

Una Song  
U.S. Environmental Protection Agency  
May 21, 2010

Dear Ms Song,

Congratulations on your recent appointment to the ENERGY STAR® Program teams for Computer Servers and for Data Center Storage. EMC welcomes to opportunity to work with you in pursuit of the shared goal of improving the energy efficiency of data center products.

We are pleased to respond to Draft 1 of Version 1 of the ENERGY STAR Program for Data Center Storage Specification with our comments and recommendations. We hope our observations and proposed options help further the ENERGY STAR Program's approach in this area. The attached document addresses a number of specific areas of the specification; there are some general themes to our comments:

- Several critical requirement areas do not contain specific proposals in terms of scope, required measurement techniques or approaches, or expected performance levels. This makes it difficult to provide specific feedback, and could slow the process of converging on a final specification.
- The storage industry is in a different state than the server industry in its ability to address certain aspects of energy efficiency. A strong collaboration between the EPA and storage industry stakeholders, such as ourselves, will help build a road map that addresses energy efficiency needs in the data center.
- There are many different architectures and technologies in use in data center storage products, and this is an area of significant innovation. To maximize its effectiveness, the ENERGY STAR specification must identify objectives in an architecturally and technologically neutral manner.

We look forward to continuing our participation in the development ENERGY STAR specification and procedures. Should you have any questions about anything in this submission, please let me know if we can be of any additional assistance.

Sincerely,

Rona Newmark  
Sr. Vice President  
Corporate Strategy  
EMC Corporation

As the world's leading developer and provider of information infrastructure technologies, services, and solutions that enable people and organizations to transform the way they create value from their information, EMC Corporation appreciates the opportunity to respond to Draft 1 of Version 1 of the ENERGY STAR® Program Data Center Storage Specification, issued April 9, 2010. The development of an effective ENERGY STAR® specification for these storage products will be an important component in achieving our shared goal of improving the energy efficiency of data centers.

We recognize, along with the EPA, that this is a multidimensional product category, spanning a wide range of functions, capabilities, capacities and price points. In light of this range of products and diversity of configurations possible for each, EMC recommends that the ENERGY STAR® program approach Version 1 of the Data Center Storage specification with clear focus on specific portions of this product space, rather than attempting to address the entire span. This will allow the program and the industry to identify how to specify and measure improvements for certain product types, before expanding the scope to cover more products. We will offer specific suggestions and recommendations within this document.

We also note that Draft 1 has left many of the significant measurement approaches and levels undefined. The result is that this version is, in effect, more similar to a revision of the earlier framework document than an initial draft specification. The industry finds it difficult to offer specific comments and recommendations on many areas of this document as a result. However, we look forward to partnering with the EPA to develop a fundamentally sound approach to categorizing and rating storage products. Given the complexity of the product set and the many configurations and mixes of storage devices that can go into a system, we believe that there will be a benefit to developing a step wise, multi-tier strategy for storage systems. We suggest beginning with a limited, specific set of energy efficiency criteria along with a data gathering component on more complex power and performance issues, to build the information base needed to create the next tier of criteria. This approach will enable both the EPA and the industry to logically progress toward our mutual goal of advancing the ENERGY STAR® program in the IT space in a way that benefits users and the environment whilst enabling ongoing innovation and introductions of efficient and capable storage products.

These concerns are reinforced by the fundamental nature of the open questions identified in the note boxes; the range of potential answers is quite broad and makes it difficult to envision the content of the next version of the specification. It is our goal to identify those particular areas raising concern that the specification may not become sufficiently specific until too late in the development cycle to allow adequate airing of differing points of view.

The comments that follow correspond to major headings in the Draft 1 Specification. Throughout the remainder of this document, italics are used to identify EMC's recommendations and suggestions.

## 1. Definitions

The specification body refers to Storage Products, while its title and focus is exclusively on Data Center Storage products. *We feel it is important to ensure that we are addressing only products designed and intended for use in data centers, and not the much broader range of storage products intended for more general purpose use.* This distinction is significant: Data Center operations have specific reliability and performance requirements for storage products such as shared/networked access, specific connectivity methods, physical form factors, etc. that can drive packaging, functional design, and system architectural decisions. These factors and considerations, in turn, fundamentally affect product power use profiles. *It is*

*important that all definitions of products and product categories remain architecturally neutral, so as not to favor specific vendors nor limit innovations that can yield significant efficiencies.*

*EMC endorses the recommendation of The Green Grid and SNIA that the scope of the initial version of the ENERGY STAR® Program Specification for Data Center Storage be limited to products in the Online 2 and 3, and Removable 2 and 3 categories. This scope will allow Version 1 to have meaningful impact on data center energy consumption while limiting the complexity of the configurations and product types that need to be tested. Given the newness of the measurement methods and interpretations that will be proposed for active load energy consumption, we believe that both the industry and the EPA can gain needed experience with the specification, allowing it to be refined prior to expanding coverage to include significantly larger products and additional categories of storage. (Lines 165-177)*

*EMC considers “hybrid systems” to consist of storage products that include aspects of two or more SNIA defined taxonomy categories. We agree that tracking the prevalence of these systems is appropriate. At the same time, power profile comparisons with systems belonging to the more stringent category should be considered inappropriate, since there are clear penalties paid for staying within the bounds of that definition. *We do not believe this term should be applied to the much more common practice of using multiple types of disks or removable media in a single data center storage product – this is simply exercising a configuration option.* (Lines 179-186 and 449-456)*

*EMC recommends that the EPA consider a modified definition of “Storage Controller” that more closely aligns with the SNIA definition. In particular, the language “... that includes a processor or sequencer...” would better serve the long-term interests of the storage market and the industry if it read “... that includes one or more processors or sequencers ...”. This provides for greater architectural flexibility in the implementation without interfering with the intention of the specification. (Lines 202-204)*

*Data Storage Efficiency and Capacity Optimization are both mentioned as means of improving the energy efficiency of data center storage products. This area is associated with many implementation-specific claims, and it is critical that architectural and implementation neutrality be maintained within the specification to encourage further innovation. As a result, specific information on the proposal and the objective methods of demonstrating the resulting energy efficiencies must be provided in a timely manner to allow adequate stakeholder review and feedback. EMC would also like to point out that many of the techniques used to reduce capacity consumption execute in background tasks to remove redundant content, increasing the background energy used; in those cases there must be a net positive energy savings over a given period of time rather than just a reduction in used capacity. If capacity reduction does not result in a reduction in the number and/or type of drives being powered, it may not actually translate to an energy saving. *EMC agrees with TGG’s recommendation that the best approach for ENERGY STAR® to take in Version 1 with regards to these types of capabilities is to require their reporting on the product performance data similar to the way power management functions were initially reported on the server PPD.* (Lines 216-224)*

*While EMC can appreciate the objective of defining requirements across multiple taxonomy categories, it is important that the requirements and related thresholds that will ultimately be defined in this specification recognize the significant differences both between classes in a given category, and between different categories. Specific examples include: RAS and maximum capacity differences between Online storage classes, and behavioral differences between Removable media and Online products that result in different operational states and energy consumption levels. *We recommend that each taxonomy category be**

*reviewed to ensure the criteria are appropriate to the operational and usage characteristics that matter to data center operators. (Lines 228-232)*

*The definition of Removable Media Library should be augmented to include the access times as defined by the SNIA taxonomy of >80 ms and <5 min. (Lines 247-250)*

*The abbreviation MB is generally used in discussions of storage capacity. MiB is generally restricted to discussions of data transfer size; other use of this term is highly unusual. (Lines 290-291)*

The discussion of Operational States appears to be more representative of the operation of Servers and Client systems than it does of Data Center Storage systems. As has been widely discussed between the EPA and the industry, Online storage systems are primarily used in configurations where they are shared across multiple servers or clients. They are generally responding to I/O requests from connected application servers, responding to backup requests from connected backup servers, or performing data integrity or capacity optimization activities, all of which require media to be active and processing to occur. Customers will only engage multiple operational states where their processes can tolerate extended latency times or where they can be assured that the storage system can manage multiple operational states (with their varied energy use profiles) without causing deterioration in performance and serviceability. Creating specific storage criteria around operational states without considering the need to limit latency and response time impacts will result in the criteria having limited applicability for real-world situations. Removable Media storage systems do, in fact, have an inactive state. They only enter this state after executing their primary function across other shared storage systems. This is one of the many instances where the differences between taxonomy categories have noticeable impact on energy consumption and operational capabilities. (Lines 313-337)

Storage product models are highly configurable with regard to several key parameters, such as host interface type and quantity, media type, media speed, media size and quantity. Product Families afford the industry a necessary tool for managing the combination of reporting requirements for the ENERGY STAR® program at the model level, making it easier for a customer to determine if a particular configuration of a storage product is ENERGY STAR® qualified. *A definition of Product Families that 1) minimizes the documentation effort for manufacturers, 2) simplifies the product identification process for customers and 3) ensures the integrity of the data reported will benefit all parties concerned. EMC looks forward to working with the EPA and others in the industry to develop such a definition. (Lines 370-384)*

While fault tolerance is one way to construct highly available systems, it is by no means the only way nor is it the most common approach in data center storage systems. *EMC recommends that the specification not include the last sentence of the current definition (“High availability is most often achieved through failure tolerance.”) so as not to overly constrain approaches to meeting this customer need. (Lines 389-391)*

Within the definition of Maximum Sustainable Performance, the concept of “transient caching effects” needs to be better clarified to avoid differing interpretations. The SNIA Measurement Spec addresses this as well as appropriate guard bands for sustained performance. *EMC recommends that these elements of the definition be augmented to improve fairness and repeatability of Active State testing. (Lines 392-396)*

*The definitions of Random Read and Random Write should be enhanced to indicate that random I/O must not have temporal locality as well as not having spacial locality. In other words, every block should have an equal probability of coming up as the next I/O. (Lines 416-421)*

## 2. Energy Efficiency Criteria

There are several significant differences between server and storage power supplies, including, but not limited to, the use of custom designs instead of “off the shelf” units, the more prevalent use of the PSU fan to cool the enclosure, not just the supply, and the greater prevalence of multi-output power supplies. This draft specification provides no insight into how the ENERGY STAR® Program intends to address these differences, if at all. *EMC suggests that the EPA work with EPRI, SNIA, the Green Grid and any other appropriate organizations, to assess the current state of single and multi-output supplies used in data center storage products.* The goal of this survey would be to assess the current distribution of power supply efficiency and power supply configurations (single vs. multi-volt, fan for power supply or enclosure cooling, integrated UPS) in the marketplace. The resulting information would provide the data needed for the EPA to set its power supply efficiency criteria for storage systems and determine what configuration based factors needed to be included in the criteria. The data will enable the EPA to set criteria that will encourage improvements in storage power supply efficiency while taking into account the current marketplace conditions of power supply efficiency. (Lines 477-510)

For those data center storage products that use the PSU fans to cool an entire enclosure, the fans’ operation can no longer be considered intrinsic to the efficiency of the PSU. *EMC recommends that future drafts of this specification address differences in how such PSUs will be measured relative to the measurements for PSUs where enclosure fans are separate. We would also like to better understand whether subsequent drafts will have separate efficiency tables for single-output and multi-output PSUs.* (Lines 477-488)

Active State and Idle State Efficiency Criteria are not defined in this draft. Even though this is an initial draft, and the exact nature and level of the goal criteria are not expected to be fully refined, it is difficult for the industry to respond to the lack of definition in these sections. *EMC endorses TGG’s recommendations on both Active State and Idle State metrics.* (Lines 511-524)

Power Management functions are a server and client concept that do not have direct analogs in data center storage products. While products in some taxonomy categories can achieve power savings by turning off drives when not in use (Removable Media) or spinning down unused disks (e.g. Near Online), Online products must be able to respond within a maximum period of time that does not allow the use of such techniques. Products in this category can only save power by reducing drive counts via techniques such as compression or de-duplication, or by storing data on lower speed devices. Most techniques seen in the market today are specific to either a particular implementation or to a particular category of storage. *EMC endorses The Green Grid and SNIA recommendations in this area, and looks forward to working with the EPA to developing definitions of architecturally neutral approaches to reducing power draw for data center storage products in future versions of the specification.* (Lines 525-530)

EMC recognizes the potential contribution of Energy Efficient Ethernet, particularly for storage products having multiple Ethernet interfaces. *We do not believe it is appropriate to incorporate it into the specification at this time, since the standard is not yet fully ratified, and is not yet available from multiple sources, or in sufficient quantities, to make it generally available for inclusion as a required element in the ENERGY STAR® specification.* (Lines 531-537)

### 3. Standard Information Reporting Requirements

Given the ongoing changes being made to the qualification and verification procedures that will apply to data center storage, as well as the lack of detail provided as to the nature of the measurements that will be included in the specification, it is not practical to make meaningful, specific comments on the PPDS at this time. The existing processes for IT products require the use of two separate forms having significant overlap in content and, at the same time, significant differences in formatting. This results in substantial duplication of effort or significant risk of incorrect filings due to the need to restructure and reformat replicated data. *We recommend a dialog with stakeholders in an effort to improve the process for accuracy and ease of use. We also wish to reemphasize the importance of Family reporting as a means of providing purchasers of data center storage with easily understood information on the configurations of qualified products, given the large number permutations possible within the energy consumption envelope.* (Lines 539-575)

*In addition, given the configuration permutations possible with storage products, EMC urges the EPA to accept PPDS submissions for product families rather than individual product configurations. We further request that the template format be sufficiently flexible to handle the wide variety of naming and numbering schemes (including model numbers, SKUs and part numbers) that different manufacturers already employ. This will improve the ease with which purchasers can map ENERGY STAR listings to actual product orders. The inclusion of an additional benchmark in the PPDS submission will not add value for data center storage products, in our opinion, since the lack of true standards in this space will prevent customer comparisons.* (Lines 539-575)

### 4. Standard Performance Data Measurement and Output Requirements

Data center storage products available on the market today do not natively provide either real time inlet temperature or input power readings. While the latter can be obtained through the use of third-party Intelligent Power Distribution Units (IPDUs), the frequency of the readings provided do not approach those stated in this draft. The specific requirements identified in the draft will require significant development by the industry, both in modifications to hardware to integrate the components needed to enable this reporting directly from the storage systems, and in the development of software to report this information into the existing data reporting systems utilized by the server systems.

EMC is concerned that the sampling and reporting rates proposed for servers in the Version 2, Draft 1, which we expect will be the basis for the storage system data reporting requirements, are unworkable. The stated collection and averaging frequencies will accumulate an inordinate amount of data and report it in a time frame which is not representative of data center response times. Data center operators may look at their temperature and power profiles on frequencies of measured in minutes. In an environment which often has thousands of individual data points, anything more frequent is focused more on the “noise” within the system than on any meaningful trend in data that requires a response or action by the data center operator. While automated data collection is becoming more prevalent in data centers, such activity occurs with a polling period measured in tens of seconds, or longer. Data center storage systems conforming to the current stated requirements will be generating data and performing calculations that must be stored, thus consuming unnecessary energy, in excess of the needs of data center operations. *We suggest the EPA work with the industry to develop Version 1 requirements that support power and thermal*

*reporting to gather operational data that can be used to manage the data center in line with the state of the practice in today's data centers. (Lines 577-608)*

Using off-the-shelf components that are purchased as fully assembled products allows manufacturers to provide some generic functions at the lowest possible cost by avoiding custom-built assemblies that provide no added value to their customers. *EMC encourages the EPA to work with interested stakeholders to assess the scope and impact of such components to determine the most appropriate way to address the impact they have on power draw.* The diversity of such products, especially those not in the scope of another ENERGY STAR program, makes it difficult to offer a single recommendation. We look forward to a more complete exploration of this with the EPA. (Lines 618-627)