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Ms. Brenda Edwards-Jones
U.S. Department of Energy
Building Technologies Program
Mailstop EE-2J
ANOPR for Distribution Transformers
EE-RM/STD-00-550
1000 Independence Ave. SW
Washington, DC 20585-0121

Re: HVOLT Inc Statement on DOE Transformer NOPR Comments EE-RM/STD-00-550 for Regulatory Information Number (RIN) 1904-AB08

Dear Ms. Edwards-Jones

HVOLT Inc is a Power and Distribution Transformer Consulting firm, located in Charlotte, NC. HVOLT President, Phil Hopkinson is a long service transformer engineer with lengthy experience at three of the major manufacturers of Distribution Transformers in our country and with consulting experience at most of the US manufacturers. I am a strong believer in Energy Efficiency Standards and support efforts to produce comprehensive standards that will strengthen the US economy and move toward energy independence. At NEMA, I chaired the task force to write NEMA TP-1 in both the first edition of 1996 and in the revision of 2002. At IEEE I have chaired the Power Engineering Societies Policy Development Coordinating Committee and have been a co-author of the IEEE PES Policy Statement on Energy and the Environment that was recently approved by the PES Board of Governors. I am an IEEE Fellow, a Registered Professional Engineer in the State of North Carolina and Technical Advisor (TA) to the US National Committee for IEC TC 14 Power Transformers.

My comments are addressed at Vault Transformers and the special considerations associated with their application

A The NEMA membership has submitted a strong endorsement for the DOE to select NEMA TP-1 as the National standard for all Medium Voltage Transformers, including Vault Transformers. I fully support this position and find that it meets some important DOE principles:

1. **Doable with known materials and methods by small and large manufacturers**
2. **Pays for itself, originally with a 3-5 year payback period and currently with a 4-7 year payback attributable to higher present material costs translating to higher transformer selling prices with steady energy costs.**
3. **Results in Real Energy Savings.**

These were the initial principles used to choose the efficiency tables for all classes of Distribution Transformers. In arriving at the NEMA tables, large and small manufacturers ran designs for each of the key power ratings with loss evaluation formulas that were based on a 3-year payback for the conditions of:

1. $0.065/kwh energy cost, translating to $0.50/wat/yr. value of losses or $1.50/watt. Of present worth over 3 years.
2. 50% rms equivalent loading for all Medium Voltage Transformers and 35% rms equivalent loading for Low Voltage Dry Type Transformers.
3. 15 kV voltage class at 95 kV BIL.
4. 55C reference temperature for Liquid and 75C for Dry Transformers.

B. The Vault Transformer

1. Vault Transformers describe a class of Distribution Transformer in which the transformers are mounted inside concrete vaults.
2. The concrete vaults are usually placed beneath sidewalks in large cities and the transformers are used to provide electrical power to large grids (networks)
3. IEEE C57.12.40 is titled "AMERICAN NATIONAL STANDARD C57.12.40-2000 for Secondary Network Transformers Subway and Vault Types (Liquid Immersed)" and describes requirements for such transformers. Items B.4-B.10 are excerpts from the standard.
4. Network Transformers are normally required to meet a temperature rise not to exceed 55 C at rated load with the following power ratings:

Table 1 – Kilovolt-ampere ratings

55°C
300
500
750
1000
1500
2000
2500

5. Network Transformers also have specific impedance requirements as shown below:

Table 3 – Impedance

kVA rating	**Percent impedance**
300–1000	5.0
1500–2500	7.0

6. Network Transformers also must meet certain tank gage requirements:

Table 7 – Minimum material thickness

Transformer enclosure	**Subway type mm-(inches)**	**Vault type mm – (inches)**
Tank wall	8 –	(0.31)
Switch housing	8 –	(0.31)
Auxiliary coolers	8 –	(0.31)
Cover	13 –	(0.5)
Tank bottom	13 –	(0.5)

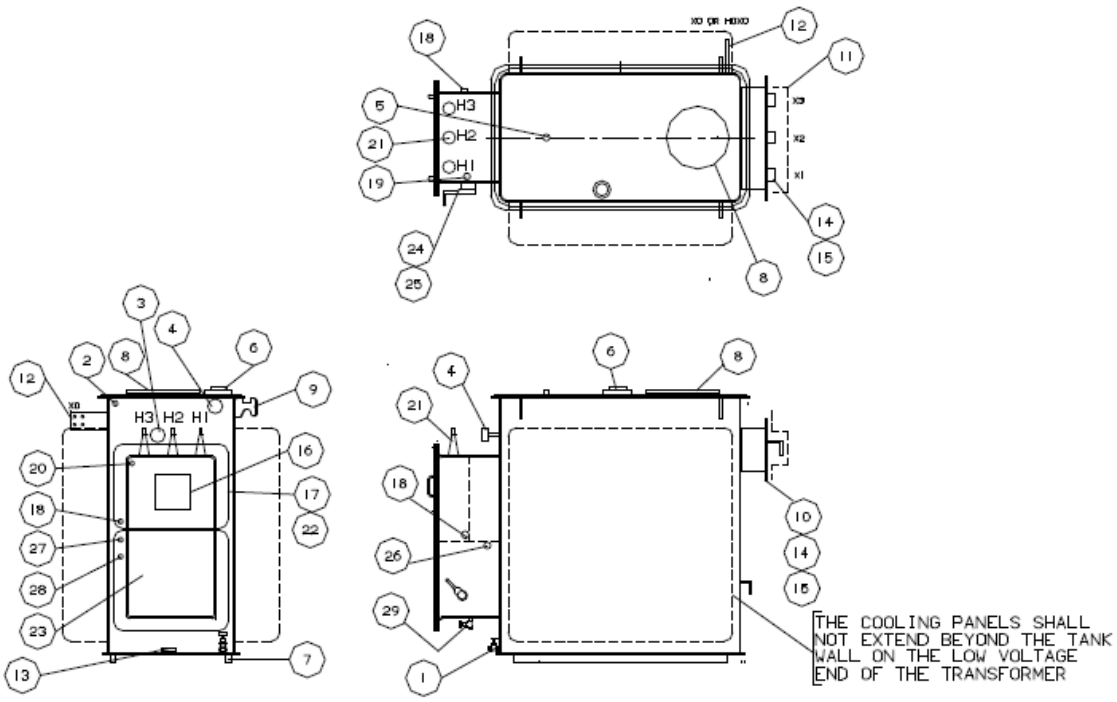
7. Network transformers must also meet certain size limitations:

Table 9

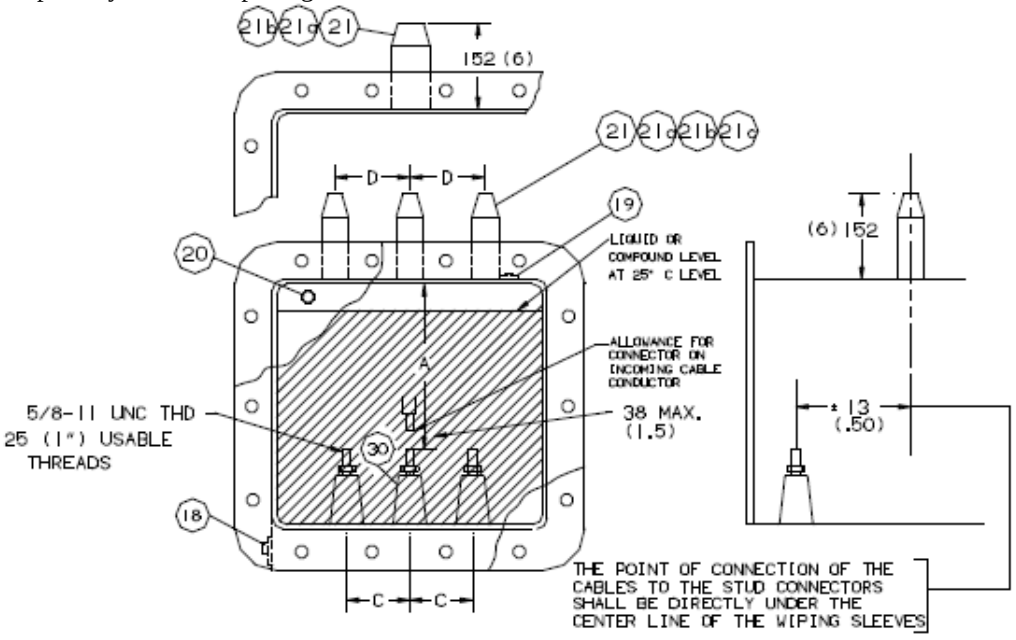
Maximum tank dimensions in Inches (4)

For mineral oil-filled units												
15 kV class and below					25 kV class				35 kV class			
kVA Rating	W	L (1)	H_c (2)	Throat H (3)	W	L	H_c (2)	Throat H (3)	W	L	H_c (2)	Throat H (3)
300	39	78	67	42	—	—	—	—	—	—	—	—
500	44	78	70	48	46	87	70	55	49	94	77	58
750	47	84	74	55	48	93	74	61	51	100	80	68
1000	52	86	84	57	55	97	78	60	58	105	90	73
1500	56	96	86	62	60	100	86	65	63	109	93	77
2000	64	105	97	70	70	115	89	70	77	117	105	84
2500	70	105	101	75	75	129	95	75	84	131	115	90
For silicone-filled units												
300	42	80	70	42	—	—	—	—	—	—	—	—
500	48	82	72	48	49	87	70	55	52	94	75	58
750	50	86	80	55	51	93	75	61	54	100	85	68
1000	54	88	84	57	55	97	85	60	58	105	90	73
1500	56	96	85	62	62	101	85	65	65	109	93	77
2000	64	105	97	70	70	115	98	70	77	120	103	84
2500	70	120	101	75	77	129	105	75	84	131	113	90

8. Tank interfaces must exactly meet the profiles of the following:



9. The primary interface opening must meet these dimensions:



High voltage	Dimensions				
BIL (kV)	A (min.)	B (max.)	C (min.)	E (min.)	F
95 and below	270 mm (10.5 in)	13 mm (0.5 in)	115 mm (4.5 in)	152 mm (4.5 in)	± 13 mm (0.50 in)
150	370 mm (14.5 in)	25 mm (1.0 in)	155 mm (6.0 in)	152 mm (4.5 in)	± 13 mm (0.50 in.)
200	470 mm (18.5 in)	25 mm (1.0 in)	165 mm (6.5 in)	152 mm (4.5 in)	± 13 mm (0.50 in.)

10. The secondary throat must exactly meet these dimensions:

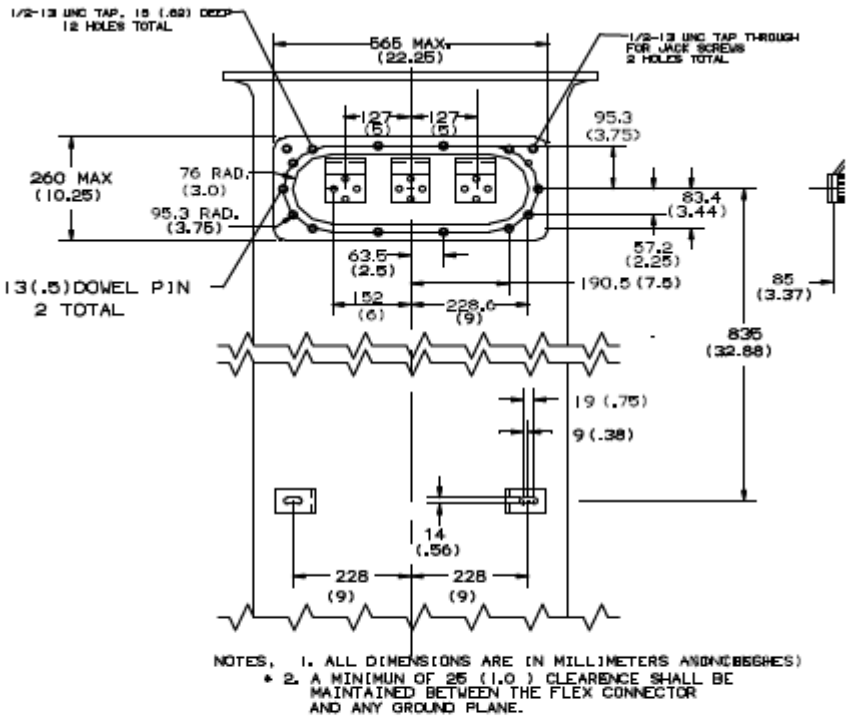


Figure 3 – Transformer throat for mounting network protector
Low voltage 216Y/125 volts, 300 – 500 KVA
Low voltage 480Y/277 volts, 500 – 1000 KVA

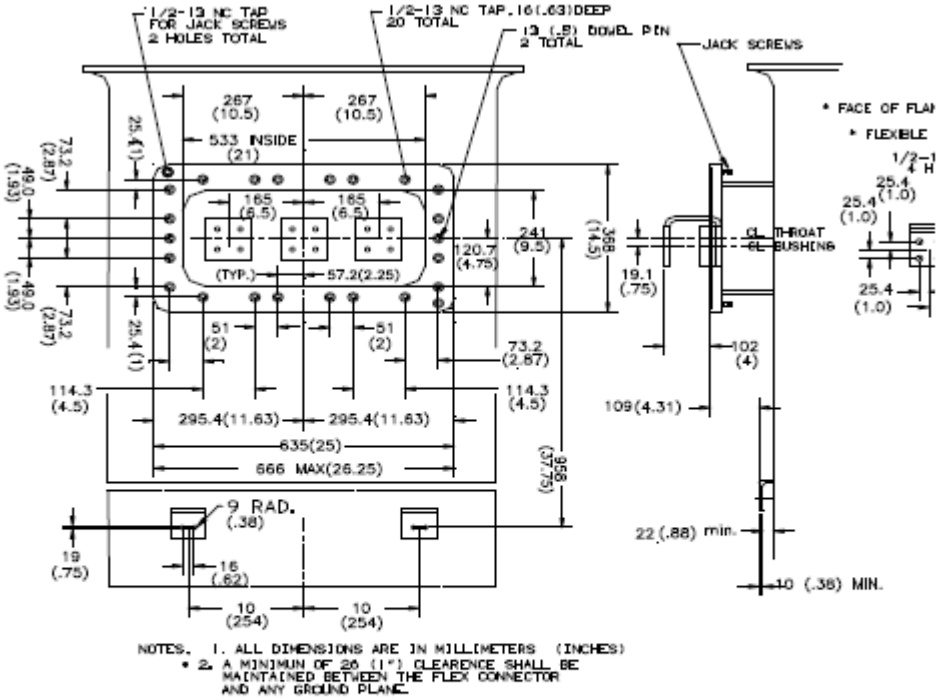


Figure 4 – Transformer throat mounting for net work protector
Low voltage 216Y/125 volts, 750 – 1000 KVA
Low voltage 480Y/277 volts, 1500 – 2500 KVA

11. The bottom line consideration for dimensions is that there is not much room for change.
12. Other considerations: Short circuits are frequent with such transformers and they are conservatively designed to meet the short circuits with minimal temperature rise. This implies that they are already energy efficient.
13. Minimal opportunity for improvement. These transformers are constrained by net core and coil dimensions to meet the tanking requirements and electrical impedance. Furthermore, the 55 C average winding rise means that they have abnormally large iron cores and higher no-load losses than 65 C rise transformers that are designed to standard 5.75% impedances. When tested at 50% load, the higher iron losses of the Network Transformers makes them appear less energy efficient than conventional transformers.
14. Network and other Vault transformers are able to meet NEMA TP-1 but are not able to be pushed to higher efficiency than TP-1 with conventional materials. In recent times, some manufacturers have been able to achieve higher efficiencies with Japanese Domain Refined Magnetic Core Steels. It is true that such materials are able to operate at higher electrical efficiencies than can be achieved with Domestic Conventional Core Steels. The problem, however, is that such materials are not available in sufficient quantity to fully displace conventional materials and can not be relied on as the basis of a National Standard.
15. Vault transformers are used in many of the major cities in the country but have been estimated as representing a total population of about 5 % of the three phase liquid immersed transformers that presently serve the US Industry.

C. Recommendations:

Vault transformers should be required to meet NEMA TP-1 and should not be asked to meet more rigorous standards.

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D. Discussion

All names of individual manufacturers have been excluded from this report to protect their competitive interests. However, I believe that the statements in this report are timely and accurate. This report is being circulated to NEMA and many of the stakeholders for their edification. Some of the manufacturers may wish to expand on areas raised here-in. They are free to use or reuse any or all parts of this report as they find useful.

Hopefully, the issues are clearly defined to help you with your considerations. Please let me know where additional information may be needed.

Very truly yours,

Philip J Hopkinson, PE
President & CEO HVolt Inc