Distribution Transformer Energy Efficiency Task Force

Philip J Hopkinson, PE

1. **Introduction**
2. **Minutes from Nashville March 13, 2012**
3. **NOPR Issued By DOE**

http://www1.eere.energy.gov/buildings/appliance_standards/commercial/distribution_transformers.html

1. **DOE DT June 21, 2012 Analysis Meeting**
2. **NEMA June 29, 2012 response**
3. **Final Rule expected After Elections**
4. **Assignments**
5. **Next meeting in Munich**

Distribution Transformer Energy Efficiency Task Force

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Meeting Minutes from Boston, November 1, 2011

IEEE/PES TRANSFORMERS COMMITTEE

TF on Department of Energy Activity on Energy Efficiency of Transformers

MINUTES

Document #:	NA	**Current Standard Date:**	NA
Document Title:	TF on DOE Energy Efficiency Activity		
Chair:	Phil Hopkinson	**Vice-Chair**	
Secretary	John A. Gauthier		
PAR Date:	NA	**PAR Expiration Date:**	NA
PAR Status:	NA		
Current Draft Being Worked On:	NA	**Dated:**	NA
Meeting Date:	March 13, 2012	**Time:**	1:45 – 3:00pm

Attendance:	**Members**	23
	Guests	20
	Guests Requesting Membership	9
	Total	52

Distribution Transformer Energy Efficiency Task Force

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Meeting Minutes from Boston, 11/1/2011 part 2

Members Present

Armstrong, James	Siemans Energy
Duckett, Don	HD Supply Utilities
Gaytan, Carlos	Prolec GE
Ghafourian, Ali	ERMCO
Hardin, Michael	H-J Enterprises
Holifield, Thomas	Howard Industries
Hopkinson, Philip	HVOLT Inc
Iman, Mike	Consultant
John, John K.	Virginia Transformer Corp
King, Gary	Howard Industries
Klaponski, Brian	Carte International
Miller, Kent	T&R Electric Supply
Mulkey, Daniel	Pacific Gas & Electric
Osborn, Gary	TCI Sales
Olen, Robert	Cooper Power Systems
Parkinson, Dwight	Cooper Power Systems
Pezzin, Justin	IFD Corporation
Prince, Jarrod	ERMCO
Simmons, Charles	Progress Energy
Smith, Edward	H-J Enterprises
Stahara, Ronald	Central Moloney Inc
Sullivan, Christopher	Heartland Solutions
Traut, Alan	Power Partners
Wilks, Alan	Consultant

Members Absent

None

Guests

Bane, William	Nashville Electric
Boettger, William	Boettger Transformer Consulting
Drees, Tony	Cindus Corp
Harden, Ken	Schneider Electric
John, John K	Virginia Transformer Corp
Mahajan, Satish	Tennessee Tech University
Marek, Richard	DuPont
McLaughlin, Richard	DNY KEMA
Morgan, Charles	Northeast Utilities
Narawane, Aniruddha	Olsun Electrics Corp
Nims, Joe	Allan & Hosnall
Platt, Don	PPL
Robalino, Diego	Megger
Sauzay, R.	SST Transformers
Schneider, Jeff	Cooper Power Systems
Sheehan, Dave	HICO America
Szewczk, Radoslaw	DuPont
Tendulkar,Vijay	Onyx Power
Trimble, Joshua	Xcel Energy
Xgochne, Delali	China Ministry of Energy

Distribution Transformer Energy Efficiency Task Force

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Meeting Minutes from Boston, 11/1/2011 Part 3

A. Introductions

The Task Force on DOE Energy Efficiency of Transformers was called to order at 1:45 PM on March 13, 2012. A quorum was present.

B. Approve Agenda for the meeting

The agenda was approved.

C. Approve the Minutes from the November 1, 2011, meeting in Boston, Massachusetts.

The chairman reviewed briefly the contents of the minutes. A motion was made and seconded to approve the minutes; the motion was approved.

D. **Report on the Status of DOE Distribution Transformer Efficiency**

The chairman noted that an NOPR has been issued by Department of Energy. He noted that he has prepared a tutorial on the NOPR that will appear on his website that is available to TF members. He further highlighted key elements. He noted in the new NOPR the reference to TSL is not the same as efficiency level and that Table 3 is not the same as appears in the 2010 law, particularly separating single phase (reducing losses from 6.2% to 12%) and three phase (reducing losses from 5.2% to17%) transformers and reducing losses in liquid and low voltage dry type transformers. He also noted that the closing date for public comment on the NOPR is 18 April 2012.

In further discussion he noted the disparity in the calculations used in determining the payback period outlined in table 6 of the presentation. It was noted that Lawrence Berkley Laboratories assumed incorrect material costs in their analysis, costs that are lower than manufacturers experienced.

At the last public meeting of DOE prior to the issuance of the NOPR, there was general acceptance of the efficiencies and data in the report, but on second look, it was felt that

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Meeting Minutes from Boston, 11/1/2011 Part 3

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Meeting Minutes from Boston, 11/1/2011 Part 3

It was noted that DOE raised 30 questions concerning this product area and requested replies.. NEMA is preparing a response. The chairman recommended individual companies may want to reply to those and provide him with an info copy as well. The questions are also included in the powerpoint presentation he prepared.

The chairman assured members that he will post any material provided him and notify members of any DOE decisions. It was noted that emphasis should be on the economic impact of those decisions on the industry and its member companies.

In a question about the impact of loss values that impact US steel companies and whether or not they would provide steel for distribution transformers, it was noted that the steel companies would likely focus on the steel cores for power transformers. The NOPR does not change the rulings of 2010.

It was noted that Canada has adopted the 2010 efficiency levels, up to 7500 kVA. Both Canada and Mexico are seeking to follow US initiatives, so eventually, what is proposed is likely to impact those countries at some point. It was noted that DOE has indicated it would not regulate step-up transformers but may include wind power transformers and transformers for solar applications. (It was pointed out that solar transformers are included in the current NOPR.) It was noted that the IEC is looking to efficiencies for transformers up to 400 mVA; these are still under development.

E. New Business

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Meeting Minutes from Boston, 11/1/2011 Part 3

There was no new business.

F. Time and place of next meeting

The next meeting will be held in conjunction with the IEEE Transformer Committee meeting in Milwaukee, Wisconsin in October 2012.

G. Adjournment

The meeting was adjourned at 3:07 PM

Reported by: John A. Gauthier, March 13, 2012

Distribution Transformer Energy Efficiency Task Force

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1. **NOPR in 77 FR 7282 10 Feb 12**
2. **DOE Link posted February 1, 2012:** http://www1.eere.energy.gov/buildings/appliance_standards/commercial/distribution_transformers.html

Note

Proposed Rulemaking

- Notice of Proposed Rulemaking and Public Meeting
  - Technical Correction
  - **Public Meeting** There will be a public meeting on February 23, 2012, from 9 a.m. to 1 p.m., at the U.S. Department of Energy, Forrestal Building, Room 8E-089, 1000 Independence Avenue, SW., Washington, DC. If you wish to attend, please notify Ms. Brenda Edwards at (202) 586–2945. In addition, the meeting will be broadcast as a webinar. For additional information, see section VII, Public Participation, in the Notice of Proposed Rulemaking.
  - **Webinar:** Interested parties who are not able to attend the public meeting are invited to participate in the Webinar, to be broadcast live from the public meeting. Space is limited. You may reserve your Webinar seat now at https://www1.gotomeeting.com/register/568522776
  - Agenda
  - Presentation
  - Transcript (coming soon)
- Technical Support Document
- Analytical Tools
  - Engineering Analysis Spreadsheets
  - Life-Cycle Cost Analysis Spreadsheets for Liquid-Immersed Distribution Transformers
  - Life-Cycle Cost Analysis Spreadsheets for Low-Voltage Dry-Type Distribution Transformers
  - Life-Cycle Cost Analysis Spreadsheets for Medium-Voltage Dry-Type Distribution Transformers
  - National and Regulatory Impact Analysis Spreadsheets
  - Government Regulatory Impact Model (GRIM)

After a regulatory action has been issued, Section 6(a)(3)(E) of EO 12866 requires agencies to identify in a complete, clear, and simple manner, the substantive changes between the draft submitted to Office of Information and Regulatory Affairs (OIRA) for review and the action subsequently announced, and identify those changes in the regulatory action that were made at the suggestion or recommendation of OIRA. The documents at the links below are intended to comply with this requirement.

- Energy Conservation Program: Energy Conservation Standards for Distribution Transformers Notice of proposed rulemaking and public meeting submitted to OMB on January 8, 2012 COMPARE with notice concluded on January 31, 2012

1. NOPR in 77 FR 7282 10 Feb 12

TABLE I.1—PROPOSED ENERGY CONSERVATION STANDARDS FOR LIQUID-IMMERSED DISTRIBUTION TRANSFORMERS (COMPLIANCE STARTING JANUARY 1, 2016)

Equipment class	Design line	Type	Phase count	BIL	Proposed TSL
1	1, 2 and 3	Liquid-immersed	1	Any	1
2	4 and 5	Liquid-immersed	3	Any	1

Note: BIL means "basic impulse insulation level."

TABLE I.2—PROPOSED ENERGY CONSERVATION STANDARDS FOR LOW-VOLTAGE, DRY-TYPE DISTRIBUTION TRANSFORMERS (COMPLIANCE STARTING JANUARY 1, 2016)

Equipment class	Design line	Type	Phase count	BIL	Proposed TSL
3	6	Low-voltage, dry-type	1	≤10 kV	1
4	7 and 8	Low-voltage, dry-type	3	≤10 kV	1

Note: BIL means "basic impulse insulation level."

TABLE I.3—PROPOSED ENERGY CONSERVATION STANDARDS FOR MEDIUM-VOLTAGE, DRY-TYPE DISTRIBUTION TRANSFORMERS (COMPLIANCE STARTING JANUARY 1, 2016)

Equipment class	Design line	Type	Phase count	BIL	Proposed TSL
5	9 and 10	Medium-voltage, dry-type	1	25–45 kV	2
6	9 and 10	Medium-voltage, dry-type	3	25–45 kV	2
7	11 and 12	Medium-voltage, dry-type	1	46–95 kV	2
8	11 and 12	Medium-voltage, dry-type	3	46–95 kV	2
9	13A and 13B	Medium-voltage, dry-type	1	≥96 kV	2
10	13A and 13B	Medium-voltage, dry-type	3	≥96 kV	2

Note: BIL means "basic impulse insulation level," and measures how resistant a transformer's insulation is to large voltage transients.

2. Definitions NOPR in 77 FR 7282 10 Feb 12

TABLE I.4—TRIAL STANDARD LEVEL TO ENERGY EFFICIENCY LEVEL MAPPING FOR PROPOSED ENERGY CONSERVATION STANDARD

Type	Design line	Phase count	Proposed TSL	Energy efficiency level
Liquid-immersed	1	1	1	1
	2	1		Base
	3	1		1
	4	3		1
	5	3		1
Low-voltage, dry-type	6	1	1	Base
	7	3		2
	8	3		2
Medium-voltage, dry-type	9	3	2	1
	10	3		2
	11	3		1
	12	3		2
	13A	3		1
	13B	3		2

- **TSL not the same as EL**
- **Base efficiency is Present DOE Mandatory Efficiencies**

3. Liquid Filled NOPR in 77 FR 7282 10 Feb 12

Table I.5. Proposed Electrical Efficiencies for all Liquid-Immersed Distribution Transformer Equipment Classes (Compliance Starting January 1, 2016)

Standards by kVA and Equipment Class			
Equipment Class 1		Equipment Class 2	
kVA	%	kVA	%
10	98.70	15	98.65
15	98.82	30	98.83
25	98.95	45	98.92
37.5	99.05	75	99.03
50	99.11	112.5	99.11
75	99.19	150	99.16
100	99.25	225	99.23
167	99.33	300	99.27
250	99.39	500	99.35
333	99.43	750	99.40
500	99.49	1000	99.43
667	99.52	1500	99.48
833	99.55	2000	99.51
		2500	99.53

1 Phase separated from 3 Phase with losses reduced by 2.6-12.1%
3 Phase Losses reduced by 5.2-17.7%

4. Low Voltage Dry NOPR in 77 FR 7282 10 Feb 12

TABLE I.6—PROPOSED ELECTRICAL EFFICIENCIES FOR ALL LOW-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMER EQUIPMENT CLASSES (COMPLIANCE STARTING JANUARY 1, 2016)

Standards by kVA and equipment class				
Equipment class 3		Equipment class 4		
kVA	%	kVA	%	3 Phase % reduction
15	97.73	15	97.44	14.7
25	98.00	30	97.95	18.0
37.5	98.20	45	98.20	20.7
50	98.31	75	98.47	23.5
75	98.50	112.5	98.66	25.5
100	98.60	150	98.78	27.9
167	98.75	225	98.92	28.1
250	98.87	300	99.02	30.0
333	98.94	500	99.17	33.6
		750	99.27	33.4
		1000	99.34	37.7

- **1 Phase remains at Base**
- **3 Phase losses reduced by 15-38%**
- **Anything > 25-30% appears to be very excessive and needs attention!**

4. Low Voltage Dry NOPR in 77 FR 7282 10 Feb 12

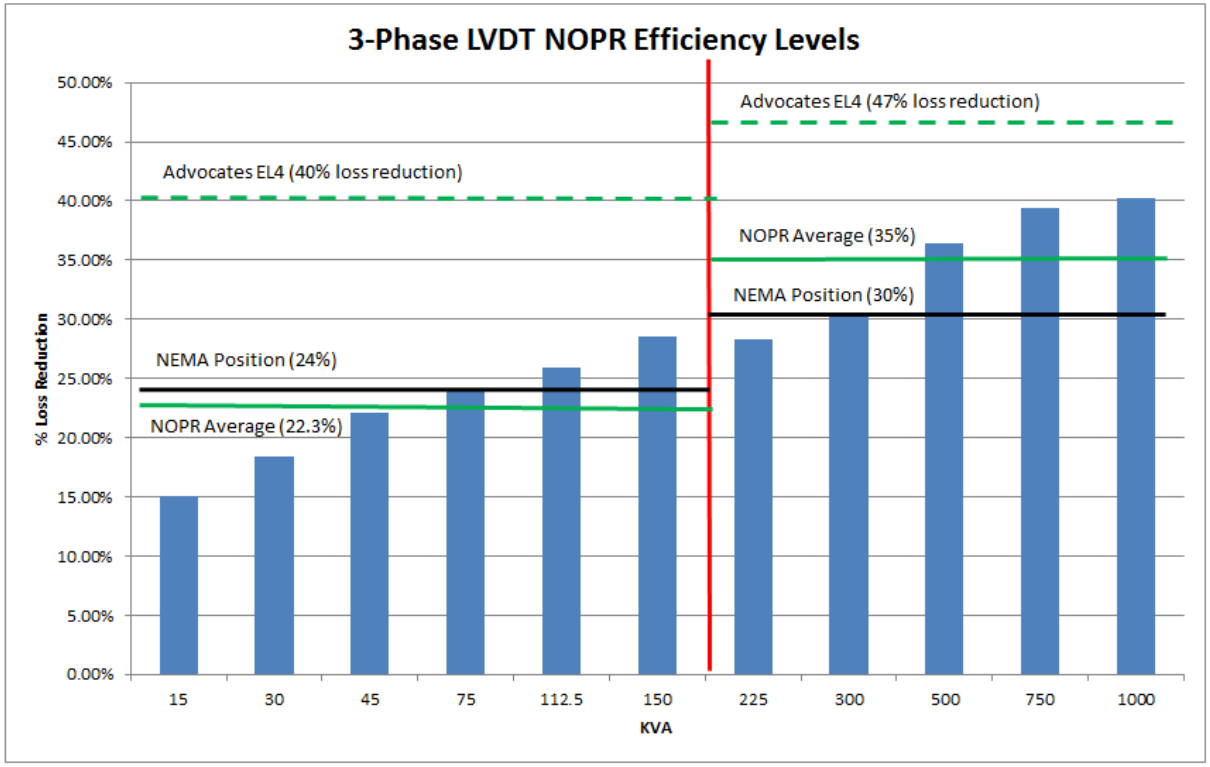

Chart Courtesy of Rob Greeson

3 Phase LV Dry Type kVA	% reduction
15	14.7
30	18.0
45	20.7
75	23.5
112.5	25.5
150	27.9
225	28.1
300	30.0
500	33.6
750	33.4
1000	37.7

- **1 Phase remains at Base**
- **3 Phase losses reduced by 15-38%**
- **Anything > 25-30% appears to be very excessive and needs attention!**

5. Medium Voltage Dry NOPR in 77 FR 7282 10 Feb 12

TABLE I.7—PROPOSED ELECTRICAL EFFICIENCIES FOR ALL MEDIUM-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMER EQUIPMENT CLASSES (COMPLIANCE STARTING JANUARY 1, 2016)

Standards by kVA and equipment class											
Equipment class 5		Equipment class 6		Equipment class 7		Equipment class 8		Equipment class 9		Equipment class 10	
kVA	%	kVA	%	kVA	%	kVA	%	kVA	%	kVA	%
15	98.10	15	97.50	15	97.86	15	97.18				
25	98.33	30	97.90	25	98.12	30	97.63				
37.5	98.49	45	98.10	37.5	98.30	45	97.86				
50	98.60	75	98.33	50	98.42	75	98.13				
75	98.73	112.5	98.52	75	98.57	112.5	98.36	75	98.53		
100	98.82	150	98.65	100	98.67	150	98.51	100	98.63		
167	98.96	225	98.82	167	98.83	225	98.69	167	98.80	225	98.57
250	99.07	300	98.93	250	98.95	300	98.81	250	98.91	300	98.69
333	99.14	500	99.09	333	99.03	500	98.99	333	98.99	500	98.89
500	99.22	750	99.21	500	99.12	750	99.12	500	99.09	750	99.02
667	99.27	1000	99.28	667	99.18	1000	99.20	667	99.15	1000	99.11
833	99.31	1500	99.37	833	99.23	1500	99.30	833	99.20	1500	99.21
		2000	99.43			2000	99.36			2000	99.28
		2500	99.47			2500	99.41			2500	99.33

1 Phase remains at Base
3 Phase losses reduced by 0-23.5%

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6. LCC and Paybacks NOPR in 77 FR 7282 10 Feb 12

TABLE I.8—IMPACTS OF PROPOSED STANDARDS ON CUSTOMERS OF DISTRIBUTION TRANSFORMERS

Design Line	Average LCC savings (2010$)	Median payback period (years)
Liquid-Immersed		
1	36	20.2
2	*N/A	*N/A
3	2,413	6.3
4	862	5.0
5	7,787	4.0
Low-Voltage, Dry-Type		
6	*N/A	*N/A
7	1,714	4.5
8	2,476	8.4
Medium-Voltage, Dry-Type		
9	849	2.6
10	4,791	8.8
11	1,043	10.7
12	6,934	9.0
13A	25	16.5

EC*	DL	Type of Distribution Transformer	kVA Range	Representative Unit for this Engineering Design Line
1	1	Liquid-immersed, single-phase, rectangular tank	10–167	50 kVA, 65°C, single-phase, 60Hz, 14400V primary, 240/120V secondary, rectangular tank
	2	Liquid-immersed, single-phase, round tank	10–167	25 kVA, 65°C, single-phase, 60Hz, 14400V primary, 120/240V secondary, round tank
	3	Liquid-immersed, single-phase	250–833	500 kVA, 65°C, single-phase, 60Hz, 14400V primary, 277V secondary
2	4	Liquid-immersed, three-phase	15–500	150 kVA, 65°C, three-phase, 60Hz, 12470Y/7200V primary, 208Y/120V secondary
	5	Liquid-immersed, three-phase	750–2500	1500 kVA, 65°C, three-phase, 60Hz, 24940GrdY/14400V primary, 480Y/277V secondary
3	6	Dry-type, low-voltage, single-phase	15–333	25 kVA, 150°C, single-phase, 60Hz, 480V primary, 120/240V secondary, 10kV BIL
4	7	Dry-type, low-voltage, three-phase	15–150	75 kVA, 150°C, three-phase, 60Hz, 480V primary, 208Y/120V secondary, 10kV BIL
	8	Dry-type, low-voltage, three-phase	225–1000	300 kVA, 150°C, three-phase, 60Hz, 480V Delta primary, 208Y/120V secondary, 10kV BIL
6	9	Dry-type, medium-voltage, three-phase, 20-45kV BIL	15–500	300 kVA, 150°C, three-phase, 60Hz, 4160V Delta primary, 480Y/277V secondary, 45kV BIL
	10	Dry-type, medium-voltage, three-phase, 20-45kV BIL	750–2500	1500 kVA, 150°C, three-phase, 60Hz, 4160V primary, 480Y/277V secondary, 45kV BIL
8	11	Dry-type, medium-voltage, three-phase, 46-95kV BIL	15–500	300 kVA, 150°C, three-phase, 60Hz, 12470V primary, 480Y/277V secondary, 95kV BIL
	12	Dry-type, medium-voltage, three-phase, 46-95kV BIL	750–2500	1500 kVA, 150°C, three-phase, 60Hz, 12470V primary, 480Y/277V secondary, 95kV BIL
10	13	Dry-type, medium-voltage, three-phase, 96-150kV BIL	225–2500	2000 kVA, 150°C, three-phase, 60Hz, 12470V primary, 480Y/277V secondary, 125kV BIL

DOE Paybacks include switch to Amorphous Core. M3 paybacks longer

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Reaction to NOPR in 77 FR 7282 10 Feb 12

a. **NEMA and transformer makers believe proposal good**
b. **EEI and Utilities believe proposal good**
c. **Conventional core steel makers believe proposal good**

Advocates not pleased with DOE proposal and have raised challenges

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7. Considerations in NOPR in 77 FR 7282 10 Feb 12

a. Material prices supposed to reflect 2010-2011
b. Energy prices that are considerably higher than today's actuals.
c. Loading remains at 35% for LV and 50% for Medium Voltage
d. OPS designs that are sufficiently corrected from early errors
e. M3 core material and Amorphous
f. Transformer Selling price versus efficiency for both core materials
g. Dollars cost per watt saved analysis
h. Energy savings versus efficiency levels
i. Payback period versus efficiency
j. Manufacturing Impact
k. Market Impact
l. Core Steel impacts
m. Proposed efficiencies.

1. All sides want M3 Core Material to remain Viable
2. Utilities worried about selling price increases
3. Considerable concern about rebuild market

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8. Cautions by Utilities, Manufacturers, and Core Steel Makers in NOPR 77 FR 7282 10 Feb 12

a. Liquid filled single phase pads hit brick wall for efficiencies > EL1.
b. Liquid filled single phase poles already at brick wall with EL0.
c. Concerns expressed that M3 disappears with hard turn> EL1.
d. Medium Voltage Dry with mitered cores hits brick wall between EL2 and EL3.
e. LV Dry beyond EL1 must change to miter core or wound cores.
f. Small manufacturers may get squeezed out!

- Hi level letters written by NEMA and Steel Companies
- Multiple analyses submitted by several manufacturers
- Excellent analysis by Core Steel Makers
- Analysis submitted by Hopkinson
- Reality of M3 / Amorphous crossover may have been most convincing

8. M3 and Amorphous cross over at Efficiency Level 1

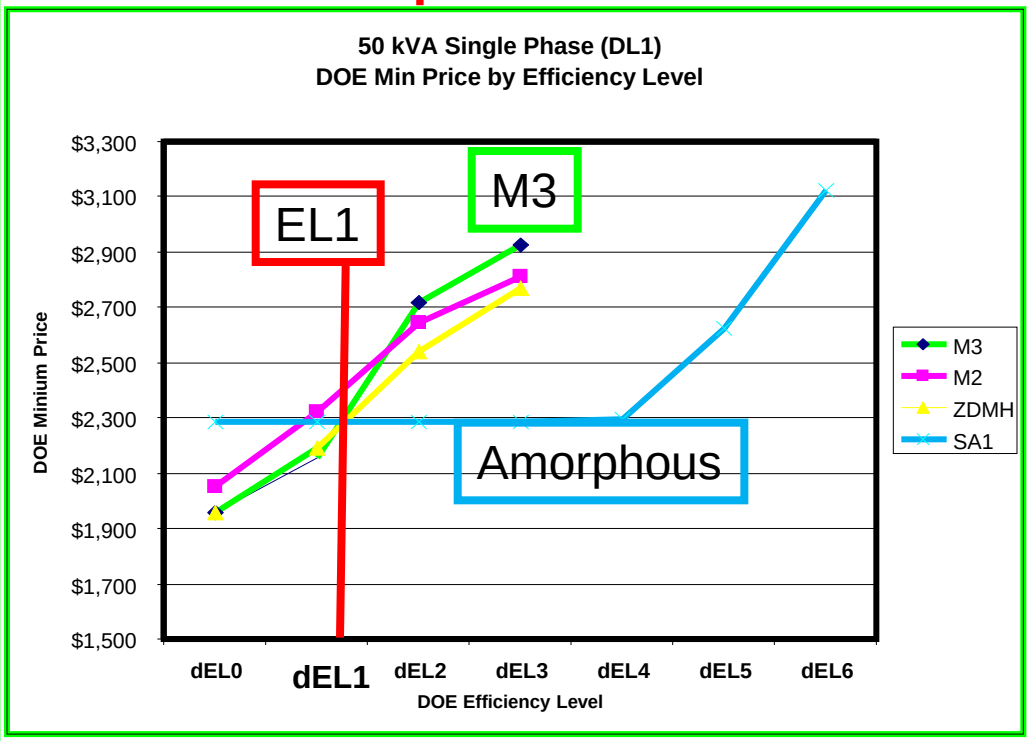

Chart Courtesy of Carlos Gaytan Based on 50 kVA single Phase Pad

Similar cost relationship for many manufacturers

- **M3, M2, and Hi B cost curves steep**
- **Amorphous cost curve flat**
- **Amorphous curve crosses M3 curve at EL1**
- **M3 not viable for efficiency > EL1**

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Design Line 12 Engineering

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

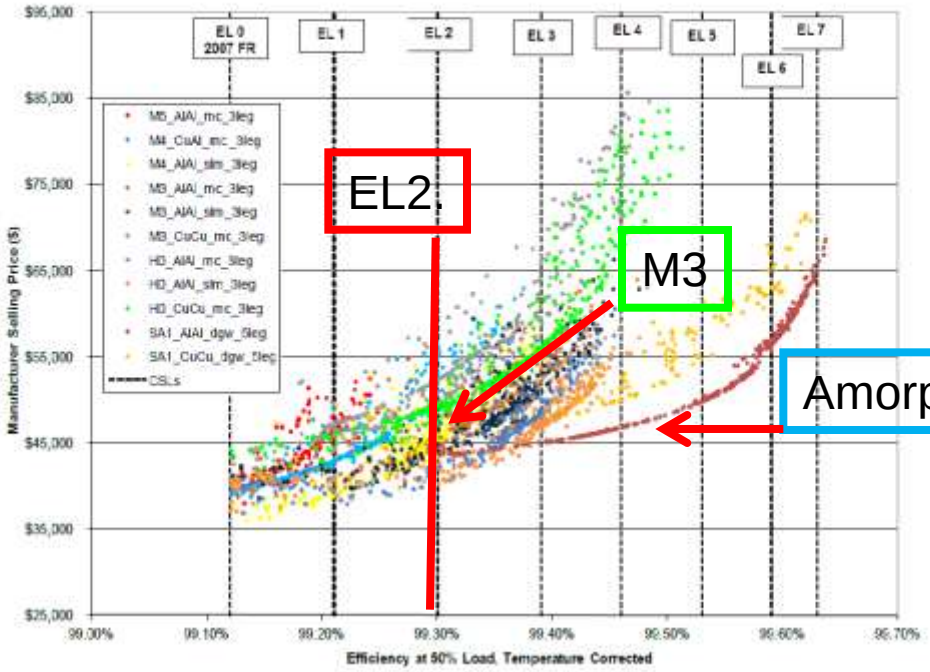

Chart Courtesy of LBL Based on 1500 kVA Three Phase MV Dry

Similar cost relationship for many manufacturers

- **M3, M2, and Hi B cost curves steep**
- **Amorphous cost curve flat**
- **Amorphous curve crosses M3 curve at EL1**
- **M3 not viable for efficiency > EL2**

9. Advocates Counter in February 23 Public Meeting

a. **Positive savings seen in DOE data to Efficiency Level 3 or higher. However manufacturers attribute this to an all Amorphous design.**
b. **Arguments about rebuild market rejected.**
c. **Push to reduce Measured load levels to emphasize core loss.**
   1. **35% instead of 50% for Liquid Filled Transformers**
   2. **18% instead of 35% for Low Voltage Dry Transformers**
d. **Arguments presented suggesting minimal investment required by manufacturers to move Low Voltage Dry to Miter Core.**
e. **DOE challenged to justify impact on small manufacturers.**
f. **DOE challenged to justify loading.**
g. **DOE challenged to justify breakeven point between M3 and amorphous**

Advocates challenges require further DOE investigation

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What's Ahead?

a. **Negotiations completed. Medium Voltage Dry Settled.**
b. **Public Meeting Raised new questions for DOE to study.**
c. **April 18 deadline established for public comment**
d. **DOE Final Rule targeted for October 1, 2012…. now after elections**

Stakeholders asked to respond to DOE's 30 questions raised in 373 page publication from February 1 DOE Public Meeting announcement
http://www1.eere.energy.gov/buildings/appliance_standards/commercial/distribution_transformers.html

10. DOE has raised 30 Questions to Stakeholders

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

1. DOE requests comment on primary and secondary winding configurations, on how testing should be required, on efficiency differences related to different winding configurations, and on how frequently transformers are operated in various winding configurations.

10. DOE has raised 30 Questions to Stakeholders

2. DOE requests comment on its proposal to require transformers with multiple nameplate kVA ratings to comply only at those ratings corresponding to passive cooling.
3. DOE requests comment on its proposal to maintain the requirement that transformers comply with standards for the BIL rating of the configuration that produces the highest losses.
4. DOE requests comment on its proposal to maintain the current test loading value requirements for all types of distribution transformers.

10. DOE has raised 30 Questions to Stakeholders

5. DOE requests comment on its proposal to require rectifier and testing transformers to indicate on their nameplates that they are for such purposes exclusively.
6. DOE requests comment on its proposal to maintain the definition of mining transformer but also requests information useful in precisely expanding the definition to encompass any activity that entails the removal of material underground, such as digging or tunneling.
7. DOE requests comment on its proposal to maintain the current kVA scope of coverage.

10. DOE has raised 30 Questions to Stakeholders

8. DOE requests comment on its proposal to continue not to set standards for step-up transformers.
9. DOE requests comment on the negotiating committee's proposal to establish a separate equipment class for network/vault transformers and on how such transformers might be defined.
10. DOE requests comment on the negotiating committee's proposal to establish a separate equipment class for data center transformers and on how such transformers might be defined.

10. DOE has raised 30 Questions to Stakeholders

11. DOE seeks comment on the operating characteristics for data center transformers. Specifically DOE seeks comment on appropriate load factors, and peak responsibility factors of data center transformers.

12. DOE requests comment on whether separate equipment classes are warranted for pole-mounted, pad-mounted, or other types of liquid-immersed transformers.

10. DOE has raised 30 Questions to Stakeholders

13. DOE requests comment on setting standards by BIL rating for liquid-immersed distribution transformers as it currently does for medium-voltage, dry-type units.

14. DOE requests comment on how best to scale across phase counts for each transformer type and how standards for either single- or three-phase transformers may be derived from the other type.

15. DOE requests comment on its proposal to scale standards to unanalyzed kVA ratings by fitting a straight line in logarithmic space to selected efficiency levels (ELs) with the understanding that the resulting line may not have a slope equal to 0.75.

16. DOE seeks comment on symmetric core designs.

10. DOE has raised 30 Questions to Stakeholders

17. DOE seeks comment on nanotechnology composites and their potential for use in distribution transformers.
18. DOE requests comment on its materials prices for both 2010 and 2011 cases.
19. DOE requests comment on the current and future availabilities of high-grade steels, particularly amorphous and mechanically-scribed steel in the United States.
20. DOE requests comment on particular applications in which transformer size and weight are likely to be a constraint and any data that may be used to characterize the problem.
21. DOE requests comment on its steel supply availability analysis, presented in appendix 3A of the TSD.
22. DOE seeks comment on its proposed additional distribution channel for liquid-immersed transformers that estimates that approximately 80 percent of transformers are sold by manufacturers directly to utilities.

10. DOE has raised 30 Questions to Stakeholders

23. DOE seeks comment on any additional sources of distribution transformer load data that could be used to validate the Energy Use and End-Use Load Characterization analysis. DOE is specifically interested in additional load data for higher capacity three phase distribution transformers.

24. DOE seeks comment on its pole replacement methodology that is used estimate increased installation costs resulting from increased transformer weight due the proposed standard. The pole replacement methodology is presented in chapter 6, section 6.3.1 of the TSD.

25. DOE seeks comment on recent changes to utility distribution transformer purchase practices that would lead to the purchase of a refurbished, specifically re-wound, distribution transformer over the purchase of new distribution transformer.

10. DOE has raised 30 Questions to Stakeholders

26. DOE seeks comment on the equipment lifetimes of refurbished, specifically re-wound distribution transformers and how it compares to that of a new distribution transformer.

27. DOE seeks comment on recent changes in distribution transformer sizing practices. In particular, DOE would like comments on any additional sources of data regarding trends in market share across equipment classes for either liquid-immersed or dry-type transformers that should be considered in the analysis.

28. DOE requests comment on the possibility of reduced equipment utility or performance resulting from today's proposed standards, particularly the risk of reducing the ability to perform periodic maintenance and the risk of increasing vibration and acoustic noise.

10. DOE has raised 30 Questions to Stakeholders

29. DOE requests comment and corroborating data on how often distribution transformers are operated with their primary and secondary windings in different configurations, and on the magnitude of the additional losses in less efficient configurations.

30. DOE requests comment on impedance values and on any related parameters (e.g., inrush current, X/R ratio) that may be used in evaluation of distribution transformers. DOE requests particular comment on how any of those parameters may be affected by energy conservation standards of today's proposed levels or higher.

11. Comment Period ends April 18, 2012.

- **a. NEMA sending in Comments.**
- **b. Others encouraged to comment.**

DOE needs data and arguments to support their NOPR Proposal

12. Significant Background Documents

a. NEMA letter to Secretary Chu
b. Steel Company letter to Secretary Chu
c. DOE Summary Presentation and White Paper by Cooper
d. HVOLT DOE Analysis 092411
e. ProlecGE Simplified Cost Efficiency Charts
f. ABB analysis
g. Core Steel Comparison

DOE needs data and arguments to support their NOPR Proposal

Distribution Transformer Energy Efficiency Task Force

Philip J Hopkinson, PE

Key Issues to establishing New Standards

1. **Transformer RMS Equivalent Load proposed to remain unchanged**
   a. Currently 35% for LV
   b. Currently 50% for MV
2. **Present worth value of a watt saved in 30 years with 3% inflation and 7% cost of money**
   a. Worth may be $6.71 for Utilities
   b. Worth probably < $9.91 for Industrials and Commercials as 30 years horizon believed excessive by manufacturers and users
3. **Core materials to be the basis of a minimum national standard**
   a. **M3 believed to be limit by manufacturers and domestic steel makers**
   b. Amorphous pushed by Conservation advocates
4. **Transformer selling price versus efficiency**
   a. OPS data questioned by LV and MV manufacturers
   b. Cost data some issues on materials costs.

References of Value

1. **DOE Materials**
   a. August 31, 2011 issued documents
   b. March 2011 documents
   c. Updated February, 2012
2. **Studies by Carlos Gaytan, Wes Patterson, and Phil Hopkinson**
   a. M3 based designs have steep cost curve versus efficiency
   b. The cost /watts saved for each makes higher efficiency look costly
   c. Amorphous cost curve much flatter versus efficiency
3. **AK Steel Global steel report**
   a. M3 believed as far as domestics can support
   b. ZDMH not available in the US
   c. Amorphous not adequately available to support 100% of DT's
4. **Reports by Utilities, Amorphous makers, users including field failures**
   a. Loading examined
   b. Field failures analyzed.

DOE Material Cost Reference for Liquid Filled Transformers

Table 5.4.1 Typical Manufacturer's Material Prices for Liquid-Immersed Design Lines

Material	Units	2010 Price *2010$*	Min. Price (2006 – 25%) *2010$*	Max. Price (2008 + 25%) *2010$*	2010 *2010$*	2009 *2010$*	2008 *2010$*	2007 *2010$*	2006 *2010$*
M6 core steel	$/lb	$ 1.46	$ 0.94	$ 2.19	$ 1.46	$ 1.64	$ 1.75	$ 1.58	$ 1.26
M5 core steel	$/lb	$ 1.51	$ 0.99	$ 2.24	$ 1.51	$ 1.67	$ 1.79	$ 1.61	$ 1.32
M4 core steel	$/lb	$ 1.59	$ 1.03	$ 2.30	$ 1.59	$ 1.70	$ 1.84	$ 1.64	$ 1.38
M3 core steel	$/lb	$ 1.88	$ 1.06	$ 2.60	$ 1.88	$ 1.96	$ 2.08	$ 1.70	$ 1.41
M3 core steel (Lite Carlite)	$/lb	$ 1.95	$ 1.47	$ 2.44	$ 1.95	$ -	$ -	$ -	$ -
M2 core steel	$/lb	$ 2.00	$ 1.32	$ 2.79	$ 2.00	$ 2.01	$ 2.23	$ 2.18	$ 1.76
M2 core steel (Lite Carlite)	$/lb	$ 2.10	$ 1.58	$ 2.63	$ 2.10	$ -	$ -	$ -	$ -
ZDMH (mechanically-scribed core steel)	$/lb	$ 2.05	$ 1.41	$ 3.22	$ 2.05	$ 2.02	$ 2.57	$ 2.29	$ 1.88
SA1 (amorphous) finished core, volume production	$/lb	$ 2.38	$ 1.72	$ 3.64	$ 2.38	$ 2.29	$ 2.91	$ -	$ -
Copper wire, formvar, round #10-20	$/lb	$ 4.87	$ 3.33	$ 5.97	$ 4.87	$ 3.81	$ 4.77	$ 4.78	$ 4.44
Copper wire, enameled, round #7-10	$/lb	$ 4.84	$ 3.31	$ 5.93	$ 4.84	$ 3.78	$ 4.74	$ 4.75	$ 4.41
Copper wire, enameled, rectangular sizes	$/lb	$ 4.97	$ 3.41	$ 6.09	$ 4.97	$ 3.91	$ 4.87	$ 4.88	$ 4.54
Aluminum wire, formvar, round #9-17	$/lb	$ 3.07	$ 2.30	$ 3.91	$ 3.07	$ 3.00	$ 3.13	$ 3.08	$ 3.07
Aluminum wire, formvar, round #7-10	$/lb	$ 2.57	$ 1.93	$ 3.28	$ 2.57	$ 2.50	$ 2.63	$ 2.58	$ 2.57
Copper strip, thickness range 0.02-0.045	$/lb	$ 4.97	$ 3.41	$ 6.09	$ 4.97	$ 3.91	$ 4.87	$ 4.88	$ 4.54
Copper strip, thickness range 0.030-0.060	$/lb	$ 4.97	$ 3.41	$ 6.09	$ 4.97	$ 3.91	$ 4.87	$ 4.88	$ 4.54
Aluminum strip, thickness range 0.02-0.045	$/lb	$ 2.08	$ 1.56	$ 2.67	$ 2.08	$ 2.01	$ 2.14	$ 2.09	$ 2.08
Aluminum strip, thickness range 0.045-0.080	$/lb	$ 2.08	$ 1.56	$ 2.67	$ 2.08	$ 2.01	$ 2.14	$ 2.09	$ 2.08
Kraft insulating paper with diamond adhesive	$/lb	$ 1.52	$ 1.17	$ 1.93	$ 1.52	$ 1.54	$ 1.54	$ 1.56	$ 1.56
Mineral oil	$/gal	$ 3.35	$ 1.94	$ 3.84	$ 3.35	$ 2.89	$ 3.07	$ 2.51	$ 2.59
Tank Steel	$/lb	$ 0.38	$ 0.32	$ 0.60	$ 0.38	$ 0.39	$ 0.48	$ 0.43	$ 0.43

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Future Posted Materials

1. **Reference Materials released to me**
2. **Decisions by DOE**

Next Meeting in Milwaukee