March 27, 2023

Submitted via www.regulations.gov

RE: Energy Conservation Program: Energy Conservation Standards for Distribution Transformers [EERE-2019-BT-STD-0018]

To Whom It May Concern:

The National Rural Electric Cooperative Association (NRECA) respectfully submits the following comments to the U.S. Department of Energy (DOE) in response to its notice of proposed rulemaking (NOPR) on Energy Conservation Standards for Distribution Transformers (EERE-2019-BT-STD-0018).

NRECA is the national trade association representing nearly 900 local electric cooperatives and other rural electric utilities. America's electric cooperatives are owned by the people that they serve and comprise a unique sector of the electric industry. From growing regions to remote farming communities, electric cooperatives power 1 in 8 Americans and serve as engines of economic development for 42 million Americans across 56 percent of the nation's landscape.

Electric cooperatives operate at cost and without a profit incentive. NRECA's member cooperatives include 62 generation and transmission (G&T) cooperatives and 831 distribution cooperatives. The G&Ts generate and transmit power to distribution cooperatives that provide it to the end of line co-op consumer-members. Collectively, cooperative G&Ts generate and transmit power to nearly 80 percent of the distribution cooperatives in the nation. The remaining distribution cooperatives receive power directly from other generation sources within the electric utility sector. Both distribution and G&T cooperatives share an obligation to serve their members by providing safe, reliable, and affordable electric service.

Electric cooperatives have a long history of supporting energy efficiency and are committed to finding cost-effective solutions that help their consumer-members save money. Given that cooperatives are cost-based any new costs borne by the cooperative must ultimately be passed to the end-of-the-line consumer. As such, cooperatives actively seek out ways to save energy and pass those savings on to their consumer-members as part of their commitment to affordable and reliable electric service.

Our members are some of the primary consumers of distribution transformers and thus we have a vital stake in the outcome of this rulemaking. If this proposal is implemented as currently contemplated, it would have serious consequences to NRECA members' ability to provide affordable, reliable electric service to millions of Americans. We urge the agency to reconsider the NOPR as currently drafted, and to issue a final rule that maintains the current standard. Contrary to DOE's assertions, the NOPR does not meet the Energy Policy and Conservation Act's (EPCA) requirements that the standard be both technologically feasible and economically justified. DOE's NOPR relies on flawed assumptions and ignores the real-world challenges facing the distribution transformer market today not just for electric

cooperatives but all electric utilities, as explained in further detail below. In preparation for our comments in this docket, NRECA engaged Power System Engineering (PSE), a full service electrical and mechanical consulting firm for utilities and other entities with a wealth of experience with electric cooperatives and we enclose PSE's memo here as further evidence to our concerns expressed below. PSE states: "we support and echo many of NRECA's concerns about this proposal as currently written and its potential consequences on the ability of U.S. electric cooperatives to continue to provide affordable, reliable electric service to their members."

We urge DOE to keep the existing standard in place, as permitted by statute, and instead focus on other means for incentivizing amorphous steel core transformers that could allow for potential expansion in the manufacturer market without jeopardizing electric reliability. DOE's top priority should be finding ways to support domestic distribution transformer manufacturers to increase production immediately and to sustain that output over the long term as electrification of the U.S. economy grows.

Now is the wrong time for this proposal. The current distribution transformer supply chain serving the utility sector is struggling to meet demand.

The current manufacturing base serving electric utilities is struggling to meet demand and DOE's NOPR exacerbates this ongoing crisis. Electric cooperatives are facing unprecedented challenges securing equipment and material to provide reliable electric service to their consumer-members. All segments of the utility sector have been sounding the alarm for more than a year about the supply chain constraints around multiple types of equipment they require to keep the lights on, with distribution transformers being the most acute challenge. It now takes more than a year on average for utilities to receive distribution transformers, compared with 60 days just a couple of years ago. Some domestic transformer manufacturers have stopped taking orders altogether. We expect the backlog to continue to increase absent U.S. government support as utilities invest in grid resilience and modernization projects and federal and state policies drive more electrification.

Given the precarious situation that electric utilities face today in procuring distribution transformers, the NOPR sends the wrong message and exact opposite signal that existing steel producers and transformer manufacturers need right now to further invest in the production capability we need to dig us out of the current hole we are in and be able to meet the increasing demand for electrification that comes with electric vehicle charging, heat pumps and other carbon reduction initiatives. One of the potential solutions identified in the last several months to address current supply chain constraints to distribution transformer manufacturers is to send a clear signal to the steel producers – for example through subsidies or purchase commitments – that there is and will remain a strong and growing demand for grain oriented electrical steel (GOES). However, DOE's NOPR does the exact opposite and instead pushes the transformer market to move almost entirely away from GOES. Contrary to DOE's assertions, this proposal will not expand the market for distribution transformers because most of the current production using traditional GOES will not be able to meet the new energy conservation standard.

DOE's NOPR injects harmful uncertainty into the distribution transformer market, upending potential progress in increasing production, just when utilities need manufacturers to be 100% focused on increasing output.

Since under DOE's proposal most current production will need to shift to using amorphous steel, distribution transformer manufacturers are being forced to consider how they will adjust and retool their

production, including sourcing their material – taking critical attention away from increasing today's output. Simply put, this proposal is already doing damage to alleviating the ongoing supply chain crisis.

Further, the NOPR is already creating immediate implications in steel production. There is only one domestic producer of GOES and this proposal risks putting the domestic electrical steel market in a precarious state. With the uncertainty caused by the NOPR itself and its implications that GOES will become irrelevant in the market once DOE finalizes the proposal, it is a natural result that this existing producer, and others considering investment in GOES, will pause any decisions on increasing GOES production – and this is all playing out when the industry needs more GOES today.

Rather than helping to diversify supply, the NOPR is counterproductive as it would deter further domestic investment in GOES production because only amorphous steel cores would be able to meet the new energy conservation standard proposed by DOE. Ultimately, DOE's NOPR will not foster competition and is instead likely to create a new monopoly supplier while simultaneously driving the existing GOES supplier out of the market. This is likely to create a ripple effect of ceasing further investment in the domestic production of GOES for distribution transformers under consideration or announced by other steel producers.

DOE's assumptions about the availability of amorphous steel are incorrect and underestimate the ability of the material to be available at a level to meet the utility sector's needs in the envisioned timeframe.

We have serious concerns about whether the only domestic producer of amorphous steel today would even be able to meet electric utilities' demand for distribution transformers. The only amorphous steel producer's output today is a mere fraction of what would be required as input to distribution transformer manufacturing to adequately meet the electric utilities' demand, raising serious implications for electric reliability and affordability. As currently drafted, the NOPR relies on a single supplier in the market to ramp up output to meet the demand in just three years. We already have a steel availability issue today. DOE's NOPR compounds this existing problem as the proposed standard would require 60% more GOES or 30% more amorphous steel per transformer. When the focus should be squarely on increasing current production of distribution transformers, it is clear that the DOE NOPR does more harm than good. Even if the lone domestic producer of amorphous steel ribbon may be able to ramp up if this rule is finalized, we have serious concerns as to whether there will be sufficient capacity in the companies that use the ribbon to turn it into wound core.

In addition, the Department of Commerce found that amorphous steel is "more labor intensive to form into cores" and "it is more economical in countries with low labor costs."[1] The United States' labor market, characterized by higher prevailing wages, is very different than the labor markets of countries, such as China and India, where most amorphous steel cores are widely produced today. Moreover, the labor shortages plaguing many U.S. industries today – including distribution transformer manufacturers– make it very unlikely that domestic production of amorphous steel cores will ramp up to the level that DOE assumes in the NOPR. The Department of Commerce also found that the current lone domestic supplier "has lost 50 percent of its employees due to its inability to compete with imports from China that have flooded the world market." We have serious doubts about the ability of one supplier to

[1] See the U.S. Department of Commerce's "The Effect of Imports of Transformers and Transformer Components on the National Security" (October 15, 2020) at: https://www.bis.doc.gov/index.php/documents/section-232-investigations/2790-redacted-goes-report-20210723-ab-redacted/file

increase output in the timeline envisioned in this proposal. If this NOPR is finalized as drafted, and the sole supplier cannot meet the demand, manufacturers will be forced to source their material from international sources (particularly China) representing a significant national security risk to the United States.

Further, it is our understanding that most of this amorphous steel producer's steel inputs are foreign-sourced, representing an additional national security risk. Relying on foreign sources for steel inputs required to support critical infrastructure should be a serious consideration for DOE as it considers whether to finalize this rule as contemplated. Moreover, with the Build America Buy America Act (BABA) becoming law with passage of the Infrastructure Investment and Jobs Act (IIJA) the steel being used by this amorphous steel producer would likely not meet the requirements of BABA.

This move will also be detrimental to bringing back domestic manufacturing capacity for large power transformers (LPTs) used for electric utility transmission services. LPTs use GOES and cannot use amorphous steel cores, and it has already been identified as another national security risk that the U.S. receives nearly all LPTs and their components from overseas.

The superiority of amorphous steel to grain oriented electrical steel is overstated in DOE's proposal.

We acknowledge that amorphous steel core transformers are technologically feasible in that they are in production and use both in the United States and more widely in other countries today. However, we believe DOE has not adequately accounted for some serious operational concerns that come with using amorphous steel cores as compared with traditional GOES cores. More work is needed to address these concerns and gain a better understanding of their potential impacts to the reliable operation of the distribution grid.

The relative energy efficiency benefits of amorphous steel core transformers cannot be realized consistently and broadly due to operating conditions that vary across electric utilities. DOE's analysis in the NOPR relies on the energy savings from improved no load losses achieved with amorphous steel core transformers. However, DOE's analysis does not accurately reflect the loading on today's transformers as well as the increased loading expected in the future due to greater electrification. DOE's assumption that utilities are loading their transformers at 30% today vastly underrepresents the loading that NRECA members report from their systems. Our members strive to maximize the loading that is both safe and maximizes usage of the asset to the extent possible. For cooperatives, it is more likely that the loading on our members' distribution transformers today on average is closer to 80%. Therefore, DOE is also undercounting the expected loading on distribution transformers due to future growth in electrification at 50% as that is well below what is already the case today.

Again, DOE's analysis in the NOPR relies on energy savings achieved through improved no load losses. However, we urge DOE to consider that amorphous steel core transformers experience improved no load losses at the expense of high load losses. Our members' experience shows that amorphous steel core transformers sustain higher full load losses, which is more likely to be the operating condition of transformers with further electrification and EV charging occurring overnight, thus reducing the amount of time that transformers are carrying no or very low load. Adding more copper and core material can compensate for these losses at full load, but the transformer will ultimately be larger, making them more difficult to handle and more expensive for cooperatives. In addition, DOE should better account for the

additional greenhouse gas emissions it will take in terms of materials to support the bigger footprint of amorphous steel core transformers, ranging from the copper in the windings to the steel for the tanks to the oils, paints, and insulating papers used on the transformers, and everything in between. Using more material to produce these transformers means more emissions and DOE should accurately reflect that in the Department's analysis.

Moreover, we have serious concerns about the material itself. Past research and experience has demonstrated to our members that amorphous steel cores are brittle and can fragment easily. Our members have seen these cores damaged during construction and during faults such as lightning strikes. When these units are damaged, it is nearly impossible to repair them. Ultimately this results in more material and operational costs to electric cooperatives that must replace damaged equipment. Our members also cite concerns regarding the potential for ferroresonance, which can result in transformer damage and create other problems during restoration of power in an outage. While there may be advances in the technology to address these concerns, more operational experience is needed prior to mandating a shift to amorphous steel core transformers. DOE should consider how to support pilot programs with utilities to gain more operating experience and provide opportunities for utilities to participate in research at the national labs to address these concerns. Finally, we urge DOE to consider more long-term research as to whether the amorphous steel cores maintain their improved no load losses over time.

Forcing the industry to move to amorphous steel core transformers will require several changes to utility operations and impose significant burden in terms of cost and redesign of other equipment.

Electric cooperatives will face significant challenges that the DOE NOPR fails to adequately account for, and if DOE incorporates all of these potential issues, its analysis would show that the standard proposed in the NOPR is not economically justified. The increased weight and size of amorphous steel core transformers, in addition to other factors, means that significant changes to utility operations need to be addressed, all of which represent increased costs:[2]

- Significant increase in wood pole class and heights as well as the frequency at which pole replacements are required.[3] Overstressed poles may lead to failures sooner than anticipated. For utilities with low customer densities such as many electric cooperatives this would be very costly as additional costs are collected from fewer consumer-members.
- Higher rated equipment required to set higher class poles.[4]
- Bigger trucks and an increase in specialty lifting services would be required, particularly in remote and hard-to-access locations.[5] May also require larger forklifts to accommodate these transformers in storage.
- Oversized/heavier pad-mount units could cause cracks in foundations.

[2] See PSE memo, page 2: PSE highlights that the potential cost increases from moving to amorphous steel core transformers could account for an increase in total Construction Work Plan costs by 3% based on their experience with cooperatives. PSE notes "At a glance, this may not seem like a big change but represents a significant cost increase for many small rural cooperatives who serve primarily residential and small commercial members and whose revenue and rates are limited by the demographics of their service territories, since all of these costs will ultimately fall to the member-owners."
[3] See PSE memo, page 3
[4] See PSE memo, page 4
[5] See PSE memo page 4

- New processes would need to be developed for design to determine the best locations for using amorphous steel core transformers and new inventory processes to store, track and manage this new type of transformer.
- Louder noise from the transformer leading to potential consumer-member complaints.
- Additional storage space required for larger transformers.
- Existing trucks cannot carry as many of these larger transformers, therefore greater fuel use (and emissions) from additional required trips to transport, leading to overall higher transportation costs.[6]
- Equipment purchases needed to facilitate movement, transportation, and installation.
- Problems where existing transformers have a defined vault and limited ingress/egress space available.
- Poor overload capacity which could result in more damage to transformers or failures[7]

Electric cooperatives with experience utilizing amorphous steel core transformers in the field report that they more often led to broken wood poles, replacement transformers had long lead times, and to switch out amorphous transformers with new equipment required two trucks. Perhaps most concerning is that the ability of amorphous steel core transformers to withstand short circuit faults is low.[8] This is due to the rectangular shape of amorphous steel cores versus the traditional circular core shape because electromagnetic forces are no longer distributed evenly. This will lead to more outage time and damaged transformers for cooperatives, which will ultimately be very costly to their consumer-members at the end of the line.

Again, we expect more pole replacements will be needed. However, DOE's analysis assumes like-for-like pole replacements which is misguided. Rather, we expect that more transformer replacements will be necessary to allow for greater capacity transformers due to electrification, thus requiring larger poles.[9] In some cases, where a pole's design will not allow for heavier transformers, the cooperative will be forced to convert to pad-mounted transformers. This type of swapping that will be necessary is not included in DOE's analysis including the higher installation costs that utilities will face.

[6] See PSE memo, page 4
[7] See PSE memo, page 5" "While cooperatives certainly don't size transformer installations with the intent of overloading them, there are many reasons (outside of the utility's control) why a distribution transformer might become loaded to capacity or overloaded. In these situations, it is critical that the transformer be able to handle the overload without damage or failure. This will become significantly more important as high demand loads like EV chargers and electric heat systems become widespread, and if cooperatives are unable to purchase replacement transformers within a reasonable timeframe, system reliability could be impacted."
[8] See PSE memo, page 5: "Amorphous cores will be able to handle fewer fault events and will be more susceptible to catastrophic damage due to fault exposure."
[9] See PSE memo page 2, For an EV project, "the demand from these chargers represents a huge increase to the total system demand, and as a result the cooperative intends to convert part of their system from 12.47 kV distribution voltage to 24.9 kV." See also, Page 3: "DOE has stated that its analysis suggests that the heavier transformer designs needed for compliance with the proposed rules will not require larger poles for like-for-like replacements. However, we would not consider that to be the main concern for electric cooperatives; the bigger concern would be around the transformer capacity upgrades that we (and the industry) expect will be necessary to accommodate electrification initiatives like EV charging and all-electric buildings."

Many electric cooperatives are Rural Utilities Service (RUS) borrowers and thus use RUS Bulletin 1724D-107, "Guide for Economic Evaluation of Distribution Transformers," to calculate the cost of owning a transformer over its useful life using the total owning cost (TOC) method. Historically, cooperatives have widely used the TOC method to evaluate transformer purchases. In more recent years, first cost has been used by more utilities largely because of the current DOE energy conservation standard. Given today's supply chain challenges, the information provided by NRECA's members shows availability of transformers is the primary concern, not the cost, and therefore DOE's estimation of the utilities using TOC are not representative of real-world experience.

As PSE notes, many electric cooperatives are RUS borrowers and thus must follow Buy American regulations that may prohibit them from using products with foreign-sourced steel as we expect amorphous steel to be for the foreseeable future.[10] This will likely be a problem on an industry-wide basis given the passage of the Build America Buy America Act that is applicable to all infrastructure spending going forward.

DOE requests specific comment regarding some assumptions in their analysis pertaining to utilities serving low customer populations. It will vary across cooperatives, but our data suggests that 15 kVA transformers are used more commonly in areas with densities of 6 customers per mile, as compared to DOE's assumption in the NOPR of 25 kVA transformer units.

A proposal of this magnitude requires more time and analysis to avoid unintended consequences.

We raise several significant concerns throughout our comments that each warrant more consideration and more accurate accounting by DOE in its analysis. We feel strongly that DOE needs to take more time to gather data from the steel producers, transformer manufacturers, and electric utilities to better reflect the real-world conditions that will impact its analysis of the standard as proposed in the NOPR.

This proposal could potentially impact the market for other products and equipment also critical to the utility sector. For example, PSE notes that "lead times for distribution voltage regulators – which include internal autotransformers and are a critical piece of cooperatives' ability to maintain adequate voltage levels on their systems – are even longer than distribution transformers, reaching up to two years. This is not likely to improve if electrical steelmakers are forced to shift to amorphous core steel production to meet distribution transformer demand."[11]

Conclusion

It is critical that DOE reconsider implementing a new energy conservation standard for distribution transformers as laid out in the NOPR given the unprecedented challenges electric cooperatives and other electric utilities are facing in receiving this critical equipment today. The proposal will exacerbate current supply chain constraints while achieving minimal energy savings. Based on today's energy conservation standard, distribution transformers are already above 98% efficient with most over 99%, meaning this proposal is focused on small incremental improvements while ignoring many of the potential risks and costs associated with mandating amorphous steel core transformers by 2027. DOE's top priority should be finding ways to support domestic distribution transformer manufacturers to

[10] See PSE memo, page 3
[11] See PSE memo, page 3

increase production immediately and to sustain that output over the long term as electrification of the U.S. economy grows.

NRECA urges DOE to keep the existing standard in place, as permitted by statute, and instead focus on other means for incentivizing amorphous steel core transformers that could allow for potential expansion in the manufacturer market without jeopardizing electric reliability. We welcome more dialogue with DOE that would provide insight into what could alleviate electric cooperatives' substantial concerns from an operational perspective about being required to move to amorphous steel core transformers, such as the increased size and weight. Investments being driven by the Infrastructure Investment and Jobs Act, Inflation Reduction Act, other electrification initiatives and increased spending on resilience all demonstrate that demand for distribution transformers is growing and will remain elevated for the foreseeable future. We need to be expanding the market for transformers rather than constricting it by driving traditional GOES distribution transformers out of the market as DOE's NOPR would do.

Thank you for considering our comments and we look forward to further discussion with DOE about how to move forward in a way that would not adversely impact our members' ability to provide affordable, reliable power to their consumer-members. Please contact Stephanie Crawford at stephanie.crawford@nreca.coop or 571-623-4049 if you have any questions about our comments.

Sincerely,

Stephanie Crawford

Stephanie Crawford
Regulatory Affairs Director
National Rural Electric Cooperative Association

Enclosure:

(1) March 13, 2023 Memo from Power Systems Engineering (PSE) to NRECA RE: Support for NRECA Comments on DoE Transformer Efficiency NOPR [Energy Conservation Standards for Distribution Transformers, EERE-2019-BT-STD-0018]

March 13, 2023

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Subject: Support for NRECA Comments on DoE Transformer Efficiency NOPR
[Energy Conservation Standards for Distribution Transformers, EERE-2019-BT-STD-0018]

Power System Engineering, Inc. (PSE) respectfully submits the following comments to the National Rural Electric Cooperative Association (NRECA) in support of its comments on the U.S. Department of Energy's notice of proposed rulemaking (NOPR) on Energy Conservation Standards for Distribution Transformers (EERE-2019-BT-STD-0018).

PSE is a full service electrical and mechanical consulting firm for utilities, private industry, government entities, and associations across North America; since our founding in 1974, electric cooperatives have been our core clientele. As of the time of this writing, we are actively supporting 160 electric cooperatives in the United States, uniting innovative solutions with proven approaches to be an industry leader for the benefit of clients and colleagues.

We strongly support the general principles and goals of energy conservation, energy efficiency, and continued electrification in service of the reduction of fossil fuel use in the United States, and work regularly with our clients to help them prepare their electric infrastructure for a zero-carbon energy future. However, we support and echo many of NRECA's concerns about this proposal as currently written and its potential consequences on the ability of U.S. electric cooperatives to continue to provide affordable, reliable electric service to their members. We have several specific concerns that we can detail based on our wealth of experience providing engineering, design, operational support, and rates & financial services to our cooperative clients.

Cost of Distribution Transformers and Effect on Cooperative Budgets

As member-owned, not-for-profit entities, electric cooperatives have a fiscal responsibility to their member-owners, who are also their ratepayers. Many cooperatives prepare or commission Construction Work Plans (CWP) to assist in developing their annual budgets; these Plans are designed to enable the cooperatives to budget for the capital expenditures that will be needed both for major construction to maintain and/or improve system conditions based on industry standards and established planning criteria, and for day-to-day operations—including purchases of distribution transformers for new services and replacements. PSE regularly prepares Construction Work Plans for our cooperative clients and assists in compiling historical transformer expenditures and estimating future transformer purchase costs.

We examined CWP projections from Plans prepared by PSE's Marietta, Ohio office, primarily covering cooperatives in Ohio, Pennsylvania and New York but also including some in Colorado, Georgia,

Indiana, Tennessee, and Virginia, and prepared between 2012 and 2022. In these plans, distribution transformers accounted for, on average, 5.7% of the total CWP cost, with some plans allocating 10% or more of their funds to distribution transformers. During a public webinar hosted by DOE on February 16, 2023, at least one manufacturer of distribution transformers commented that based on preliminary designs of units compliant with the proposed rule, the new standards could result in a 50% cost increase for all distribution transformers. This increase has the potential to drive transformers to account for 8% of CWP costs on average, and to increase total CWP costs by 3%. At a glance, this may not seem like a big change but represents a significant cost increase for many small rural cooperatives who serve primarily residential and small commercial members and whose revenue and rates are limited by the demographics of their service territories, since all of these costs will ultimately fall to the member-owners.

We should also consider specific project needs, especially for small cooperatives. PSE is currently supporting a small Pennsylvania cooperative that serves a Turnpike Plaza where sixteen electric vehicle (EV) chargers are being installed. The demand from these chargers represents a huge increase to the total system demand, and as a result the cooperative intends to convert part of their system from 12.47 kV distribution voltage to 24.9 kV; this will require the purchase of about 150 distribution transformers. A 50% increase in cost for these transformers will represent a significant increase in the total cost of the system improvements, perhaps enough to cause the cooperative and its Board of Directors to consider less effective alternative solutions. This is not ideal for something as important to a zero-carbon future as EV adoption.

Availability and Lead Times

It is well known throughout the industry that transformer availability and lead times are an issue right now, with lead times up to a full year even for distribution transformers. Beyond this basic problem, cooperatives sometimes face a particular challenge in sourcing transformers because of their (often) smaller size compared to investor-owned utilities (IOUs). In many places, cooperatives must form purchasing groups to meet the quantities needed to have competitive pricing, availability, and delivery times. When competing directly with IOUs, cooperatives often find that their orders take lower priority; we see this regularly today with power transformers, with manufacturers knowingly failing to meet promised delivery dates to cooperatives when large IOU orders come in and are given priority. In these scenarios, cooperatives have little to no recourse other than imposing fees per their purchase contracts. There is no reason to think this issue will improve when all distribution transformers need to be made with amorphous steel cores.

There is currently only one domestic producer of amorphous steel (Metglas). Metglas has expressed—both during the public webinar and in written comments included in the text of the proposed rules—that it is prepared to make substantial investments to meet the increased demand for amorphous steel that would follow the implementation of the rule as written. However, multiple transformer manufacturers expressed skepticism that Metglas alone could produce enough amorphous steel for all the distribution transformers purchased by US utilities; Howard Industries stated that based on analysis of preliminary designs that would meet the proposed standards, their distribution transformer designs could require 30-60% more core steel than existing grain-oriented electrical steel (GOES) designs. Furthermore, it is not known whether other US steel producers that are currently producing GOES and electrical steels used in electric vehicles and other electrical products could (or would) begin producing amorphous steel as well to fill the gaps. There is significant concern among transformer manufacturers and utility organizations that there will not be enough supply of domestic amorphous steel to fulfill the needs of all US utilities; it is likely that smaller cooperatives with lesser buying power compared to large IOUs will

experience the worst of any material shortages, forcing them to defer necessary capital expenditures and potentially slowing the transition to clean energy and widespread electrification (since large numbers of distribution transformers will be needed to accommodate new loads).

We should also note that lead times for distribution voltage regulators—which include internal autotransformers and are a critical piece of cooperatives' ability to maintain adequate voltage levels on their systems—are even longer than distribution transformers, reaching up to two years. This is not likely to improve if electrical steelmakers are forced to shift to amorphous core steel production to meet distribution transformer demand.

There are also some concerns about national and energy security if transformer manufacturers are forced to source amorphous steel from overseas. It is worth noting that electric cooperatives that are RUS borrowers are subject to the "Buy American" provision of the Rural Electrification Act of 1936. While there are provisions in this rule allowing for waivers on an individual contract basis, it must be considered that these cooperatives may be prohibited from using RUS funds to purchase transformers with cores built from foreign-manufactured amorphous steel. This could exacerbate problems with obtaining transformers in a timely manner and impede cooperatives' ability to use RUS funding for these purchases (which, as noted previously, represent a significant portion of their capital expenditures).

Increased Transformer Size & Weight

At least five transformer manufacturers stated during the public webinar that their preliminary compliant transformer designs would be larger and heavier than existing designs (the underlying issue being that to maintain the same level of winding losses with amorphous steel cores, more coil turns are needed and thus the cores and tanks need to be larger). Estimates on this ranged from 20 to 40 percent increases in weight; this will affect utility pole sizing practices, concrete pad construction practices, and operational practices related to the transportation and installation of transformers.

On pole sizing practices: DOE has stated that its analysis suggests that the heavier transformer designs needed for compliance with the proposed rules will not require larger poles for like-for-like replacements. However, we would not consider that to be the main concern for electric cooperatives; the bigger concern would be around the transformer capacity upgrades that we (and the industry) expect will be necessary to accommodate electrification initiatives like EV charging and all-electric buildings.

To get a basic idea of the effect of an across-the-board 40% weight increase for pole-mounted transformers, we can look first at the Lineman's and Cableman's Handbook. Using typical weights of existing pole-mounted transformers, the break point between class 5 and class 4 poles for a single unit is around 100 kVA; if all transformers were 40% heavier, this tipping point could drop to 37.5 kVA. For three-phase banks, the break point between class 4 and class 3 is currently (3)-75 kVA; this would drop to (3)-37.5 kVA.

With a more detailed analysis of three-phase transformer banks using PLS-Lite pole loading software (as shown in the table on the next page), we can see that the pole classes required are larger, and that if transformer weights were increased by 40%, a 75-kVA bank would require a change from a class 2 pole to a class 1. This analysis was performed only on the basic C1 pole assembly and did not consider any other pole attachments; we can expect that for many other pole assemblies (particularly poles with any kind of deflection angle) and for poles with more attachments, pole class increase requirements will be even more common.

	OVERHEAD TRANSFORMERS, BANKS OF THREE							
	GOES Transformers				Compliant Amorphous Transformers			
Pole Assembly	Xfmr Size	Weight / Xfmr (lb.)	Pole Class	Utilization (%)	Xfmr Size	Weight / Xfmr (lb.)	Pole Class	Utilization (%)
C1	10	253.5	3	83.7	10	354.9	3	84.5
C1	15	286.6	3	85.8	15	401.24	3	86.7
C1	25	385.8	3	92.3	25	540.12	3	93.6
C1	37.5	518.1	2	82.1	37.5	725.34	2	83.3
C1	50	639	2	89	50	894.6	2	90.6
C1	75	881.8	2	99.6	75	1234.52	1	83.4
C1	100	1047.2	1	82.6	100	1466.08	1	84.5
C1	167	1609.4	H1	82.6	167	2253.16	H1	85.1

Consider a scenario where a pole-mounted transformer serving several homes is sized at 25 kVA but needs to be upgraded when one or more of the customers purchases and electric vehicle or converts their gas heating system to electric. It is not infeasible that this 25 kVA unit would need to be replaced with a 75 kVA unit to provide adequate capacity and maintain appropriate efficiency in this situation. With the expected new transformer designs and weight levels, the class 5 pole holding this transformer would need to be replaced as well (based on the Handbook). If we presume that electric vehicle adoption and whole-home electrification are to be widespread in the coming decades, it is not unreasonable to think that cooperatives would need to use 37.5 kVA or larger transformers for all but the smallest single-home services, and so class 4 poles would essentially become the standard size for most or all transformer poles. A 35-foot class 4 pole is about 27 pounds heavier than a 35-5, and a 40-foot class 4 pole is 352 pounds heavier. It is possible that cooperatives would need to use larger crews and more or larger trucks to set these poles or to hang transformers, increasing the labor cost of all transformer installations. Comments from NRECA member cooperatives indicated that bucket truck lifting capacities can range from 600 lb. for smaller trucks to 1,500 lb. for large bucket trucks. Looking at the table above, we can see that amorphous-core transformers could pass 600 lb. in weight at 37.5 kV of capacity, requiring many cooperatives to have heavier-duty bucket trucks to move and hang anything 50 kVA and larger. As with purchase costs, these equipment costs will ultimately be borne by the member-owners.

Pad-mounted transformers will see weight increases on the same scale. While this may require new, stronger concrete foundation designs, the more pertinent issue for cooperatives may be in handling and installation. Many cooperatives can use small diggers to lift and install pad-mounted transformers, but weight increases on the scale of 25 to 40% may prohibit this for larger three-phase units. Cooperatives could be forced to purchase and maintain crane trucks (costing half a million dollars each) that are only needed a few times per year or outsource lifting services whenever a large three-phase unit needs to be installed. The need to schedule these services could cause delays in providing electric service to large and critical facilities.

As this proposed rule is an energy efficiency standard, it is important to consider that the cumulative effects of these weight increases will also fall to transportation, causing more fuel to be used to move similar loads of equipment and potentially creating a negative offset to the carbon reduction intended by the increased efficiency levels.

Overload Capacity and Fault Current Withstand

Distribution transformers with amorphous steel cores have significantly less overload capacity than GOES-core units. Existing GOES designs today can handle 120% of their nameplate capacity without many issues, but amorphous designs are more likely to sustain degradation or damage when loaded above 80% of their rating. While cooperatives certainly don't size transformer installations with the intent of overloading them, there are many reasons (outside of the utility's control) why a distribution transformer might become loaded to capacity or overloaded. In these situations, it is critical that the transformer be able to handle the overload without damage or failure. This will become significantly more important as high demand loads like EV chargers and electric heat systems become widespread, and if cooperatives are unable to purchase replacement transformers within a reasonable timeframe, system reliability could be impacted.

Amorphous cores are typically designed with a rectangular shape, in contrast to GOES cores which are generally round. These rectangular cores experience significantly more mechanical stress during faults and so have less ability to handle sustained or repeated fault currents. While proper system protection practices can help minimize transformers' exposure to fault current, it is impractical to think that they will never need to handle through faults. Amorphous cores will be able to handle fewer fault events and will be more susceptible to catastrophic damage due to fault exposure.

Conclusions

These are just a few factors that PSE can speak to with some authority based on our experience with engineering and operations on electric cooperative systems. Additional concerns exist that have been brought up by other knowledgeable parties, including the higher losses incurred by amorphous cores at higher loading levels, reduced durability of amorphous cores and inability to repair them, and the fact that proposed standard covers transformers up to 5 MVA of capacity, which is arguably not a distribution-size transformer.

Based on all these concerns, we agree with NRECA's assertion that—at a bare minimum—more time is needed before this proposed rule is finalized and enacted. It is unreasonable to expect all of the work needed to ensure that all new distribution transformers are compliant with the proposed efficiency levels (major increase in the domestic supply of amorphous steel, transformer redesigns and testing, transformer factory retooling or conversion and/or construction of new plants, utility adaptation to larger transformers with less overload capacity, construction adaptation to larger pads and vaults, and more) can occur before 2027 and not exacerbate the supply chain issues already occurring in the industry. We further agree that more analysis is needed before these standards are put in place; transformer manufacturers need adequate time to develop effective transformer designs and to thoroughly test amorphous-core transformers to ensure that they are as reliable and resilient as existing designs, with equivalent life spans. The concerns of all relevant stakeholders should be seriously considered, the indirect effects of the proposal on important related industries (electric vehicles and renewable energy in particular) should not be ignored, and the potential unintended consequences should be taken seriously. We believe that these precautions are necessary to ensure that U.S. electric cooperatives will be able to continue providing affordable, reliable, and safe power to their members.

Respectfully submitted,

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