The ThermalRate™ System

Overview

ThermalRate™ determines the rating of an overhead transmission line in real-time. It harnesses the existing, yet presently unused capacity of the line. It makes no contact with the line, so a line outage is never needed for installation. It increases system reliability by showing the true rating to the operator and warns if there is ever a time of low rating. ThermalRate™ is an inexpensive solution with a fast pay-back. It is based on the widely-used IEEE-738 standard and backed by UC Synergetic's extensive engineering and application knowledge.

Installation

Low-cost installation is a major advantage of ThermalRate™. It makes no contact with the line, and no modification of the line is required. No line outage is ever needed for installation or calibration, so installation can be done quickly. ThermalRate™ comes calibrated and ready to use. The ThermalRate™ Sensor may be installed on a mast on the control house, on a separate pole set for this purpose, or on an existing transmission structure.

How It Works

The ThermalRate™ Monitor is comprised of a Sensor and a Controller.

- ThermalRate™ Sensor – The Sensor consists of two parallel replicas of line conductor and mimics how the line behaves in the given weather conditions. The replicas have the same material, diameter, and surface as the line and are each approximately one foot in length. The Sensor is installed in the vicinity of the line. It is mounted at the average conductor height and oriented parallel to the line in order to see the same weather conditions as the line itself.
- ThermalRate™ Controller - The Controller contains the microprocessor and radio and is typically installed near ground level under the Sensor for ease of installation. It measures the Sensor, calculates the normal and emergency ratings, and responds to DNP3 SCADA requests.

- Powering - The Monitor requires 15 W from either 24 VDC or 110/220 VAC.

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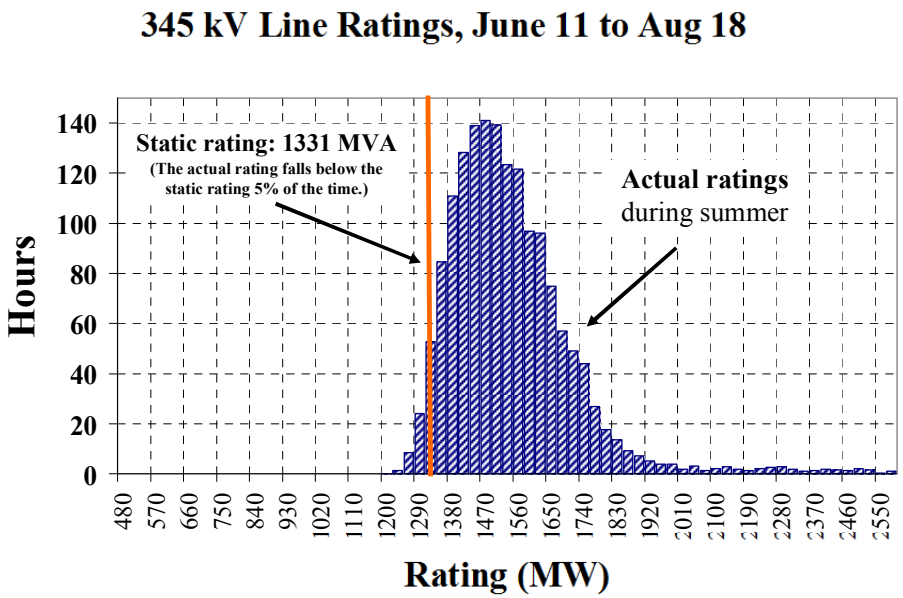
One of the Sensor replicas is heated with a constant wattage, and one is not heated. The temperature of the heated replica rises above the other. The weather conditions influence the difference in temperature between the two conductor replicas. By simply comparing the temperatures of two replicas and using the IEEE-738 standard equations, the effect of all weather conditions can be accurately determined, and the line capacity can be provided to the system operator. This is a very direct approach for accurately calculating the line's thermal rating.

The Value of Dynamic Rating

Historically, line owners have set a "static" line rating based on an assumed set of extreme weather conditions. However, ThermalRate™ allows line ratings to be recalculated as weather conditions change, harnessing the actual capacity without sacrificing safety.

The following plot shows actual ThermalRate™ data from a certain line, but which is very typical. A static rating of 1331 MVA was used by the line owner to limit the power flow, but ThermalRate™ shows that the transfer capacity is typically much higher. The entire area to the right of the vertical static rating line represents wasted transfer capacity that might have been used to reduce a transfer constraint. Also, notice that the seemingly conservative static rating is really not conservative enough, because the actual rating was less than the static rating 5 percent of the time. ThermalRate™ allows using the substantial line capacity on the right, and also increasing system reliability by warning the operators of the left tail.



Testing

The Electric Power Research Institute (EPRI) performed laboratory testing of ThermalRate™ over a number of different operating conditions. The operation of ThermalRate™ was verified by comparing its rating to the rating calculated by IEEE-738 and to the temperature of an actual conductor loaded to rating current.

Connecting ThermalRate™ to SCADA

The ThermalRate™ Monitor includes a spread-spectrum radio to communicate with SCADA. A receiving radio is provided for the SCADA-side and connects to an existing RTU in the substation. This avoids wiring in the substation. No software changes are required in SCADA, since the ThermalRate™ Monitor does the calculation of rating. SCADA simply measures this added point and displays it for the operator. Standard DNP3 protocol is used so system integration is straightforward.

Why ThermalRate™ Excels in Dynamic Line Rating

The design of the ThermalRate™ System is based on years of experience in monitoring technology and methods of upgrading lines. ThermalRate™ is accurate and reliable. It is rugged with no moving parts to fail, and it is an integrated solution.

Accuracy at Normal Electrical Loading

Tension, sag, and line temperature monitoring all have the same disadvantage; they cannot determine ratings with low electrical load on the line. During normal line operation, though, most lines have fairly low load, since they have to handle the jump in load in the event of a contingency somewhere on the system. ThermalRate™ uses an approach which determines the line rating without depending on the actual line load. With this approach, the line rating can be consistently calculated and provided to the system operator before as well as during the contingency. This is also very useful for offline analysis of the ratings.

ThermalRate™ is a Direct Method of Determining Rating

ThermalRate™ responds to weather conditions as the line does. The nature of the ThermalRate™ design takes into consideration difficult but very important quantities to measure such as variable wind speed and variable wind direction (turbulence) which happens especially at low speeds; wind that has some vertical component; fog or rain; solar radiation; sun reflected off the ground or clouds; humidity; clear sky radiation; and the time constant of the conductor. These are all inherently accounted for and are reflected in the temperatures of the Sensor.

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ThermalRate™ Gains Time for the Line Owner

There is uncertainty in new generation coming on-line and related uncertainty in line loading due to open access. ThermalRate™ can be installed to safely operate the line until it can be decided if a new line or major maintenance is really required. A new line can take years to get built, and ThermalRate™ gains the utility some time to continue safe operation of the existing line.

Wind Farm Application

ThermalRate™ can be an ideal solution for a transmission line connecting a wind farm to the grid. When the wind is high, more power flows through the line, but the rating is also higher. Therefore, when the capacity is needed, ThermalRate™ will show that it is available.

River Crossing Application

River crossings can limit the entire line, since they are long and sag more than shorter spans. A ThermalRate™ Monitor installed at one of the span ends can accurately determine the true rating for the span.

About the Pike Corporation

The Pike Corporation is a leading provider of energy solutions to over 300 investor-owned, municipal and cooperative utilities in the United States. Our comprehensive services include siting, permitting, engineering design, installation, maintenance and repair of power delivery systems, including renewable energy projects. Our common stock is traded on the New York Stock Exchange under the symbol PIKE. For more information, visit us online.

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