REAL TIME MONITORING AND RATING OF TRANSMISSION LINES

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Introduction

Overhead line thermal ratings are normally calculated assuming conservative weather conditions and a maximum allowable conductor temperature, which allows adequate electrical clearance and avoids annealing the aluminum or copper wires. In contrast to power transformers or underground cable, both the maximum allowable conductor temperature and the "worst case" weather conditions used in calculating line ratings are selected by the utility rather than the manufacturer or standards groups. Thus the thermal rating of an overhead line is, more than any other type of power equipment, determined by the engineering judgment of utility engineers. The exercise of this judgment leads to a range of calculated ratings that can exceed 2:1 for the same conductor in similar terrain.

Because of uncertainty over load growth on particular circuits and increasing interest in finding low cost methods of increasing capacity, a number of low cost incremental methods have been used to increase the thermal capacity of older overhead lines. Tension or sag monitors combined with weather monitors, can be used to increase line ratings at modest cost.

Dynamic Thermal Ratings - The thermal rating of an overhead line may be increased by the use of actual (rather than worst-case) weather and line loading conditions. Line sag-tension monitors must be installed and communications links established between the remote monitoring devices and utility central computing locations (SCADA).

To illustrate the concept of dynamic line ratings, consider Figure 1. The right-most bell shaped curve represents the probability distribution of line thermal ratings calculated based upon field calibration testing. Note that the ratings of the line typically vary over a range of more than 2:1. The very lowest ratings correspond to still air, maximum air temperatures, and full sun. A typical static thermal rating of 800 amperes is shown at the left tail of the rating distribution, as is a second less conservative static rating of about 900 amps.

The left-most distributions are line loadings (which vary as a result of varying customer load levels and system configuration changes) appropriate to each of the static ratings. Note that the line loadings approach but do not exceed the static ratings but that for each loading curve the load occasionally exceeds the dynamic rating. This happens more frequently (larger overlap area) for the higher load distribution.

The advantage of using dynamic line ratings is clear from the figure where the line rating is clearly higher than the static rating most of the time. Also, the operator knows when the line rating is low and is able to avoid clearance infringements by reducing line load temporarily. The disadvantage of dynamic thermal ratings centers on the difficulty system operators have in utilizing variable ratings in light of their need to make contract commitments and allow maintenance outages.

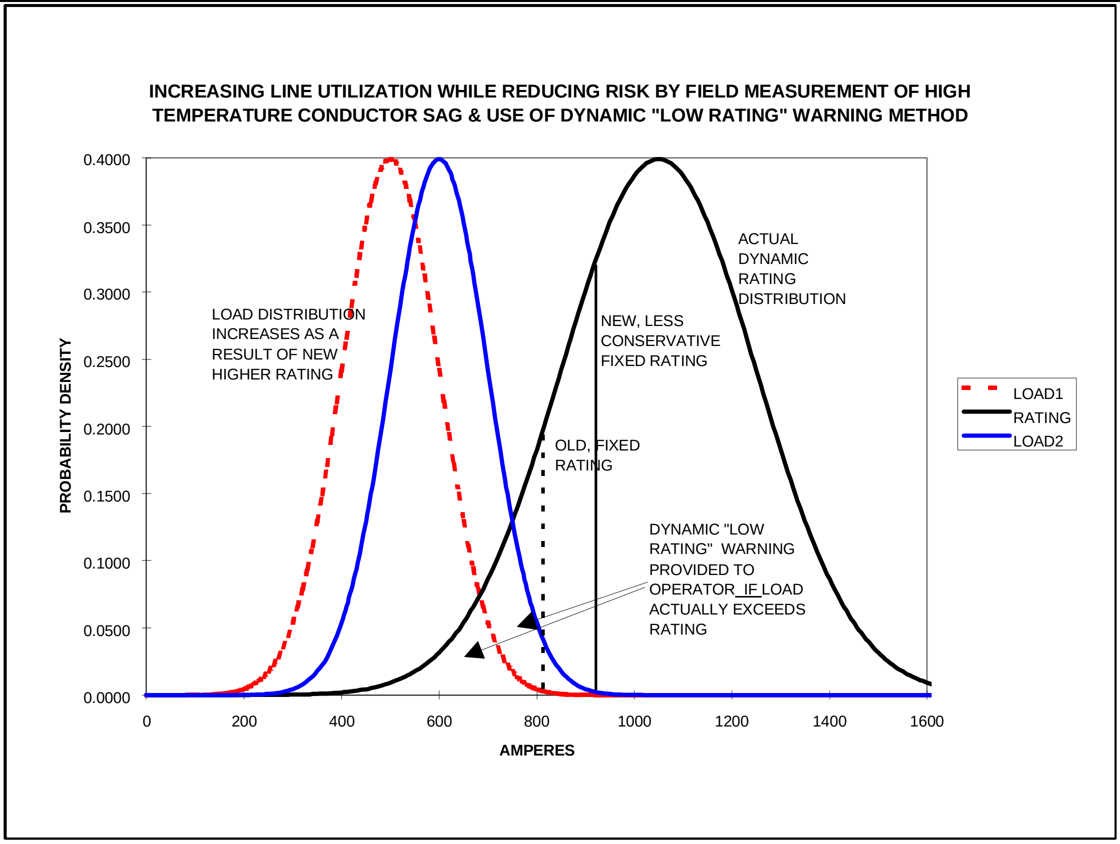

Figure 1 - Illustration of How Dynamic Rating Methods can Be Used to Reduce Risk While Allowing the use of Less Conservative Static Ratings

Note that the use of dynamic ratings eliminates the increase in risk associated with the use of less conservative weather conditions (e.g using 4 ft/sec rather than 2 ft/sec as a rating wind speed). Note also, that the field calibration tests required to validate the dynamic rating method provide a solid basis for physical line modifications avoiding uncertainty there also.