CAT-1

TRANSMISSION LINE MONITORING SYSTEM

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WHY TENSION MONITORING?

1. Increases transmission capabilities by 10-30%, safely and economically.
   - Unmonitored lines are operated on conservative assumptions (static or “book” ratings).
   - When a transmission path is contingency-limited, a small rating increase in the limiting line makes a much larger improvement in the complete interface rating.

2. Very high accuracy - measures sag within 1-2 inches (3-6 cm).

3. Rates lines the same way they are designed.
   - Each span must maintain mandated regulatory clearances to the ground.
   - Keeping tensions above design minimum values guarantees safe clearances.
   - Tensions vary due to variation in line currents, wind, solar radiation, and ambient temperature.

4. Tension is directly related to the average conductor temperature of the suspension section.
   - Weather data and spot conductor surface temperature are not accurate measures.

5. Even conservative “book” ratings are not 100% safe and reliable.
   - Safe ratings should be based on zero wind, unless the lines are monitored.

6. The most widely accepted thermal rating method in the world.
   - Between 1991-2000, over 70 utilities installed more than 200 CAT-1 systems* on 5 continents.
   - Over two thirds of the 30 largest utilities in North America use CAT-1.
   - The majority already use CAT-1 for real time rating data direct to their EMS.

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*U.S. Patents #5,235,861, #5,517,864, #5,559,430, #5,918,288
CAT-1 SYSTEM COMPONENTS

CAT-1 main unit
- Weatherproof aluminum enclosure with electronics
- Solar power supply and backup battery
- Cellular or radio communications
- Ambient temperature sensor

Load cells
- Each of two load cells measures the tension of one suspension section
- Electrical protection for lightning and high voltage environment

Net Radiation Sensor (NRS)**
- Ingenious method of modeling line temperature without load
- Combines ambient temperature with wind and solar effects, emissivity and conductor time constant
- Greatly simplifies measurements and rating calculations

CATMaster Base Station
- 19” rack mount
- Converts data to utility’s EMS protocol
- Seen as an addressable RTU by EMS

*U.S. Patent #5,918,288
**U.S. Patent #5,550,430

Rating algorithms
- Programmed into EMS, or
- Substation or PC-based solutions

Advanced rating options
- Advanced analysis
- Statistics
- Forecasted ratings
- Ratings data to various utility functions
- Complete circuit ratings, including transformers

For more information and component specifications, go to www.cat-1.com
The data you need
Tensions, Net Radiation Temperatures, sags, clearances, conductor temperature, capability

CAT-1 measures the most meaningful data for rating calculations: Tensions and Net Radiation Temperatures (NRT). Tension and NRT measurements both take into account the effects of ambient temperature along with wind and solar effects, emissivity and conductor time constant. The result?

- Simplified rating calculations
- Highly accurate ratings

Getting from Tension to Ratings

Figure 1 shows how CAT-1 measurements are used to calculate the rating information of most interest to you - conductor temperature, sags, clearances, and real time ratings.

Forecasted ratings

- Short, medium, long term statistical rating forecasts:
  - 30 minute – Contingency response
  - 1-4 hour – Minimizing or avoiding dispatch changes
  - 24 hour – Dispatch, generation, and outage scheduling
  - Quarterly – Planning and design
- Backed up by accurate, observable CAT-1 real time ratings
- For power marketing, operations planning, maintenance scheduling, and asset management decisions
- Derives optimal operating decisions based on real time ratings

Why are increased ratings possible?

1. A change in wind speed from 2 ft/sec to 4 ft/sec increases capability by 20-30%.
   - Wind is the most significant weather variable influencing ratings.
   - Knowing actual, instead of assumed wind effects is critical.

2. High winds and high ambient temperatures generally coincide.
   - Provides favorable daytime rating conditions.
   - Simple “ambient-adjusted” ratings thus are often erroneous and may be dangerous.

3. Wind data from meteorological sites is poorly suited for ampacity analysis.
   - Simultaneous wind speed measurements at two sites one mile apart typically vary in a 2:1 ratio.
   - Anemometers have stall speeds of 4-5 ft/sec, exaggerating the occurrence of thermally limiting “calm”.
   - Meteorological sites are in very different terrain and elevation than transmission corridors.
WHY REAL TIME RATINGS?

Allows full utilization of CAT-1 for economic benefits throughout your network

- What do your operators normally do in a contingency situation?
- If a power plant is down, do you import expensive power from a neighboring utility?
- What if a tie line load exceeds its static rating?
- Do you have to start up expensive gas turbines?

Instead, a progressive utility would use CAT-1 systems for the real time rating of key transmission lines as a superior economic alternative.

Are your contingencies costly?

With a real time CAT-1 System:

- The operator can load the lines above their "book" rating (an estimated rating).
- The operator will see the current real time rating (the actual rating) of each suspension section.
- Lines can be operated at the generally higher real time rating.
- An algorithm in EMS calculates the maximum safe load for the operator.
- In most cases, imported energy and startup of expensive backup generation can be delayed or prevented.

Are you running your lines safely?

- In some cases, lines cannot be run at even supposedly conservative static ratings!
- Monitored lines can be operated 100% safely and reliably.

Example – California’s Path 15

Immediate savings being realized

- California’s 40GW electricity market is split into two areas, joined by the weak 3GW Path 15.
- Constraints of this transmission path cost California over $160 MM in fourth quarter 2000.
- In March 2001, California Energy Commission provided The Valley Group with a $360,000 contract to design line rating software for the path, to be operational in August 2001.
- The payback period will be one afternoon.
- Solution to be used on other major lines in California.
CAT-1 OPERATING MODES

Real Time Ratings
- Radio communications via CATMaster to your EMS
- Provides the actual, accurate real time rating instead of static rating “approximation”
- Provides alarms of impending clearance violations*
- Ratings are continuously displayed in a format familiar to system operators
- Alarm handling follows established procedures

Data Logging Mode/Clearance Warning Mode
- Cellular communications for data downloads
- Analog or digital cellular, including GSM
- Provides a warning of any impending clearance violation*

*U.S. Patent #5,235,861

Thermal rating applications
- Economy transactions
- Better operating decisions
- Postponing construction
- Avoiding unnecessary contingency actions
- Improving generation dispatch
- Economically optimized choice between thermal rating and physical uprating
- Fastest transmission solution for new generation

Other applications
Detection, studies, and warnings of:
- Icing
- Annealing
- Galloping
- High temperature creep
- Wind loads

Versatility and reliability
Over 10 years of high reliability in a variety of high voltage environments
- At voltages up to 500 kV
- At temperatures as low as -40°F
- At temperatures as high as +50°C
- Performance not affected by weather – rain, wind, snow, or fog
- A self-calibrating system
- Solar powered
- No moving parts
- No maintenance except battery change every 5 years