



Facility Ratings Webinar

Michelle Cross, RF Manager, Entity Engagement
April 4, 2022

PUBLIC



Welcome and Logistics

- This WebEx event is not being recorded.
- Today's presentations will be posted to RF public website at rfirst.org.
- Please submit all questions through Slido instead of the WebEx chat.
- For your convenience, we will provide the workshop survey live during the break and at the end of event via Slido.

Join the
conversation at
Slido.com
#FacilityRatings



It is ReliabilityFirst's policy and practice to obey the antitrust laws and to avoid all conduct that unreasonably restrains competition. This policy requires the avoidance of any conduct which violates, or which might appear to violate, the antitrust laws. Among other things, the antitrust laws forbid any agreement between or among competitors regarding prices, availability of service, product design, terms of sale, division of markets, allocation of customers or any other activity that unreasonably restrains competition.

It is the responsibility of every ReliabilityFirst participant and employee who may in any way affect ReliabilityFirst's compliance with the antitrust laws to carry out this policy.



Agenda

Slido.com
#FacilityRatings

Presentation	Presenter(s)	Time
Introductions	Michelle Cross, RF	1:00 – 1:05 pm
Risks/Challenges	Jim Uhrin, RF	1:05 – 1:20 pm
Enforcement – Facility Ratings Extent of Condition	Patrick O'Connor, RF	1:20 – 1:35 pm
FERC Update – Order 881	Dillon Kolkmann, FERC	1:35 – 1:50 pm
RC Update – PJM	David Hislop, PJM	1:50 – 2:10 pm
RC Update – MISO	Vikram Godbole, MISO	2:10 – 2:30 pm
BREAK		2:30 – 2:40 pm
TO Update (AEP)	Chris Shaffer, AEP	2:40 – 3:00 pm
GO Update (Aurora)	Anthony Miles (IHI) and Aaron Bottoms (Aurora Generation, LLC)	3:00 – 3:20 pm
O&P Facility Rating Expectations	Jim Kubrak, RF	3:20 – 3:30 pm
Dynamic Line Ratings, PPL	Horst Lehman and Eric Rosenberger, PPL	3:30 – 3:55 pm
Closing Remarks	Michelle Cross, RF	3:55 – 4:00 pm



Mark your calendar for **Monday, April 18th** Technical Talk with RF

Link to WebEx at rfirst.org



UPCOMING EVENTS [VIEW ALL](#)

April 18, 2022

[Technical Talk with RF](#)



April Agenda Topics:

- Enforcement Updates and Trends – Elizabeth Emanuel, RF Counsel; Mike Hattery, RF Council, Farzaneh Tafreshi, NERC Manager of Analysis and Reporting

PUBLIC





Click anywhere on
image to open the
newsletter

**Check out RF's Q1 Newsletter for an
article on "The Impact of FERC Order 881
on Facility Ratings"**

More on Facility Ratings Around the ERO [slido.com](https://www.slido.com) #FacilityRatings



Common Failure Point Documents

FAC 008 Position Paper

[Link](#)



MRO Annual Reliability Conference

May 18, 8:00 – 4:00 Central Time (9:00 - 5:00 Eastern)
[Webinar Link](#)



Compliance Bulletin

NPCC Continued Focus on FAC-008
[Link](#)



Talk with Texas FAC-008

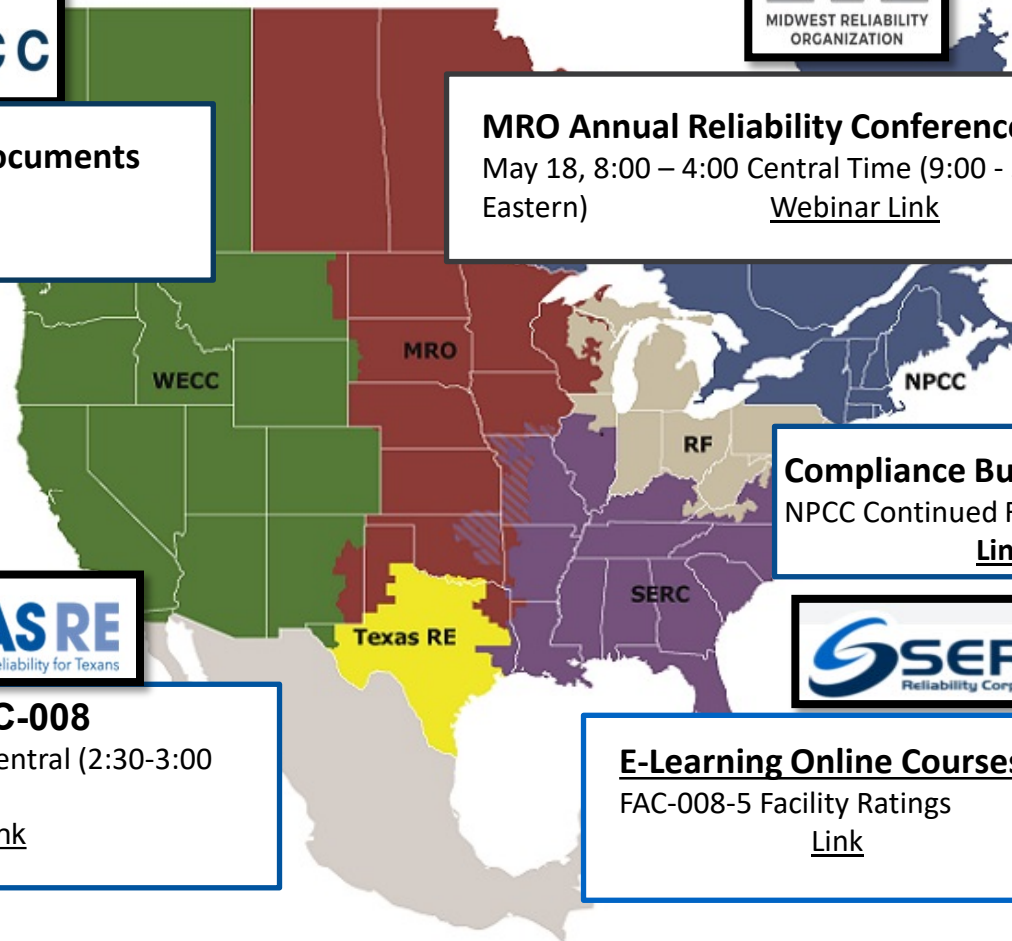
April 28, 1:30-2:30 p.m. Central (2:30-3:00 Eastern)

[Webinar Link](#)



E-Learning Online Courses

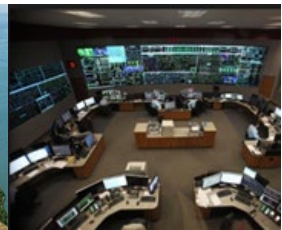
FAC-008-5 Facility Ratings
[Link](#)



Facility Ratings

What are the Risks and Challenges

Jim Uhrin
Director, Engineering and Reliability Services
April 2022



Background

➤ Facility Ratings were initially discussed across the ERO in the 2018-19 timeframe.

- Regional Entity Outreach
 - Questionnaires
 - Focused Workshops
 - Newsletter Articles
- Specific to ReliabilityFirst
 - Issued a letter from one of our Executives.
 - Held one on one meetings with targeted entities
 - Adopted new techniques to assess the accuracy of Facility Ratings (i.e., substation walk downs etc.)
- ERO Collaboration with North American Transmission Forum (NATF).
- ERO Practice Guides were written.

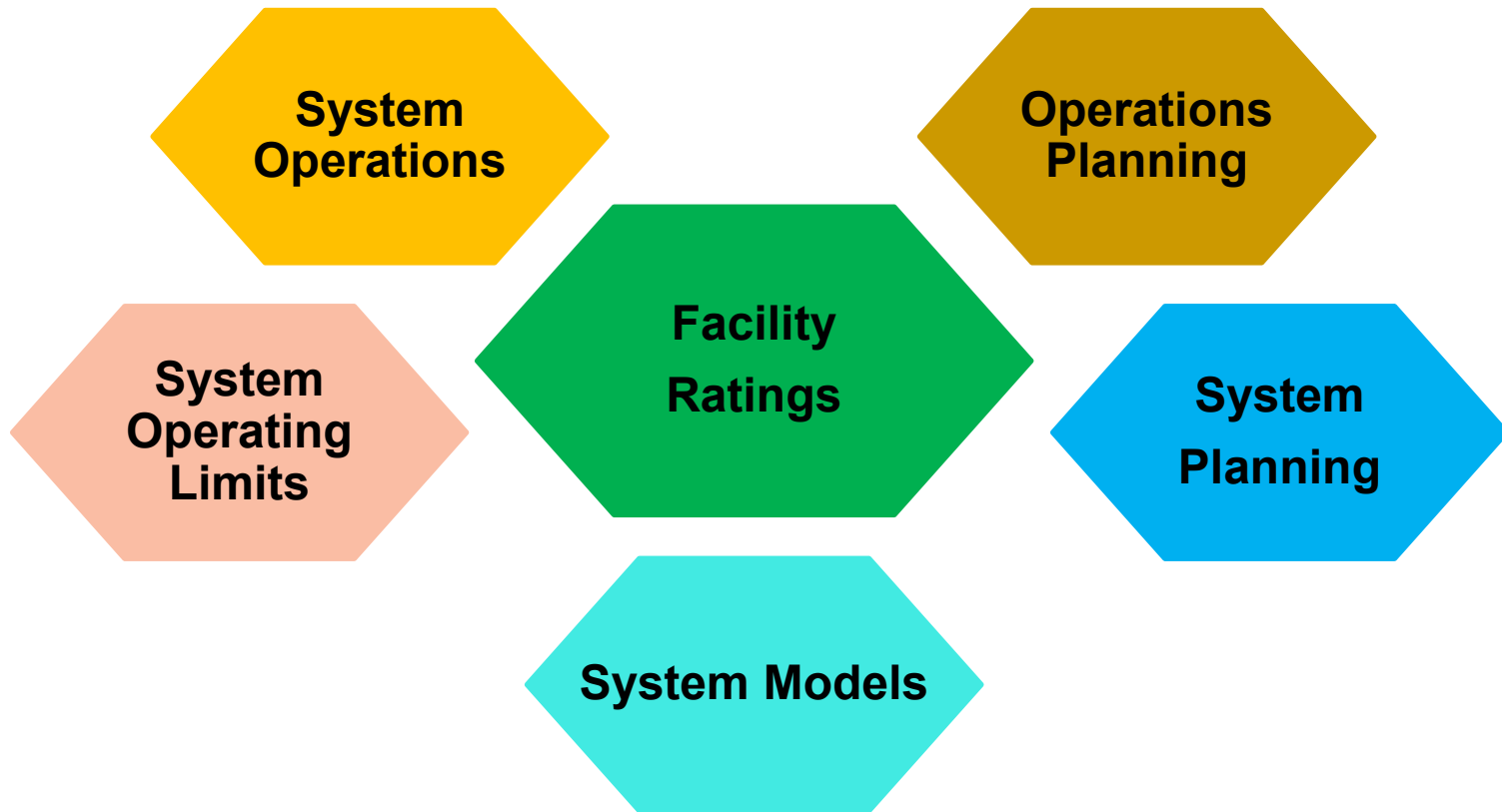


Slido Poll

- **Where do you think Facility Ratings have an impact on the Bulk Power System? (a. System Operation, b. System Planning, c. Determining a System Operating Limit, d. Building System Models, e. All of the above)**
- **Thinking about the previous question, if an incorrect Facility Rating were in place, what risks would exist, can you think any? (Word Cloud)**



Where Facility Ratings Can Have An Impact



SLIDO Polls

- **What challenges do you feel your company faces, when trying to sustain accurate Facility Ratings? (Word Cloud)**

Join at
slido.com
#FacilityRatings



Typical Substation



Some Challenges

➤ Change Management

- Controls to monitor and process changes

➤ Assets Management

- Thousands of pieces of equipment to keep track and have an accurate inventory.

➤ Contractor Management

- Oversight and Commissioning

➤ Designed versus As-Built

- What is reality in the field?



Some Challenges

➤ Field Verifications

- Post as-built and periodically due to maintenance and restoration work

➤ Facility Ratings Database

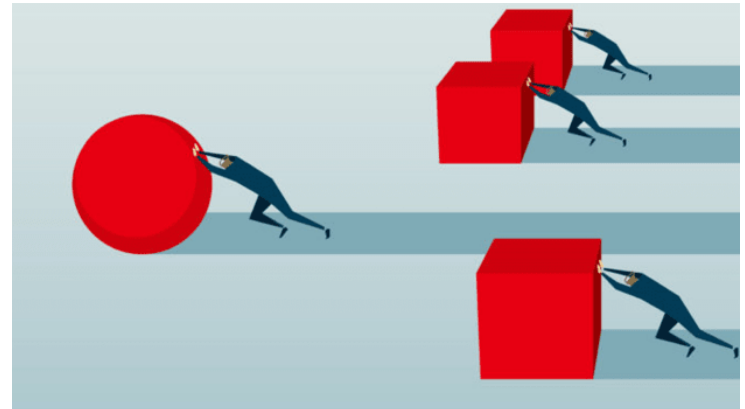
- Checks accuracy and sustainability

➤ Documentation

- Methodology, Processes, Controls, etc.

➤ Impact of Order 881

- Introduces more data and calculations



Potential Areas to Focus

➤ Some Identified Problem Areas

- Seams: tie-lines with neighboring entities
- Customer substations embedded in your system
- Any area impacted by a change (acquisition, project, etc.)

➤ Some Identified Problem Types

- Missing components
 - Have you identified all the pieces and parts that make up the Facility?
 - Are you missing jumpers and risers inside substations, or possibly a wavetrap?
- Incorrect ratings on components
 - Current Transformers Thermal
 - Jumpers/Risers Inside Substations
 - Relay Thermal – Relay Line Loadability
 - Transmission Line Conductor
 - Incorrect Aluminum Conductor Stranding



As We Go Forward

➤ **Some questions to ask ourselves:**

- Do we have solid foundation to start from?
- Is our documentation, processes and controls in place to identify, assess and correct issues?
- Do we include some type of Verification & Validation step (i.e., field check, etc.)?
- With the injection of renewables and needed infrastructure are our processes robust enough?
- How can we maintain our models (i.e., system and planning)?
- Order 881 Impacts



Questions & Answers

Forward Together  ReliabilityFirst



Facility Ratings Enforcement Themes & Perspectives

Patrick O'Connor, Senior Counsel

April 4, 2022



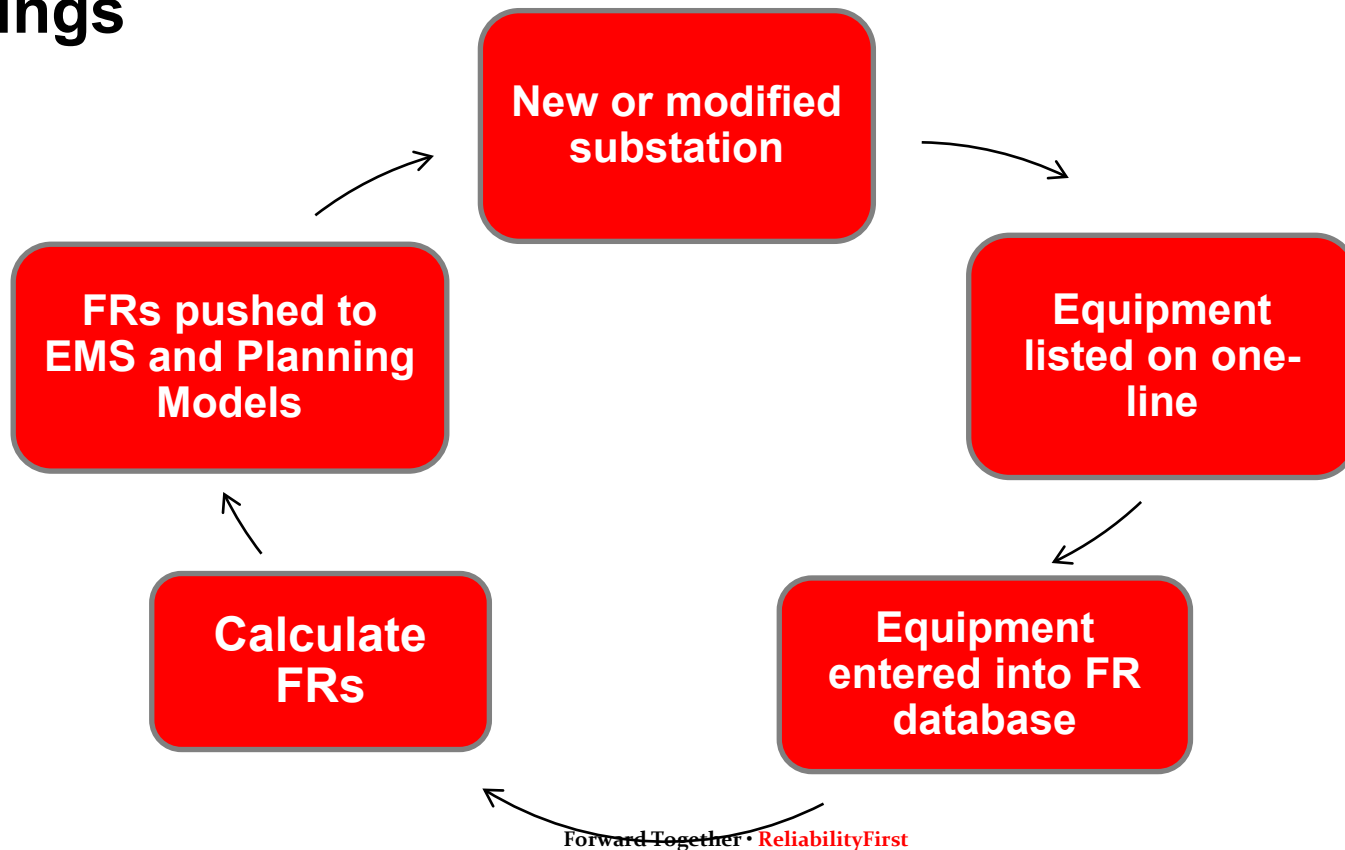
Agenda

- **Types of Facility Rating issues have we been seeing**
- **RF Enforcement's approach to mitigation / extent of condition reviews**
- **Takeaways / Action Items**



Recent Facility Rating Issues

- Facility Rating issues come in all shapes and sizes
- Missing equipment & incorrectly calculated Facility Ratings



Mitigation / Extent of Condition Reviews

- **Mitigation must accomplish two things:**
 - Correct the issue
 - Prevent recurrence

- **Extent of condition review is key to correcting the issue**
 - Scope of the review depends on the nature of the issue and your company's history with respect to Facility Ratings
 - General rule: scope should include all Facilities and include full physical walkdowns
 - Exception: you already have a quality internal control in place to check Facility Ratings and have a demonstrable basis to explain why the issue is isolated in nature
 - Risk-based approach, which can look different in each case

- **To prevent recurrence, mitigation should generally include some type of periodic control to verify Facility Rating accuracy**



Takeaways

- **Check the health of your Facility Rating program**
- **If you identify issues, reach out to RF**
- **Understand the implications of performing narrow extent of condition review**
- **If you perform full extent of condition review, stay in touch and provide updates**
- **Review recently filed Facility Rating cases from across the ERO to help set expectations**



Questions & Answers

Forward Together  ReliabilityFirst



Order 881: Managing Transmission Line Ratings

Dillon Kolkmann, Energy Industry Analyst

Office of Energy Policy and Innovation
Federal Energy Regulatory Commission

April 4, 2022

Disclaimer: my comments today represent only the author's opinions and do not necessarily represent the opinions of the Federal Energy Regulatory Commission or any Commission members



Background

- Issued in December 2021, Order 881 required (among other things):
 - Transmission providers to implement ambient-adjusted ratings (AARs) for near-term transmission service;
 - RTOs/ISOs to be able to accept dynamic line ratings (DLRs) from any transmission owner that wants to voluntarily implement DLRs;
 - Transmission providers to use uniquely determined emergency ratings; and
 - Enhanced transparency.



Jurisdiction and Need for Reform

- In Order 881, the Commission acted pursuant to its authority under Federal Power Act (FPA) section 206, to ensure just and reasonable wholesale rates.
- The Commission did not exercise its reliability authority under FPA section 215.
- The Commission determined that:
 - “Transmission line ratings, and the rules by which they are established, are practices that directly affect the rates for the transmission of electric energy in interstate commerce and the sale of electric energy at wholesale in interstate commerce (hereinafter referred to collectively as ‘wholesale rates’); and that
 - “because of the relationship between transmission line ratings and wholesale rates, inaccurate transmission line ratings result in wholesale rates that are unjust and unreasonable.”
- To remedy unjust and unreasonable rates, Order 881 required AARs, emergency ratings, RTOs/ISOs to be able to accept DLRs, and enhanced transparency.



Ambient-Adjusted Rating (AAR) Definition

- Order 881 established the following definition:
 - “Ambient-Adjusted Rating” (AAR) means a Transmission Line Rating that:
 - (a) Applies to a time period of not greater than one hour;
 - (b) Reflects an up-to-date forecast of ambient air temperature across the time period to which the rating applies;
 - (c) Reflects the absence of solar heating during nighttime periods, where the local sunrise/sunset times used to determine daytime and nighttime periods are updated at least monthly, if not more frequently;
 - (d) Is calculated at least each hour, if not more frequently. ”

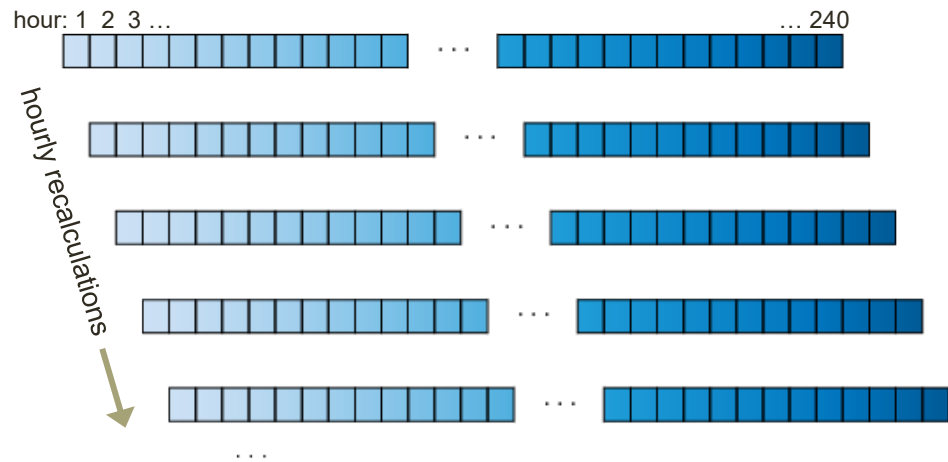


Scope of Transmission Provider AAR Obligations (1)

- Order 881 defines a transmission line rating as:
 - “the maximum transfer capability of a transmission line, computed in accordance with a written Transmission Line Rating methodology and consistent with Good Utility Practice, considering the technical limitations on conductors and relevant transmission equipment (such as thermal flow limits), as well as technical limitations of the Transmission System (such as system voltage and stability limits). Relevant transmission equipment may include... circuit breakers, line traps, and transformers.”
- Thus, AARs must be calculated for more than overhead conductors, where applicable.
 - This definition reflects the fact that line ratings must incorporate a set of electrical equipment ratings that collectively operate as a single bulk electric system element and that the most limiting component from that set determines the transmission line rating.
- The AAR requirements are applicable to all transmission lines, not just historically congested transmission lines.

Scope of Transmission Provider AAR Obligations (2)

- AARs must be used for “near-term transmission service” (including requests for such service and info posted about such service)
 - “Near-term” defined as service ending within 10 days of request or info posting
 - Exceptions for reliability and for lines whose ratings are not impacted by air temperature or solar heating
 - Requirements for granularity and frequency of recalculation (both must be at least hourly – see figure)
- For RTOs/ISOs, Order 881 clarified that it expects AARs to generally only be calculated for the real-time and day-ahead markets (except for lines at market seams, which are subject to the normal 10-day rule).





Scope of Transmission Provider AAR Obligations (3)

- Aside from the requirements of the AAR definition (hourly granularity, hourly recalculations, reflects up-to-date forecasts of air temperature, day/night ratings), Order 881 also clarified that AARs must:
 - Be applied to any inter-day and intra-day reliability unit commitment processes;
 - Be calculated for at least the historical range of temperatures +/- a margin of 10 degrees Fahrenheit;
 - Where look-up tables are used, be calculated for at least every five-degree Fahrenheit increment of temperature change.



Seasonal Line Ratings

- Order 881 established the following definition:
 - “Seasonal Line Rating” means a Transmission Line Rating that:
 - (a) Applies to a specified season, where seasons are defined by the Transmission Provider to include not fewer than four seasons in each year, and to reasonably reflect portions of the year where expected high temperatures are relatively consistent;
 - (b) Reflects an up-to-date forecast of ambient air temperature across the relevant season over which the rating applies;
 - (c) Is calculated annually, if not more frequently, for each season in the future for which Transmission Service can be requested.”
- Thus, seasonal ratings will generally need to be more granular than prior to Order 881 (at least four seasons per year) and re-calculated more frequently (at least annually).



Dynamic Line Ratings (DLRs)

- Order 881 defined DLRs as line ratings that:
 - Apply to time periods of not greater than one hour; and
 - Reflect up-to-date forecasts of inputs such as ambient air temp, wind speed/direction, solar heating, transmission line tension, and transmission line sag.
- Order 881 also:
 - Requires RTOs/ISOs be able to accept DLRs; and
 - Determined the record in Order 881 was not sufficient to evaluate a potential DLR requirement, and therefore established a new proceeding in Docket No. AD22-5-000 to consider that issue.
 - In February 2022, the Commission issued in that new docket a Notice of Inquiry on the need for a DLR requirement and on its possible structure.



Emergency Line Ratings

- Order 881 established the following definition:
 - “Emergency Rating” means a Transmission Line Rating that reflects operation for a specified, finite period, rather than reflecting continuous operation. An Emergency Rating may assume an acceptable loss of equipment life or other physical or safety limitations for the equipment involved.”
- Order 881 also requires that transmission providers:
 - Must use uniquely determined emergency ratings for contingency analysis in the operations horizon and in post-contingency simulations of constraints; and
 - Include separate AAR calculations for each Emergency Rating duration used.



Exceptions to line rating requirements under Order 881

- Order 881 provides the following exceptions to the line rating requirements:
 - (1) For reliability: Allow for the temporary use of a line rating different than would otherwise be required in instances when the use of such a temporary alternate rating is necessary to ensure safety and reliability.
 - (2) Where the transmission line rating is not affected by ambient air temperature or solar heating, AARs and seasonal line ratings are not required. Examples of such a transmission line may include (but are not limited to):
 - (1) a transmission line for which the technical transfer capability of the limiting conductors and/or limiting transmission equipment is not dependent on ambient air temperature or solar heating (for example an underground transmission line); or
 - (2) a transmission line whose transfer capability is limited by a Transmission System limit (such as a system voltage or stability limit) which is not dependent on ambient air temperature or solar heating.



Transparency Requirements

- Order 881 established the following transparency requirements:
 - (1) Transmission Owners must share line ratings and line rating methodologies with transmission providers and market monitors in RTOs/ISOs;
 - (2) Transmission providers must share line ratings and line rating methodologies with other transmission providers upon request in a timely manner;
 - (3) Transmission providers must maintain a database of their transmission owners' transmission line ratings and methodologies on the password-protected section of their OASIS site or other password-protected website; or
 - (4) Transmission providers must post any uses of exceptions to the Order 881 requirements and document the nature of and basis for each exception, as well as the date(s) and time(s) of initiation and (if applicable) withdrawal for the exception or the alternate rating.



Timeline for Compliance, Rehearing/Clarification, and New DLR Inquiry

- **January 18, 2022:** Five requests for rehearing and/or clarification are filed.
- **February 17, 2022:** DLR Notice of Inquiry is issued in AD22-5-000.
- **February 18, 2022:** Commission issued a notice stating that rehearings were denied by operation of law, and that the requests for rehearing would be addressed in a future order.
- **April 25, 2022:** DLR Notice of Inquiry comments due.
- **May 25, 2022:** DLR Notice of Inquiry reply comments due.
- **July 12, 2022:** Order 881 compliance deadline.
 - Date by which compliance filings must be filed with the Commission (adopting the new pro forma Attachment M requirements, or proposing deviations).
- **July 2025:** Order 881 implementation deadline.
 - Date by which required AARs and other requirements must be put into practice.



QUESTIONS???



RF Facility Ratings Webinar: PJM Order 881

David Hislop
Manager, Outage Analysis
Technologies

RF Webinar
April 4, 2022



PJM Current Approach

Human Performance Temp set changes are deliberate and not automatic.

- Operator-driven move to appropriate temp set within each given TO zone.
- Zonal weather forecasts provided to operators.

Parameters Procedural expectations.

- Minimum moves per day. (Night to Day and Day to Night ratings.)
- No maximum.

Awareness Thermal ratings posted on PJM OASIS every 10 minutes.

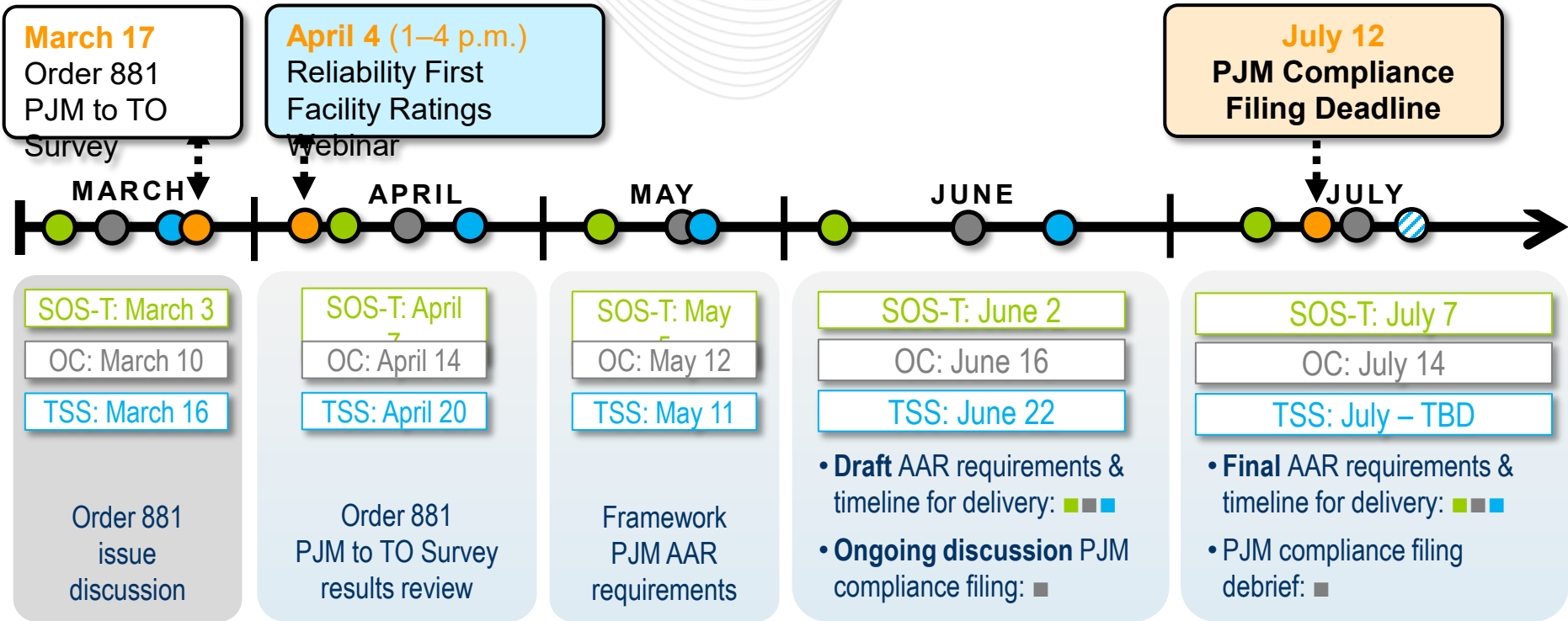
- As temperature sets. (32F – 95F, in 9F increments; Includes normal and 3 emergency ratings.)

Exceptions Beyond the above.

- Operator may adjust station or equipment from zonal ratings to local temps with owner agreement. Includes known conditional thermal ratings or should another rating be apropos.
- Seasonal zones are adjusted twice a year, with advance notice to downstream systems.



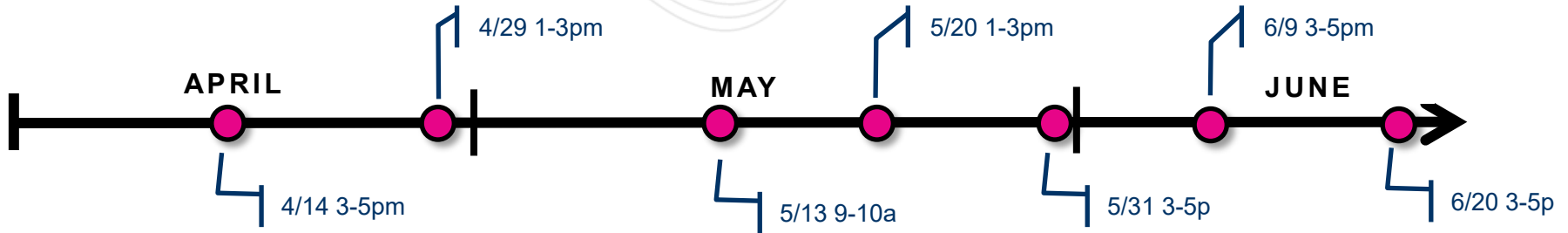
Timeline for PJM Compliance Filing



NOTE: Beyond the above, PJM will collaborate with additional stakeholder bodies such as TOPWG, RSCS, DTS and others as needed to work towards requirements and compliance objectives.



PJM OC Special Sessions



PJM has scheduled several OC special sessions to allow stakeholder feedback and input on PJM's Order 881 Compliance Filing. Although open to all stakeholders, these collaboration sessions are intended to be highly technical discussions among PJM subject matter experts and, principally, transmission owner subject matter experts relating to ambient adjusted ratings implementation on transmission owner lines. In PJM's continued updates to the full Operating Committee about the status of the Order No. 881 compliance efforts, PJM will report out on the progress and substance of the technical discussions in these OC special sessions. To the extent stakeholders have higher level general policy feedback or commentary about PJM's Order No. 881 compliance efforts, PJM encourages such discussions to occur at full Operating Committee meetings so that subject matter expert collaboration can proceed as needed at these technical special sessions.

Q1) Is the TO seeking to telemeter RT ratings to PJM for any facility?

Q2) If YES to Q1, will the TO be providing temp sets as well?

Q3) If YES to Q1, how will coordination of ratings take place with neighboring TOs/TOPs?

Q4) Will a TO be seeking to provide any portion of the 10 day hourly forecast for any facilities?

Q5) Will a TO have an issue with conforming to an RTO-based historic temp set? (i.e., Rather than one custom to their zone.)



Order 881: transmission owner requirements

- Calculate and share transmission line ratings and methodologies with their transmission provider(s) and with market monitors in RTOs/ISOs. [39]

For the pages that follow, “transmission line ratings” will be *ratings*.



Order 881: transmission provider requirements

- Share its *to ratings* and methodologies with any *tp* (upon the *tp*'s request). [39]
- Share & maintain a DB of their *to ratings* and methodologies on OASIS or other pwd-protected site. [39]
- Post on OASIS or other pwd-protected site exceptions and temporary alternate *ratings*. [39]
- Must use either AARs or seasonal line ratings, as appropriate. [41]
- Use AARs when evaluating requests for near-term transmission service (within next 10 days); and, for request responses on potential near-term transmission service; and, for posting ATC and other near-term transmission service to OASIS. [86]
- Use AARs in determining curtailment/interruption of near-term point-to-point transmission service. [87]
- Use AAR in determining curtailment/interruption/redispach of network or secondary service. [88]



Order 881: transmission provider requirements (cont.)

- Determine necessity of recourse ratings to utilize for the **safety** and reliability of the transmission system. [180]
- Determine that the *rating* is not affected by ambient air temperatures. [227]
- Determine that the use of a temporary alternate rating is necessary to ensure the **safety** and reliability of the transmission system. [228]
- Reevaluate AAR exceptions at least every five years to ensure technical basis remains valid. [233]
- Maintain DB for of exceptions and postings for five years. [234]
- Use emergency ratings for contingency analysis / constraints in operations horizon. [293]
- Use uniquely determined (from normal ratings) emergency ratings. [294]
- Duration of each emergency rating must be specified and communicated. [299]
- The *tp* has the obligation & latitude to develop accurate, safe, and reliable transmission line ratings. [127]



Order 881: RTO/ISO requirements

- Implement AARs in both DA & RT markets and intra-day reliability unit commitment.
- Implement AARs within SCED/SCUC models in both DA & RT markets and reliability unit commitments. [89]
- Allow *to* [electronically update ratings](#) (for each period for which they are calculated) at least hourly directly into the RTO/ISO EMS through SCADA or related systems. [255]



Order 881: Other areas

- Relevant transmission equipment **may include, but is not limited to**, circuit breakers, line traps and transformers. [40]
- Emergency rating duration best determined by *to* judgement. [301]
- ❑ Duration of each emergency rating must be specified and communicated by the *tp*. [299]

System Reliability: (Attachment M, Pages 292-293)

If the **Transmission Provider reasonably determines**, consistent with Good Utility Practice, that **the temporary use of a Transmission Line Rating** different than would otherwise be required by this Attachment **is necessary to ensure the safety** and reliability of the **Transmission System**, then the Transmission Provider may use such an alternate rating. The Transmission Provider must document in its database of Transmission Line Ratings and Transmission Line Rating methodologies on OASIS or another password-protected website, as required by this Attachment, the use of an alternate Transmission Line Rating under this paragraph, including the nature of and basis for the alternate rating, the date and time that the alternate rating was initiated, and (if applicable) the date and time that the alternate rating was withdrawn and the standard rating became effective again.



Order 881: Intent on Exceptions to AAR

- Flexibility for *to* and *tp* to apply good utility practice in AAR exception determination. [45]
- *to* will be required to provide to the RTO/ISO the list of transmission lines which have been exempted from the AAR requirement (under the “Exceptions” paragraph of pro forma OATT Attachment M) or temporary alternate ratings (under the “System Reliability” section of pro forma OATT) [140, footnote 333]

NOTE: In other paragraph requirements [180, 227, 228], the determination of exceptions was placed upon the *tp*.

- The *to* here is providing the AAR Exceptions to the RTO/ISO, who the Order indicates is the *tp*.
- The *tp* is also obligated [233] to reevaluate Exceptions every five years.



AAR Temp Set: What might this look like?

F	NL	LTE	STE	LD
130				
125				
120				
115				
110				
105				
100				
95				
90				
85				
80				
75				
70				
65				
60				
55				
50				
45				
40				

F	NL	LTE	STE	LD
35				
30				
25				
20				
15				
10				
5				
0				
-5				
-10				
-15				
-20				
-25				
-30				
-35				
-40				
-45				
-50				
-55				

- Repeated twice to include Night/Day temp sets.
- Extremes (min/max) subject to meeting PJM RTO / TO needs and Order 881 requirements.
- Potentially includes a TO telemetering their in-use temp set to PJM, per zone.

Presenters:
Dave Hislop
David.Hislop@PJM.com



FERC Order No. 881



Review of MISO's Rating Process and Order 881 Impacts

Reliability First Facility Ratings
Webinar

April 4, 2022

Purpose & Key Takeaways



Purpose:

- Provide an overview of the landscape of ratings at MISO and highlight the impacts of FERC Order 881

Key Takeaways:

- Transmission Owners provide MISO with equipment ratings
- MISO will maintain a database of hourly AARs and other ratings information.
- MISO has been leveraging AARs for nearly a decade
- FERC Order 881 will require more advanced ways to manage real-time and forecasted ratings, especially on jointly own facilities


Key Definitions

- **Ambient-Adjusted Ratings (AARs):** a transmission facility rating that: (1) applies to a time period of not greater than one hour; (2) reflects an up-to-date forecast of ambient air temperature across the time 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 periods are updated at least monthly, if not more frequently; and (4) is calculated at least each hour, if not more frequently.
- **Dynamic Line Ratings (DLRs):** a transmission facility rating that: (1) applies to a time period of not greater than one hour; and (2) reflects up-to-date forecasts of inputs such as (but not limited to) ambient air temperature, wind, solar heating intensity, transmission line tension, or transmission line sag.
- **Emergency Rating:** a transmission facility rating that reflects operation for a specified, finite period, rather than reflecting continuous operation. An emergency rating may assume acceptable loss of equipment life or other physical or safety limitations for the equipment involved
- **Facility:** a set of electrical equipment ratings that collectively operates as a single bulk electric system element (e.g., transformers, relay protective devices, terminal equipment, and series and shunt compensation devices)
- **Facility Rating:** The maximum or minimum voltage, current, frequency, or real or reactive power flow through a facility that does not violate the applicable equipment rating of any equipment comprising the facility
- **Seasonal Line Rating:** transmission line rating that: (a) applies to a specified season, where seasons are defined by the transmission provider to not include more than three months in each season; (b) reflects an up-to-date forecast of ambient air temperature across the relevant season over which the rating applies; and (c) is calculated monthly, if not more frequently, for each season in the future for which transmission service can be requested.”

Current Ratings Process

TOs are charged with providing ratings to MISO

MISO Transmission Owners Agreement



TO are required to provide normal and emergency ratings for all equipment in the Transmission System



MISO has the ability to verify and accept ratings



MISO has the ability to request rating methodologies

Current Roles and Responsibilities

MISO

- MISO uses the ratings provided by TOs for congestion management and maintaining reliability
- MISO has a clear line of demarcation and handoffs between TOs

Transmission Owners

- Required to provide ratings to MISO
- Responsible for maintaining the equipment and updating ratings as necessary

Order 881 AAR Requirements

- AARs must be developed and updated for all transmission equipment that is capable of temperature adjustment
- AARs must use night and day periods to broadly account for solar effects
- Hourly rating forecast for the next 10 days (240 hours)
- AARs must be refreshed at least hourly with best available data
- Exceptions must be documented

AARs must be leveraged in...

- Real-time Ratings
 - Real-time markets (UDS/SCED)
 - MISO supports this today
 - Transmission Service
 - Interregional congestion (e.g. TLR)
- Forecasted Ratings
 - Transmission service in the next 10 days
 - Foreword markets
 - Day-Ahead
 - Forward unit commitment
- Curtailment, interruption, and/or redispatch expected to occur in the next 10 days

Emergency Ratings Requirements



Each transmission facility must have uniquely-determined emergency ratings

Rating must account for ambient air temperature and daytime/nighttime solar heating

Duration of emergency rating is determined by TO and communicated to the TP

Emergency rating determined for real-time and forecasted hourly rating, for next 10 days

Additional Seasonal Ratings

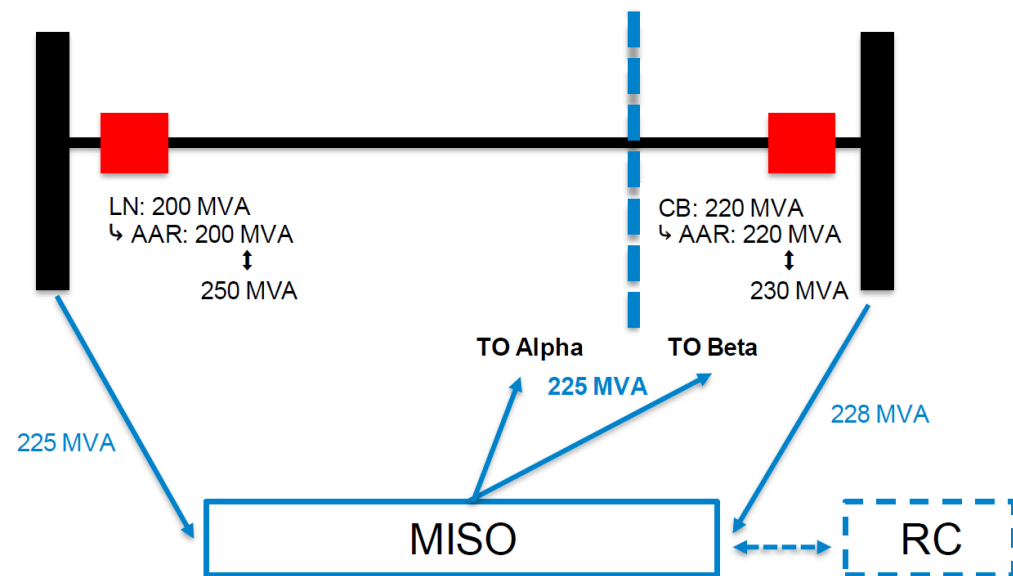
- FERC is requiring at least 4 seasons
 - MISO currently supports 4 seasons in most systems
 - Seasonal ratings must be uniquely determined but need not arbitrarily differ
- FERC allowed flexibility in defining the timespan of each season

Additional Transparency

- MISO must maintain 5 years of ratings data, including supporting methodology
- This data must be available on the OASIS or similar website (e.g. MISO Extranet)
- Rating Methodologies must also be shared with Market Monitors
 - Transmission providers must share with other transmission providers upon request

Ratings Clearinghouse

- MISO evaluating providing a central service to submit multiple ratings for a facility
- MISO would clear the most conservative and communicate to all interested entities



MISO Impacts

- MISO's real-time AAR systems are mature and support AARs and Dynamic Line Ratings (DLRs)
- Leveraging forecasted ratings:
 - Day-Ahead and Forward Reliability Assessment Commitment
 - Transmission Service
- New ratings data interface with TOs
- Transparent web postings
- More to come as the implementation specifics with TOs come into focus...

Next Steps



Compliance Filing:

By July 12, 2022



Effective Date

By July 12, 2025



Continued Collaboration

MISO will develop implementation plan and collaborate with TOs



AAR Preparedness

MISO is ready and partnering with TOs to add their new AAR as they are made available.

Questions?

Contact MISO:

Vikram Godbole, vgodbole@misoenergy.org

Brian Kiefer, bkiefer@misoenergy.org

Chris Supino, csupino@misoenergy.org

10min Break

We will take a 10 min break



Don't need the full 10 min?

Complete our
webinar survey at
Slido.com
#FacilityRatings





Ambient Adjusted Rating (AARs)

Chris Shaffer

American Electric Power



Energy Delivery Operations

- Operate in 11 states
- Across Texas RE, RF & MRO
- ~5.5 million regulated customers
- ~16,800 employees
- ~30,000 MW Generation
- ~40k miles Transmission line
- ~223k miles Distribution line
- Over 6000 substations



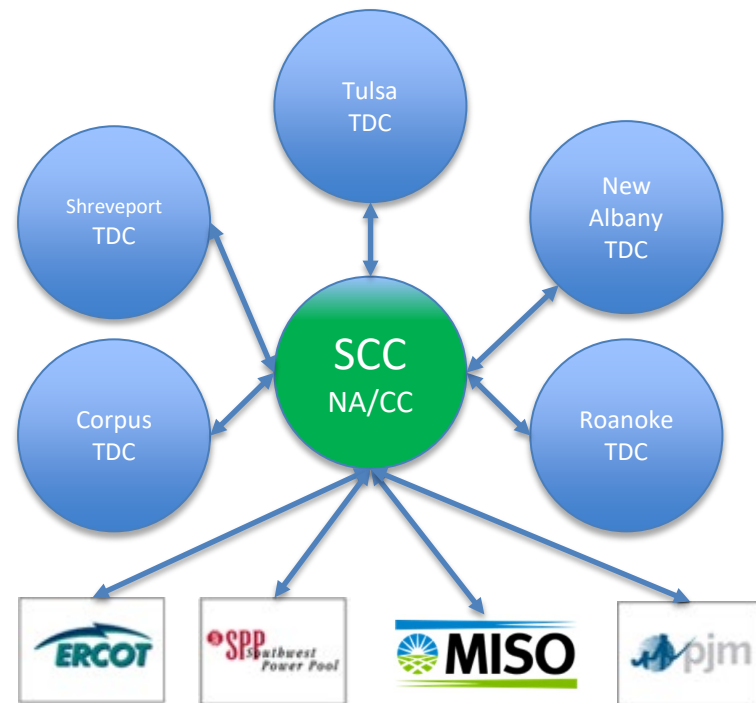
AEP Transmission and Service Area Map

*BOUNDLESS ENERGY*SM

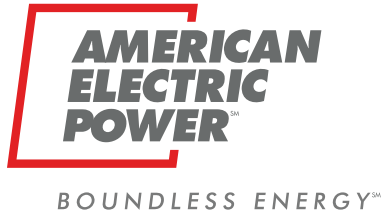


Energy Delivery Operations

- AEP Energy Delivery Operations has **five** active control centers responsible for the operation of AEP's Transmission System
- AEP functions as TOP in PJM, MISO, SPP, and ERCOT



BOUNDLESS ENERGYSM



AEP State Estimator Ambient Adjusted Ratings

- AEP presently using a GE/Alstom EMS platform
 - AAR algorithm was custom built by AEP
 - GE/Alstom does include an AAR calculation as part of their base product (different from AEP version)
- AEP is in the process of moving to OSI Monarch EMS platform
 - OSI Monarch includes AAR algorithm similar to what AEP is using in the AEP customized version of GE/Alstom EMS



BOUNDLESS ENERGYSM



AEP State Estimator Ambient Adjusted Ratings

- 3rd Party Vendor used for Temperature Data
 - Contract includes data security and encryption
- AEP created a diverse and redundant application which queries 3rd party's Web API
 - Application runs on a protected but non-CIP network
 - Front end processors then poll the application to update SCADA (CIP) with temperature data



*BOUNDLESS ENERGY*SM



AEP State Estimator Ambient Adjusted Ratings

- AEP State Estimator Temp Zones & Monitoring
 - Real-time temperature data retrieved every 5 minutes and refreshed with every SE process run

AEP SE Temperature Zone Monitoring		
PJM-MISO	SPP	ERCOT
IM – Indiana & Michigan	PSO – Tulsa	TNN – Childress
OOC – Ohio (OPCO)	SWEP – Shreveport	TNC – Abilene
RO – Roanoke	SYSTEM – AEP System Average	TNW – San Angelo
AB – Abingdon		TCC – Corpus Christi
TR – Tristate		TCS – Harlingen & Mcallen
SYSTEM – AEP System Average		TCW – Del Rio & Laredo
		TCN – Victoria

**AMERICAN
ELECTRIC
POWER™**

BOUNDLESS ENERGY™

AEP State Estimator

Ambient Adjusted Ratings

Kremlin Production - Branch Data

BranchID: 180463 | Group: | Bus KV: 138 | DPGC1 WPC | BusName1: 242968
 Branch Description: WEST BELLAIRE 138 - BRUES 138 1 | BusName2: 243143
 BranchNum: 1 | Circuit ID: 2 | From Bus: 05BRUES 138 | Metered Side = To Bus: Yes | To Bus: 05WBELLA 138 | Status: 1 - In Serv | History | Mark | Del. Req.
 CKT Name: Brues - West Bellare 138 kV | WKeyID: 5399 | WO | REV
 Station1: BRUES | Zone 1: 9 | Authorized By: BRIAN HOLBROOK | In Date: 12/31/2015 | In Project ID: TP-2009-138
 Station2: WEST BELLAIRE | Zone 2: 8 | Data Entry By: rebecca naugle | Out Date: | Out Project ID: |
 Branch Data | Sub Branch Data | Terminal Elements / Relays / C | MLSE | Cop | Suits | TOR | Attachments

MLSE Entry Date: 8/21/2015
 MLSE Authorized By: |
 MLSE Entry By: rebecca naugle

Overall MLSE (MVA) (including limiting elements, conductors and Interconnection overrides)
 SN: 205 | WN: 258
 SE: 284 | WE: 320

Relay Compliance Trip Limit is a calculated limit - actual relay trip setting is higher, based on PRC-023 requirements

Description	Bus_Bus	Bu	Mult	Comments	SN_M	SE_M	WN_M	WE_M
ACSR ~ 556.5 ~ 26/7 ~ DOVE	05BRUES - 05WBEL	138	1	Conductor Section 1	205	284	258	320
ACSR ~ 556.5 ~ 26/7 ~ DOVE	05BRUES - 05WBEL	138	1	Conductor Section 2	205	284	258	320
Bus 1.5" AL Tubular	05BRUES	138	1	Brues Line Loops	287	337	363	400
Wavetrap (2000A)	05BRUES	138	1	Brues Wavetrap	487	550	539	597
Wavetrap (2000A)	05WBELLA	138	1	W. Bellaire Wavetrap	487	550	539	597
Switch (2000A)	05WBELLA	138	1	Brues Sw. CB C1 (2)	548	601	712	756
Sub cond 2-1272 AAC	05BRUES	138	1	Brues Bus/Risers	588	686	742	815
Breaker (3000A) Non Oil	05BRUES	138	1	Brues CB C1	747	747	926	926

- Engineering ensures core/seasonal ratings from TPLAN database match in the SE and are submitted to RTOs

- Ambient Adjusted Ratings
- Core/Seasonal Ratings

LN Limit Information OK

LN	From Station	To Station	ID	From End	To End	In	Out	NORM	EMERG (Line: MVA)	LDSHD
1	BRUES	WBELLAIR						228.9	300.2	309.6
Eligible: <input checked="" type="checkbox"/> Enterable: <input type="checkbox"/> Online Set: 1 <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>								205.0	284.0	293.0
Alternate Set: SUMMER								258.0	320.0	330.0
Alternate Set: WINTER										

BOUNDLESS ENERGY™



AEP State Estimator

Ambient Adjusted Ratings

- The AEP State Estimator calculates ambient adjusted ratings based on real-time temperature data
 - AAR algorithm performs calculation via interpolation between the core summer/winter facility ratings (normal and emergency)
 - All facilities are assigned to a zone and temperature data is applied to each zone for use in the state estimator AAR algorithm

AAR

STUDY CA BRANCH SUMMARY									
CTVL: 13 Items									
KV	Monitored Elements	Emergency Limit (MVA)	Pre CTG (MVA)	Post CTG (MVA)	% Over Limit	CTG Description	NEW Viol	Time Since	CTG ID
138	MALISZEW-HYATTCS-0138-1@MALISZEW	254	170	299	117	HYATT - MALISZEWSKI 138-2	<input checked="" type="checkbox"/>	29-May-2014 10:56:06	CCT00253
345	AMOS TRANSF 3/X__8	800	354	797	100	AMOST7 345/138/34.5	<input type="checkbox"/>	29-May-2014 06:14:28	XFMR2048
138	AMOS TRANSF 1/X__8	800	351	796	99	AMOST7 345/138/34.5	<input type="checkbox"/>	29-May-2014 06:14:28	XFMR2048
138	NCROWNCI-THIVENER-0138-1@NCROWNCI	108	55	98	91	SPORNTB 3/1 MOAB	<input checked="" type="checkbox"/>	29-May-2014 10:56:06	XFMR2264
138	NEWCOMER TRANSF 1/X__1	72	40	64	88	MUSKING - ENEWCON - WCAMBRID 138	<input type="checkbox"/>	29-May-2014 09:26:06	CCT02357
345	NEVERLY MUSKINGH 345/138/34.5	1072	522	922	86	KAMMER - MASSEL 345	<input checked="" type="checkbox"/>	29-May-2014 10:56:06	CCT01262

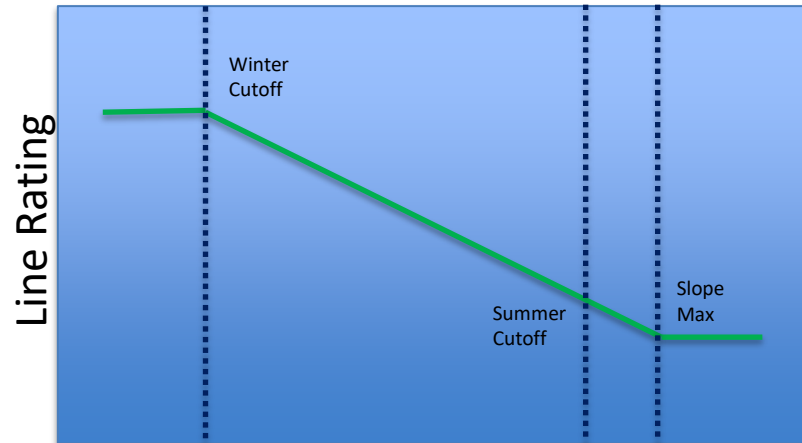


AEP State Estimator

Ambient Adjusted Ratings

- Regional differences in AAR calculations based on planning criteria / RTO recommendations

SE	Equipment	Cutoff Summer Temp	Cutoff Winter Temp	Slope_Max Temp	Slope_Min Temp
PJM-MISO	Lines	95°F	35°F	104°F	35°F
SPP	Lines	104°F	68°F	115°F	68°F
ERCOT	Lines	104°F	68°F	115°F	68°F



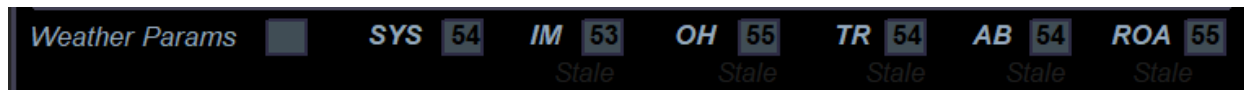
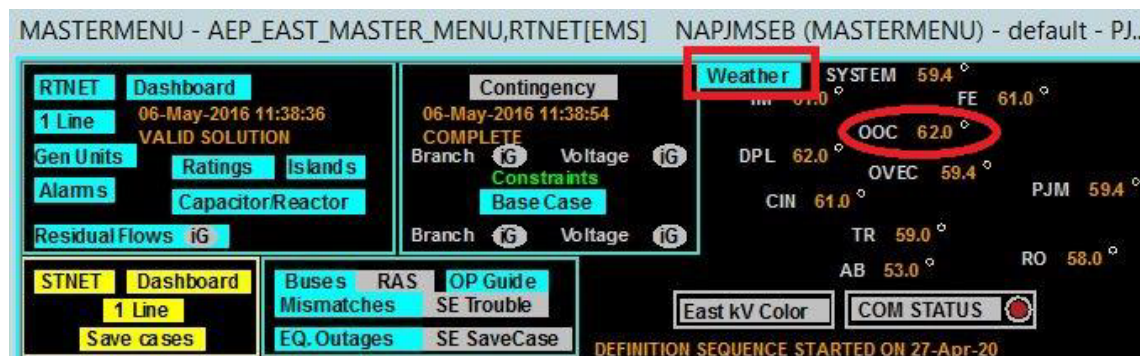
Ambient Temperature

BOUNDLESS ENERGYSM

AEP State Estimator

Ambient Adjusted Ratings

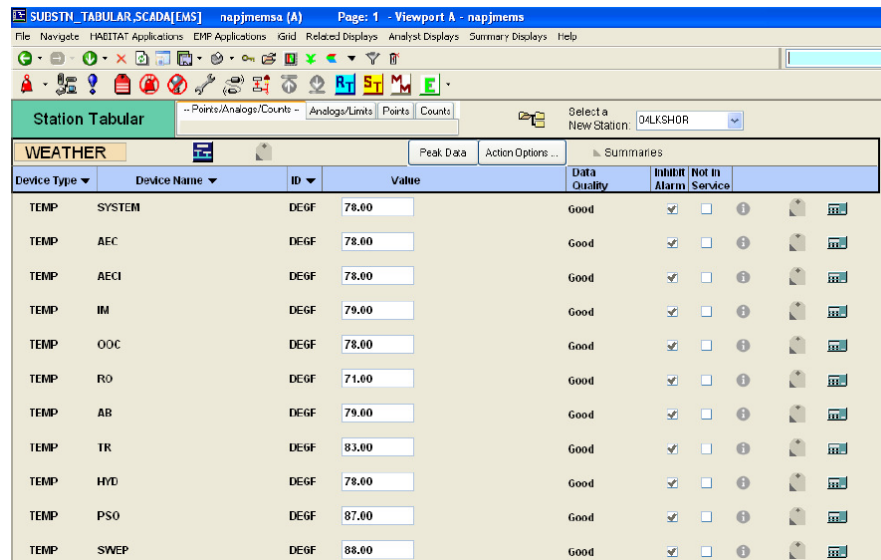
- Operators monitor weather parameter status through visual indicators on dashboards and supplemental PI displays



AEP State Estimator

Ambient Adjusted Ratings

- SYSTEM temperature zone values are used as the default backup for individual point failures
- Operational procedures established to manually override Temperature zone values for failed / unreasonable data
- Temperature data may also be adjusted for Operational study purposes



Device Type	Device Name	ID	Value	Data Quality	Inhibit	Not In Service		
TEMP	SYSTEM	DEGF	78.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
TEMP	AEC	DEGF	78.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
TEMP	AEC1	DEGF	78.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
TEMP	IM	DEGF	79.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
TEMP	OOC	DEGF	78.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
TEMP	RO	DEGF	71.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
TEMP	AB	DEGF	79.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
TEMP	TR	DEGF	83.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
TEMP	HYD	DEGF	78.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
TEMP	PS0	DEGF	87.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		
TEMP	SWEP	DEGF	88.00	Good	<input checked="" type="checkbox"/>	<input type="checkbox"/>		



AEP State Estimator

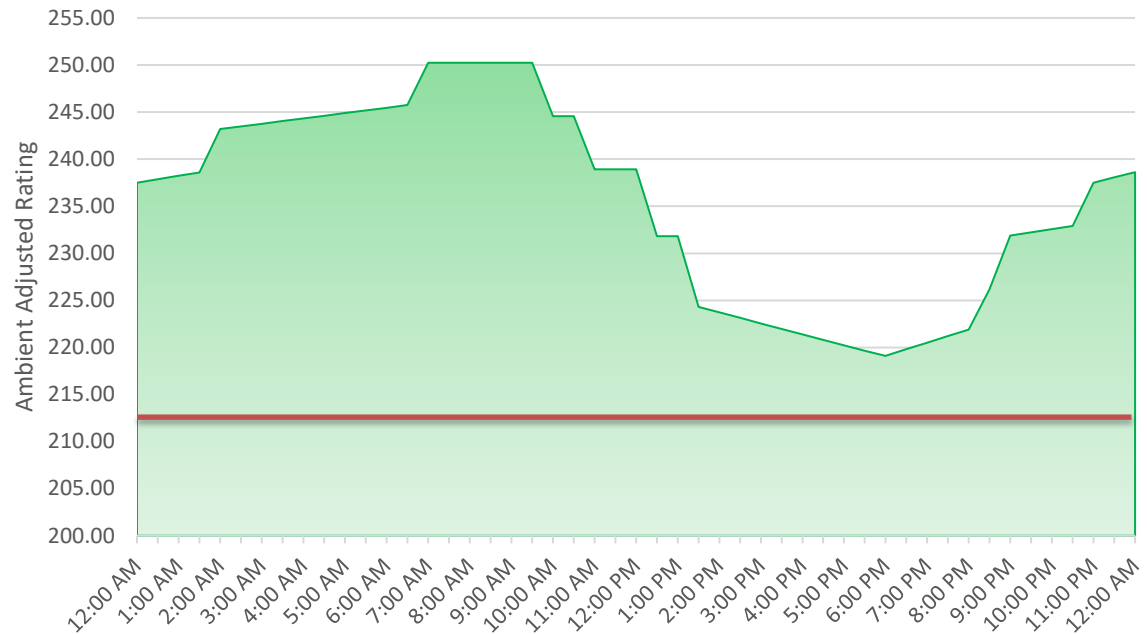
Ambient Adjusted Ratings

- Sample AARs for Sept 1 on one AEP facility
 - With no AAR, would be limited to Summer static limit only

AAR example for 21STTAP_TULSE1 138 kV

LN Limit Information

LN	From Station	To Station	ID	From End	To End	In	Out	NORM
1	21STTAP	TULSA_SE						
Eligible: <input checked="" type="checkbox"/> Enterable: <input type="checkbox"/> Online Set: 1 <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>								229.0
Alternate Set: SUMMER								212.0
Alternate Set: WINTER								263.0



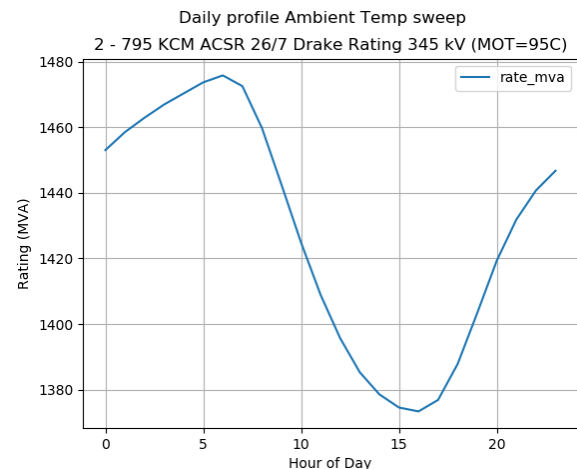
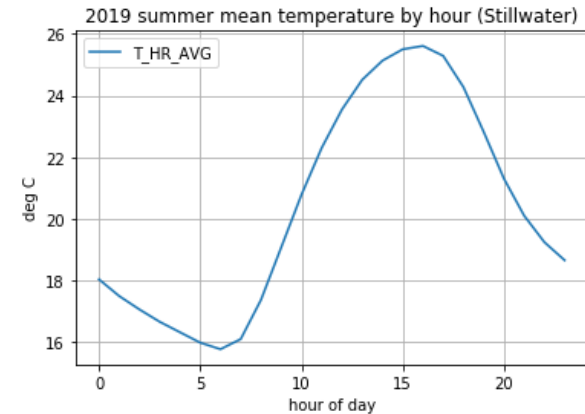
September 1, 2021



AEP State Estimator

Ambient Adjusted Ratings

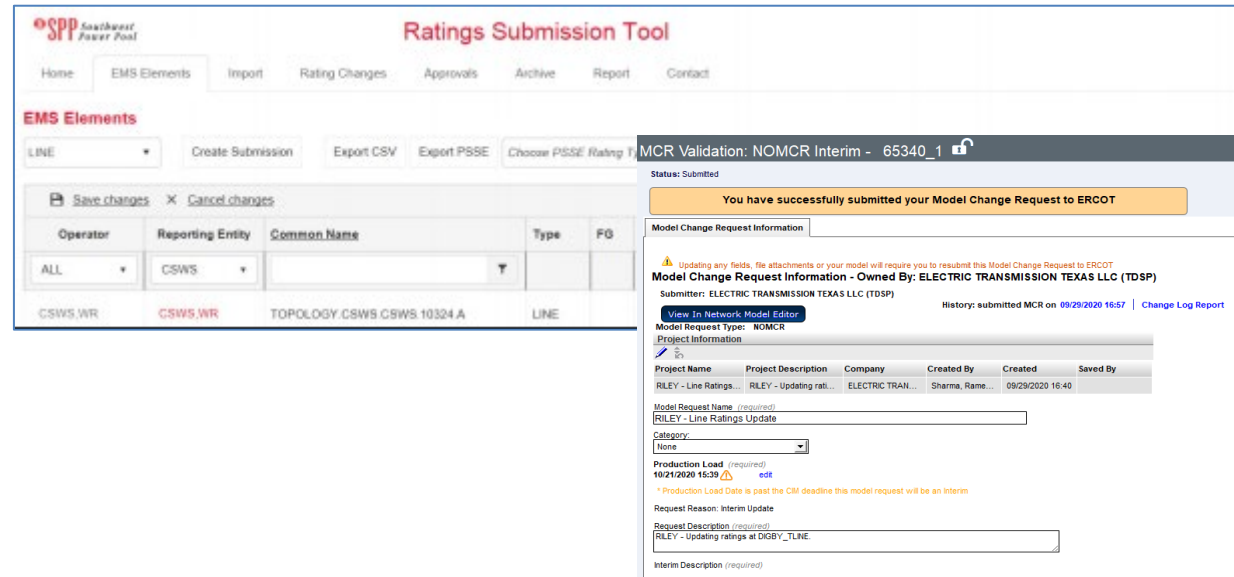
- Example AAR for a typical daily temperature profile for a 345 kV line in the AEP footprint



RTO Coordination Ambient Adjusted Ratings

- PJM TERM Tickets
 - AEP AARs closely match PJM 8 temperature sets
- SPP Rating Submission Tool
 - Subset of AEP AARs sent via ICCP
- MISO seasonal rating provided via email
 - AARs for AEP only facilities sent via ICCP
- ERCOT NOMCR rating submittals
 - AEP AARs closely match ERCOT temperature sets (btw 20-115 degrees) for select facilities

	Normal		Long Term		Short Term		Load Dump	
Temp	Day	Night	Day	Night	Day	Night	Day	Night
95	1108	1108	1108	1108	1108	1108	1142	1142
86	1175	1175	1175	1175	1175	1175	1211	1211
77	1242	1242	1242	1242	1242	1242	1280	1280
68	1309	1309	1309	1309	1309	1309	1349	1349
59	1377	1377	1377	1377	1377	1377	1419	1419
50	1444	1444	1444	1444	1444	1444	1488	1488
41	1511	1511	1511	1511	1511	1511	1557	1557
32	1578	1578	1578	1578	1578	1578	1626	1626



SPP Southwest Power Pool

Ratings Submission Tool

Home | EMS Elements | Import | Rating Changes | Approvals | Archive | Report | Contact

EMS Elements

LINE * Create Submission Export CSV Export PSSE Choose PSSE Rating Type

MCR Validation: NOMCR Interim - 65340_1

Status: Submitted

You have successfully submitted your Model Change Request to ERCOT

Model Change Request Information

Updating any fields, file attachments or your model will require you to resubmit this Model Change Request to ERCOT

Model Change Request Information - Owned By: ELECTRIC TRANSMISSION TEXAS LLC (TDSP)
 Submitter: ELECTRIC TRANSMISSION TEXAS LLC (TDSP) History: submitted MCR on 09/29/2020 16:57 | Change Log Report

View In Network: Model Editor

Model Request Type: NOMCR

Project Information

Project Name	Project Description	Company	Created By	Created	Saved By
RILEY - Line Ratings	RILEY - Updating rat...	ELECTRIC TRAN...	Sharma, Rama...	09/29/2020 16:40	

Model Request Name (required)
RILEY - Line Ratings Update

Category: None

Production Load (required)
10/21/2020 15:39 edit

* Production Load Date is past the CIM deadline this model request will be an Interim

Request Reason: Interim Update

Request Description (required)
RILEY - Updating ratings at DIGBY_TLINE

Interim Description (required)



RTO Coordination Ambient Adjusted Ratings

- Upon recognition of a constraint, the SCC engages in a constraint verification process with the RC
- Any rating discrepancy between the RTO and AEP is logged and the most conservative limits is used until the discrepancy is resolved
- If necessary, AAR can be overridden with manually entered values
 - May be necessary for tieline coordination or field identified equipment issues
- AAR coordination via ICCP could increase significantly
 - Presently providing to SPP and MISO on select facilities
 - Pending Order 881 implementation



FERC Order 881

- AEP formed a task force to review potential gaps for adherence to Order 881
 - Legal
 - Regulatory
 - Compliance
 - Operations
 - Planning
 - Engineering
- AEP has a good start on AARs but additional process changes likely needed to meet all requirements of Order 881

*BOUNDLESS ENERGY*SM



Summary

- AEP supportive of AARs to reliably optimize use of the AEP system as temperature varies while operating within FAC-008 SOL methodologies
 - Maximize transmission capability during cooler temps
 - Operate more conservatively during hotter temps
- Imperative operators can trust the situational awareness tools and processes must be in place to resolve discrepancies
- Internal FERC Order 881 team developed to review potential process changes
- Consistency in implementation, coordination and data management of AARs will be critical moving forward



BOUNDLESS ENERGY™



BOUNDLESS ENERGY™

Aurora Generation, LLC
Operated and Maintained by IHI Power Services



NERC FAC-008 Facility Ratings
from a Generator Owner Perspective

Presentation Overview

Establishing and maintaining accurate Facility Ratings greatly enhances the reliability of Facilities and the Bulk Electric System (BES).

- In this session, learn how Aurora Generation established and manages their Facility Ratings from a GO perspective in accordance with NERC Reliability Standard FAC-008 by reviewing their internal controls and lessons learned.

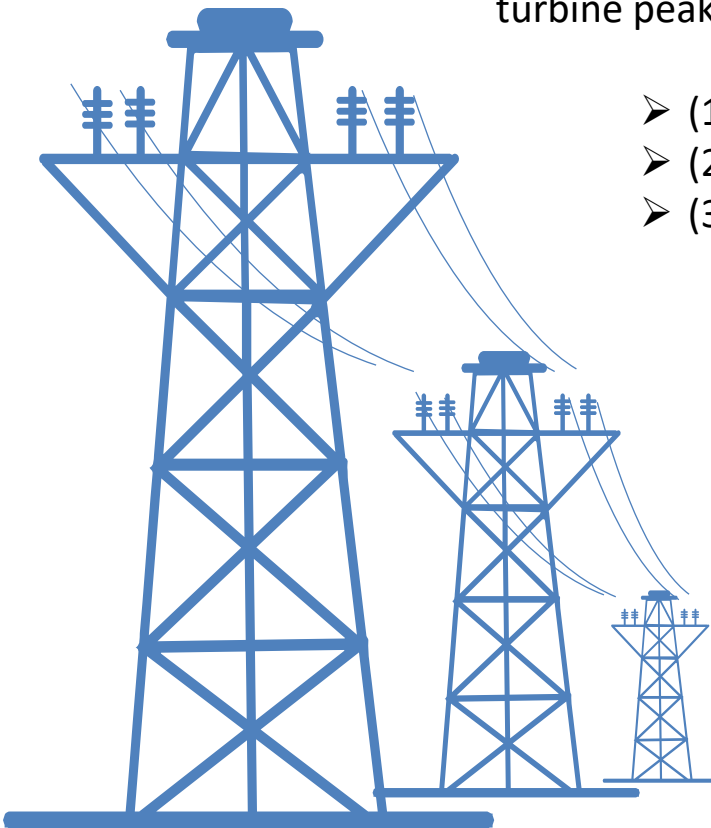
Aurora Generation Site Overview
Definitions
Internal Controls
Lessons Learned
Summary



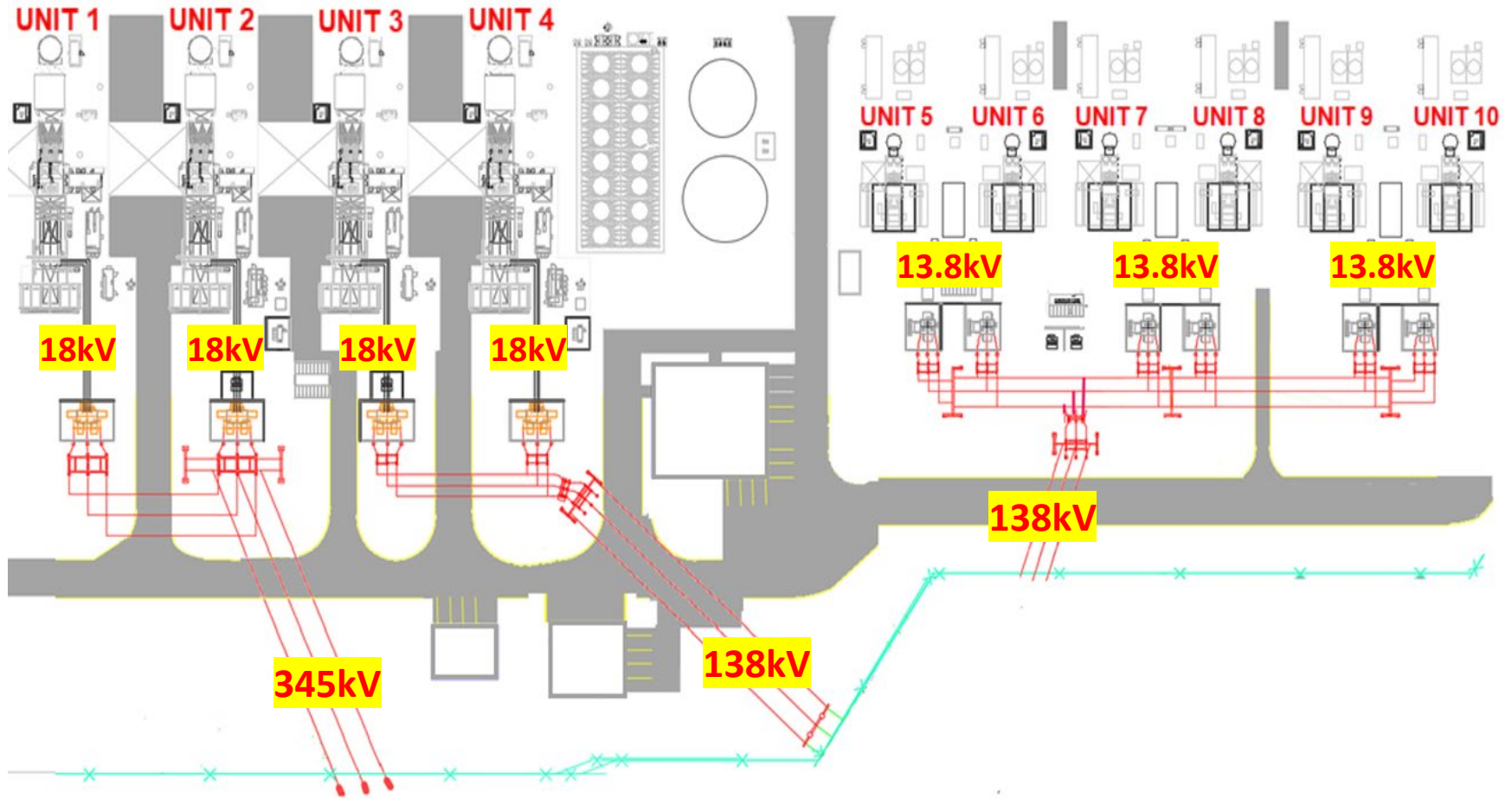
Aurora Generation Site Overview

➤ Aurora Generation is a natural gas-fueled, simple-cycle combustion turbine peaking plant that consists of the following:

- (10) Generating Units (listed Units 1-10)
- (2) Different type & rating Turbines and Generators
- (3) Separate High Voltage Interconnection Lines

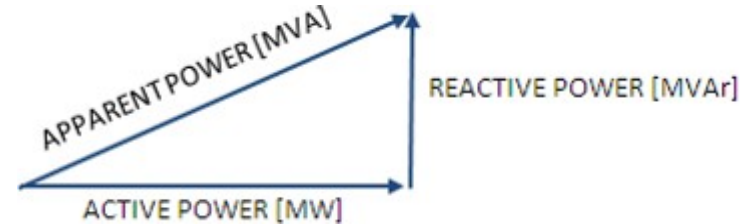


Aurora Generation Site Overview



Definitions

Apparent Power - Commonly referred to in the power industry by its unit of measure MVA. It is the vector sum of active power (MW) and reactive power (MVAR)



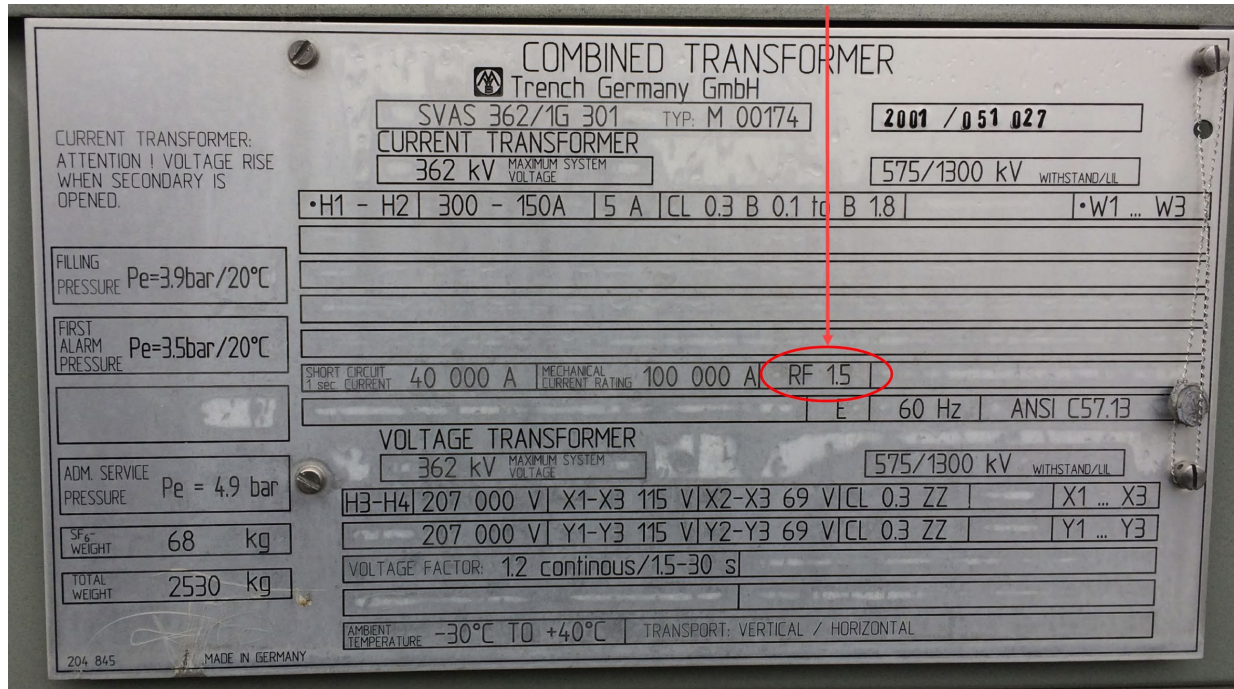
Emergency Ratings - The rating as defined by the original equipment manufacturer that specifies the level of electrical loading or output, usually expressed in megawatts (MW) or Mvar or other appropriate units, that a system, facility, or element can support, produce, or withstand for a finite period. The rating assumes acceptable loss of equipment life or other physical or safety limitations for the equipment involved.

Rating Factor (RF) - Is the number representing the amount by which the **rated current may be increased above a “nominal” or “standard” nameplate rating** without exceeding an allowable temperature rise.

Lesson Learned

Rating Factor (RF)

Rating Factor



- Rating Factor (RF) is a term that applies to Current Transformers. A Rating Factor greater than 1, provides additional margin of equipment ratings and should be utilized, especially if that equipment is found to be more limiting.
- Rating Factor can be missed during a review process, leading to possible inaccurate facility ratings.

Internal Controls

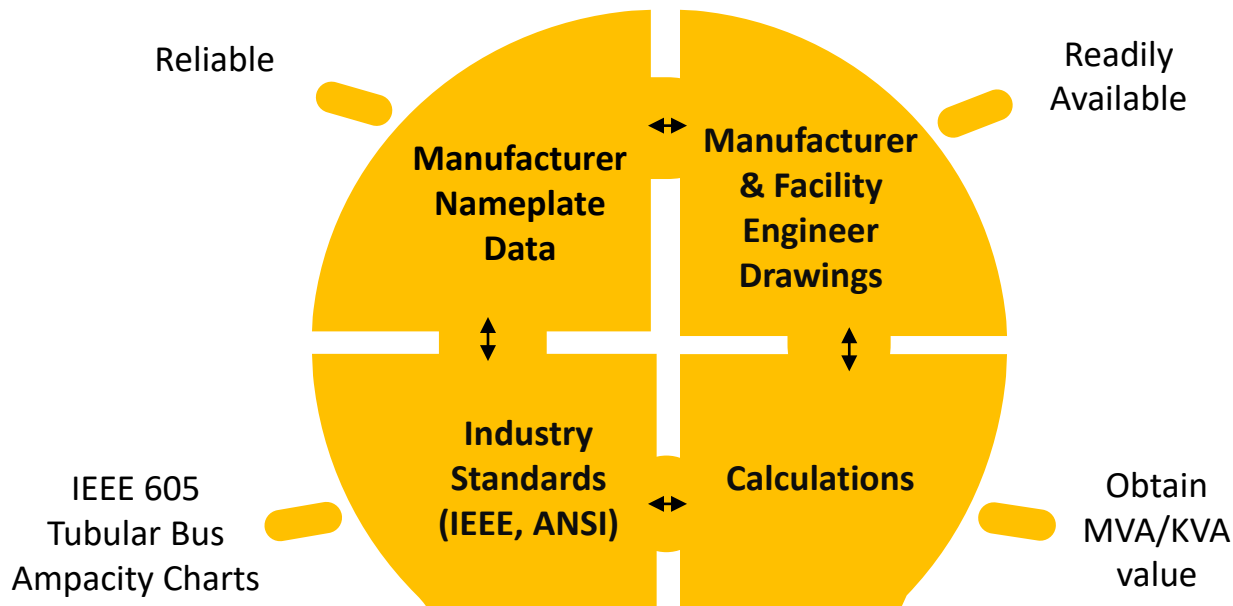
Identify all Individual Series Components

- Current as-built, official engineer approved/dated one-line and switchyard elevation drawings are utilized to identify all individual series components **from each generator to the Point of Interconnection.**
 - Including:
 - Current Transformers
 - Associated Protective Relays
 - Connecting bus detail (jumpers, A-Frame transition pieces)
- Perform field equipment walkdowns and compare with the prints.

Internal Controls

Basis of Equipment Ratings

Accurate facility and component ratings can prevent exposure of Facility components to overload conditions and potential degradation or failure



- Consider ratings for:
 - Current Transformers
 - Protective Relays
 - Limiting Component
- CT secondary current applied to each protective relay device is verified to be within the relay OEM's continuous current rating at the facility rated current.



Internal Controls Emergency Ratings

- Emergency ratings are required to be addressed within your facility ratings documents. If not utilized, the facility rating Methodology should specify that the emergency ratings are the same as normal ratings.
- Aurora does not operate utilizing emergency ratings to preclude the potential for equipment degradation and the adverse impact on equipment life expectancy.

*This is current state and does not address potential implications of Order 881 around emergency ratings for applicable entities”

Internal Controls

Identify Most Limiting Equipment

Each generating unit, from the generator, to the common GSU high side connecting circuit, was listed and evaluated to determine the most limiting component.

Each of the three switch-yard interconnecting circuits, from the GSU high side common point, to the POI, was listed and evaluated to determine if a limiting component existed based on total generation supplied to that common circuit and interconnection point.

The most limiting element was identified by establishing an MVA rating.

The MVA rating for each component listed was compared to each other and the most limiting component was identified.

The simple cycle combustion turbine operational limitations were noted to be more limiting than the generator or electrical equipment ratings from an overall operational aspect.

Internal Controls

Equipment List

- An Excel workbook was used with individual tabulations categorizing the 10 generating units based on the 3 Points of Interconnections (POI). Each tab is broken down into different sections that include the following:
 - Most limiting
 - Generator Facility
 - Transformer Facility
 - Relay Protective Devices
 - Notes

- Key items included:
 - Clearly identify most limiting component(s)
 - Identify Point of Interconnections (POI)
 - A “Note” section used for clarification
 - A revision tab is used to track, evaluate and document any changes to any components that could affect facility ratings.

Internal Controls Equipment List

Most Limiting & Second Most Limiting Equipment

Aurora Generation, LLC - Facility Ratings FAC-008 [Units 3 & 4] (Note 5)			
Parameter	Facility	Limiting Equipment (Note 6)	Equipment Rating (MVA)
Most Limiting [individual unit]	Generator	Generator	212.6
Most Limiting [combined]	Transformer	Substation Conductor	387.9
Second Most Limiting [individual unit]	Generator	Isolated Phase Bus Duct	218.2

Generator Facility: Generator to the Low Side Terminals of the GSU

Generator Facility (Generator to Low-Side GSU Transformer) (Note 3)						
Equipment	Designation / Manufacturer	Nominal Voltage (volts)	Rated Current Normal / Emergency (amps) (Note 1)	Apparent Power Normal / Emergency Rating (MVA) (Note 1)	Description	Basis of Equipment Rating
(2) Generator(s)	CT3 & 4 Generator(s) / GE	18 KV	6821 / 6821	212.6 / 212.6	GE - Hydrogen Cooled Generator	Manufacturer Data Plate Dwg. # 326B1319
Isophase Bus	Isolated Phase Bus Duct / Calvert	18 KV	7000 / 7000	218.2 / 218.2	Isophase Bus Duct from Generator Terminals to Generator Circuit Breaker	Calvert IPB Installation Layout D - 6179 - 31 - A1
Circuit Breaker	Generator Circuit Breaker 3 & 4 / Asea Brown Boveri (ABB)	18 KV	8000 / 8000	249.4 / 249.4	Generator Circuit Breaker Unit Type HEC 3	Manufacturer Name Plate [Guaranteed Rated Data of the Generator Circuit Breaker System HEC]
Isophase Bus	Isolated Phase Bus Duct / Calvert	18 KV	7000 / 7000	218.2 / 218.2	Isophase Bus Duct from Generator Circuit Breaker to GSU Transformer	Calvert IPB Installation Layout D - 6179 - 31 - A1

Nominal Voltage
18kV

Normal /
Emergency Ratings

Basis of
Equipment Rating

Internal Controls Equipment List

Transformer Facility: Low Side Terminals of the GSU to the Point of Interconnection

Transformer Facility (Low-side GSU transformer to Point of Interconnection) (Note 4)						
Equipment	Designation / Manufacturer	Nominal Voltage (volts)	Rated Current Normal / Emergency (amps) (Note 1)	Apparent Power Normal / Emergency Rating (MVA) (Note 1)	Description	Basis of Equipment Rating
Generator Step Up Transformers	Main Power Transformer 3 & 4 / Asea Brown Boveri (ABB)	138-18 KV	[H] 920.4 ; [L] 7056 / [H] 920.4 ; [L] 7056	220 / 220	Generator Step Up Transformer	Dwg # E1000 Sh. 3-4 Manufacturer Nameplate Data
Substation Conductors/Busses	Conductor from Main Power Transformer(s) to 138 KV Combined Metering CT / VT	138 KV	1623 / 1623	387.9 / 387.9	Aluminum Conductor 2156 KCMIL ACSR (84/19), Bluebird	138 KV SWYD ELEC. EQUIP. PLANS & MATL. Dwgs. T-202, T-207 (item #64) and T-221 & Manufacturer Specifications
Current / Voltage Transformers	138 KV Combined Metering CT / VT(s) Trench Limited	138 KV	3000 / 3000	717.1 / 717.1	Combined Current & Potential Transformer Type N5-650-138-302-S w/Thermal RF 1.0	Manufacturer Nameplate Data
Substation Conductors/Busses	Conductor from 138 KV Combined Metering CT / VT to 138 KV MOD(s)	138 KV	1623 / 1623	387.9 / 387.9	Aluminum Conductor 2156 KCMIL ACSR (84/19), Bluebird	138 KV SWYD ELEC. EQUIP. PLANS & MATL. Dwgs. T-202, T-207 (item #64) and T-221 & Manufacturer Specifications
Substation Disconnect Switches	138 KV Disconnect Switch 138 T3 & 4 / Pascor	138 KV	1200 / 1200	286.8 / 286.8	High Voltage Disconnect Switch Type TTR-8	138 KV SWYD ELEC. EQUIP. PLANS & MATL. DWGS. T-101, T-202, T-207 (item #3) and T-221
Substation Conductors/Busses	Common Bus from 138 KV MOD (s) T3 & T4 to & from A-frame bus transitions	138 KV	2783 / 2783	665.2 / 665.2	4" Aluminum Tubular Bus Schedule 40 SPS 6061-T6	138 KV SWYD ELEC. EQUIP. PLANS & MATL. Dwgs. T-202, T-207 (item #51) and T-221 & Manufacturer Specifications
Substation Conductors/Busses	138 KV A-frame bus transition(s)	138 KV	3520 / 3520	841.4 / 841.4	2 1/2" Aluminum Tubular Bus Schedule 40 SPS 6061-T6 (2/phase 1760 A each)	138 KV SWYD ELEC. EQUIP. PLANS & MATL. DWGS. T-202, T-207 (item #53) and T-221 & Manufacturer Specifications
Substation Conductors/Busses	Common Bus Line from 138 KV A-frame bus transition(s) to Line CB and Disconnect	138 KV	1623 / 1623	387.9 / 387.9	Aluminum Conductor 2156 KCMIL ACSR (84/19), Bluebird	138 KV SWYD ELEC. EQUIP. PLANS & MATL. Dwgs. T-202, T-207 (item #64) and T-221 & Manufacturer Specifications
Circuit Breaker	138 KV Line Circuit Breaker 138 CB2 / Asea Brown Boveri	138 KV	3000 / 3000	717.1 / 717.1	ABB GCB Type 145 PM 63 - 30	Manufacturer Specifications
Substation Disconnect Switches	138 KV Line Disconnect Switch 138 L2 / Pascor	138 KV	2000 / 2000	478.0 / 478.0	High Voltage Disconnect Switch Type TTR-8	138 KV SWYD ELEC. EQUIP. PLANS & MATL. Dwgs. T-101, T-202, T-207 (item #3) and T-221
Substation Conductors/Busses	138 KV Line 95103 to COMED (POI)	138 KV	1623 / 1623	387.9 / 387.9	Aluminum Conductor 2156 KCMIL ACSR (84/19), Bluebird	138 KV SWYD ELEC. EQUIP. PLANS & MATL. Dwgs. T-101, T-206 (item #64) and T-221 & Manufacturer Specifications

Most Limiting Component
(Combined Generation)

Point of
Interconnection

Nominal Voltage
138kV

Internal Controls Equipment List

Each Relay Device Listed Facility Rated Current (most limiting component) CT Tap Ratio Calculated Relay Input Relay OEM Continuous Current Rating CT & Relay Limiting? Yes or No

Relay Protective Device

Relay Protective Devices (Note 2)										
Designation	Facility Rated Current (amps) (from equipment worksheet above)	CT Tap Used	RF (if known) (Assume 1.0 if not known)	Calculated Relay Input (amps)	Limiting Relay/Secd Device Continuous Current Rating (amps)	Limiting Relay/Secd Device Type	CT Limiting? (Yes/No)	Relay Limiting? (Yes/No)	Basis for equipment ratings	
Beckwith M3430 Protection System	6821	8000 / 5	2.0	4.3	10	Multi-Function Generator Protective Relay	NO	NO	Manufacturer Specifications	
GE DGP	6821	8000 / 5	2.0	4.3	10	GE Multi-Function Digital Generator Protection	NO	NO	Manufacturer Specifications	
GE MDP [50RE]	6821	8000 / 5	1.0	4.3	5	GE Generator Digital Time Overcurrent Relay	NO	NO	Manufacturer Specifications	
GE LPSO	6821	8000 / 5	3.0	4.3	15	GE Line Protection System Relay	NO	NO	Manufacturer Specifications	
Main Power Transformer Diff Relay 87 T3/T4	[H] 920.4 : [L] 7056	[H] 1200 / 5 [L] 8000 / 5	1.0	[H] 3.8 : [L] 4.4	15	Schweitzer SEL-587 Transformer Differential Relay	NO	NO	Manufacturer Specifications	
18 KV Bus Diff Relay 87B	[H] 920.4 : [L] 7056	[H] 1200 / 5 [L] 8000 / 5	1.0	[H] 3.8 : [L] 4.4	15	Schweitzer SEL-387 Differential Relay	NO	NO	Manufacturer Specifications	
138 KV Line / Bus Relay 87HB2	1623	2000 / 5	1.0	4.1	5	Alstom MFAC 34 High Impedance Diff Relay	NO	NO	Manufacturer Specifications	
138 KV Line / Bus Relay 87PRI	1623	2000 / 5	4.0	4.1	20	Type LFCB 102 Current Differential Line Protection Relay System	NO	NO	Manufacturer Specifications	
138 KV Line / Bus Relay 21SEC	1623	2000 / 5	1.0	4.1	15	Schweitzer SEL-321 Phase & Gnd Distance , Dir OC Relay and Fault Locator	NO	NO	Manufacturer Specifications	
138 KV Line / Bus Relay 50/2LBB	1623	2000 / 5	1.0	4.1	15	Schweitzer SEL-251C Multi-Function Distribution Relay	NO	NO	Manufacturer Specifications	

Notes

Notes	
Number	Notation:
1	Plant does not operate using emergency ratings. Emergency Ratings are considered the same as Normal Ratings unless otherwise indicated.
2	All relay protective devices verified to not be limiting considering facility rated current, rating of current transformer, and relay rating.
3	The Generator Facility is defined as from the generator to the low side terminal of the main step-up transformer (GSU)
4	The Transformer Facility is defined as from the low side terminal of the GSU to the point of interconnection or the point of change in ownership as applicable.
5	There are (2) 18 KV generators, isophase bus and circuit breakers connected to 2 individual feeder circuits. Each circuit is equipped with a 138/18 KV step up transformer rated at 220 MVA. Combined generator output is transmitted to Point of Interconnect (POI) with Commonwealth Edison via a single 138 KV Line with a 138 KV CB and Disconnect.
6	The GE simple cycle gas turbine nameplate rating of 159.4 MW (187.6 MVA), providing a combined unit turbine capability of 375.2 MVA is limiting under nominal operating conditions.

Note 2: All relay protective devices verified to not be limiting considering facility rated current, rating of CT, & relay rating

Internal Controls

Ambient Adjusted Ratings:

- Original Equipment Manufacturer (OEM) ratings and specifications incorporate ambient temperature considerations.

Underlying Assumptions:

- Equipment is operating as designed. The facility's generation and switchyard components are in a normal, steady state, configuration. Abnormal configurations for maintenance outages should be evaluated separately for impact with respect to "limiting component".
- OEM specifications and established "as-built" drawings accurately reflect ratings developed within acceptable industry guidelines to provide for continuous operation of components and equipment under nominal operating conditions.

Internal Controls

Operating Limits:

- If a component is identified to be the most limiting, administrative guidance should be put in place to prevent generation from exceeding the component's rating.

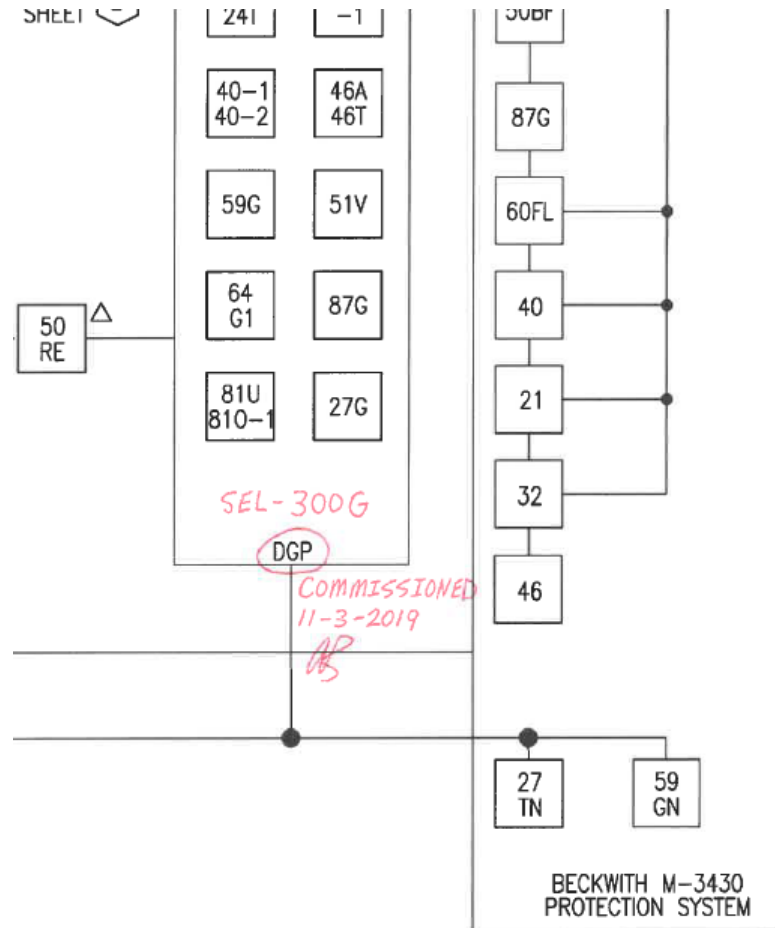
Consider the Generator Prime Mover:

- Operational limitations of the generator prime mover (gas turbine) was found to be limiting with regards to overall capability (MW/MVAR). This may vary seasonally with ambient conditions.
- Prime mover limitations can provide margin to as-built electrical Facility Ratings. The Facility turbine/generator capability limitations are specifically determined and reported in accordance with the MOD-025 Standard.
- **Mechanical equipment ratings are not required under FAC-008** but we include a note on our facility ratings list, to help the viewer understand that the prime mover is most limiting under normal operating conditions, especially when there is other equipment more limiting than the generator.

Internal Controls

Updating Prints

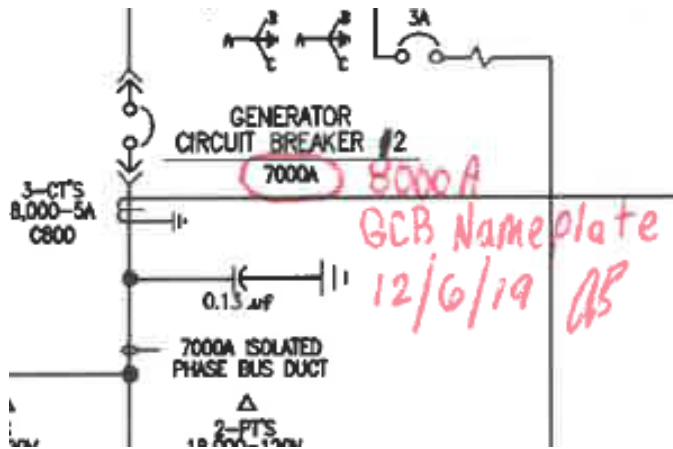
- Update facility drawings when there are equipment changes or if discrepancies are noted.



TION, SEE DEG. E-1000 SHT. 1

Lessons Learned

- In instances where a discrepancy existed between the as-built drawings and the “verified installed” OEM ratings, the “verified installed” equipment rating was utilized.



Guaranteed Rated Data of the Generator Circuit Breaker

System Data	
Type:	HEC 3
Year of manufacture:	2000
Serial number:	HA 1168-10
Order number:	13019598
Rated maximum voltage:	18 kV
Power frequency:	60 Hz
Rated continuous current:	8000 A
Rated short-circuit current, symmetrical:	100 kA
DC component of the peak value of the rated short-circuit current:	75 %
Close, latch and carry peak current:	300 kA
Short-time current, 1 sec:	100 kA
Assigned out-of-phase switching current:	63 kA
Rated power frequency withstand voltage:	60 kV / 70 kV
Rated full-wave impulse withstand peak voltage:	125 kV / 145 kV
Capacitor on generator side:	130 nF
Capacitor on transformer side:	260 nF
Total weight of the breaker system:	4100 kg
Instruction book / part list number:	CH-HS 2260 95
Circuit Breaker	
Serial number:	HA 1168-10
Rated design current:	9990 A
Rated operating SF6-pressure at 20 °C (68 °F):	90 psi
Rated short-circuit duty cycle:	CO - 30 min - CO
Load current operating sequence:	CO - 3 min - CO
Rated interrupting time:	55 ms
Operating Mechanism of the Circuit Breaker	
Type:	AHMA 4
Serial number:	HA 1168-11
Rated control voltage for closing coil:	125 V DC
Rated control voltage for tripping coil:	125 V DC
Rated voltage for motor drive:	125 V DC

Lessons Learned

Protective Relay Device Ratings:

5 Amps Nominal

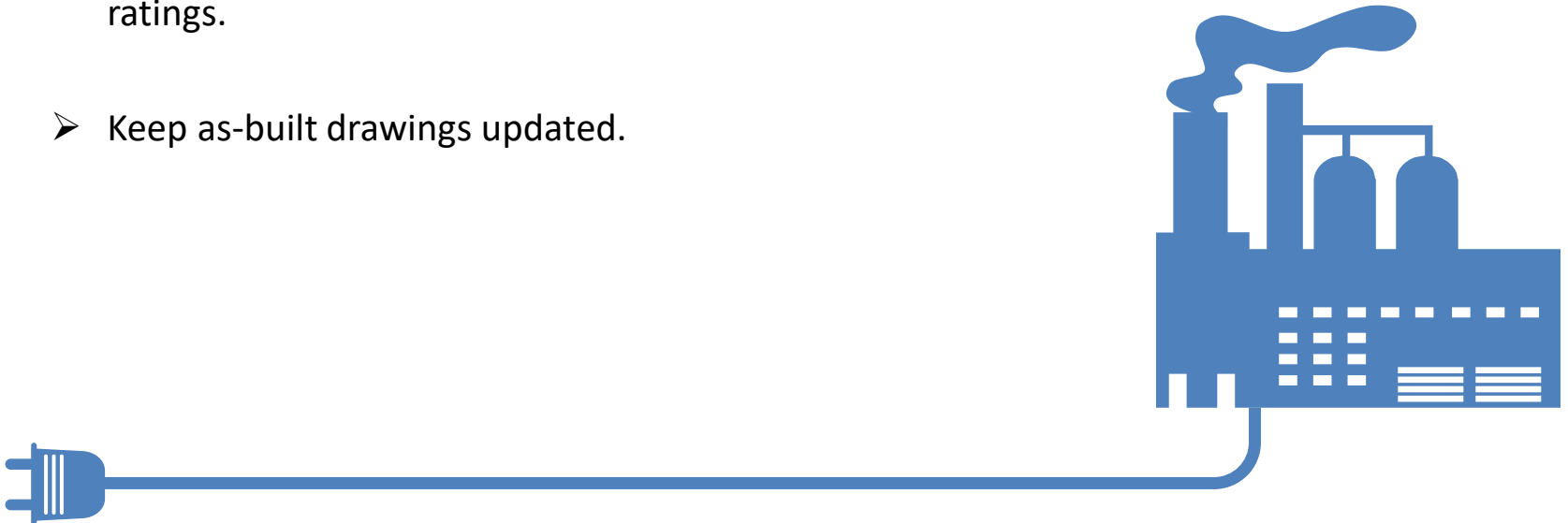
Seven Current Inputs: Rated nominal current (I_R) of 5.0 A or 1.0 A (optional), 60 Hz/(50 Hz optional). Will withstand $2I_R$ continuous current and $100I_R$ for 1 second. Current transformer burden less than 0.5 VA at 5 A (5 A option), or 0.3 VA at 1 A (1 A option).

10 Amps continuous

- Some protective relay manufacturers give a nominal and continuous current rating. In these instances, Aurora used the higher continuous current rating.

Summary

- Perform field equipment walkdowns on a routine basis, Verifying field installed equipment ratings, helps detect discrepancies between the as-built drawings and the “verified installed” equipment ratings.
- Performing multiple independent detailed reviews helps to verify items that have been overlooked such as CT Rating Factors and protective relay OEM continuous current ratings.
- Keep as-built drawings updated.





**NERC FAC-008 Facility Ratings
from a Generator Owner Perspective**

Thank You



Questions?



RELIABILITY FIRST

Facility Ratings – O&P Expectations

Jim Kubrak

Manager, Operations and Planning Monitoring



➤ **Monitoring initiative**

- 2022 - 2024
- Most Self-Certification specific to FAC-008



The Why

- **Through mitigation we are seeing the following results:**
 - We have seen up to **92%** inaccurate components
 - **84%** derate based on CT Thermal Limit
 - **60%** derate based on a missing Wave Trap
 - **5-20% average** Facility Rating derates
- **The operational data has shown that some of these Facilities were occasionally operating above their normal limits.**



Call To Action

- **Schedule a meeting with your FAC-008 SMEs**
- **Build & implement a self assessment strategy**
- **If no issues are found**
- **If issues are found self report**
- **RF is here to help**



“The best time to plant a tree was 20 years ago.
The second best time is now.”

– *Chinese Proverb*



Questions & Answers

Forward Together



ReliabilityFirst

Reliability First Presentation-
Facility Ratings Workshop
4/4/2022

Dynamic Line Ratings with Sensors

Horst Lehmann, Senior Engineer -
Transmission Planning

Eric Rosenberger, Senior Engineer -
Transmission & Substation Engineering
and Maintenance Standards



\$23.5 Million in annual congestion costs projected in 2025

Harwood to Susquehanna #1 & #2 | 230 kV | ACSS |

Juniata to Cumberland | 230 kV | ACSR |

2020/21 RTEP Market Efficiency Window Eligible Energy Market Congestion Drivers* (Posted 03-05-2021)				ME Base Case (Annual Congestion \$million)		ME Base Case (Hours Binding)	
FG#	Constraint	FROM AREA	TO AREA	2025 Simulated Year	2028 Simulated Year	2025 Simulated Year	2028 Simulated Year
ME-1	Kammer North to Natrium 138 kV	AEP	AEP	\$ 2.02	\$ 6.56	69	167
ME-3	Junction to French's Mill 138 kV	APS	APS	\$ 9.18	\$ 11.97	276	301
ME-4	Yukon to AA2-161 Tap 138 kV	APS	APS	\$ 4.36	\$ 5.16	1742	1958
ME-5	Charlottesville to Proffit Rd Del Pt 230 kV	DOM	DOM	\$ 3.76	\$ 4.96	121	124
ME-6	Plymouth Meeting to Whitpain 230 kV	PECO	PECO	\$ 3.33	\$ 4.09	111	101
ME-7	Cumberland to Juniata 230 kV***	PLGRP	PLGRP	\$ 9.00	\$ 6.61	213	179
ME-8	Harwood to Susquehanna 230 kV***	PLGRP	PLGRP	\$ 14.49	\$ 8.69	830	501

Reconductor



Rebuild



Dynamic Line Rating



Time to Implement	2 – 3 Years	3 – 5 Years	~1 Year
Downtime	Extended Outages	Extended Outages	No Outages
Cost	\$0.5 M per mile	\$2 - 3 M per mile	< \$1 M
Est Capacity Benefit	+ 34%	+ 106%	+ 10 – 30%

System of line sensors installed to measure conductor and environmental real time data to determine a real time rating for the line based on live measurements instead of assumed condition values.

- Existing Line Ratings

Assumes:

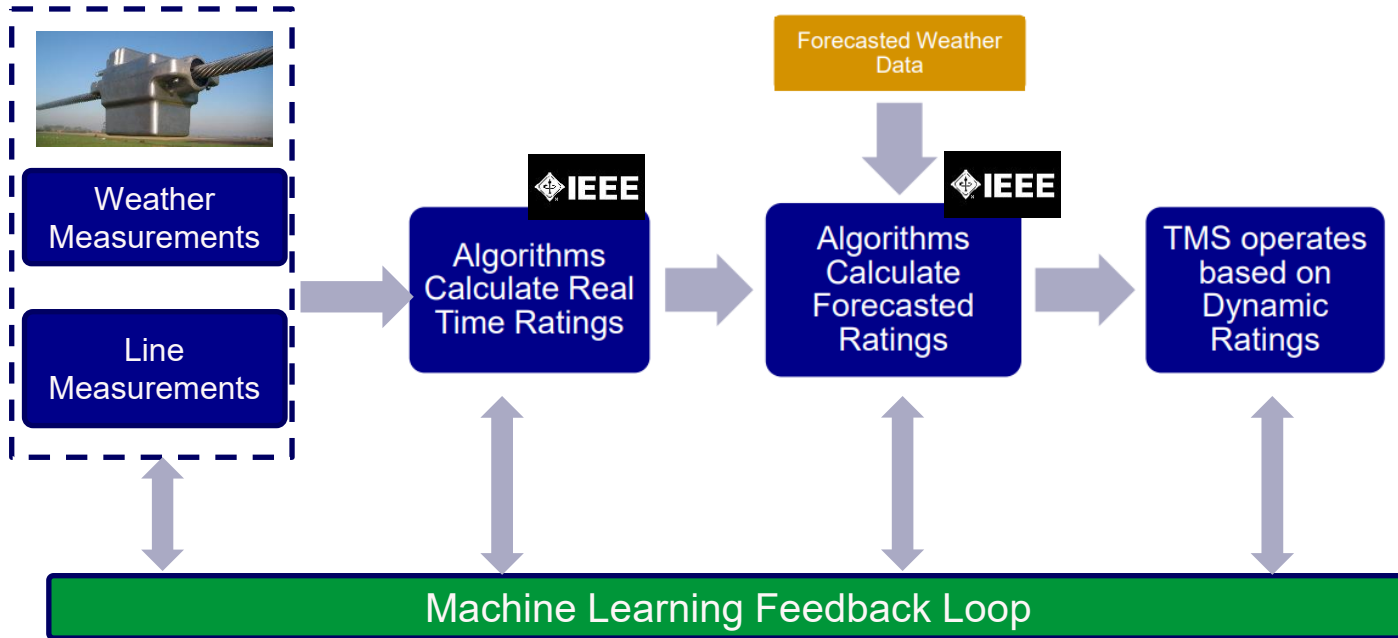
- Wind speed
- Ambient Temp
- Solar Radiation
- 2 Seasons (Summer & Winter) (Planning)
- Ambient Adjusted (Operations)
- Conservatively Calculates Ratings

- Dynamic Line Ratings

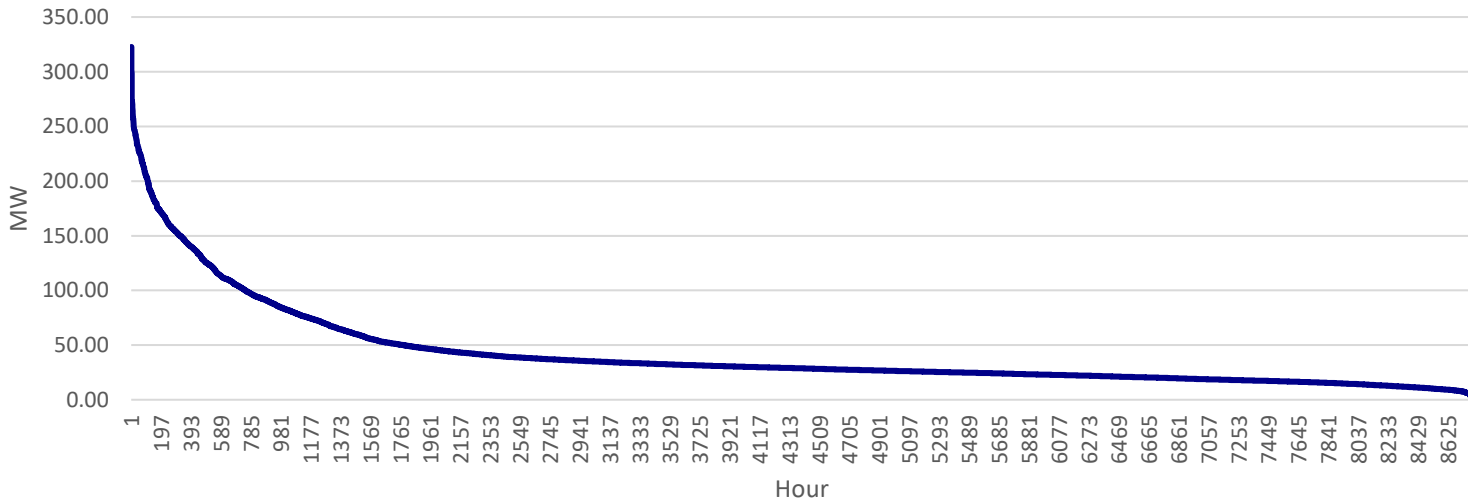
Measures:

- Wind Speed
- Ambient Temp
- Conductor Temp
- Conductor Sag
- Provides Accurate Real Time Ratings
- Allows for Forecasted Rating
 - Measures Conductor Health

Expected average normal ratings gain of almost 30%



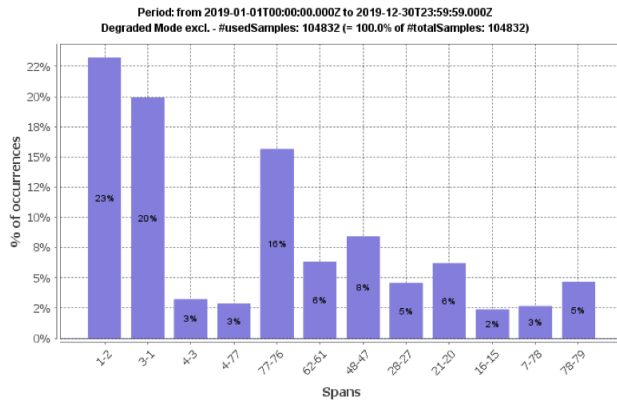
Steady-state DLR at emergency rating temperature Projected Rating Increase on Pilot 230kV line (DLR minus AAR)



5% Average Gain Relative to Emergency Ambient Adjusted Rating

1

Critical Span Distribution From DLR Simulation



2

Required Span Selection Rules

- Orientation between spans changes more than 15°
 - → To capture variability in wind direction
- Distance is greater than 10 km
- Conductor or number of sub-conductor change
- Span safety concerns
- Utility span data identifies high risk span(s)

3

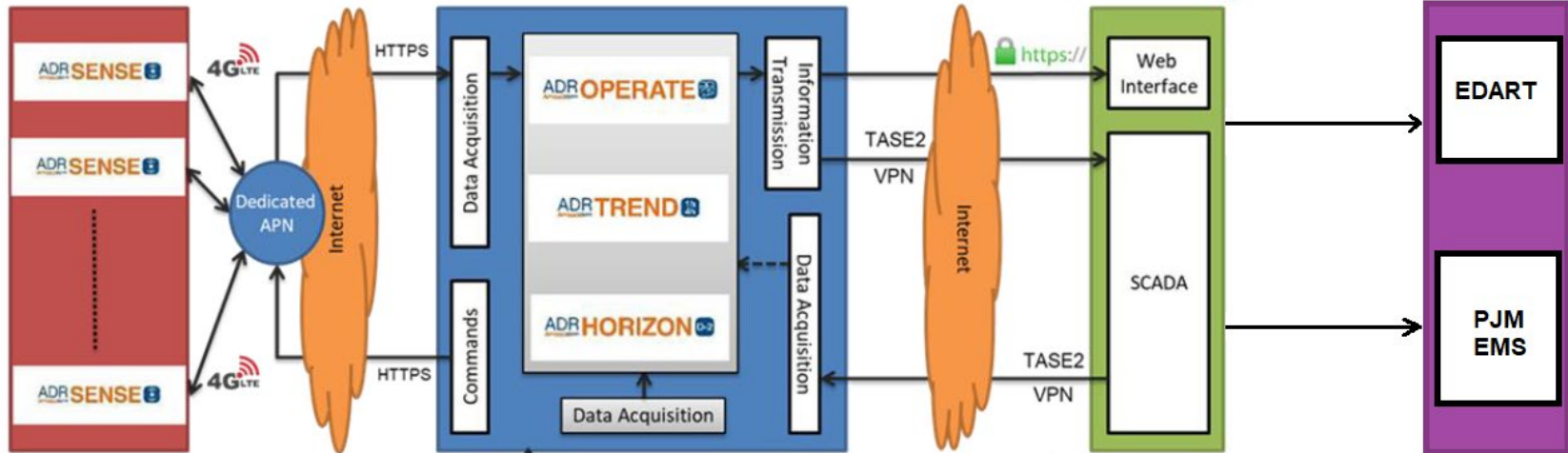
Final Span Selection



- **On PPL 230kV Lines: 6 Sensors per 230kV Line**
 - Total of 18 Sensors installed
- Installed December 2020
- One phase per identified span
- Sensor mounted 5 – 10% of the total span length from either tower
- Live Line Installation Via Helicopter
 - Select spans installed from ground
- Mounting procedure is 5 - 10 minutes per sensor



Hosting (or) Integration with EMS/SCADA



- List of all non-critical data which are encrypted in communication are:
- Raw acceleration
 - Sensor internal board temperature
 - Sensor's power supply voltage
 - Sensor's diagnostic data
 - RMS Current
 - Tension
 - Each data package also contains the Sensor ID

- Sag, Effective Wind speed
- State Change Equations
- IEEE / Cigré thermal modelling
- Ruling span
- Line capacity based on the true limits (Amp, MVA, MW, & MVAR)
- Fault Detection
- Galloping and Ice Accretion
- Storing historical data
- Statistics and reporting
- Forecasting applications

- Dynamic Line Rating:
- Real-time
 - Intra-day
 - Days-ahead forecast
 - MVA, MW & MVAR

- Fault Detection:
- Momentary
 - Permanent

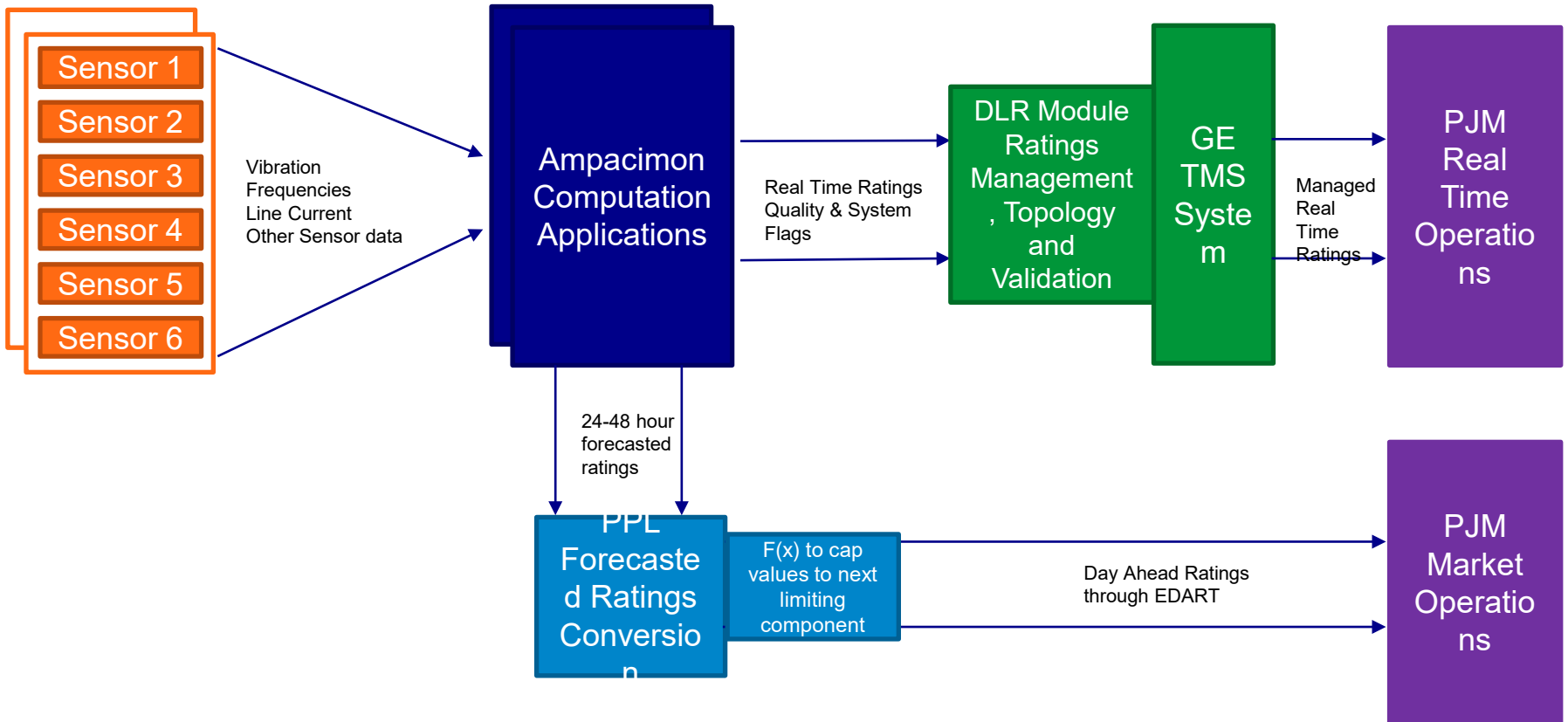
- Galloping & Ice Accretion:
- Conductor Twisting
 - Galloping
 - Ice Accretion

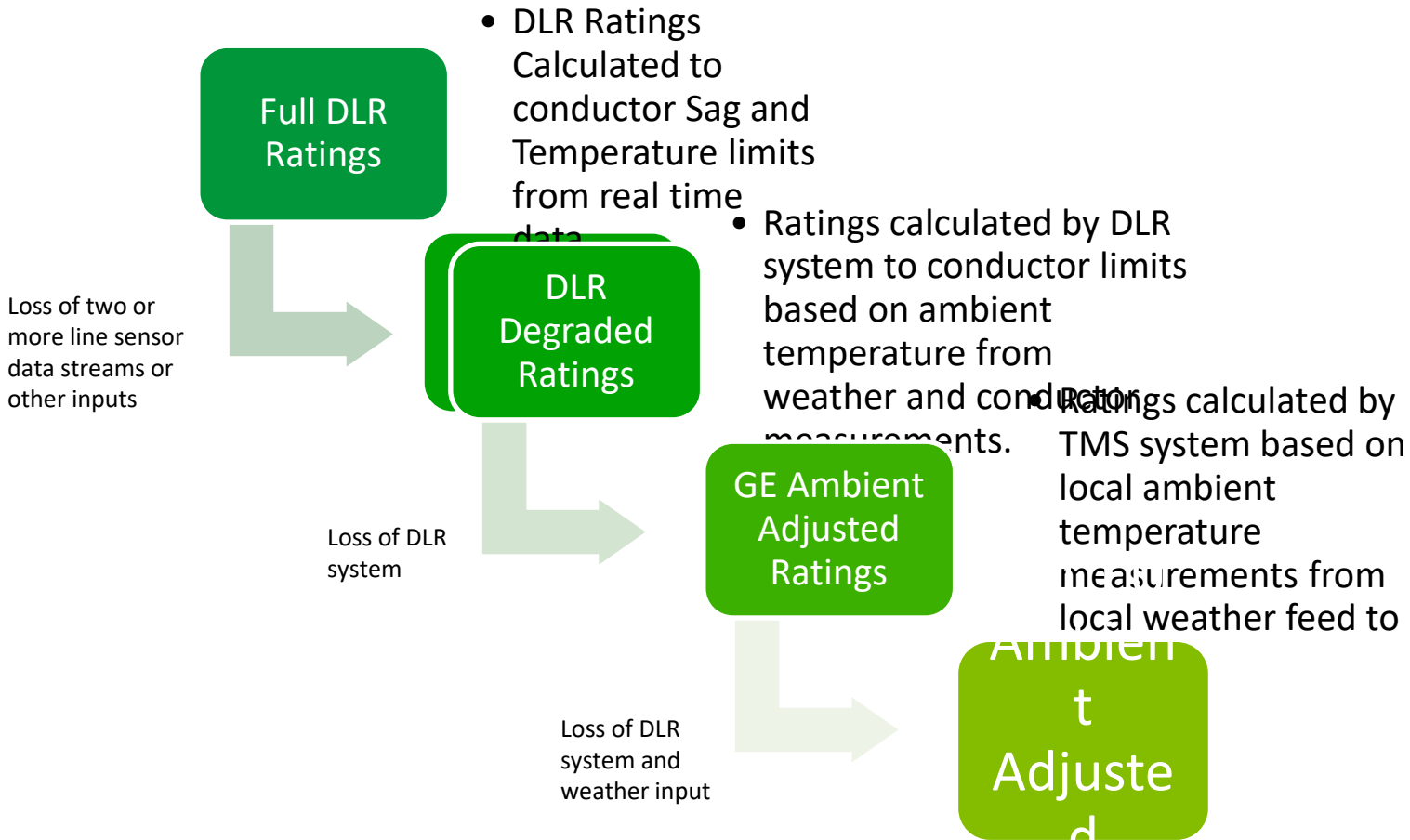
Real Time Ratings (5 minute updates):

- Normal Rating
- Emergency Rating
- Load Dump Rating

Forecasted Ratings:

- Days ahead





CIP Standards:

CIP-002: System Categorization

CIP-005: Electronic Security Perimeters

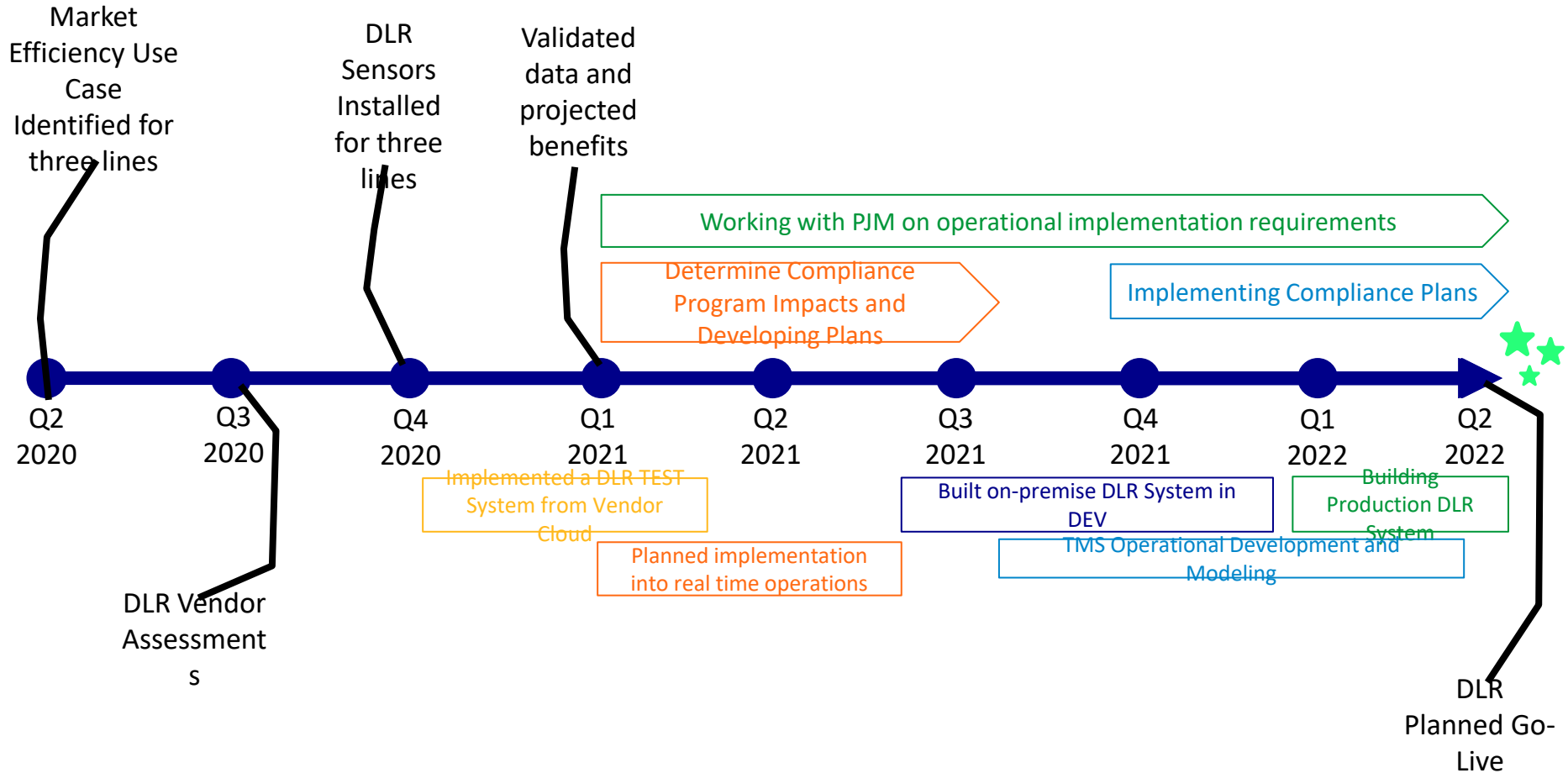
CIP-006: Physical Security

PRC-023 – Relay Loadability

FAC-008 – Ratings Methodology



Our Roadmap So Far.....





What is next?



Get Ready for FERC Order 881 Compliance

- ✓ Work with your RCs
- ✓ Work with your EMS vendors
- ✓ Identify any limitations
- ✓ Identify any potential projects

The sooner the better!

Need Help?



RF's Assist Visit Program

Please use RF's Assist Visit program at [rfirst.org](https://www.reliabilityfirst.org) to help navigate questions or concerns



Questions & Answers

Forward Together  ReliabilityFirst

PUBLIC