September 16, 2016

Verena Radulovic
US Environmental Protection Agency
Product Manager
Energy Star Program
Office of Air and Radiation

Re: Draft 2 Version 1.0 ENERGY STAR Specification for Distribution Transformers

Sent via email to distributiontransformers@energystar.gov

Dear Ms. Radulovic:

The Copper Development Association Inc. (CDA) appreciates the opportunity to provide inputs on the Draft 2 Version 1.0 ENERGY STAR Specification for Distribution Transformers which was released in July 2016. The CDA is a U.S-based, not-for-profit association of the global copper industry, influencing the use of copper and copper alloys through research, development and education, as well as technical and end-user support. CDA is committed to promoting the proper use of copper materials in sustainable, efficient applications for business, industry and the home.

Copper is the best conductor of electricity and heat among non-precious metals and is therefore vital for energy efficient designs of electro-thermal equipment including distribution transformers. Due to its superior electrical, thermal and mechanical properties, copper is indisputably the material of choice for transformer coil conductors. Moreover, the use of copper in coils enables the design of more compact and economical distribution transformers with a smaller tank, lesser core material and reduced liquid filling.

CDA has been a leading advocate and supporter of Energy Efficiency and Renewable Energy Policies in the USA for over two decades. CDA has supported US DOE in the 2016 implementation of 10 CFR Part 431 as well as the Energy Star program.

CDA welcomes and supports EPA's objective of increased national energy savings by using voluntary approaches for the promotion of distribution transformers with cost-effective efficiency levels that exceed the minimum DOE-compliant design. ENERGY STAR labeling has been highly successful in endorsing products that provide consumers with credible and cost-effective energy savings. We also welcome EPA's endorsement of a Total Ownership Cost approach to the procurement and sale of distribution transformers based on a utility's specific no-load and load loss evaluation factors. However, we recognize that TOC based purchases have largely been displaced by most of the utilities today, which purchase to the DOE required minimum efficiencies.

One very key ingredient in the current DOE efficiency derivations has been an implicit belief that all liquid filled distribution transformers are loaded to an RMS equivalent load of 50% of nameplate rating. This assumption was questioned at the previous rule-making deliberations but factual data was not easily available and there was not a good basis to depart from the 50% loading assumption for testing purposes. At the same time it was acknowledged that distribution transformers experience a range of loading levels when installed in the field (see annexure). Unfortunately, that is still the status for the industry today, which is why the IEEE Transformers Committee has established a working Taskforce

under the Distribution Transformers Subcommittee to collect loading data and to document findings publicly. Interestingly, in the early preparatory work, the first large utility to report data would point toward 49% of nameplate as typical for residential loads but this is extremely preliminary. The plan is to examine the full scope of distribution transformers by region, by application, and by size. It is early to speculate on the outcome of the investigation.

We believe that it is early to establish tiers for load factors that are at such low utilizations of nameplate ratings as has been proposed in the Draft 2 document before the loading study has been completed in the IEEE Transformers Committee. There may, in fact be significant groups of transformers that are lightly loaded but it is also quite apparent that many locations in the United States have higher loading than the implications of these bands and would be penalized by such ranges.

The proposed classification into three groups of load factors <30%, 30-40%,>40% has the consequence of biasing transformer designs towards higher coil losses and lower core losses (and lower loss core materials, principally amorphous core technologies) as compared with minimum cost DOE compliant designs. Such transformer designs have lower efficiency levels than the minimum cost DOE compliant designs at load factors above 50%.

If we concentrate attention to the 25 kVA rating pole type transformer, which is normally considered as the average rating for pole type transformers, and start with the DOE required minimum efficiency for transformers built and installed after January 1, 2016, then such transformers must meet an efficiency at 50% load of 98.95%. This means that the total allowable watts loss at 50% load is 132.6 watts. This could be accomplished with transformers having equal parts of core loss and load loss or with transformers having unequal parts of core loss and load loss. However, the maximum efficiency point for any of the options will always occur at the point where core loss is equal to load loss.

This is clearly visible in the Table on page 7 of the Draft 2 Version 1.0 specifications, reproduced below for ease of reference.

Source	Core Loss (W)	50% Winding Loss @ 55°C (W)	100% Winding Loss @ 85°C (W)	Peak Eff. Load Factor*	Savings over DOE Min. Design	
					20%	35%
Min cost Design	66	66	286	50%	–	–
Design 1	44	89	384	35%	25%	12%
Design 2	52	81	349	40%	16%	7%
Design 3	47	84	363	37%	21%	11%
Design 4	51	82	355	39%	17%	8%
Design 5	52	81	351	40%	15%	7%
Design 6	44	84	370	36%	25%	14%
Design 7	43	89	393	35%	25%	12%
Design 8	44	88	389	35%	24%	12%

Note: Table is based on actual calculations but Losses are rounded off for clarity.

* Peak Efficiency calculated from 50% WL @ 55C

With the limited data about these designs available to us, we estimate that designs 2 and 5 in the Table which are optimized at a 40% load factor, and would presumably qualify for The ENERGY STAR Label for load factors >40%, would lose up to 8% of energy compared with the minimum cost DOE compliant design at a 70% loading. The other 6 designs would lose between 7 and 12%. This is clearly contrary to EPA's stated intention of recognizing products that deliver energy savings beyond those mandated by DOE minimum efficiency standards.

It could be contended that load factor groups represent some kind of an "average" and that excursions above 50% would somehow get "averaged out" leading to a net positive energy saving. Such an "averaging" thought process certainly seems to be behind the estimation of national energy savings in slides 36-38 of the presentation of August 11, 2016. This is fallacious, as energy lost when a transformer is loaded above 50% cannot be recovered when it is loaded below 50%.

It is not difficult to see the complexities with the concept of an "average" loading:

- Individual feeders fed by identical transformers have different connected loads.
- The load on an individual transformer can vary continuously over a 24-hour cycle.
- The load on an individual transformer varies from season to season.

For the above reasons, CDA believes that the classification of distribution transformers into the three load factor groups in its current form as proposed, apart from being too preliminary and difficult to implement in practice, would diminish the realization of the full national energy savings potential expected from an ENERGY STAR program.

In order to safeguard these potential national savings, we suggest an approach in which suitable upper limits are additionally placed on total losses, supplementing the minimum efficiency requirement at 50% load. The merits of such an approach would be that the ENERGY STAR labelled transformers would save energy compared with the minimum-cost DOE-compliant design irrespective of the loading, time of day or season. CDA would gladly participate in and support the development of such an approach.

CDA appreciates the opportunity to provide a response to these issues. If you have any questions, please do not hesitate to contact me.

Sincerely

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Annexure

Extract from rule 10 CFR Part 431 (emphasis ours):

Quote "Currently, DOE requires that both liquid-immersed and medium-voltage dry-type distribution transformers comply with standards at 50 percent loading and that low voltage dry-type distribution transformers comply at 35 percent loading. DOE wishes to clarify that *the loading discussed herein pertains only to that which manufacturers must use to test their equipment*. DOE's economic analysis uses loading distributions that attempt to reflect the most recent understanding of the United States electrical grid. *DOE does not believe that all (or the average of all) customers utilize transformers at the required test procedure loading values*". Unquote.

Quote "*DOE understands that distribution transformers experience a range of loading levels when installed in the field*. DOE understands that the majority of stakeholders, including manufacturers and utilities, support retention of the current testing requirements and DOE determined that its existing test procedure provides results that are representative of the performance of distribution transformers in normal use. Although *DOE may examine the topic of potential loading points in a dedicated test procedure rulemaking in the future*, at this time, DOE does not believe that the potential improvement in testing precision outweighs the complexity and the burden of requiring testing at different loadings depending on each individual transformer's characteristics." Unquote.

Conclusion:

It is clear from the above that the concept of a common loading point for a population of distribution transformers was an artifice created by DOE with the sole purpose of simplifying test procedures, and that DOE is aware of the limitations of such an approach to testing, which it is open to reviewing in the future. Further, DOE has explicitly cautioned against any inference that the test procedure loading value represents the average loading of the population of distribution transformers and has acknowledged that these are subject to a wide range of loading in practice.