COMMENTS ON THE COMPETITIVENESS OF
GRAIN ORIENTED ELECTRICAL STEELS AT HIGHER dELs

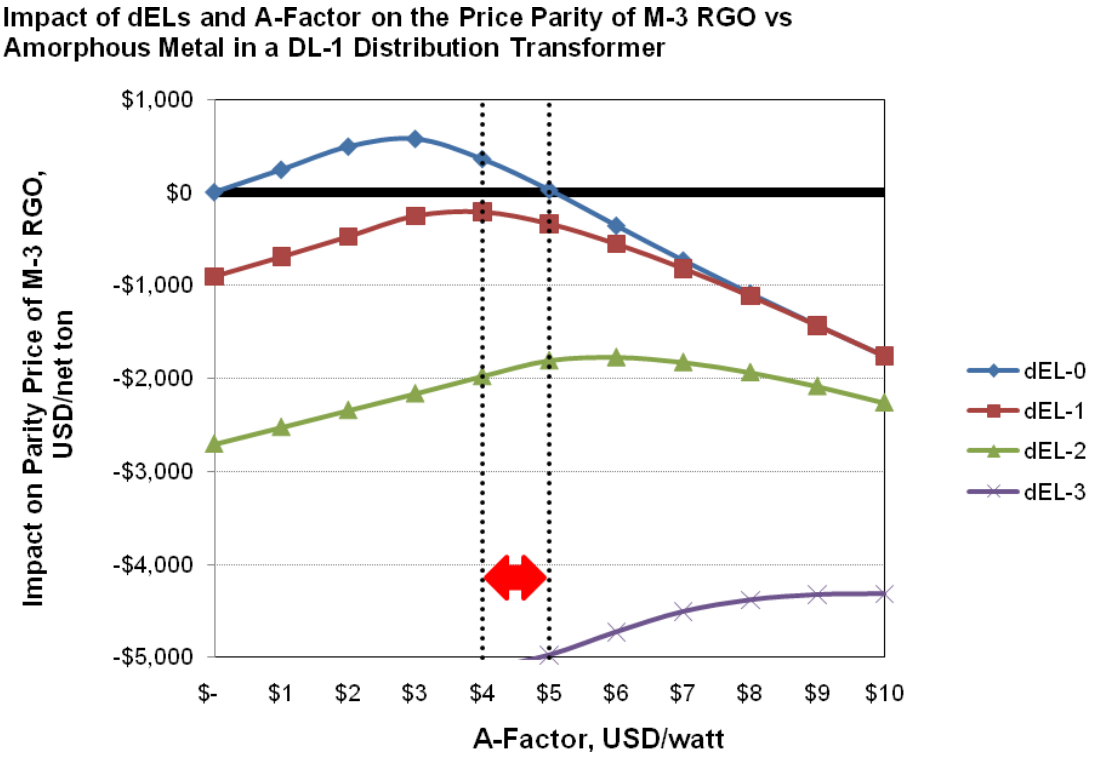
1. BACKGROUND

AK Steel transformer modeling capabilities are limited to (i) single-phase MV liquid-immersed shell-type (DL-1) and (ii) three-phase three-leg stacked-core type ultra-high-voltage power transformers. The latter model is not useful for the NOPR because it is not capable of handling the design changes needed to use SA1 for the core material. Both models are designed for "product price parity" analyses, that is, they are tools to estimate the value of a core material with specific loss and excitation characteristics versus operating induction over a range of A-factor (no-load-loss evaluation) and dELs. The "value" is the calculated cost of the core and coil, the no-load and load losses and the estimated manufacturing cost thereof. We utilize this model routinely and believe it to be reliable for pricing impact assessments.

The sub-committee members have expressed their intention to maintain a well-supplied, competitive market comprised of a variety of capable core material suppliers. In a truly competitive well-supplied market, there will be price elasticity between different grades of materials, that is, they have an "economic worth" relative to one another. As the valuation placed on the "A" factor (i.e., no-load loss) changes, the worth of the materials relative to one another will also change. Using AK Steel's DL-1 transformer model with the materials prices used in the NOPR, we ran an analysis of the relative worth of M3 and M2 versus SA1 to illustrate the effect of A-factor (from $0/watt to $10/watt) and proposed efficiency standards (from dEL-0 to dEL-3). As our results indicate, modeling above dEL-3 is unnecessary.

2. RESULTS FROM AK STEEL DL-1 MODELING

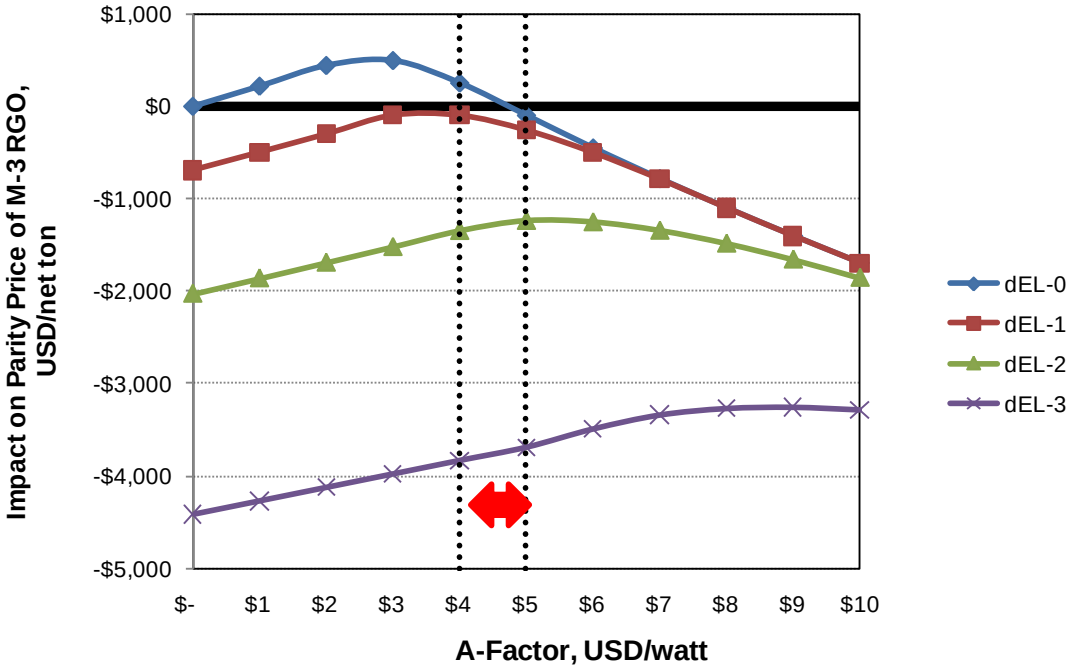
The figure below shows the results from our DL-1 model for M3. The red arrow shows what we believe is a typical range for A-factor in dEL-0 compliant units.



Our model suggests that at dEL-0, M3 is competitive with SA1 at A-factors up to $5/w, falling rapidly in value thereabove. At dEL-1, the competitiveness of M3 is significantly impacted regardless of A-factor. At dEL-2, M3 is uncompetitive. At dEL-3, M3 would have to be supplied at, essentially, zero cost.

The figure below shows the results from our DL-1 model for M2.

Impact of dELs and A-Factor on the Price Parity of M-2 RGO vs Amorphous Metal in a DL-1 Distribution Transformer



Our model suggests that at dEL-0, M2 is slightly more competitive with SA1 than M3 at A-factors up to $5/w; however, it also falls off rapidly in value thereabove. At dEL-2, M2 is uncompetitive across the entire spectrum of A-factor. At dEL-3, M2 would have to be supplied at, essentially, zero cost.

3. REVIEW OF OPS AND OTHERS ON THE CAPABILITY OF GRAIN ORIENTED ELECTRICAL STEELS TO MEET HIGHER dELs

This response is based on information contained in the August[1] and September[2] 2011 NOPR documents, comments submitted by HVolt Inc.[3] and ProlecGE[4] and AK Steel's internal analysis.

SINGLE-PHASE MV LIQUID-IMMERSED (DLs 1-3)

Figures 1/1(A), 2/2(A) and 3 are the OPS results by design line. Please note that the "A" figures limit the graphs to M3-based designs. The OPS graphs were also annotated with MS data provided by HVolt.

1. DOE/Navigant report "Analytical Results in Support ot Stakeholder Negotiations on Amended Energy Conservations Standard for Distribution Transformers" dated August 23 2011.
2. DOE/Navigant engineering analyses from NOPR for MV Liquid-Immersed and Dry-Type transformers dated Sept 09 2011.
3. HVolt report dated Sept 24 2011. This document provides comment from a manufacturer survey (MS) summarizing estimated selling costs for several transformer design lines at various dELs using M3/Al-Al designs. In our opinion, this provided reasonable "real-world" estimates for widely available materials.
4. Prolec GE comment to subcommittee dated Sept 30 2011. The ProlecGE comment provided a different means of viewing the NOPR technical support document by extracting information in order to facilitate a direct comparison of OPS selling costs for transformers made from various core materials (M2, M3 and ZDMH).

DL-1: There is good agreement between the OPS and MS selling prices. Figure 1/1(A) suggests that M3 may be competitive with SA1 up to dEL-1. Above dEL-2, any type of GOES ceases to be competitive and SA1 would be the only core material choice which corroborates AK Steel's modeling results.

DL-2: There is poor agreement between the OPS and MS selling prices. The OPS results in Figure 2/2(A) show that M-3 is not competitive with SA1 above dEL-0. The MS suggests that M3 may be competitive to dEL-1 but not above. Above dEL-1, SA1 would be the only core material choice.

DL-3: The OPS results in Figure 3 suggest that M3 is uncompetitive with SA1 at dEL-0. In present conditions, SA1 should be the core material of choice.

THREE- PHASE MV LIQUID-IMMERSED (DLs 4-5)

DL-4: There is good agreement between the OPS and MS selling prices. Figure 4/4(A) suggests that M3 is not competitive with SA1 above dEL-0. Figure 4 shows that ZDMH, or to a lesser extent M2, would be competitive only up to dEL-1. Above dEL-1, SA1 would be the only core material choice.

DL-5: There is good agreement between the OPS and MS selling prices. Figure 5/5(A) suggests that M3 is competitive with SA1 at dEL-0 but by dEL-1, M3 and all other types cease to be competitive leaving SA1 as the only core material choice.

THREE- PHASE MV DRY-TYPE (DLs 4-5)

DL-9: The OPS data in Figure 6/6(A) suggests that M3 would be competitive up to dEL-2. A domain refined high permeability steel (H-0 DR or equivalent) was comparable to M3.

DL-10: The OPS data in Figure 7/7(A) suggests that M3 would be competitive up to dEL-2. A domain refined high permeability steel (H-0 DR or equivalent) was comparable to M3.

DL-11: The OPS data in Figure 8/8(A) suggests that M3 would be competitive up to dEL-1. A domain refined high permeability steel (H-0 DR or equivalent) was comparable to M3.

DL-12: There is very poor agreement between the OPS and MS selling prices. The OPS results in Figure 9/9(A) suggests that M-3 is competitive with SA1 up to dEL-2. This is contradicted by the MS results which suggest that M3 is competitive only to dEL-1. The concern is that the rate of increase in per unit costs reported by the MS is much greater than the OPS estimate.

DL-13A/B: The OPS data in Figure 10/10(A) and 11/11(A) suggests that M3 would be competitive up to dEL-3. A domain refined high permeability steel (H-0 DR or equivalent) was comparable to M3.

4. RECOMMENDATIONS

To best capture our thoughts and perspectives, we summarized the information from sections 2 and 3 into the table below.

Summary of Competitive/Capable/Widely Available Core Materials by dEL Levels by Design Line

	Design Line										
Characteristic	DL-1	DL-2	DL-3	DL-4	DL-5	DL-9	DL-10	DL-11	DL-12	DL-13A	DL-13B
Capable	dEL-1	dEL-0	dEL-0	dEL-0	dEL-0	dEL-2	dEL-2	dEL-1	dEL-2	dEL-2	dEL-2
Competitive	dEL-0	dEL-0	dEL-0	dEL-0	dEL-0	dEL-1	dEL-1	dEL-1	dEL-2	dEL-2	dEL-2
Widely Available	dEL-0	dEL-0	dEL-0	dEL-0	dEL-0	dEL-1	dEL-1	dEL-1	dEL-2	dEL-2	dEL-2

DLs where OPS shows AM as material of choice | DLs where OPS shows GOES and AM at parity

DL-1 through DL-5: It is AK Steel's view that the steel industry could endorse a standard which is based on competitive use of M3/M-0H, which are widely available high grade core material types. This supports maintaining the existing standard (dEL-0) and allows transformer designs to A-factors above $4/watt to source core materials from a well-supplied and competitive marketplace.

DL-9 through DL-13: It is AK Steel's view that the steel industry should be able to endorse a standard which is based on widely available core materials. For that reason, we would endorse a standard based on the competitive use of M4. We believe that raising the standard to dEL-1 is reasonable; however, given the very poor agreement between the OPS model and MS on DL-12, we would request that transformer engineering experts resolve this disparity pursuant to endorsing dEL-1.

The OPS models intend to provide a comprehensive tool across a wide range of transformer designs which would meet the dEL-1, dEL-2, etc., standard. Thereby, AK Steel proposes that OPS validate AK Steel's DL-1 analysis provided in section 2 of this document. The methodology is straightforward, that is OPS could discount the input price of M3 or increase the price of SA1 in their design models to show the effect of higher dELs on the price parity (competitiveness) of M3 versus SA1 for DL-1 through DL-5. For DL-9 through DL-13, the analysis should include both M3 and M4 types.

5. CAVEATS

Given the many questions from transformer manufacturing and engineering members about the accuracy of the cost and calculation using the OPS models that have been expressed in this and earlier rulemakings, AK Steel has concerns about using the OPS results for such a "precision rulemaking" without an extensive review and validation by the transformer manufacturing members of the subcommittee. Accordingly, we believe that the test procedures and standards should conform to accepted industry standard methods for design, testing and certification which have been put in place by the IEEE.

6. ACKNOWLEDGEMENTS

AK Steel wishes to acknowledge the excellent information provided in the comments submitted by HVolt and ProlecGE. Both the information and approaches in presenting the information were a help and encouragement in assembling our thoughts and information into what we hope is a cogent discourse.

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