Cable Thermal Limits

Real-Time Distribution Cable Temperature Monitoring

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Austin Energy at a Glance

- **9th largest municipally-owned electric utility**
- **2,600 MW of firm generation**
- **Electric service area of 437 square miles serving 400,000 customers**
- **Provide service to**
  - City of Austin
  - Travis County
  - Small portion of Williamson County

Discussion Points

- Current Process
- A New Approach - Distributed Temperature Sensing
- Installation Types
- Demonstration Phase
- Full Substation Implementation
- Future???
- Questions

Ampacity Programs

- **In-house developed programs**
- **Software packages**
  - CYMCAP
  - ETAP
  - EPRI UT work station
  - PowerAmp
  - USAmp+
  - Others

Parameters

- All conduits 5-inch, PVC schedule 40 with 2 inch spacing (from edges)
- 25°C ambient temperature
- Soil Rho of 90[1]
- Fill Rho of 55[1]
- Average dry soil
- Heavy aggregate fill
- Burial depth of thirty six inches to top of duct bank[2]

Ampacity Study

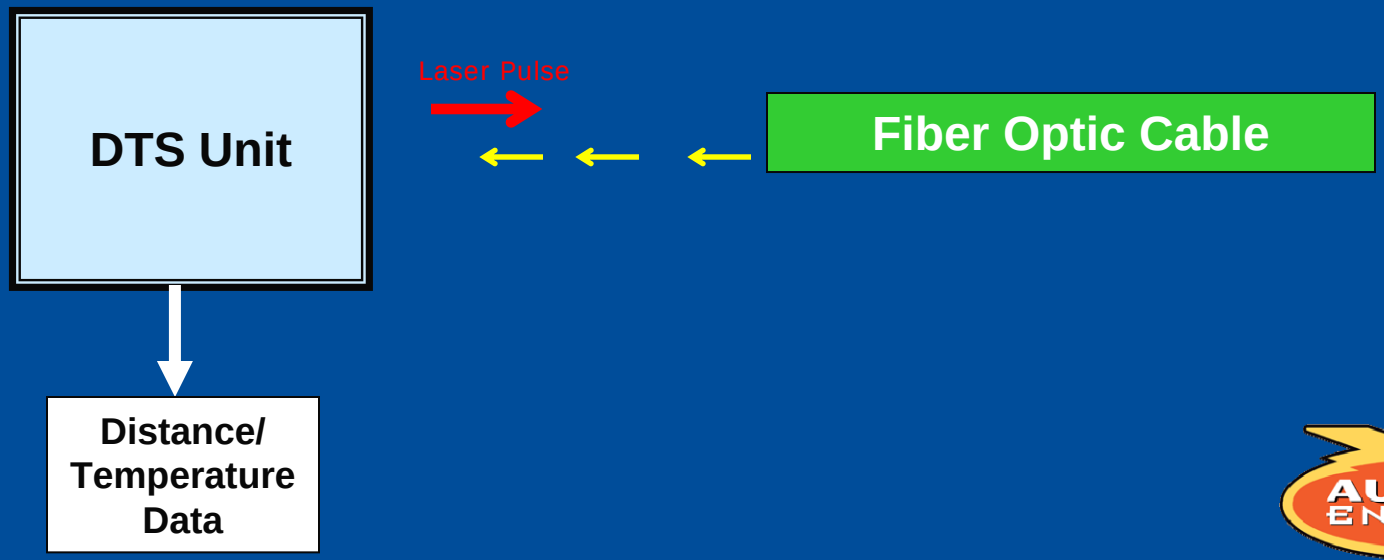
- **Based on NEC Neher-McGrath approach**
- **Transient Temperature Calculation**
- **Urban Load Profile**
- **Normal Rating**
  - Uniformly raising loading of all circuits in duct bank until one reaches a temperature of 90^{o}C
- **Emergency Rating**
  - Loading on the circuit is raised while holding the remaining circuits constant and a temperature of 130^{o}C is reached

Concerns With The Current Process

- **How accurate is the existing model?**
- **Is the existing model too conservative?**
  - Assumes all circuits in a given duct are loaded at the same level
- **During summer months useable circuit capacity may be reduced**
  - Higher temperatures
  - Higher loading on feeders
  - Can loads be safely increased?

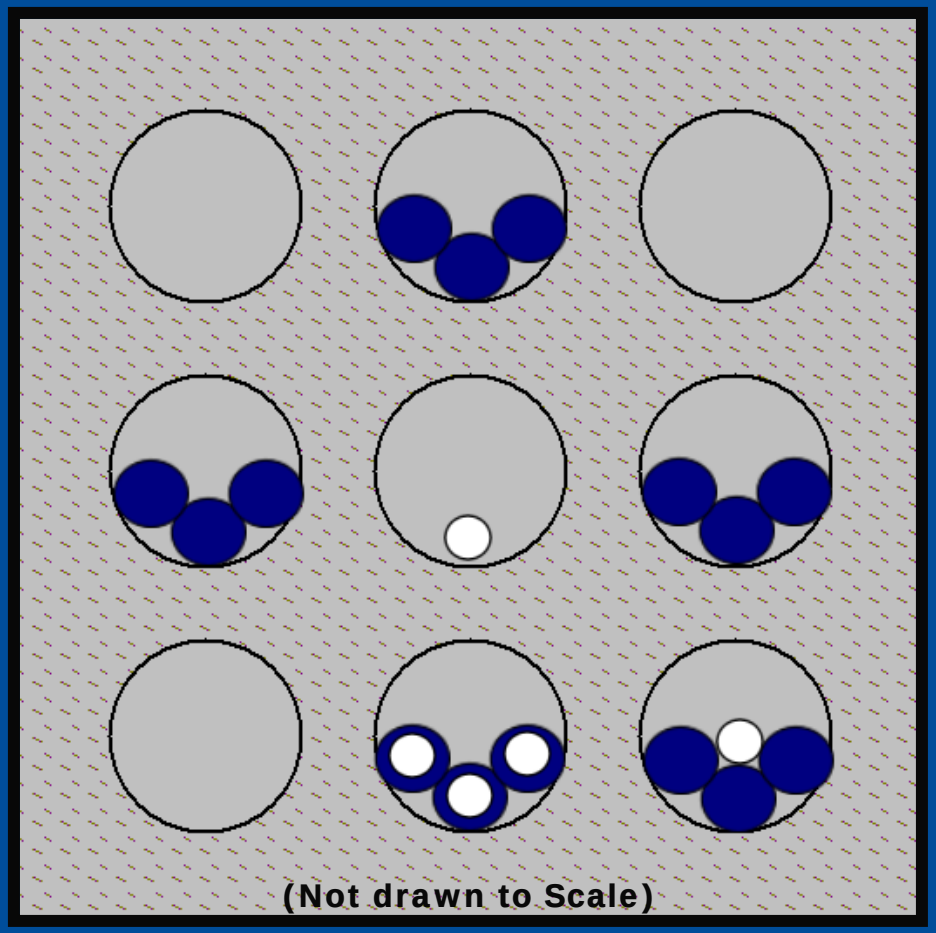
A New Approach - Distributed Temperature Sensing

- Monitoring system that utilizes fiber optic technology to provide real-time temperature data along the entire length of a circuit

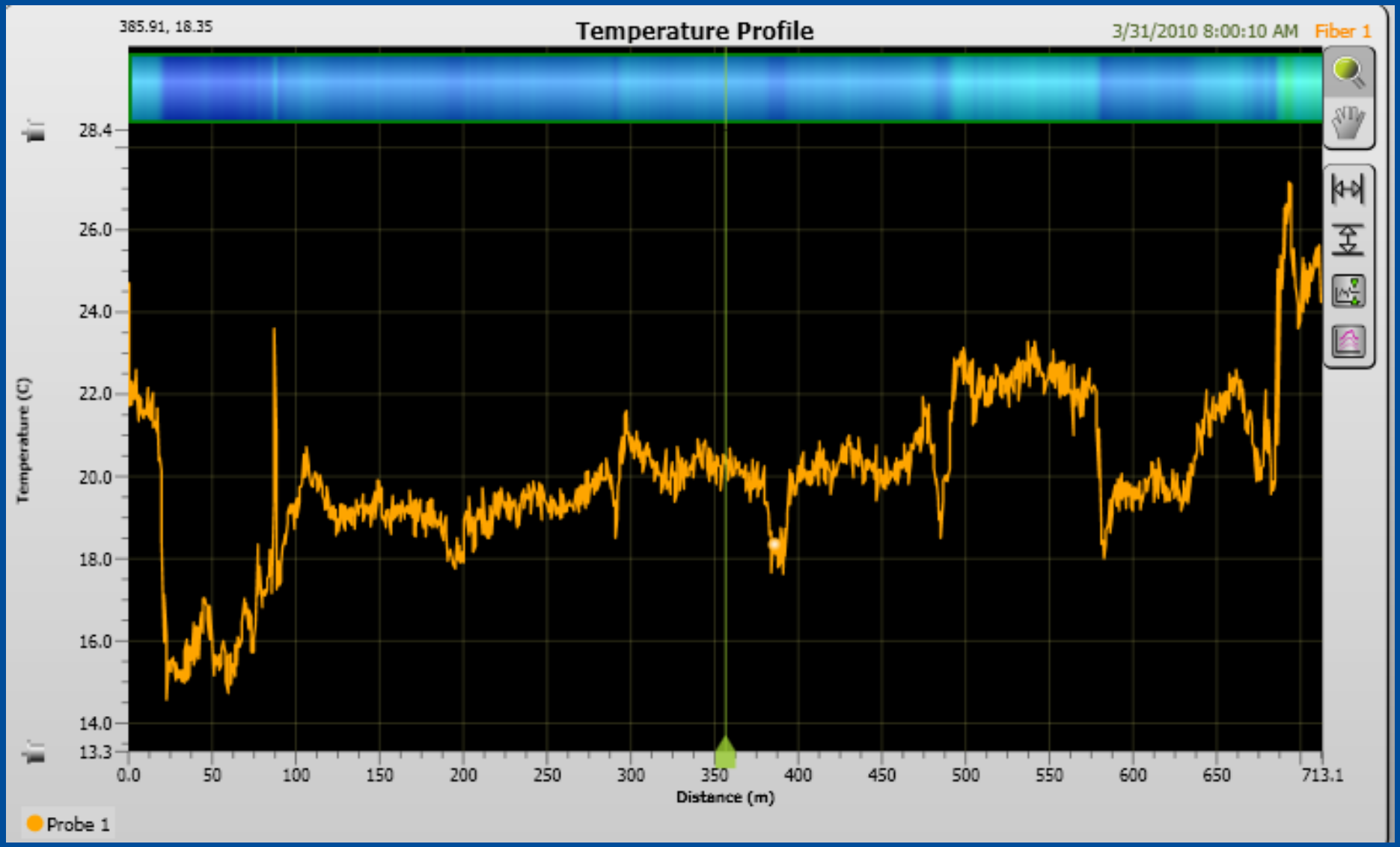


Installation Types

- Power cable with imbedded fiber
- Fiber pulled in adjacent conduit
- Fiber pulled thru already populated conduit



Sample Output



Demonstration Phase - Goals

- Limit the risk of physical cable damage during the installation
- Improve the utilization of available circuit capacity
- Maintain safe cable operating temperature
- Limit the risk of cable damage due to high temperature operation

McNeil Substation

- 12.5 KV substation
- 4 – 30 MVA Transformers
- 8 feeders serving commercial & residential customers

Demo Phase – Fiber Installation

- **Issues/Concerns**
  - Damage to existing power cable
  - 90 degree corners
  - Long vertical runs
- **Worked with vendor on these issues**
- **Installed fiber only in limiting run to minimize risk**

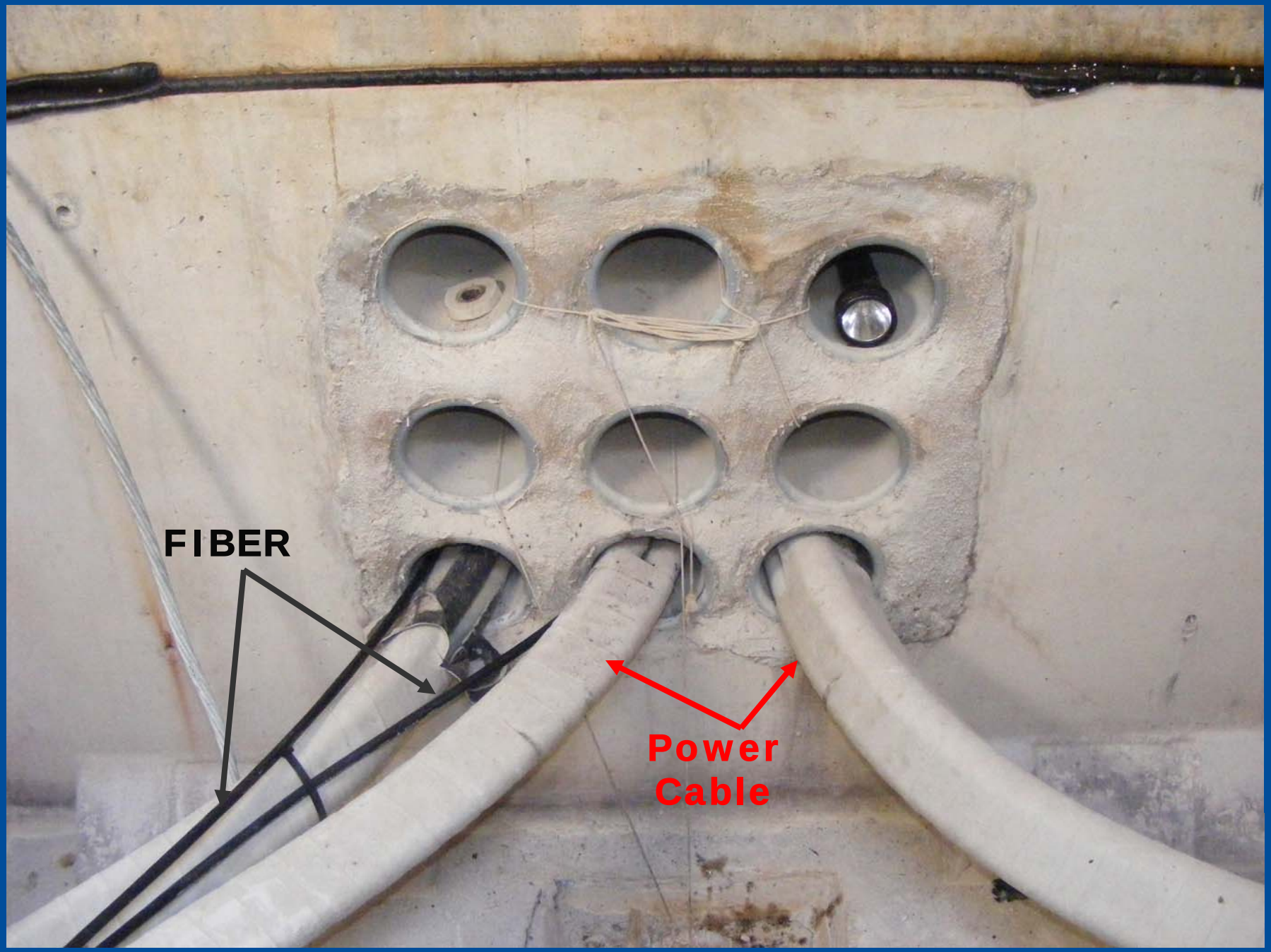
Demonstration Phase

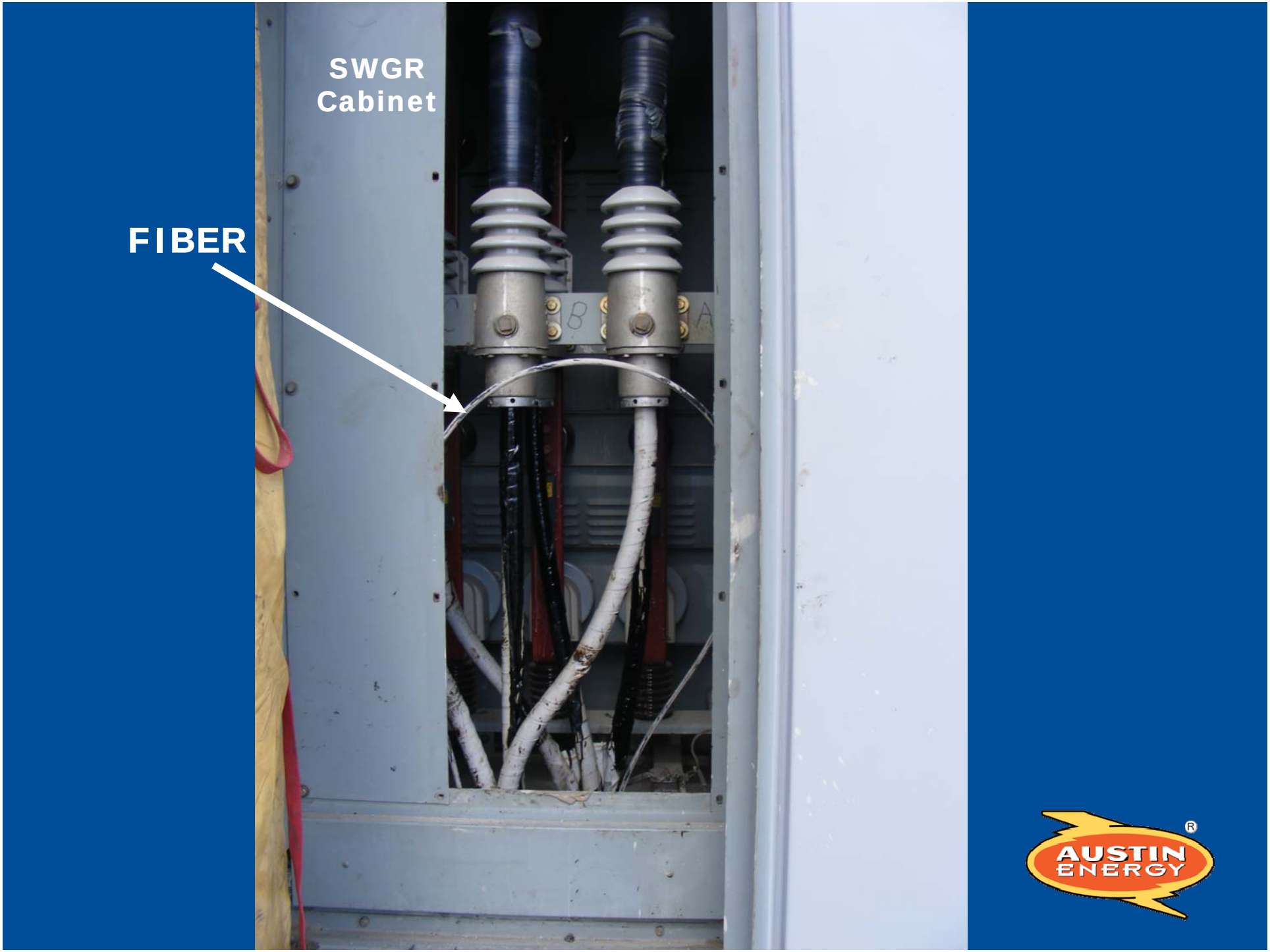
- **MC-07 Feeder Selected**
  - Normal Rating = 490 Amps
  - Overhead feeder
  - Limiting run identified
  - Loading increased above 500 Amps
- **Results**
  - DTS = 58° C
  - Calculated = 61.66° C

Full Substation Implementation

- **Fiber Installation**
  - Took about 2 weeks
  - 3 runs of fiber installed in limiting runs only
  - Fiber runs ranged in length from 800 to 2,400 feet
  - AE crews did installation to minimize # of splices
  - Only splices are located in the control house
- **Rack mounted DTS unit installed in the control house**

Fiber Installation


FIBER
Power
Cable


SWGR
Cabinet
FIBER

Project Status

- **Data being collected**
  - DTS unit holds 1 year of data
- **Preliminary look at data**
  - Calculated results significantly differ from real-time data (WHY???)

Future ???

- Temperature Based Alarm Limits
- Maximize the capacity of the existing infrastructure
- Operation of cable closer to its maximum capacity
- Deferral of projects
- Other ???

Questions?