Another stakeholder noted that the input power measurements must be contiguously sampled at least once in a 10 second interval, internally to the storage product. They pointed out that a rolling average may be used to filter spikes and noise but should be no longer than 30 seconds and contain at least 3 contiguous samples. However, one stakeholder asked why a rolling average is necessary and also why the internal sample rate matters, except for accuracy. They also requested sampling examples and that language be added to clarify that time-stamping is optional.</p> <p>A stakeholder agreed with the approach to align with the Computer Server specification reporting requirements but to report inlet temperature as an optional item for Version 1.0. However, another stakeholder noted that storage systems have significant differences from computer servers such as scale (servers have a single chassis). They stated that these differences need to be taken into account in the input power sampling requirements. For a medium/large storage system, the number of power sensors which must be queried can get quite large (10s to 100s). The sampling requirements might interfere with the system's primary task when scaled to such magnitudes and so they recommended a simple, scalable set of data reporting to encourage an industry-wide specification creation for this data.</p>	<p>EPA has clarified that input power and optional air inlet temperatures shall be made at the system level. Additionally, the input power rolling average requirement has been removed from Version 1.0.</p>
27	Measurement and Output Requirements	iPDUs	<p>Several stakeholders asked for the following clarifications of the requirement that iPDUs must "Be available for sale and delivery with qualified ENERGY STAR storage products."</p> <ul style="list-style-type: none"> • Does it have to be sold or offered as an option? • Can a manufacturer refer a customer to a third party to purchase it? • What if a customer previously purchased data center iPDUs in existing rack space or purchases multiple systems that can share a single PDU? <p>One stakeholder requested that the sampling requirements be modified to accommodate a PSU based implementation that reports input power on a per PSU/plug basis (or per chassis) and an iPDU implementation that reports input power per iPDU.</p>	<p>EPA has clarified that iPDUs which satisfy the requirements in Section 3.7 must be available on the manufacturer's website or in marketing material along with the storage product information. The manufacturer may use third party sources for the iPDUs, but the iPDUs must be listed as a marketed and supported option for the storage product being qualified.</p>

28	Testing	SNIA	<p>Stakeholders recommended that the language be modified to require that all active and idle testing be completed in accordance with the SNIA Emerald™ Specification Version 2.0 Rev. 1 and the EPA test method document be eliminated. They stated that all environmental and accuracy parameters are already set in the Emerald™ Specification and any additional EPA requirements not explicitly detailed in the Emerald™ specification can be included under Section 4. They also recommended that SNIA reference the User Guide in Table 7 (Test Methods for ENERGY STAR Qualification) to ensure quality and repeatability of data. Two commenters believed EPA received sufficient data to validate the Hot Band workload to identify it as the test method.</p> <p>Another stakeholder noted a need for clarity and consistency on sources and revisions of referenced documents including verbatim use of table defining values (such as those used in the test method) and aligning definitions that appear in more than one product category.</p>	<p>EPA will maintain the current ENERGY STAR Data Center Storage Test Method, as part of the final ENERGY STAR Version 1.0 Data Center Storage Program Requirements.</p> <p>Environmental variables in the ENERGY STAR test method are consistent with other ENERGY STAR data center product test methods, and ASHRAE guidance on testing data center products.</p>
29	Testing	Replacement Drives	<p>A stakeholder provided the following adjustment suggestions for criteria for replacement devices:</p> <ul style="list-style-type: none"> • After data is generated for one type of HDD storage media for a given product family, additional storage media should be qualified after reporting test data only for the optimal configuration. • Enable companies to qualify products with a quantity of SSDs. • Remove common interface requirements for evaluation of replacement drives to enable drives with comparable performance and power profiles to be grouped. <p>Without these changes, the stakeholder noted that the testing would take 6-7 weeks as opposed to 6-7.</p>	See Index #18
30	Future Revisions		<p>A stakeholder recommended several considerations for future revisions of the Storage specification including:</p> <ul style="list-style-type: none"> • Energy efficiency requirement - an addition of a number of other energy efficient features • Included products - expand the scope to include more than just online data storage products, such as MAIDS, near-online systems, and NAS. • Criteria for active state and idle state efficiency by categorizing storage technologies and defining more than one set of requirements. • Power supply rightsizing - requiring manufacturers to provide online power calculation tools that support buyers in choosing the right sized power supply. • Requiring products equipped with redundant power supplies to offer an opportunity to switch the redundant power supply into standby when not being used. 	EPA thanks the stakeholder for these suggestions, and has implemented them into Section 6 of the Final Draft.
31	Test Method	Input Power and Frequency Requirements	<p>Two stakeholders requested that 400V ac be added to the 3-phase requirements and also that 3-phase frequency should be changed to '50Hz or 60Hz'. They also had the following questions regarding these requirements:</p> <ul style="list-style-type: none"> • How to accommodate line voltage without power conditioner for high power systems? Also, is 1.5 the correct kW threshold to change from conditioned power to line voltage? • Should 208V (in addition to 230V) be considered for line voltage for high power systems? <p>One of these stakeholders stated that +/- 1.0% voltage sources cost approximately \$5,000/1000W and systems in taxonomy 4 can use several thousand watts. A stakeholder also provided data on the relationship between PSU efficiency and input voltage</p>	EPA has added European three-phase test voltage and frequency requirements. All voltage tolerance ranges have also been increased from ±4% to ±5% for products with rated output greater than 1500W.
32	Test Method	NAS	<p>Two stakeholders requested verification that the test method approach for NAS system configurations that offer block I/O options is only necessary when the NAS functionality cannot be disabled or reconfigured. Some products offer a NAS option on a block system but the addition of more equipment will only add to power draw without improving performance. Also, the additional equipment is not necessary for the operation of the block portions of the system.</p>	EPA has clarified that if a system is being sold ONLY as Block I/O, then no additional NAS equipment is needed. However, if the system is being sold with a combination of NAS and Block I/O, then any and all additional equipment needed to support the NAS capability must be included, configured and in a minimal ready-idle state.

33	Test Method	Idle Testing	Several stakeholders supported the reduction of the idle test period from 24 hours to the test specified in Version 2.0 of the Emerald™ Specification.	EPA thanks the stakeholders for these comments.
34	General	Anonymized Data	<p>Several stakeholders requested an anonymous reporting time period of 18-24 months similar to that proposed for servers because:</p> <ul style="list-style-type: none"> • There is a limited amount of test data that has been generated to date by the SNIA Emerald™ Specification. • Industry will need to assess the data to ensure there are no repeatability issues, biases, or anomalies prior to public posting. • This is the first large-scale assemblage of data sets from the SNIA test methodology. <p>One stakeholder recommended that EPA publish limited Emerald test data on the PPDS as opposed to publishing all of the workload test scores, if the anonymous period is not acceptable.</p>	<p>EPA does not plan to anonymize or delay test data publication as this data is the primary benefit of the ENERGY STAR program for Storage. Delaying for 18 - 24 months would greatly reduce the specification's utility for that time period. EPA will work with partners and CBs to address issues with repeatability, biases, or anomalies in generated data.</p>