FirstEnergy

Transmission

FirstEnergy (FE) Assumptions Meeting

SRRTEP Committee Meeting

December 11, 2025

FE Transmission – Annual Planning Analysis

- **FE performs independent analysis from PJM on the FE zonal areas**
- **PJM and FE perform assessments consistent with North American Electric Reliability Corporation (NERC) and ReliabilityFirst Corporation (RF) planning requirements**
- **PJM focus is to apply PJM criteria (Manual 14B: Attachments D&G)**
- **FE focus is to apply the FE criteria and methodologies:**
  - FE Transmission Planning Criteria
  - FE Requirements for Transmission Connected Facilities
  - System Performance Excellence Methodology
- **Net result is the validation of system performance by FE and PJM**
  - Baseline or supplemental projects are proposed in accordance with the PJM processes

FE Transmission – Building the System Model

- **The base FE model is updated annually using a 50/50 load forecast**
- **The updated FE transmission system model is inserted into the latest available model from the NERC/RF Multiregional Modeling Working Group (MMWG)**
- **A 90/10 load sensitivity case and other sensitivity cases (e.g., light load, winter peak, maintenance condition analysis, and others) are used to identify system constraints and potential upgrade alternatives**
- **FE uses the PJM models to develop its local plan**

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-connections use the FE Internal Load Forecast Data Management System (LFDMS) to forecast loads**
2. **Wholesale customer connections (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 FirstEnergy Load Forecasting group**

FE Transmission Planning Criteria

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

Supporting Documentation is posted on the PJM website

Supplemental Project Planning Assumptions

- **The Supplemental Project process categorizes system needs into six categories:**
  - System condition projects
  - System performance projects
  - Operational flexibility projects
  - Communications: reliability, capability and resilience projects
  - Security projects
  - Transmission asset health and inventory programs
- **Supplemental projects on the transmission system are identified based on**
  - FE's "System Performance Excellence Methodology" Document
- **Supplemental Projects to provide Customer service connections are based on:**
  - FE's "Requirements for Transmission Connected Facilities" Document
  - FE's Transmission Planning Criteria

Supplemental Project Assumptions – Global Factors

FE's "System Performance Excellence 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 number of customers impacted

Supporting Documentation is posted on the PJM website

Supplemental Project Assumptions – Condition Projects

FE's "System Performance Excellence Methodology" document

- **1.1 Substation Condition Rebuild/Replacement**
  - Evaluation of component and operational/maintenance history
  - Circuit breakers, power transformers, protection systems, capacitor banks…
  - Lightning arresters, switches, risers and connections, metering…
- **1.2 Line Condition Rebuild/Replacement**
  - Evaluation of component and operational/maintenance history
  - Steel and wood poles, 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 "System Performance Excellence 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

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 "System Performance Excellence 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 Circuit Breakers and Other Fault Interrupting Devices

    3.3 Transmission EMS Power Network Analysis (PNA) Enhancements

    3.4 System Upgrades

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

FE End of Life

FE's "End of Life (EOL) Project Methodology" Document

End of Life Methodology for BES Transformers and Lines

I. Introduction

FE 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 of failure, age, and other considerations

1. End of Life Projects

Identifying FE transmission facilities approaching their end of life is one of the core objectives of the program. Strategically reviewing the condition of 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 transmission system and to determine when those transformers are approaching their end of life.

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
- Equipment installation times (long lead and/or extended)
- Negative impact on equipment health and/or system reliability
- 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
- Environmental considerations
- Operational or design considerations
- Feasibility of repair

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:

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
   - Bushing power factor (Doble)

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

D. **Dissolved gas in oil**
   - Oxygen content
   - Total combustible gas

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

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

G. **Load Tap changer**

H. **Loading and fault history**

I. **Moisture content**

J. **Oil dielectric**

K. **Oil screen**

L. **Pump/fan issues**

M. **Radiators or other cooling issues**

N. **Turns ratio**

O. **Oil Containment / environmental considerations**

P. **Winding resistance**

Q. **Furan testing results**

R. **Software analytics tools scoring**

End of Life

1.2 Line Condition Rebuild / Replacement

The health of the FE transmission line 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 rehabilitated, rebuilt or replaced based on their age, performance, system criticality, risk of failure, and condition-based assessment, the following global characteristics may be considered:

- Customer reliability impact/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 limits, 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 and 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 replaced:

A. Conductor between 50 - 60 years of service life
B. Multiple splices per phase per mile
C. Conductor core/strands
D. Connectors
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 replaced:

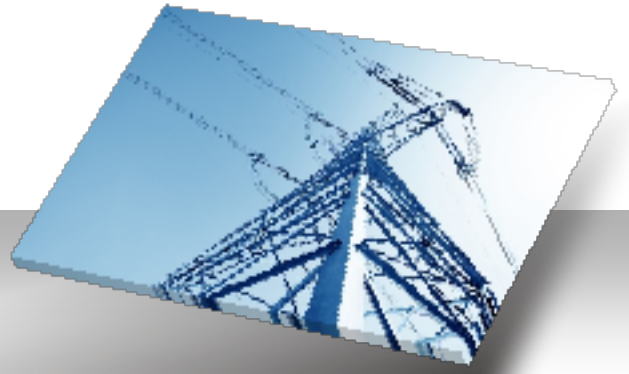
A. Flexible power cable

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. Oil
B.6. Manholes
B.7. Monitoring and protection systems
B.8. Nitrogen gas systems
B.9. Oil preservation systems
B.10. Pressure systems
B.11. Shielding
B.12. Terminators between 25 - 40 years of service life

Thank You



Q&A