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DLR and Transmission Capacity Forecasting

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SMARTLINE
TCF

Dynamic Line Rating
Transmission Capacity Forecasting

Since 1947
Feature Summary

• Provides real-time (instantaneous) DLR
• By direct measurement, methodology assures:
  • Clearance-to-ground limits are not violated
  • Thermal limits of the conductor are not violated
• Provides forecasts of line capacity capability
  • 1+ hours ahead
  • 1+ days ahead
  • Complex forecast “packages”
  • 98% confidence factor by default
• Line sensors directly measure critical parameters
• Cloud-based software provides direct EMS input
• Cyber-secure
• SOON: Transmission Line Asset Management
Overview of SMARTLINE-TCF

Live conductor data from line mounted monitors

Live weather data

Develop Learned Conductor Behavior Model

Weather forecast data

Line Power Capacity Forecast

Compute Instantaneous DLR

Based on:
- Clearance
- Conductor temperature
What limits line rating?

**Clearance to Ground**
- A line is not safe unless clearance is maintained
- Compliance requirements

**Conductor Temperature**
- Overheating leads to weakening and loss of life
- Premature replacement

*What effects these parameters? Weather.*
• Line ratings (static) are traditionally based on conservative weather conditions

• **Seasonal Adjusted Ratings** and **Ambient Adjusted Ratings** recognize weather related effects on line capacity
  • Both adjust only on ambient temperature
• Line ratings (static) are traditionally based on conservative weather conditions

• **Seasonal Adjusted Ratings** and **Ambient Adjusted Ratings** recognize weather related effects on line capacity
  • Both adjust only on ambient temperature
  • Wind has MUCH more impact than ambient
    • +2 mph wind ≅ 15°F change

Optimizing line capacity based on weather
Lindsey TLM Conductor Behavior Monitor

- **Internal CT** measures **LINE CURRENT**
- **Internal CONDUCTOR TEMPERATURE SENSOR**
- **Ground temperature sensor**
- **Roll/Tilt angle and vibration sensors**
- LiDAR unit provides **CONTINUOUS CONDUCTOR TO GROUND MEASUREMENTS**
- **Iridium satellite radio**
  - Remote locations
  - Cyber-security
- **765kV corona free housing**
- **Magnetic field harvesting power supply**
- **Simple single-bolt clamping mechanism**

**LINDESEY since 1947**
Combines:

• Real-time weather

• Corresponding **direct measurements**:
  • Conductor temperature
  • Clearance-to-ground
  • Recall these are the critical line parameters

To Produce:

• Continuously learned line behavior model
Dynamic Line Rating

Decades of studies show 10-25% capacity availability 95% of the time

BUT
• Changes rapidly
• Changes erratically
• Real-time
Dynamic Line Rating

The Historical Dilemma

What is my next DLR rating?
Using Real-time DLR is operationally difficult
Dynamic Line Rating

Like a map app in a traffic jam...

...Real-time is too slow
Generation is FORECAST because it varies

Load is FORECAST because it varies

Yet transmission capacity is generally assumed as fixed
What is it?

• An advanced statistical process that provides:
  • Forecasts of transmission line capacity from 1-hour to 1-week ahead
  • Very high (98% or greater) confidence factors
  • Local line measurements avoids weather-only errors

• Can provide direct EMS input

• Combines:
  • Learning-based conductor behavior models
  • Continuous Forecasting
Transmission Capacity Forecasting

![Graph showing transmission capacity forecast data]

- **Load**: 53 MVA
- **Real-time DLR**: 244 MVA
- **2-hour Capacity Forecast**: 193 MVA
- **24-hour Capacity Forecast**: 184 MVA

This graph illustrates the transmission capacity forecasting with various data points and historical trends.
Transmission Capacity Forecasting

Per DOE Report, DLR and TCF Provide:

- Congestion Relief
- Increased Resilience
- Increased Reliability
- Enhanced Market Operations
- Situational Awareness
- Curtailment Reduction