FirstEnergy

Transmission

FirstEnergy (FE) Assumptions Meeting

SRRTEP Committee Meeting

December 18, 2020

FE Transmission – Annual Planning Analysis

- **FE performs separate analysis from PJM on the FE zonal areas**
- **PJM and FE perform analysis consistent with North American Electric Reliability Council (NERC) and ReliabilityFirst Corp. (RFC) planning requirements**
- **PJM focus is to apply PJM criteria (Manual 14B: Attachments D&G)**
- **FE focus is based on the system planning model:**
  - FE Transmission Planning Criteria
  - FE Facility Connection Requirements
  - FE Energizing the Future (EtF) Project / Program Methodology
- **Net result is the validation of system analysis by FE and PJM**
  - Then, propose baseline or supplemental projects in accordance with the PJM process

FE Transmission – Building the System Model

- **The base FE model is updated annually using a 50/50 load forecast**
- **The updated FE system model is inserted into the latest available model from the NERC/RFC Multiregional Modeling Working Group (MMWG)**
- **A 90/10 load forecast sensitivity case and other sensitivity cases (e.g., light load and maintenance condition analysis) are used to assess constraints and robustness of solutions**
- **FE provides the base model used in developing its local plan to PJM – consistent with any applicable confidentiality restrictions, PJM's CEII process and copyright limitations**

FE Transmission – Updating System Loads

The loads in the system models are established using three (3) sources:

1. **FE distribution substations and retail customer transmission-connected substations use the FE Internal Load Forecast Data Management System (LFDMS) to forecast loads**
2. **Wholesale customer substations (e.g., rural electric cooperatives and municipals) are also forecasted in LFDMS utilizing information provided by the wholesale customers**
3. **FE aggregated system forecasted loads are provided by the FE Retail Tariff Analysis & Forecasting group**

FE Transmission – Planning Criteria

- **Intended to meet or exceed all applicable minimum requirements of NERC, RFC and PJM**
- **Applicable to FE-owned bulk transmission and non-bulk transmission facilities**
  - Bulk transmission facilities are 100 kV and above
  - Non-bulk transmission facilities are networked systems less than 100 kV
- **Address load-ability criteria, voltage level criteria, voltage and transient stability requirements, load curtailment criteria, voltage regulation requirements, reactive power requirements and short circuit requirements**

Supporting Document Location:
www.pjm.com/planning/planning-criteria

Supplemental Project Planning Assumptions

- **The Supplemental Project process categorizes system needs into five categories:**
  - Equipment material condition, performance and risk
  - Operational flexibility and efficiency
  - Infrastructure resilience
  - Customer service
  - Other
- **For FE, transmission system needs that follow the Supplemental Project process are based on:**
  - FE's "Energizing the Future Project/Program Methodology" Document
- **And customer service connections that follow the Supplemental Project process are based on:**
  - FE's "Requirements for Transmission Connected Facilities" Document
  - FE's Transmission Planning Criteria

Supplemental Project Assumptions – Global Factors

FE's "Energizing the Future (EtF) Project/Program Methodology" document

- **FE Global Factors**
  - Criticality, impact on reliability, customer outages
  - Failure risk, age and condition, obsolescence, operational or design limitations
  - System reliability and performance
  - Substation and line equipment limits
  - Reliability of non-bulk electric system (Non-BES) facilities
  - Load at risk and customers impacted

Supporting Document Location:
www.pjm.com/committees-groups/committees/srrtep-ma

Supplemental Project Assumptions – Condition Projects

FE's "Energizing the Future (EtF) Project/Program Methodology" document

- **1.1 Substation Condition Rebuild/Replacement**
  - Evaluation of component and operational/maintenance history
  - Circuit breakers, power transformers, protection systems, capacitor banks…
  - Line arresters, switches, risers and connections, metering, facilities…
- **1.2 Line Condition Rebuild/Replacement**
  - Evaluation of component and operational/maintenance history
  - Steel and wood pole, line hardware, switches conductor…
  - Evaluated with historical or recently completed field condition assessments…
    - Results in projects to rebuild the transmission line or the replacement of components

FE Transmission

Supplemental Project Assumptions – System Performance

FE's "Energizing the Future (EtF) Project/Program Methodology" document

- **2.0 System Performance**
  - Evaluation of the transmission system to improve the overall reliability and system performance for customers

2.1 Equipment / Technology / Design Upgrades

2.2 System Conversion Methodology

2.3 Network Radial Lines

2.4 Reconductor / Rebuild Transmission Line

2.5 Add / Replace Transformers

2.6 Add / Expand Bus Configuration

2.7 Build New Transmission Line

2.8 Generation Switching Stations

2.9 Upgrade Relay Schemes

2.10 Automatic Sectionalizing Schemes

2.11 Add SCADA Control

2.12 Improve Fault Recorder Communications

NOTE: Certain condition and operational flexibility needs may also be classified as contributing to a system performance need.

Supplemental Project Assumptions – Operational Flexibility

FE's "Energizing the Future (EtF) Project/Program Methodology" document

- **3.0 Operational Flexibility**
  - Strengthen and improve the reliability and performance of the transmission system for future capacity and operational flexibility

3.1 Permanent Reactive Device

3.2 Replace Breakers

3.3 Operational Metering

NOTE: Certain condition and performance needs may also be classified as contributing to an operational flexibility need.

FE End of Life

End of Life

End of Life Methodology for 100kV-and-above Transformers and Lines

I. Introduction

FirstEnergy determines an individual asset is near or at the end of its useful life based on an engineering recommendation driven by multiple factors:

- Asset failure or presenting undue risk of failure
- Uneconomical maintenance
- Outdated or obsolete technology and equipment

Factors for a particular asset that is near or at the end of its useful life are evaluated based upon the facility's:

- Health and condition
- Performance and maintenance history
- Equipment criticality, risk, age, and other considerations

1. End of Life Projects

Identifying FirstEnergy transmission facilities approaching their end of life is one of the core objectives of the EtF program. Strategically reviewing the present system is important to achieving this objective.

End of Life

1.1 Transformers

It is imperative to gauge the health of transmission power transformers on the FE system and to determine when those transformers are approaching their end of life and should be replaced.

The following global characteristics may be considered:

- At or beyond expected service life, typically in the range of 40-50 years
- Level of criticality to system performance and operations
- Outage frequency and/or durations
- Increasing negative trend in maintenance findings and/or costs
- Failure risk
- Limited availability of spare parts or vendor technical support
- Operational, Design, or other considerations
- Feasibility of repairs
- Environmental considerations

The review may also consider operational information, maintenance history, and ancillary equipment performance associated with the transformer.

End of Life

1.1.1 Power transformers

The following components and operational/maintenance history with degraded and/or unacceptable results may be considered to determine if power transformers have reached their end of life and should be replaced:

A. **Alarm and device testing (including thermometers, pressure devices and nitrogen system)**

B. **Bushings**
   - Between 40 – 50 years of service life
   - Known failure history
   - No monitoring capability

C. **Core ground issues (heating, unintentional)**

D. **Dissolved gas in oil**

E. **Insulation power factor (Doble)**

F. **Internal inspection of the clamping, blocking, steel core, and core and coil support structure**

G. **Loading and fault history**

H. **Moisture content**

I. **Oil dielectric**

J. **Oil screen**

K. **Oxygen content**

L. **Radiators or other cooling issues**

M. **Total combustible gas**

N. **Turns ratio**

O. **Oil Containment / Environmental considerations**

P. **Tap Changer**

End of Life

1.2 Line Condition Rebuild / Replacement

The health of the FE transmission facilities can be improved by rebuilding and/or replacing transmission lines where appropriate. FE will review and assess existing transmission facilities for equipment characteristics that are near or beyond their existing service life or contain components or designs that are obsolete. To determine whether lines should be rehabbed, rebuilt or replaced based on their age, performance, system criticality, risk, and condition-based assessment, the following global characteristics may be considered:

- Customer/contingency risk
- Negative impact on equipment health
- Customer outage frequency and/or durations
- Increasing negative trend in maintenance findings and/or costs
- Failure risk, to the extent caused by asset design characteristics, or historical industry/company performance data
- Operation, design, or installation limitations
- Age/condition of wood pole transmission line structures typically in the range of 40-60 years
  - Must pass a hammer sound test

End of Life

1.2 Line Condition Rebuild / Replacement (Continued)

- Age/condition of steel tower or steel pole transmission line structures typically in the range of 40-60 years
- Age/condition of transmission line conductors and hardware typically in the range of 40-60 years
- System characteristics including lightning and grounding performance, galloping overlap, insulation coordination, structural capacity needs, and future needs (e.g., fiber path)
- Current design criteria, applicable codes, and industry best practices
- Environmental factors

When evaluating the replacement of in-service transmission line assets, the review may also consider maintenance operating experience, manufacturer and accepted industry practices, and current engineering design standards associated with the asset types. The lists of components and operational/maintenance history described are not a fully inclusive list of considerations.

End of Life

1.2.1 Transmission Steel Tower, Wood & Steel Poles

The following components and operational/maintenance history with degraded and/or unacceptable results may be considered to determine if transmission steel towers and wood/steel poles should be rebuilt or replaced:

A. Access to the structure
B. Structural Steel
   - B.1. Anchor Bolts
   - B.2. Joints and flanges
   - B.3. Tubular steel
   - B.4. Lattice
   - B.5. Bolts / fasteners
   - B.6. Insulator attachment points
C. Foundations
   - C.1. Direct Embedded
   - C.2. Grillage
   - C.3. Concrete
D. Weathering Steel Structures
   - D.1. Members
   - D.2. Marginal loss
   - D.3. Hardware

End of Life

1.2.1 Transmission Steel Tower, Wood & Steel Poles (Continued)

The following components and operational/maintenance history with degraded and/or unacceptable results may be considered to determine if transmission steel towers and wood/steel poles should be rebuilt or replaced:

E. Wood Components
- E.1. Poles
  - E.1.1. Phase Raisers
  - E.1.2. C-truss reinforced
  - E.1.3 Pole top extensions
  - E.1.4. General Condition and remaining strength
- E.2. Crossarms
- E.3. Braces

F. Hardware
- F.1. Insulators
  - F.1.1. Polymer
  - F.1.2. Porcelain
  - F.1.3. Glass
- F.2. Clamps
- F.3. Armor Rod
- F.4. Dampeners
- F.5. Corona Rings

G. Grounding System

End of Life

1.2.2 Transmission Line Conductor

The following components and operational/maintenance history with degraded and/or unacceptable results may be considered to determine if transmission line conductors should be rebuilt or replaced:

A. Conductor between 50 - 60 years of service life
B. Multiple splices per phase per mile
C. Conductor core/strands
D. Connector
E. Corrosion
F. Heat damage
G. Span Length
H. Metal type
I. Shield wire

End of Life

1.2.3 Transmission Power Cable and Support Equipment

The following components and operational/maintenance history with degraded and/or unacceptable results may be considered to determine if transmission power cable and support equipment should be rebuilt or replaced:

A. Flexible power cable

A.1. Between 25 - 40 years of service life
A.2. Conduit
A.3. Impulse test
A.4. Insulation
A.5. Shielding
A.6. Terminators between 25 - 40 years of service life

B. High-pressure oil insulated pipe type cable

B.1. Between 60 - 75 years of service life
B.2. Conduit
B.3. Impulse test
B.4. Insulation
B.5. Monitoring and protection system
B.6. Nitrogen gas system
B.7. Oil preservation system
B.8. Pressure system
B.9. Shielding
B.10. Terminators between 25 - 40 years of service life

Thank You