February 27, 2015

Verena Radulovic
Product Labeling
ENERGY STAR Program
U.S. Environmental Protection Agency

Re: ENERGY STAR Distribution Transformers Draft Specification Framework

Sent via email to: DistributionTransformers@energystar.gov

Dear Ms. Radulovic:

The American Public Power Association (APPA) and National Electric Cooperative Association (NRECA) (collectively referred to as the "Associations")[1] appreciate the opportunity to submit the following comments in response to the ENERGY STAR Distribution Transformers Draft Specification Framework (hereinafter referred to as the "Framework").

The Associations and our member utilities have long supported the ENERGY STAR program as an important tool to help consumers identify and purchase products with superior energy performance. Our member utilities often make use of the ENERGY STAR product program in their energy efficiency programs through provision of rebates and other incentives, or by adoption of city-wide purchasing policies.

ENERGY STAR has achieved tremendous success in its labeling program by offering a consistent brand that promises cost-effectiveness to the consumer while providing reliable and credible energy savings without sacrificing product features or performance. Should the program decide to continue pursuing a renewed distribution transformer specification, it is important to follow these principles that have made the program so effective. However, we see some significant challenges with the proposed approach as outlined in the Framework. Specifically, the one size fits all approach that is proposed does not work well for a voluntary performance specification for distribution transformers due to the variable performance of transformers under different load conditions. Setting a one size fits all specification for high performing distribution transformers would pose a serious challenge to its acceptance as a credible and reliable label. The Framework as proposed would lead to designation of ENERGY STAR for distribution transformers in cases where their installation is less cost effective and energy efficient that might otherwise be expected. For more details, please see the attached white paper "Transformer Loss Energy Savings Flexibility," which was commissioned for purposes of these comments. This white paper in its entirety should be considered a part of these comments.

The DOE analysis upon which the proposed specification is based contains substantial flaws, which were pointed out during the DOE standard setting process. If EPA wishes to develop a credible standard, it is of paramount importance that these flaws are addressed in a manner that enables the major stakeholders (including utilities and manufacturers) to support the program.

It is also imperative that EPA understand the implications of a Framework that could result in higher energy losses. In some states, local governments and utilities have purchasing policies that require purchase of ENERGY STAR products. If this specification leads to purchases that are not cost-effective and that increase energy losses, organizations may be forced to lobby against ENERGY STAR policies or otherwise amend purchasing policies to fit their fiduciary and best practice policies. Therefore, EPA must address and resolve the significant concerns of stakeholders if it chooses to move forward with the program.

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[1] A description of each Association is included in Appendix B.

A Single ENERGY STAR Specification Approach to Distribution Transformers Is Flawed

In the mid-1990's ENERGY STAR rolled out a high-efficiency distribution transformer program which recognized that the ideal method for selecting a cost-effective high-efficiency transformer was to conduct a tailored analysis – one that used a total ownership cost approach that involved calculations of "A" and "B" ratios. However, EPA's proposed Framework follows a one size fits all approach that is unworkable for distribution transformers. While the Department of Energy (DOE) recently chose to take a one size fits all approach for minimum standards, it is not appropriate for EPA to specify an above-minimum performance standard based on this approach because the actual performance of distribution transformers is highly dependent on the application for which it will be operated.

In a 1995 open letter to the electric utilities, Mary Nichols, then Assistant Administrator for EPA's Office of Air and Radiation wrote of several major industry concerns that EPA sought to address with their program. The issues identified in 1995 still exist, and are very real and important, yet EPA has failed to address them in this time around with the specification, which is unacceptable. For example, Nichols wrote: "EPA recognizes that utility and manufacturer engineers have spent hundreds of man-years developing the highly sophisticated and complex methodologies commonly used to analyze transformer costs." However, with this proposed Framework, EPA appears to have discounted the importance of the analyses to optimize the selection of distribution transformers. EPA has instead chosen a TSL level based on a flawed DOE analysis and approach that does not reflect the on the ground reality for utilities.

The Analysis Upon Which EPA is Basing the Specification Is Flawed

The DOE analysis upon which ENERGY STAR proposes to base its new specification is flawed and should not be used in any further rulemaking, standards setting, or specification analysis. In the final DOE rule, a TSL level was selected that sufficiently satisfied interested stakeholder so further litigation was not brought forth, but the analytical flaws were not addressed. Proceeding to set a new specification on the basis of this analysis is not appropriate.

One of the most significant problems with the proposed framework (based on DOE's analysis) is the use of a uniform choice of a capacity factor upon which transformer efficiency is measured. This uniform capacity factor is a false indication of the true efficiency of the transformer. To illustrate this concept and the consequences of the proposal's approach -- that a one size fits all approach deprives the utility industry of the means to save energy by adapting transformer designs to fit the application -- please see "Transformer Loss Energy Savings Flexibility."

Another significant flaw in DOE's analysis was the way in which utility energy costs and savings were treated. Issues with the rates used to calculate payback included outdated and misapplied wholesale and retail electric rates and capacity costs. More detail on concerns with DOE's analysis is available throughout the DOE rulemaking docket and the Associations have identified a host of critical problems with the DOE transformers rulemaking in prior comments submitted to the DOE. We incorporate those comments here by reference.[2]

The Proposal Specifies One Technology and Impacts Supply Chain

In her 1995 open letter to the electric utilities, Mary Nichols wrote: "Participation does not restrict a utility's choice. Virtually any transformer manufacturer can supply transformers that meet the program's efficiency criteria." Again, the program has strayed from this value by selecting a specific technology that only certain manufacturers provide. Limiting the type of technology that can achieve ENERGY STAR creates potential supply chain issues (specifically with amorphous material), potential pricing and competition issues, restricts the ability of utilities to choose the most efficient and cost-effective product, and may force utilities to make investments in additional supporting infrastructure that are not captured in DOE's cost-benefit analysis. As is outlined in detail in

[2] See the Associations comments in docket EERE–2010–BT–STD–0048

the DOE rulemaking docket, there is not enough supply of amorphous core metal to meet the demands of the market that EPA seeks to achieve. As EPA works to promote this technology, small manufacturers are particularly disadvantaged due the significant up-front capital investment that would be needed to upgrade manufacturing lines to meet an ENERGY STAR specification of amorphous core technology. The Associations cannot support a Framework that proposes efficiency levels that will bar steel core transformers from the program.

Product "Features and Functionality" of Amorphous Core Transformers Are Different

ENERGY STAR's appliance program asserts that "ENERGY STAR products are independently certified to save energy without sacrificing features or functionality." However, in the case of distribution transformers key "features and functionality" can be compromised by adopting a one size fits all approach. For example, amorphous core transformer related anomalies such as ferroresonance cannot be "corrected" for by adding arresters because arresters typically fail catastrophically during a ferroresonance event. In addition, the Framework suggestion that 3-Phase switching is a small change to utility operations practices is incorrect. 3-Phase switching is not a "small change to the operating practice", as it requires the installation of a gang operated switch.

Features and functionality are also impacted due to amorphous core transformer weight and size. Amorphous core transformers can be larger and heavier than alternatives. If a utility has poles, vaults, or any other equipment that cannot handle a larger product, then selecting ENERGY STAR would require very costly equipment upgrade. In addition, maintenance replacements during emergency events may be very costly as the supporting infrastructure may require a complete re-build, causing delays in power restoration.

New equipment and its installation would lead to increased effort and costs which would negate the savings that could be achieved. This is especially concerning if a utility has a policy to purchase ENERGY STAR products, or is required by law and is therefore forced to either pay a high price for their commitment to the ENERGY STAR program or to advocate to abandon ENERGY STAR purchasing policies.

Concern that a Specification Is a Precursor to Increased DOE Minimum Standards

In her 1995 open letter to the electric utilities, Mary Nichols wrote: "this program does not serve as a precursor to transformer standards." EPA needs to directly address this concern because there is a real perception that cannot be ignored that this indeed is a precursor to a new DOE minimum standard. EPA's objectives are to drive adoption rates up and to hopefully drive costs down (although the opposite could occur if demand is increased and supply cannot keep up). If sales are increased due to incentives or purchasing policies that do not require cost-effectiveness to be met, it may lead DOE or other policy makers to believe that it is time to increase minimum efficiency standards again. Inflated, incentivized sales could be inaccurately used to justify another one size fits all standard by DOE. Adopting a common-sense approach using A and B factors and specific load factors by customer class results in the most cost-effective product being selected for the application. This type of accurate analysis could help mitigate the concerns by providing a more solid analytical foundation for the industry to follow than DOE's one size fits all approach.

ENERGY STAR Specification Could Lead to Increased or Suboptimal Energy Use

Basing a specification on DOE's analysis and using a one size fits all approach will lead to suboptimal energy use. A distribution transformer is not like a standard appliance where the only relevant variables to energy consumption are whether the product is "on", "off, or in "standby mode." Distribution transformers are complex and their appropriate selection is based on a number of dynamic variables including the loading characteristics. Please see the attached white paper for more information.

Thank you for your review and consideration of our comments, including the attached white paper. We would be happy to discuss any details of our comments and concerns as a follow-up.

Respectfully submitted,

AMERICAN PUBLIC POWER ASSOCIATION / NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

By **/s/**

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Attachment A

TRANSFORMER LOSS ENERGY SAVINGS FLEXIBILITY

INTRODUCTION

Electric utilities, including public power utilities and rural electric membership cooperatives, have historically used a distribution transformer evaluation methodology that saves energy by focusing transformer selection on the characteristics of the loads that these transformers will serve. This evaluation process may have resulted in lower distribution transformer losses than the EPA's initial Framework assumptions. **This approach can save substantially greater energy than basing transformer selection on efficiency at a fixed level of loading that is applied to all distribution transformers, independent of their intended application.** This white paper compares energy losses of transformers selected on the basis of minimum efficiency at an arbitrarily selected level of loading with transformers selected based on the intended application.

TRANSFORMER LOADING CHARACTERISTICS

Most electric load services, such as residences, farms, and commercial facilities, vary in power demand over the course of a day and the seasons of the year. Transformers are applied to serve defined loads, and different transformer sizes and voltage ratings tend to serve certain types of load, based on local factors such as dominant industries or agricultural activities, climate, and the effect of electric rate tariffs on electricity usage patterns. As locally-focused entities, public power utilities and rural electric cooperatives are very aware of the types of loads that are most commonly served by a particular type of transformer in their locality. For example, a rural cooperative in the Great Plains may know that the vast majority of the small 75 kVA padmounted transformers with 480 Volt secondaries are used to supply center-pivot irrigation pumps that operate for a relatively short period of each year, and are virtually unloaded for the remainder of the year. Conversely, a municipal utility may be well aware that the exclusive use of large 1500 kVA transformers is to serve industrial facilities and large commercial facilities that have consistently heavy load demands, and are often 24/7 operations.

Load factor, which is the average load divided by the peak load, is often used to characterize electric load demand. A similar, but slightly different factor characterizing the loading of transformer serving loads is the capacity factor. The capacity factor is the average loading of the transformer relative to the transformer's nameplate rating. When the transformer rating is equal to the peak load demand, then the two factors are equal. This is usually not the case, however, as distribution transformers are only available with discrete standard kVA ratings while the peak demands of the loads to which the transformers might be applied are a continuum. For example, standard three-phase transformer ratings include 500 kVA and 750 kVA, with no ratings between. A load with a predicted peak demand of 600 kVA is likely to have a 750 kVA transformer applied. While some transformers may be applied to loads having peak demands slightly greater than the transformer rating, exploiting the short-term overload capability of the transformers, most transformers are applied to loads having estimated peak demands less than their nameplate rating. Therefore, transformer capacity factor is generally less than the load factor.

The capacity factors of distribution transformers can vary over a wide range. For the illustrative examples described above, the transformers serving the irrigation pumps may be less than 20%, while the capacity factor for transformers serving large commercial and industrial facilities can be in excess of 70%. The largest quantity of transformers purchased by electric utilities is used to serve residential customers. The load factor of residential loads is typically on the order of 20%-30%, and transformers serving these loads may have capacity factors that are even less. These capacity factors span a wide range, with many transformer applications having capacity factors that are substantially different than the 50%

capacity factor specified as the test basis in the proposed ENERGY STAR standard. While the range of actual capacity factors is large, it is not random. Certain types, sizes, and voltage ratings of distribution transformers tend to be applied to defined load types.

TRANSFORMER LOSSES AND EFFICIENCIES

Transformers have both a no-load loss, that is present whenever the transformer is energized and is independent of the load level, and a load loss that is related to the transformer loading squared. Different transformer designs have different ratios between load and no-load losses. In general, design choices that achieve reduction in one type of loss typically cause an increase in the other.

Transformer efficiency can only be defined with respect to a given loading characteristic (capacity factor), and one transformer may provide the greatest efficiency for one load characteristic, and another transformer may be more efficient for a second load characteristic. In Figure 1, the efficiencies of three 25 kVA poletop distribution transformer designs are compared as a function of their loading, relative to their nameplate rating[3]. Design 1 reaches its maximum efficiency, equal to the proposed efficiency target of 99.07% for this class of transformer (Design Line 2), at 50% load. **Designs 2 and 3 have lower efficiencies than this goal at the 50% load point, but they both exceed this efficiency at another load level (their designed load level).** Design 2 is optimized for reduced no-load loss, and its efficiency peaks at 99.09% for a 36% capacity factor. Design 3 is optimized for reduced load loss, and has a peak efficiency of 99.07% at a 76% capacity factor. This clearly illustrates that there can be important energy savings benefit obtained by selecting transformers based on how they are most likely to be utilized. For example Design 2 would provide a favorable 99.09% efficiency in a low 36% capacity-factor application, while Design 1, which meets the proposed ENERGY STAR requirements, would provide only a 99.0% efficiency in that application.

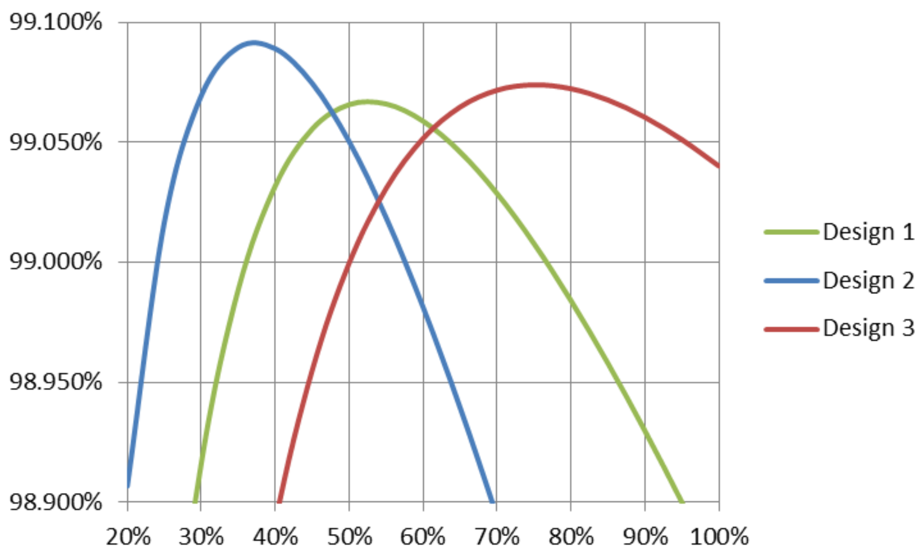

Figure 1 – Comparison of transformer efficiencies as a function of capacity factor.

[3] The transformer data used for this analysis were produced on behalf of the U.S. Department of Energy during their 2011 proceedings with regard to the DoE minimum distribution transformer standards. These data are for Design Line 2, representing round tank oil immersed transformers with ratings of 10 to 167 kVA. These data were downloaded from http://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-STD-0048-0075

TRANSFORMER EVALUATION

The established transformer evaluation process used by utilities to conserve energy and minimize costs to customers and members is a methodology based on total owning cost including the costs of losses. The total owning cost is the purchase price of the transformer, plus the evaluated costs of no-load and load losses. The evaluated no-load cost is the product of the no-load loss, in Watts, times an A factor. The A factor is based on a number of parameters, including the cost of energy and generating capacity, as well as economic factors that put the cost of the losses in the same terms as the purchase price. The evaluated load-loss cost is the tested load loss of the transformer at rated load times a B factor. The B factor includes consideration of the anticipated transformer loading, the costs of electric energy and electric power demand, as well as economic factors.

Considering the upper range of energy and capacity costs that a rural electric cooperative or a public power utility might sustain, the A factor could be up to $6.35/Watt and the B factor could be up to $1.23/Watt for a transformer with a 30% capacity factor. **When these evaluation factors are applied to the transformer design database produced by the DoE in their 2011 transformer efficiency proceedings, the transformer providing the least total owning cost has an efficiency at the 50% capacity factor test value of 98.96%, and the efficiency at the actual 30% capacity factor of the application is 98.83%.** A transformer selected from the DoE design database, solely on the criterion of achieving the proposed ENERGY STAR efficiency level 0f 99.07% (for 25 kVA transformers; Design Line 2) at 50% load for minimum cost, would have a 98.88% efficiency in the 30% capacity factor application. While the transformer selected according to the proposed ENERGY STAR criterion has slightly less (-4%) loss, the purchase cost of the transformer is 17% greater. The incremental transformer annual cost (considering interest, depreciation, etc.) divided by the saved loss energy per year indicates that the cost of the energy savings to the ratepayers is in excess of $0.40/kWh.

The A/B factor transformer evaluation methodology allows for the transformer selection to be customized to the application characteristics. For a high 70% capacity factor transformer application, the B factor might increase to up to $3.67/W while the A factor remains unchanged. Using these factors, the transformer providing the least total owning cost has an efficiency of 99.03% at the 50% capacity factor test value, and the efficiency at the actual 70% capacity factor of the application is 99.07%. A transformer selected solely on achieving the proposed ENERGY STAR efficiency level at 50% load for minimum cost would have 99.03% efficiency in a 70% capacity factor application, and thus would waste 4% more energy in losses than the transformer optimally selected for the application based on the A/B factor evaluation.

The results of the comparisons between transformers selected by the established utility practice and the lowest price transformer meeting the proposed ENERGY STAR criterion are summarized in Table 1.

TABLE 1
COMPARISON OF TRANSFORMER SELECTIONS

Actual Capacity Factor	Evaluation Factors		Transformer Selected by A/B Evaluation		ENERGY STAR Transformer
	A	B	Efficiency at Actual Capacity Factor	Efficiency at Arbitrary 50% CF	Efficiency at Actual Capacity Factor
30%	$6.35/W	$1.23/W	98.83%	98.96%	98.88%
70%	$6.35/W	$3.67/W	99.07%	99.03%	99.03%

This analysis indicates that the proposed efficiency standards are not justified alone by the economic value of reduced losses; i.e., the payback over the life of the transformer is negative. The A and B factors required for the economic transformer selection to yield efficiencies as great as the proposed ENERGY STAR standard are substantially greater than the loss evaluation factors that can be rationally calculated using energy costs seen by public utilities and rural cooperatives. Table 2 shows the results of analysis where the A and B factors are increased until the transformer evaluation process yields a transformer with efficiency exceeding the proposed ENERGY STAR standard, when the standard is based on a 50% capacity factor as proposed, and when the efficiency at the actual capacity factor is used as the criterion. The A and B factors were increased by increasing the cost of energy component with capacity costs and other economic factors (other than the capacity factor) held constant. While the conventional A/B evaluation methodology does not typically include the value of externalities such as environmental impacts, the economic valuation of the externalities would need to approach the cost of the energy alone in order for payback to be achieved.

TABLE 2
LOSS EVALUATION FACTORS REQUIRED TO JUSTIFY PROPOSED EFFICIENCY FOR 25 KVA TRANSFORMERS

Actual Capacity Factor	A and B Factors Justifying 99.07% Efficiency at Actual Capacity Factor		A and B Factors Justifying 99.07% Efficiency at 50% Capacity Factor	
	A	B	A	B
30%	$10.22/W	$1.74/W	$10.22/W	$1.74
70%	$5.40/W	$3.12/W	$9.67/W	$5.57/W

HYBRID EVALUATION

If the proposed ENERGY STAR efficiency levels are accepted as a given, there is value to further consideration of the importance of the capacity factor for the intended transformer application. This results in reduced situational efficiency. To demonstrate this, a hybrid transformer evaluation approach is proposed, where the selected transformer design meets or exceeds the proposed ENERGY STAR efficiency levels **at the capacity factor of the application**, with the least total owning cost as calculated using realistic A and B factors. The total energy losses for transformers selected using this hybrid approach are compared to transformers selected using the proposed standard, based on the arbitrary 50% capacity factor, in a series of examples below. The results of this comparison are summarized in Table 3.

Residential Application

Residential loads typically have a capacity factor of 30% or less. Thus, transformer designs optimizing no-load loss in preference to load loss provide the greatest actual efficiency. From the DoE database of 25 kVA transformer designs, the design having the least evaluated total owning cost, using A = $6.35/Watt and B = $1.23/Watt, and exceeding the 99.07% efficiency level at 30% capacity factor, has no-load loss of 21.22 W and load loss of 329.54 W at rated load. The transformer design selected based on meeting only the 99.07% efficiency level at the arbitrary 50% capacity factor of the proposed ENERGY STAR standard has a no-load loss of 64.64 W and a load loss of 214.55 W. In the residential application with 30% capacity factor, the total annual energy loss of the transformer selected using A/B factor analysis is 536.6 kWh/year and the energy loss of the transformer selected to meet the proposed ENERGY STAR criteria is 794.6 kWh/year, an increase of 48%.

High Capacity Factor Commercial Application

Commercial and industrial loads can have very high capacity factors, exceeding 70%, and very large distribution transformers are typically used only for such loads. Transformers optimized to serve these high-capacity-factor loads are

preferably optimized for reduced load loss, as no-load loss is of comparatively less significance. From the DoE database of Design Line 5 representative 1500 kVA three-phase transformers, the design having the least evaluated total owning cost while exceeding the 99.57% efficiency for Design Line 5 at 70% load, has a no-load loss of 701.02 W and a load loss at rated load of 7283.61 W. The B factor for the loss evaluation in this case increases to $3.67 due to the increased load factor. The annual energy loss for this transformer is 39,415 kWh/year. In comparison, the transformer design selected solely for meeting the ENERGY STAR criteria (at 50% capacity factor) has a no-load loss of 613.54 W and a load loss at rated load of 7962.53 W. The ENERGY STAR transformer has an annual energy loss of 41,750 kWh/year, an increase of 2,335 kWh/year or 5.9%.

TABLE 3
COMPARISON OF ENERGY LOSS FOR TRANSFORMERS SELECTED BY HYBRID EVALUATION AND PROPOSED ENERGY STAR CRITERION

Application		**Low Capacity Factor Residential**	**High Capacity Factor Commercial**
Transformer kVA Rating		25 kVA	1500 kVA
Capacity Factor of Application		30%	70%
Loss Factor of Application (Average Loss/Loss at Rated Load)		0.1215	0.5215
Loss Evaluation Factors for Application	**No-Load Loss (A) Factor**	$6.35/Watt	$6.35/Watt
	Load-Loss (B) Factor	$1.23/Watt	$3.67/Watt
Transformer Selected Using Hybrid Evaluation	**No-Load Loss**	21.22 Watts	701.02 Watts
	Load Loss at 100% Load	329.54 Watts	7,283.61 Watts
	Actual Load Loss	40.04 Watts	3,798.40 Watts
	Total Loss	61.26 Watts	4,499.42 Watts
	Annual Energy Loss	536.6 kWh/yr	39,414.9 kWh/yr
Transformer Selected Based on Meeting Proposed ENERGY STAR Standard	**No-Load Loss**	64.64 Watts	613.54 Watts
	Load Loss at 100% Load	214.55 Watts	7,962.53 Watts
	Actual Load Loss	26.07 Watts	4,152.46 Watts
	Total Loss	90.7 Watts	4,766 Watts
	Annual Energy Loss	794.6 kWh/yr	41,750 kWh/yr
	Additional Energy Loss Using ENERGY STAR Criterion	258 kWh/yr	2,335 kWh/yr
	Percentage Increase	48.1%	5.9%

CONCLUSIONS

Various types of loads have widely varying capacity factors. Frequently, transformers of a certain type, kVA size, and voltage rating are used by a utility for specific types of loads for which the capacity factor can be reasonably predicted. The most efficient transformer design depends on the capacity factor of its utilization, with designs for low capacity factors favoring reduced no-load loss, and designs optimized for high capacity factors having reduced load loss. Distribution transformer designs have, as a practice, been optimized to the specific load factors for the anticipated service applications, including capacity factor, as well as the utility's costs of generation capacity and energy production. **A uniform and arbitrary choice of a capacity factor upon which transformer efficiency is measured is a false indication of the true efficiency in the actual utilization of the transformer.** A one size fits all approach deprives the utility industry of the means to save energy by adapting transformer designs to fit the application. **EPA is urged to not adopt a standard for efficiency based on a uniform capacity factor of 50%, which is unrealistically high for most applications, but instead adopt a flexible efficiency standard that is based on the intended capacity factor of the load to be served by the transformer.**

Appendix B

APPA is the national service organization representing the interests of the more than 2,000, not-for-profit municipal and other state and local community-owned electric utilities that collectively provide electricity to approximately 47 million Americans. These utilities, or "public power" systems, are among the most diverse of the electric utility sector, providing power to small, medium, and large communities in 49 states, except Hawaii, and in many American territories, such as the U.S. Virgin Islands, Puerto Rico, American Samoa, and Guam.

NRECA is the national service organization for more than 900 not-for-profit rural electric utilities that provide electric energy to over 42 million people in 47 states. Cooperatives own and maintain 2.5 million miles or 42 percent of the nation's electric distribution lines covering three-quarters of the nation's landmass. Electric cooperatives provide electric service in all or parts of 2,500 of the nation's 3,141 counties.