





Study Committee B2

Overhead Lines

11143_2022

Operational Efficiencies and Risks Associated with Static,

Ambient Adjusted, and Dynamic Line Rating Methodologies Kristine ENGEL, Jonathan MARMILLO Mahraz AMINI, Hamid ELVAS, Babak ENAYATI

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Motivation

- Advanced transmission line ratings provide operational efficiencies and enhance grid reliability.
- Understating capacity in transmission-constrained areas can cause market binding events, curtailment, and roadblocks for renewable energy projects.
- Overstating capacity during periods with low or no wind present can put National Electrical Safety Code (NESC) mandated line clearances and conductor health in jeopardy.

Method/Approach

- SLR utilizes a fixed set of assumptions that do not change, or change once per year for a Winter and Summer Rating.
- AAR calculations are based upon a varying ambient temperature and can offer limited extra capacity over SLR. At times AAR will overestimate capacity because the assumed wind speeds are not available.
- DLR takes into account real-time field measurements of weather and conductor position to determine the conductor ampacity.

			Dynamic Line Ratings
Î	Seasonal Static Line Ratings	Ambient Adjusted Ratings	Ambient Temperature Solar Irradiance Effective Wind Speed
	Ambient Temperature Solar Irradiance Effective Wind Speed	Sour mataince Effective Wind Speed	

 To study the operational efficiencies and risks associated with the different types of line ratings, National Grid and LineVision evaluated each rating methodology for the same transmission line.

Objects of Investigation

 The study was conducted on a 115 kV transmission line in Massachusetts owned and operated by National Grid.

Conductor	Emissivity /	Conductor
Type	Absorptivity	MOT
477 (18/1) ACSR Pelican	0.8 / 0.8	100 C (212 F)

Experimental Setup & Test Results

- Ratings are calculated using the IEEE 738 heat balance equation.
- The line was equipped with LineVision V3 noncontact line monitors in July of 2019.
- Static assumptions are outlined below:

Input	Ambient Temp.	Solar Irradiance	Perp. Wind Speed
Static Line Ratings (SLR)	100 F summer 50 F winter	1097 W/m ² summer 644 W/m ² winter	3.0 ft/sec
Ambient Adjusted Ratings (AAR)	dynamic	1097 W/m ² summer 644 W/m ² winter	3.0 ft/sec
Dynamic Line Ratings (DLR)	dynamic	dynamic	dynamic

Advanced line ratings increase capacity by up to 34% over static line ratings.



Static ratings and ambient adjusted ratings may overstate capacity when wind speeds are low.

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Comparison of DLR and SLR



On average, DLR is 34% higher than SLR in summer, and 19% higher than SLR in winter.

 DLR drops below SLR 7% of the time in the summer months and 23% of the time in the winter months.

Jun Jul Aug Sep Month

Comparison of AAR and SLR

 On average, AAR is 15% higher than SLR in summer, and 3% higher than SLR in winter.
AAR always exceeds SLR in the summer months and drops below SLR 22% of the time in the

Jan Feb Har Apr

Month

Comparison of DLR and AAR



winter months.

•	DLR often
	exceeds AAR
	during midday
	hours due to
	the cooling
	effect of wind.

 The few instances of negative percentages indicate that AAR incorrectly indicated additional capacity was available.

Line Ratings

Several line rating methodologies exist in practice across the US grid operators, each utilizing a different approach based on fixed assumptions or variable inputs for the properties that make up the IEEE 738 steady state heat balance equation for line ratings.



Discussion

- SLR relies on fixed assumptions of both wind speed and ambient temperature.
- AAR frequently indicates additional capacity is available during periods of cooler ambient temperatures in the winter months and overnight hours but often overstates available capacity due to a fixed assumption of wind speed.
- DLR provides extra capacity during cooler weather in addition to midday peak demand hours when wind speeds are strong. DLR, as a field sensor-based technology, mitigates the risk of exceeding the conductor maximum operating temperature by utilizing real time measurements of all input parameters.

Summary of Key Findings	Summer	Winter
% of Time AAR is above SLR	100%	78%
% of Time DLR is above SLR	93%	77%
% of Time DLR is above AAR	78%	73%
Avg % Capacity Increase, AAR over SLR	15.1%	2.7%
Avg % Capacity Increase, DLR over SLR	33.8%	19.3%
Avg % Capacity Increase, DLR over AAR	16.3%	16.2%

Conclusion

- Advanced line ratings increase capacity by up to 34% over static line ratings.
- Static ratings and ambient adjusted ratings may overstate capacity when wind speeds are low.

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