

# Distribution Transformer Energy Efficiency Task Force

Philip J Hopkinson, PE

1. Introduction
2. Minutes from MKE, October 23, 2012
3. NOPR Issued By DOE

[http://www1.eere.energy.gov/buildings/appliance\\_standards/commercial/distribution\\_transformers.html](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 Elusive
4. Assignments
5. Next meeting in St. Louis

# Distribution Transformer Energy Efficiency Task Force

Philip J Hopkinson, PE

Meeting Minutes from Milwaukee, October 23, 2012 Part 1 of 4

## Distribution Transformer Subcommittee

### Task force / Working Group Report

Document #: NA Current Standard Date: NA

Document Title: **Task Force on Department of Energy Activity on Energy Efficiency of Transformers**

Chair: Phil Hopkinson Vice-Chair

Secretary Steve Griffith

PAR Date: NA PAR Expiration Date: NA

PAR Status: NA

Current Draft Being Worked On: NA Dated: NA

Meeting Date: October 23, 2012 Time: 1:45 – 3:00pm

Attendance:	Members	<u>30</u>
	Guests	<u>48</u>
	Guests Requesting Membership	<u>14</u>
	Total	<u>78</u>

# Distribution Transformer Energy Efficiency Task Force

Philip J Hopkinson, PE

Meeting Minutes from Boston, 11/1/2011 part 2 of 4

## Members Present

Armstrong, James  
Duckett, Don  
Gaytan, Carlos  
Ghafourian, Ali  
Hardin, Michael  
Holifield, Thomas  
Hopkinson, Philip  
Iman, Mike  
John, John K.  
King, Gary  
Klaponski, Brian  
Miller, Kent  
Mulkey, Daniel  
Osborn, Gary  
Olen, Robert  
Parkinson, Dwight  
Pezzin, Justin  
Prince, Jarrod  
Simmons, Charles  
Smith, Edward  
Stahara, Ronald  
Sullivan, Christopher  
Traut, Alan  
Wilks, Alan

## Members Absent

None

Siemens Energy  
HD Supply Utilities  
Prolec GE  
ERMCO  
H-J Enterprises  
Howard Industries  
HVOLT Inc  
Consultant  
Virginia Transformer Corp  
Howard Industries  
Carte International  
T&R Electric Supply  
Pacific Gas & Electric  
TCI Sales  
Cooper Power Systems  
Cooper Power Systems  
IFD Corporation  
ERMCO  
Progress Energy  
H-J Enterprises  
Central Moloney Inc  
Heartland Solutions  
Power Partners  
Consultant

## Guests

Bane, William  
Boettger, William  
Drees, Tony  
Harden, Ken  
John, John K  
Mahajan, Satish  
Marek, Richard  
McLaughlin, Richard  
Morgan, Charles  
Narawane, Aniruddha  
Nims, Joe  
Platt, Don  
Robalino, Diego  
Sauzay, R.  
Schneider, Jeff  
Sheehan, Dave  
Szewczk, Radoslaw  
Tendulkar Vijay  
Trimble, Joshua  
Xgochne, Delali

Nashville Electric  
Boettger Transformer Consulting  
Cindus Corp  
Schneider Electric  
Virginia Transformer Corp  
Tennessee Tech University  
DuPont  
DNY KEMA  
Northeast Utilities  
Olsun Electrics Corp  
Allan & Hosnall  
PPL  
Megger  
SST Transformers  
Cooper Power Systems  
HICO America  
DuPont  
Onyx Power  
Xcel Energy  
China Ministry of Energy

# Distribution Transformer Energy Efficiency Task Force

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Meeting Minutes from Milwaukee, October 23, 2012 Part 3 of 4

## **Meeting Minutes / Significant Issues / Comments:**

The Task Force on DOE Energy Efficiency of Transformers was called to order at 1:45 PM on October 23<sup>rd</sup>, 2012. The new secretary was introduced. A hand count of the members was made and a quorum was declared. The chairman briefly reviewed the contents of the minutes. A motion was made (Mr. Buchanan) and seconded (Mr. Klaponski) to approve the minutes; the motion was approved.

The chairman informed the TF that he does not expect the DOE final ruling on the NOPR until after the elections. The chairman reviewed the history of the NOPR that was issued by the Department of Energy. He walked through the tutorial he had prepared on the NOPR. He further highlighted some key elements. 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% to 17%) transformers and reducing losses in liquid and low voltage dry type transformers.

In Table 4 he noted that anything > 25-30% in 3 phase reduction appears to be very excessive and needs attention. In further discussion he mentioned that the reaction to the NOPR issued 10 Feb 2012 was favorable from NEMA, EEI, Utilities, and conventional steel manufacturers. A concern was expressed regarding the crossover between M3 and Amorphous, and the fact that the DOE never understood this concept.

Negotiations were completed. NEMA had prepared and submitted comments by the 28 June 2012 deadline. The chairman asked Mr. Caskey from NEMA to give a presentation on the negotiation process. He made a few observations on the negotiating process. Both the manufacturers and utilities were honest and forthright in providing the consultants valid data for their models. Going forward these consultants will now have better data that they can use to improve their models. A better understanding was achieved with the other participant's. Finally, the process in itself was valuable even w/o a negotiated settlement. The chairman asked Mr. Patterson to provide his comments and any known status. He mentioned that an agreement was reached on medium voltage dry, and that when the NOPR does finally come out there might be

# Distribution Transformer Energy Efficiency Task Force

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Meeting Minutes from Milwaukee, October 23, 2012 Part 4 of 4

## Distribution Transformer Subcommittee Working Group Report

some new proposed standards for product classes that fall outside the proposed efficiency levels. There was no new status to report on when the date for the final rule is expected.

A comment was made from a member that the life cycle cost analysis that had been completed previously by the chairman be included in the minutes as it was felt that the DOE version is inadequate. The Chairman would provide analysis and it would be posted. A comment was made from an IEC delegate that they are seeing a similar issue in Europe; this is in the early stages. There was no new business. The next meeting will be held in conjunction with the IEEE Transformer Committee meeting in Munich Germany during the week of March 17-21<sup>st</sup>, 2013.

The meeting was adjourned at 3:00 PM

Submitted By:	<u>Steve Griffith</u>
Date:	<u>11/6/12</u>

# Distribution Transformer Energy Efficiency Task Force

Philip J Hopkinson, PE












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

## Proposed Rulemaking

Note

- **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](#) 

# Distribution Transformer Energy Efficiency Task Force

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## 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.



# Distribution Transformer Energy Efficiency Task Force

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## 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



# Distribution Transformer Energy Efficiency Task Force

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## 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%

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## 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	%
15 .....	97.73	15 .....	97.44
25 .....	98.00	30 .....	97.95
37.5 .....	98.20	45 .....	98.20
50 .....	98.31	75 .....	98.47
75 .....	98.50	112.5 .....	98.66
100 .....	98.60	150 .....	98.78
167 .....	98.75	225 .....	98.92
250 .....	98.87	300 .....	99.02
333 .....	98.94	500 .....	99.17
		750 .....	99.27
		1000 .....	99.34

3 Phase  
% reduction

14.7  
18.0  
20.7  
23.5  
25.5  
27.9  
28.1  
30.0  
33.6  
33.4  
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!

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

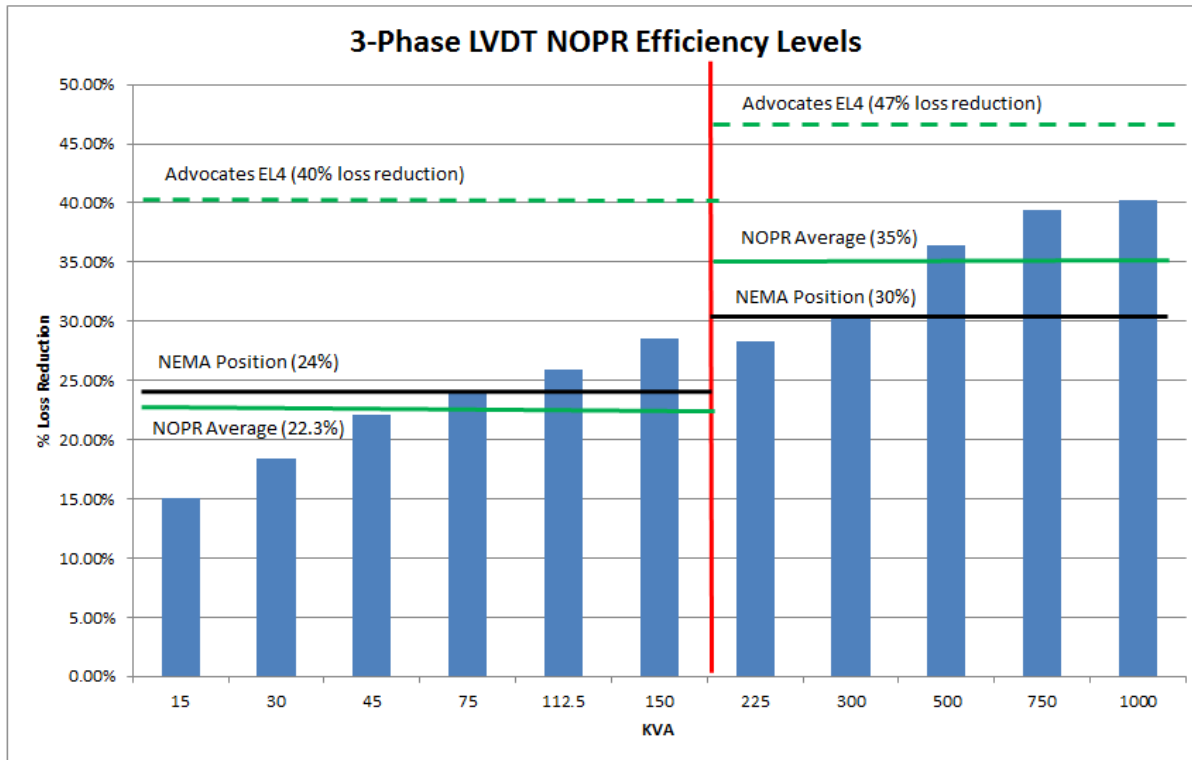


Chart Courtesy of  
Rob Greeson

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!

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## 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 pay-back period (years)
<b>Liquid-Immersed</b>		
1 .....	36	20.2
2 .....	* N/A	* N/A
3 .....	2,413	6.3
4 .....	862	5.0
5 .....	7,787	4.0
<b>Low-Voltage, Dry-Type</b>		
6 .....	* N/A	* N/A
7 .....	1,714	4.5
8 .....	2,476	8.4
<b>Medium-Voltage, Dry-Type</b>		
9 .....	849	2.6
10 .....	4,791	8.8
11 .....	1,043	10.7
12 .....	6,934	9.0
13A .....	25	16.5

**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**

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## 8. M3 and Amorphous cross over at Efficiency Level 1

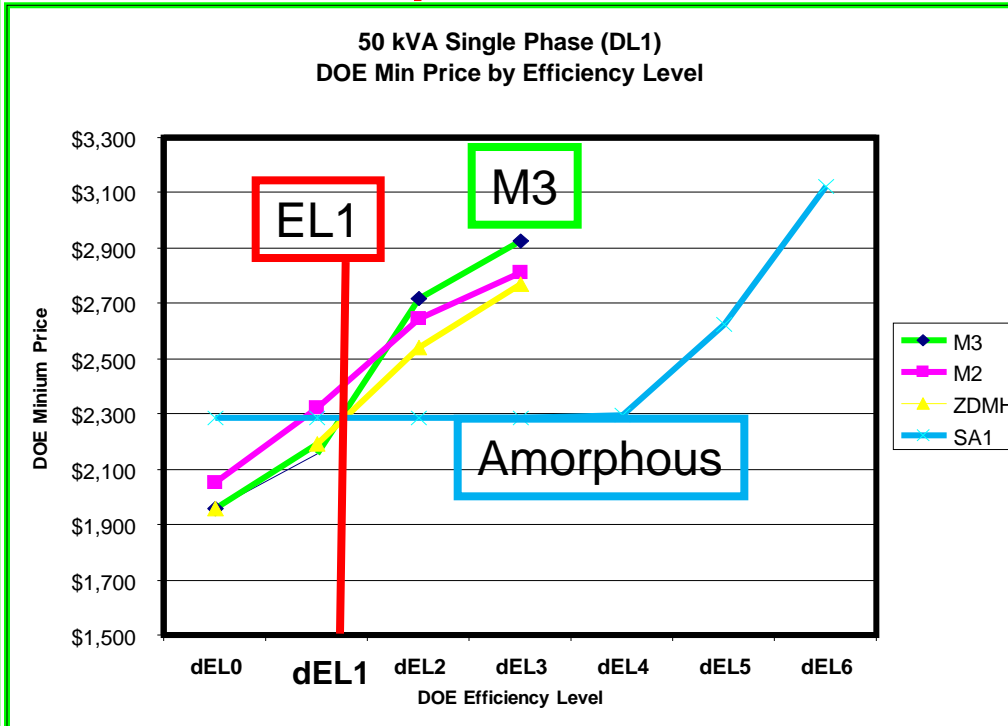


Chart Courtesy  
of Carlos Gaytan  
Based on 50 kVA  
single Phase Pad

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

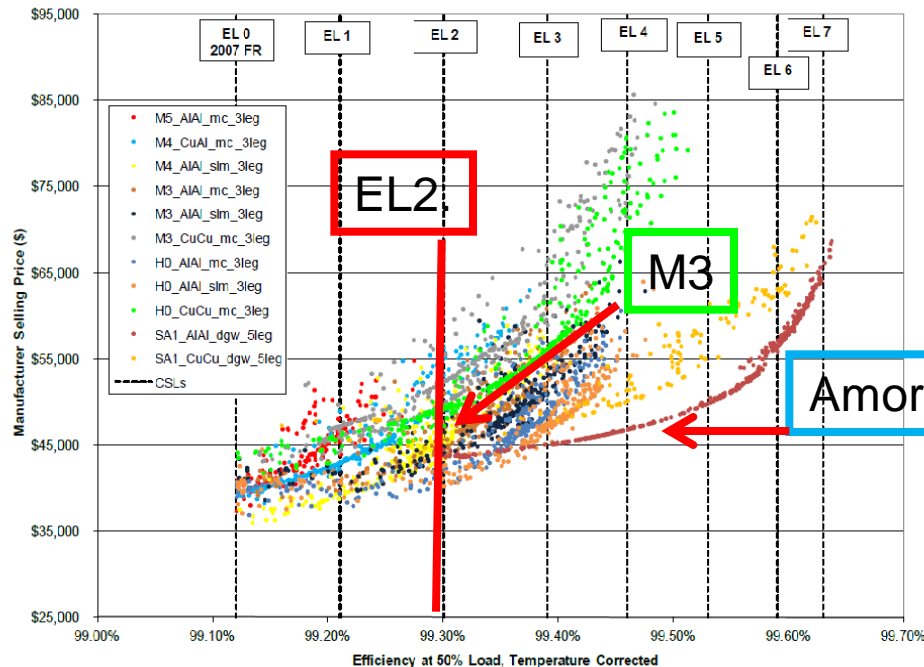


Chart Courtesy of LBL  
Based on 1500 kVA  
Three Phase MV Dry

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

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## 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](http://www1.eere.energy.gov/buildings/appliance_standards/commercial/distribution_transformers.html)

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## 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.

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## 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.



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## 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.

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## 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.

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## 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.

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## 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.

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## 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.

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## 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.

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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.

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## 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.



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## 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.

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## 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**

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## 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**

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## 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.

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## 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.

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## 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 St. Louis**