TABLE OF CONTENTS

Purpose

FirstEnergy (FE) employs an End of Life (EOL) Methodology, for 100kV and above transformers and lines, to determine if an individual asset is near or at the end of its useful life. The methodology is based on an engineering recommendation driven by multiple factors, such as an asset failure or presenting undue risk of failure, uneconomical maintenance, and outdated or obsolete technology and equipment.

Those factors for a particular asset, near or at the end of its useful life, are evaluated based upon the facility's health and condition, which can be determined by performance history, maintenance history, equipment criticality, risk, age, and other considerations relevant to a specific facility.

Applicability

All steps to be completed by Transmission employees, or applicable personnel, unless specifically noted otherwise.

1. End of Life Projects

Identifying FE transmission facilities approaching EOL is one of the core objectives of the System Performance Excellence Methodology program. Strategically reviewing the present system is important to achieving this objective.

Consider the following topics when evaluating a system:

1.1. Transformers

Consider the following global characteristics, and assess power transformer health to determine if a system is approaching EOL and may need replaced:

- At or beyond expected service life, typically in the range of 40-50 years
- Level of criticality with regard to system performance and operations
- Outage frequency and/or durations
- Equipment installation times (long lead and/or extended)
- Negative impact on equipment health and/or system reliability
- Increasing negative trend findings in maintenance and/or costs
- Failure risk
- Limited spare parts availability or vendor technical support
- Environmental considerations
- Operational, design, or other considerations
- Repair feasibility
- Environmental considerations

1.1.1. Power Transformers

Consider the following components and operational/maintenance history. Check for degraded and/or unacceptable results to determine if power transformers have reached EOL and need replaced:

- Alarm and device testing (including thermometers, pressure devices, and nitrogen system)
- Between 40-50 years of service life
- Bushings
  - Known failure history
  - No monitoring capability
  - Bushing power factor (Doble™)
- Core ground issues (heating, unintentional)
- Dissolved gas in oil
- Total combustible gas
- Insulation power factor (Doble™)
- Internal inspection of clamping, blocking, steel core, and core and coil support structure
- Load Tap Changer
- Loading and fault history
- Moisture content
- Oil dielectric
- Oil screen
- Oxygen content
- Pump/fan Issues
- Radiators or other cooling issues
- Turns ratio
- Oil containment/environmental considerations
- Winding Resistance
- Furan Testing Results
- Frequency/severity of oil leaks
- Software analytics tools scoring

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 reviews and assesses existing transmission facilities for equipment characteristics, near or beyond their existing service life, or contain components or designs that are obsolete.

Consider the following global characteristics. Determine if lines need repaired, rebuilt, or replaced, based on their age, performance, system criticality, risk, and condition-based assessment:

- 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
  - Consider replacing a line segment when it reaches an average age of 40 years.
- Must pass a hammer sound test.
- Age/condition of steel tower or steel pole transmission line structures
  - Consider replacing when a line reaches an average age of 60 years.
- Age/condition of transmission line conductors and hardware
  - Consider replacing when a line segment reaches an average age of 40 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, consider maintenance operating experience, manufacturer and accepted industry practices, and current engineering design standards associated with the asset types listed and summarized in the Index below and further described within this document.

The lists of components and operational/maintenance history described within this document are not a fully inclusive list of considerations.

Index	Asset Type
1.2.1	Transmission Steel Tower, Wood & Steel Poles
1.2.2	Transmission Line Conductor
1.2.3	Transmission Power Cable and Support Equipment

1.2.1. Transmission Steel Tower, Wood & Steel Poles

Consider the following components and operational/maintenance history. Check for degraded and/or unacceptable results, and determine if transmission steel towers and wood/steel poles need rebuilt or replaced:

- Access to the structure
- Structural steel
  - Anchor bolts
  - Joints and flanges
  - Tubular steel
  - Lattice
  - Bolts/fasteners
  - Insulator attachment points
- Foundations
  - Direct Embedded
  - Grillage
  - Concrete
- Weathering steel structures
  - Members
  - Material loss
  - Hardware
- Wood components
  - Poles
  - Phase raisers
  - C-truss reinforced
  - Pole top extensions
  - General condition and remaining strength
  - Crossarms
  - Braces
- Hardware
  - Insulators
  - Polymer
  - Porcelain
  - Glass
    - Clamps
    - Armor rod
    - Dampeners
    - Corona rings
- Grounding system

1.2.2. Transmission Line Conductor

Consider the following components and operational/maintenance history. Check for degraded and/or unacceptable results, and determine if transmission line conductors need rebuilt or replaced:

- Conductor between 50-60 years of service life
- Multiple splices per phase per mile
- Conductor core/strands
- Connector
- Corrosion
- Heat damage
- Span Length
- Metal type
- Shield wires

1.2.3. Transmission Power Cable and Support Equipment

Consider the following components and operational/maintenance history. Check for degraded and/or unacceptable results, and determine if transmission power cable and support equipment need rebuilt or replaced:

- Flexible power cable
  - Between 25-40 years of service life
  - Conduit
  - Impulse test
  - Insulation
  - Shielding
  - Terminators between 25-40 years of service life
- High pressure oil insulated pipe type cable
  - Between 60-75 years of service life
  - Conduit
  - Impulse test
  - Insulation
  - Oil
  - Manholes
  - Monitoring and protection system
  - Nitrogen gas system
  - Oil preservation system
  - Pressure system
  - Shielding
  - Terminators between 25-40 years of service life

Acronyms

Acronym	Definition
EOL	End of Life
FE	FirstEnergy

Revision History

Rev.	Effective Date	Preparer	Comments
2	11/13/2025	D. Shultz	Triennial review SMEs: L. Hozempa (TPP), J. Lojek (TPP), D. Kibler (TSS), R. Preslan (TLS) **Summary of Changes:** Updated to C&P template **Purpose:** Updated original doc section, 'End of Life Methodology for 100kV & Above Transformers and Lines', to fit C&P template Purpose section. Updated language throughout to present tense.
1	11/17/2022	L. Koshar/ C. Adanitsch	Biennial Review. Minor revisions. Updated verbiage throughout document. Updated format to more closely align with C&P standard.
0	NA	M. Barnes	Initial procedure creation.

Approvals

This document was reviewed and approved electronically. Records are available upon request through the Transmission Operations Support Compliance & Procedures group.

Name	Title	Date
J. Martinez	Director, Transmission Planning & Protection	11/13/2025
R. Vavrek	Director, Transmission Operations Services	11/13/2025