LET'S BE PACIFIC™

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DOE Publishes in the April 13, 2013 Federal Register Notice of Final Rule for Distribution Transformers

The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including **distribution transformers**. EPCA requires the U.S. Department of Energy (DOE) to review its standards at least once every 6 years, and specifies that any new DOE standard for **distribution transformers** may not go into effect sooner than 3 years from its date of adoption.

EPCA also requires DOE to determine whether more-stringent standards would be technologically feasible and economically justified. The DOE must prove that the new standard would save a noteworthy amount of energy and reduce significantly various types of airborne pollutants, primarily carbon dioxide, CO_2, sulfur dioxide, SO_2, and nitrogen oxides, NO_X.

In this **final rule**, DOE is adopting more-stringent energy conservation standards for distribution transformers that meet the above criteria. Covered in this final rule are three principal categories of distribution transformers: (1) Medium-Voltage Dry (Ventilated and CAST); (2) Low-Voltage Dry (Ventilated); and (3) Liquid-filled transformers. The Equipment Classes, Design Lines, Type, Power Ratings in KVA and the Representative Unit used for detailed analysis are listed in Exhibit 1, which includes all the distribution transformers whose efficiencies will go up in 2016. Discussion on the changes affecting liquid transformers is beyond the scope of this newsletter.

Next the most important chart is Exhibit 3 that defines which dry transformers will be required to perform at higher efficiencies than the efficiencies that went into effect January 1, 2007 (Low Voltage) and January 1, 2010 (Medium Voltage).

In this new final rule there are some things that did not change from the present rules:

1. Although the efficiencies increased, the ratings and other feature attributes covered (Exhibit 1 and Exhibit 2) stayed the same.
2. The presumed loadings at which efficiency ratings are calculated (50% of NP for all designs except 35% of NP for Low Voltage) stayed the same for the Design Lines.
3. All of the presently existing efficiencies of the **Single Phase** MVDT and LVDT design lines and equipment classes will remain **unchanged**.

So that we can take a more specific look at how much the efficiencies will need to improve by January of 2016, Exhibit 5 and Exhibit 6 illustrate to what extent the losses will be reduced by Equipment Class, Design Line, KVA rating and BIL. As you can observe, there was only barely enough time for the DOE consultants and the manufacturers to optimize a representative sample of designs. The other designs were scaled based on industry accepted mathematical algorithms. Federal Pacific has shown these improvements graphically in Exhibits 6 through Exhibit 9.

As the efficiencies rise to the minimum levels set by DOE, the manufacturer will begin using higher grades of core steel, more step lap, miter cores, and in some cases more wound core construction. Most of these changes in the transformer cores will require significant capital investment in new core cutting equipment and perhaps annealing ovens.

As you might expect, as the industry moves to comply with the higher DOE mandated efficiencies, the new designs will require higher pricing than the designs at present. From his presentation to the Distribution Transformer Engineering Task Force, Mr. Phil Hopkinson, a leading transformer consultant, calculated the payback period for the higher efficiency transformer to range from 2.6 years to 16.5 years.

For much more detailed information on the process by which the DOE along with the advocates, the manufacturers, and users of distribution transformers arrived at these new efficiency levels, please refer to the aforementioned article published in the April 13, 2013 issue of the *Federal Register*. We at Federal Pacific will be available to help all of our readers and customers arrive at the best selection of these higher efficiency transformers as they become available.

Exhibit 1
Listing of Design Lines by Equipment Class

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	50kVA, 65°C, single-phase, 60Hz, 14400V primary, 240/120V secondary, rectangular tank, 95kV BIL
	2	Liquid-immersed, single-phase, round tank	10-167	25kVA, 65°C, single-phase, 60Hz, 14400V primary, 120/240V secondary, round tank, 125kV BIL
	3	Liquid-immersed, single-phase	250-833	500kVA, 65°C, single-phase, 60Hz, 14400V primary, 277V secondary, 150kV BIL
2	4	Liquid-immersed, three-phase	15-500	150kVA, 65°C, three-phase, 60Hz, 12470Y/7200V primary, 208Y/120V secondary, 95kV BIL
	5	Liquid-immersed, three-phase	750-2500	1500kVA, 65°C, three-phase, 60Hz, 24940GrdY/14400V primary, 480Y/277V secondary, 125kV BIL
3	6	Dry-type, low-voltage, single-phase	15-333	25kVA, 150°C, single-phase, 60Hz, 480V primary, 120/240V secondary, 10kV BIL
4	7	Dry-type, low-voltage, three-phase	15-150	75kVA, 150°C, three-phase, 60Hz, 480V primary, 208Y/120V secondary, 10kV BIL
	8	Dry-type, low-voltage, three-phase	225-1000	300kVA, 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	300kVA, 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	1500kVA, 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	300kVA, 150°C, three-phase, 60Hz, 12470V primary, 480Y/277V secondary, 95kV BIL
	12	Dry-type, medium-voltage, three-phase, 46-95kV BIL	750-2500	1500kVA, 150°C, three-phase, 60Hz, 12470V primary, 480Y/277V secondary, 95kV BIL
10	13A	Dry-type, medium-voltage, three-phase, 96-150kV BIL	75-833	300kVA, 150°C, three-phase, 60Hz, 24940V primary, 480Y/277V secondary, 125kV BIL
	13B	Dry-type, medium-voltage, three-phase, 96-150kV BIL	225-2500	2000kVA, 150°C, three-phase, 60Hz, 24940V primary, 480Y/277V secondary, 125kV BIL

**See Exhibit 2 for the definitions of Equipment Class*

Exhibit 2

Table IV.1 — Distribution Transformer Equipment Classes

EC	Insulation	Voltage	Phase	BIL Rating	kVA Range
1	Liquid-immersed	Medium	Single	—	10-833 kVA
2	Liquid-immersed	Medium	Three	—	15-2500 kVA
3	Dry-type	Low	Single	—	15-333 kVA
4	Dry-type	Low	Three	—	15-1000 kVA
5	Dry-type	Medium	Single	20-45kV	15-833 kVA
6	Dry-type	Medium	Three	20-45kV	15-2500 kVA
7	Dry-type	Medium	Single	46-95kV	15-833 kVA
8	Dry-type	Medium	Three	46-95kV	15-2500 kVA
9	Dry-type	Medium	Single	≥96kV	75-833 kVA
10	Dry-type	Medium	Three	≥96kV	225-2500 kVA

Exhibit 3

A Distribution Transformer has the following attributes with ratings shown in Exhibit 1

1. An input voltage of 34.5 kV or less
2. An output voltage of 600 volts or less
3. Is rated for operation at a frequency of 60 Hz
4. Has a power rating of 10 kVA to 2500 kVA — Liquid: single phase or three phase
5. Has a power rating of 15 kVA to 2500 kVA — Ventilated Dry-Type: single phase or three phase

MVDT, EC8, 3Ø, Unit Substation, Ventilated Dry-Type

MVDT, EC7, 1Ø, High Rise, Ventilated Dry-Type

MVDT, EC8, 3Ø, Mine Duty Sub-Surface

LVDT, EC3, 3Ø, Low Voltage General Purpose, Ventilated

Types of Transformers Covered by DOE per 10 CFR Part 431	
Type	**Higher Efficiencies Mandated by DOE Beginning in 2016**
All Distribution Transformer Ratings (Liquid and Dry) shown in Exhibit 1 except single-phase low-voltage dry	Yes
Medium Voltage Mine Duty Transformers (Underground and Surface) Special Equipment Class	No
Data Center Transformers	Yes
Network Transformers	Yes
High Rise MVDT Transformers (Three Phase only)	Yes
Single Phase Ventilated Dry-Type Transformers (Low Voltage and Medium Voltage)	No

Types of Transformers Excluded From DOE Mandated Efficiencies
All transformers whose ratings are not contained within Exhibit 1
All transformers repaired and/or refurbished
Transformers not rated for 60 Hz
Drive Isolation Transformers
Rectifier Transformers
Transformers with a tap range >20% per Table 2 10 CFR 431.102
Transformers with special impedances
Step-up transformers having a secondary voltage greater than 600 volts
Sealed dry and encapsulated dry transformers
Uninterruptable power supply transformers
Testing transformers
Regulating transformers
Auto transformers
Grounding transformers
Machine Tool and Control Transformers
UPS transformers
Welding transformers

Exhibit 4 — MVDT

MVDT Single Phase 20-45 BIL (EC5)

Design Line	KVA	2010 EFF	2010 Watts	EL Level	Final Rule Eff.	2016 Watts	% Reduction From 2010
	15	98.10%	145	Scaled	98.10%	145	0.00%
	25	98.33%	212	Scaled	98.33%	212	0.00%
	37.5	98.49%	287	Scaled	98.49%	287	0.00%
	50	98.60%	355	Scaled	98.60%	355	0.00%
	75	98.73%	482	Scaled	98.73%	482	0.00%
	100	98.82%	597	Scaled	98.82%	597	0.00%
	167	98.96%	878	Scaled	98.96%	878	0.00%
	250	99.07%	1173	Scaled	99.07%	1173	0.00%
	333	99.14%	1444	Scaled	99.14%	1444	0.00%
	500	99.22%	1965	Scaled	99.22%	1965	0.00%
	667	99.27%	2452	Scaled	99.27%	2485	0.00%
	833	99.31%	2894	Scaled	99.31%	2894	0.00%

MVDT Three Phase 20-45 BIL (EC6)

Representative Unit in Orange

Design Line	KVA	2010 EFF	2010 Watts	EL Level	Final Rule Eff.	2016 Watts	% Reduction From 2010
DL9	15	97.50%	192	Scaled	97.50%	192	0.0%
	30	97.90%	322	Scaled	97.90%	322	0.0%
	45	98.10%	436	Scaled	98.10%	436	0.0%
	75	98.33%	637	Scaled	98.33%	637	0.0%
	112.5	98.49%	862	Scaled	98.52%	845	2.0%
	150	98.60%	1065	Scaled	98.65%	1026	3.6%
	225	98.73%	1447	Scaled	98.82%	1343	7.2%
	300	**98.82%**	**1791**	**EL1**	**98.93%**	**1622**	**9.4%**
	500	98.96%	2627	Scaled	99.09%	2296	12.6%
DL10	750	99.07%	3520	Scaled	99.21%	2986	15.2%
	1000	99.14%	4337	Scaled	99.28%	3626	16.4%
	1500	**99.22%**	**5896**	**EL2**	**99.37%**	**4755**	**19.4%**
	2000	99.27%	7354	Scaled	99.43%	5733	22.0%
	2500	99.31%	8685	Scaled	99.47%	6660	23.3%

MVDT Single Phase 46-95 BIL (EC7)

Design Line	KVA	2010 EFF	2010 Watts	EL Level	Final Rule Eff.	2016 Watts	% Reduction From 2010
	15	97.86%	164	Scaled	97.86%	164	0.00%
	25	98.12%	240	Scaled	98.12%	240	0.00%
	37.5	98.30%	324	Scaled	98.30%	324	0.00%
	50	98.42%	401	Scaled	98.42%	401	0.00%
	75	98.57%	544	Scaled	98.57%	544	0.00%
	100	98.67%	674	Scaled	98.67%	674	0.00%
	167	98.83%	989	Scaled	98.83%	989	0.00%
	250	98.95%	1326	Scaled	98.95%	1326	0.00%
	333	99.03%	1631	Scaled	99.03%	1631	0.00%
	500	99.12%	2220	Scaled	99.12%	2220	0.00%
	667	99.18%	2757	Scaled	99.18%	2757	0.00%
	833	99.23%	3232	Scaled	99.23%	3232	0.00%

MVDT Three Phase 46-95 BIL (EC8)

Representative Unit in Orange

Design Line	KVA	2010 EFF	2010 Watts	EL Level	Final Rule Eff.	2016 Watts	% Reduction From 2010
DL11	15	97.18%	218	Scaled	97.18%	218	0.0%
	30	97.63%	364	Scaled	97.63%	364	0.0%
	45	97.86%	492	Scaled	97.86%	492	0.0%
	75	98.12%	719	Scaled	98.13%	715	0.5%
	112.5	98.30%	973	Scaled	98.36%	938	3.6%
	150	98.42%	1204	Scaled	98.51%	1134	5.8%
	225	98.57%	1632	Scaled	98.69%	1493	8.5%
	300	**98.67%**	**2022**	**EL1**	**98.81%**	**1806**	**10.7%**
	500	98.83%	2960	Scaled	98.99%	2551	13.8%
DL12	750	98.95%	3979	Scaled	99.12%	3329	16.3%
	1000	99.03%	4898	Scaled	99.20%	4032	17.7%
	1500	**99.12%**	**6659**	**EL2**	**99.30%**	**5287**	**20.6%**
	2000	99.18%	8268	Scaled	99.36%	6441	22.1%
	2500	99.23%	9700	Scaled	99.41%	7419	23.5%

MVDT Single Phase >96 BIL (EC9)

Design Line	KVA	2010 EFF	2010 Watts	EL Level	Final Rule Eff.	2016 Watts	% Reduction From 2010
	75	98.53%	559	Scaled	98.53%	559	0.00%
	100	98.63%	695	Scaled	98.63%	695	0.00%
	167	98.80%	1014	Scaled	98.80%	1014	0.00%
	250	98.91%	1378	Scaled	98.91%	1378	0.00%
	333	98.99%	1699	Scaled	98.99%	1699	0.00%
	500	99.09%	2296	Scaled	99.09%	2296	0.00%
	667	99.15%	2859	Scaled	99.15%	2859	0.00%
	833	99.20%	3359	Scaled	99.20%	3359	0.00%

MVDT Three Phase >96 BIL (EC10)

Design Line	KVA	2010 EFF	2010 Watts	EL Level	Final Rule Eff.	2016 Watts	% Reduction From 2010
DL13A	225	98.53%	1678	Scaled	98.57%	1632	2.8%
	300	98.63%	2084	Scaled	98.69%	1991	4.4%
	500	98.80%	3036	Scaled	98.89%	2806	7.6%
DL13B	750	98.91%	4133	Scaled	99.02%	3711	10.2%
	1000	98.99%	5102	Scaled	99.11%	4490	12.0%
	1500	99.09%	6888	Scaled	99.21%	5972	13.3%
	2000	99.15%	8573	Scaled	99.28%	7252	15.4%
	2500	99.20%	10081	Scaled	99.33%	8431	16.4%

NOTE: All watts losses for medium voltage transformers are taken at 50 % load corrected to 75C
EC= Equipment Class DL = Design Line

Exhibit 5 — LVDT

LVDT Single Phase (EC3)

Design Line	KVA	2010 EFF	2010 Watts	EL Level	Final Rule Eff.	2016 Watts	% Reduction From 2010
DL6	15	97.70%	124	Scaled	97.70%	124	0.00%
	25	98.00%	179	Scaled	98.00%	179	0.00%
	37.5	98.20%	241	Scaled	98.20%	241	0.00%
	50	98.30%	303	Scaled	98.30%	303	0.00%
	75	98.50%	400	Scaled	98.50%	400	0.00%
	100	98.60%	497	Scaled	98.60%	497	0.00%
	167	98.70%	770	Scaled	98.70%	770	0.00%
	250	98.80%	1063	Scaled	98.80%	1063	0.00%
	333	98.90%	1296	Scaled	98.90%	1296	0.00%

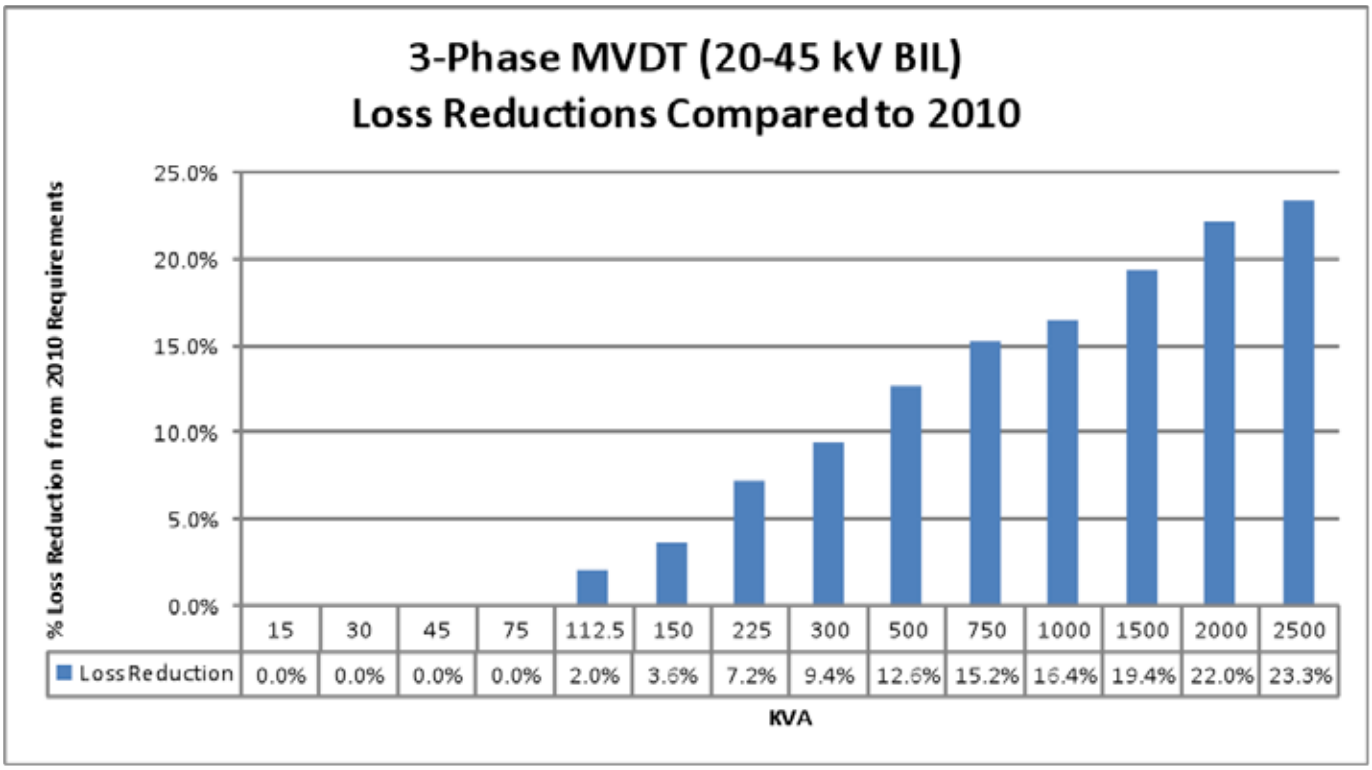
LVDT Three Phase (EC4)

Representative Unit in Orange

Design Line	KVA	2010 EFF	2010 Watts	EL Level	Final Rule Eff.	2016 Watts	% Reduction From 2010
DL7	15	97.00%	162	Scaled	97.89%	113	30.31%
	30	97.50%	269	Scaled	98.23%	189	29.73%
	45	97.70%	371	Scaled	98.40%	256	30.93%
	75	**98.00%**	**536**	**EL2**	**98.60%**	**373**	**30.43%**
	112.5	98.20%	722	Scaled	98.74%	502	30.38%
	150	98.30%	908	Scaled	98.83%	622	31.55%
DL8	225	98.50%	1199	Scaled	98.94%	844	29.65%
	300	**98.60%**	**1491**	**EL2**	**99.02%**	**1039**	**30.30%**
	500	98.70%	2305	Scaled	99.14%	1518	34.14%
	750	98.80%	3188	Scaled	99.23%	2037	36.11%
	1000	98.90%	3893	Scaled	99.28%	2538	34.80%

NOTE: All watts losses for low voltage transformers are taken at 35 % load corrected to 75C
EC= Equipment Class DL = Design Line

Exhibit 6



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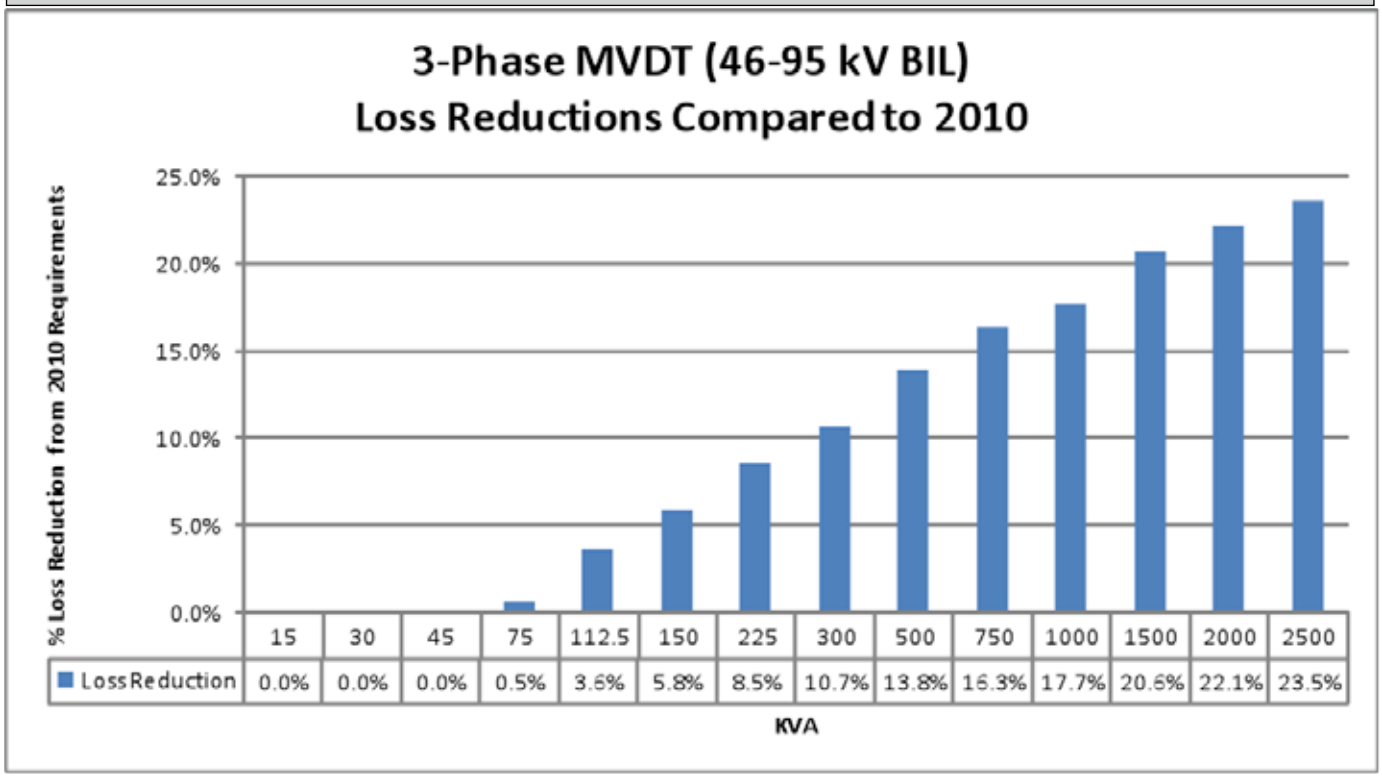

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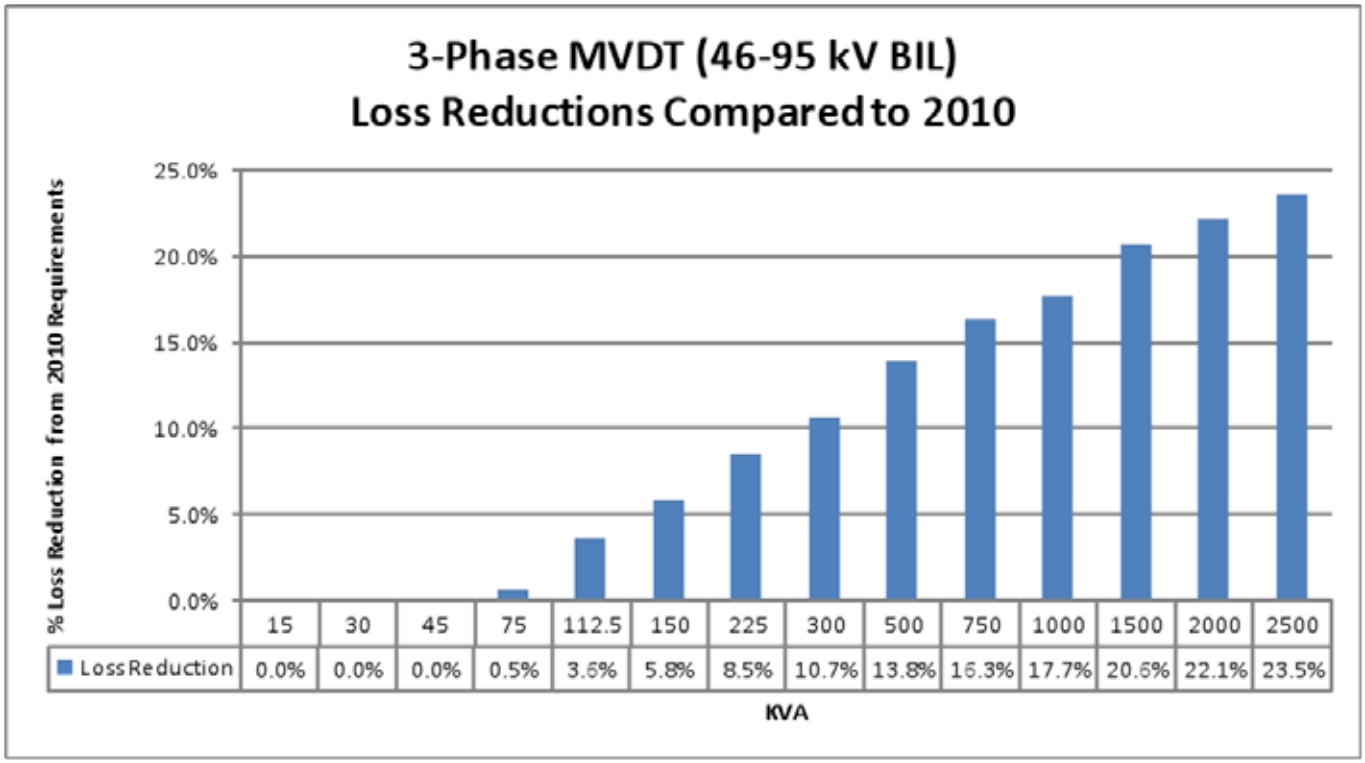

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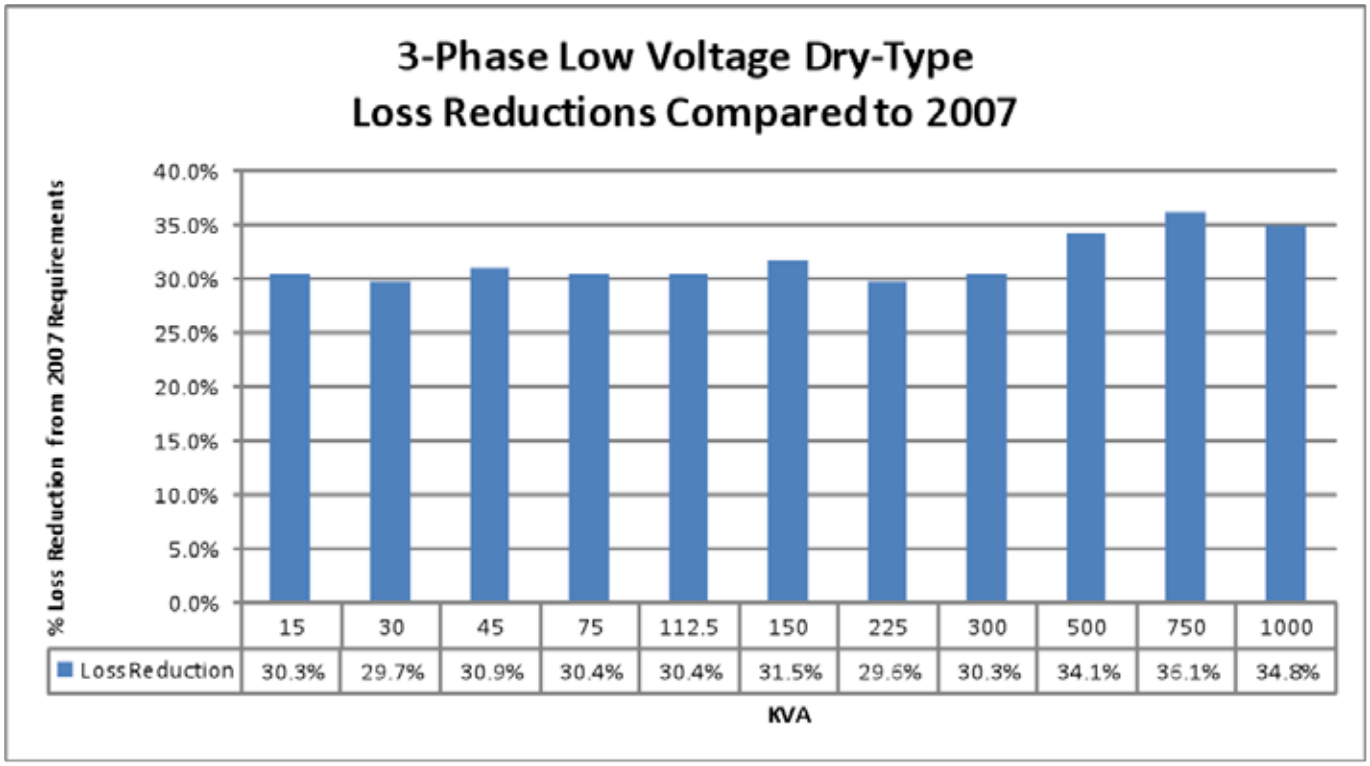

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