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Transmission – Duke Energy Florida

NERC Standard	FAC-008-3
Document Title	DEF Electrical Facilities Rating Methodology (FRM)
Purpose	To ensure that Facility Ratings used in the reliable planning and operation of the Duke Energy Florida (DEF) Bulk Electric System (BES) are determined based on an established methodology or methodologies.
Applicability	TO
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TERMS AND DEFINITIONS

Facility - A set of electrical equipment that operates as a single Bulk Electric System Element (e.g., a line, a generator, a shunt compensator, transformer, etc.)

Element - Any electrical device with terminals that may be connected to other electrical devices such as a generator, transformer, circuit breaker, bus section, or transmission line. An element may be comprised of one or more components.

Emergency Rating - The rating as defined by the equipment owner 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.

Equipment Rating - The maximum and minimum voltage, current, frequency, real and reactive power flows on individual equipment under steady state, short circuit and transient conditions, as permitted or assigned by the equipment owner.

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.

Normal Rating - The rating as defined by the equipment owner that specifies the level of electrical loading, usually expressed in megawatts (MW) or other appropriate units that a system, facility, or element can support or withstand through the daily demand cycles without loss of equipment life.

Bulk Electric System - Unless modified by the Inclusion and Exclusion lists per the full definition in NERC's Glossary of Terms (see www.nerc.com), all Transmission Elements operated at 100 kV or higher and Real Power and Reactive Power resources connected at 100 kV or higher. This does not include facilities used in the local distribution of electric energy.

Shunt Compensation Device - Capacitor, Reactor, Static Var Compensator.

Series Compensation Device – Capacitor, Reactor.

Rate A – Normal continuous rating for facilities.

Rate B – 2 hour emergency rating for facilities.

Rate C – 15 minute emergency rating for facilities.

CLARIFYING STATEMENT

Prior to the merger of Duke Energy and Progress Energy, the Transmission Facilities Rating Methodology of Progress Energy Florida had both the NERC FAC-008-3 compliance language and the equipment rating methodology scope describing the bases, criteria, and methodology in the determination of the ampacity ratings of the different equipment comprising a facility. In order to streamline the approach to facility ratings throughout the enterprise, the decision was made to have two (2) separate documents; the Electrical FRM which is this document describing the NERC FAC-008-3 compliance, and the DEF Equipment Ratings Methodology (ERM), mentioned below, describing the bases, criteria, and methodology in the determination of the ampacity ratings of the different equipment comprising a facility.

The effective date of this document is as stated above.

BACKGROUND AND GENERAL RATING METHODOLOGY

With regard to electrical facility ratings, a facility is the set of all current carrying components, including protective and control devices, between two buses that carry the same load.

DEF's facility ratings include one (1) continuous and two (2) emergency ratings. The continuous rating is used predominantly, but the emergency ratings are available for use during system contingency events. [FAC-008-3: R3.4.2] The ratings are defined as follows:

Continuous Rating [FAC-008-3: R3.4.2]

The Continuous Rating (a.k.a. normal rating or rate A) is the maximum load that the power system element can carry continuously without exceeding its normal allowable operating temperature. This rating will have acceptable impact on loss of life.

Two Hour Emergency Rating [FAC-008-3: R3.4.2]

The Two Hour Emergency Rating (a.k.a. contingency rating or rate B) is the rating that can be utilized for a period of time up to 2 hours in duration. This rating is intended to be utilized in the event of a single contingency. It is expected that the 2 hour emergency loading will be reduced to, or below, the Continuous Rating within 2 hours.

15 Minute Emergency Rating [FAC-008-3: R3.4.2]

The 15 Minute Emergency Rating (a.k.a. rate C) is the rating that can be utilized for a time period up to 15 minutes in duration. This maximum 15 minute emergency current rating is intended to be very infrequent in nature, utilized when an unusually heavy loading is brought about by the occurrence of multiple contingency events, which can significantly alter normal system loading. It is expected that the 15 minute emergency loading will be reduced to, or below, the 2 Hour Emergency Rating within 15 minutes.

Situational Rating

DEF reserves the right to develop a situational rating that is temporary in nature (with a defined time) for a specific facility under specific conditions.

Loadability

DEF generally calculates Facility Ratings at 40 (winter) and 95 (summer) degrees F, and are utilized by both Planning and Operating personnel.

Facilities

DEF's facilities can be divided into the following groups: transmission conductors, transformers, relay protective devices, terminal equipment and series and shunt compensation devices. The process by which the Rating of equipment that comprises a Facility is determined is contained in ADM-TRMF-00009, Duke Florida – Facility Ratings Procedure document. [FAC-008-3: R3.4]

Transformer Facilities include all the components that carry the same load as that transformer bank, i.e. components on the low voltage side and high voltage side. Transmission Line facilities include all the components that carry the same load as the transmission line conductor including those at both ends. Breaker facilities do not overlap transformer facilities or transmission line facilities. Breaker facilities include components that carry the same load as the breaker, such as switches, protective devices, etc.

The facility rating will be equal to the minimum rating of the components that make up the facility. [FAC-008-3: R3.3] Electrical schematics are reviewed to document the current carrying components within the facility. Electrical ratings have been developed for each current carrying component. Components that make up a facility are documented in order of current flow with their respective ratings.

Ratings for transformers are developed on an individual basis to account for design and final test data.

To develop the ratings for line conductors, the conductor, the line's construction, and the clearances to ground and other items crossing under the line conductors are reviewed. The clearances are used to determine the maximum operating temperature of the line conductors. This maximum operating temperature is then used to determine the ampacity (or rating) of the line segment.

Facility ratings are entered into DEF's electronic planning/operating model of the transmission system to allow the performance of planning and operating studies of the system. Facility ratings are also entered into the 'real time' Energy Management System (EMS) used by DEF's system operators to monitor and control the daily activities on the transmission system.

Planning, Engineering, and Operational Guidelines for Loading Transmission Lines and Terminal Equipment

Operating conditions can affect facility ratings in regards to normal versus emergency ratings of equipment, switching arrangements, and when operational concerns exist.

In the case of normal versus emergency ratings, an underground high voltage cable may be the limiting element for continuous ratings, but a disconnect switch may be the limiting element for a two-hour emergency rating.

When a transmission line is terminated with two breakers, and the facility rating is based on both breakers being closed, switching can result in a lower facility rating. When one of the breakers is opened and the remaining breaker has an ampacity lower than the established Facility Rating when both breakers are closed, the facility rating must be reduced to the rating of the closed breaker.

Protective device settings can be utilized to limit facility ratings when operational concerns exist that require the facility's rating to be lower than what is dictated by the equipment comprising the facility. In those cases, the protective device setting becomes the facility rating.

When there are concerns associated with a rating determined by this methodology and the facility must remain in service due to grid reliability or customer load, an engineering analysis shall be used to determine an interim facility rating until the issue is resolved. In these cases, the basis for the interim rating will be documented and maintained for the duration of the limitation.

Conductor ratings may be set by the maximum temperature at which the conductor, using its designed installation or more recently verified clearances, can operate and still maintain required NESC clearances. Ratings may also be set to avoid thermal damage to conductor or line accessories. Equipment ratings are based on American National Standards Institute (ANSI), Institute of Electrical and Electronics Engineers (IEEE), and other industry standards requirements or by limits set by the equipment manufacturer.

The ratings for conductors and equipment should be adjusted for as-built conditions that are discovered in the field. These can result from items such as right-of-way encroachments or through errors created during the initial design and construction of the facility. When an as-built condition is discovered that delivers clearances less than those required by the NESC, the following actions should be taken:

1. Identify all the spans that do not meet the NESC clearance requirements.
2. Analyze each span identified to determine the new temperature rating.
3. Notify System Operations of the new temperature rating.
4. System Operations, together with Field Operations, Planning and Engineering as appropriate, will perform an operational risk assessment associated with implementing the new rating.
 - a. If the risk assessment determines that the operational risk is acceptable, then de-rate the line to the new rating and develop a work plan to return the line to the desired rating in a timely fashion.
 - b. If the risk assessment determines that the operational risk is not acceptable, then put an emergency operational plan in place that allows the facility to be operated at a rating that mitigates the operational risk. Additionally, a work plan will be developed to return the line to the desired rating in a timely fashion.
5. The PLS-CADD model should be updated to reflect as-built conditions.

Due to limitations of planning models' ability to accurately reflect flows of breaker-and-a-half or ring bus configurations, DEF reserves the right to apply multipliers to represent some amount of expected current split between two breakers. If a breaker multiplier is used, actual breaker flows are evaluated over some time (typically 1 year) to determine if a conservative multiplier is reasonable. DEF considers that multiplier reasonable if it would have worked for a high percentage of the evaluated time. When applicable, the multipliers are applied to breaker paths.

Jointly-owned and jointly-operated facilities [FAC-008-3: R6]

Examples of these facilities include transmission lines that run between DEF transmission system and generating facilities and facilities that run between DEF transmission system and neighboring utilities.

The rating of jointly-owned and jointly-operated facilities will be coordinated among the joint owners and operators so that there is a single set of ratings for these facilities.

For each interconnection:

- DEF’s neighbors provide limiting rating for components on their side;
- DEF lists all components on DEF’s side;
- DEF and neighbor combine those to determine overall limit.

Generator owners supply facility ratings for components starting with the generator and up to the point of interconnection with the transmission owner (could be the generator step-up transformer). Transmission owners determine facility ratings for the components on their side of the interconnection point. Depending on the model (tool) and the generator – GSU – transmission arrangement, facility ratings are determined. The Generation methodology for FAC-008-3 R2 and the Transmission methodology for FAC-008-3 R3 share a common methodology for some generator interconnecting facilities, typically from the generator step-up transformer (GSU) to the point of interconnection. [FAC-008-3: R6]

EQUIPMENT RATINGS METHODOLOGY

The SPS: Equipment Ratings Methodology-DEF document provides the methodology for the determination of equipment ratings that comprise the facility. The methodology is based on manufacturer’s specifications, industry standards, or engineering/industry practices that have been verified by testing, performance history, or engineering analysis. [FAC-008-3: R3.1] The underlying assumptions, design criteria, and methods used to determine the equipment ratings include the following considerations [FAC-008-3: R3.2]:

- ratings provided by equipment manufacturers [FAC-008-3: R3.2.2]
- design criteria (industry practices, industry standards, etc.) [FAC-008-3: R3.2.1]
- ambient temperature (the temperature of the surrounding medium such as air, earth, liquid, etc.) [FAC-008-3: R3.2.3]
- operating limitations [FAC-008-3: R3.2.4]
- other assumptions (solar, wind, etc.)

The scope of equipment addressed in the SPS: Equipment Ratings Methodology-DEF document in determining ratings of the BES shall include, but not be limited to transmission conductors, transformers, relay protective devices, terminal equipment, and series and shunt compensation devices (shunt capacitors, shunt reactors, static VAR compensators, series reactors). It should be noted that no primary fuses are utilized as terminal equipment in the DEF transmission BES. [FAC-008-3: R3.4, R3.4.1]

The most current version of the SPS: Equipment Ratings Methodology-DEF document (STDP-STD-TRM-00069) is stored in the corporate electronic document management system.

Relay Settings

For those transmission lines that meet PRC-023 by using requirement R.1 criteria 1 and 10:

For relays set to criterion 1, relay loadability is at 0.85 per unit voltage and a power factor angle of 30 degrees is part of the Facility Rating. For relays set to criterion 10, transformer overcurrent relay settings should be based on the applicable maximum transformer nameplate rating.

Capacitor Banks

DEF determines effective Mvar based on kV ratings of cans, number of cans in series, kvar rating of cans and nominal voltage, and inserts those capacitors in planning models accordingly.

COMMUNICATION OF FACILITY RATING METHODOLOGY

DEF will provide Facility Ratings **[FAC-008-3: R8.1.1]** and the identity of the most limiting component **[FAC-008-3: R8.1.2]** for its solely owned and jointly owned Facilities to its associated RC, PC, TP, TO and TOP, when requested.

Under the circumstances listed in FAC-008: R8.2, DEF will provide the identity of the next most limiting component **[FAC-008-3: R8.2.1]** and its thermal rating. **[FAC-008-3: R8.2.2]**

Date	Revision	Changed By	Pages or Sections Revised and Description
7/31/2015	0	Bart White	Revised as part of the Roles and Responsibilities Agreement on Transmission Facility Ratings signed/agreed upon in 2014 by Transmission Planning, Compliance, System Operations, Engineering, and Asset Management to be implemented in 2015. Facility Ratings Methodology for the NERC FAC-008-3 compliance language in this revised FRM document. The bases, criteria, and methodology in the determination of the ampacity ratings of the different equipment comprising a facility which were in the previous revision are now included in the SPS: Equipment Ratings Methodology-DEF (previously Document ID TSS-LRS-SPS-FL-0003, now STDP-STD-TRM-00069) document. Both documents become effective with the Effective Date of this FRM document. Note: entered into FUSION as GDLP-EGR-TRM-00007.
8/18/2017	1	Bart White	Routine 2-year FUSION Revision. Updated BES definition (p. 3); corrected SPS document number reference (p. 8); removed retired R4 and R5 references; other minor grammar, punctuation, formatting changes.