ENERGY STAR® Program Requirements for Data Center Storage

Partner Commitments

Following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacture and labeling of ENERGY STAR certified products. The ENERGY STAR Partner must adhere to the following partner commitments:

Certifying Products

1. Comply with current ENERGY STAR Eligibility Criteria, which define performance requirements and test procedures for Data Center Storage. A list of eligible products and their corresponding Eligibility Criteria can be found at www.energystar.gov/specifications.

2. **Prior to associating the ENERGY STAR name or mark with any product**, obtain written ENERGY STAR certification from a Certification Body recognized by EPA for Data Center Storage. As part of this certification process, products must be tested in a laboratory recognized by EPA to perform Data Center Storage testing. A list of EPA-recognized laboratories and certification bodies can be found at www.energystar.gov/testingandverification.

Using the ENERGY STAR Name and Marks

3. Comply with current ENERGY STAR Identity Guidelines, which define how the ENERGY STAR name and marks may be used. Partner is responsible for adhering to these guidelines and ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance. The ENERGY STAR Identity Guidelines are available at www.energystar.gov/logouse.

4. Use the ENERGY STAR name and marks only in association with certified products. Partner may not refer to itself as an ENERGY STAR Partner unless at least one product is certified and offered for sale in the U.S and/or ENERGY STAR partner countries.

5. Provide clear and consistent labeling of ENERGY STAR certified Data Center Storage.

   Partner shall adhere to the following product-specific commitments regarding use of the ENERGY STAR certification mark on certified products:

   5.1. Partner must use the ENERGY STAR mark in all of the following ways:

   5.1.1. The ENERGY STAR mark shall be included on the product specification sheet on the Partner's Web site where product information is displayed. This mark shall serve as a hyperlink from the manufacturer's specification sheet to the ENERGY STAR product website for Data Center Storage;

   5.1.2. The ENERGY STAR mark shall be used to identify certified storage products and storage product families in electronic and printed marketing collateral materials, including but not limited to user manuals, product guides, and marketing brochures.

   5.2. If additional information about the ENERGY STAR program(s) or other products provided by the Partner on its Web site, Partner must comply with the *ENERGY STAR Web Linking Policy*, which can be found at www.energystar.gov/partners.

Providing Information to EPA

6. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:

    6.1. Partner must submit the total number of ENERGY STAR certified Data Center Storage shipped in the calendar year or an equivalent measurement as agreed to in advance by EPA and Partner. Partner shall exclude shipments to organizations that rebrand and resell the shipments (unaffiliated private labelers).

    6.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.

    6.3. Partner must submit unit shipment data for each calendar year to EPA or an EPA-authorized third party, preferably in electronic format, no later than March 1 of the following year.

    Submitted unit shipment data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner;

7. Report to EPA any attempts by recognized laboratories or Certification Bodies (CBs) to influence testing or certification results or to engage in discriminatory practices.

8. Notify EPA of a change in the designated responsible party or contacts within 30 days using the My ENERGY STAR Account tool (MESA) available at www.energystar.gov/mesa.

Performance for Special Distinction

In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures, and should keep EPA informed on the progress of these efforts:

- Provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR certified products, and to promote awareness of ENERGY STAR and its message.

- Consider energy efficiency improvements in company facilities and pursue benchmarking buildings through the ENERGY STAR Buildings program.

- Purchase ENERGY STAR certified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR certified product information to employees for use when purchasing products for their homes.

- Feature the ENERGY STAR mark(s) on Partner website and other promotional materials. If information concerning ENERGY STAR is provided on the Partner website as specified by the ENERGY STAR Web Linking Policy (available in the Partner Resources section of the ENERGY STAR website), EPA may provide links where appropriate to the Partner website.

- Ensure the power management feature is enabled on all ENERGY STAR certified displays and computers in use in company facilities, particularly upon installation and after service is performed.

- Provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR certified products.

- Provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, and communicate Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR website, etc. The plan may be as simple as providing a list

of planned activities or milestones of which Partner would like EPA to be aware. For example, activities may include: (1) increasing the availability of ENERGY STAR certified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrating the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) providing information to users (via the website and user's manual) about energy-saving features and operating characteristics of ENERGY STAR certified products; and (4) building awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event.

- Join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. The SmartWay Transport Partnership works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit www.epa.gov/smartway.

- Join EPA's Green Power Partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities. For more information on Green Power, visit www.epa.gov/greenpower.

ENERGY STAR® Program Requirements
Product Specification for
Data Center Storage

Eligibility Criteria
Draft Version 1.1

1 Following is the Draft Version 1.1 ENERGY STAR Product Specification for Data Center Storage. A
2 product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1   DEFINITIONS

4   A. Product Types:

5   1) Storage Product: A fully-functional storage system that supplies data storage services to
6   clients and devices attached directly or through a network. Components and subsystems that
7   are an integral part of the storage product architecture (e.g., to provide internal
8   communications between controllers and disks) are considered to be part of the storage
9   product. In contrast, components that are normally associated with a storage environment at
10   the data center level (e.g., devices required for operation of an external SAN) are not
11   considered to be part of the storage product. A storage product may be composed of
12   integrated storage controllers, storage devices, embedded network elements, software, and
13   other devices. For purposes of this specification, a storage product is a unique configuration
14   of one or more SKUs, sold and marketed to the end user as a Storage Product.

15   2) Storage Device: A collective term for disk drives (HDDs), solid state drives (SSDs), tapes
16   cartridges, and any other mechanisms providing non-volatile data storage. This definition is
17   specifically intended to exclude aggregating storage elements such as RAID array
18   subsystems, robotic tape libraries, filers, and file servers. Also excluded are storage devices
19   which are not directly accessible by end-user application programs, and are instead
20   employed as a form of internal cache.

21   3) Storage Controller: A device for handling storage request via a processor or sequencer
22   programmed to autonomously process a substantial portion of I/O requests directed to
23   storage devices (e.g., RAID controllers, filers).

24   B. Storage Product Connectivity:

25   1) Direct-attached Storage (DAS): One or more dedicated storage devices that are physically
26   connected to one or more servers.

27   2) Network Attached Storage (NAS): One or more dedicated storage devices that connect to a
28   network and provide file access services (File I/O) to remote computer systems.

29   3) Storage Area Network (SAN): A network whose primary purpose is the transfer of data
30   between computer systems and storage products. A SAN consists of a communication
31   infrastructure, which provides physical connections, and a management layer, which
32   organizes the connections, storage controllers / devices, and computer systems so that data
33   transfer is secure and robust. The term SAN is usually (but not necessarily) identified with
34   block I/O services rather than file access services.

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	Note: EPA has clarified in the NAS definition that file access and File I/O are synonymous, and that the SAN definition is typically identified with Block I/O services for the purposes of this specification.
36 37	

C. <u>Capacity Optimizing Methods (COMs)</u>[1]: The reduction of actual data stored on storage devices through a combination of hardware and / or software. Common COMs include:

1) <u>Thin Provisioning</u>: A technology that allocates the physical capacity of a volume or file system as applications write data, rather than allocating all the physical capacity at the time of provisioning.

2) <u>Data Deduplication</u>: The replacement of multiple copies of data – at variable levels of granularity – with references to a shared copy in order to save storage space and/or bandwidth.

3) <u>Compression</u>: The process of encoding data to reduce its size. For the purpose of this specification, only lossless compression (i.e., compression using a technique that preserves the entire content of the original data, and from which the original data can be reconstructed exactly) is recognized.

4) <u>Delta Snapshots</u>: A type of point-in-time copy that preserves the state of data at an instant in time by storing only those blocks that are different from an already existing full copy of the data.

D. <u>Storage Taxonomy</u>[1]: A categorization scheme for use in segmenting the data center storage market by end-use application and key product characteristics. The major categories of the taxonomy that are referenced in this document are as follows:

1) <u>Online Storage</u>: Storage products that are intended to service a mixture of Random and Sequential I/O requests with a short response time. All data stored in Online storage must be accessible MaxTTFD ≤ 80 ms, unless the storage product is in a Deep Idle state. Online storage is typically comprised of one or more HDDs or SSDs and a storage controller, and provides primary data storage to supplement a Computer Server's internal memory.

2) <u>Near-online Storage</u>: Storage products that are intended to service a mixture of Random and Sequential I/O requests with a short to moderate response time. Near-online storage products offer an asymmetrical response; a portion of data may be accessible MaxTTFD ≤ 80 milliseconds, while other data may be accessible MaxTTFD > 80 milliseconds.

3) <u>Virtual Media Library</u>: Storage products that are intended to service primarily Sequential I/O, with a short response time. The media in a Virtual Media Library (e.g., HDD, optical disk) is not designed to be physically removed from the system. All data stored in the Virtual Media Library must be assessable MaxTTFD ≤ 80 ms, unless the storage product is in a Deep Idle state. Virtual Medial Libraries are intended primarily for moderate and long term data storage.

4) <u>Removable Media Library</u>: Storage products that are intended to service primarily Sequential I/O, with a moderate to long response time. The media (e.g., tape cartridge, optical disk) in a Removable Media Library is designed to be physically removed from the storage product. Removable Media Libraries are intended primarily for long term data archiving.

5) <u>Adjunct Storage Products</u>: Products which closely support storage devices by adding in real time value or additional control capabilities not present in the storage device(s) itself. Examples include SAN based virtualization controllers, NAS gateways, or other storage services. A key feature of these products is that no end user data is primarily stored on Adjunct Storage products, though data may be held in cache or other working buffers.

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[1] The ENERGY STAR storage taxonomy and COM references in this document are consistent with the terminology developed by the Storage Networking Industry Association Green Storage Initiative as defined in "SNIA Emerald[TM] Power Efficiency Measurement Specification" Version 3.0.1. Further detail may be found at www.snia.org/green.

| 79 | | 6) | Interconnect Element: Devices which provide for interconnection functionality within a storage area network. Examples include SAN Switches, etc. |
| 80 | | | |

79   6)   Interconnect Element: Devices which provide for interconnection functionality within a storage
80   area network. Examples include SAN Switches, etc.

81   E.   Other Data Center Equipment:

82   1)   Computer Server: A computer that provides services and manages networked resources for
83   client devices (e.g., desktop computers, notebook computers, thin clients, wireless devices,
84   PDAs, IP telephones, other computer servers and other network devices). A computer server
85   is sold through enterprise channels for use in data centers and office/corporate environments.
86   A computer server is primarily accessed via network connections, versus directly-connected
87   user input devices such as a keyboard or mouse. For purposes of this specification, a product
88   must meet all of the following criteria to be considered a computer server:

89   i)   is marketed and sold as a Computer Server;

90   ii)   is designed for and listed as supporting computer server operating systems (OS) and/or
91   hypervisors;

92   iii)   is targeted to run user-installed applications typically, but not exclusively, enterprise in
93   nature;

94   iv)   provides support for error-correcting code (ECC) and/or buffered memory (including both
95   buffered DIMMs and buffered on board (BOB) configurations)

96   v)   is packaged and sold with one or more ac-dc or dc-dc power supplies; and

97   vi)   is designed such that all processors have access to shared system memory and are
98   visible to a single OS or hypervisor.

99   2)   Network Equipment: A device whose primary function is to provide data connectivity among
100   an arbitrary combination of devices connected to its several ports. Data connectivity is
101   achieved via the routing of data packets encapsulated according to Internet Protocol, Fibre
102   Channel, InfiniBand or other standard protocol. Examples of network equipment commonly
103   found in data centers are routers and switches.

104   3)   Power Distribution Unit (PDU): A single- or three-phase power strip designed for data center
105   use. A PDU may include instrumentation for metering power input and output, switched
106   outlets for control of individual receptacles, or other advanced features.

107   i)   Intelligent Power Distribution Unit (iPDU): A PDU with additional functionality to provide
108   operational measurements of power consumption and environmental temperature.

109   4)   Blade Storage: A storage product that is designed for use in a blade chassis. A blade storage
110   product is dependent upon shared blade chassis resources (e.g., power supplies, cooling) for
111   operation.

112   5)   Cache: Temporary storage used to transparently store transitory data and which is not
113   directly addressable by end-user applications. Primarily used for expediting access to or from
114   (typically) slower devices.

115   F.   Capacity: Capacity is reported in units of either binary bytes (1 MiB = 1,048,576 Byte) or decimal
116   bytes (1 MB = 1,000,000 Byte).

117   1)   Assigned Capacity: The amount of space on a system or data container which has been
118   allotted to be written by an end user or application. (Note: For thin provisioning systems, an
119   assigned capacity number represents a promise that that amount of space will be provided on
120   demand; usable capacity is allocated as the container is written too. For fully-provisioned
121   systems, usable capacity must be committed at the same time the container is allocated.)

122   2)   Effective Capacity: The amount of data stored on a storage product, plus the amount of
123   unused formatted capacity in the system.

3) <u>Formatted (Usable) Capacity</u>: The total amount of bytes available to be written after a storage product or storage device has been formatted for use (e.g., by an object store, file system or block services manager). Formatted capacity is less than or equal to raw capacity. It does not include areas set aside for system use, spares, RAID parity areas, checksum space, host- or file system-level remapping, "right sizing" of disks, disk labeling and so on. However, formatted capacity may include areas that are normally reserved – such as snapshot set-asides – if these areas may be configured for ordinary data storage.

4) <u>Free Space</u>: The amount of unused, formatted capacity as reported by the storage product.

5) <u>Raw (Addressable) Capacity</u>: The sum total amount of addressable capacity of the storage devices in a storage product. The raw capacity of a storage device is commonly understood to be the number of bytes available to be written via SCSI or equivalent protocol. It does not include unaddressable space, ECC (error correcting code) data, remap areas, inter-sector gaps, etc.

G. <u>Operational States</u>:

1) <u>Active State</u>: The state in which a storage product is processing external I/O requests.

2) <u>Idle State</u>: An operational state in which the storage product is capable of completing I/O transactions, but no active I/Os are requested or pending. The system may, however, be servicing self-initiated I/Os from background data protection and cleansing, and other operations not initiated by the user.

   i) <u>Ready Idle</u>: The state in which a storage product is able to respond to arbitrary I/O requests within the MaxTTFD limits for its taxonomy category, but is not receiving external I/O requests. The storage product may perform routine housekeeping tasks during Ready Idle, provided such operations do not compromise the product's ability to meet MaxTTFD requirements.

   ii) <u>Deep Idle</u>: A state in which one or more storage product components or subsystems have been placed into a low-power state for purpose of conserving energy. A storage product in Deep Idle may not be able to respond to I/O requests within the MaxTTFD limits for its taxonomy category, and may need to perform a managed 'wake-up' function in order to return to a Ready Idle or Active State. Deep Idle capability must be a user-selected, optional feature of the storage product.

H. <u>Power Supply Unit (PSU)</u>: A device that converts ac or dc input power to one or more dc power outputs for the purpose of powering a storage product. A storage PSU must be self-contained and physically separable from the system and must connect to the system via a removable or hard-wired electrical connection. Note: Storage PSUs may be Field Replaceable Units (FRUs), but in some cases may be further integrated with the storage product.

1) <u>Ac-dc Power Supply</u>: A PSU that converts line-voltage ac input power into one or more dc power outputs.

2) <u>Dc-dc Power Supply</u>: A PSU that converts line-voltage dc input power to one or more dc power outputs. For purposes of this specification, a dc-dc converter (also known as a voltage regulator) that is internal to a storage product and is used to convert a low voltage dc (e.g., 12 V dc) into other dc power outputs for use by storage product components is not considered a dc-dc power supply.

3) Single-output Power Supply: A PSU that is designed to deliver the majority of its rated output power to one primary dc output. Single-output PSUs may offer one or more standby outputs that remain active whenever connected to an input power source. For purposes of this specification, the total rated power output from all additional PSU outputs that are not primary or standby outputs shall be less than or equal to 20 watts. PSUs that offer multiple outputs at the same voltage as the primary output are considered single-output PSUs unless those outputs (1) are generated from separate converters or have separate output rectification stages, or (2) have independent current limits.

4) Multi-output Power Supply: A PSU that is designed to deliver the majority of its rated output power to more than one primary dc output for the purpose of powering a storage product. Multi-output PSUs may offer one or more standby outputs that remain active whenever connected to an input power source. For purposes of this specification, the total rated power output from all additional PSU outputs that are not primary and standby outputs must be greater than or equal to 20 watts.

5) Redundant Power Supplies: Two or more PSUs that are configured to maintain uninterrupted output load in the event of failure of one PSU.

I. Product Family: A group of models/configurations that share a set of common attributes that are variations on a basic design.

1) Common Product Family Attributes: A set of features common to all models/configurations within a product family that constitute a common basic design. All models/configurations within a product family must share the following:

   i) made by the same manufacturer;

   ii) be from the same model line or machine type;

   iii) utilize the same model of storage controller;

   iv) fall under the same taxonomy category; and

   v) contain equal or greater amount of cache than the corresponding certified configuration.

2) Optimal Configuration: A product configuration that lies between the minimum and maximum certified configurations and is representative of a product with maximum peak energy efficiency performance (performance/watt) for a given workload. This configuration is provided by the manufacturer and may be optimized for the following workload types:

   i) Transaction: A workload optimized for random I/O usage measured in I/O per second per watt;

   ii) Streaming: A workload optimized primarily for sequential I/O usage, measured in MiB per second per watt;

   iii) Composite (File I/O products only): A workload optimized for mixed I/O usage, measured in MiB per second per watt.

   iv) Capacity (Block I/O products only): A workload optimized for maximum storage as measured by GB (Raw Capacity) per watt.

Note: EPA received stakeholder feedback suggesting that in order to expand the scope to include File I/O systems, a new File I/O only optimization called composite is necessary to properly address those systems. Feedback received indicates that the existing transaction and streaming definitions remain applicable. EPA is proposing this composite definition, has specified that it is only applicable to products certified as File I/O, and clarified that the existing capacity optimization is only applicable to Block I/O products.

210   3) Fixed Certification Range: Defined by testing product configurations at the Optimal
211   Configuration and at points that are 40% smaller and 15% larger in storage device count than
212   the Optimal Configuration. This certification range is fixed at 20% smaller and 5% larger than
213   the Optimal Configuration. Product configurations which are unable to be configured for either
214   the Fixed Maximum or Fixed Minimum Certified Configuration are not required to perform that
215   respective test. In such a case, the certification range is limited to the region between the
216   Optimal Configuration and whichever one of the Fixed Configurations is tested.

217   i)   Fixed Maximum Certified Configuration: A product configuration that includes the
218   combination of base components that generates a system which is 5% larger in storage
219   device count than the Optimal Configuration.

220   (a) The resulting storage device count may be rounded up to the nearest drawer
221   boundary.

222   ii) Fixed Minimum Certified Configuration: A product configuration that includes the
223   combination of base components that generates a system which is 20% smaller in
224   storage device count compared to the Optimal Configuration.

225   (a) The resulting storage device count may be rounded down to the nearest drawer
226   boundary.

227   4) Flexible Certification Range: Defined by testing product configurations at the Optimal
228   Configuration and at two manufacturer chosen points, one smaller than the Fixed Minimum
229   Certified Configuration and one larger than the Fixed Maximum Certified Configuration.
230   This certified range is extended out to the smaller and larger points, provided they are
231   within 15% of the Optimal Configuration's performance/watt value.

232   i)   Flexible Maximum Certified Configuration: A product configuration that includes a
233   combination of base components that generate a system which is larger in storage device
234   count than the Fixed Maximum Certified Configuration and which is within 15% of the
235   Optimal Configuration performance/watt, validated through the testing data requirements
236   in Section 3.5 below.

237   (a) Performance will be measured using the appropriate relative weighting of workloads
238   defined in Table 6 or Table 7.

239   (b) Modeled data may not be used for Expanded Maximum Certified Configuration
240   submissions.

241   (c) The resulting storage device count may be rounded up to the nearest drawer
242   boundary.

243   ii) Flexible Minimum Certified Configuration: A product configuration that includes a
244   combination of base components that generate a system which is smaller in storage
245   device count than the Fixed Minimum Certified Storage Configuration and which is within
246   15% of the Optimal Configuration performance/watt, validated though the testing data
247   requirements in Section 3.5 below.

248   (a) Performance will be measured using the appropriate relative weighting of workloads
249   defined in Table 7 or Table 8.

250   (b) Modeled data may not be used for Expanded Minimum Certified Configuration
251   submissions.

252   (c) The resulting storage device count may be rounded down to the nearest drawer
253   boundary.

5) Mixed Certification Range: Defined by testing one of the fixed points in 1.I.3 and one of the flexible points in 1.I.4, provided they are on opposite sides of the Optimal Configuration. On the side with the Flexible Configuration, the certification range is extended from the Optimal Configuration out to the chosen flexible point. If the Fixed Minimum Certified Configuration was chosen, the range is kept to 20% smaller than the Optimal Configuration. If the Fixed Maximum Certified Configuration was chosen, the range is kept to 5% larger. A fixed testing point described in 1.I.3 can be used in place of a flexible testing point described in 1.I.4 to extend a range of certification so long as that point in storage device count is within 15% of the Optimal Configuration performance/watt, validated through the testing data requirements in Section 3.5 below.

6) Systems Composed of Combinations of Single Device Optimal Configurations: A product family which has demonstrated more than one Single Device Optimal Configuration may be sold as ENERGY STAR certified using a combination of those Single Device Optimal Configurations, provided all of the following apply:

   i) Combined systems are configured using only those storage devices, or validated replacement storage devices (Section 3.6), and configuration options which were used in the individual certified Optimal Configurations.

   ii) The combined system consists of percentage allocation of storage devices, or validated replacement storage devices (Section 3.6), from one or more Optimal Configurations.

   iii) The total sum of all percent allocations of storage devices drawn from the Optimal Configurations must equal 100%.

   iv) After allocation, storage devices and drawers are rounded per the Maximum and Minimum Certified Configuration rules above.

   v) When rounding to a drawer, storage devices are added or removed (as appropriate) to maintain storage device percentages in a proportion as close as possible to the proportion used in the combined system configuration prior to drawer rounding.

   vi) Allocation of Optimal Configurations is also used when a storage product provides Block I/O capability in addition to NAS capabilities. In this usage, the system wide percentage of defined allocations will include the portion of the system providing NAS functionality.

   vii) Multiple transaction or streaming optimizations may be submitted to incorporate different storage device technologies and customer usage needs.

7) Systems Composed of Multiple Device Types in an Optimal Configuration: An Optimal Configuration that contains more than one type of addressable storage device may be certified as part of an ENERGY STAR product family provided **all** of the following apply:

   i) System features used during certification of Multiple Device Configurations must include automated storage tiering for those portions of the Multiple Device Configurations containing mixed storage devices.

   ii) If SSD storage devices are used as part of the certified Multiple Device Configuration, they must be included in all certification testing and modeling.

   iii) The ratio of the different storage devices in the certified Multiple Device Configuration must be maintained as closely as possible during testing of the required Minimum and Maximum Certified Configurations, as well as in all configurations sold as ENERGY STAR certified.

   iv) Multiple Device Configurations may be combined with Single Device Configurations under the same product family, and combinations of Multiple and Single Device Configurations from that family may be sold as ENERGY STAR certified.

   v) End-user selectable automated storage tiering functionality must be included with all Multiple Device Configurations sold as ENERGY STAR certified,

302   vi) All other conditions in Section 1.I.6 above for both Single Device Optimized
303   Configurations and Multiple Device Optimized Configurations must be met.

304   8) Capacity Optimization Family Restriction: Since the scope in 2.1.1 only encompasses
305   Online systems, a product family may not be based solely on Capacity Optimized
306   Configurations. Every storage device submitted for certification under Capacity Optimized
307   Configurations must also include one or more Transaction Optimized Configuration(s)
308   and/or Streaming Optimized Configuration(s) using the same storage device. A Capacity
309   Optimized Configuration may only be submitted as an addition to one (or more) of the other
310   optimizations and cannot be submitted for a File I/O certification as it is not a testable
311   workload for that configuration.

312 **Note**: EPA has clarified that the capacity optimization family restriction does not apply to File I/O
313 product certifications.

314   J. Other Definitions:

315   1) Scale-Up Storage: A storage product comprised of a discreet storage controller (with or
316   without redundancy), which has a full view of all the storage devices in the storage product.
317   Incremental storage capacity is added by the addition of storage devices under the control
318   of the existing storage controller.

319   2) Scale-Out Storage: A storage product capable of being comprised of two or more discreet
320   storage controllers (with or without redundancy), combined with an overall integration or
321   aggregation function resulting in a single storage product view for attached servers. Each
322   discreet storage controller often has a partial view to a partition of the overall system's
323   storage devices, but this is not a fixed requirement. Incremental storage capacity is added
324   by the addition of storage devices under the control of the existing storage controller(s)
325   and/or addition of additional storage devices along with additional controller(s).

326   3) Automated Storage Tiering: Automatic movement of data between different types of
327   storage devices. Tiering may occur within a single storage product or may span multiple
328   storage products. For the purposes of this specification, only tiering within a single storage
329   product is applicable. If automated storage tiering is enabled during testing, then the multi-
330   storage device groups necessary for tiering may be represented as a single storage device
331   when determining testing and certification ranges and when calculating storage device
332   allocations. While doing so, the ratio of each discrete storage device within the multi-
333   storage device group must remain as constant as the system architecture and configuration
334   options allow.

335   4) Field-replaceable Unit (FRU): A unit, or component of a system that is designed to be
336   replaced "in the field;" i.e., without returning the system to a factory or repair depot. Field
337   replaceable units may either be customer-replaceable, or their replacement may require
338   trained service personnel.

339   5) High-availability (HA): The ability of a system to perform its function continuously (without
340   interruption) for a significantly longer period of time than the reliabilities of its individual
341   components would suggest. High availability is most often achieved through failure
342   tolerance.

343   6) Maximum Time to First Data (MaxTTFD): The maximum time required to start receiving
344   data from a storage product to satisfy a read request for arbitrary data.

345   7) RAS Features: An acronym for reliability, availability, and serviceability features. RAS is
346   sometimes also expanded to RASM, which adds "Manageability" criteria. The three primary
347   components of RAS as related to storage products are defined as follows:

348   i)   Reliability Features: Features supporting a storage product's ability to perform its
349   intended function without interruption due to component failures. Technologies applied to
350   increase reliability include: component selection (MTBF), redundancy (both at a micro
351   and macro levels), temperature and/or voltage de-rating, error detection and correction
352   technologies.

353   ii) Availability Features: Features that support a storage product's ability to maximize normal
354   operating time and minimize planned and unplanned down time.

355   iii) Serviceability Features: Features that support a storage product's ability to be serviced
356   (e.g., hot-plugging).

357   iv) Advanced Data Recovery Capability: A collective term used in this specification to refer to
358   error detection and correction features such as RAID, mirroring / grid technology, or other
359   comparable advanced error detection and recovery systems

360   v)   Non-disruptive Serviceability: Support for continued availability of data and response
361   times during all FRU and service operations; including break/fix, code patches,
362   software/firmware upgrades, configuration changes, data migrations, and system
363   expansion.

364   8) Physical Data: Data generated by testing a storage product using the ENERGY STAR Test
365   Method for Data Center Storage.

366   9) Modeled Data: Data generated from an algorithmic tool, designed either by the ENERGY
367   STAR Partner or a third party, which generates estimated test results (e.g., power,
368   performance) for a set of storage product configuration inputs.

369   10) Block I/O Loads:

370   i)   Random Read: Any I/O load in which consecutively issued read requests do not specify
371   adjacently addressed data. The term random I/O is commonly used to denote any I/O
372   load that is not sequential, whether or not the distribution of data locations is indeed
373   random.

374   ii) Random Write: Any I/O load whose consecutively issued write requests do not specify
375   adjacently addressed data. The term random I/O is commonly used to denote any I/O
376   load that is not sequential, whether or not the distribution of data locations is indeed
377   random.

378   iii) Sequential Read: An I/O load consisting of consecutively issued read requests to
379   adjacently addressed data.

380   iv) Sequential Write: An I/O load consisting of consecutively issued write requests to
381   adjacently addressed data.

382   v)   Hot Band: An I/O load consisting of a collection of read and write requests that models
383   areas of higher frequency I/O activity over the addressed data.

384   **Note**: EPA has renamed this from "Read/Write" to "Block I/O Loads" in Version 1.1 as there are now
385   separate File I/O workloads below that were not present in Version 1.0. EPA has also included a
386   definition for the Hot Band workload based on feedback from stakeholders, and welcomes feedback
387   on this new definition.

388   11) File I/O Loads:

389   i)   DATABASE: An I/O load that simulates an OLTP database Table and Log file scenario.

390   ii) Software (SW) Build: An I/O load that simulates a large software project compilation or
391   build phase of an EDA workflow.

392	iii)	<u>Video Data Acquisition (VDA)</u>: An I/O load that simulates acquisition of data from a temporarily volatile source such as surveillance or big data ingestion.
393		
394	iv)	<u>Virtual Desktop Infrastructure (VDI)</u>: An I/O load that simulates the workload generated by a hypervisor to support a heavy steady-state knowledge worker workload.
395		

> **Note**: EPA is proposing File I/O workload definitions which largely harmonize with terminology used within the SPEC SFS 2014 storage benchmarking tool. The SNIA Emerald Version 3.0.1 File I/O test methodology uses this benchmark to assess File I/O performance/watt. EPA welcomes stakeholder feedback on any necessary tweaks needed to better harmonize with the SPEC SFS 2014 storage benchmarking tool.

12) <u>Response Time</u>: The time required for the UUT to complete an I/O request.

13) <u>Unit Under Test (UUT):</u> The storage product being tested.

2 CERTIFYING PRODUCTS

2.1 Included Products

2.1.1 Products that meet all of the following conditions are eligible for ENERGY STAR certification, with the exception of products listed in Section 2.2:

    i. meet the definition of a Storage Product provided in Section 1 of this document;

    ii. are comprised of one or more SKUs and be able to be purchased in a single order from a storage product vendor;

    iii. are characterized within the Online 2, 3, or 4 Storage Taxonomy categories[2] with the following additional criteria;

       a) contain a controller with advanced data recovery capability

       b) support Block I/O and/or File I/O storage functions; and

       c) implement scale-up or scale-out storage.

> **Note**: EPA has revised this section to include products that support File I/O storage functions either entirely or as an additional capability.

2.2 Excluded Products

2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for certification under the ENERGY STAR Data Center Storage specification. The full list of specifications currently in effect can be found at www.energystar.gov/specifications.

2.2.2 The following products are specifically excluded from certification under this specification:

    i. Personal / Portable Data Storage Products;

    ii. Computer Servers;

    iii. Blade Storage Products;

    iv. Direct Attached Storage Products

    v. Storage Products capable of only object based storage;

---

[2] As defined in the "SNIA Emerald™ Power Efficiency Measurement Specification", Version 3.0.1.

427   vi.   Storage devices in the following categories of the taxonomy: Near-online, Removable Media
428   Library, Virtual Media Library, Adjunct Storage Products, and Interconnect Elements;

---

429 **Note**: EPA has removed NAS from the scope exclusion list as NAS products are covered by the inclusion
430 of the support for File I/O storage functions. EPA also received stakeholder feedback stating that some
431 File I/O systems can also support object based storage capability. As a result, EPA has clarified that
432 products which can only support object based storage remain out of scope, but that supporting object
433 based storage as a characteristic no longer excludes a product from certifying as ENERGY STAR.

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434 # 3   CERTIFICATION CRITERIA

435 ## 3.1   Significant Digits and Rounding

436   3.1.1   All calculations shall be carried out with directly measured (unrounded) values.

437   3.1.2   Unless otherwise specified, compliance with specification limits shall be evaluated using
438   directly measured or calculated values without any benefit from rounding.

439   3.1.3   Directly measured or calculated values that are submitted for reporting on the ENERGY STAR
440   website shall be rounded to the nearest significant digit as expressed in the corresponding
441   specification limit.

442 ## 3.2   Power Supply Requirements

443   3.2.1   <u>Power Supply Units (PSUs):</u> PSUs used in storage products eligible under this specification
444   shall meet the following requirements when tested using the *EPRI Generalized Internal Power*
445   *Supply Efficiency Test Protocol, Rev. 6.6* (available at
446   http://www.plugloadsolutions.com/docs/collatrl/print/Generalized_Internal_Power_Supply_Effic
447   iency_Test_Protocol_R6.6.pdf).

448   3.2.2   <u>Efficiency and Power Factor in Primary Embedded Equipment</u>: Embedded PSUs that power
449   primary components of the storage product, including controllers and drawers, must meet the
450   requirements in Table 1 and Table 2.

451   i.   <u>Efficiency</u>: A storage product PSU shall meet efficiency requirements as specified in Table 1.

452 **Table 1: Efficiency Requirements for PSUs**

PSU Type	Rated Output Power	20% Load	50% Load	100% Load
Redundant and Non-Redundant Capable PSU	All Output Levels	85%	89%	85%

453

454   ii.   <u>Power Factor</u>: A storage product PSU shall meet power factor requirements as specified in
455   Table 2.

		Table 2: Power Factor Requirements for PSUs			

Table 2: Power Factor Requirements for PSUs

PSU Type	Rated Output Power	20% Load	50% Load	100% Load
Redundant and Non-Redundant Capable PSU	All Output Levels	0.80	0.90	0.95

    iii. Embedded PSUs that do not power primary components of the storage product are not subject to PSU requirements.

3.3   Power Modeling Requirements

    3.3.1 <u>Power Modeling Presale tool</u>: For systems that certify using modeled data, EPA expects that a power modeling tool characterizing the storage product will be made available to manufacturer certified purchasers of the product. The power modeling tool must provide an estimated energy efficiency performance of a deployed configuration based on user-selected configuration characteristics. Systems that are certified using modeled data are expected to make performance/watt data available to manufacturer certified purchasers of the product.

3.4   Energy Efficiency Feature Requirements

    3.4.1 To certify for ENERGY STAR, a storage product must contain the following feature, implemented as specified:

      i. *Adaptive Active Cooling*: Primary components of a storage product must utilize adaptive cooling technologies that reduce the energy consumed by the cooling technology in proportion to the current cooling needs to the storage product. (e.g., reduction of variable speed fan or blower speeds at lower ambient air temperature). This requirement is not applicable to devices that employ passive cooling.

    3.4.2 A storage product shall make available to the end user configurable / selectable features listed in Table 3 in quantities greater than or equal to those listed in Table 4.

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

478

479

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

480 ## 3.5   Information Reporting Requirements

481   3.5.1   <u>Active and Idle State Efficiency Disclosure</u>: To certify for ENERGY STAR, all active and idle
482   state test results based on workload tests listed in Table 5 or Table 6 shall be reported:

483 **Table 5: Required Workload Tests for all Block I/O Configurations**

Workload Test
Hot Band
Random Read
Random Write
Sequential Read
Sequential Write
Ready Idle[3]

484 **Table 6: Required Workload Tests for all File I/O Configurations**

Workload Test
DATABASE
SW Build
VDA
VDI
Ready Idle[3]

485 **Note**: EPA has revised Table 5 to focus on Block I/O test configurations, and added Table 6 to address
486 products that test with File I/O test configurations.

487   3.5.2   <u>Workload Weighting Requirements</u>: The weighted percentages shown in Table 7 or Table 8
488   shall be used to calculate the appropriate Optimal Configuration point for a given storage
489   product.
490

---

[3] SNIA defined workload tests in Table 5, Table 6, and through the rest of this document can be found in
the "SNIA Emerald™ Power Efficiency Measurement Specification" Version 3.0.1. Further detail may be
found at www.snia.org/green.

491 **Table 7: Workload Weighting Requirements for all Block I/O Systems**

Workload Test	Transaction Optimization	Streaming Optimization	Capacity Optimization
Hot Band	100%	0%	0%
Sequential Read	0%	50%	0%
Sequential Write	0%	50%	0%
Ready Idle	0%	0%	100%

492
493 **Example**: To optimize for a streaming workload, manufacturers should identify a system configuration
494 and storage device count where the weighted sum (per Table 6) of the Sequential Read and Sequential
495 Write results are maximized. The resulting storage device count should be used as the streaming
496 optimization point for ENERGY STAR testing and certification. The same weighting of the sums should
497 also be used for subsequent certification measurements (e.g. determining optional flexible or mixed
498 certification ranges).
499

500 **Table 8: Workload Weighting Requirements for all File I/O Systems**

Workload Test	Transaction Optimization	Streaming Optimization	Composite Optimization
DATABASE	50%	0%	0%
SW Build	0%	0%	100%
VDA	0%	100%	0%
VDI	50%	0%	0%

501

502 **Note**: EPA has revised Table 7 to focus on Block I/O test configurations, and added Table 8 to address
503 products that test with File I/O test configurations. The transaction and streaming optimizations remain
504 unchanged for File I/O products, but the capacity optimization is replaced with the composite optimization.

505   3.5.3   <u>Testing Data Requirements for Scale-up Storage Products using only Physical Data</u>: The
506   following test data is required for each configuration submitted for certification as ENERGY
507   STAR:

508   i.   The manufacturer must choose a workload type for testing from 1.I.2.

509   ii.   The manufacturer must choose a storage device representative of its highest predicted
510   deployed volume for the chosen workload.

511   iii.   The manufacturer may determine to test either a Fixed Size Certification Range, a Flexible
512   Size Certification Range, or a Mixed Certification Range.

513   iv.   For the chosen workload type, highest predicted deployed volume storage device, and
514   certification range, physical data for all measurements listed in Table 5 or Table 6 shall be
515   submitted for a manufacturer determined Single or Multiple Device Optimal Configuration
516   point. Additionally:
517   a) If a fixed range, two additional points must be tested, one 40% smaller and one 15%
518   larger in storage device count compared to the Optimal Configuration.
519   b) If a flexible range, two additional points must be tested. The points are manufacturer
520   determined. One must be at least 40% smaller and the other at least 15% larger in
521   storage device count compared to the Optimal Configuration.
522   c) If a mixed range, test the smaller (larger) fixed point at 40% smaller (15% larger) in
523   storage device count, and test the larger (smaller) manufacturer determined flexible point.

524   v.   To include any additional storage devices (not chosen in 3.5.3.ii) for the selected workload,
525   physical data for all measurements listed in Table 5 or Table 6 shall be submitted for all of the
526   following system sizes for each additional storage device:

(a) A manufacturer determined Single or Multiple Device Optimal Configuration point. No additional smaller or larger points are necessary.

(b) Configurations using additional storage devices certified under 3.5.3.v will assume the certification range of the configuration certified under 3.5.3.iv.

vi. To certify additional workload types, repeat the above starting at 3.5.3.i for a different workload.

vii. The following rules apply to all testing above:

(a) Test points with storage device counts smaller and larger than the Optimal Configuration may be rounded down and up, respectively, to the nearest drawer boundary.

(b) Configurations consisting *exclusively* of SSD storage devices (and that are also not part of a Multiple Device Configuration certification) are not required to submit physical test point results. Note this exclusion does not apply to configurations consisting of mixed storage devices where one of the devices is an SSD or when an SSD storage device is representative of the highest predicted deployed volume by the manufacturer.

(c) Verification testing of COM features (Table 3) specified by the storage product shall be executed at least once using storage devices of the vender's choice. Once verified there is no requirement to re-execute the COM verification testing procedure with different storage devices.

(d) If the storage product is not marketed with storage device configurability or scalability needed to achieve either the smaller or larger test points above, then these points are not required.

(e) As noted in 1.I.8, a product family may not be based solely on Capacity workload Optimized Configurations. Every storage device submitted for certification under Capacity Optimized Configurations must also include one or more Transaction workload Optimized Configuration(s) and/or Streaming workload Optimized Configuration(s) using the same storage device. A Capacity workload Optimized Configuration may only be submitted as an addition to one (or more) of the other optimizations.

(f) As noted in 1.J.3, if automated storage tiering is enabled during testing, then the multi-storage device groups necessary for tiering may be counted as single storage devices when determining testing and certification ranges and when calculating storage device allocations. The ratio of each single storage device within the multi-storage device group must remain as constant as possible across different test points.

3.5.4 <u>Testing Data Requirements for Scale-up Storage Products using Physical and Modeled Data</u>: The following test data is required for each configuration submitted for certification as ENERGY STAR:

i. The manufacturer must choose a workload type for testing from 1.I.2.

ii. The manufacturer must choose a storage device representative of its highest predicted deployed volume for the chosen workload.

iii. The manufacturer may determine to test either a Fixed Size Certification Range, a Flexible Size Certification Range, or a Mixed Certification Range.

iv. For the chosen workload type, highest predicted deployed volume storage device, and certification range, physical data for all measurements listed in Table 5 or Table 6 shall be submitted for a manufacturer determined Single or Multiple Device Optimal Configuration point. Additionally:

a) If a fixed range, two additional points must be tested, one 40% smaller and one 15% larger in storage device count compared to the Optimal Configuration.

b) If a flexible range, two additional points must be tested. The points are manufacturer determined. One must be at least 40% smaller and the other at least 15% larger in storage device count compared to the Optimal Configuration.

| 576 | | c) | If a mixed range, test the smaller (larger) fixed point at 40% smaller (15% larger) in storage device count, and test the larger (smaller) manufacturer determined flexible point. |

576   c) If a mixed range, test the smaller (larger) fixed point at 40% smaller (15% larger) in
577   storage device count, and test the larger (smaller) manufacturer determined flexible point.
578

579   v. If manufacturer generated modeled data for all physical measurements submitted in Section
580   3.5.4.iv above are within ±10%, modeled data shall be submitted for all of the following
581   system sizes;

582   (a) Manufacturer determined Optimal Configuration points for all other storage devices
583   certified for the respective workload type that are not defined in Section 3.5.4.ii
584   above;

585   (b) At least 6 manufacturer chosen points smaller in storage device count compared to
586   the Optimal Configuration, with two of those points being at least 10% smaller than
587   the smallest physical point tested in 3.5.4.iv

588   (c) At least 6 manufacturer chosen points larger in storage device count compared to the
589   Optimal Configuration, with two of those points being at least 10% larger than the
590   largest physical point tested in 3.5.4.iv

591   vi. To certify additional workload types, repeat the above starting at 3.5.4.i for a different
592   workload.
593

594   vii. The following rules apply to all testing above: See Section 3.5.3.vii

595 3.5.5   Testing Data Requirements for all Scale-out Storage Products: The following test data is
596   required for each configuration submitted for certification as ENERGY STAR:

597   i. All testing and data requirements of Sections 3.5.3 and 3.5.4 shall be followed.

598   ii. When testing, the smallest marketed quantity of storage controllers / nodes shall be tested.

599   iii. Additional systems with a larger quantity of storage controllers may be optionally submitted.

600 3.5.6   Data for display on the ENERGY STAR website shall be submitted for each ENERGY STAR
601   certified storage product or storage product family.

602   i. Whenever possible, Partners should also provide a hyperlink to a more detailed power
603   calculator on their website that purchasers can use to understand power and performance
604   data for specific configurations within the product family.

605 3.5.7   The following information will be displayed on the ENERGY STAR website:

606   i. Product model name, model number, and SKU or other configuration identification number;

607   ii. A list of important product characteristics, including;

608   (a) System configuration and tested I/O type;

609   (b) Storage controller details (e.g. model name and number);

610   (c) Software configuration and transfer protocols used in testing;

611   (d) Storage controller power supply information;

612   (e) Storage device drawer power supply information;

613   (f) Storage devices used per optimization points;

614   (g) Input power and environmental characteristics during testing;

615   (h) System power optimization capabilities;

616   (i) Inlet air temperature and power consumption reporting capabilities.

Note: EPA has added tested I/O type and transfer protocol used in testing to the list of characteristics that will be displayed on the ENERGY STAR website.

    iii. A list of certified system configurations, including maximum, minimum and optimal configurations of certified product families; and disclosure of the time period used for data averaging.

    iv. A list of power management and other power saving features available and enabled by default;

    v. Specified thermal measurements conducted during testing;

    vi. For product families, a list of certified storage products within the family; and

    vii. Energy Efficiency Performance data (performance/watt) for required active and idle state test reporting specified in Table 9 or Table 10 below:

Table 9: Active and Idle State Efficiency Block I/O Test Results Displayed

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

Table 10: Active and Idle State Efficiency File I/O Test Results Displayed

Workload Test	Transaction Optimization	Streaming Optimization	Composite Optimization
DATABASE	Yes	No	No
SW Build	No	No	Yes
VDA	No	Yes	No
VDI	Yes	No	No
Ready Idle	Yes	Yes	Yes

Note: EPA has revised Table 9 to focus on Block I/O test configurations, and added Table 10 to address products that test with File I/O test configurations. As in Table 8 above, the transaction and streaming optimizations remain unchanged for File I/O products, but the capacity optimization is replaced with the composite optimization.

    3.5.8 The following test information shall be submitted as part of the certification process, but will not be displayed on the ENERGY STAR website:

    i. Discrete power and performance data for all tested configurations;

| 639 | | ii. | Response time measurement data for all tested configurations. |

3.6 Storage Product Family Variation Allowances

3.6.1 <u>Storage Product Performance Improvement Cap</u>: Any changes to a storage product after testing (replacement storage devices, storage controller firmware, etc.) shall not lead to a change of greater than 20% of the overall system performance/watt as defined by Table 7 or Table 8 (with the exception of the Ready Idle metric). Any combination of changes that cause the storage product's performance/watt value to cross this threshold will require testing of a new Optimal Configuration for inclusion in the product family definition.

3.6.2 <u>Replacement Storage Devices in As-Shipped Configurations</u>: In order to reduce testing burden, manufacturers may replace storage devices that were used during certification with storage devices that have similar energy efficiency (performance/watt) compared to the device being replaced after certification. Storage product manufacturers must submit specification sheets for the original and replacement devices to validate the following:

   i. No change in the following area:

      (a) Interface type

   ii. No reduction in the following features:

      (a) Data capabilities (e.g. Self-encryption);

      (b) Power management-related features and capabilities (e.g. Power Down Modes).

   iii. Reported values within ± 10% for the following categories:

      (a) Reported average power consumption in like modes of operation;

      (b) Rotational speed;

         (i) Not applicable to Non-Rotational storage devices;

         (ii) If the storage device is capable of multiple spindle speeds, the discreet speeds must be within 5%, and the criteria for entering each of those speeds must be the same.

3.7 Standard Performance Data Measurement and Output Requirements

3.7.1 <u>Data Elements</u>: Online 3 and Online 4 storage products shall be capable of measuring and reporting the following data elements at the storage product level:

   i. Input Power, in watts. Input power measurements must be reported with accuracy within ±5% of the actual value for measurements greater than 200 W, through the full range of operation. For measurements less than or equal to 200 W, the accuracy must be less than or equal to 10 W multiplied by the number of installed PSUs; and

   ii. Inlet Air Temperature (optional), in degrees Celsius, with accuracy of ± 2°C.

3.7.2 <u>Reporting Implementation</u>:

   i. Data shall be made available in a published or user-accessible format that is readable by third-party, non-proprietary management systems;

   ii. Data shall be made available to end users and third-party management systems over a standard network connection;

   iii. Data shall be made available via embedded components or add-in devices that are packaged with the storage product (e.g., a service processor, embedded power or thermal meter or other out-of-band technology, iPDU, or pre-installed OS);

680   iv.   When an open and universally available data collection and reporting standard becomes
681   available, manufacturers should incorporate the universal standard into their products.

682   3.7.3   <u>Sampling Requirements</u>:

      i. *Input power*: Input power measurements must be sampled internally to the storage product
         at a rate of greater than or equal to 1 measurement per contiguous 10 second period.

      ii. *Inlet air temperature (optional)*: Inlet air temperature measurements must be sampled
         internally to the storage product at a rate of greater than or equal to 1 measurement every
         10 seconds.

     iii. *Timestamping*: Systems that implement time stamping of environmental data shall sample
         internally to the storage product data at a rate of greater than or equal to 1 measurement
         every 30 seconds.

      iv. *Management Software*: All sampled measurements shall be made available to external
         management software either via an on-demand pull method, or via a coordinated push
         method. In either case the system's management software is responsible for establishing
         the data delivery time scale while the storage product is responsible to assuring data
         delivered meets the above sampling and currency requirements.

696   3.7.4   <u>Documentation Requirements</u>: The following information shall be included in the data submission:

      i. Guaranteed accuracy levels for power and optional temperature measurements, and

      ii. The time period used for data averaging (if present).

699   3.7.5   Use of iPDUs: Section 3.7 may be satisfied using iPDUs. In order to satisfy the Data Elements
700   requirement, an iPDU must:

      i. Meet all requirements for accuracy, sampling, and data reporting;

      ii. Be made available for sale and delivery with certified ENERGY STAR storage products by
         appearing on the manufacturer's website and/or in marketing material where information on
         the storage product is displayed.

4   TESTING

4.1   Test Methods

4.1.1   Test methods identified in Table 11 shall be used for purposes of evaluating active and idle
        state storage product energy efficiency.

Table 11: Test Methods for ENERGY STAR Certification

Product Type	Test Method
All	ENERGY STAR Test Method for Data Center Storage Equipment, Rev. January 2018.

4.2   Number of Units Required for Testing

4.2.1   Representative Models shall be selected for testing per the following requirements:

        i.   For certification of an individual product model, a product configuration equivalent to that which is intended to be marketed and labeled as ENERGY STAR is considered the Representative Model;

        ii.   For certification of a product family one or more Optimization Configurations shall be tested and submitted. Within the range defined by the Maximum Certified Configuration, Minimum Certified Configuration, and Optimal Configuration, manufacturers continue to be held accountable for any efficiency claims made about their products, including those not tested or for which data was not reported;

5   EFFECTIVE DATE

5.1.1   <u>Effective Date</u>: The Version 1.0 ENERGY STAR Data Center Storage specification shall take effect on **December 2, 2013**. To certify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on its date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.

5.1.2   <u>Future Specification Revisions</u>: EPA reserves the right to change this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through stakeholder discussions. In the event of a specification revision, please note that the ENERGY STAR certification is not automatically granted for the life of a product model.

6   CONSIDERATIONS FOR FUTURE REVISIONS

6.1   **Active and Idle State Efficiency Criteria:** EPA intends to set active and idle state efficiency criteria in Version 2.0 for all storage products in which it has enough data to adequately differentiate products.

6.2   **Right Sizing of Power Supplies:** EPA will investigate opportunities for encouraging right-sizing of power supplies in Version 2.0.

6.3   **Redundant Power Supply Standby:** EPA will investigate requiring redundant power supplies to switch to standby when not in use in Version 2.0. EPA is aware that this circuitry is already offered by some manufacturers in data center products.

6.4   **Expansion of Scope:** EPA will investigate expanding the scope of Version 2.0 to potentially cover larger Online products, as well as Near-Online, Removable Media Libraries, and Virtual Media Libraries. EPA may also explore requirements for SAN equipment if it not covered in the Version 1.0 Large Network Equipment Program Requirements currently under development.

6.5   **Improved Input Power Calculation:**: EPA will investigate requiring improvements to the Input Power calculations, such as rolling average capability in Version 2.0.

6.6   **Inlet Air Temperature Sensing:** EPA will investigate making the current option to provide air inlet temperature measurements in Section 3.7 a requirement in Version 2.0.