UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Managing Line Ratings

COMMENTS OF THE WATT COALITION
March 22, 2021

I. Introduction and summary

The WATT Coalition appreciates the opportunity to comment and heartily supports the direction the Commission is taking in this Notice of Proposed Rulemaking (NOPR) “to improve the accuracy and transparency of transmission line ratings.” Accurate ratings reduce consumer costs and increase reliability. The initiative is important as stated by market monitors, utilities, and regulators:

Potomac Economics, the market monitor for some ISO/RTOs: “this is one of the most important issues before the Commission and one of the best opportunities to make significant improvements to the efficiency of wholesale electricity markets in the U.S.”¹

AEP: “the subject matter and timing could not have been more apropos.”²

Organization of MISO States: “There are a variety of benefits from enhanced line ratings, including those related to: economics, reliability, increased access to resources, mitigation of impacts from outages (scheduled and unscheduled), greater flexibility of the system, deferred uprating of circuits, and lower consumer costs... Customers are harmed when transmission line ratings do not reflect the actual capabilities of the facilities based on changing ambient conditions. This can lead to higher energy prices and increased levels of congestion due to sub-optimal flows on the system.”³

We note that accurate line ratings would only bring electricity transmission up to standard practice across many sectors which have adopted condition monitoring and optimization of assets. That upgrade is long overdue to be applied to electricity transmission. Standard practice in the electric industry presently is to essentially ignore the principal factors affecting how

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much power transmission lines can carry: wind speed, wind direction and ambient temperature at different points in time. Yet these factors are very knowable, as are the actual line sag and other asset conditions, using commercially available and proven technology. Where factors influencing the amount of capacity that is available and in demand by transmission customers are readily knowable, that information should be incorporated into line ratings. Requiring accurate ratings would make rates just and reasonable, and would be a natural extension of Commission Orders 888 and 889 issued 25 years ago requiring transparency and standardization of available transfer capability postings.

In the NOPR the Commission makes a modest advancement over standard Static Line Ratings (SLR) by requiring broad use of Ambient Adjusted Ratings (AAR). AAR incorporates temperature, making line ratings with AAR a better estimate than current practice under most circumstances. We applaud this modest step but do urge the Commission to adopt Dynamic Line Ratings (DLR) where appropriate.

The NOPR’s approach of stopping at AAR without proceeding to requiring DLR where appropriate leaves significant inaccuracies because AAR ignores key factors that affect line capacity. The Commission notes that DLR is not applicable for all lines and we agree. But the same is true for AAR, and the Commission addressed that by allowing exemptions where AAR would not differ from the static rating. The same policy could be applied for DLR. The Commission must address the question: if DLR would materially satisfy transmission customers’ demands over a given line or set of lines, should the Transmission Owner provide that service based on DLR? The NOPR suggests the answer is ‘no.’ We respectfully urge the Commission to change the answer to ‘yes’ and require either AAR or DLR where each may be appropriate. We also suggest that relevant data on constraints that may be conducive to DLR or other Grid-Enhancing Technologies be made available to stakeholders subject to appropriate CEII protections.

II. Who We Are

The WATT Coalition is a group of companies interested in facilitating the adoption of advanced technologies on the US electric transmission system that improve reliability, lower cost, and accelerate decarbonization, benefiting American citizens and businesses. The WATT coalition has seven members and these companies offer technologies including Advanced Power Flow Control, DLR, and Topology Optimization. Our members include Ampacimon, Lindsey Systems, LineVision, NewGrid, WindSim, Heimdall Power, and Smart Wires.

III. Transmission demand is rising dramatically

Resilience and environmental concerns dictate that transmission capacity in the country must expand dramatically. In the Commission’s inquiry into power system resilience, each of the RTOs and ISOs emphasized transmission as their primary source of resilience, more so than generation. For example, ISO-New England stated, “The system’s ability to withstand various
transmission facility and generator contingencies and move power around without dependence on local resources under many operating conditions...results in a grid that is...resilient.”

Studies show that transmission capacity needs to increase 2 to 3 times over today’s delivery capacity to support a bulk power system with low carbon renewable energy, to access the least cost resources, meet utility goals, consumer preferences, and public policy. Yet currently most generation is stuck in lengthy interconnection queues due to limited transmission capacity.

Building new transmission lines and expanding physical capacity is important. But it is difficult, expensive, and takes a long time. Accurate line ratings can increase use of the existing network very quickly and at very low cost.

IV. Accurate line ratings reduce costs to electricity consumers

Accurate line ratings increase the efficiency of the system. Capacity that is in high demand that is not provided to customers is often wasted today in the form of phantom congestion. By artificially withholding actual capacity, higher cost generation is dispatched, and consumers pay more, both in ISO/RTO regions with locational marginal pricing, and in non-RTO/ISO regions where out of merit economic dispatch takes place. As FERC staff’s paper on line ratings stated, “Rating transmission lines more dynamically allows for adjusting line limits of those lines, which have the potential to increase transmission system efficiency; reduce production costs, congestion costs, curtailments, and reserve requirements; and help manage system disturbances.”

Accurate line ratings, particularly DLR, can reduce capital investment costs borne by customers. As FERC staff’s paper noted, “DLRs and AARs can potentially defer capital costs by improving utilization of existing assets. Outreach participants indicated that, because transmission upgrades can be difficult to build, DLRs are an important bridge source of transmission capacity in the interim between the identification of need and project completion. Deferred capital costs can be a benefit of AARs, but to a lesser degree.”

DLR equipment is being considered by a number of select utilities to inform planning decisions and potentially defer major transmission expansion upgrades that may not be cost effective or in their customers’ best interests. An example of this in PJM is shown by the application of DLRs on PPL’s Cumberland-Juniata and Harwood-Susquehanna 230kV lines which are potential

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market efficiency projects with significant congestion expected in 2025 and 2028, as shown in figure 1 below from the Market Efficiency Update at a recent TEAC meeting.9

**Figure 1: 2020-2021 PJM Regional Transmission Expansion Plan Market Efficiency Window**

<table>
<thead>
<tr>
<th>FG#</th>
<th>Constraint</th>
<th>FROM AREA</th>
<th>TO AREA</th>
<th>ME Base Case (Annual Congestion $million)</th>
<th>ME Base Case (Hours Binding)</th>
<th>In Line Conductor Limited?</th>
<th>Conductor Ratings*</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME-1</td>
<td>Kammer North to Natrium 138 kV</td>
<td>AEP</td>
<td>AEP</td>
<td>$2.02</td>
<td>$6.56</td>
<td>2025 Simulated Year</td>
<td>2028 Simulated Year</td>
<td>2025 Simulated Year</td>
</tr>
<tr>
<td>ME-3</td>
<td>Junction to French’s Mill 138 kV</td>
<td>APS</td>
<td>APS</td>
<td>$9.18</td>
<td>$11.97</td>
<td>276</td>
<td>301</td>
<td>No</td>
</tr>
<tr>
<td>ME-4</td>
<td>Yukon to AAE-161 Tap 138 kV</td>
<td>APS</td>
<td>APS</td>
<td>$4.36</td>
<td>$5.16</td>
<td>1742</td>
<td>1158</td>
<td>Yes</td>
</tr>
<tr>
<td>ME-5</td>
<td>Charlottesville to ProFit Rd Del Pk 230 kV</td>
<td>DOM</td>
<td>DOM</td>
<td>$3.76</td>
<td>$4.96</td>
<td>121</td>
<td>134</td>
<td>Yes</td>
</tr>
<tr>
<td>ME-6</td>
<td>Plymouth Meeting to Whitpain 230 kV</td>
<td>PECO</td>
<td>PECO</td>
<td>$3.33</td>
<td>$4.90</td>
<td>111</td>
<td>101</td>
<td>No</td>
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<tr>
<td>ME-7</td>
<td>Cumberland to Juniata 230 kV***</td>
<td>PLGRP</td>
<td>PLGRP</td>
<td>$9.00</td>
<td>$6.61</td>
<td>213</td>
<td>179</td>
<td>Yes</td>
</tr>
<tr>
<td>ME-8</td>
<td>Harwood to Susquehanna 230 kV***</td>
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<td>PLGRP</td>
<td>$14.49</td>
<td>$8.69</td>
<td>830</td>
<td>501</td>
<td>Yes</td>
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</tbody>
</table>

Notes:
* ME-2, ME-9 and ME-10 constraints no longer eligible congestion drivers (updates to the base reduced congestion below the eligibility threshold).
* Conductor ratings provided by TCOs that are limited by station equipment.
* **Conductor ratings provided by TCOs for congestion drivers that are limited by station equipment.
*** Cumberland – Juniata and Harwood – Susquehanna Congestion drivers may be impacted by DLR (Dynamic Link Rating) projects (Expected in-service date 06/01/2021).

Benefits from more accurate line ratings are significant and worth significant policy attention. The market monitor for MISO found benefits equal to approximately 11 percent of real time congestion value across the footprint, or around $150 million per year in 2017 and 2018, just for emergency and ambient adjusted ratings, without even considering dynamic line ratings.10 An analysis of Grid-Enhancing Technologies generally found benefits can be in the hundreds of millions of dollars, “comparable to the scale of some of the operational benefits provided by RTO- or ISO-operated regional power markets, and yet often for a significantly lower cost and quicker installation.”11

The US Department of Energy recently observed, “By forecasting the expected transmission capacity more accurately, a more favorable commitment of generators in day-ahead markets and more efficient dispatch within real-time markets will be possible, thus reducing congestion costs.”12

We agree with the Commission that “transmission line ratings currently based on seasonal or static assumptions may indicate less transmission system transfer capability than the transmission system can actually provide, leading to restricted flows and increased congestion costs.”13

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13 NOPR Par 2.
MISO stated to the Commission that “utilizing a more dynamically generated line rating system can result in additional economic benefits through market efficiencies.”\textsuperscript{14} PJM found in one study that “The line’s DLR was shown to provide significant additional capacity, as compared to its static line rating.”\textsuperscript{15}

V. Accurate ratings improve reliability and resilience

Modifying line ratings based on ambient conditions is not new, and is in fact a routine practice during emergency conditions. For example during the “Bomb Cyclone” in New England in early January 2018, as stated in ISO-NE’s report, “At 16:00 on 1/3/18, the scheduling limit on the NY A.C. ties was increased from 1,400 to 1,600 MW. The increased limit was made possible by the cold conditions which helped to improve thermal transfer capability.”\textsuperscript{16} Changing the ratings based on ambient conditions allowed 200 MW more imports than normal levels from New York to New England, where the power was most needed. We agree with IEEE that more accurate ratings are safer during extreme conditions, improving reliability and resilience.\textsuperscript{17}

Accurately rated lines are more reliable lines. As the Department of Energy found, “DLR can potentially improve reliability by calculating the true thermal limit for those lines and informing relay settings used to protect transmission equipment.”\textsuperscript{18} DOE also noted “Another benefit of installing sensing and monitoring technologies like DLR is an increased situational awareness of the transmission system. Understanding when conditions may exceed constraints is critical in situations where lines may sag below clearances, making the system vulnerable to faults and safety hazards.”\textsuperscript{19} Further, DOE stated, “Generally, methods, tools, and technologies that relax constraints on a system, give it more flexibility, or provide better situational awareness increase the resilience of the system. DLR can support more electric-delivery options during a disruption to mitigate load interruptions and facilitate recovery and restoration after an event.”\textsuperscript{20}

Over-stating capacity resulting from inaccurate ratings can harm reliability. As the Commission stated, “while current line rating practices usually understate transmission capability, they can also overstate transmission capability... overstating transmission capability may risk damage to equipment.”\textsuperscript{21} FERC staff’s paper noted the common phenomenon where transmission line capacity is often over-stated a few percent of the time: “By using actual, real-time inputs, DLRs provide reliability benefits by reflecting the actual current-carrying capabilities of the conductor which may, at times, be less than a static rating would have allowed.” The staff paper showed a

\textsuperscript{14} MISO post-conference comments, AD19-15 p. 2.
\textsuperscript{15} PJM post-conference comments, AD19-15, p. 5.
\textsuperscript{17} IEEE PES post-conference comments, AD19-15, p. 1
\textsuperscript{18} DOE DLR Report to Congress, p. 13.
\textsuperscript{19} DOE DLR Report to Congress, p. 15.
\textsuperscript{21} NOPR Par 42.
typical duration curve, shown in Figure 2 below, where 3 percent of the time, reliability may have been at risk.\textsuperscript{22}

**Figure 2: Indicative Transmission Line Rating Static and Dynamic Line Rating Duration Curve**

The Organization of MISO States recognized that “Enhanced line rating methodologies will increase visibility and situational awareness. Increased transparency and consistency of methods and ratings could also increase reliability.”\textsuperscript{23}

DLR’s resilience benefits were summarized by McCall and Goodwin: “Widespread preemptive installation of DLR can address the problem of determining long term line overload ratings that are necessary when facing the sudden yet long term absence of major assets. DLR can alleviate congestion and other constraints that may appear during recovery. Finally, DLR can provide the added capacity that may be required by lower voltage lines in such events but which would otherwise be difficult to justify economically for normal operation.”\textsuperscript{24}

Changing line ratings due to ambient conditions has been critical during reliability events. In the FERC/NERC review of the South Central cold weather event of January 2018, the report stated: “The RCs were using SOLs based on transmission facility ratings established by the Transmission Owners. For the most part, these ratings reflected the expected ambient conditions (i.e., winter/low ambient temperatures). In general, using SOLs based on the colder temperatures afford more capacity to transfer needed power to locations within the Event Area. For example, Southern Company enabled SeRC to have what it called ‘dynamically rated’ transmission lines, based on the extremely cold weather, which effectively raised the SOLs, allowing more power to reliably flow. Had SeRC used static limits (e.g., year-round/summer limits), it would have


needed to employ significant generation redispatch (detrimentally impacting BA contingency reserves), possible transmission reconfiguration, and/or TLRs.” And “SPP monitored flows on certain facilities in the Event Area using SOLs that were based on average ambient conditions (warmer weather) rather than on the colder weather conditions of January 17. On the morning of January 17, to address the constrained system conditions, SPP operators consulted with their TOP operators to verify these SOLs to aid in determining potential mitigation measures. If the ratings and SOLs had reflected cold weather ambient conditions, SPP may have been able to avoid some of the generation redispatch and transmission reconfiguration measures they took on the morning of January 17.”

These reliability benefits are not only in extreme cases with manual on-the-fly changes, but can be routinely incorporated to provide organized, systematic reliability benefits at any time reliability is in jeopardy for any reason.

VI. DLR is always more accurate than AAR

Wind speed is the most significant factor affecting line capacity, with much greater impact than temperature. DLR takes wind speed and associated conductor cooling impacts into account to better inform operations, while AAR does not. As the DOE 2014 DLR study showed, modest wind speed changes lead to close to 50 percent increase in capacity while temperature changes of over 20 degrees Fahrenheit lead to just over 10 percent change in capacity.

Table 1: Impacts of Changing Operating Conditions on Transmission Line Capacity

<table>
<thead>
<tr>
<th>Operating Conditions</th>
<th>Change in Conditions</th>
<th>Impact on Capacity</th>
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<tbody>
<tr>
<td>Ambient temperature</td>
<td>2 °C decrease</td>
<td>+ 2%</td>
</tr>
<tr>
<td></td>
<td>10 °C decrease</td>
<td>+ 11%</td>
</tr>
<tr>
<td>Solar radiation</td>
<td>Cloud shadowing</td>
<td>+/- a few percent</td>
</tr>
<tr>
<td></td>
<td>Total eclipse</td>
<td>+ 18%</td>
</tr>
<tr>
<td>Wind</td>
<td>3 ft./s increase,</td>
<td>+ 35%</td>
</tr>
<tr>
<td></td>
<td>45° angle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 ft./s increase,</td>
<td>+ 44%</td>
</tr>
<tr>
<td></td>
<td>90° angle</td>
<td></td>
</tr>
</tbody>
</table>

Source: Navigant Consulting, Inc. (Navigant) analysis; data from (7)

Dynamic Line Ratings, adjusting the ratings based on actual conditions such as wind speed, wind direction, and line sag, is a mature and well-tested technology. In Belgium, the


AARs may be more or less accurate than static line ratings depending on the way they are implemented; however, DLRs are always more accurate than AARs. With respect to AAR, the Commission noted, “While such long-term assumptions may be appropriate in various planning contexts, they often do not reflect the true near-term transfer capability of transmission facilities as relevant to the availability of, and arrangement for, point-to-point transmission service. Thus, they fail to reflect the true cost of delivering wholesale energy to transmission customers.”\footnote{NOPR Par 39.} The exact same reasoning could apply to DLR vs AAR. One can simply replace the terms in that statement and it would be equally accurate: “AAR often do not reflect the true near-term transfer capability of transmission facilities as relevant to the availability of, and arrangement for, point-to-point transmission service. Thus, they fail to reflect the true cost of delivering wholesale energy to transmission customers.”

AARs are not necessarily a conservative approach from a reliability perspective. Typically a few percent of the time, the static ratings over-state the safe and reliable amount of capacity that should be provided. AARs also have a similar pitfall as SLRs in that they use the same assumptions around constantly available wind speeds cooling transmission lines which, in many instances, are not correct. Like static line ratings, the assumed wind speed for AAR is typically low but not zero. Wind speed has the highest, non-linear impact on conductor rating when the wind is not available to cool the line, and AAR does not account for this decrease in the true line rating. A recent study evaluated AAR and DLR for a 345kV line in the Midwest equipped with line monitoring sensors. The heatmap below in Table 2 illustrates the percentage of time when the AAR approach incorrectly and unsafely would have provided additional capacity above the field sensor verified DLR value. Since AAR assumes a fixed wind speed is cooling the line even when it is not, it often incorrectly indicated extra capacity, putting reliability and safety at risk, especially during the overnight hours when wind speeds are typically lowest in the region. AAR, and the static rating approach, ignores the variation of the most influential component in a line rating: wind speed.
Table 2: Percentage of Time the Line’s DLR Verified Rating was Below the Value Indicated by AAR\textsuperscript{29}

<table>
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<tr>
<th>Hour</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
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<td>0</td>
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<td>29%</td>
<td>15%</td>
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<td>12%</td>
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<td>1</td>
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<td>42%</td>
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<td>25%</td>
<td>18%</td>
<td>4%</td>
<td>17%</td>
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VII. The Commission has jurisdiction and responsibility to ensure accurate line ratings

We agree with the Commission’s preliminary finding “that transmission line ratings and the rules by which they are established are practices that directly affect the cost of wholesale energy, capacity and ancillary services, as well as the cost of delivering wholesale energy to transmission customers. Because of those relationships, inaccurate transmission line ratings may result in Commission-jurisdictional rates that are unjust and unreasonable.”\textsuperscript{30} The

\textsuperscript{29} Unpublished study for a utility in SPP, reported here: https://watt-transmission.org/2021/02/22/its-time-to-use-accurate-line-ratings/

\textsuperscript{30} NOPR Pars 1, 38.
Commission has legal jurisdiction over practices that directly affect the cost of wholesale energy, capacity, and ancillary services, such as transmission line ratings.

While some parties claimed in the line ratings inquiry docket (AD19-15) that line ratings are fundamentally a reliability issue and current NERC standards and oversight are adequate, many others note that FERC has not only reliability authority but separate authority and responsibility to make sure transmission service is just, reasonable, and not unduly discriminatory. As TAPS suggests, “this effort is part of its economic regulation—ensuring non-discriminatory open access transmission service pursuant to Federal Power Act (“FPA”) Sections 205 and 206.” 31 It is important for the Commission to ensure accurate ratings for its economic regulatory responsibilities, just as it was for the Commission to require ATC to be accurately calculated and posted in Orders 888 and 889 in the mid-1990s.

**VIII. Responses to specific issues**

**A. Whether and in what instances to require DLR**

The Commission declined to require DLR be used by any TO in any instance. It did put DLR on the table and within the scope of this rulemaking as something the Commission could require. The Commission included many comments about DLR and stated, “we seek comment on whether to require transmission providers to implement DLRs across their systems or on certain transmission lines that have the most to benefit from a dynamic rating.” 32 So the issue is in scope and any DLR requirement would be a logical outgrowth of the NOPR, such that due process requirements would be met.

We recommend that transmission owners be required, for each line that has or is forecast to become congested, to be assessed for the applicability of DLR and implement DLR if certain criteria are met. Specifically, the following minimum criteria could be used to determine when DLR should be required:

**Sensor-Based DLR required on thermally limited lines/circuits >= 69 kV when:**

- Market congestion totaling over $1 million has occurred within the past 1 years, OR
- The line is identified as being a constraint projected to have market congestion over $1 million over the coming three years as a part of the current ISO/RTO transmission planning cycle process, which can be economic or reliability based. OR
- Thermally limited lines show up as limiting in generator interconnection system impact studies. OR
- Generation curtailed by more than 10% on average for 1 year due to factors that include line capacity.

When a line/circuit meets the above criteria, DLR sensors must be installed within a one-year time period and implemented into operations within 6 months after the installation. If equipment other than the conductor is the limiting factor, the transmission provider must

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32 NOPR Par 100.
provide information about the limiting elements, the costs to upgrade, and the amount of capacity that could be made available.

We agree with the industrial customers comments in AD19-15 that RTOs/ISOs study the benefits and effectiveness of DLR on the most congested, thermally limited lines.

The Commission declined to require DLR in any instance in part because of concerns regarding risks and challenges. The Commission stated, “Relative to AARs, these additional costs and challenges include placing sensors in remote locations, ensuring the cyber security of sensors, and various additional costs.” However the concern about challenges exceeding benefits can easily be addressed the same way the Commission addressed the issue for AAR. With respect to AARs, the Commission stated, “our proposed pro forma OATT language provides that where the transmission provider determines that the rating of a transmission line is not affected by ambient air temperature, the transmission provider may use a transmission line rating for that line that is not an AAR or seasonal line rating.” Similarly, the Commission could rule that where the transmission provider determines through studies properly reported that the rating of a transmission line is not thermally limited (i.e., limited by other equipment), the transmission provider may use a rating for that line that is not a DLR. That approach would address any concern with costs exceeding benefit in some situations.

The Commission stated that DLR may not have reliability benefits relative to AAR because “We note that the “safety margin” cited by commenters is not dependable—it exists only during periods where the ambient air temperature happens to be lower than the temperature assumed when the static or seasonal line rating was calculated... With respect to assumptions about ambient conditions, under our proposal, transmission owners have latitude, consistent with good utility practice, to develop assumptions about ambient conditions that result in transmission line ratings that reflect what transmission flows the system can safely and reliably accommodate.” We think the Commission erred in this finding and contradicts its own statements above about the role of DLR in past reliability events.

We note that while it is true Transmission Owners have latitude to make judgments, if they are making judgments without readily available information on lines where capacity is influenced by ambient conditions, those are not likely good judgments.

The Commission raised cost and complexity concerns with DLR: “The additional data and communications required under DLR approaches increase implementation costs and system complexity. DLR implementation requires the strategic deployment and maintenance of sensors... Moreover, DLRs can require additional training or knowledge for some transmission providers or transmission owner personnel.” That concern is addressed by requiring DLR only where conditions are warranted. Costs would be incurred only where consumers benefit. Furthermore, studies have shown that the payback period associated with DLR systems are extremely fast, one PJM authored CIGRE Grid of the Future paper showed an analysis that

33 NOPR Par 100.
34 NOPR Par 103.
35 NOPR Par 27.
projected the payback period of an operationalized DLR system would be as rapid as two months.\textsuperscript{36}

The Commission raised cybersecurity concerns: “By increasing the amounts of transmission line rating data and by introducing additional communication nodes inside a transmission owner network, DLRs introduce additional physical and cyber security risks.”\textsuperscript{37} We disagree. DLR only provides operators with more information. The Commission could clarify that operators may always default to a static rating if there is a lapse or suspected corruption of the information being sent. Obtaining information on line sag or wind provides attackers no ability to disrupt a system. Moreover, the communications channel used by DLR systems provides an extra, alternative source of information to operators that is in addition to their existing channels, thus decreasing their dependence on their existing systems which can also fail or be hacked. Like all electronic systems, DLR equipment can and should be physically and cyber protected to safeguard the accuracy of the measurements of actual conditions.

We recommend that DLRs or other congestion mitigation technologies should be made available at a customer’s request. Very often transmission customers know what constraints are leading to curtailment or congestion. They should be able to request a utility implement DLR to alleviate a known constraint, especially if they are willing to pay for the change. Allowing for this will increase the speed of the generator interconnection process where line upgrades may be identified as being needed but are prohibitive in terms of cost and construction timelines.

\textit{B. Requiring use of AARs for short term transmission service}

The Commission proposed “to require transmission providers to use AARs as the relevant transmission line ratings when (1) evaluating requests for near-term point-to-point transmission service, (2) responding to requests for information on the availability of potential near-term point-to-point transmission service (including requests for ATC or other information related to potential service), and (3) posting ATC or other information related to near-term point-to-point transmission service to the their OASIS site.”\textsuperscript{38}

We support this proposal for use of AAR. We also recommend that DLR be used in lieu of AAR in this same way.

\textit{C. Requiring use of seasonal ratings for long term transmission service}

The Commission’s proposal provides, “For other (longer-term) point-to-point transmission service requests, we propose to require transmission providers to use seasonal line ratings as the relevant transmission line ratings when (1) evaluating requests for such service, (2) responding to requests for information on the availability of such service (including requests for

\textsuperscript{37} NOPR Par 27.
\textsuperscript{38} NOPR Par 87.
ATC or other information related to such potential service), and (3) posting ATC or other information related to such service to their OASIS site.\textsuperscript{39}

We support the use of AARs in this way. We also recommend that DLR be used in lieu of AAR in this same way.

\textbf{D. Requiring AAR for curtailment}

The Commission stated, “We also propose to require that transmission providers use AARs as the relevant transmission line ratings when determining whether to curtail or interrupt point-to-point transmission service.”\textsuperscript{40}

We support the use of AARs in this way. We also recommend that DLR be used in this same way, where appropriate.

\textbf{E. Whether to require emergency ratings}

The Commission stated, “we seek comment on whether to require transmission providers to implement unique emergency ratings that would be used during post-contingency operations.”

We support this proposal.

\textbf{F. Whether to prioritize implementation on historically congested lines}

In its consideration of implementation timing, the Commission proposed to “prioritize implementation on historically congested lines.”

We support this prioritization because it will benefit customers in the relative near term. While history may be a good basis for projecting future congestion, it may not be appropriate given planned transmission upgrades, resource changes, etc. As a result, due consideration needs to be given to extrapolating historical constraints and congestions patterns into the future.

\textbf{G. Requiring RTOs to accommodate DLR}

The Commission made one change in support of DLR which is its proposal “to require RTOs/ISOs to establish and implement the systems and procedures necessary to allow transmission owners to electronically update transmission line ratings on at least an hourly basis.”\textsuperscript{41}

We support this proposal, as it will create the opportunity for DLR to be used in all RTO/ISO regions.

\textbf{H. Transparency and requiring methodologies to be provided}

The Commission stated, “We preliminarily find that the current level of transparency into transmission line ratings and transmission line rating methodologies may result in unjust and

\textsuperscript{39} NOPR Par 88
\textsuperscript{40} NOPR Par 89.
\textsuperscript{41} NOPR Par 5.
The Commission further stated, “we propose to require transmission owners to share transmission line ratings and methodologies with their transmission provider(s) and, in regions served by an RTO/ISO, also with the market monitor(s) of that RTO/ISO. We also seek comment on whether transmission line ratings and transmission line rating methodologies should be shared with other transmission providers, upon request.”

The Commission stated, “We also seek comment on whether to require transmission owners to make their transmission line ratings and rating methodologies available to other interested stakeholders, including posting information on their OASIS pages or other password protected online forum.”

We believe line ratings methodologies need to be shared with transmission customers. As ELCON notes, “most of those methodologies are non-public, not accessible, and do not make it easy for customers and Market Participants to replicate the calculations and assumptions used by the Transmission Owners to arrive at a particular facility rating value.” Similarly DTE points out that “the monopoly of information that transmission owners currently possess is one of the primary reasons for the claim that they are in the best position to determine where AARs make sense. Requiring transmission owners to provide their ISO/RTOs with limiting element information to inform planning decisions and stakeholder reviews (subject to appropriate CEII protections) would allow a more transparent planning process and potentially enable more cost-effective solutions to real-time or day-ahead economic congestion issues to be identified and implemented.”

DTE also “found that the current process lacks uniformity and has limited oversight thus failing to provide safeguards for customer affordability.”

FERC staff paper noted the lack of transparency: “Staff notes that NERC reliability standard FAC-008-3 R8 requires transmission owners to make their transmission rating methodologies available upon request, but such requests can only be made by reliability coordinators, planning coordinators, transmission Planners, Transmission Owners and Transmission Operators. However, such requests ensure that the transmission line rating methodologies remain non-public. Moreover, on June 7, 2019, FAC-008-3’s R8 was proposed to be removed in Docket No. RM19-7-000. This would remove the possibility of even non-public requests for transmission line rating methodologies.”

For customers to know they are receiving just and reasonable service, and to know specifically whether DLR or other rating methodology changes would improve their service, methodologies need to be made available to all transmission stakeholders (subject to appropriate CEII protections).

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42 NOPR Par 47.
43 NOPR Par 7, 125.
44 NOPR Par 129.
45 ELCON post-conference comments, p. 19.
46 DTE post-conference comments, p. 4.
47 DTE post-conference comments, p. 6.
48 FERC staff paper, p. 28.
I. Accurate line rating comments should apply broadly

The Commission stated “We propose to apply the proposed requirements for AARs and seasonal line ratings to all transmission lines, rather than targeting only congested transmission lines.”

While some parties argue that line ratings requirements should apply only to certain congested facilities, we agree with MISO that any transmission facility could become the next most limiting element as the system changes, and that therefore AARs should be applied to any facility where temperature is a determining factor.

J. Using seasonal ratings for network service

The Commission proposed, “For network transmission service, we propose to require transmission providers to evaluate requests to designate network resources (under section 30 of the pro forma OATT) or network load (under section 1 of the pro forma OATT) based on seasonal line ratings.”

We agree with this proposal.

K. Application to day-ahead markets

The Commission proposes to apply AAR to day-ahead as well as real-time markets. The Commission stated “we observe that day-ahead markets already rely upon forecasts for weather to inform next-day load and intermittent generation availability. Instead, we agree with PJM that temperatures can be forecast within a reasonable degree of certainty.”

We agree and note that the same applies to DLR. Both temperature and wind speed impacts to conductors can be measured, as well as be predicted and applied with appropriate incorporation of uncertainty to DLR just as with AAR. Forecasting of line ratings should be no different than forecasting of generation and load, which have been done for decades. In each case, appropriate use of statistical probability and conservatism can be applied.

L. Requirements for transmission providers outside RTOs

In paragraph 82 of the NOPR, the Commission stated, “we propose to require all RTOs/ISOs to implement the systems and procedures necessary to allow transmission owners to electronically update transmission line ratings at least hourly. We also seek comment on whether to apply this requirement to transmission providers located outside of RTO/ISO markets.”

We think the same requirements should apply outside RTOs as they do inside. We note the concerns of utilities considering voluntary RTO membership that regulatory requirements are stiffer inside than outside RTOs which serves as a disincentive to RTO participation.

49 NOPR Par 92.
50 MISO conference comments, AD19-15, p. 2-3
51 NOPR Par 90.
52 NOPR Par 102.
M. Overlap with incentives

The Commission did not raise incentives in this docket and the topic is being addressed in another FERC docket (RM20-10). We agree with ELCON that the “Commission should explore ways to increase a Transmission Owner’s incentive to employ DLRs, given that the Transmission Owner may not have any financial incentive or return for its efforts to improve operational efficiency.”\textsuperscript{53}

Unlike unregulated sectors, there is no profit waiting for whoever succeeds in providing more service, unless the regulator makes it so. The Commission proposed a set of unworkable incentives for Grid-Enhancing Technologies, based on Return on Equity, in RM20-10.\textsuperscript{54} We propose implementing the requirements, as detailed in our comments to the Line Ratings NOPR but we also urge the Commission to address the current misalignment of incentives separately. It is essential that the Commission also move towards a competitive shared savings approach for incentivizing Grid Enhancing Technologies as proposed by the WATT Coalition.

N. There is no increased liability from accurate line ratings

We note some TOs expressed concern in AD19-15 about litigation over facility ratings if they become more accurate. We do not see how increasing accuracy increases litigation risk. DLR, which provides feedback on line performance regardless of how the line is operated, should decrease litigation risk as TOs will have demonstrable information on line clearances and thermal performance. Poor ratings where the TO fails to monitor and adjust ratings appropriately or keep up with industry best practice should be more vulnerable to litigation. As long as TOs post their methodology, follow the posted method, and are subject to audit by an independent entity, there should be no greater litigation risk than today.

O. Accurate line ratings should be used in planning as well as operations

Using an AAR or DLR would be very difficult in the long-term planning process as utilities don’t increase firm-fixed capacity. However, with AAR or DLR systems installed, utilities will collect valuable data that could inform key parameters.

Data from DLR sensors and monitors is very valuable and can be used to help inform key parameters for refined seasonal static ratings for long term planning purposes. In addition, data and algorithms are available as a result of DLR installations that can be used to better inform end-of-life decisions regarding equipment. The asset management value of data regarding equipment condition can be extremely important in prioritizing equipment replacement and rebuild decisions.

P. Accurate line ratings should be used in the interconnection process

As one aspect of the planning process described above, accurate line ratings can and should be used by transmission providers when they are assessing network upgrade cost assignments for

\textsuperscript{53} ELCON post-conference comments, p. 16.
interconnection customers. For example, wind plant output should be expected to correlate highly with wind cooling transmission lines, leading to a need for fewer physical upgrades. Additional capacity will be made available on the existing infrastructure from the DLR. Such factors can be estimated, with appropriate conservatism, in interconnection studies. The cost of DLR systems can be included in cost assignments to customers.

IX. Conclusion

We appreciate the Commission moving in the direction of more accurate line ratings. We support the progress proposed, but recommend that the Commission go further and require the use of DLR where appropriate.

Respectfully submitted,

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I was asked by the WATT Coalition to review the comments made about DLR in the Commission’s proceeding Managing Transmission Line Ratings Technical Conference (AD19-15). I provide each comment that I found in that docket and my response to each one below.

Comments of Francisco Velez on behalf of Virginia Electric and Power Company

- “The operational experiences at Dominion Energy Virginia system operator planning and operation procedures have shown its transmission system is more frequently voltage constrained than thermally constrained in real-time operations and the benefits of having Dynamic Line Ratings might not materialize in real-time operations.”
  - Response: We agree, DLR helps increase capacity on thermally limited lines. It can help with situational awareness on voltage-constrained lines.

- “...a DLR system might introduce uncertainty to operations due to unforeseeable weather conditions and terrain discrepancies. As an example, Dominion Energy Virginia operates a 500 kV line that has an elevation difference of 2500 feet along its 65 mile long distance.”
  - Response: The placement of monitoring stations can account for each location’s weather conditions and terrain. The conservative SLR is always available to be used at any time when uncertain weather raises any question about local conditions or if relevant information is not available.

- “...the opportunity to realize increased line facility capacity through the use of higher ambient wind speeds may be limited by substation terminal equipment.”
  - Response: Line ratings take substation terminal equipment into account consistent with FAC-008 requirements.

- “...the line and terminal equipment that comprise a line facility including line switches, line leads, wave traps, substation conductors, and underground line segments have different thermal characteristics than a line conductor which may make full DLR implementation difficult to achieve.”
  - Response: Line and terminal equipment are taken into account with any line rating, whether it is SLR, AAR, or DLR.

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Speaker comments of Chad Thompson – ERCOT Senior Manager of Operations Support

- “...when a dynamically rated line is upgraded, the TSP may fail to update the rating information in the network model or in the TSP’s ICCP telemetry for the line. So long as the telemetered value’s data quality is good, and no model change is requested, there is no indication to ERCOT that the rating is no longer correct. When these discrepancies are discovered, ERCOT quickly works with the TSP to correct the model, but significant congestion may have occurred on this line in real-time.”
  - *Response:* System operators need to change line ratings when lines are upgraded or any other change occurs. Failure of a TSO to notify their ISO/RTO of changes in facility ratings, whether higher or lower, is unacceptable and could result in a breach of system reliability.

- “Another issue is related to lines that have joint- or co-ownership. For their own reasons, a TSP may rate its portion of a line different from the other TSP that owns that same line. ERCOT uses the most conservative of the ratings that are provided, and this has caused some confusion among ERCOT market participants in the past with regards to which rating is correct.”
  - *Response:* Joint owners need to agree on a rating or use a conservative rating, whether using SLR, AAR, or DLR as defined by the subsequent ruling in this NOPR.

Comments of National Grid

- “Cyber Security: Not all DLR vendors have their equipment certified to meet utilities’ digital risk and security requirements and so integration to Energy Management Systems (“EMS”) may require additional time and resources. Compliance with NERC Critical Infrastructure Protection (“CIP”) standards for line and tower-based devices communicating with bulk power system substation remote terminal units (“RTUs”) can also pose challenges.”
  - *Response:* DLR vendors can comply with any risk and security requirements.

- “DLR forecast data calibration may take a few weeks after the installation as the vendors utilize neural network for their forecast models. Risks or issues associated with the real-time variability of ratings due to changing environmental conditions (irradiance, wind speed, etc.).”
  - *Response:* DLR can be conservatively and gradually implemented as data are collected and assessments are refined.

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Comments of Carlos Casablanca – Director of Advanced Transmission Studies and Technology, AEP

- “We believe that neither Ambient Adjusted Ratings nor Dynamic Line Rating technology should be considered as permanent solutions to address any thermal constraints identified in long-term Transmission Planning reliability assessments, as these long-term Transmission Planning assessments are meant to be deterministic and conservative, and assume system peak load conditions that coincide with higher ambient temperatures.”
  - Response: DLR is mainly an operational practice and not a replacement when a new line is needed.

Opening Statement of Michael Kormos – Senior VP Transmission & Compliance, Exelon

- “…moving to dynamic line ratings may not provide much additional benefit, especially given the costs of the equipment necessary to implement it. And incurring costs to implement dynamic line ratings on a widespread basis could displace needed transmission investments (and operational and maintenance resources) that could otherwise be utilized to enhance the reliability and resilience of the transmission system in other important ways.”
  - Response: DLR need not be applied everywhere. We provide criteria in our comments where they should apply.
- “…any additional benefits that a widespread mandate to adopt dynamic line ratings might provide above the benefits achieved through ambient-adjusted facility ratings are limited by the nature of system operations – dispatchers can only move generation so rapidly in response to changing line ratings.”
  - Response: In many systems including PJM, the system is redispatched every five minutes and hundreds of resources across many states respond to the dispatch signals.

Post-Technical Conference Comments of MISO

- “MISO is... capable of receiving a real time ARR/DLR rating via ICCP that is calculated by the Transmission Operator. Although this capability is not universally utilized by Transmission Operators in the MISO region, expanded use could stress current system abilities. Scalability is a concern with greater use of ICCP and/or expanded lookup tables.”
  - Response: A vague concern is not evidence of a lack of MISO’s capability to process information.

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MISO’s dispatch operations is only capable of utilizing a single rating for a transmission constraint for each five minute solution. However, this single rating can change from solution to solution as necessary for an AAR/DLR rating. ARRs only require an ambient temperature measurement which are more readily available, whereas DLRs require additional information (e.g. wind speed, cloud cover) that likely does not currently exist and the capability to utilize this data to determine a more complicated DLR rating may not exist either.67

Response: SLR is always available as a conservative option. But we are confident MISO and other RTOs can figure out how to take advantage of ever-expanding computing power to process DLRs.

Post-Technical Conference Comments of EEI

...neither [AAR/DLR] should be considered when engaging in long-term planning or interconnection processes because weather-condition uncertainty will not ensure increased transmission capability from AARs/DLRs with sufficient certainty to support planning decisions.68

Response: In long term planning, appropriate assumptions can be made about each season. We note that many reliability challenges in recent years have been during cold snaps with limited transmission availability. In planning scenarios of such situations, typical temperatures and wind speeds can be taken into account to inform mitigation decisions as well as measures to ensure system security and resilience.

Some DLR vendors utilize cloud-based analytics, which may not meet cyber security standards.69

Response: DLR vendors are able to meet cyber security standards. In fact, the alternative stream of information can provide system operators with a valuable alternative source to their existing systems, making the information quality more robust overall.

The transmission line conductor itself may not be the most limiting component affecting a transmission line rating; rather, another piece of equipment may be the limiting component, reducing the value of implementing AAR/DLR.70

Response: Any limiting component is taken into account in setting line ratings.

The limitation factor on a particular line may not be thermal, but may instead be another factor—such as voltage or stability—making the application of AAR/DLR of little to no value.71

Response: DLR is not needed on every line. When a line is thermally limited and occasionally congested, DLR has the most value.

• “In some cases, the installation would take place in remote, difficult to access areas, where communications networks may be lacking or otherwise inadequate to support this technology. In addition, the introduction of new communications devices gives rise to additional cyber security concerns.”  
  
  o *Response*: Adding another source of information does not increase cyber security threats. SLR is always available as a backup if for whatever reason the system fails.

• “…DLR does not take into account changes in transmission rights-of-way conditions that may impact ratings that are not sufficiently conservative.”  
  
  o *Response*: Monitoring station placements can account for different weather and system conditions at different points along lines. The exercise of determining what lines are candidates for DLR should help utilities address risks associated with system conditions that exist, but may be unknown given current practices.

Post Technical Conference Comments of Exelon

• “DLRs do not provide value in terms of increased system utilization where a transmission facility is not congested. Also similar to AARs, DLRs will not increase transmission system utilization where the limit is not thermal or where the limiting element is not sensitive to ambient conditions.”  
  
  o *Response*: DLR provides the most value on thermally limited lines that are congested. In other cases they help with system awareness. The benefits may not exceed the costs in all cases.

• “Even where a transmission facility’s limit is thermal and the limiting element is the conductor, DLRs may be ineffective if there are different ambient conditions at different points on the transmission line.”  
  
  o *Response*: DLR can take account of different conditions at different points. Analysis of the benefits of a particular DLR application can also take such factors into account.

• “The benefits of DLR implementation will also be limited where the ambient conditions that increase a transmission line rating are not sustained or do not occur simultaneously with periods of significant congestion on the line.”  
  
  o *Response*: Benefits assessments of any particular DLR application can account for the timing of congestion and ambient conditions that may increase a line’s capacity. For example, if congestion occurs on hot still summer afternoons (which is very uncommon), then DLR’s benefits would show up as relatively low.

• “…the costs associated with implementing DLRs are far higher than those associated with implementing AARs…while the costs of deploying DLR-enabling technologies may

be lower than the cost of developing new infrastructure, implementing DLRs will not, in
the vast majority of cases, provide a level of benefits anywhere near as high as the
benefits that new transmission infrastructure provides.” 77
  o Response: New lines can provide many benefits and when they are needed and
can clear all of the many hurdles to their development, they should be
developed.

Post-Technical Conference Comments of ITC

• “...while the use of AAR and DLR appears intended to “free up transmission capacity,”
there can be limiting elements (voltage limits, stability limits, current transformers,
switches, etc.) other than the transmission line conductor and for which deployment of
AAR and DLR provide no benefit.”78
  o Response: Appropriate line ratings must take limiting elements into account.

Post-Technical Conference Comments of NRECA

• “It can be expensive to implement AARs or DLRs on a long transmission line, since
ambient conditions (wind, temperature, precipitation, solar irradiation) will vary by
location... An across-the-board requirement for transmission owners to use AARs or
DLRs likely would increase transmission costs disproportionately for rural consumers.”79
  o Response: Wholesale power customers would benefit from many deployments
of DLR. To say they would not benefit from every possible deployment or a
requirement to use them everywhere is not the point.

Post-Technical Conference Comments of Dominion Energy Services

• “Dominion Energy Virginia believes DLR devices may very likely introduce more
uncertainties to the accuracy of the line rating values as weather conditions such as
wind speed and solar irradiance change on a minute to minute basis. While solar
irradiance intensity might be a good addition to the calculation of any required AARs,
wind forecast without local sensors might be too variant to be considered.”80
  o Response: The point of monitoring actual conditions is to track and accurately
capture these changing conditions into appropriate line ratings.
• “DLRs must be calibrated and benchmarked just like any other field device to ensure the
ratings produced are accurate. Short of that, the use of DLRs could be a threat to system
reliability and also be counterproductive.”81
  o Response: DLRs are calibrated and benchmarked just like any other field device.

• “The cyber assets used to establish AAR assumptions and the cyber assets associated with DLRs represent a new cyber security threat vector. An attacker could compromise these cyber assets and input false values.”
  
  o Response: There is no increased cyber risk with DLR because the operator can always revert to the SLR if there is any issue. DLR systems provide an alternative communications system and increase situational awareness to help operators better understand system conditions.

Post-Technical Conference Comments of the MISO Transmission Owners

• “...there is an inherent inaccuracy in any line rating based on ambient weather and other conditions, such as survey and modeling inaccuracy, and the elongation of the conductors due to everyday tensions that the conductor experiences over a period of time (i.e., conductor creep). One of the major concerns about requiring the expanded use of AARs and DLRs is the potential for liability if a market participant does not agree with the outcome of a specific rating or decides to “second-guess” a transmission owner’s line ratings.”
  
  o Response: Line ratings, whether SLR, AAR, or DLR, are subject to equal regulatory oversight and Commission jurisdiction. If a conductor has elongated beyond its designed post-creep specification and the utility is not aware of this, the conductor’s sag/clearance could be in violation of safety limits and line monitoring from DLR would highlight this safety concern allowing the utility to remediate the issue.

• “Implementing AARs and DLRs would involve installing sensors at disparate and possible numerous locations on a transmission owner’s transmission system, some of which may be extremely remote. It would be difficult to ensure the security of such assets, from both physical and cyber-attacks.”
  
  o Response: SLR is always an option to which operators can revert if there is any loss of signal from any monitoring system.

Post-Technical Conference Comments of PJM

• “DLRs are not easily adaptable to reliable forecasting outside of real time determinations.”
  
  o Response: Transmission line forecasting can be done with any probability level operators may choose. PJM performs highly accurate wind generation forecasting on a daily basis and the same practices are able to be applied to line ratings.