



## Transmission Services

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### FAC-009: Facility Ratings Methodology

The BPA Facility Rating Methodology is comprised of the Operational Bottleneck Report, Line Design Specifications, Conductor Characteristics, By-Line Rating Program, transformer loading guides and Manufacture specifications. The BPA Bottleneck report is developed by Technical Operations group. The By-Line Program is supported by BPA Line Design Group. And the BPA System Electrical Data Book is managed by the BPA Grid-Modeling group. **The technical merits and standard of practices for establishing facility ratings are documented in BPA Facility Rating Methodology.** Information from each of these groups is consolidated into BPA data base for transmission elements. From this data set, which is annually updated, the Branch Data file is utilized to form the associated transmission models as specified by BPA and WECC.

Transmission models are comprised of various transmission elements which have ratings based on ambient temperatures. For aerial conductors a sag clearance has to be included based on the Maximum Operating Temperature (MOT). If these elements are modeled as individual and uniquely rated elements, the rating will be comprised of the most limiting rating provided by the manufacturer or by BPA equipment experts using the most relative means to calculate the required rating for the noted season. The majority of the operational equipment is documented in the Operational Bottleneck report which notes the incremental MVA and associated amperage limit for each transmission element.

These operational equipments and their associated normal ratings are also documented in the BPA System Electrical Data Book (SED). The BPA SED is design to provide documentation for BPA's transmission lines, transformers, shunt devices both capacitor and reactor, SVC devices, DC terminal equipment, and Power Circuit breakers. These sections constitute the seven elements referred to in the NERC standards for modeling. The general section defines the conductor characteristics and equations used in the industry to calculate the relative data and their respective ratings, if applicable. The numbers documented in the SED book are designed to be associated with the operational and planning models developed for and submitted to the RRO and its (WECC) technical staff.

Facility ratings are based on normal operating topology as specified for the applied seasonal temperature and location in the NW region. These facility ratings note the most limiting element as associated to the transmission element and how it is modeled for the associated application. This includes any transformer limit (if applicable), and associated circuit breaker, (s) if a breaker and a half scheme. Other terminal equipment such as disconnects switches are not included in the facility rating, will have to be confirmed by reference to the Bottleneck report based on any known topology shift deemed to be permanent configuration. Imposing limits can account for bushing limitations, sag clearances, fused-linked lines, disconnect switches, etc.



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### Modified branch elements

Based on internal Project Diagrams and documentation, any transmission rating that is identified as changing, is tagged as a modified transmission branch element. Once tagged the transmission capacity is reviewed and confirmed via the bottleneck report, line design specification, conductor specifications, and other associated equipment. This applied review capture the most limiting capacity to be associated to the noted transmission element.

### BPA Base Case Facility Ratings

The following ratings are in the branch data files:

Rate_N	Nominal Rating
Rate_WT	Winter Peak Thermal Rating
Rate_WE	Winter Peak Emergency Rating
Rate_WB	Winter Peak Bottleneck Rating
Rate_HWT	Heavy Winter Thermal Rating
Rate_HWE	Heavy Winter Emergency Rating
Rate_HWB	Heavy Winter Bottleneck Rating
Rate_IWT	Intermediate Winter Thermal Rating (No longer used)
Rate_IWE	Intermediate Winter Emergency Rating (No longer used)
Rate_IWB	Intermediate Emergency Bottleneck Rating (No longer used)
Rate_SpT	Spring Thermal Rating
Rate_SpE	Spring Emergency Rating
Rate_SpB	Spring Bottleneck Rating
Rate_SuT	Summer Thermal Rating
Rate_SuE	Summer Emergency Rating
Rate_SuB	Summer Bottleneck Rating

The first column in the above list is the heading in the Access branch data program. The second column provides a fuller description. I usually substitute more descriptive terms for the rating columns when I produce branch data Excel files for documentation (e.g., Rating Winter Thermal (Amps) instead of Rate\_WT).

The branch data ratings are in Amps for lines and MVA for transformers. The Amp ratings are converted to MVA for the GE epc records.

The thermal line ratings for BPA lines are the allowable current ratings (in Amps) consistent with the following ambient air temperatures (deg C):



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Load Period	Lines West of Cascades	Lines East of Cascades
Abnormal Winter (1-in-20 probability)	-15 degrees C	-30 degrees C
Intermediate Winter (1-in-5 probability)	-10 degrees C	-22 degrees C
Normal Winter (1-in-2 probability)	-5 degrees C	-15 degrees C
Spring	20 degrees C	20 degrees C
Summer	30 degrees C	30 degrees C

For the line compensation sections (i.e., sections with negative values for per unit X), the Irated amps are used for bottleneck ratings and the I-½ hour amps are used for thermal and emergency ratings.

The MVA ratings for BPA transformers are obtained from the BPA-Owned Transformer Loading Guide. The loading guide for each transformer has the appropriate rows for ambient temperature highlighted for Abnormal Winter, Intermediate Winter, Normal Winter, Spring, and Summer.

- The thermal ratings are under the Loading Capability columns. The ratings under the Forced Cooled column are used if they are available. Otherwise, the numbers under Self Cooled column are used.
- The emergency ratings are in the lower part of the form under Emergency MVA Capabilities. Winter and summer values are provided for 0.9, 0.8, 0.7, and 0.6 weekly load factors. We have been using an old list provided by Mike Schnell to select the winter and summer load factor for the given transformer. If a transformer location is not on the list, the recommendation was to use 0.7 for winter and 0.8 for summer. The summer emergency rating for a BPA transformer is also used for the spring emergency rating.
- The transformer rating called the bottleneck rating is the rating associated with bushing capability. The loading guide has columns under Bushing Capability for High Side and Low Side. The branch data emergency rating is the lower (more limiting) rating of the two ratings.

Other utilities provide their line and transformer ratings.

The branch data program allows the selection of a year and month for producing GE epc branch records for a case. The export form also has other choices:

- The program has a place to select the line and transformer Access tables.
- The Voption selection has three choices: v\_hold\_oct\_feb, v\_hold\_mar\_sep, and v\_hold\_light. The choice results in the preferred selection of voltage holds from three columns in the LPAC bus table. The first is used for winter cases. The second is used for summer and spring cases. The third has not been used. This determines the v<sub>max</sub> and v<sub>min</sub> values on the transformer records that have automatic LTC control.
- There is also a selection of normal, intermediate, and heavy for winter ratings. The default choice is normal and it is used for peak load cases. The heavy choice is used for the cases with extremely heavy winter loads (1-in-20 probability). The summer, spring, and fall ratings on the epc records will be



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the same regardless of whether the normal or heavy winter ratings are selected.

- Pressing the GE button will produce GE epc files with 8 ratings. Pressing the 5rating button will produce GE epc files with 5 ratings. The 8-rating and 5-rating conventions are described later in this document.

The branch data files may not have entries for every rating field for every branch. However, the program defaults to other selected ratings when producing GE epc records so all of the ratings are filled on the GE epc branch records produced for the power flow.

- The appropriate ratings for the season are the first choice. The program defaults to other ratings when the first choice is unavailable for any column.
- If a branch does not have any non-nominal ratings, the nominal rating is used for all the ratings in the GE epc branch records.
- In the past, all branches had nominal ratings even if they did not have the other ratings. The new branch data program techniques can now result in branches without nominal ratings. When a GE epc file is used to produce branch data records, the branches do not have nominal ratings. However, they should have other ratings that would be used in preference to the nominal ratings.
- If a branch does not have any spring ratings and it has summer ratings, the summer ratings will be used for the spring GE case ratings. If no Spring ratings exist in branch data, the program defaults to summer (if summer branch data ratings exist) or nominal (if summer branch data ratings do not exist). Several utilities provide winter and summer ratings for the branch data so the summer branch data ratings are used for the spring and fall case ratings in the epc file for those branches.
- If at least one spring rating exists in branch data but other spring ratings are zero or blank, the spring ratings that exist will be used for the spring case ratings. For example, if a branch has a spring thermal rating but no other spring ratings and the branch has thermal and bottleneck summer ratings, the program will use the spring thermal rating in branch data for both spring case ratings in the epc file. The program will not use the summer bottleneck for the case spring bottleneck.
- The branch data files do not have fall ratings. The ratings used for spring case ratings will be used for fall case ratings.
- Intermediate winter ratings are still in the branch data and the program allows the selection of them for producing GE epc records. Although we have discontinued the production of intermediate winter cases, the program can handle them if they are ever revived.

### Branch Rating Selections

The branch ratings in the CY10 PowerWorld cases have the same convention as the branch ratings in the CY10 cases. This addressed a preference by the TOP group and others that the cases only have ratings for the specific season of the case instead of



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the WECC convention of 8 ratings devoted to 4 seasons. The WECC rating convention only allows two ratings per season. The branch data file could include thermal, emergency, and bottleneck ratings for each season. Therefore, it was not obvious from the WECC case rating convention whether a branch was limited by the thermal rating or a bottleneck rating.

### Branch Ratings in the 8-Rating GE Cases

The 8-rating GE cases have branch ratings for all seasons and follow the same convention as the WECC cases. The 8-rating GE cases only have 2 ratings per season.

The ratings in the 8-rating GE cases are:

- 1<sup>st</sup> Line Rating = Normal Summer = lower of thermal or bottleneck
  - 2<sup>nd</sup> Line Rating = Emergency Summer = emergency if it exists (otherwise same as the 1<sup>st</sup> rating)
  - 3<sup>rd</sup> Line Rating = Normal Winter = lower of thermal or bottleneck
  - 4<sup>th</sup> Line Rating = Emergency Winter = emergency if it exists (otherwise same as the 3<sup>rd</sup> rating)
  - 5<sup>th</sup> Line Rating = Normal Fall = lower of thermal or bottleneck - used spring ratings
  - 6<sup>th</sup> Line Rating = Emergency Fall = emergency if it exists (otherwise same as the 5<sup>th</sup> rating)
  - 7<sup>th</sup> Line Rating = Normal Spring = lower of thermal or bottleneck
  - 8<sup>th</sup> Line Rating = Emergency Spring = emergency if it exists (otherwise same as the 7<sup>th</sup> rating)
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- 1<sup>st</sup> Transformer Rating = Normal Summer = lower of thermal or bottleneck
  - 2<sup>nd</sup> Transformer Rating = Emergency Summer = lower of bottleneck or emergency
  - 3<sup>rd</sup> Transformer Rating = Normal Winter = lower of thermal or bottleneck
  - 4<sup>th</sup> Transformer Rating = Emergency Winter = lower of bottleneck or emergency
  - 5<sup>th</sup> Transformer Rating = Normal Fall = lower of thermal or bottleneck - used spring ratings
  - 6<sup>th</sup> Transformer Rating = Emergency Fall = lower of bottleneck or emergency - used spring ratings
  - 7<sup>th</sup> Transformer Rating = Normal Spring = lower of thermal or bottleneck
  - 8<sup>th</sup> Transformer Rating = Emergency Spring = lower of bottleneck or emergency

Most lines do not have emergency ratings in the branch data program. The emergency line ratings have been added for Grant County PUD and a few other branches. Therefore, most line ratings for Northwest lines will have the same rating for the normal and emergency rating.

If transformers do not have emergency or bottleneck ratings in the branch data program files, the emergency transformer rating on the GE transformer record for each season will match the normal transformer rating for that season.



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### Branch Ratings in the 5-Rating GE Cases

The branch ratings in the 5-rating GE cases are restricted to the season of the case. The first two ratings match the ratings in the 8-rating case for the season of the case. For example, the first two ratings in the 5-rating winter case would match the third and fourth ratings in the 8-rating GE case.

1<sup>st</sup> Line Rating = Normal = lower of thermal or bottleneck for the season of the case

2<sup>nd</sup> Line Rating = Emergency = emergency for the season of the case if it exists (otherwise same as the first rating).

3<sup>rd</sup> Line Rating = Thermal rating from branch data for the season of the case.

4<sup>th</sup> Line Rating = Emergency rating from branch data for the season of the case.

5<sup>th</sup> Line Rating = Bottleneck rating from branch data for the season of the case.

1<sup>st</sup> Transformer Rating = Normal = lower of thermal or bottleneck for the season of the case

2<sup>nd</sup> Transformer Rating = Emergency = lower of bottleneck or emergency for the season of the case

3<sup>rd</sup> Transformer Rating = Thermal rating from branch data for the season of the case.

4<sup>th</sup> Transformer Rating = Emergency rating from branch data for the season of the case.

5<sup>th</sup> Transformer Rating = Bottleneck rating from branch data for the season of the case.

The sixth through eighth ratings are all zero.

If the branch data file does not have a rating for the selection, the first two ratings default to other values (e.g., summer ratings for spring if spring ratings are not in branch data, nominal ratings if no other ratings are in branch data, thermal ratings if bottleneck and emergency do not exist, etc.) Therefore, the first two ratings in the 5-rating case should have entries for all Northwest branches. The third through fifth ratings will be non-zero if the associated ratings are in branch data and zero if the associated ratings are not in branch data. For example, a branch in a spring case that uses summer ratings or the nominal rating for the first two ratings will not have any ratings in the third through fifth rating columns.

### Branch Ratings in PowerWorld Cases

The branch ratings in the PowerWorld cases match the ratings for the 5-rating GE cases. The ratings are restricted to the season of the particular case.

Line Limit A = Normal = lower of thermal or bottleneck for the season of the case

Line Limit B = Emergency = emergency for the season of the case if it exists (otherwise same as the first rating).

Line Limit C = Thermal rating from branch data for the season of the case.

Line Limit D = Emergency rating from branch data for the season of the case.

Line Limit E = Bottleneck rating from branch data for the season of the case.



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Transformer Limit A = Normal = lower of thermal or bottleneck for the season of the case.

Transformer Limit B = Emergency = lower of bottleneck or emergency for the season of the case.

Transformer Limit C = Thermal rating from branch data for the season of the case.

Transformer Limit D = Emergency rating from branch data for the season of the case.

Transformer Limit E = Bottleneck rating from branch data for the season of the case.

### Version History

Version	Issue Date	Action/Changes	Prepared By	Reviewed By	Approved By Signature	Date Signed
1	August 11, 2010	Update link to Branch data	TPM	Thong Trinh	<i>John Haner</i>	

Uncontrolled When Printed