Distribution Transformer Subcommittee
Task force / Working Group Report

Document #:			
Document Title:	**DOE Efficiency Task Force**		
Chair:	**Phil Hopkinson**	**Vice-Chair**	**Dan Mulkey**
Secretary	**Paul Orr**	**Per Cent Complete**	
Current Draft Being Worked On:		**Dated:**	
Meeting Date:	**April 26, 2021**	**Time:**	**9:10am CST**

Attendance:	**Members**	**2**
	Guests	**>78**
	Total*	**>80**

*** For details of attendance, please refer to AMS system of the Transformers Committee**

Meeting Minutes / Significant Issues / Comments:

The minutes shall record the essential business of the Working Group.

1. **Call to order and any Chair's remarks**
   - 9:10 am meeting was called to order

2. **Quorum Verification**
   - Not a working group; Quorum is not necessary

3. **Confirmation of the essential patent statement and responses**
   - Not a working group, no patents were discussed.

4. **Approval of minutes of the previous meeting**
   - Minutes approved.

5. **Approval of agenda for this meeting.**
   - Agenda was posted and followed for this meeting.

6. **Phil Hopkinson Introduction**

   a. Mr. Hopkinson noted that loading likely to increase 10- 40% with Electric vehicle charging and HVAC conversions as we move away from gas and oil. Some key points noted are:

   - New insulations allow higher loading at higher temperatures
   - Possibility to raise kVA without loss of life
   - Base kVA must meet DOE energy efficiency

   We now anticipate that future load growth can be met without increasing physical transformer tank sizes.

   b. Dan Mulkey Reports on utilities loading data:
   Annual Load Factor =Data from Dominion Avg annual load/ Peak Annual Load
   RMS/Peak Mode 0.30, 0.31 Avg/Peak Mode 0.26
   Reviewed Annual Load Factor by KVA Size

Annual Load Factor Summary
0.3 is a reasonable number for load factor
Increases with increasing transformer size
Increases with increasing customer count
Need more data
Peak / Nameplate
Commercial 0.4
Residential 0.5
Need more data
Peak Responsibility Factor
0.3 but with a wide range
Need more data

7. **Steve Rosenstock report on future utility outlook**

Phil Hopkinson led report presentation in Mr. Rosenstock's absence.
Key trends in electric loading are due to:
• Transportation Electrification
• Building Electrification
• Codes, Standards, Policies, and Laws

Light Duty Vehicles
As of August 2020, there are ~ 1.6 Million all electric or plug in hybrid electric vehicles operating in the US.
Commercial (Medium / Heavy Duty) Duty Vehicles
"FedEx Acquires 1,000 ChanjeElectric Vehicles" (Nov 2018)
"UPS orders 10,000 electric delivery vans from startup Arrival" (January 2020)
"Amazon has ordered 100,000 custom electric delivery vehicles from electric vehicle maker Rivian." (February 2020).
"Wal-Mart to electrify and zero out emissions from all of its vehicles, including long-haul trucks, by 2040" (September 2020)

Buildings
Electrification due to:
• Higher efficiency + higher efficiency gains with technologies (e.g., geothermal heat pumps, LED lights, heat pump water heaters)
• Stable pricing compared to other fuels
• Apps, Artificial Intelligence, 5G communications allow more on-site and remote controls
• External Factors

Codes / Standards / Policies / Laws that are already in place in certain states:
• Economy-wide carbon reduction goals (e.g., 50% reduction from 2005 levels by 2030)
• "Carbon neutral" or "net zero" carbon by 2040-2050
•Higher Renewable Portfolio Standards for Electricity (e.g., 50-70% by 2030, "zero-carbon" or 100% RPS by 2040-2050)
• "EV Ready" or "EV Capable" infrastructure required for new buildings
• Policies / Goals on restricting fossil fuel infrastructure (pipelines)
• Restrictions on using gas / all fossil fuels in new (or existing) buildings.

8. **Kevin Rapp report on insulation thermal class**

- Mr. Rapp reviewed Natural Ester as a High Temperature Thermal Class Liquid offering Higher loading at higher temperatures
- Accelerated Aging Tests FR3 ™ fluid. tested. To be approved and pass the test, they must reach 5x the IEEE unit of life. Test Results: FR3 ™+TUK approved

- Natural Ester FR3 fluid is a proven high-temperature thermal class liquid with greater than 20 years of field success
- •Natural Ester FR3 fluid –TUK Paper Insulation System surpassed 19 times IEEE Unit Life at (7800 hours at 183ºC)
- •Natural Ester FR3 fluid –TUK Paper Insulation System allows designs for higher loads at higher temperature according to IEEE C57.154

9. Tom Prevost report on Thermally upgraded Kraft Paper

Phil Hopkinson and Kevin Biggie presented - Weidman Paper different than standard thermally upgraded Kraft (green color). Special mix Weidmann insulations DPE Paper. Kraft cellulose paper and mineral oil together are a reliable effective insulation system. The following was noted:
• It has been in use for over 100 years
• The size, weight, health, and life of transformers are, to a great extent, defined by the solid insulation

10. Casey Ballard report on thermally upgraded solid materials

Casey Ballard presented High Temperature Distribution Transformers. High Temperature Insulation Development. There are different ways to solve the higher temperature insulation requirements.
In summary, Nomex® has been used in high performance electrical equipment for over 50 years
•Nomex® paper and press board was first used in liquid immersed transformers in high temperature applications over 30 years ago.
•Nomex® 910 is a cost-effective alternative to esters and achieves a 130 Thermal Class using Mineral Oil
•A Nomex® based insulation system may achieve a Thermal Class of 180 or higher and is limited by the liquid performance

11. Al Trout report on dual nameplate designs
Discussion of New Dual Nameplate kVA for Distribution Transformers
Design and Application Considerations for Dual kVA Transformers
Transformer Design Considerations:
Material selection to meet desired thermal class
Thermal design differences for different liquids
Coil ducting practice (size, quantity and location) to support higher loads
Component selection for higher continuous loads (leads, bushings, switches, etc)
Switching and load interrupting at higher loads and liquid temperatures.
Under oil fuse and LV breaker operation. Is de-rating required for higher oil temperatures?
Gaskets and seals for different liquids and temperatures
Gas space volume, liquid level and tank pressure coordination
Maximum conductor temperatures under long duration short circuit

Transformer Application Considerations
Conductor sizing for transformer installation
External fuse selection
Maximum voltage drop at peak loading conditions
External transformer touch temperature (eg, padmounts)

12. Documents

Note: Updated material will be posted prior to the meeting at http://transformerscommittee.org/ (under distribution transformers – TF DOE Energy eff).

13. Next meeting--date and location

No additional comments before adjournment at 10:35am EDT.

Submitted by: Phil Hopkinson

Date: April 27, 2021