SMARTLINE® AAR/881™

Ambient Adjusted Rating Platform

The SMARTLINE AAR/881 system provides transmission operators ambient adjusted ratings (AAR) optimized on a per-line basis. Forecasts of AAR values are made available on a per hour basis, for up to 10 days. The system provides for a simple upgrade to dynamic line ratings for those lines where maximizing line capacity is required. This sensor-free system builds on Lindsey Systems' 10-year experience in providing transmission line ratings.

A Comprehensive AAR Solution

The AAR/881 product addition to the SMARTLINE line rating platform provides transmission operators with a highly sophisticated and simple to implement solution to implement ambient adjusted line ratings on one line, or across your entire network.
The system provides:

- Individual modeling of each transmission line to maximize capacity while minimizing risk
- Up to 10-days of hourly AAR forecasts updated hourly based on up-to-the hour weather forecasts
- Consideration of differences in solar heating during daytime and nighttime, by the hour
- The ability to provide ratings directly to system operators as well as RTOs/ISOs/TSOs
- A traceable, proven, rating methodology
- The SMARTLINE AAR/881 system develops ambient adjusted ratings for any line. No sensors are required to be installed on the transmission line

Ambient Adjusted Ratings vs SMARTLINE AAR/881

Adjusting transmission line ratings to account for changes in ambient temperature is a well-established practice. However, implementations often make infrequent use of temperature adjustments, neglect making other necessary weather-related corrections (1), and rarely account for the difference in daytime and nighttime weather effects. Further, lines are commonly treated as homogeneous in their geography and behavior. The result is both increased risk in over-stating capacity (2) from inadequate modeling and missed opportunity by understating capacity from assumptions on the uniformity of line behavior.

In comparison, SMARTLINE AAR/881 treats each transmission line as a unique entity. SMARTLINE considers both individual line parameters and line geography. Time of day to the hour, and the documented relationship between ambient and other weather parameters are also used. Both current and forecast ambient temperatures are updated hourly.

SMARTLINE then computes AAR ratings for each hour of the next 10 days, providing you and your TSO the ultimate flexibility in applying ratings.

The result is an optimal picture of your transmissions system's ambient adjusted capabilities.

(1): "TB 299 Guide For Selection Of Weather Parameters For Bare Overhead Conductor Ratings," CIGRE, Working Group B2-12, August 2006

(2): "Post-Technical Conference Comments of the WATT Coalition, Docket AD19-15", Washington, DC: US Federal Energy Commission, 2019, pp. 2-4.

LINDSEY SYSTEMS

SMARTLINE® AAR/881™ Ambient Adjusted Rating Platform

Methodology

Many regulatory entities require the method used to develop transmission line ratings be documented and made available in regulatory, operational, utility, and/or public databases. SMARTLINE AAR/881 ratings are developed using a comprehensive and easily documented method based on a combination of industry standards and time proven processes. These are as follows:

Required AAR Parameters:

Going beyond standardized parameters, SMARTLINE updates ambient and forecast ambient temperatures hourly, and takes into account the impact of daytime and nighttime solar radiation on line ratings.

IEEE Standard 738:
The standard heat exchange formulas identified in IEEE Standard 738 are used to ensure the developed rating will not heat the conductor beyond its maximum average conductor temperature (MACT) limit.

CIGRE Technical Brochure TB299:
Developed by an IEEE and CIGRE joint task force, this guide defines other parameters to be used in developing ambient adjusted ratings and how these parameters may need to be adjusted.

SMARTLINE Method:
Proven in use by utilities for over a decade, the SMARTLINE method includes the use of multiple AAR computations over the path of the line to ensure ratings reflect the impact of temperature and solar radiation differences across the length of the line.

Utility Analysis:
Consistent with the process described in CIGRE TB299, any parameters used in developing a line's rating can be modified to reflect the transmission operator's own engineering analysis of a line.

Installation Requirements

- ✓ No sensors are required to be installed to develop ambient adjusted ratings.
- ✓ For lines where SMARTLINE DLR is already implemented and TLM line sensors are installed, this software release adds the AAR/881 ratings to the available line rating set.
- ✓ For lines where only SMARTLINE AAR/881 is being deployed, implementation of full dynamic line ratings will only require the installation of Lindsey type TLM sensors on the transmission line.

Secure Cloud-based Software

SMARTLINE AAR/881 is provided as a highly secure cloud-based system that is easy to integrate into utility applications, while providing useful graphical tools for engineering analysis.

Cyber Security

- Two-factor authentication ensures access is granted only to the person authorized. SMARTLINE provides for unlimited users.
- Regular penetration testing assesses the effectiveness of SMARTLINE's security controls by simulating real-world cyber-attacks.
- All databases and software have full redundant backup ensuring minimal disruption in the event of failure.
- Independent databases are maintained for all customers ensuring no commingling of data.

Web-based Display

A visual display of the developed ambient adjusted ratings is provided for simple examination by engineering and operations personnel (See Figure 1).

Application Programming Interface Included

- SMARTLINE AAR/881 includes an easy to use application programming interface (API) which allows for quick integration into EMS, system historian, or other applications (See Figure 2).
- All ratings and underlying data are easily accessible using a minimum of data requests.
- Designed as a RESTful API that uses https requests to collect data, the API uses less bandwidth than other methods making it ideal for internet usage.

Weather Data

SMARTLINE AAR/881 includes the use of both primary and secondary weather feeds. Users may choose to use SMARTLINE's default weather feed service or may choose to specify alternate or more local weather services for primary and/or backup.

Figure 1:
SMARTLINE AAR/881 provides a simple visual display of all 240 1-hour line ratings for each line.

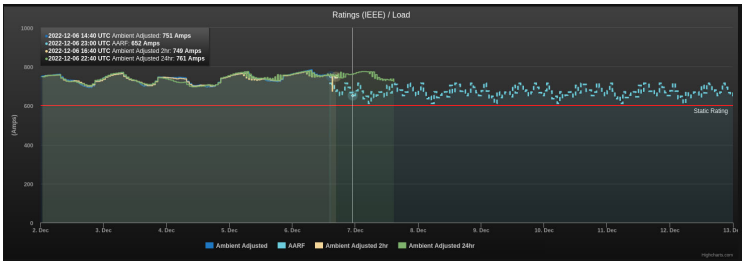
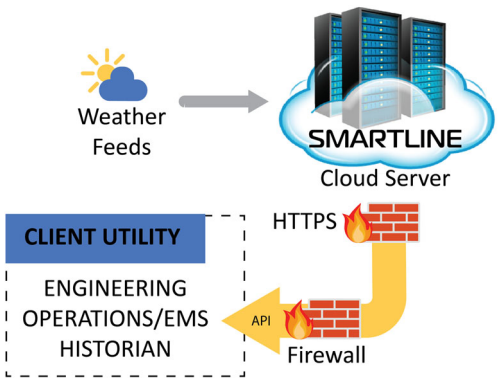


Figure 2: Secure API provides encrypted transmission of ratings.



Summary of SMARTLINE® AAR/881™ Features:

SMARTLINE AAR/881 Feature Summary	
Feature	**SMARTLINE AAR/881**
Real-time AAR	YES
Hourly AAR forecasts	YES Hourly forecasts available out through 10 days, up to 240 ratings total.
One-hour AAR rating durations	YES
Ratings updated hourly	YES
Use of up-to-date ambient forecasts	YES
Accounts for daytime and nighttime solar heating	YES Updates solar heating based on latitude/longitude location.
API provided for EMS integration	YES
Cyber secure	YES
Uses a proven methodology	YES AAR/881 is based upon: 1. CIGRE TB299 2. Time proven SMARTLINE methodology
Customizable methodology	YES As provided for in CIGRE TB 299.
Provides upgrade path to full DLR on any given line	YES By installing Lindsey type TLM conductor monitors on pre-identified spans. No other change required.
Web-based engineering interface	YES

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