



System Review Subcommittee

FERC Order 881
Education Moment

May 2023

Tracy Rolstad
SRS Chair

Managing Transmission Line Ratings

- FERC 881
 - Managing Transmission Line Ratings
 - [E-1-RM20-16-000 | Federal Energy Regulatory Commission \(ferc.gov\)](#)
- FERC 881-A
 - Order Addressing Arguments Raised on Rehearing and Clarification
 - [eLibrary | File List \(ferc.gov\)](#)
- Federal Registry
 - [2020-26107.pdf \(govinfo.gov\)](#)
- **READ THESE!**
 - Learn how FERC writes...
 - Discussion is IN the order(s)

FERC 881 Summary (a quote)

- The Federal Energy Regulatory Commission (Commission) is revising both:
 - the pro forma Open Access Transmission Tariff
 - and the Commission's regulations under the Federal Power Act to improve the accuracy and transparency of electric transmission line ratings.
 - Note the invocation of the "Commission's regulations under the [FPA]"
 - The FPA is a powerful regulatory instrument that is, practically speaking, inescapable
 - 10 June 1920 with multiple amendments by the Congress (that is to say, The People)
 - See page 21 of Order 881 where FERC declares basis of its authority

FERC 881 Unpacked (AAR cherry picked)

- Read the thing to appreciate its discussion and depth...
- However, the easy “Cliff’s Notes” would be Attachment M of the OATT
 - The Transmission Provider will implement **Ambient-Adjusted Ratings** and Seasonal Line Ratings
 - “Transmission Line Rating” means the maximum transfer capability of a transmission line
 - Ambient-Adjusted Ratings:
 - Time not greater than 1 hour
 - Up-to-date forecast of ambient temperature
 - Calculated at least each hour, if not more
 - Accommodates solar irradiance or lack thereof
 - Plus/minus 10 F from highest/lowest historical temperatures
 - Ratings for every 5 F

Ambient Adjusted Rating

An ambient-adjusted rating (AAR) is a transmission line rating that:

- 1) Applies to a period of not greater than one hour;
- 2) Reflects an up-to-date forecast of ambient air temperature across the period to which the rating applies;
- 3) **Reflects the absence of solar heating during nighttime periods** where the local sunrise/sunset times used to determine daytime and nighttime are updated at least monthly, if not more frequently; and
- 4) Is calculated at least each hour, if not more frequently.

FERC Clarifies in its Orders!

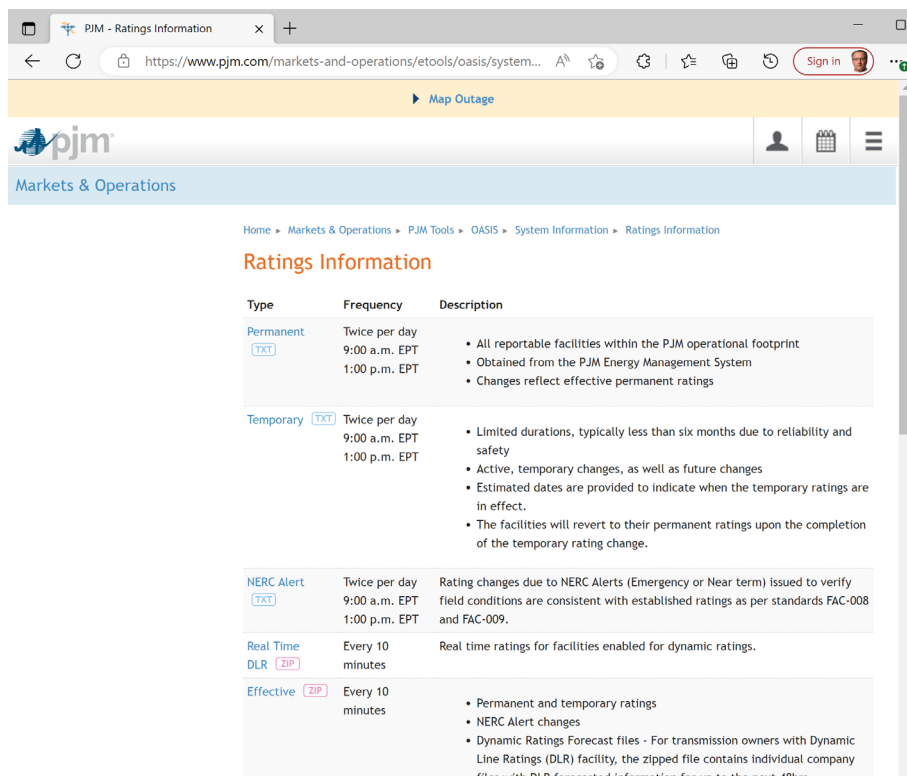
- **YOU MUST READ THESE ORDERS IN DETAIL!**
 - [...] we clarify that a transmission provider must implement AARs that update at least with every five degree Fahrenheit increment of temperature change...
 - [...] we clarify that any methods for determining AARs must be valid for at least the range of local historical temperatures (over the entire period for which records are available) plus or minus a margin of 10 degrees Fahrenheit...
 - For example, if the historical range is -30 degrees Fahrenheit to 107 degrees Fahrenheit, the valid range must be at least -40 degrees Fahrenheit to 117 degrees Fahrenheit.

FERC 881 Unpacked (Seasonal Ratings)

- Attachment M of the OATT
 - The Transmission Provider will implement...**Seasonal Line Ratings**
 - “Transmission Line Rating” means the maximum transfer capability of a transmission line
 - Seasonal Line Rating:
 - Applies to a specified season (to not include more than three months in a season)
 - Up-to-date forecast of ambient temperature over the season
 - Might be interpreted to adopt the plus/minus 10 F requirement of AAR
 - Calculated at least monthly, if not more
 - There is much room for debate as to how the order on AARs might influence Seasonal Line Ratings
 - Solar irradiance, peak historical temperatures (+/-10 F), etc.

FERC 881 Unpacked (Database via OASIS)

- Attachment M of the OATT
 - The Transmission Provider will implement...Database of Ratings



The screenshot shows a web browser window displaying the PJM Ratings Information page. The page title is "Ratings Information" and it is part of the "Markets & Operations" section. The page contains a table with the following data:

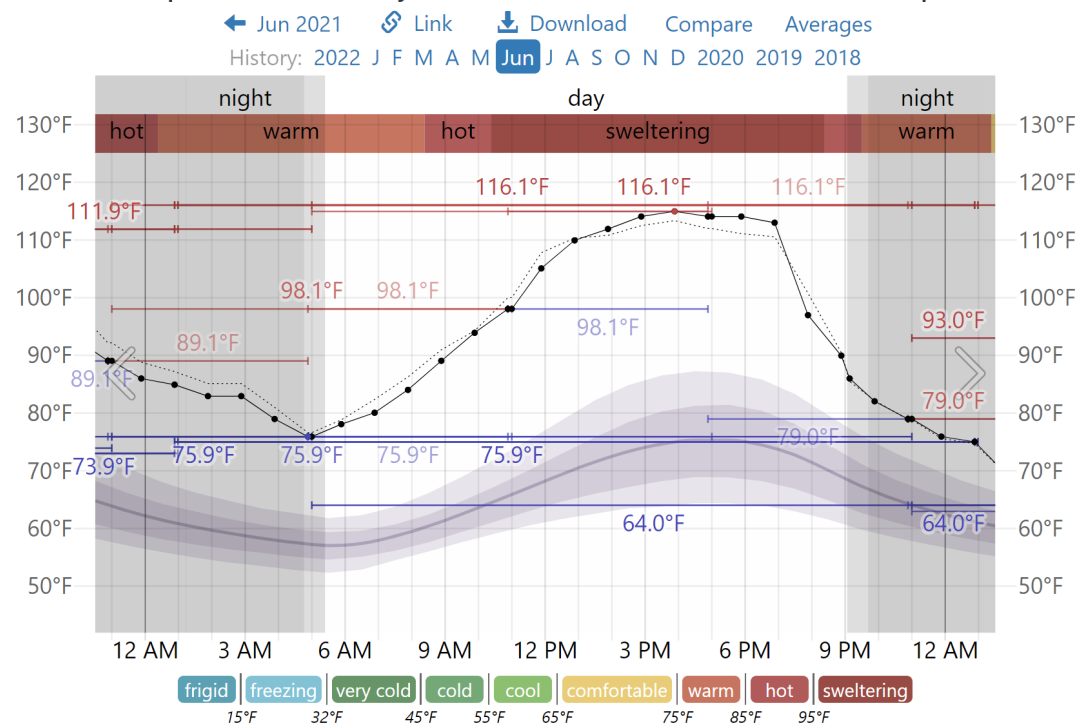
Type	Frequency	Description
Permanent TXT	Twice per day 9:00 a.m. EPT 1:00 p.m. EPT	<ul style="list-style-type: none">• All reportable facilities within the PJM operational footprint• Obtained from the PJM Energy Management System• Changes reflect effective permanent ratings
Temporary TXT	Twice per day 9:00 a.m. EPT 1:00 p.m. EPT	<ul style="list-style-type: none">• Limited durations, typically less than six months due to reliability and safety• Active, temporary changes, as well as future changes• Estimated dates are provided to indicate when the temporary ratings are in effect.• The facilities will revert to their permanent ratings upon the completion of the temporary rating change.
NERC Alert TXT	Twice per day 9:00 a.m. EPT 1:00 p.m. EPT	Rating changes due to NERC Alerts (Emergency or Near term) issued to verify field conditions are consistent with established ratings as per standards FAC-008 and FAC-009.
Real Time DLR ZIP	Every 10 minutes	Real time ratings for facilities enabled for dynamic ratings.
Effective ZIP	Every 10 minutes	<ul style="list-style-type: none">• Permanent and temporary ratings• NERC Alert changes• Dynamic Ratings Forecast files - For transmission owners with Dynamic Line Ratings (DLR) facility, the zipped file contains individual company files with DLR forecast information for up to the next 48hrs

What Ratings in June 2021?

Record summer temps (www.extremeweatherwatch.com)

- Billings, MT
 - 112 F, 31 July 1901
- Las Vegas, NV
 - 118 F, 26 July 1931
- Lewiston, ID
 - 117 F, 28 June 1939
- Moses Lake, WA
 - 115 F, 29 June 2021
- Phoenix, AZ
 - 122 F, 26 June 1990
- Portland, OR
 - 116 F, 28 June 2021
- Richland, WA
 - 115 F, 27 June 2021
- Seattle, WA
 - 108 F, 28 June 2021
- Spokane, WA
 - 109 F, 29 June 2021
- Walla Walla, WA
 - 116 F, 29 June 2021
- Wenatchee, WA
 - 113 F, 30 June 2021

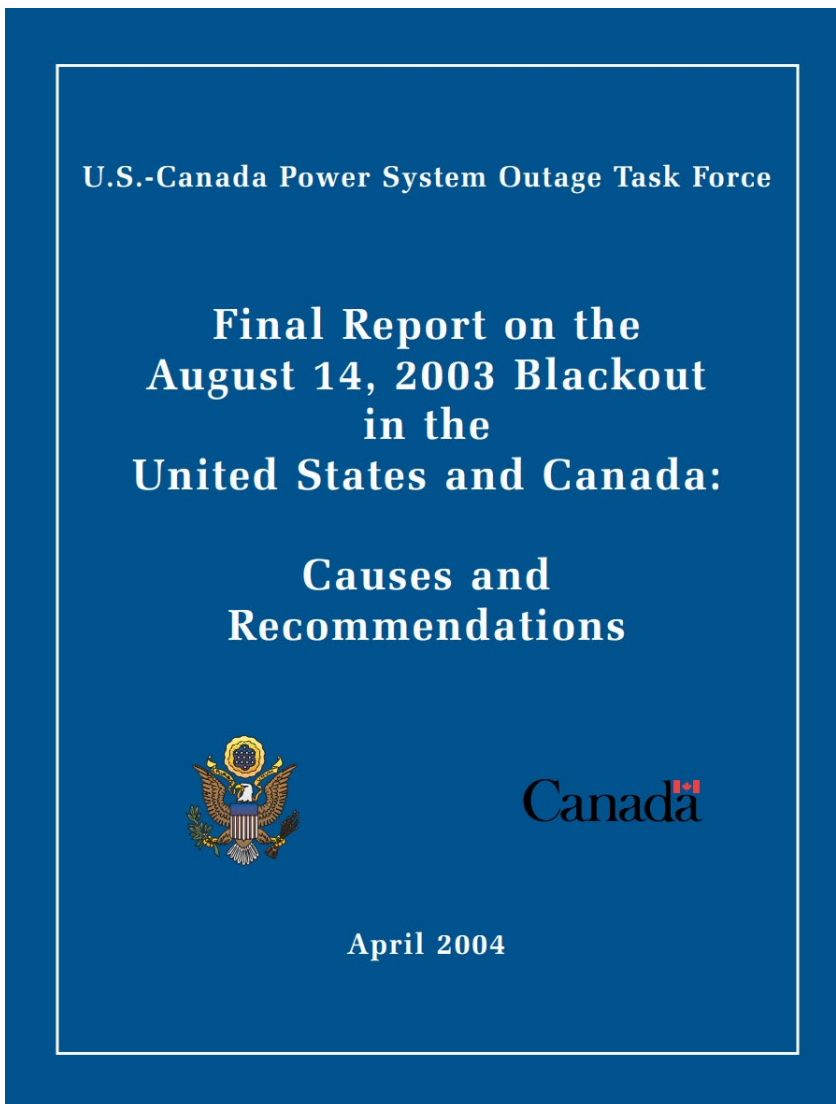
Temperature on Monday, June 28, 2021 at Portland International Airport



*Continued use of 30 C (86 F) ratings in the Northwest might just be a terrible idea...
 Hanford, WA, set the Washington record high at 120 F.
 Hanford hosts a large nuclear power plant (CGS).
 Why are 30 C ratings still used?*

Transmission Lines Ratings=Compliance

- Poor rating practice
 - 6.3 ft/sec?
 - 0 to 2 ft/sec actuals
- Not the only cause
 - But thanks for the:
 - EAct of 2005!



Line Ratings

A conductor's normal rating reflects how heavily the line can be loaded under routine operation and keep its internal temperature below a certain temperature (such as 90°C). A conductor's emergency rating is often set to allow higher-than-normal power flows, but to limit its internal temperature to a maximum temperature (such as 100°C) for no longer than a specified period, so that it does not sag too low or cause excessive damage to the conductor.

For three of the four 345-kV lines that failed, FE set the normal and emergency ratings at the same level. Many of FE's lines are limited by the maximum temperature capability of its terminal equipment, rather than by the maximum safe temperature for its conductors. In calculating summer emergency ampacity ratings for many of its lines, FE assumed 90°F (32°C) ambient air temperatures and 6.3 ft/sec (1.9 m/sec) wind speed,^a **which is a relatively high wind speed assumption for favorable wind cooling.** Actual temperature on August 14 was 87°F (31°C) but wind speed at certain locations in the Akron area was somewhere between 0 and 2 ft/sec (0.6 m/sec) after 15:00 EDT that afternoon.

^aFirstEnergy Transmission Planning Criteria (Revision 8), page 3.

Software Viewpoint to Rating Lines

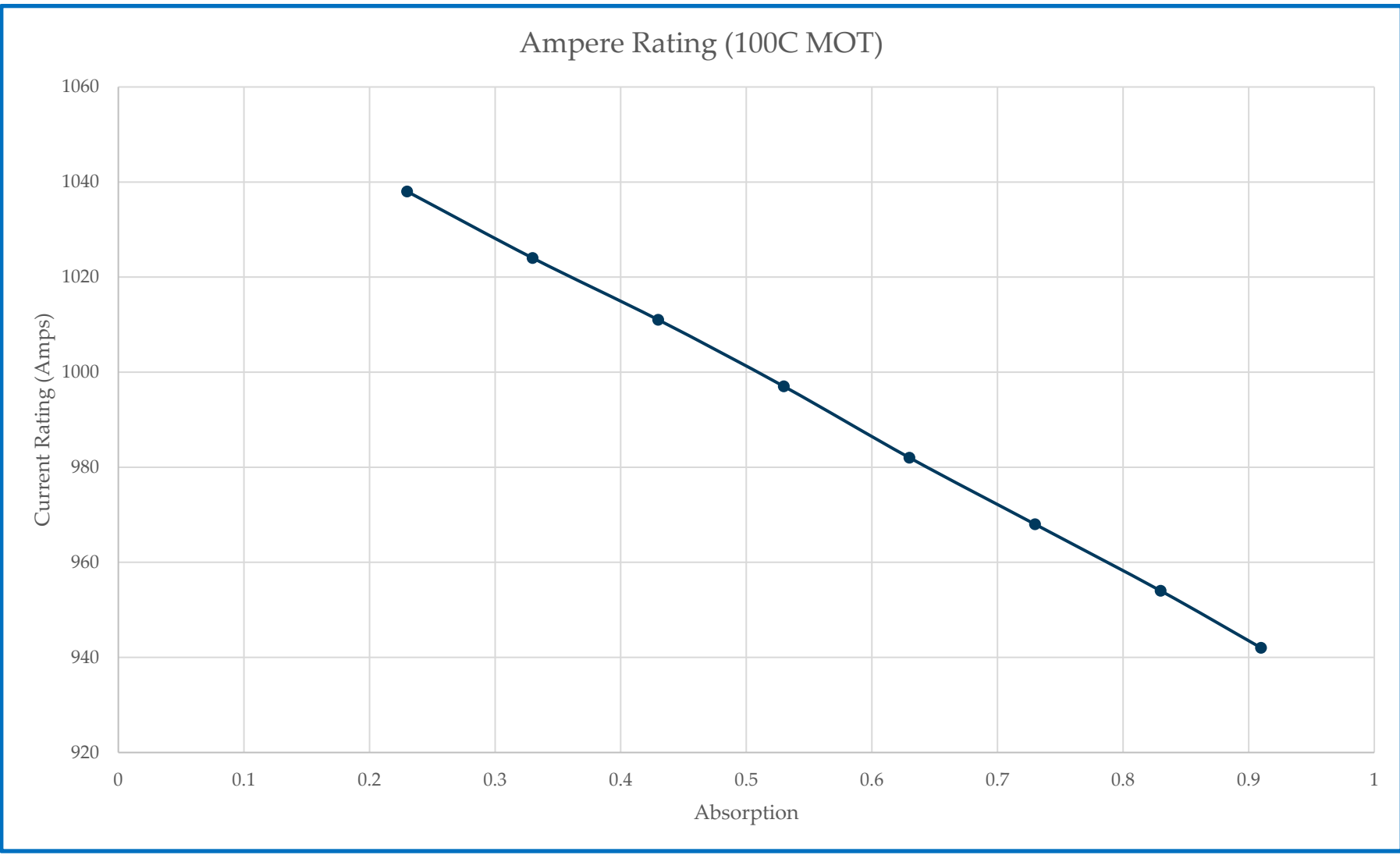
- Red-dashed box
 - Physical attributes of wire
 - Absorption and Emissivity
 - Variables that might be controlled
 - E3X from General Cable for example
 - Now Prysmian Group
 - Increases emissivity
 - Decreases Absorption
- Thermal coefficients for the conductor. The values entered here are subject to engineering judgment as to the effects of the operating environment on the surface condition of the conductor over time.
 - **Coefficient of Thermal Absorption** – The rate at which the conductor absorbs heat from its environment. Values can range from 0.23 for a new conductor to 0.96 for a blackened conductor.
 - **Coefficient of Emissivity** - The rate at which the conductor emits heat into the environment. Values can range from 0.23 for a new conductor to 0.91 for a blackened conductor.

The screenshot shows the SWRate software interface, Version 3.0. The main window contains several input panels. A red dashed box highlights the 'Core Information', 'Conductor Information', 'Thermal Coefficients', 'Low Temperature AC Resistance', and 'High Temperature AC Resistance' sections. The 'Local Conditions' panel includes fields for Wind Speed (2 ft/sec), Wind Angle (90 degrees), Ambient (40 °C), Frequency (60 Hz), and Atmosphere (Clear). The 'Location' panel includes fields for Altitude (40 ft), N. Latitude (47 degrees), Line Azimuth (0 degrees), Local Time (12 - Noon), and Solar Day (Jun 10). The 'Utilities' panel at the bottom right has buttons for 'Save Conditions As Defaults', 'Edit Conductors', and 'Restore Default Conditions'. On the right side of the interface, there are two vertical panels: 'Steady State' with 'Conductor Temperature' and 'Current Rating' buttons, and 'Transient' with 'Conductor Temperature' and 'Current Rating' buttons.

Absorption Sensitivity

Emissivity @ 0.5

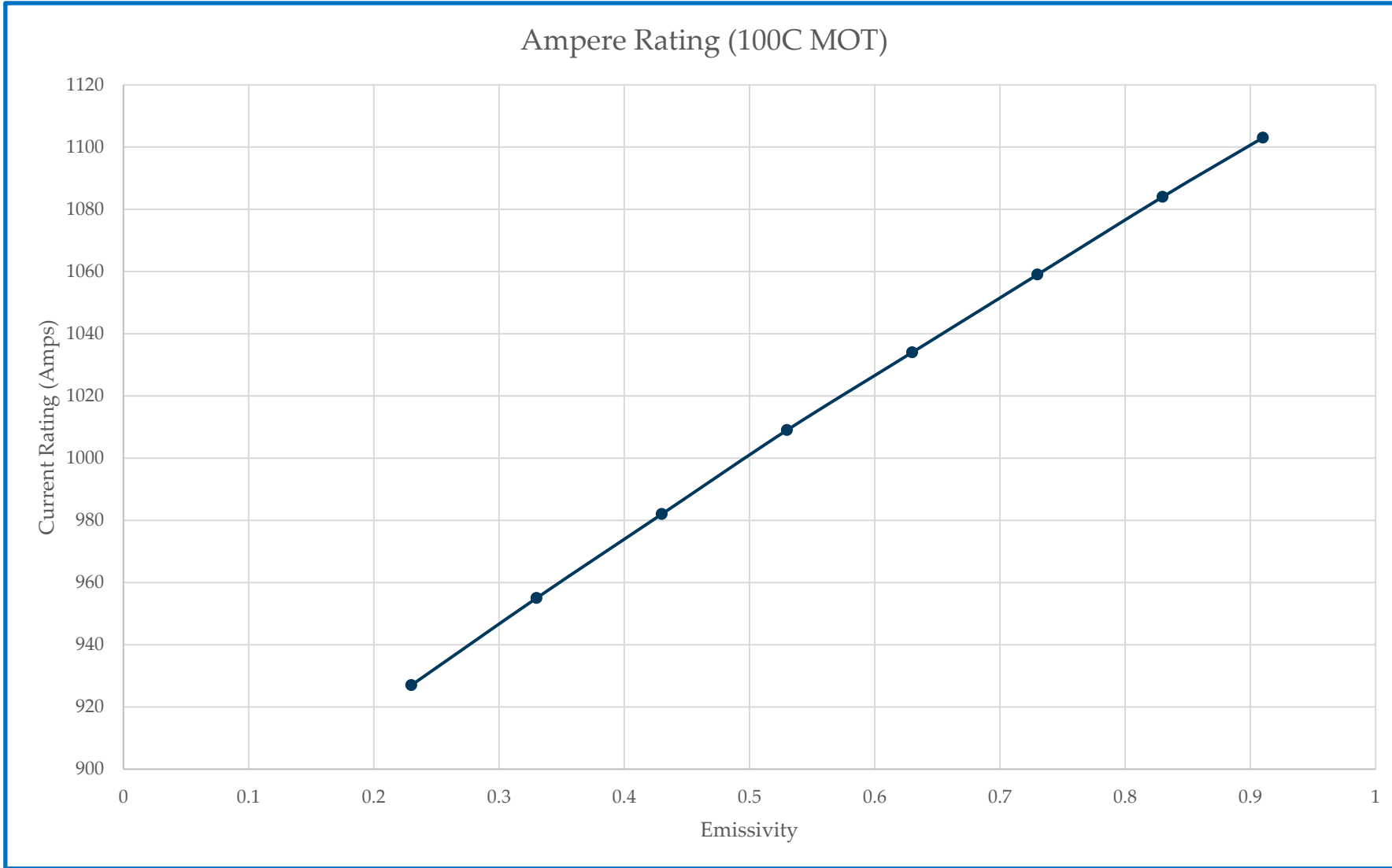
Core Information	
Strand Count:	<input type="text" value="7"/>
Strand Dia:	<input type="text" value="0.136 in"/>
Conductor Information	
Strand Count:	<input type="text" value="26"/>
Strand Dia:	<input type="text" value="0.1749 in"/>
Conductor OD:	<input type="text" value="1.108 in"/>
Thermal Coefficients	
Absorption:	<input type="text" value="0.5"/>
Emissivity:	<input type="text" value="0.5"/>
Low Temperature AC Resistance	
Temperature:	<input type="text" value="25 °C"/>
Resistance:	<input type="text" value="0.1166 Ohm/mi"/>
High Temperature AC Resistance	
Temperature:	<input type="text" value="75 °C"/>
Resistance:	<input type="text" value="0.1390 Ohm/mi"/>



Emissivity Sensitivity

Absorption @ 0.5

Core Information	
Strand Count:	<input type="text" value="7"/>
Strand Dia:	<input type="text" value="0.136 in"/>
Conductor Information	
Strand Count:	<input type="text" value="26"/>
Strand Dia:	<input type="text" value="0.1749 in"/>
Conductor OD:	<input type="text" value="1.108 in"/>
Thermal Coefficients	
Absorption:	<input type="text" value="0.5"/>
Emissivity:	<input type="text" value="0.5"/>
Low Temperature AC Resistance	
Temperature:	<input type="text" value="25 °C"/>
Resistance:	<input type="text" value="0.1166 Ohm/mi"/>
High Temperature AC Resistance	
Temperature:	<input type="text" value="75 °C"/>
Resistance:	<input type="text" value="0.1390 Ohm/mi"/>



Wind Speed

Absorption @ 0.5
Emissivity @ 0.5

Local Conditions

Wind Speed: ft/sec

Wind Angle: degrees

Ambient: °C

Frequency: Hz

Atmosphere:

Location

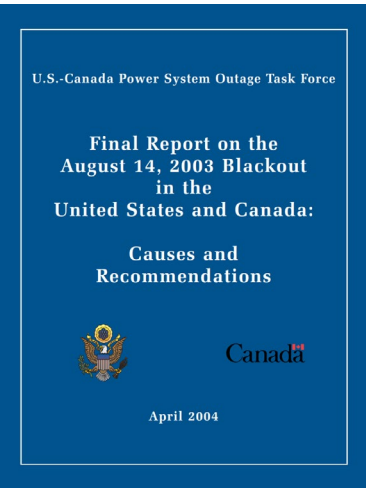
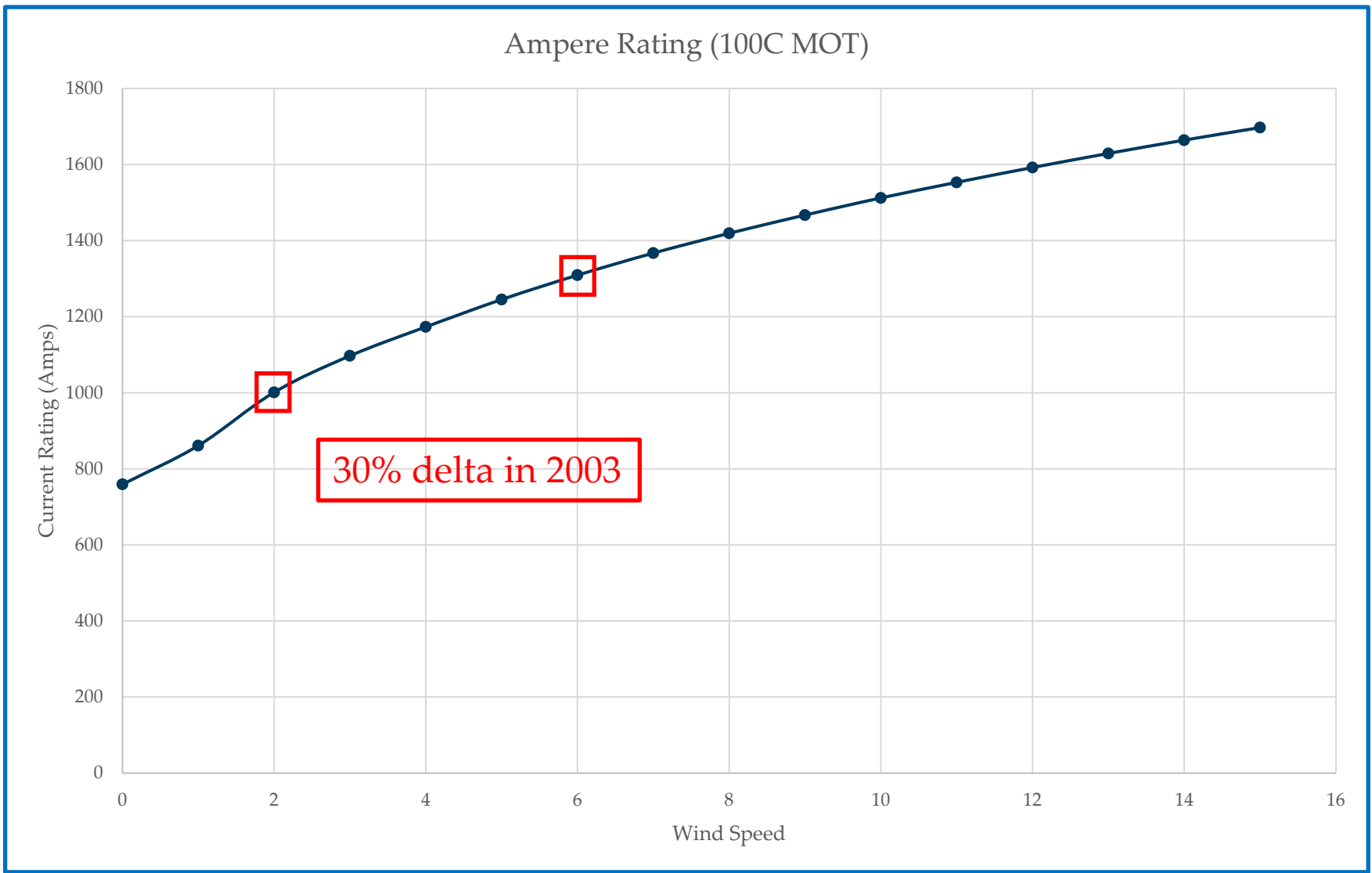
Altitude: ft

N. Latitude: degrees

Line Azimuth: degrees

Local Time:

Solar Day:



Wind Angle (measured normal to wire)

Absorption @ 0.5
Emissivity @ 0.5

Local Conditions

Wind Speed: ft/sec

Wind Angle: degrees ←

Ambient: °C

Frequency: Hz

Atmosphere:

Location

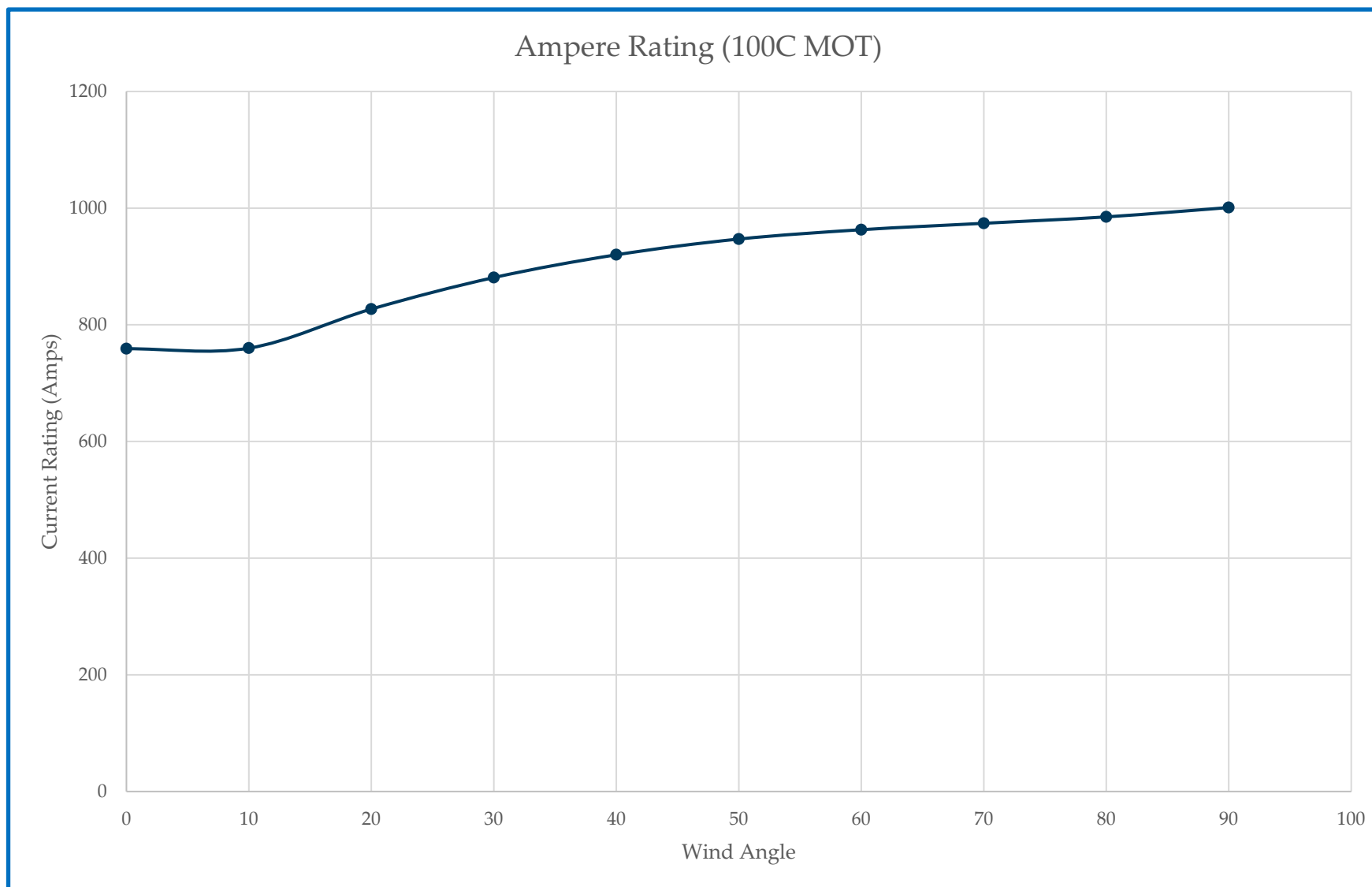
Altitude: ft

N. Latitude: degrees

Line Azimuth: degrees

Local Time:

Solar Day:



Wind Angle – The angle of the wind relative to the conductor, in degrees. A value of 90 degrees would indicate that the wind is blowing perpendicular to the conductor, providing maximum heat removal.

Isn't a 45 degree angle more appropriate? Transmission lines are seldom in straight lines and the wind direction is variable.

The difference in ampacity is notable at ~100 amps!

Atmosphere

- Introduces the concept of nebulosity
 - Aka cloudiness
 - Clear atmosphere → 1001 Amps
 - All other factors at default
 - Industrial atmosphere → 1016 Amps
 - All other factors at default
 - Bring on the smog?

Changes in Altitude

Absorption @ 0.5
Emissivity @ 0.5

Local Conditions

Wind Speed: ft/sec

Wind Angle: degrees

Ambient: °C

Frequency: Hz

Atmosphere:

Location

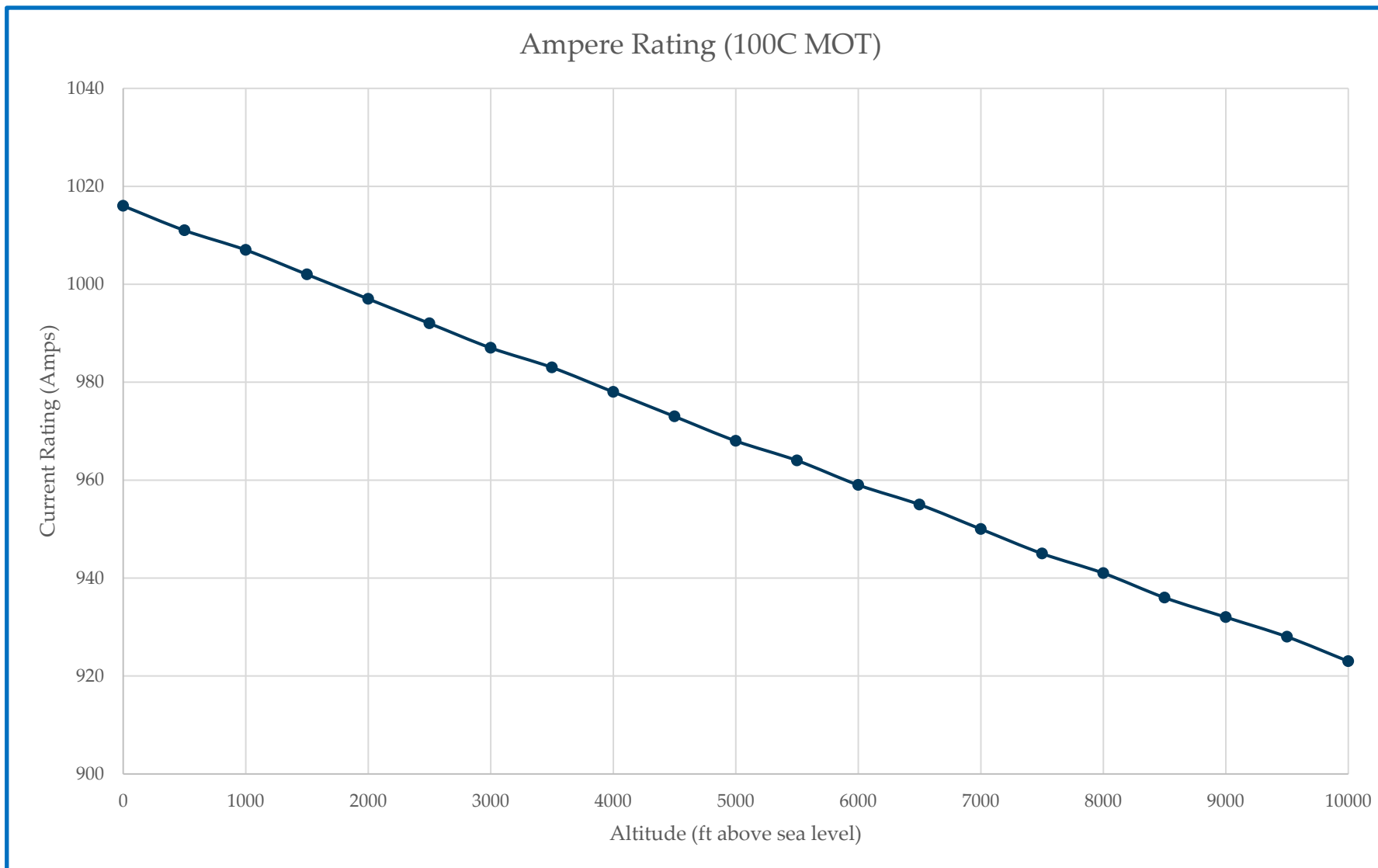
Altitude: ft ←

N. Latitude: degrees

Line Azimuth: degrees

Local Time:

Solar Day:



Changes in Latitude (props to J. Buffett)

Absorption @ 0.5
Emissivity @ 0.5

This is a multi-variable problem associated with time of day... however, in general, ratings go down the farther toward the equator one goes.

The screenshot shows a control panel with two sections: 'Local Conditions' and 'Location'. The 'Local Conditions' section includes: Wind Speed (2 ft/sec), Wind Angle (90 degrees), Ambient (40 °C), Frequency (60 Hz), and Atmosphere (Clear). The 'Location' section includes: Altitude (40 ft), N. Latitude (47 degrees), Line Azimuth (0 degrees), Local Time (12 - Noon), and Solar Day (Jun 10). A blue arrow points to the 'N. Latitude' input field.

Need for an OASIS Accessible Database

- [...] to maintain a database of transmission owners' transmission line ratings and transmission line rating methodologies on the transmission provider's Open Access Same-Time Information System (OASIS) site or other password-protected website.
 - Definition (Merriam-Webster):
 - *a usually large collection of data organized especially for rapid search and retrieval (as by a computer)*

So...

- Just what ratings should we be using?
 - Solar irradiance, no solar?
 - What temperature for Heavy/Light Summer/Winter, etc.
 - Hint ... 30 C is NOT appropriate.
 - 40 C is nominal for switches and breakers (mostly).
 - ACCC ratings ... A01 to F06 (aged to newish).
 - Do we need 16 ratings ... or just 2?
 - Do we want to plan with emergency ratings?
 - I think this is a BAD idea!



Electric Reliability and Security for the West

www.wecc.org