Tampa Electric Company Facility Rating Methodology

Approved 11/20/2018

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Substation Engineering Technical Manual
Transmission Engineering Compliance Code Assurance
Transmission Engineering Rerate Process
Transmission Engineering ROW Assurance
Transmission Engineering As-Built Process
Temporary De-rating of Circuits Procedure

Purpose

The purpose of this document is to provide a comprehensive rating methodology that covers all Tampa Electric Company (TEC) Bulk Electric System (BES) equipment from the generator to the high side of distribution substation transformers. The methodology described herein covers solely owned TEC Facilities and joint owned Facilities for which TEC is responsible for providing ratings.

TEC's System Planning group has the overall responsibility for the TEC Bulk Electric System design, Facility Ratings and methodology documents for TEC. All updates and changes are processed through this department to maintain the accuracy and consistency of the ratings and methodology documents. System Planning compiles the individual equipment ratings provided by Energy Supply and various other Electric Delivery engineering departments. From these, individual equipment ratings, Normal and Emergency Ratings (where appropriate) are assigned to each TEC BES Facility. The most limiting applicable equipment rating, or weak link, in a BES Facility determines the rating of that Facility. System Planning documents and maintains these ratings in the Facility Rating Database. These Facility Ratings are communicated and utilized in the design and operation of the system.

This document describes the current TEC rating methodology for the following BES Facilities as defined in the NERC Glossary of Terms dated July 3rd, 2018:

1) Transmission Line Facilities
2) Transformer Facilities
3) Shunt Compensation Facilities (includes Shunt Capacitors and Shunt Reactors)
4) Series Compensation Facilities
5) Generation Facilities

BES Facilities are comprised of multiple elements and the ratings are provided by multiple engineering groups including: Substation Engineering, Transmission Engineering, System Security (relay protective devices), Energy Supply in consultation with the stations for Generators and outside owners/operators for jointly owned equipment. For example, a transmission line which includes conductors, wave traps, switches, breakers, protective relays are included as part of the Transmission Line Facility. All of the equipment operates together with the limiting Facility Ratings being derived from the individual equipment ratings. Thus, the Facility Ratings will be limited by the most limiting applicable equipment rating of that Facility. Likewise, the Facility Rating will not exceed the most limiting rating of any equipment that comprises that Facility.

The scope of equipment addressed in this document includes the following:

1) Transmission Conductors
2) Transformers
3) Series and Shunt Compensation Devices
4) Terminal Equipment
   a) Circuit Breakers
   b) Switches (including disconnect switches)
   c) Substation conductors
   d) Transformers
   e) Wave Traps
   f) Relay Protection Devices (current and potential devices, fuses, relays)
5) Generators

All equipment rating parameters are considered such as Normal and Emergency Ratings, rating methodology, design criteria, manufacturer's equipment ratings, ambient conditions, operating limitations, references to IEEE, ANSI or other standards, as well as, other assumptions. Although some equipment rating assumptions such as ambient temperature, maximum operating temperature, or governing design standard are noted here, the complete rating methodology for the various equipment types that make up a facility are addressed in the specific departments' methodology documents. These documents are available for reference as part of the FAC-008-3 compliance evidence.

The division of responsibility for compiling equipment ratings between Electric Delivery and Energy Supply is as follows:

Electric Delivery:

Tampa Electric's Facility Rating for Electric Delivery is equal to the most limiting applicable rating of the individual equipment that comprises that Facility. Electric Delivery is responsible from the high side of the Generating Step-Up Transformer (GSU) to the customer meter. The comprehensive scope of equipment includes, but is not limited to, transmission conductor, transformers, relay protective devices, series and shunt compensation devices, terminal equipment, and generators. Terminal equipment may include, but is not limited to, circuit breakers, switches, substation conductors, instrument transformers, line traps, and associated relay protective devices.

Energy Supply:

Tampa Electric's Facility Rating for Energy Supply is equal to the most limiting applicable rating of the individual equipment that comprises that Facility. Energy Supply is responsible from the generator to the high side of the GSU. For Solar Facilities, the Energy Supply is responsible from the solar panel to the high side of the GSU. Generating units are characterized by several performance parameters including: capacity, heat rate, availability, planned maintenance, and forced outage rates. Generating capability must be accounted for in a uniform manner. Generating maximum dependable capability expectations are based upon each Generating Stations expectations of their units' capabilities considering current unit derations, future maintenance plans, demonstrated unit output for prescribed time periods required under expected operating conditions (re: demonstrated historical operation) and unit real and reactive power testing. For this procedure, nameplate and maximum ratings will be utilized. For the equipment that makes up the electrical path from the generator, generator bushings CT's, circuit breakers, iso-bus, switches, etc. to the high side of the generator step up transformer, original design specifications, manufacturer specifications, and nameplate ratings are utilized.

TEC is the Transmission Owner (TO) and Generator Owner (GO) in all instances where TEC is owner of the generating unit. The demarcation between the TO and GO at these locations is the high-side of the Generating Step-Up (GSU) transformer.

In locations where TEC is the TO and connects with a GO other than Tampa Electric, the demarcation is described in the interconnection documentation. In locations where TEC is the TO and connects with a GO other than Tampa Electric, and there is not an interconnection agreement, the demarcation between TO and GO is the high- side of the GSU transformer.

Facility and Equipment Ratings Methodologies

Tampa Electric's Facility Rating will not exceed the most limiting applicable equipment rating of the individual equipment that comprises that Facility. All equipment or elements comprising the Facility are assigned an equipment rating. These equipment ratings include Normal and Emergency Rating where applicable. All equipment ratings take into account the equipment manufacturer's rating, design criteria, manufacturer's warranty, IEEE, ANSI, and other standards. They also take into consideration ambient conditions, operating limitations, and other assumptions.

Another part of the process involves the reconciliation of discrepancies found relating to equipment types or ratings. If a weak link discrepancy is found an attempt is made to determine if the documented rating is correct based on engineering drawings, work orders or other communication and if necessary a field verification. If the discrepancy (once resolved) does not involve the facility weak link, it is noted but no facility rating change is made. If the discrepancy (once resolved) impacts the facility weak link, the facility rating will be immediately updated.

TEC has determined that pre-contingency loadings which are below the normal Facility Rating provide a time component needed for thermal heating to reach the design criteria temperature under a contingency that changes the facility loading. This transient heating time varies with the magnitude of the initial loading, the magnitude of the new loading and the specific facility. As a result, a facility can have different varying time interval emergency ratings depending upon the transient time for the specified rating. For example, each TEC Transmission Facility has applicable Facility ratings and associated time parameters depending on actual or expected system conditions. These Facilities ratings include the Normal Rating (NRML), the Long-Term Emergency Rating (LTE) and the Short-Term Emergency Rating (STE). If there is no LTE, then the LTE is the same as the STE:

- Normal Rating: maximum continuous rating with no time parameter
- Long-Term Emergency Rating: emergency rating with a time-parameter that is typically four (4) hours
- Short-Term Emergency Rating: emergency rating with a time parameter that is typically seven (7) minutes

The transient time allows for certain manual or automatic system reconfiguration from an operational standpoint such as switching of the transmission system. However, real-time system operating conditions may require reconfigurations that take more time to execute. In instances where post contingency transmission facility loading can be reduced to the normal level with a system reconfiguration that requires more time to execute, pre-contingency system reconfiguration may be used, or a longer transient time rating may be used in conjunction with a lower pre-contingency loading to allow for system reconfiguration.

1 Transmission Line Facilities

TEC's BES transmission line end-points are delineated by the fault interrupting circuit breakers. These lines may have one or more distribution (load serving) substation in the line between breakers. The lines between distribution stations are termed "transmission line segments."

BES Transmission Line Facilities are comprised of three main categories of equipment: transmission line conductors, transmission substation terminal equipment, and distribution substation high-side equipment. Series

Reactors are considered part of the Transmission Line Facility and are sized to meet the line rating requirements and not be the most limiting element for that Facility. As related to this document, an autotransformer in series with a transmission line is treated as a separate Transformer Facility with its own ratings.

A transmission line segment may have multiple conductor sizes, types, and ampacity ratings with the rating based on the most limiting rating of its associated equipment. In some cases, the limiting element for a line may change with various switching arrangements. Where a line is terminated with two breakers in parallel the line rating may be reduced when one of the breakers is open and the remaining breaker has an ampacity lower than the line conductors. Such situations are handled by the Energy System Operators (ESOs) with specific actions made in the EMS system to communicate and operate to the most limiting Rating.

The transmission terminal equipment includes breakers, switches, line traps, bus, current transformers and protective relays. Switches and bus also comprise distribution substation high- side equipment. As terminal equipment is used in other Facilities besides transmission lines, the rating methodology for this is shown under this section entitled, "1.3 Terminal Equipment."

The normal and emergency ratings for each Transmission Line Facility are documented within the Facility Rating Database. This database lists all limiting elements for each transmission line segment of the Facility. The Facility Rating Database is used to verify the weakest link. This database is updated as changes are made to the system; such as removals, equipment changes, or the addition of a new Transmission Line Facility or segment. Appendix A illustrates an example of our Transmission Line Rating Methodology.

1.1 **Overhead Transmission Conductors**

TEC designs, maintains and operates transmission lines to meet the clearance requirements of the National Electric Safety Code (NESC) and currently uses a methodology based primarily on IEEE Std 738–2006 IEEE Standard for Calculating the Current- Temperature of Bare Overhead Conductors. TEC uses statistically determined values for ambient air temperature and wind speed but departs from the Standard by also using a statistically determined value for solar heat gain rather than the value calculated per the IEEE Standard.

Prior to 1991, TEC used conductor ratings based on manufacturer publications. In 1991, the "Statistically Determined Thermal Line Ratings" methodology was introduced. The methodology was based on IEEE Std 738-1986 and historical weather observations obtained through the National Oceanic and Atmospheric Administration (NOAA) for Orlando International Airport. A statistical analysis was performed on the weather data to develop confidence intervals and determine the weather parameters used for calculation of conductor ratings. All transmission lines constructed after 1991 utilized this rating methodology. Re-rates of lines using the pre-1991 ratings are done by requesting field verification from Transmission Engineering to confirm the conductor can safely operate at 100 ° C and meet applicable clearance requirements per the TEC Transmission Engineering Transmission Line Rerate Process.

The methodology was updated in 2009 with the "Conductor Ampacity Review" and included adoption of IEEE Std 738–2006 and the statistical analysis of weather observations obtained from the Florida Automated Weather Network (FAWN). Historical observations were obtained from three FAWN stations within TEC's service territory – Balm, Dover and Lake Alfred, and one station just south of the TEC territory boundary in Ona, FL. Conductor ratings were updated accordingly. (See Appendix A as an example of this methodology and its calculations).

1.2 **Underground Transmission Cable**

TEC does not have any underground cable operating at BES level voltages.

1.3 **Terminal Equipment**

TEC Substation Engineering Department determines the rating for substation terminal equipment including, but not limited to, circuit breakers, switches, substation conductors, bus work and line traps. Ratings for relay protective devices are determined by System Security. Equipment ratings are listed on the Substation One-Line Diagrams for each substation. This information is provided to TEC System Planning group which is responsible for determining the Facility Ratings. These Facility Ratings are kept in the System Planning Facility Rating Database. Equipment ratings as listed in the Substation Engineering Technical Manual (SETM) section 33 shall be used for all substation construction to accommodate loadings required by System Planning. These ratings comply with industry standards such as IEEE, ANSI and take into consideration manufacturer's ratings and warranty, ambient conditions and operating limitations.

1.3.1 **Circuit Breakers**

For normal operation, outdoor circuit breaker loading shall not exceed the nameplate rating of the breaker. There are typically no emergency ratings of circuit breakers. Most manufacturers do not list emergency ratings and their bids for SF6 gas and vacuum circuit breakers do not include an emergency rating. If an emergency rating is required for a specific circuit breaker, Substation Engineering shall be consulted to see if a rating is available or if the breaker should be upgraded to a larger size. Circuit breakers are covered under IEEE Guide for High Voltage Circuit Breakers, Std. C37.04-1999 and ANSI Std C37.06-2000.

1.3.2 **Outdoor Switches**

Outdoor switches are typically limited to their nameplate rating. If an emergency rating is required for a specific switch, Substation Engineering shall be consulted to see if a rating is available. Switches are covered under IEEE Stds C3730-1997, C37.37-1996 and ANSI Std C37.32-2002.

1.3.3 **Substation Conductor and Tubular Bus Bar**

Ratings used for conductors in TEC substations are the same as those used for TEC transmission lines. See section 1 Transmission Line Facilities listed above.

Ratings for Substation Tubular Bus Bar were generated by Substation Engineering in March 2010 according to the methodology described in IEEE Std 605-1998 (Tables in Annex B). The ratings are based on a maximum bus bar temperature of 90° C (40° C ambient – 50° C rise). An incident wind angle of zero degrees was used to account for the various orientations of buses within a substation and the wind shielding possible at many substation sites. The thirty (30) minute emergency rating is based on a maximum bus bar temperature of 100° C (40° C ambient – 60° C rise). The Normal and Emergency Ratings are shown in the Substation Engineering Technical Manual Section 33.

1.3.4 **Substation Transformers**

Substation transformers may be loaded above nameplate rating provided that the winding hot-spot temperature is kept under control. Loading levels are determined per IEEE guidelines. Top oil temperature should never exceed 110°C and the winding hottest- spot temperature should never exceed 120°C. Operation at winding hot-spot temperatures above 140°C can cause gassing in the

solid insulation and oil, resulting in a rapid breakdown in the dielectric strength of the transformer, and a possible failure.

1.3.5 **Wave Traps**

Wave traps are rated according to the manufacturer's specifications. The Normal Rating for the wave trap is shown on the manufacturer's nameplate. TEC does not have Emergency Ratings for wave traps.

1.3.6 **Relay Protective Devices**

Relay protective devices are selected based on the protection scheme required at each substation according to IEEE Standards C57.13 and C37-90 in effect at the time of manufacture. As it relates to equipment loading (lines, transformers etc.) the critical rating for a relay is the normal current rating. The nominal current rating of TEC relays is 5 amps. However, some have a higher normal current rating, around 10 amps dependent on the specific relay model. When a project is designed, the CT ratio is selected such that the secondary current going to the relay at maximum load is approximately 5 amps. Other examples of equipment include instrument transformers (e.g. current transformers, potential transformers and CCVTs) which are rated according to manufacturer's ratings based on IEEE Standard C57.13-2008 for instrument transformers. On the TEC BES system, relay settings comply with NERC Reliability Standard PRC-023-4.

2 Transformer Facilities

Transformer facilities include Generator Step-up (GSU) transformers, autotransformers and associated connected equipment. Associated equipment connected to the transformer such as circuit breakers, bus-work, switches, and protective relay devices are discussed in section "1.3 Terminal Equipment." This other equipment is typically designed not to be the limiting elements for the operation of the transformer. Therefore, the transformer ratings would become the limiting ratings of the Facility. In cases where there is a limiting element such as bus work, conductors, breakers, or switches; a caution note in the loading guide is added for that transformer.

Substation Engineering is responsible for specifying normal and emergency loading levels for all substation transformers (GSUs are not considered substation transformers). Maximum loading tables and rating methodology are listed in the *Auto-Transformer Loading Guide* published by Substation Engineering.

Substation transformers may be loaded above nameplate rating provided that the winding hot- spot temperature is kept under control. Loading levels are determined per IEEE guidelines. Top oil temperature should never exceed 110° C and the winding hot-spot temperature should never exceed 120 ° C.

2.1 **Auto-transformers**

The *Auto-transformer Loading Guide* contains loading tables which were developed using the IEEE Guide for Loading Mineral-Oil-Immersed Transformers, Std C57.91-1995. A computer program was written using the transient heating equations and transformer life expectancy curves from this standard. The program calculates maximum allowable peak loading, hot-spot temperature, and top oil temperature based on transformer test report data, ambient temperature, pre-load, duration of peak and transformer life expectancy.

In auto-transformers where TEC has temperature monitoring equipment, TEC will continue to monitor until a real time condition warrants the unloading of that transformer. The IEEE guide states that gassing in solid insulation and oil can occur above 140°C winding hot-spot temperature and recommends that transformers not be loaded above 120°C for normal life expectancy. The winding hot-spot temperature in the loading tables was limited to 120°C. The alarm point is set at 115°C. In some instances, there is an external limiting element such as bus work, conductors, breakers or switches. A caution note in the loading guide has been added for each transformer where this occurs.

2.2 **Generator Step-Up Transformers (GSU's)**

Generator Step Up transformers at TEC are specified and rated according to the IEEE C57.1200, IEEE General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers, IEEE C57.109 IEEE Guide for Liquid-Immersed Transformer Through Fault Current Duration, and IEEE C57.116 Guide for Transformers Directly Connected to Generation.

The GSU's are specified, designed and applied for the full range of normal system loading conditions and ranges to which they will be subjected. The Normal Rating for GSU's are rated per the manufacturer's nameplate. Unless otherwise specified, TEC does not have ratings above normal for GSU's therefore the Emergency Ratings are equal to the Normal Ratings.

Other associated power system equipment connected to the GSU such as breakers, switches, bus work, and relay settings are designed not to be limiting elements for the operation of the GSU. Therefore the GSU ratings becomes the limiting rating of the facility.

3 Shunt Compensation Device Facilities

Shunt capacitors are normally limited to their manufacturer ratings. The devices are ordered from the manufacturers based on size requirement information provided by System Planning.

The elements in series with these devices are specified such that the capacitor is the weak link of the facility. If an emergency rating is required for a specific device, Substation Engineering shall be consulted to see if a rating is available. TEC does not have any shunt reactors.

Ratings for the Shunt Compensation Device Facility are captured within the Facility Rating Database.

4 Series Compensation Facilities

TEC does not have any series capacitors.

Series reactors are considered part of the transmission line and sized to meet the line rating requirements.

Generation Facilities

Methodology

Energy Supply sets Facility Ratings from the generator to the high side of the generator step-up transformer at TEC's Generating stations. The Facility Rating is the maximum rating based on ideal conditions and is higher than the typical daily capability of that Generating Unit. The Portfolio Optimization group publishes the Daily Capability Report and annual Unit Capability Memo stating actual daily capabilities based on current conditions. Equipment rating parameters included in this rating methodology are Ambient Conditions, design criteria, Normal and Emergency Ratings, Manufacturer's Equipment Ratings, Operating Limitations, references to IEEE, ANSI or other standards and other assumptions.

The methodology used to establish the Ratings of the equipment that comprises the Facility starts with individual equipment's nameplate ratings to determine the unit's "weakest link" component. Then the totality of all unit generator and transformer equipment is verified, in accordance with IEEE standards, though unit performance history and engineering analysis to determine the Facility Ratings.

Assumptions

The Facility Ratings are never greater than the most limiting applicable equipment rating of the individual equipment that comprises that Facility.

Units are designed and modified to operate under current statutory, regulatory and environmental requirements. Equipment is designed at specified pressures, temperatures, steam flows, heat transfer rates and other parameters. Generation Facility Ratings incorporate and are limited by these criteria. Energy Supply reviews these criteria to develop Facility Ratings for each of the Generating Units based on the most limiting equipment rating, or "weakest link".

The output of a generating unit is not constrained by the capacity of the "weakest link" because the capacity of the "weakest link" is adequate to carry the highest current produced by the unit.

Energy Supply performs "weakest link" analyses of unit circuit elements that carry the full output of the generator. These analyses demonstrate that no element is overloaded when units are operated at maximum capability. The current carrying capacity in Amperes is established for each element. The lowest value is selected as the "weakest link," and the "weakest link" is compared to the generator output current that is produced when the unit is operated at various conditions. Since the "weakest link" analyses are based on electrical current, current ratings must be established for all the elements. Some elements are rated in Amperes, while others are rated in kVA. Equivalent Ampere ratings must be calculated for the elements that are rated in kVA.

Load path components included in "weakest link" analyses are:

1. Generator
2. Generator bushing CT's
3. Generator bus or cable
4. Generator circuit breaker
5. Generator circuit breaker CT's
6. Generator disconnect switch
7. GSU transformer primary bushing CT's
8. GSU transformer primary winding, bushings, secondary windings, and secondary bushings
9. GSU transformer secondary bushing CT's sets

GSU transformers on the Tampa Electric system are either two-winding and three-winding transformers. Therefore, the load on the secondary components is directly related to the load on the primary winding. The

manufacturer selects primary bushings, secondary bushings, and the tap changer and designs the secondary winding and so that no component is overloaded so long as the generator current into the transformer does not exceed the rating of the primary winding. Therefore, "weakest link" analyses are based on the ratings of the primary windings.

TEC does not use daily unit ratings above normal operations, such as uneconomical combustion turbine peak firing; therefore, all Emergency Ratings are equal to the unit's Maximum Daily Capability or Normal Ratings. In addition, Summer and Winter Gross and Net Capability ratings are established for each of TEC's Generating Units at each Generating Station. Generating capabilities are determined for each Generating Unit and reflect operation at a power factor level at which the generating equipment is normally expected to be operated over the Daily Peak Capacity period.

Generating capability expectations are based upon each generating station's expectations of their units' capabilities considering current unit derations, future maintenance plans, demonstrated unit output for prescribed time periods required under expected operating conditions (re: demonstrated historical operation) and unit real and reactive power testing. Normal generating capability is required to be such that Generating Station management has a high level of confidence that the stated capabilities are reasonable to expect on a routine daily basis.

4.1 Portfolio Optimization: Generation Facility Rating Procedure

1) Perform a trend analysis of previous years' Unit Capability Memos, reviewing unit Summer and Winter Gross Capabilities to create the new unit capability forecast.

2) Discuss with each station unit issues and planned maintenance activities that will impact future changes to the unit capability forecast.

3) Using engineering judgment to maximize unit availability and generation, correlate historical unit availability and capability to unit net generation.

4) Use the above cumulative unit inputs and engineering judgment to create a new annual Unit Capability Memo by July for use in the annual Fuel Budget.

5) Submit the updated Unit Capability Memo to the Manager of Resource Planning for consolidation and review by Generating Stations and Vice President of Energy Supply for signature.

6) Communicate confirmed new unit ratings to the Energy Control Center, Generating Stations and other departments through email with attached Unit Capability Memo.

4.2 Energy Supply Compliance: Generation Facility Ratings Procedure

1) Perform "weakest link" analyses to ensure that the output of each generating unit will not exceed the capacity of the electrical components that transfer power between the prime movers and the high side of the generator step-up transformer when the unit is operated at its maximum published MW capability while delivering rated VARS to the bulk electric system.
2) Review latest "Verification and Data Reporting of Generator Real and Reactive Power Capability and Synchronous Condenser Reactive Power Capability" reports to ensure that current or potential unit capabilities can be obtained within all environmental and safety parameters.
3) Conduct a peer review of the "ES Weak Link Analysis" spreadsheet with Engineering, Compliance

Managers (ES & ED) and Director of Transmission & System Operations.

4) Communicate with PC, TP, TO, TOP and ED Compliance Manager and upload latest version to Sharepoint
5) If any ratings change due to modifications to existing Facilities or new additional Facilities are added, the above steps will be repeated within the year to update the Unit Capability Memo and "weakest link" analyses.

4.3 Definitions

Ambient Conditions: Facility Ratings are adjusted when ambient temperatures deviate from:

(i) Winter air temperature of 31°F, (ii) Summer air temperature of 85°F, (iii) Winter water temperature of 65°F, and (iv) Summer water temperature of 80°F. Gas burning units use inlet air temperatures while coal burning units use water temperatures.

Daily Peak Capacity: Expected Gross Power Output for the current day at the time of expected peak load.

Emergency Rating: Tampa Electric Company does not use daily unit ratings above normal operations, such as uneconomical combustion turbine peak firing; therefore, all Emergency Ratings are equal to the unit's Maximum Daily Capability or Normal Ratings.

Generating Stations: Big Bend Station, Bayside Power Station, Polk Power Station and all Solar sites currently in-service on TEC's system.

Generating Unit: Individual facilities listed on the annual Unit Capability Memo at our Generating Stations.

Gross Capability: Expected Gross Power Output which can be obtained for a period adequate to satisfy the daily load patterns under expected conditions of operations reflecting seasonal variations in ambient temperature, condensing water temperature, fuel quality, steam temperatures and component availability with equipment in an average state of maintenance.

Gross Power Output: Expected amount of MW produced by the Generating Unit which can be obtained for a period adequate to satisfy the daily load patterns under expected conditions of operations reflecting seasonal variations in ambient temperature, condensing water temperature, fuel quality, steam temperatures and component availability with equipment in an average state of maintenance.

Manufacturer's Equipment Rating: The manufacturers' nameplate ratings are reviewed and then facility ratings are adjusted for operational experience, performance history, reliability considerations, age of units, unique real time issues, fuel parameters, fuel feed rate and Ambient Conditions.

Maximum Daily Capability on AGC: Expected Gross Power Output by each Generating Unit while on Automatic Governor Control sustainable over prolonged periods of time maximizing annual unit generation.

Maximum Daily Capability or Normal Rating: Expected Gross Power Output by each Generating Unit sustainable over prolonged periods of time maximizing annual unit generation.

Maximum Unit Capability: Expected Gross Power Output of the Generating Unit assuming, as applicable: (i) Winter air temperature of 31°F, (ii) Summer air temperature of 85°F and water temperature of 80°F, (iii) Winter water temperature of 65°F, (iv) Summer water temperature of 80°F, (v) optimum and stable equipment conditions. The Generating Unit should be able to sustain this capability for a minimum of four hours.

Net Capability: Expected Gross Capability less generating station service.

Net Power Output: Expected Gross Power Output less generating station service.

Operating Limitations: These include Ambient Conditions, equipment performance, main steam pressure level, fuel quality, air and water environmental limits and other unit specific limitations such as temporary derations of impaired equipment in accordance with good utility practice.

Summer: Period of operation between April 1 and November 30

Winter: Period of operation between December 1 and March 31

Change Log

Date	Summary of Change	Reason for Change	Changed By
7/15/2009	Document Issued		Paul F. Allen
7/21/2009	Issue date changed to effective date and Change/Reason Log added	Clarification and to provide document control	Paul F. Allen
9/30/2010	Significant Revision to Format of Document	Clarification of document, example, and addition of appendix A.	Chris LaRussa
11/16/2010	Facilities Rating Methodologies, Overhead and Underground transmission conductor sections; Section 1.1 Add reference to 1991 ratings, 1.2 Add design standard references, 1.3.2 Deleted reference to upgrading switch, 1.3.6 Added examples to description; removed transmission conductor rating example	Clarification of document	Paul F. Allen

7/19/2011	Removed date from header; Revision to Scope and Purpose - Add references to owner/operators of jointly owned equipment, equipment ratings methodologies, time dependent ratings, 1991 line ratings document, clarify list of equipment covered; Section 1.2 removed underground rating references; Section 1.3.5 add Wave Trap reference to Line Trap; Section 2.2 added GSU emergency rating reference; added Appendix A example	Avoid conflicting with effective date; Scope and Purpose - Clarification of document; Section 1.2 -TEC has no BES underground transmission circuits ; Section 1.3.5 – clarify Line Trap reference; Section 2.2 – Clarify GSU may have emergency rating; Appendix A -remove substation references and correct wire type listed	Paul F. Allen
9/1/2012	Updated ES information, clearer wording and defined terms that were not in the Definitions section.	Annual review of document for FAC-008-3	Brian Buckley
12/6/2013	Added description of demarcation between GO and TO on page 4.	Clarification for compliance.	John Hrabe
4/30/2014	Appendix A and Example one-line diagram, various editing for clarity.	General update to accommodate new FRCC SOL direction.	Min Tra/John Hrabe
4/13/2016	Updated database name to Facility Rating Database. Updated Appendix A and related figure.	New Facility Ratings Database & changes to Facilities equipment.	Paul Hodges/Min Tra
2/14/2018	Removed circuit number and substation numbers from example in Appendix A. Performed several format changes.	Removed distinguishing information to allow this document to be posted on OASIS as non-CEII.	Matt LaRussa
10/10/2018	1. Updated to include references to solar facilities and Portfolio Optimization Group 2. Update the transformer rating methodology to be consistent throughout the document 3. Remove duplicitous paragraphs throughout the document. 4. Update logo and add a review cycle 5. Update IEEE/ANSI Standards	Addition of Solar Facilities and general update to the document.	Ana Payes Mike Kotch Phillip Hughes Matt LaRussa Steve Joseph Dave Darden Denise Ward Kristy Baksh
11/20/2018	Approved by TEC Management: R. Bishop (Dir. Substation, Meter Eng & Ops) F.Busot (Mgr. Dir. Wholesale Pwr, Plng & Fuels) R. Donahey (Dir. Tariffs, Comp. & FRCC Rel) R. Haines (Dir. Trans. & Sys. Operations) B. Young (Dir. Asset Mgmt, Plng & Support)		

Appendix A: Transmission Line Facility Rating Example

The following example for a 230kV circuit will illustrate the procedure defined above.

(1) Identify all equipment that comprises the Facility.

Terminal Equipment: The Substation One-Line Diagrams from each station are reviewed to enter all the elements into the Facility Rating Database. The database determines the most limiting elements inside each terminating substation for the circuit, which could be, but not limited to a circuit breaker, switch, transformer, bus bar, series or shunt compensation devices, an inductor or other terminal equipment type if the rating is applicable. This 230kV circuit requires a review of two substations for all terminal equipment.

Substation "A" One-Line:
Breaker Disconnects: (4) 3000A
Breakers: (2) 3000A

Breaker Leads: (2) 1590 ACSR = 3662A

Bus: 3" EHPS AL = 2647A
Bus: 3" SPS AL = 2284A

Jumper: (2) 2" EHPS AL = 3284A

CT CB600: 2000:5 with rating factor of 2 = 4000A
CT CB552: 1200:5 with rating factor of 2 = 2400A
Terminal Span Conductor: 1590 ACSR = 1831A
Relays: (2) = 10495A & 4373A

Substation "B" One-Line:
Breaker Disconnects: (4) 2000A
Breakers: (2) 3000A

Breaker Leads: (2) 1590 ACSR = 3662A
Bus: 3" SPS AL = 2284A

Jumper: (2) 2" SPS AL = 2804A

CTs (2): 3000:5 with rating factor of 2 = 6000 A
Terminal Span Conductor: 1590 ACSR = 1831A
Relays: (2) = 2981A

Transmission Conductor: Review the System Diagram Transmission 138 & 230kV Circuits to determine wire type, size and configuration.

230kV Circuit: 1590 ACSR = 1831A

(2) Obtain normal and emergency rating, where applicable, for each piece of equipment that comprises the Facility. Conductor Ratings are provided by Transmission Engineering. Substation Engineering and System Security provide ratings for all terminal equipment. See

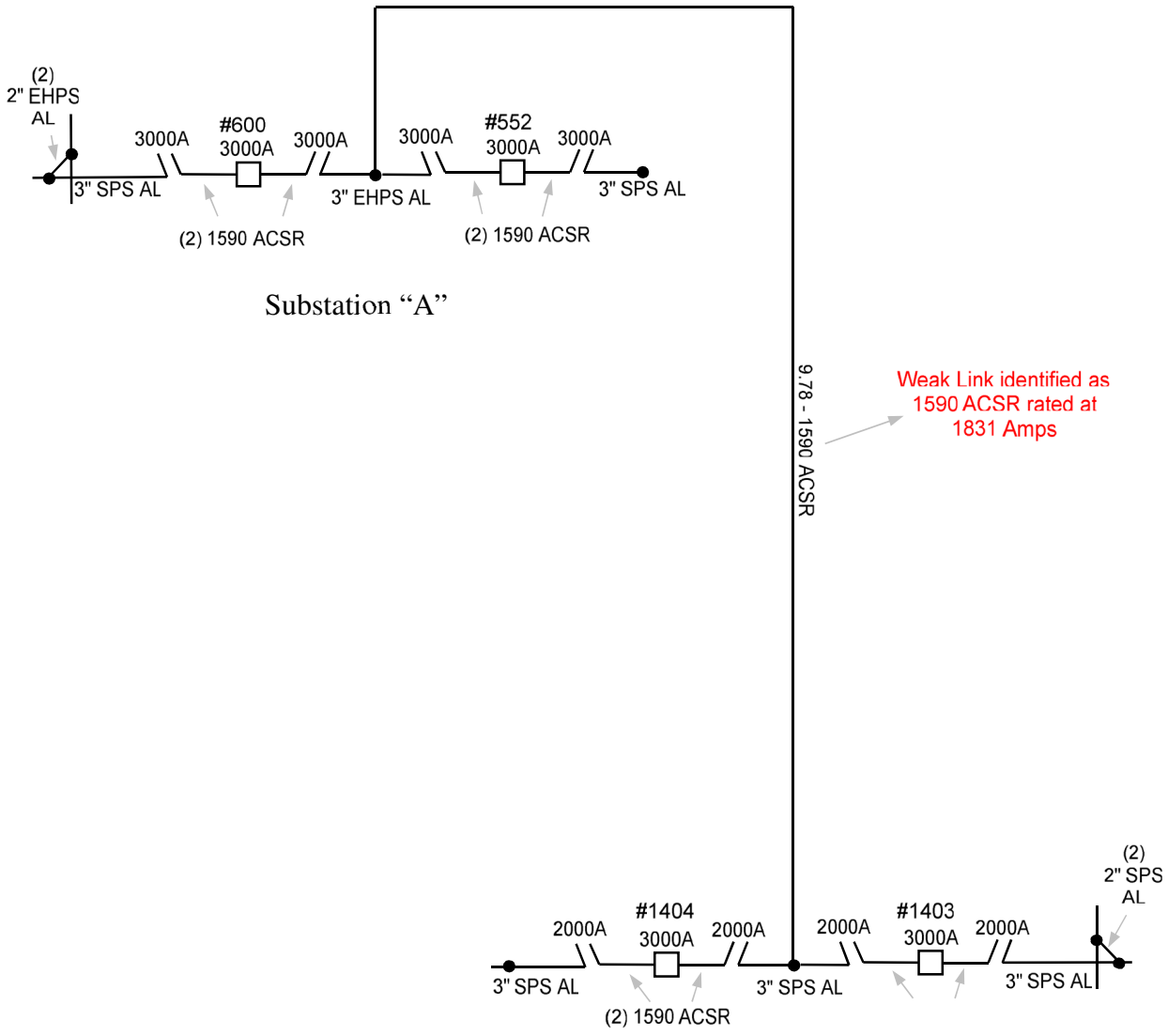
ratings listed next to each piece of equipment (above).

Identify the lowest rating or weak link in the Facility (performed by Facility Ratings Database). Set the Facility Rating equal to the lowest rated piece of equipment that comprises the Facility. The most limiting applicable equipment rating determines the rating of the Facility.

For this 230kV circuit, the weak link is the 1590 ACSR conductor. Therefore the normal or continuous rating of that Facility is 1831A. The emergency rating is 2514A for 7 minutes. Comparing this with the relay testing shown in the BES PSSE list sorted by Circuit Number spreadsheet confirms the relays will support the emergency rating.

See Figure below for clarification. The one line is an illustration representing of 230kV circuit 230605 from the Appendix A Transmission Line Facility Rating Example.

Transmission Line Rating Example One Line Diagram



Continuous Rating = 1831 Amps
Emergency Rating = 2514 Amps