

National Transmission Technology Research Center

U.S. Department of Energy
Transmission Reliability Program
Peer Review



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National Transmission Grid Study

One of the 51 Recommendations

“DOE will develop national transmission-technology testing facilities that encourage partnering with industry to demonstrate advanced technologies in controlled environments.

Working with TVA, DOE will create an industry cost-shared transmission line testing center at DOE 's Oak Ridge National Laboratory (with at least a 50 percent industry cost share).*”

*National Transmission Grid Study, U.S. DOE, May 2002 www.ntgs.doe.gov

National Transmission Technology Research Center

T1

Outdoor PCAT

*Powerline Conductor
Accelerated Test Facility*

T2

Indoor PCAT

*Powerline Conductor
Accelerated Test Facility*

T3

**PCOT
(TVA lines)**

*Powerline Conductor
Operational Test Facility*

T4

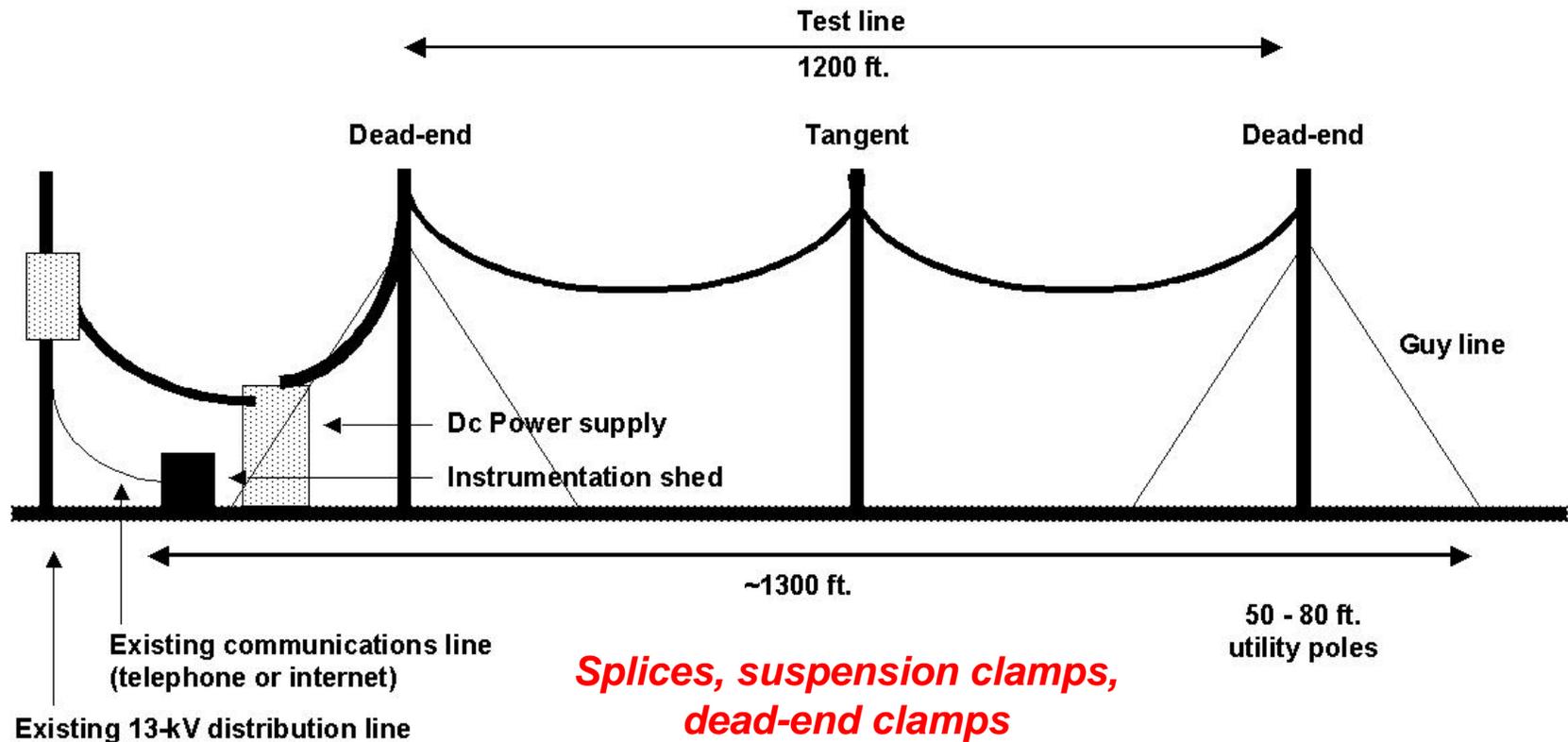
**TPET
(Substation)**

*Transmission Power
Electronics Test Facility*

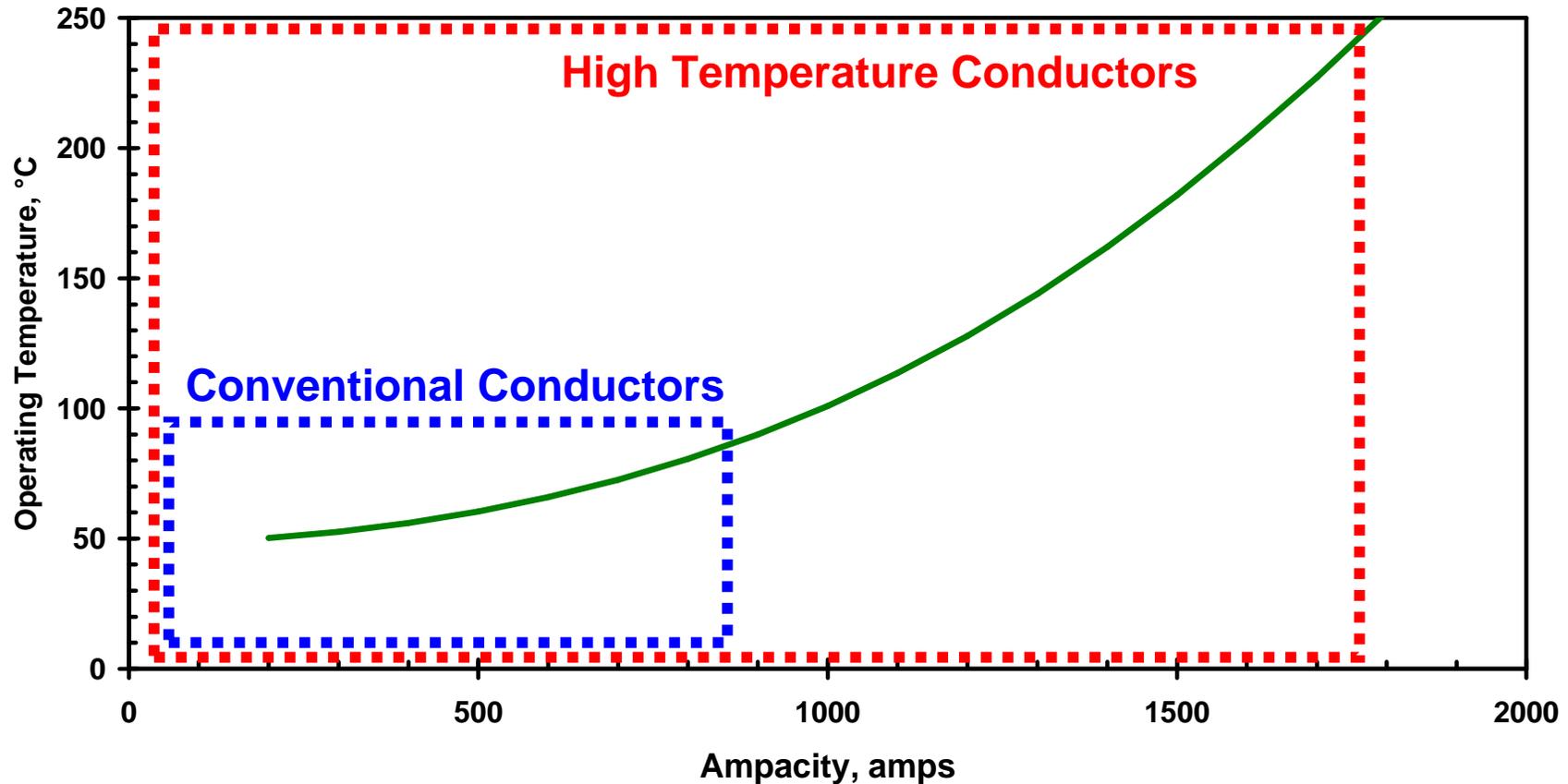
T1. PCAT - Profile View of Outdoor Test Line

PCAT - Powerline Conductor Accelerated Test

Initial Concept for Test Facility
Developed with 3M Company

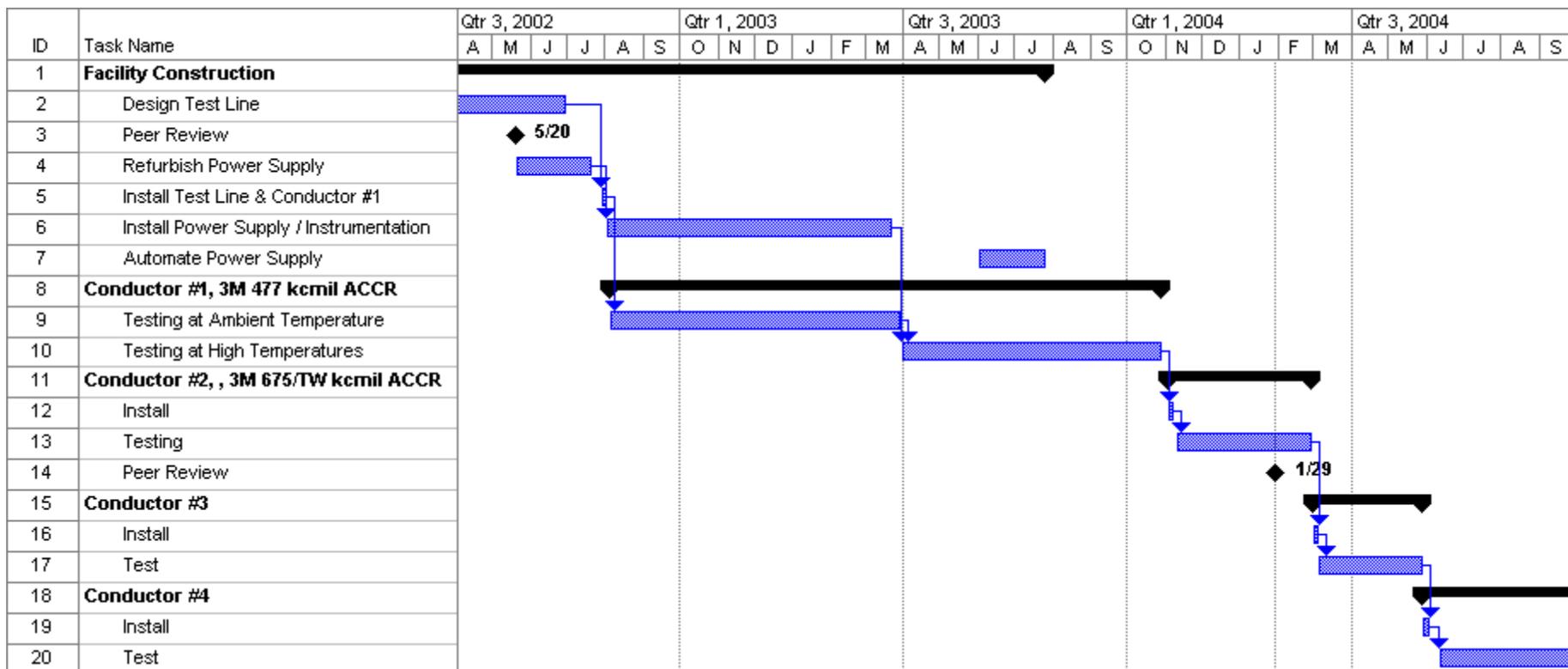


T1. PCAT - Benefit of Advanced Transmission Line Conductors

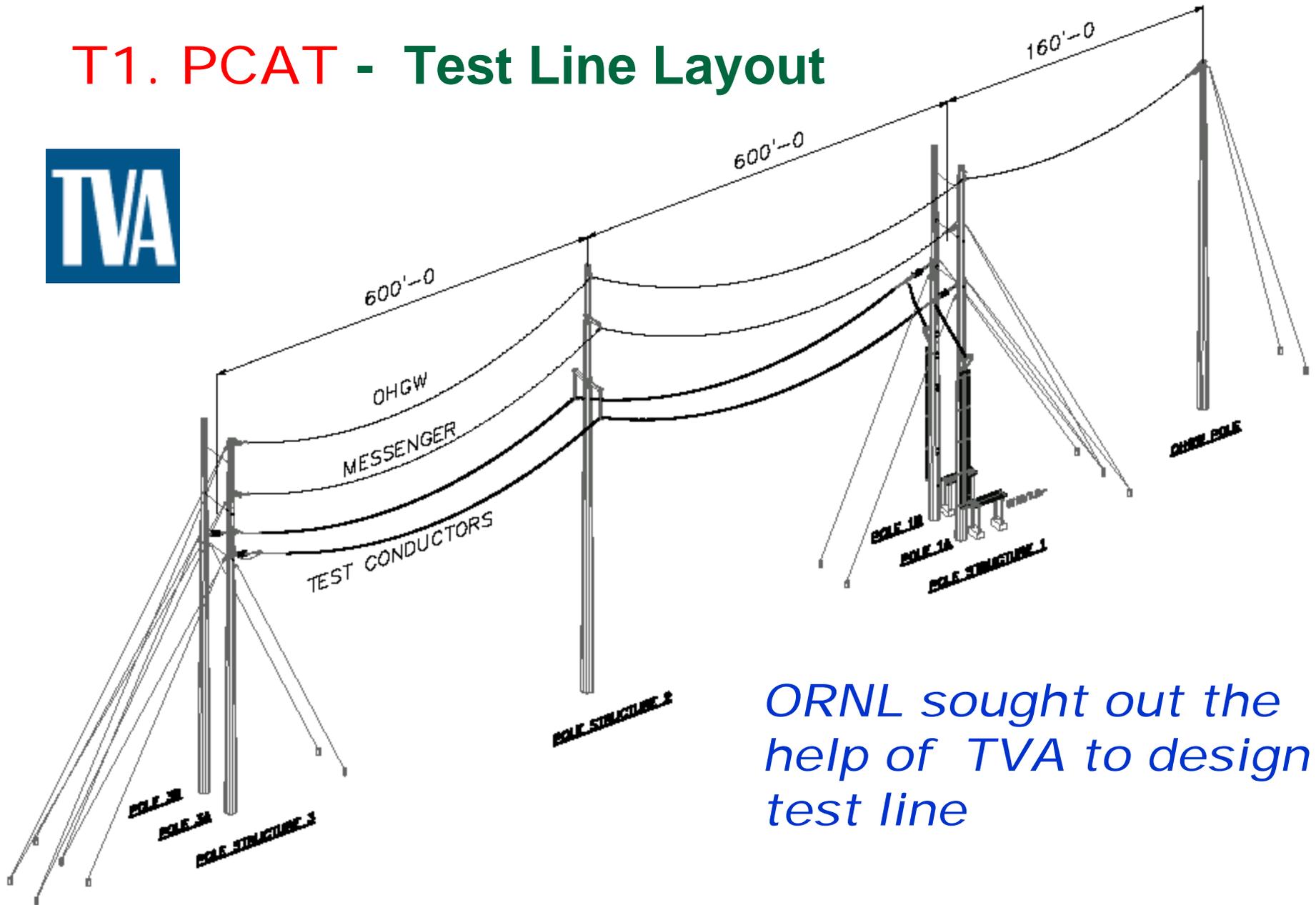


Need to test / verify new conductors over entire operating range

T1. PCAT - Project Schedule



T1. PCAT - Test Line Layout



ORNL sought out the help of TVA to design test line

T1. PCAT - TVA Constructed the Test Line and Installed the First 3M Test Conductor in July 2002



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T1. PCAT – A surplus power supply was refurbished and tested in June / July 2002



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T1. PCAT - Line Structures and Test Hardware

Structure #1,
Dead-end

Structure #2,
Suspension

Structure #3,
Dead-end

Structure #0,
Fiberglass
Pole



- Two 600 ft. spans with 2400 ft. of test conductor
- Four dead-end clamps
- Two suspension clamps
- Two splices
- Conductor clamps
- Jumpers and terminal pads

T1. PCAT - Transmission Structures

Structure #1 and #3 are dead-ends

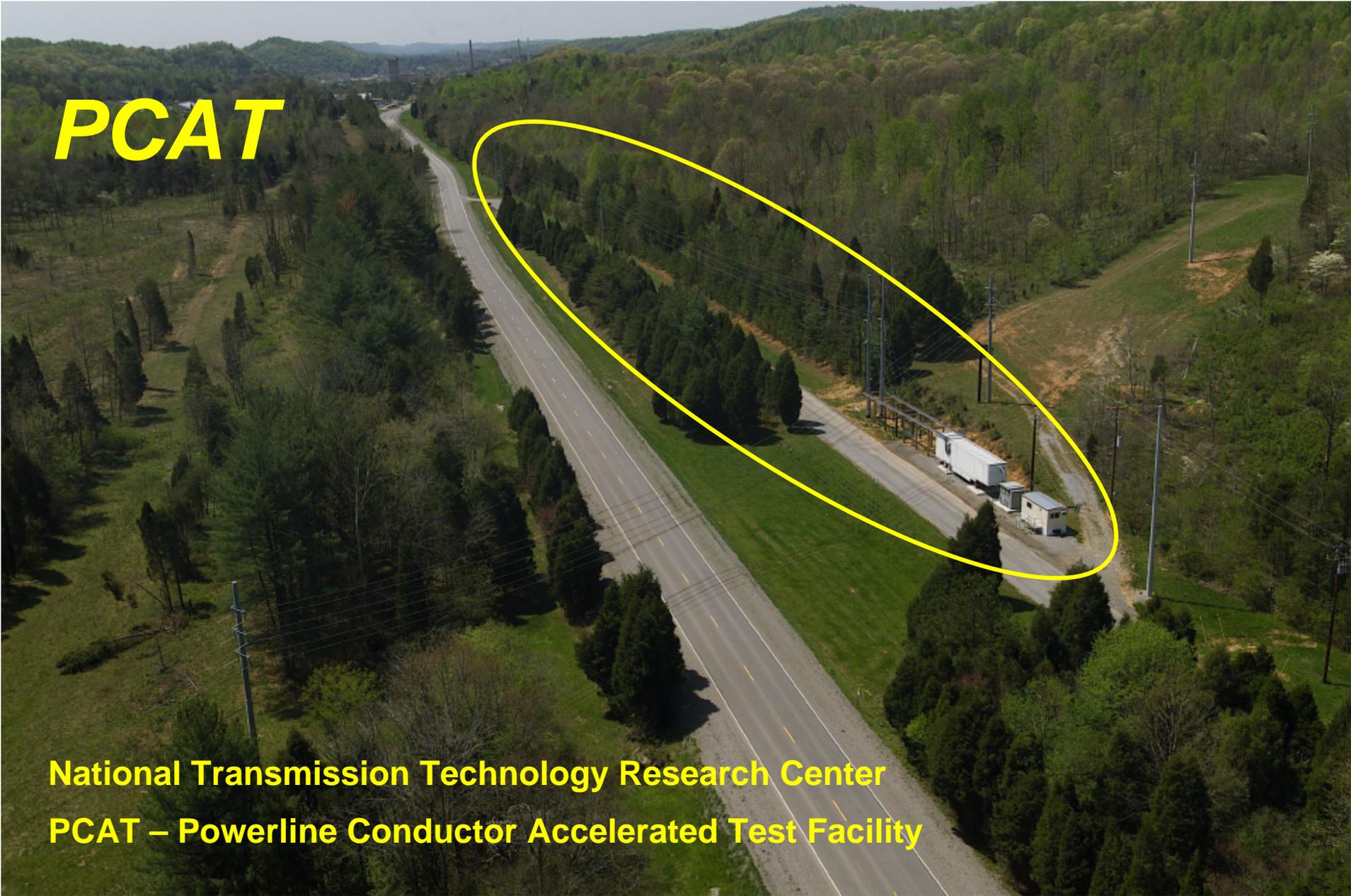


Structure #2, Suspension



T1. PCAT - CAT-1 Transmission Line Monitoring System



An aerial photograph showing a two-lane road winding through a forested area. A yellow oval highlights a facility on the right side of the road, which includes a small building and a trailer. The surrounding landscape is lush green with many trees.

PCAT

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PCAT – Powerline Conductor Accelerated Test Facility**

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T1. PCAT – Facility Capabilities

- **Powerline Conductor Accelerated Testing**

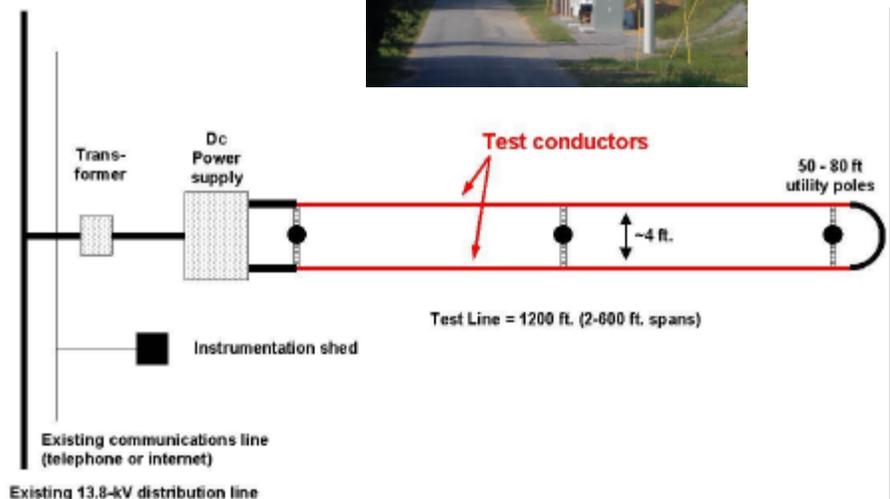
- Accelerated life-cycle testing
- Initially will test new 3M conductors
- Will test other new conductor designs and existing conductors

- **Thermal Cycle Testing**

- Controlled testing
- Conductor and accessories
- Up to 300°C

- **Capabilities**

- 2400 feet of conductor
- 2 – 600 foot spans
- Low Voltage, 0 to 400 Vdc
- High Current, up to 5,000 Adc

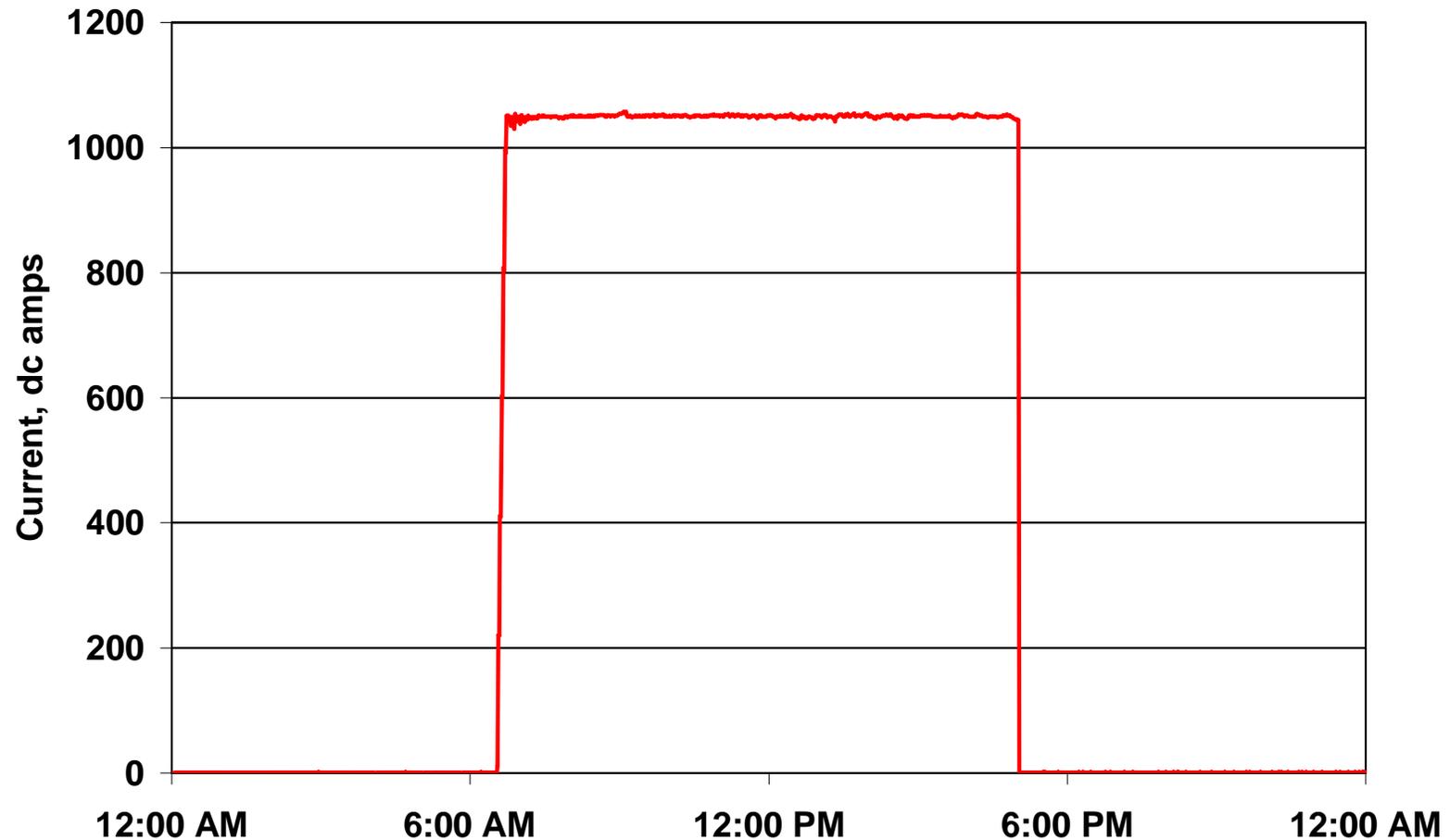


T1. PCAT - Measurements

- **Conductor/accessory temperature**
 - Direct contact on surface or conductor core
 - 128 thermocouples available
 - 40 to 80 thermocouples used for testing
- **Applied current and voltage**
 - Measured by power supply
- **Conductor sag**
 - Laser at mid-span #1 on tree side circuit
- **Conductor tension**
 - Load cells on both circuits
- **Weather**
 - Ambient temperature, wind speed, wind direction
 - Conductor net radiation sensor
- **PC-based data acquisition system**
 - 10 second polling
 - 1 minute data archive

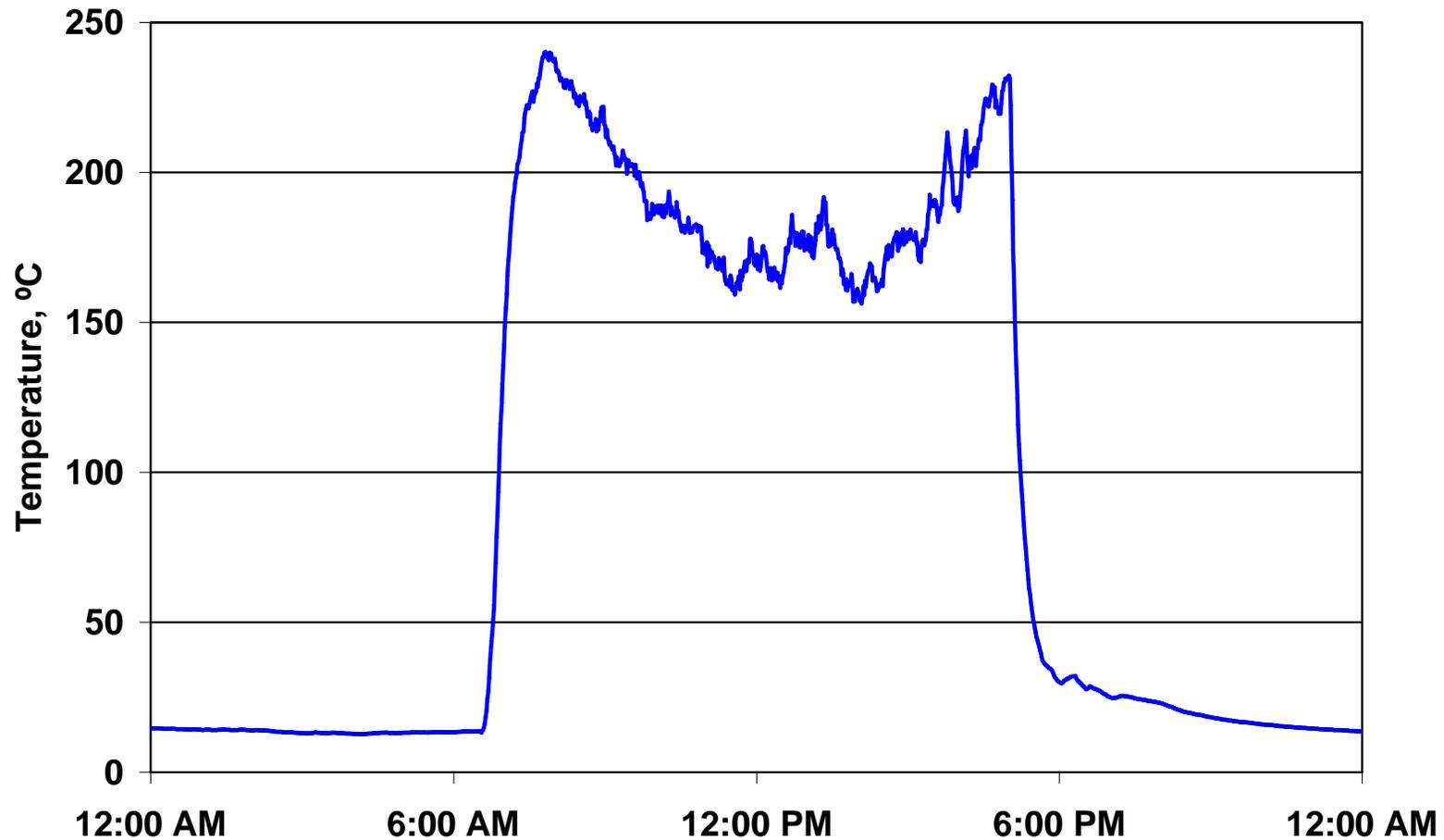
T1. PCAT – Constant Current Test

Current, 6/9/2003



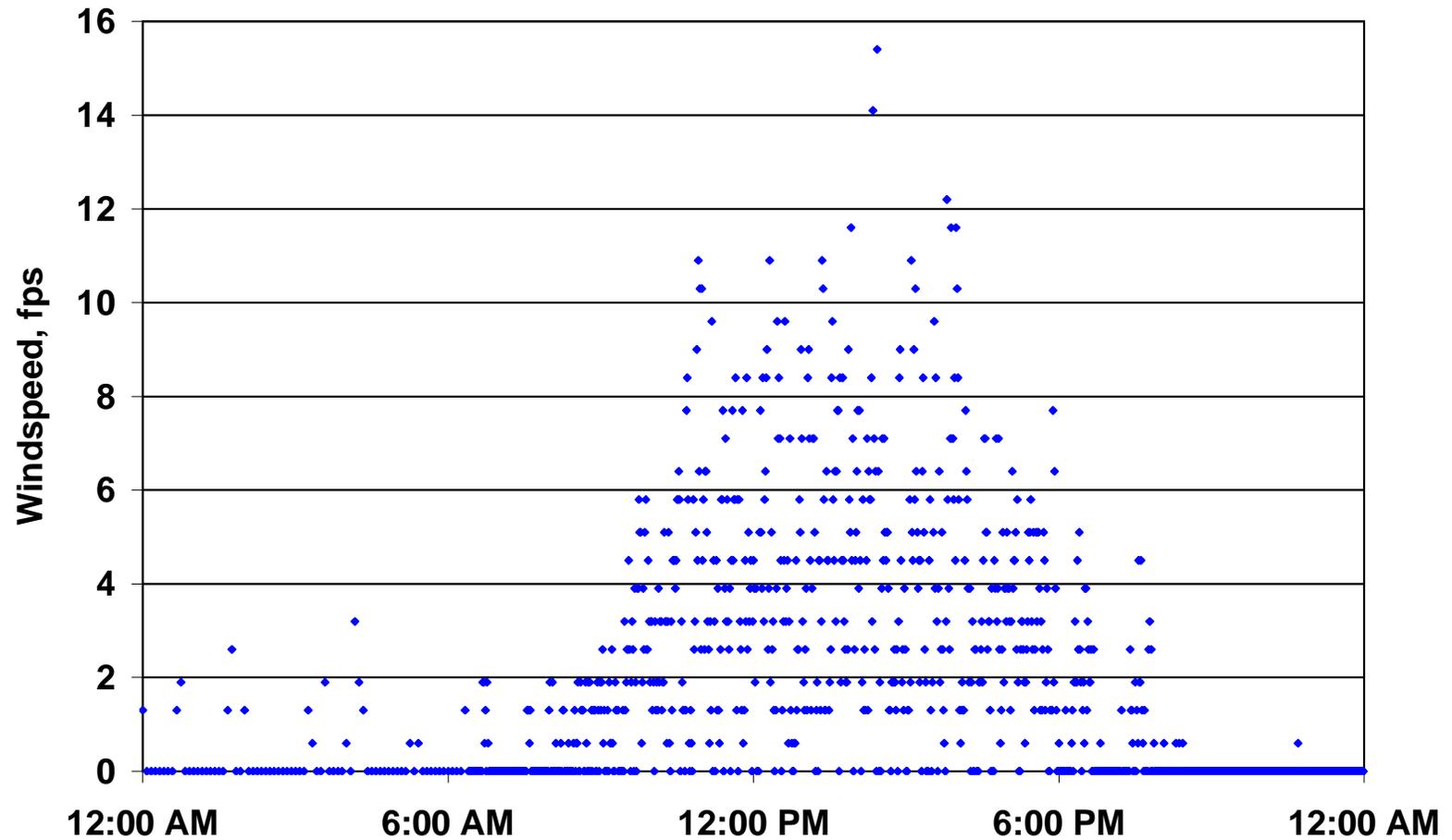
T1. PCAT – Constant Current Test

Average Conductor Temperature, 6/9/2003



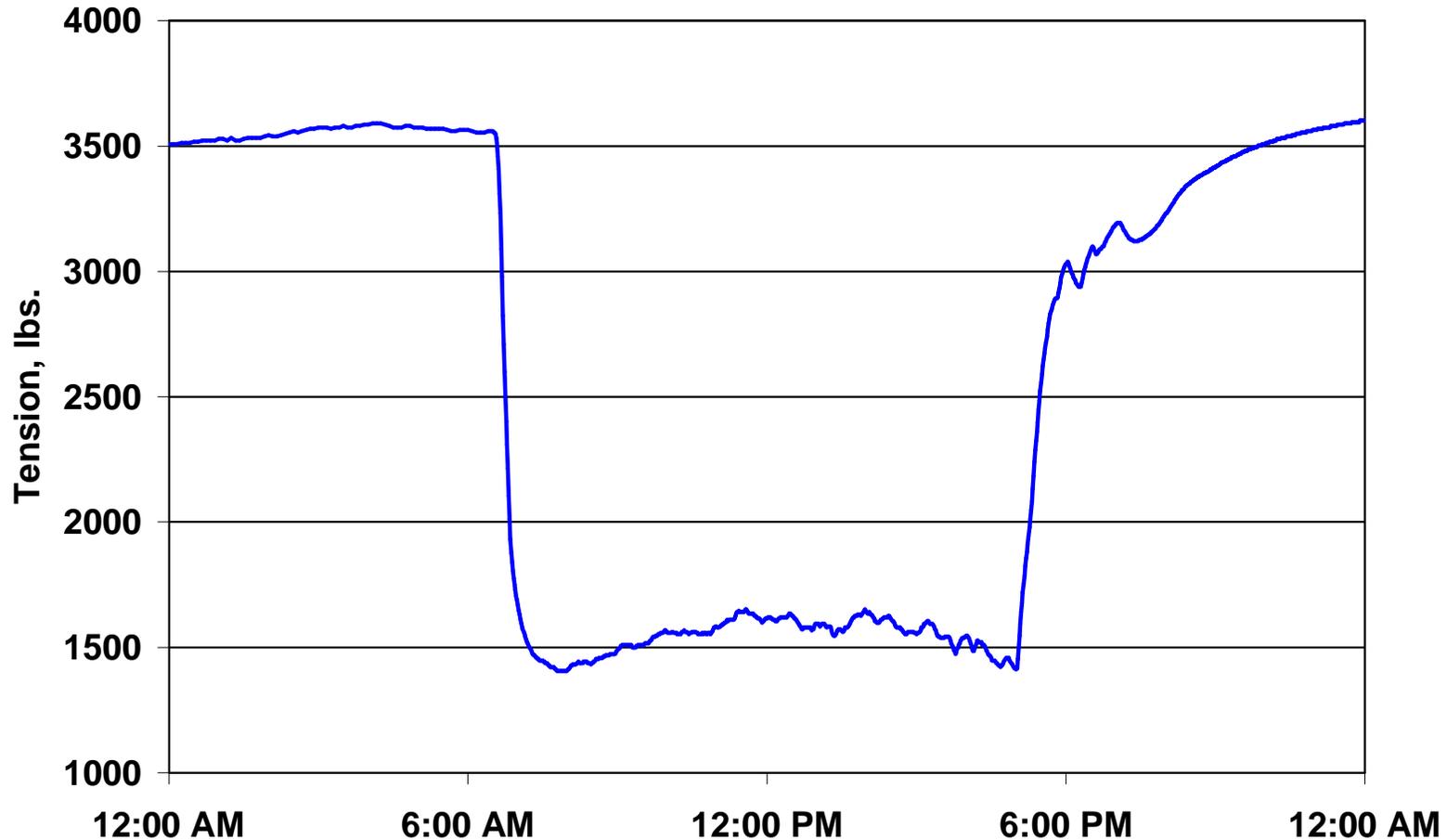
T1. PCAT – Constant Current Test

Windspeed, 6/9/2003



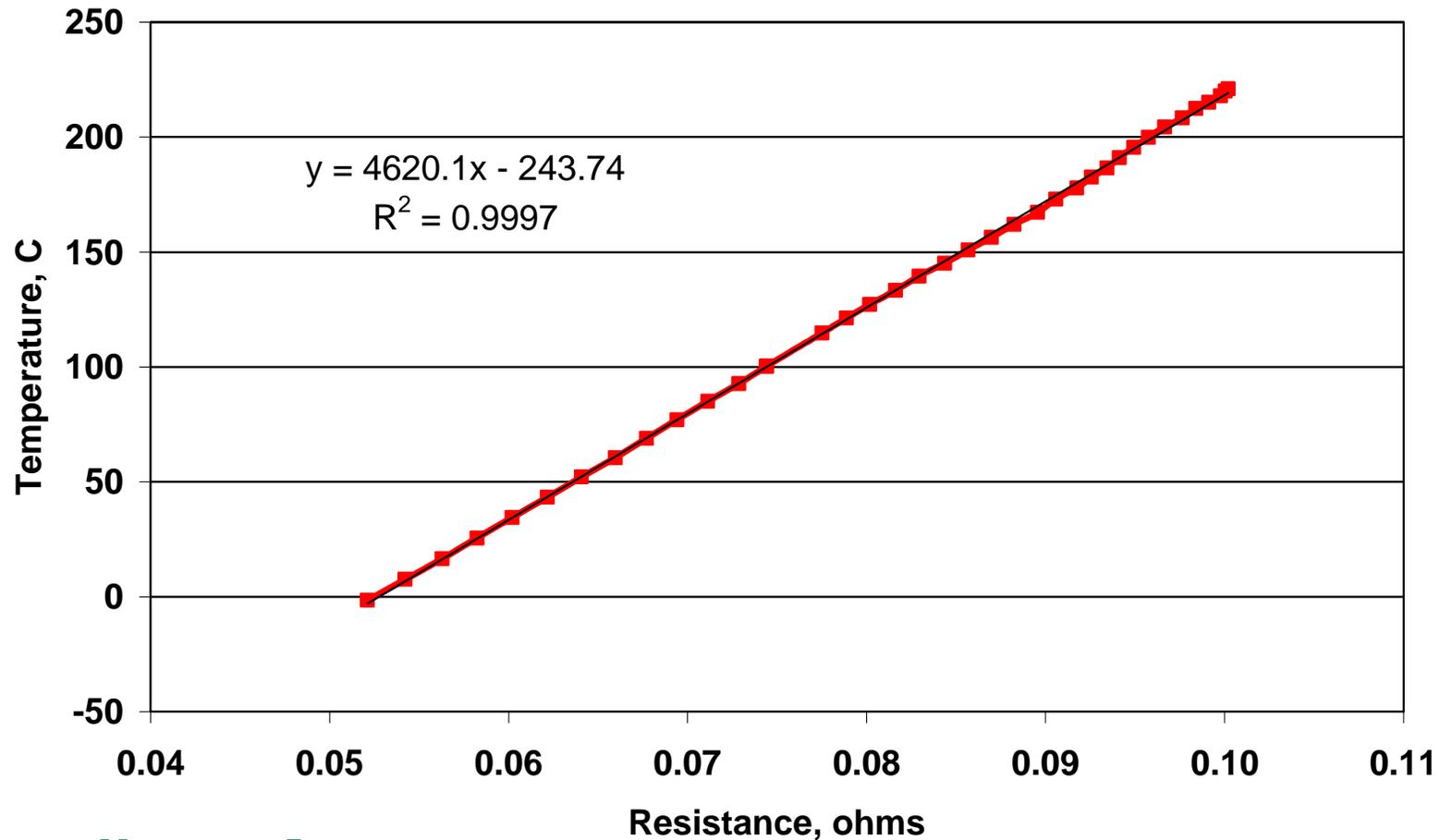
T1. PCAT – Constant Current Test

Conductor Tension, 6/9/2003



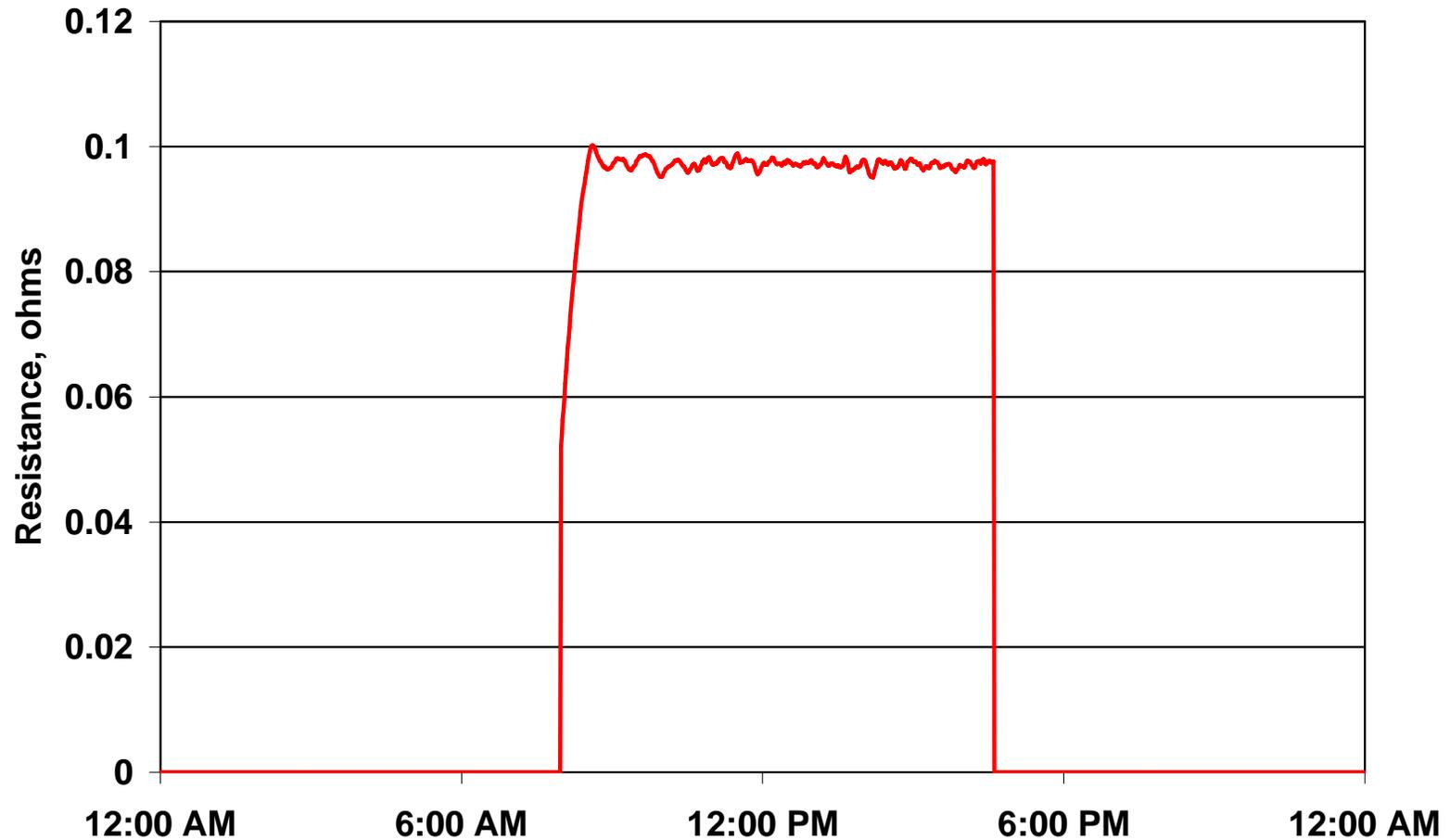
T1. PCAT – Constant Temperature Test

Conductor Temperature verses Resistance



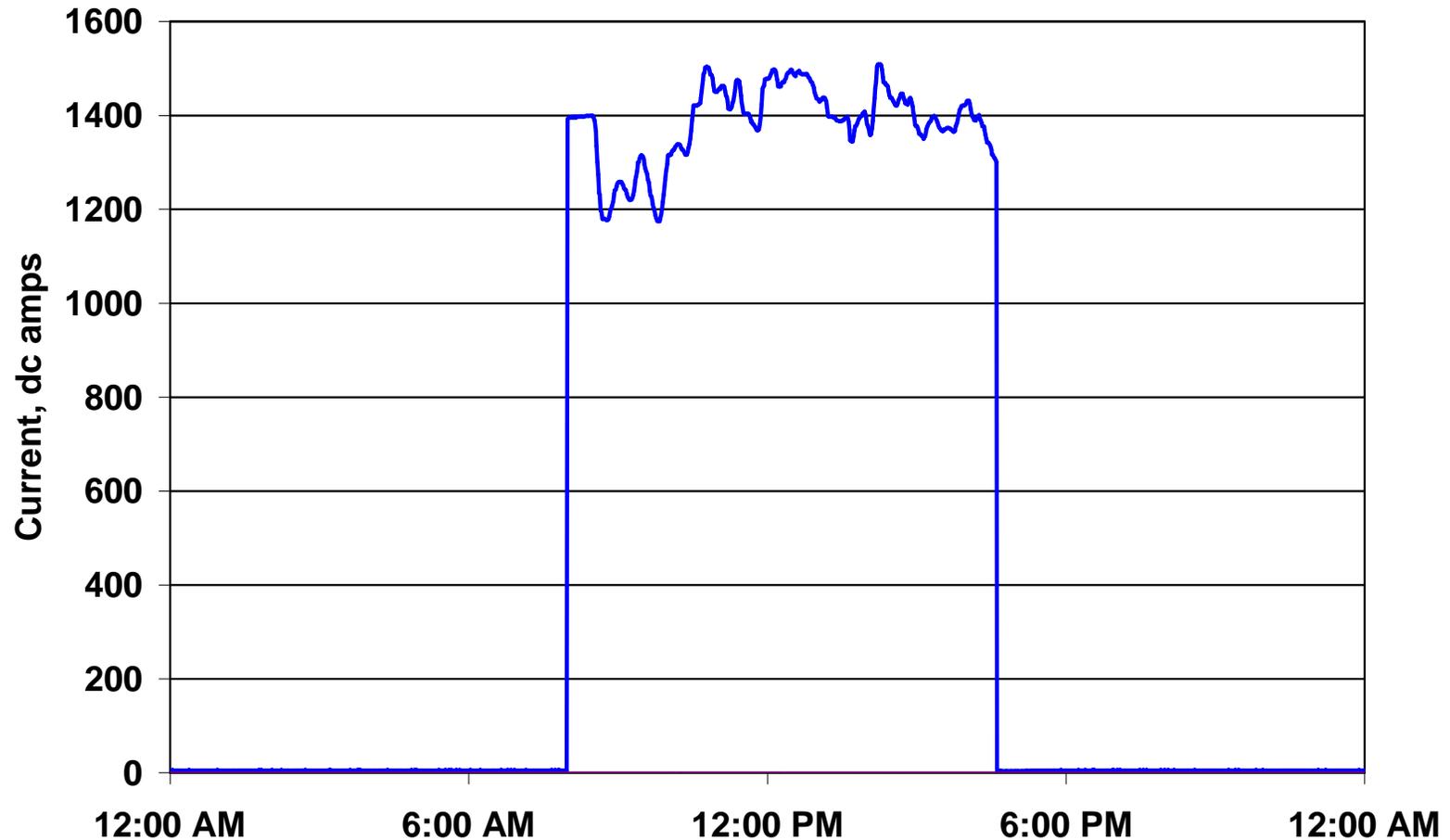
T1. PCAT – Constant Temperature Test

Circuit Resistance, 1/16/2004



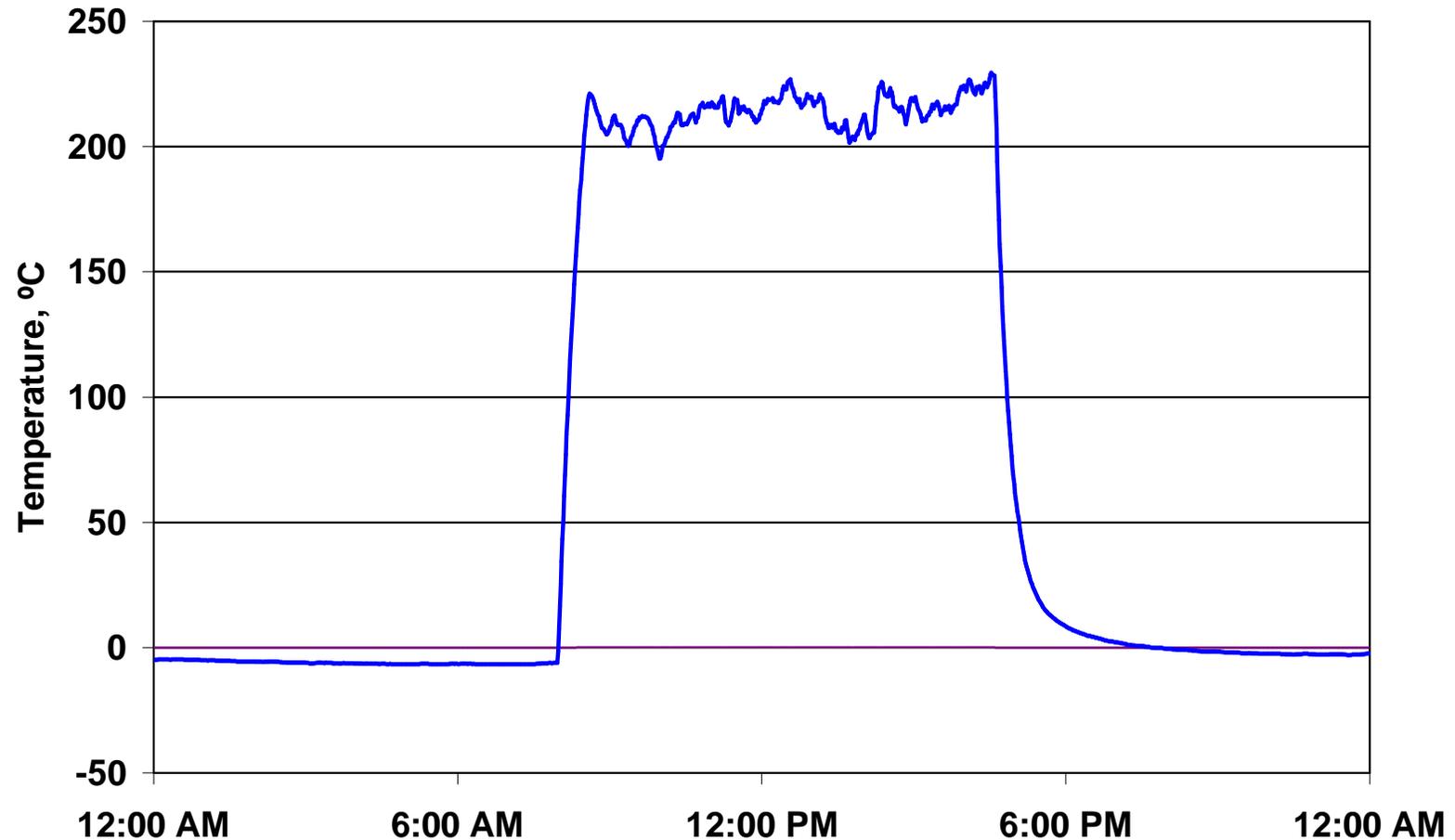
T1. PCAT – Constant Temperature Test

Current, 1/16/2004



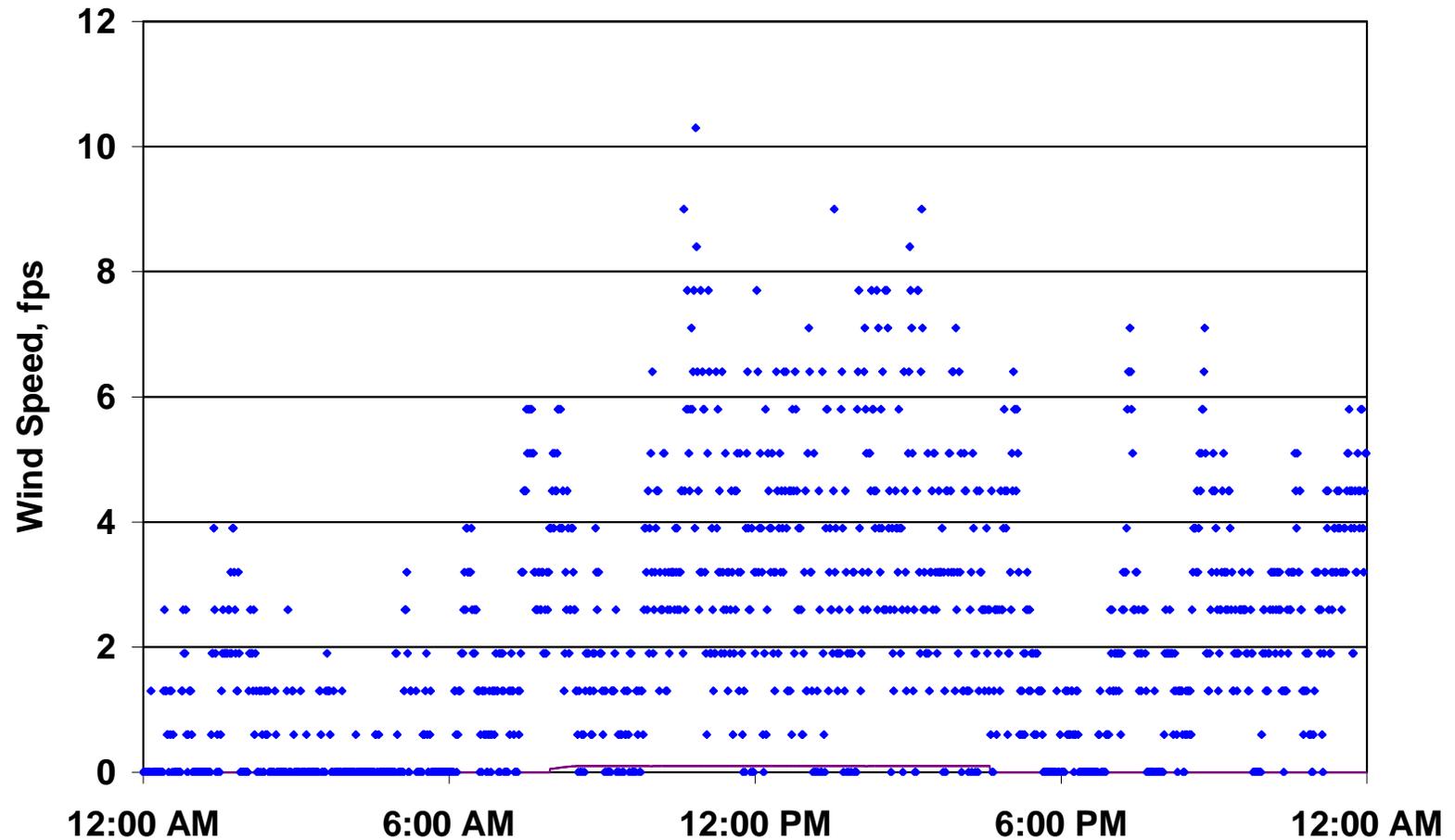
T1. PCAT – Constant Temperature Test

Conductor Core Temperature, 1/16/2004



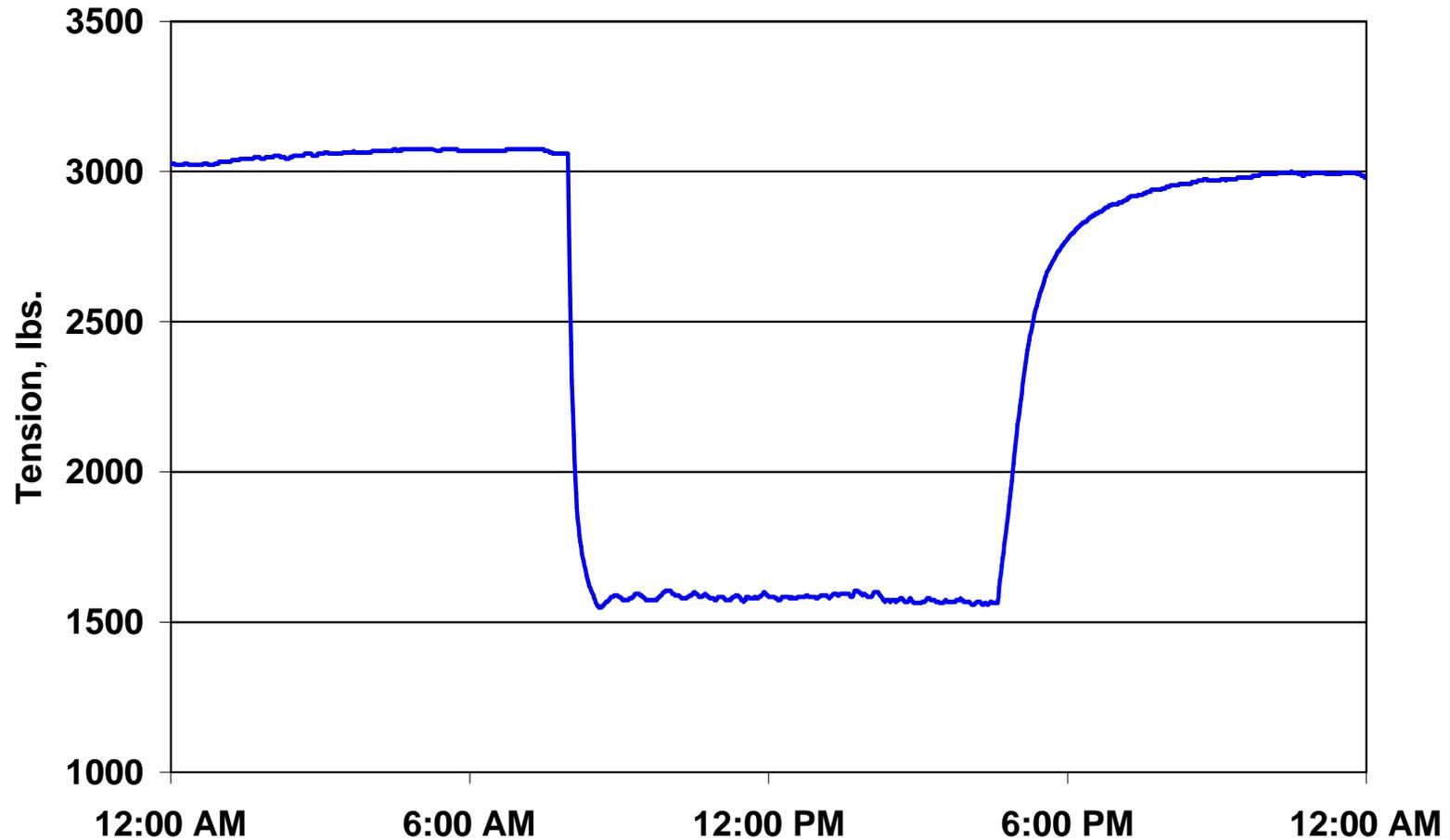
T1. PCAT – Constant Temperature Test

Wind Speed, 1/16/2004



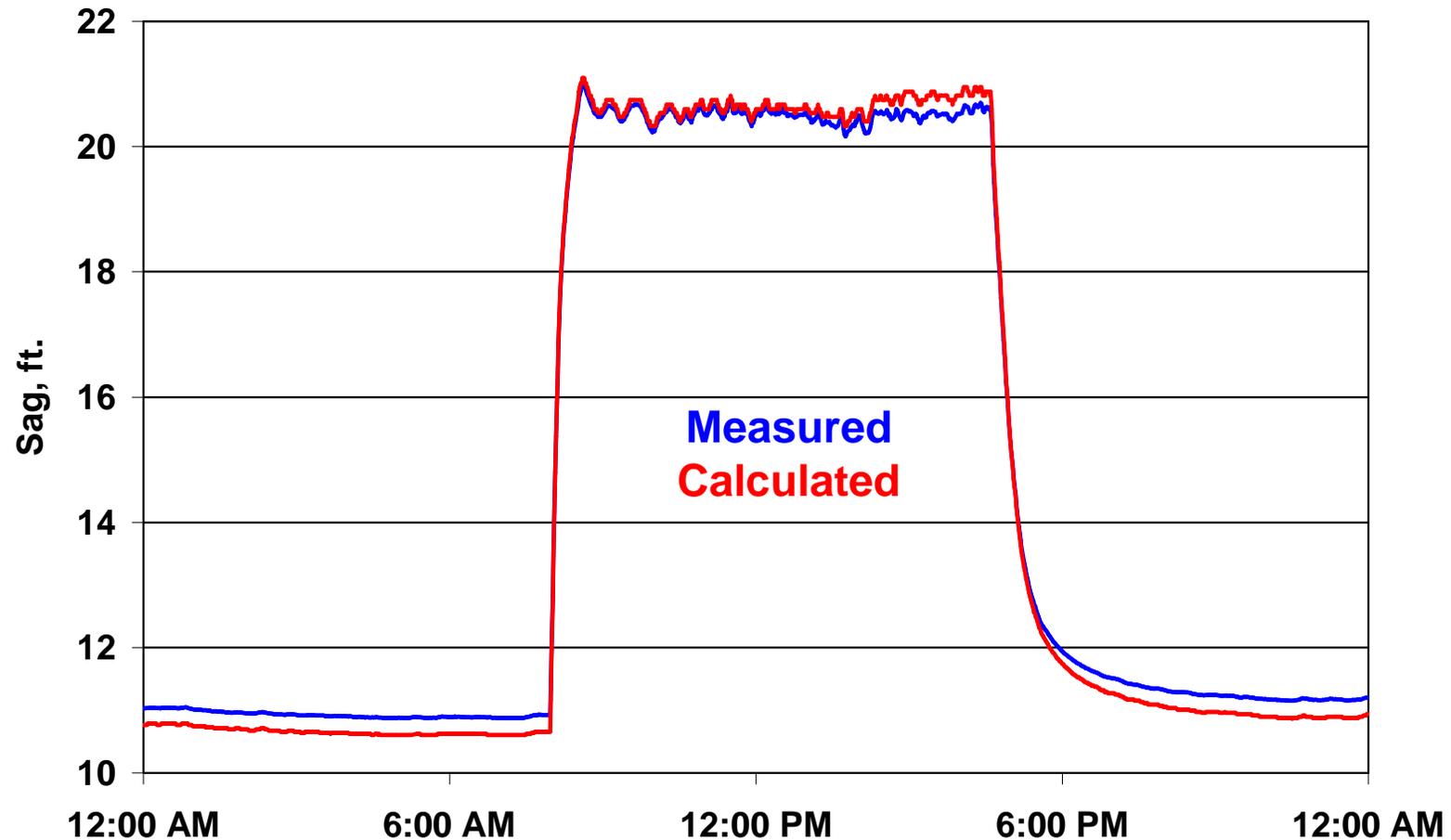
T1. PCAT – Constant Temperature Test

Conductor Tension, 1/16/2004



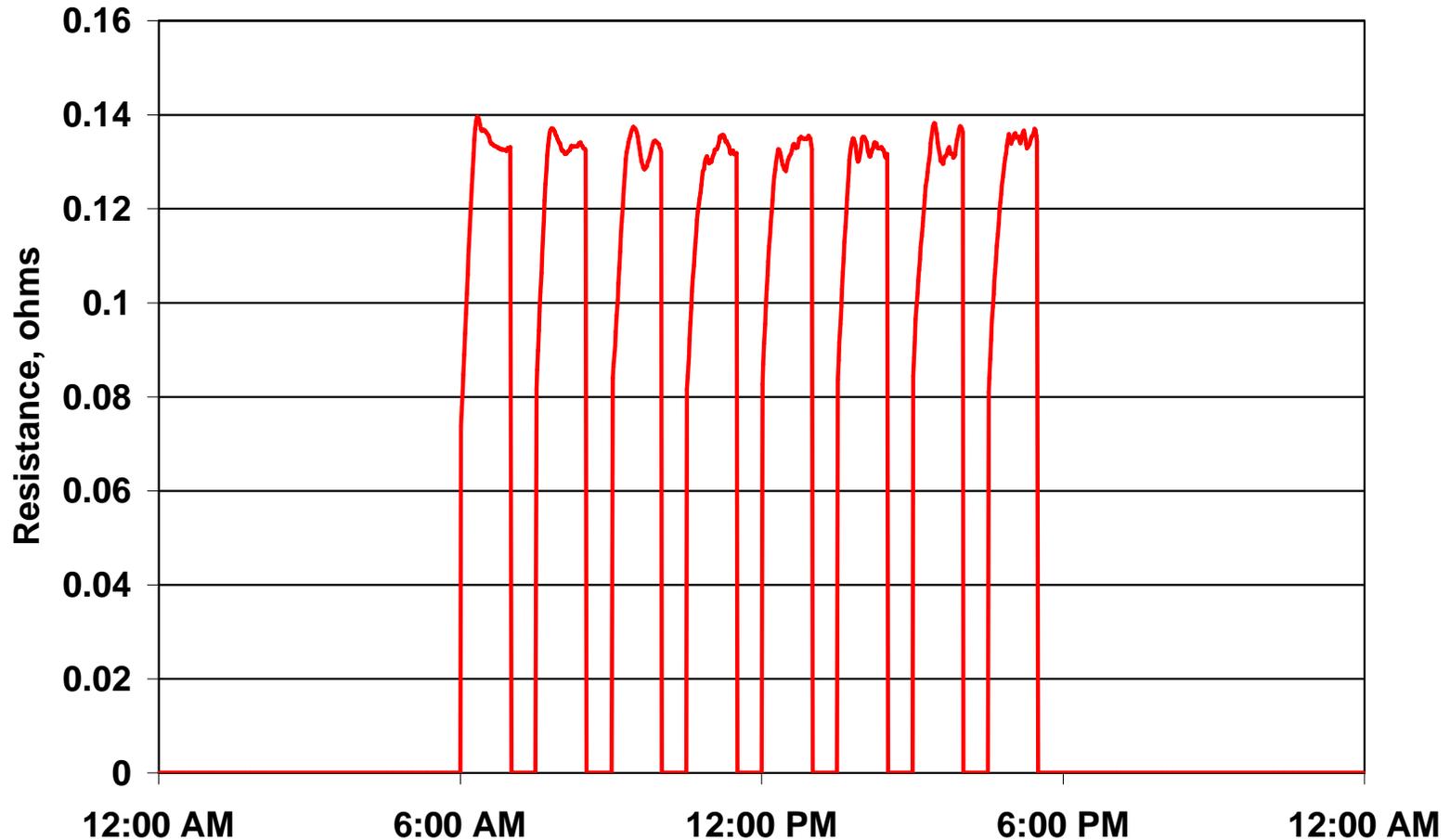
T1. PCAT – Constant Temperature Test

Conductor Sag, 1/16/2004



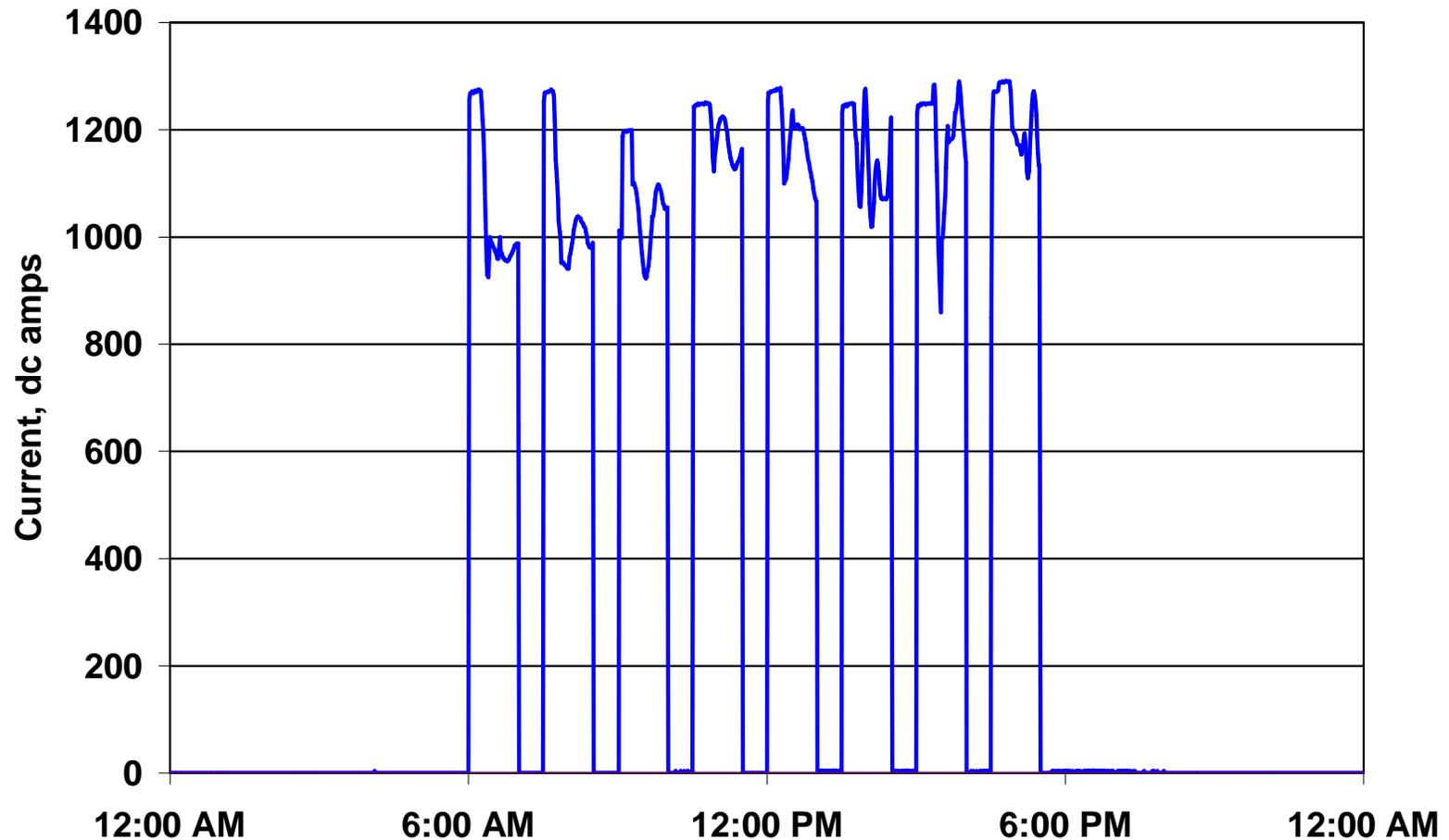
T1. PCAT – Thermal/Mechanical Cycling

Circuit Resistance, 10/2/2003



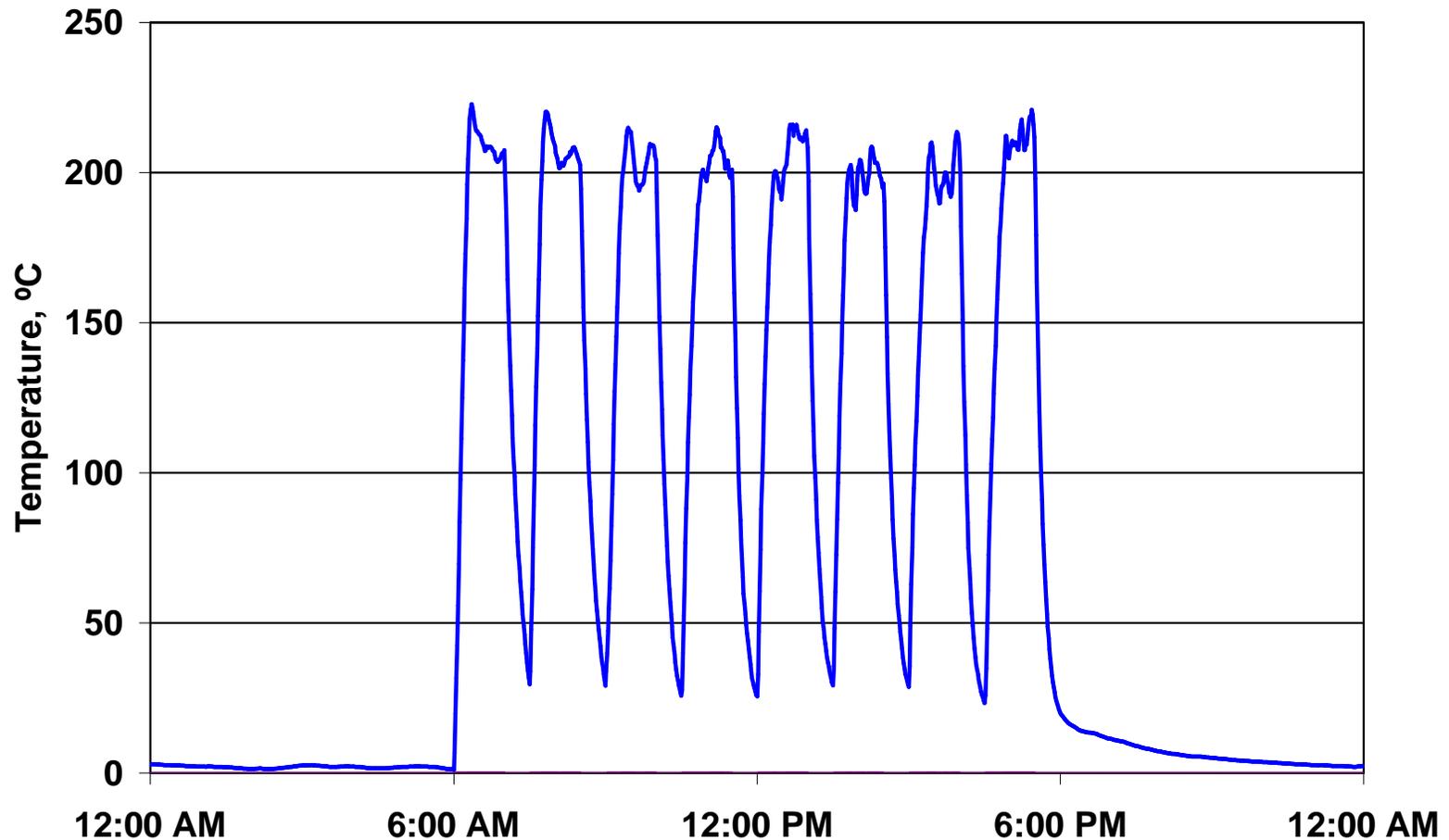
T1. PCAT – Thermal/Mechanical Cycling

Current, 10/2/2003



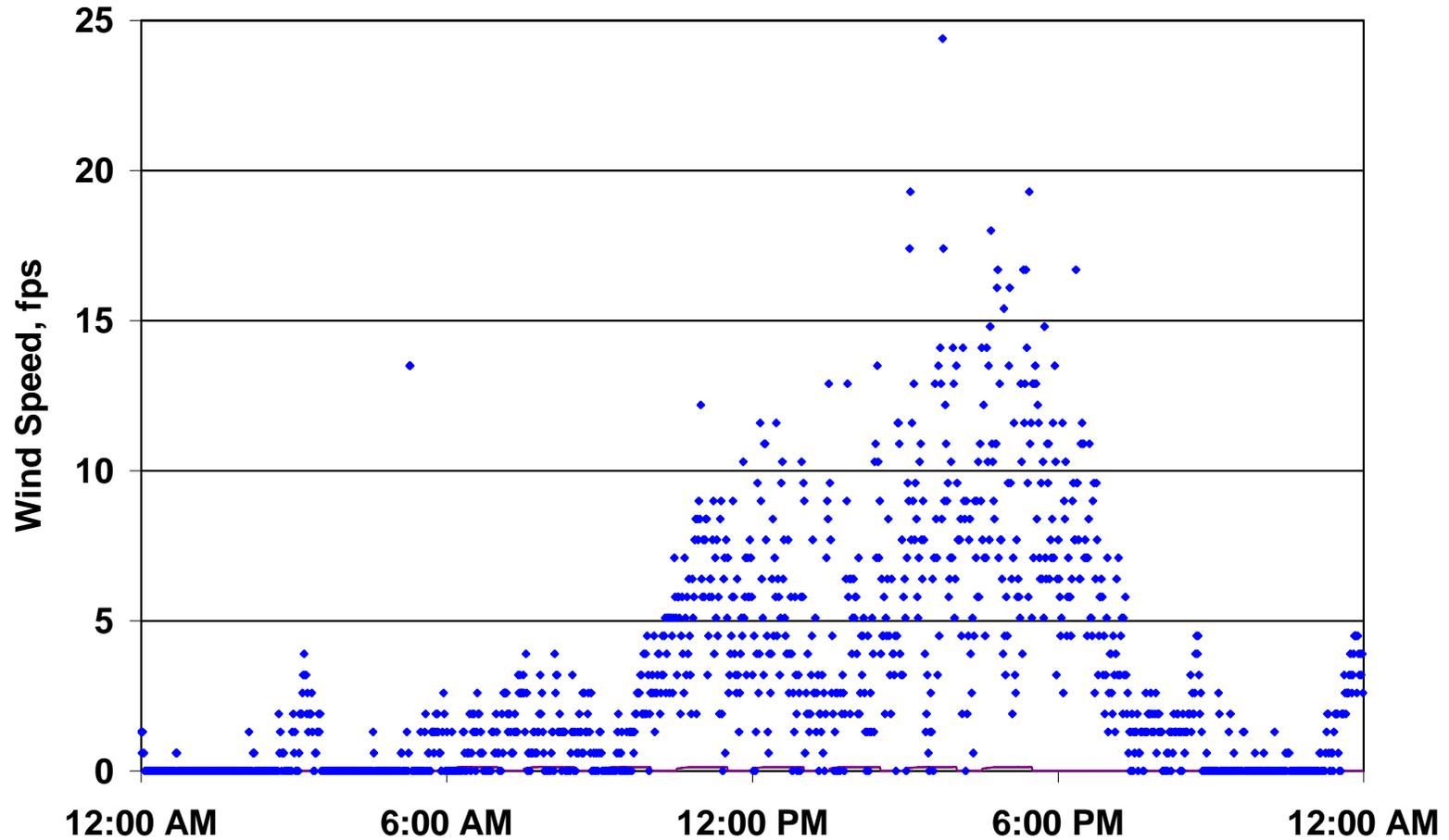
T1. PCAT – Thermal/Mechanical Cycling

Conductor Core Temperature, 10/2/2003



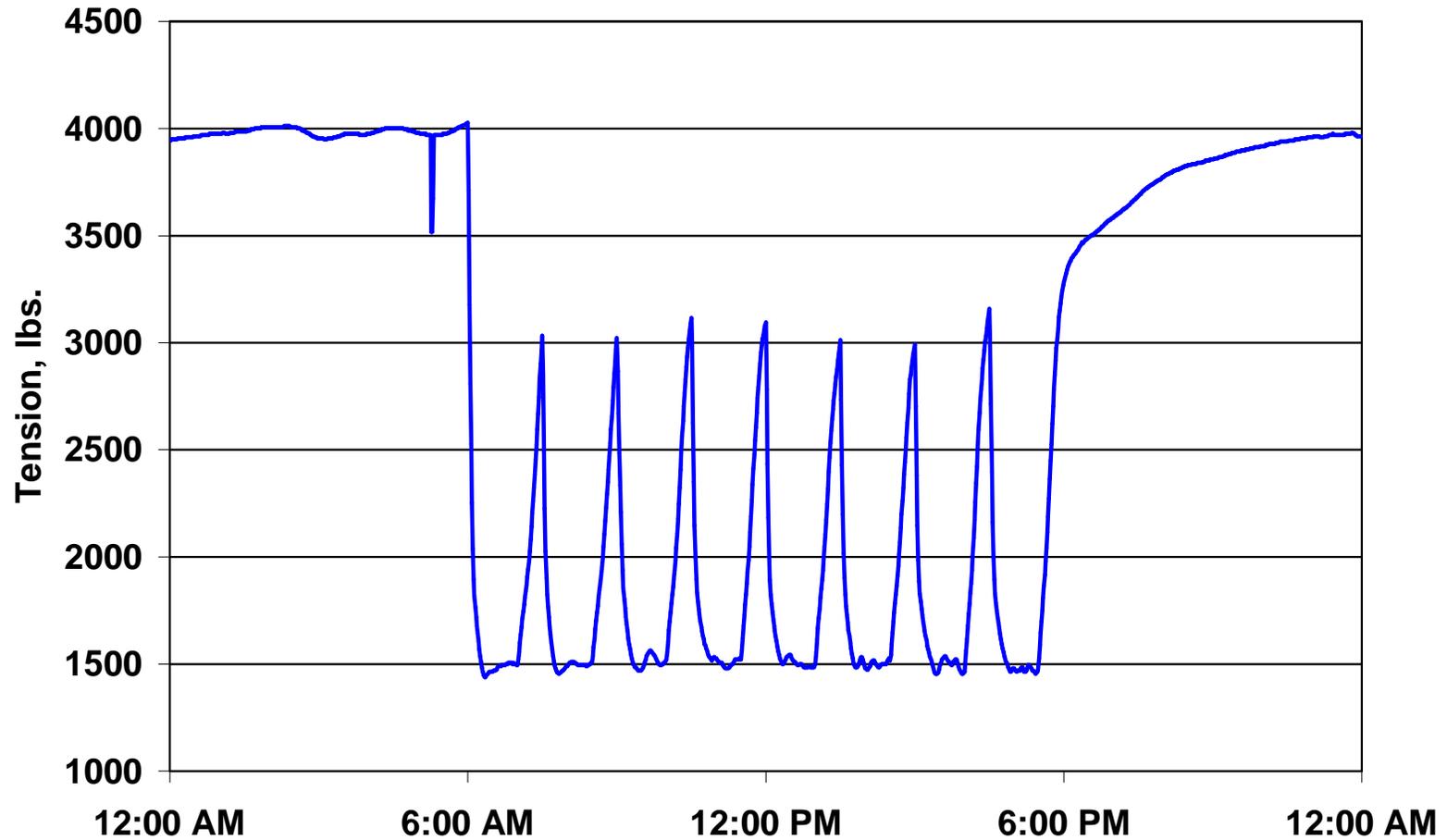
T1. PCAT – Thermal/Mechanical Cycling

Wind Speed, 10/2/2003



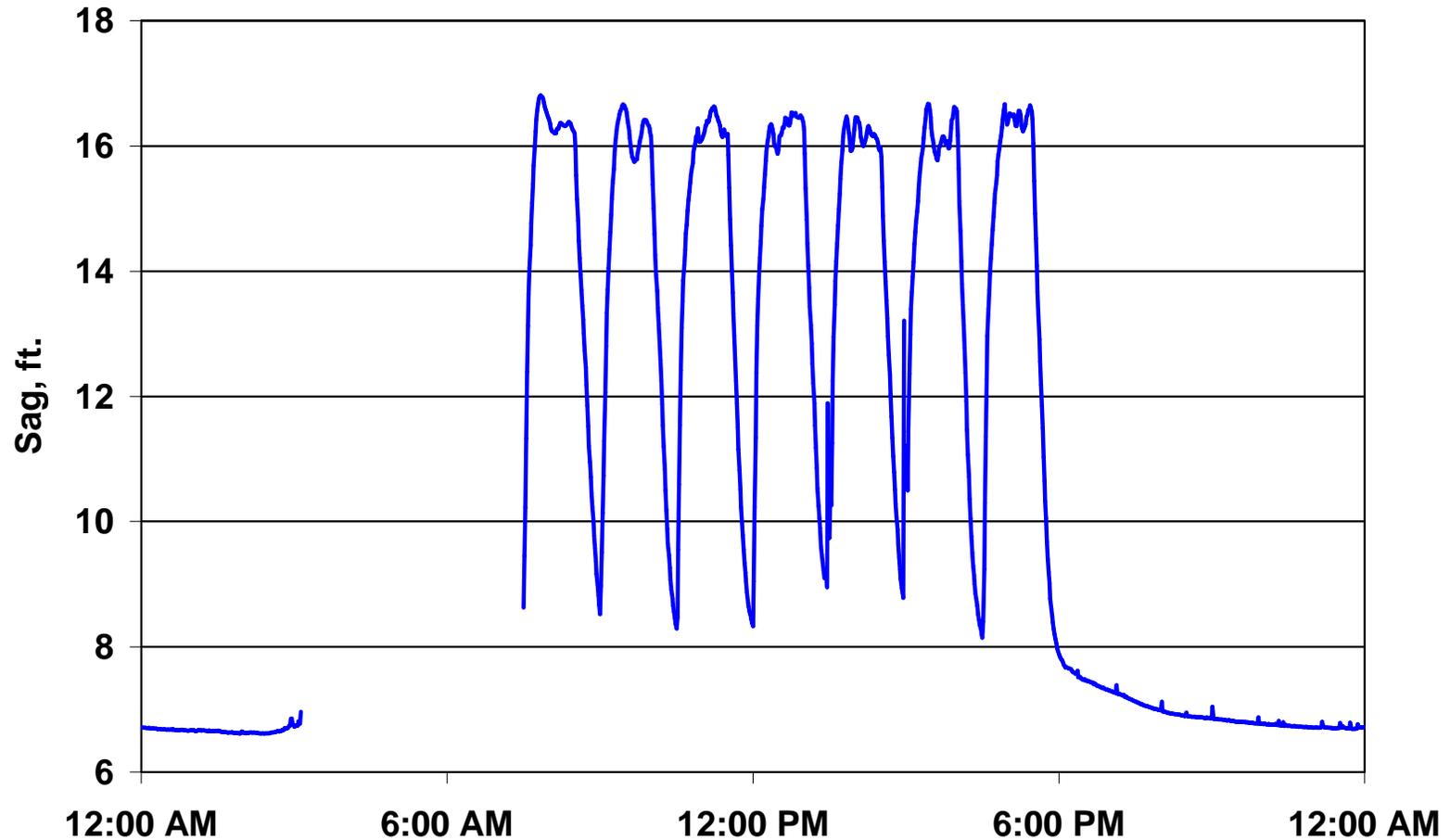
T1. PCAT – Thermal/Mechanical Cycling

Conductor Tension, 10/2/2003



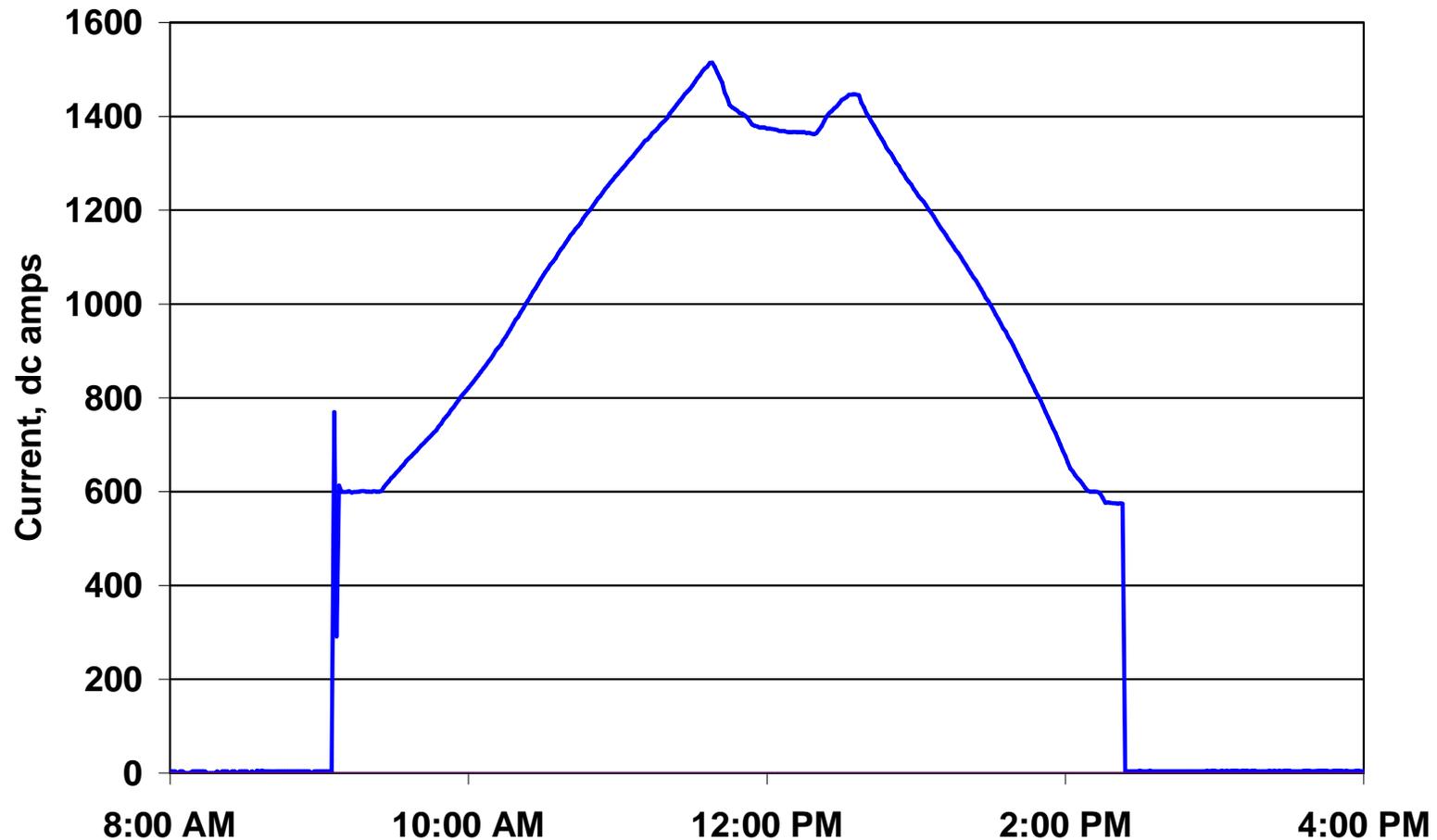
T1. PCAT – Thermal/Mechanical Cycling

Conductor Sag, 10/2/2003



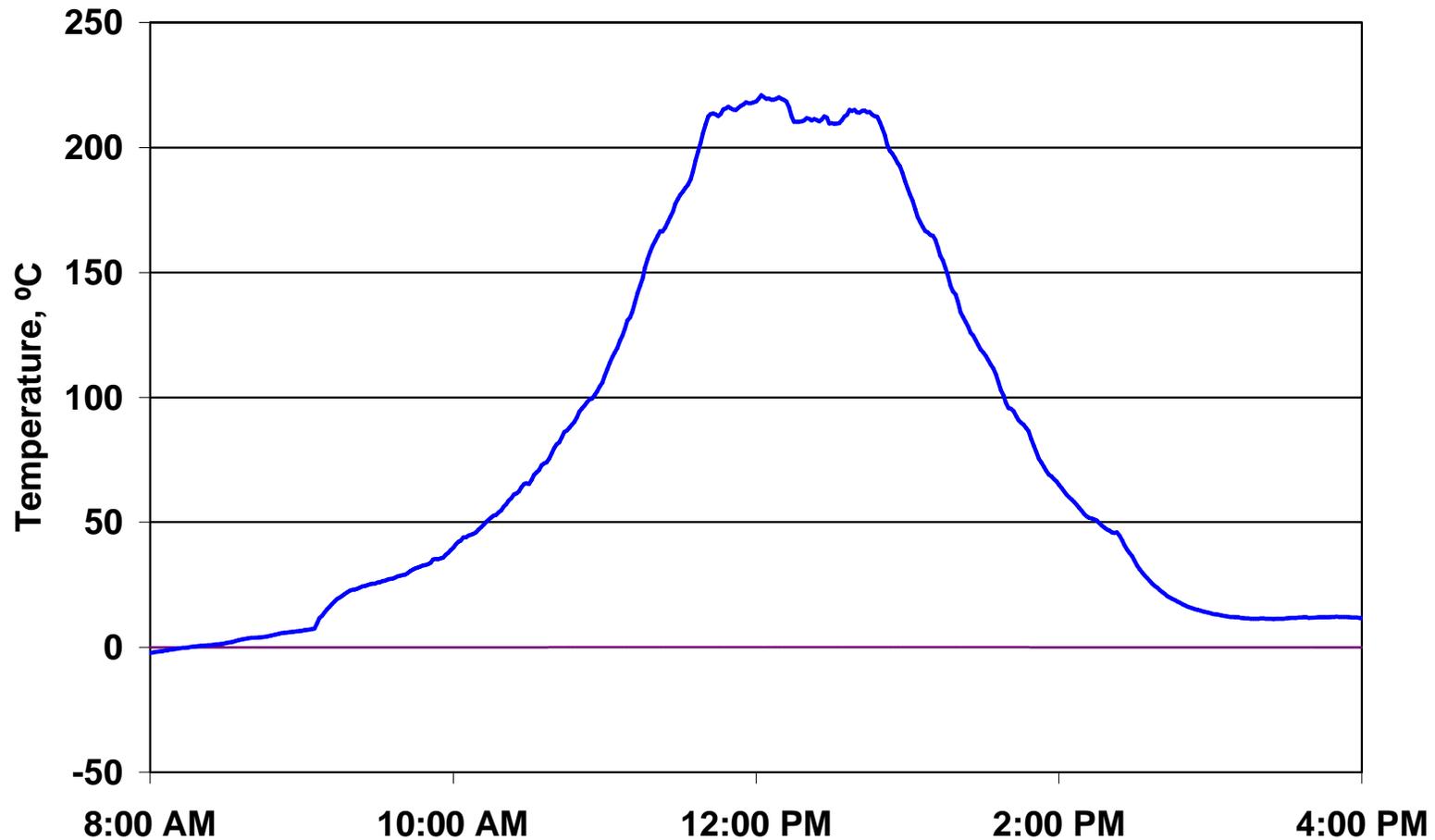
T1. PCAT – Current / Temperature Ramp

Current, 11/14/2003



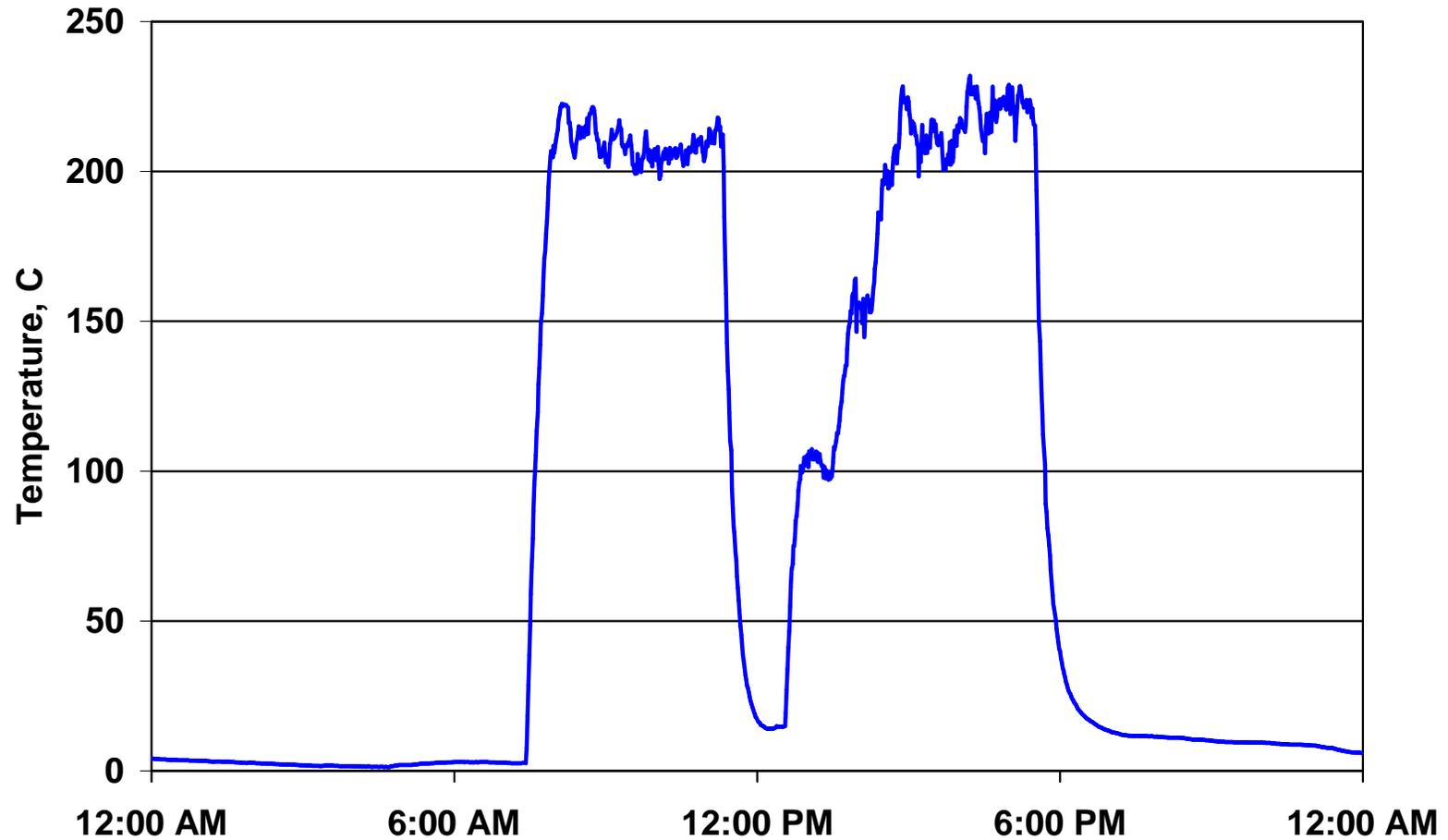
T1. PCAT – Current / Temperature Ramp

Conductor Core Temperature, 11/14/2003



T1. PCAT – Ramp and Hold

Conductor Temperature, 10/23/2003



[Click To Start Movie of Conductor Sag](#)

T1. PCAT – Summary of Testing Capabilities Used to Date

- **Constant Current**
- **Constant Temperature**
- **Thermal / Mechanical Cycling**
- **Current / Temperature Ramp**
- **Current / Temperature Ramp and Hold**



Laser at mid-span measure conductor sag

T2. - Indoor PCAT

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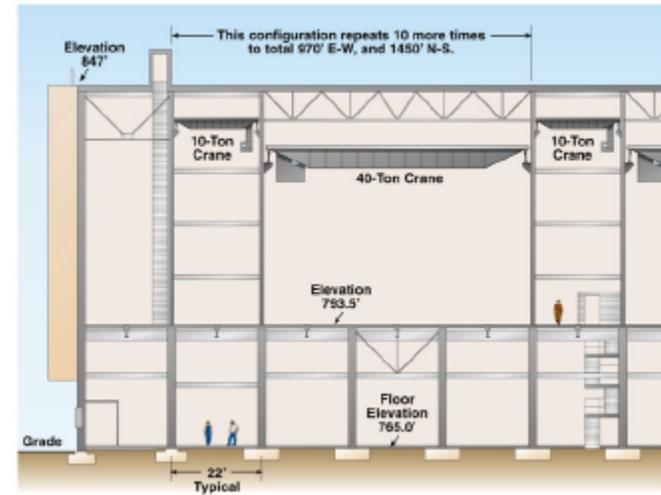
Indoor PCAT – indoor Powerline Conductor Accelerated Test Facility

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T2. Indoor PCAT Facility Offers Unique Capabilities

- Indoor version of outdoor Powerline Conductor Accelerated Test facility
- 54 ft. high, 40 ft. wide and 1456 ft. long bay
- No wind, rain, lightning, solar, temperature gradients
- Tighter measurement tolerances
- Easier instrumentation
- Controlled accelerated aging of components



T3. PCOT

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PCOT – Powerline Conductor Operational Test Facility



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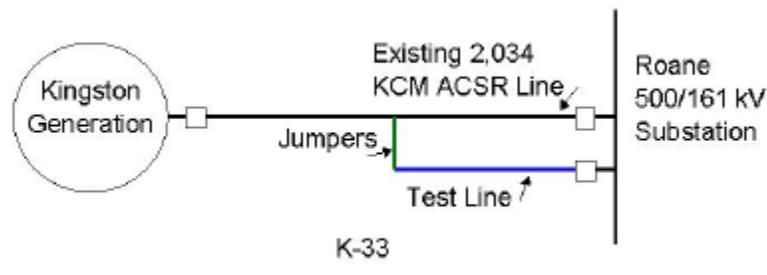


T3. PCOT Facility



- **Powerline Conductor Operations Testing**

- Test conductor at operating voltage and load current
- TVA 161-kV lines between TVA Kingston power plant and TVA Roane substation
- On DOE property - no public exposure
- Unique location - ability to switch test in and out of service and control loading
- Exceptional size - 2034 KCM ACSR
 - will not limit advanced conductor test
- Plan to heavily instrument facility - long life and multiple uses



CAT-1 Transmission Line Monitoring System has been purchased.

T4. TPET

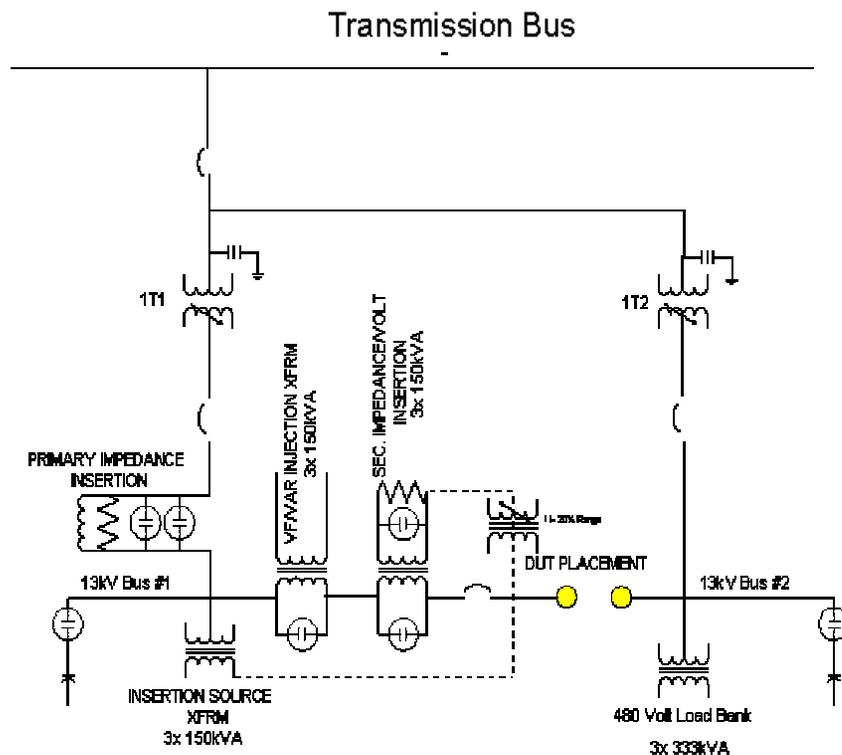
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TPET – Transmission Power Electronics Test Facility



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T4. Transmission Power Electronics Test Facility



- 13 kV for transmission level devices
- 2 power transformers allow flow control
- Dynamic testing capabilities
- Power quality of neighboring loads *not* degraded



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T4.

**TPET
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*Transmission Power
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Questions



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