Guide for Selection of Weather Parameters for Bare Overhead Conductor Ratings

CIGRE TB 299

Based on IEEE/ CIGRE Joint Task Force Recommendations

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Joint Activity between TF B2-12.6 and IEEE TP&C Subcommittee

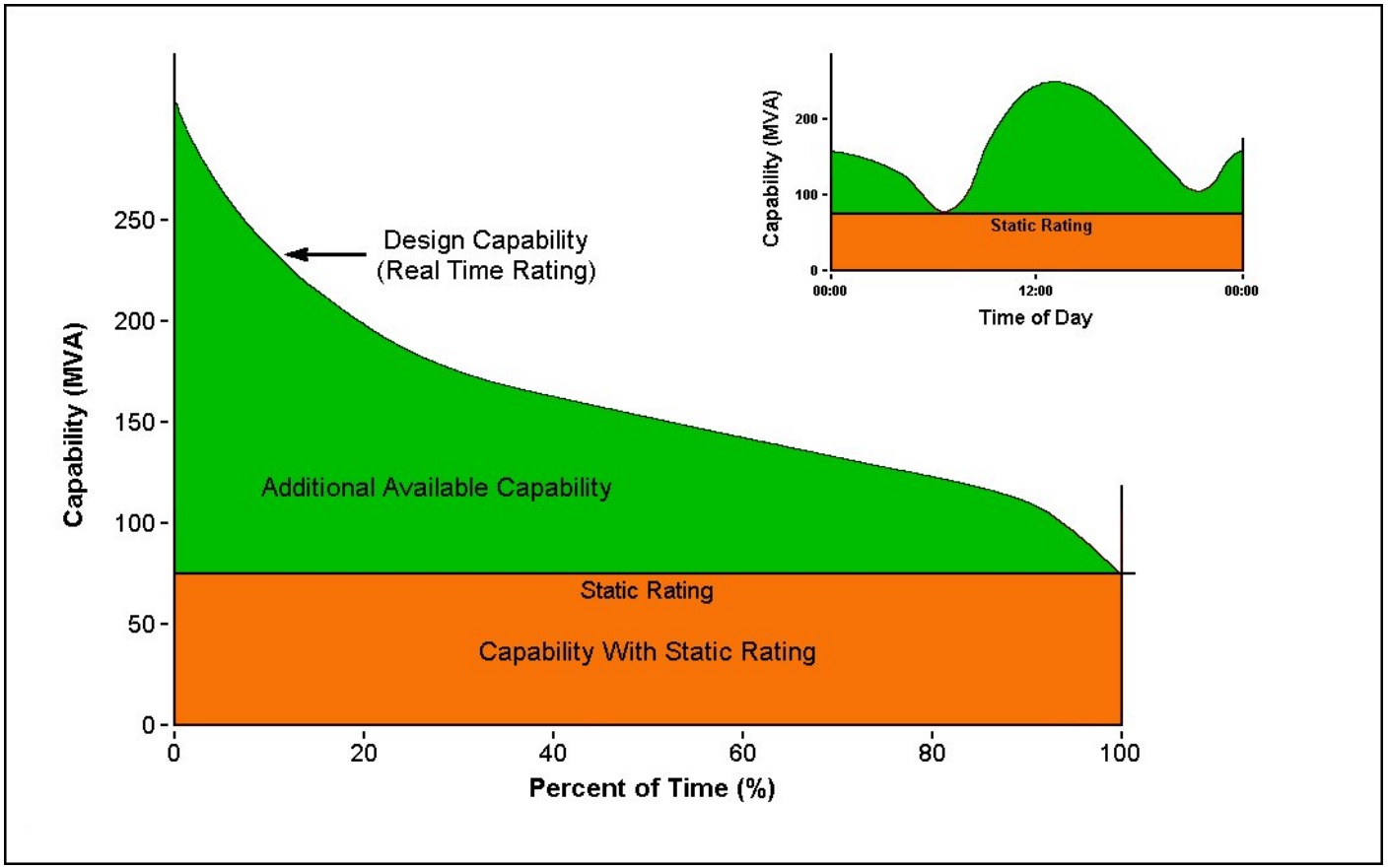
TOR:

Identify and describe a logical process whereby suitably conservative weather conditions can be selected for use in conventional static thermal line rating methods based on limited field data collection. The methods may include probabilistic or those based on engineering judgment.

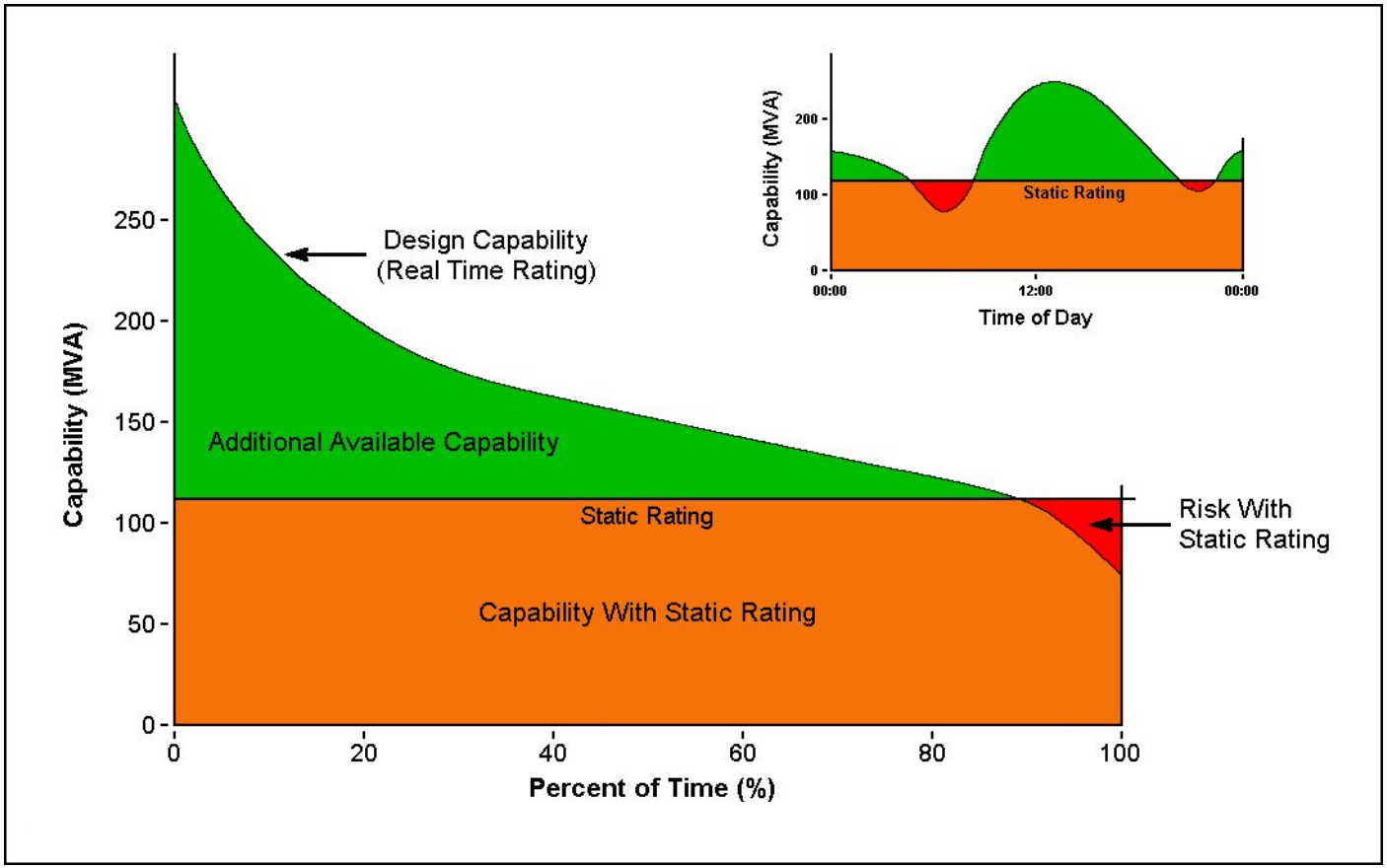
Deliverable: A brochure that clearly describes a conservative process whereby weather conditions may be selected for overhead line rating calculations.

Transmission line capabilities

SAFE = No wind, high ambient temperature, full sun



Transmission line capabilities
Reasonable engineering assumptions



Engineering judgment factors

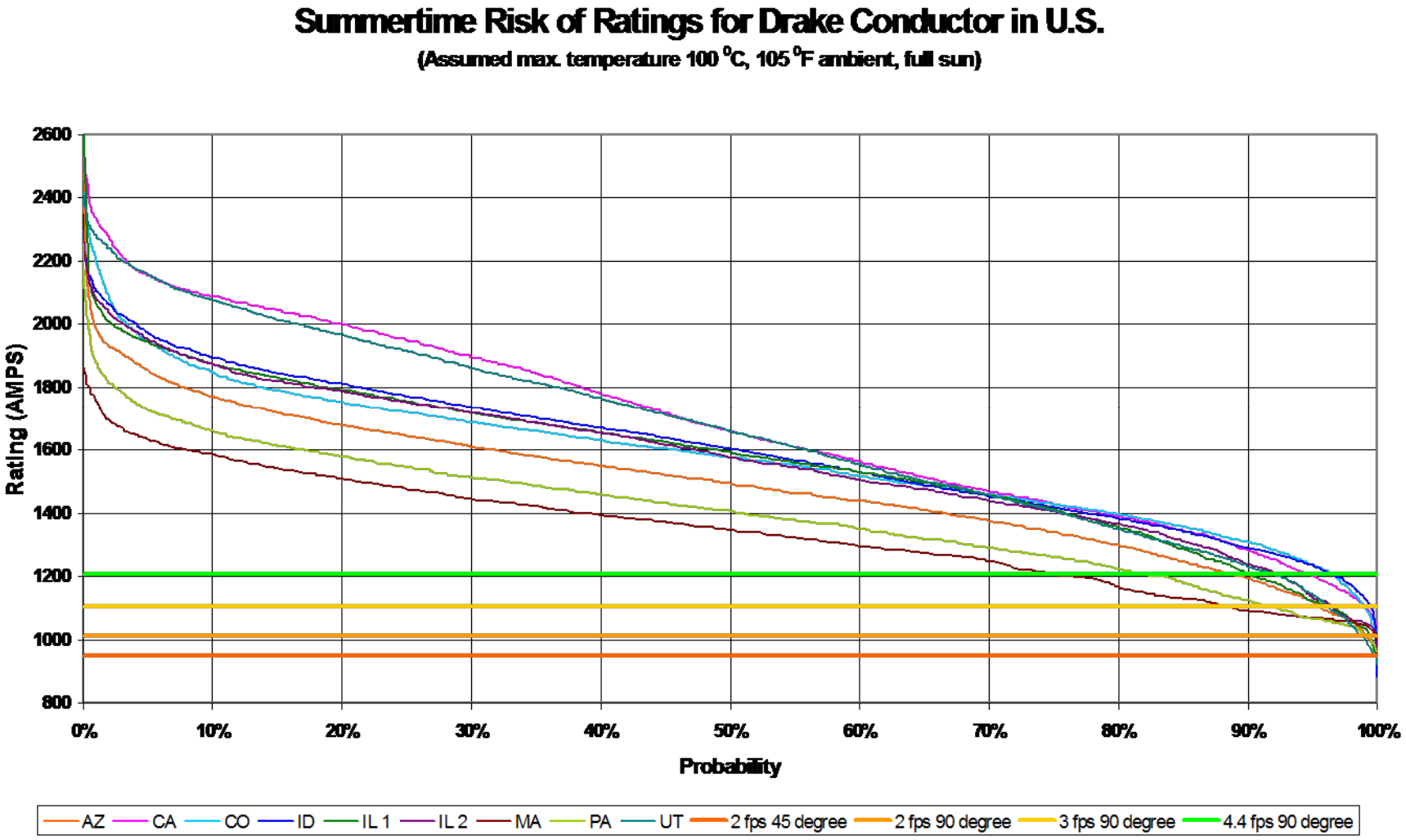
- The most important limitations for high temperature operation are the sags of the line.
- Experience tells that high temperature sag errors of the line, compared to design criteria, are typically 0.6-0.45 m. Even when design and construction are sophisticated, the sag errors are 0.3-0.2 meters.
- Sag errors of 0.3- 0.2 meters typically correspond to conductor temperature differences of 12-15^{o}C.
- Thus the Task Force decided to use 10^{o}C as the reasonable limit of engineering accuracy for thermal calculation.
- The line designers should provide clearance limits to at least this level of tolerance, or more if they are not fully confident of the line design and construction accuracies.
- TF also noticed that highest local spot temperature rises could be 10-15% higher than average temperature rises of a line section.

Engineering criteria

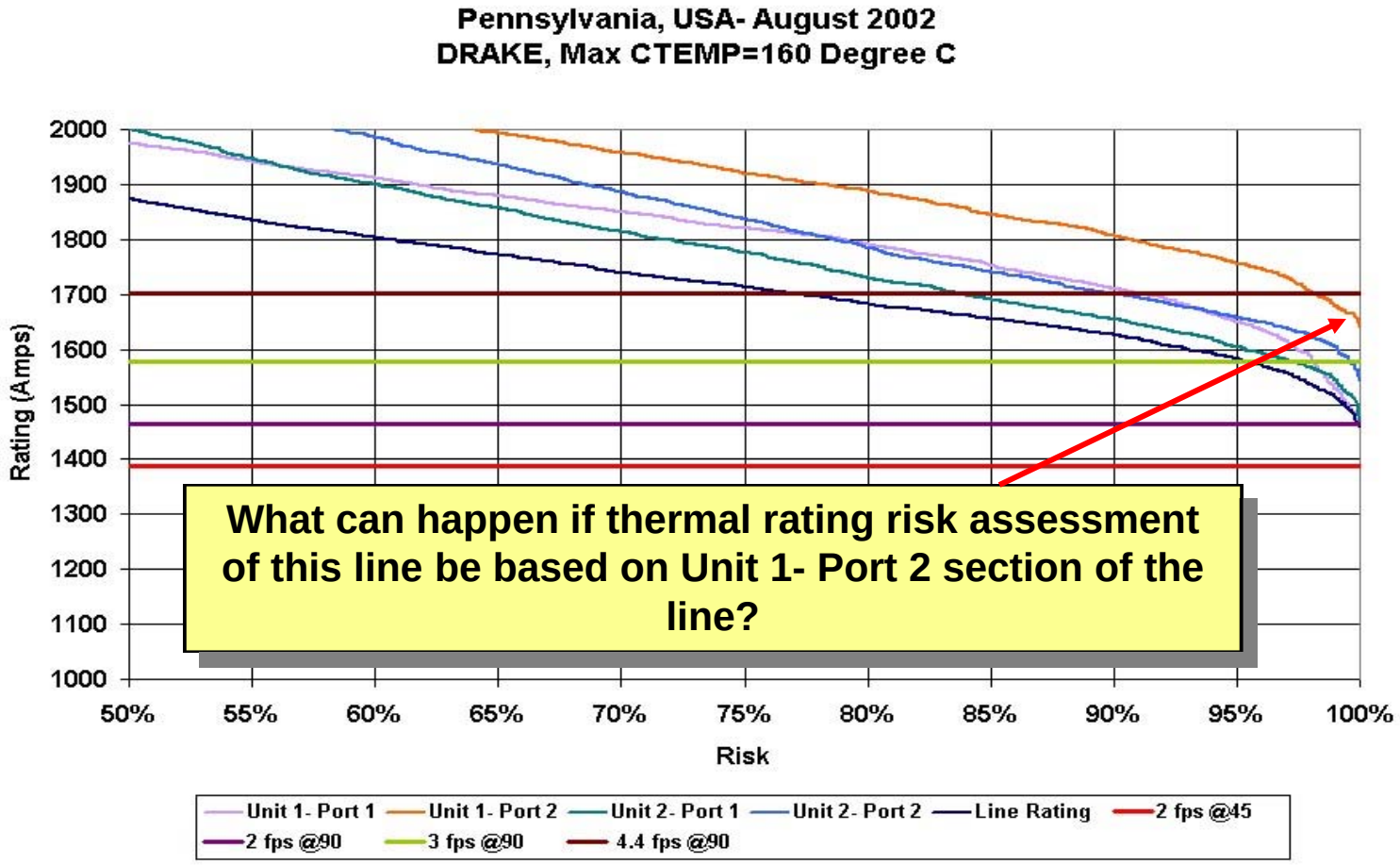
- The criteria for the limits was thus selected as:

- A set of weather parameters resulting in a average temperature error of the line section of no more than 10^{o}C, resulting in sag errors of 15-20 cm. The probability of temperature occurrences in excess of design (templating) temperature to be no more than 2% in a line constantly loaded to its rated ampacity.
- A maximum local temperature should based on a slightly lower wind speed, to accommodate for hot spots caused by sheltering from the wind.

Temperature risks based on wind data



Risk of a complete line is higher than that of any individual line section, thus several sites are needed



Literature observations also indicated that:

- **The statistics of wind speeds showed that assumption of a 0.6 m/s perpendicular wind indicated a risk level of less than 1-2% when combined with high ambient temperature and full solar radiation. Wind speeds at night and at lower ambient temperatures could be lower.**
- **TF also noticed that there were sites where local observations could justify higher wind speed assumptions.**
- **Literature also indicated that there were sites where low wind speeds had very low probabilities, especially at times when line loads were high. At such sites, variable ratings could be economically advantageous.**

Recommendations

- **Three-tiered process:**

- **Base ratings which may be applied to any transmission line.**
- **Study-based ratings, which can be applied if qualified weather or rating studies are available.**

  Variable ratings, which include continually ambient-adjusted ratings or real-time ratings.

  Probabilistic ratings which are calculated based on combined probabilities of weather, loads and activities under the line are not considered in this document.

Base ratings

- For sag-limited lines, assume an effective (perpendicular) wind speed of 0.6 m/s, ambient temperature close to the maximum annual value along the line route and a solar radiation of 1000 W/m^2. Absorptivity of at least 0.8 and emissivity of 0.1 below absorptivity.
- For seasonal ratings, assume an ambient temperature close to maximum value of the season (temperature which is exceeded only 1-2 days/year).

The base ratings are considered to represent a risk probability of 1-2% and a maximum temperature risk of 10 ^{0}C . They can be applied anywhere.

Study-based ratings

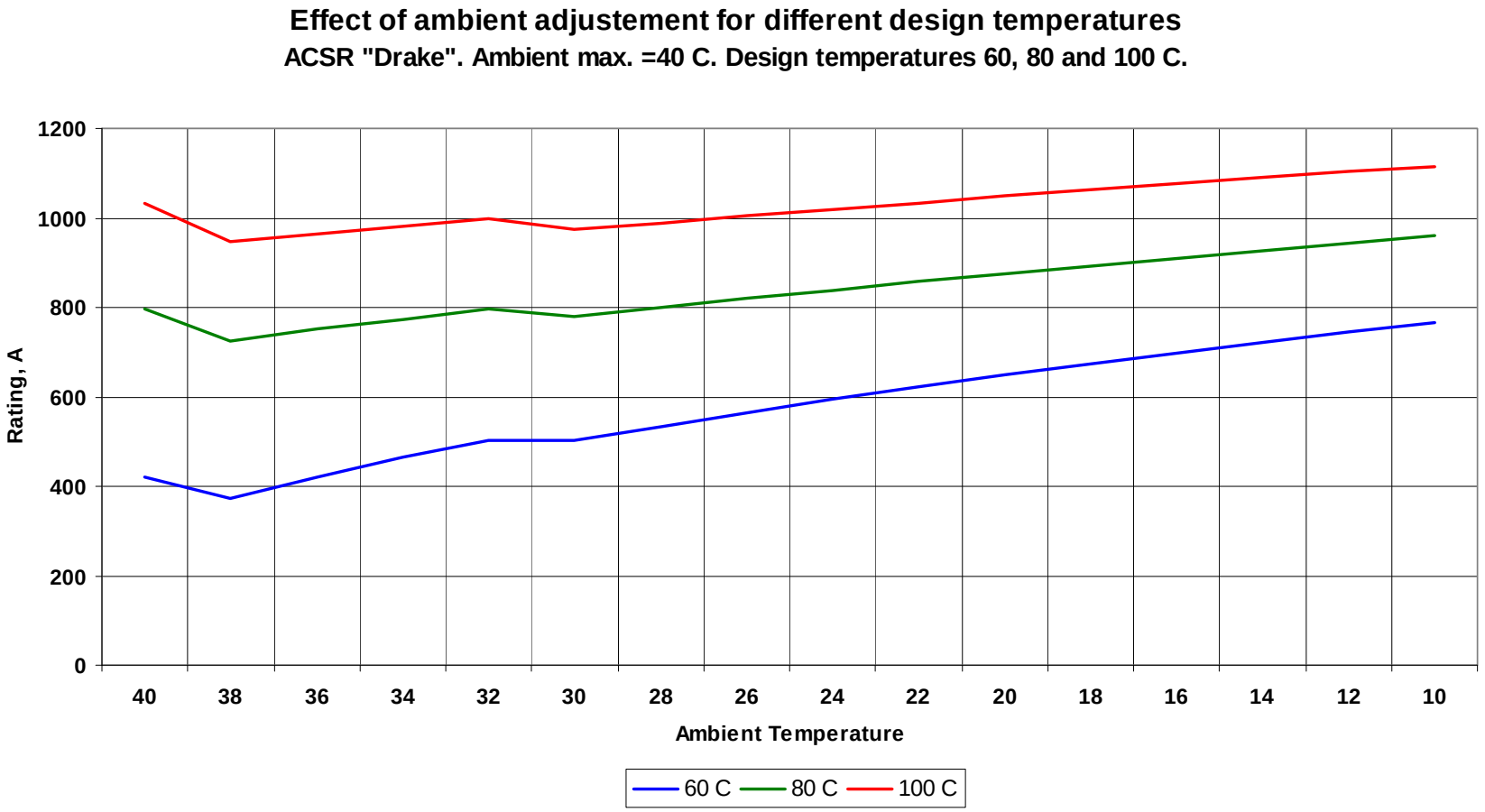
- Rating studies must be conducted in actual transmission line environment and in terrain conditions which represent the most sheltered sections of the line.
- Because National Weather Service Stations are located at open spaces, NWS data is not acceptable.
- Section 5 of TB 299 describes the required minimum level of instrumentation, its installation, data collection and data analysis.
- Depending of the types of instrumentation used and the number of data collection sites, the ratings should be set at a risk level between 5% and 1% of combined rating statistics.

Rating studies can be conducted also with devices which monitor line tension, sag or temperature.

Continually ambient-adjusted ratings

- For daytime conditions, if ambient temperature adjustment compared to base rating ambient temperature assumption is less than 8^0C, assume 0.5 m/s wind. E.g., if max. design temperature is 40^0C and the actual temperature is between 40^0C and 32^0C, assume 0.5 m/s.
- If ambient temperature adjustment compared to base rating ambient is more than 8^0C, assume 0.4 m/s wind.
- Continually ambient-adjusted ratings provide technically justified ampacity increases for lines designed for low max. conductor temperatures (below 60-70^0C). They generally do not show justified benefits for lines designed for maximum temperatures of 90-100^0C or higher.
- Nighttime ambient adjustment combined with no solar radiation assumption can be risky unless wind is assumed to be zero.

Continually ambient-adjusted ratings



Real-time ratings

Real-time monitoring can be based on tension, sag, clearance or conductor temperature.

Field verification of design clearance requirements is a prerequisite.

Monitors must meet the accuracy requirements specified in the brochure and must be applied in statistically sufficient quantity.

The operator must have the capability of adjusting line current to the level of base or study-based ratings.

Ratings can then be based on higher probability levels than the base ratings, because the operators have advanced warnings of clearance limitations and can use remedial actions to reduce the line current to a level indicated by real time ratings.