Underground Transmission Capacity Increases from Dynamic Rating Analysis

Erich Schoennagel, PE
CenterPoint Energy
Background

- In 2000, CenterPoint Energy began an ampacity study of 138kV Polk to Garrott circuit
- Addition of new Midtown Substation
- Investigate methods to increase capacity
Circuit Detail

- 138kV Underground
- HPFF Cable
- 8 inch pipe
- 2500 Kcmil conductor
- Oil Dielectric
- Rated 257 MVA
- Installed in 1966
Circuit Route

- Downtown Houston
- 12,300 feet
Approach

- Evaluate dielectric fluid for evidence of aging
- Evaluate paper insulation aging
- Install DTS fiber for temperature profile
- Evaluate impact of crossing pipe-type cable circuit
Testing

- DGA test on oil performed by Detroit Edison
- Field Dissipation test performed on paper insulation
- Result showed cables virtually un-aged from initial installation
DTS Installation

- Distributed Thermal Sensing (DTS)
- Installed in parallel duct
- Multi-mode fiber optic
DTS Midtown to Polk

Hot Spot
Ampacity Considerations

- Association of Edison Illuminating Companies CS2 recommends reducing max conductor temperature from 85C to 75C when environmental conditions are unknown
- CenterPoint Energy followed AEIC and rated circuit at 75C
- Study of circuit allowed 85C uprate
- Typically this would increase ampacity by 20%
Unfortunately, even with a 10°C increase, the result was a 3.4% decrease in ampacity due to crossing circuit hot spot.
DTCR Consideration

- Polk to Garrott circuit has a cyclical load pattern
- Short duration of high loads
- The long thermal time constant of underground HPFF circuits is approximately 130 hours
Load Pattern
DTCR Model

- Modified to support a real time temperature interference from a measured source
- This was used to model heating influence from a cable crossing
- Run in simulated mode using summer 2000 data
Using summer 2000 data, DTSCR showed an increase of almost 21% in dynamic rating over the conventional book rating.
DTCR Components

- Thermocouples
- SCADA
- Simple PC
DTCR Output

- Calculated conductor temperature
- Reported Amperage
- Allowable Amperage
- Input parameters
- Time remaining to thermal overload
### Dynamic Thermal Circuit Rating Report

**Circuit: Polk_Midtown**
- Ratings (Amps/MVA) =
  - Normal: 1311(325)
  - 24 hr: 1530(380)
  - 100 hr: 1378(342)
  - 300 hr: 1245(309)
  - Load = 728(181)

**Circuit: Midtown_Garrott**
- Ratings (Amps/MVA) =
  - Normal: 1291(323)
  - 24 hr: 1524(381)
  - 100 hr: 1375(343)
  - 300 hr: 1245(311)
  - Load = 769(192)

**Circuit: Polk_Downtown**
- Ratings (Amps/MVA) =
  - Normal: 1311(325)
  - 24 hr: 1530(380)
  - 100 hr: 1378(342)
  - 300 hr: 1245(309)
  - Load = 728(181)

### Element 1
- **La_Branch&Polk**
- Ratings (Amps/MVA) =
  - 1311(325)
  - 1530(380)
  - 1378(342)
  - 1245(309)
- Load Fctr: 0.826
  - Loss Fctr: 0.699
- TTO: -999
  - CdrTemp_C: 50.544

### Element 2
- **La_Branch&Bell**
- Ratings (Amps/MVA) =
  - 1326(329)
  - 1542(383)
  - 1389(345)
  - 1257(312)
- Load Fctr: 0.826
  - Loss Fctr: 0.699
- TTO: -999
  - CdrTemp_C: 50.543

### Element 3
- **Garrott_Sub_Entr**
- Ratings (Amps/MVA) =
  - 1300(325)
  - 1532(383)
  - 1382(345)
  - 1252(313)
- Load Fctr: 0.845
  - Loss Fctr: 0.728
- TTO: -999
  - CdrTemp_C: 53.488

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**Note:** The above content is a screenshot of a dynamic thermal circuit rating report from MyCenterPointEnergy.com. The report details the thermal ratings and load factors for various circuits and elements, along with other related data.
Polk to Midtown Ratings (2/29/08)

- Static Normal Rating = 1035 amperes
- Emergency Rating = 1180 amperes
- Thermal Limit Rating = 1311 amperes
What have we gained?

- Time
- Establish a five part upgrade plan
  - Dynamic rating
  - Shuttle oil
  - Additional pipe for circulating
    - Design is ready
  - Reconductor
  - Add a parallel circuit
DTCR Implementation

- Ampacity increase
- RTO tool during high circuit load
- Grid operator predictive tool
Future Use of DTCR

- XLPE Underground Cables
- Overhead circuits
Summary

- Ampacity study of Polk to Garrott showed a decrease in book rating using steady state calculations.
- DTGR takes advantage of cyclical load pattern and thermal response of UG cable.
- Dynamic rating uses real-time temperature and load input.
- Polk to Garrott ampacity increased almost 21%.
- System operators have a better information tool.
- Market predictive tool.
Project Team

- EPRI
  - Cable system assessment
  - DTCR development
- Power Delivery Consultants, Inc.
  - DTCR development
  - Ampacity study and condition assessment
- Ulrich Associates, Inc.
  - Software development
Questions?
DTS Correlation
Utilities Using DTCR

- Southern California Edison (XLPE cable)
- PECO Energy (pipe type cable)
- BC Hydro (submarine SCFF cable)
- United Illuminating Co. (pipe type cable)
- ComEd (XLPE cable)