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PJM Southern Sub-Regional RTEP Meeting

Planning Assumptions

Planning Criteria and Assumptions

- PJM Assumptions Apply
- All analysis and solutions must satisfy
  - NERC TPL standards
  - PJM Planning Criteria in Attachment D & G of PJM Manual 14B
  - Dominion Energy's Facility Interconnection Requirements
    - Requirements to connect to Dominion's Transmission system
    - Exhibit A – Dominion's FERC 715 Planning Criteria
    - Exhibit C – Generation Interconnection Protection Requirements
- PJM and Dominion validate each other's study results to ensure solutions resolve specific need and create no other harm to system
- Proposed solutions are presented
  - TEAC for facilities 230 kV and above
  - Southern Sub-regional for facilities below 230 kV

Power Flow Modeling Assumptions

- Dominion uses PJM RTEP developed power flow models for 5 year and intermediate year assessments
- For situations where a PJM RTEP model is not available, Dominion will create a specific case using a PJM RTEP case
- Dominion at times may also utilize a MMWG series power flow case
- Loads used in all power flow cases will be modeled consistent with the 2020 PJM Load Forecast Report
- Generation retirements modeled as outlined in the PJM's Generation Retirement Process
  - Dominion may also consider future generation retirements consistent with the VA/NC Integrated Resource Plan

Dominion Energy's End of Life Criteria

- Dominion has an End of Life (EOL) FERC 715 criteria for addressing transmission lines
  - Infrastructure to be evaluated under this end-of-life criteria are all transmission lines at 69 kV and above.
  - The decision point of this criterion is based on satisfying two metrics:
    1) Facility is nearing, or has already passed, its end of life, and
    2) Continued operation risks negatively impacting reliability of the transmission system.
- Projects approved by PJM under this criteria are classified as baseline
- Detailed discussion on the End of Life criteria can be found in Exhibit A, section C.2.9 of Dominion Energy's Facility Interconnection Requirements document
- All other asset management transmission infrastructure is covered by the M-3 Supplemental process
- The Appendix lists transmission lines expected to be evaluated using End of Life criteria in the 2020 RTEP cycle

Supplemental Project Drivers

Summary of Supplemental Project Drivers

I. Customer Service	• Service to new and existing customers. Interconnect new customer load. Address distribution load growth, customer outage exposure, equipment loading
II. Equipment Material Condition, Performance and Risk	• Degraded equipment performance, material condition, obsolescence, equipment failure, employee and public safety and environmental impact • Substation Assets, Transmission Line Assets, Transmission Transformers
III. Operational Flexibility and Efficiency	• Optimizing system configuration, equipment duty cycles and restoration capability, minimize outages
IV. Infrastructure Resilience	• Improve system ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event, including severe weather, geo-magnetic disturbances, electromagnetic pulses, physical and cyber security challenges, critical infrastructure reduction.
V. Other	• Meet objectives not included in other definitions

I. Customer Service

- Service to new and existing customers. Interconnect new customer load. Address distribution load growth, customer outage exposure, equipment loading

Customer Service Considerations

Project Drivers typically include:

- New Load Delivery Points (DP)
- Upgrades or modifications to existing Load Delivery Points(DP)
- Other customer requests

II. Equipment Material Condition, Performance and Risk

- Degraded equipment performance, material condition, obsolescence, equipment failure, employee and public safety and environmental impact
- Substation Assets, Transmission Line Assets, Transmission Transformers

Equipment Material Condition, Performance and Risk

Types of equipment assessed include but not limited to:

- Line Components (not part of EOL Criteria)
- Transformers
- Breakers
- Circuit Switchers
- Reactors
- Capbanks
- Wave Traps
- Relaying
- Switches
- Bus Work, Leads
- FACTS Devices

Transmission Line and Substation Asset Management

Project Drivers

- Line and Substation Asset Management projects include the replacement, modification, upgrade or addition of transmission equipment for the following purposes:
  - Replacement of equipment due to eminent failure
  - Safety concerns
  - Compliance (internal and external)
  - Reliability
  - Operating Flexibility
  - Obsolescence
  - Other

Transmission Line and Substation Asset Management

- Projects “Needs” for Substation assets are developed and managed by Dominion’s Substation Engineering Department
- Project “Needs” for Transmission Lines are developed and managed by Dominion’s Transmission Engineering Department
- Project requests and inputs are received from various groups including:
  - Engineering
  - Operations and Maintenance
  - Field Personnel
  - Transmission Planning
  - System Operations
  - IT / Telecommunications
  - System Reliability

Transmission Line Facilities

Project Development Process

- All project requests and inputs are reviewed
- Records of inspections, component failures, refurbishments/repairs, tower loading studies, COR-TEN corrosion studies and other relevant information are reviewed
- Field sampling and inspections are performed
- Perform analysis to determine condition of individual lines and a ranking to support remediation

Transmission Line Components

Project Development Process

- Industry typical “expected” service life are considered:
  - Steel structures 40 to 60 years
  - Conductors 60 years
  - Connectors 40 to 60 years
  - Insulators (Porcelain/Glass) 50 years+ (Polymer) 30 years
  - Fiber 30 years
  - Wood 55 years with maintenance
- However, the actual service life is dependent upon many variables and ongoing inspection to evaluate condition is the best determinant of end of service life.

Substation Asset Management

Project Development Process

- All project requests and inputs are reviewed
- Compliance projects (time based) are identified and documented. These typically include:
  - Wave Traps – 25 years
  - CCVT's - 25 years
  - Batteries – 20 years
  - Battery Chargers – 20 years
  - Nuclear (Switchyard and one terminal away)– 20 years
- A high level scope and cost is developed

Substation Asset Management

Project Development Process (Continued)

- Projects are prioritized based on many different factors including:
  - Project Type
  - Likelihood and consequence of failure
  - Completing work in conjunction with other planned capital improvement work or scheduled maintenance activities and outages
  - Project cost
- Projects are assigned to a project manager and the conceptual team for detailed review and estimating
- Planning reviews projects to ensure they do not conflict with long term plans prior to submittal to PJM through the M-3 Planning process

Transformer Health Assessment Program (THA)

500 kV Transformer Failure in 2000

230 kV Transformer Failure in 2001

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Transmission Transformer THA Overview

- For Transmission Transformers Dominion uses a Transformer Health Assessment (THA) approach to prioritize replacement
- A proven systematic approach to calculating transformer health and risk
- Not just about age – several condition-based parameters are considered
- Supports possible additional maintenance, online monitoring, proactive replacements

Parameters Considered for Proactive Replacement

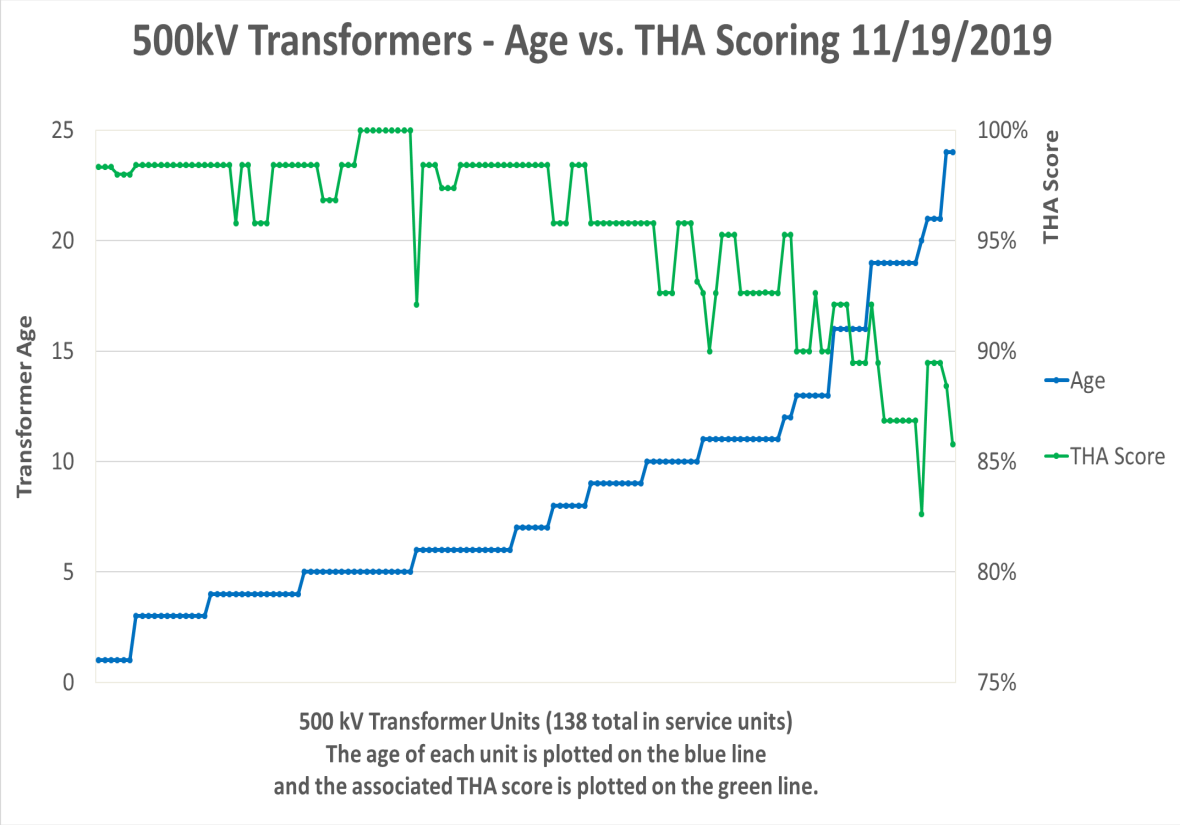
- THA score less than 80
- Maintenance history/environmental risk
- Previous transformer failures of same manufacturer
- Previous failures and remanufacturing history
- Dissolved Gas-in-Oil Analysis (DGA) trends

THA Condition-Based Parameter Weighting

Parameter	Weight for 500 kV Txs	Weight for 230 kV Txs
Dissolved Gas-in-Oil Analysis	25%	25%
Winding Power Factor	20%	15%
LTC Design	-	15%
Age	10%	10%
BIL Ratings	10%	10%
Loading	5%	-
Oil Acidity	5%	-
Moisture in Oil/Insulation	5%	5%
Bushing Power Factor	5%	5%
Tertiary Design/Presence	5%	5%
Bushing Type/Age	5%	5%
Fault Exposure	5%	5%

Example Scoring of Age Parameter

Age	Score
0 - 10 years	10
10 - 30 years	7
30 - 40 years	4
40 - 45 years	1
45 - 50 years	-5
50 - 55 years	-10
> 55 years	-15



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III. Operational Flexibility and Efficiency

- Optimizing system configuration, equipment duty cycles and restoration capability, minimize outages

Operational Flexibility and Efficiency Considerations

Project Drivers typically include:

- Operational flexibility issues identified by Dominion's SOC and/or field operations
- Reoccurring thermal, voltage, or stability issues identified by System Operations in real time but not captured in planning studies
- Projects related to ability to safely and reliably operate the transmission system
- Provide flexibility and improvement to serve customer load
- Adherence to Facility Interconnection Requirements
- Other

IV. Infrastructure Resilience

- Improve system ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event, including severe weather, geo-magnetic disturbances, physical and cyber security challenges, critical infrastructure reduction

Infrastructure Resilience
Considerations

Project Drivers typically include:

- Hardening for severe weather
- GMD (geo-magnetic disturbances)
- EMP (electromagnetic pulses)
- Physical and Cyber security challenges
- Reduction of Critical Infrastructure
- Rapid Restoration of Services (mobiles, spares, etc.)
- Adherence to Facility Interconnection Requirements

V. Other

- Meet objectives not included in other definitions

Other Planning Considerations

Project Drivers typically include:

- Unique situations that drive “needs” not covered in other objectives
- Adhere to Good Utility Practice
- Maintain system reliability

Questions?

Appendix: Transmission lines expected to be evaluated using End of Life criteria in 2020 RTEP cycle

Line A	Line B	Line Section	Line A kV	Line B kV	Line A Year	Line B Year
293		Staunton – Valley	230		1981/1971	
1001		Battleboro – Chestnut	115		1959	
1024		Chestnut – South Justice Branch	115		1959	
2019		Greenwich – Thalia	230		1970/1988	
87		Chesapeake Energy Center – Churchland	115		1957	
514		Goose Creek – Doubs	500		1966	
204	220	Gum Springs -Jefferson St, Gum Springs - Ox	230		1966	
579	2110	Septa – Yadkin, Suffolk – Thrasher	500	230	1975	1975
26		Balcony Falls – Lexington	115		1928	
2007		Lynnhaven – Thalia	230		1970	

Note: This list covers lines to be evaluated under Dominion's End of Life criteria during the 2020 planning cycle. The evaluation could lead to some of these facilities being delayed, cancelled or removed from consideration as well as other facilities added.

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