

ROCHESTER PUBLIC UTILITIES



FACILITY RATINGS METHODOLOGY FOR TRANSMISSION, SUBSTATION, & GENERATION EQUIPMENT

The document describes the current methodology used for developing facility ratings of Rochester Public Utilities' transmission, substation, and generation facilities. This document has been prepared to comply with the North American Electric Reliability Corporation (NERC) Facilities Ratings Methodology requirements of standard FAC-008-1.

REQUIREMENTS

R1.1 GENERAL

In general, a facility is considered a system of equipment and major components that must be integrated and operated together. The facility rating shall equal the most limiting applicable equipment rating of the individual equipment or major components that comprise that facility.

R1.2 SCOPE

The scope and method by which the rating of major bulk electric system equipment is based on the criteria and factors shown in section R1.3 of NERC Standard FAC-008-1. The resulting ratings for RPU's solely and jointly owned facilities are collected and reported in the RPU System Data Book, as required in section R1 of NERC Standard FAC-009-1.

R1.2.1 APPLICABLE EQUIPMENT

Equipment addressed by this standard covers all 161 kV substation equipment and lines, including transmission conductors, transformers, relay protective devices, terminal equipment, and series and shunt compensation devices.

R1.2.2 NORMAL AND EMERGENCY RATINGS

Normal and emergency ratings are addressed for applicable equipment.

R1.3.1 MANUFACTURER'S EQUIPMENT RATINGS

Ratings listed per equipment such as circuit breakers, disconnect switches, and transformers, shall be provided by the manufacturer. Where possible, these ratings shall appear on the equipment nameplate.

Ratings listed per major component such as line conductors, bus, and related accessories, shall be provided by the manufacturer or shall be calculated by accepted industry practices or applicable standards.

For Transmission and Substation Facilities, the following apply:

- A. Circuit Breakers The summer and winter normal and emergency ratings of the equipment shall be the nameplate rating of the equipment.
- B. Circuit Switchers The summer and winter normal and emergency ratings of the equipment shall be the nameplate rating of the equipment.
- C. Disconnect Switches The summer and winter normal and emergency ratings of the equipment shall be the nameplate rating of the equipment.
- D. Wave Traps The summer and winter normal and emergency ratings of the equipment shall be the nameplate rating of the equipment.
- E. Power Transformers The summer and winter normal and emergency ratings of the equipment shall be the nameplate rating of the equipment. Power transformers are sized based on the ability to support four distribution feeders each loaded at 50% of summer emergency rating plus one feeder loaded at 100% of summer emergency rating. The resulting total load when allowed for a maximum of three hours and must not exceed 0.1% loss of transformer life in accordance with ANSI/IEEE standards.
- F. Current Transformers The summer and winter normal ratings of the equipment shall be the nameplate rating and applied continuous overload rating of the equipment. Continuous overload thermal rating factors will be applied to tapped windings per manufacturer's data and recommendations as well as in accordance with ANSI/IEEE Standard C37.110. The summer and winter emergency ratings of the equipment shall be 110% of the normal rating and applied continuous overload rating as long as the circuit breaker rating (if the CT is associated with a circuit breaker) is not exceeded.
- G. Tubular Bus The summer and winter normal ratings of the equipment shall be the calculated rating determined in accordance with NEMA Standard CC1.
- H. Line Conductors The summer and winter normal ratings of the equipment shall be based on not exceeding the maximum allowable design temperature of the conductor.
 - 1. Under no circumstances shall the normal or emergency operating temperature of a line exceed the sag limit based on minimum clearances specified in the National Electrical Safety Code.

2. Bare overhead conductor transmission line conductor ratings are based on the maximum operating temperature for the line at which minimum clearances are in accordance with the National Electrical Safety Code. If clearances are not a factor, the ratings are based on 167 degrees F or 212 degrees F maximum conductor temperature for ACSR, depending on the line.
 3. Emergency ratings are 10% over normal ratings.
 4. Line ratings may be adjusted for certain short-term operating conditions, such as during operating conditions in which a transmission line may load above its seasonal rating. For such situations, the rating of the bare overhead conductor is calculated at ambient conditions in 10 degree F increments from -20 degrees F to 110 degrees F. In the determination of the adjusted ratings, only the ambient temperature is modified. All other atmospheric conditions remain unchanged. In the determination of the overall transmission line adjusted rating, other facility limits such as terminal equipment ratings are observed.
- I. Jumpers & Connectors The summer and winter normal ratings of the equipment shall be based on not exceeding the maximum allowable operating temperature of the substation equipment to which it is connected. For equipment without condenser bushings, the maximum temperature is 90 degrees C. For equipment with condenser bushings, the maximum temperature is 70 degrees C. Standard ratings of conductors are based on data published by Southwire Company with conductor temperature of 75 degrees C, ambient temperature 25 degrees C, emissivity 0.5, wind 2 ft./sec., in sun light. Adjustment of the published ratings is allowed using Southwire Company's SWRATE software program or similar software or direct calculations based on ANSI/IEEE standards. Ratings for all connectors are based on ANSI/IEEE Standard C119.4 for line applications and NEMA Standard CC1 for substation applications.

For Generator Facilities, the following apply:

- A. Ratings listed per generator shall be based on manufacturer's ratings as provided by the manufacturer. Where possible, these ratings shall appear on the equipment nameplate, design document, or machine capability graph or table.
- B. For generating units where hydrogen is used as the generator coolant, the manufacturer's maximum nameplate MVA rating is given for a hydrogen pressure of 30.0 PSI gauge. The manufacturer's minimum nameplate MVA rating is given for a hydrogen pressure of 0.5 PSI gauge.

- C. The generator Maximum MW and MVAR output and Maximum MVAR intake ratings shall be based on the manufacturer’s published limits of the machine.
- D. Generator ratings may be modified based on the results of URGE testing.
- E. Ratings of bus duct and other series components shall be based on manufacturer’s ratings as provided by the manufacturer. Where possible, these ratings shall appear on the equipment nameplate or design document.

R1.3.2 DESIGN CRITERIA

Design criteria shall follow applicable industry rating practices, including recommendations and guidelines from manufacturer’s literature, IEEE, ANSI, NEMA, and ASTM standards. These standards are not listed here for brevity. It is the project engineer’s responsibility to research the appropriate and current version applicable to the equipment or major component.

R1.3.3 AMBIENT CONDITIONS

A. Ambient Conditions – Substation Equipment.

Ratings of all equipment shall be selected to meet the anticipated indoor and outdoor environmental conditions. Factors shall include:

1. Elevation

Elevation Range (Mean Sea Level)	Less than 1500 Feet
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2. Temperature and Humidity – Substation Equipment

Outdoor Conditions	Ambient Temperature, °F	Relative Humidity, %
Summer Design Condition – 50 yr	104°F	100%
Summer Design Condition – Typical	95°F	95%
Winter Design Condition – 50 yr	-40°F	---
Winter Design Condition –	-20°F	---

Typical		
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Indoor Conditions	Ambient Temperature, °F	Relative Humidity, %
Summer Design Condition – 50 yr	95°F	100%
Summer Design Condition – Typical	80°F	95%
Winter Design Condition – 50 yr	50°F	---
Winter Design Condition – Typical	70°F	---

3. Precipitation

Rainfall

100 year	24 hour storm	6.2 inches
25 year	24 hour storm	4.8 inches
10 year	24 hour storm	4.3 inches
2 year	24 hour storm	3.0 inches

Flood Elevation (100 years): site specific

Design Ground Snow Load: 50 Lbs/Ft²

Frost Depth: 42 Inches

4. Wind

Basic Wind Speed 90 mph

5. Seismic

Earthquake loads and seismic provisions are not required in accordance with Minnesota Building Code Sections 1305.0011 Subpart 4.

6. Other factors as applicable to specific project circumstances

B. Ambient Conditions – Transmission Lines.

The normal bare overhead conductor rating shall be calculated under the following assumed conditions:

1. Ambient air temperature of 80 degrees F for summer season rating and 32 degrees F for winter season ratings.
2. Wind velocity of 2 ft./sec.
3. Incident wind angle of 90 degrees to the conductor
4. Solar factors of:
 - Latitude 44 degrees north and longitude 92 degrees west (approximate for Rochester, MN)
 - Elevation of 1100 ft. above mean sea level
 - East-West line orientation
 - Absorptivity and emissivity coefficients of 0.5.

R1.3.4 OPERATING LIMITATIONS

All facilities shall be planned so the resulting rating shall meet or exceed the operating forecasts of the intended facility across the planned life of the facility.

Operating limits of a facility shall reflect the lowest rating of the set of equipment and major components that make up the facility. Conductor temperature, sag limits, relay settings and CT secondary circuit limits shall be part of this consideration.

R2 RECORDS DISTRIBUTION & REVIEW

Facility ratings are recorded in the RPU System Data Book, and are updated periodically. Updates will generally occur following major system changes or after an accumulation of new or upgraded equipment has occurred. The RPU System Data Book is the record.

RPU will communicate facility ratings recorded in the RPU System Data Book to its associated Reliability Coordinator(s), Planning Authority(ies), Transmission Planner(s), and Transmission Operator(s) as follows:

- Upon request by such entities, a copy of the RPU System Data Book will be provided within 15 business days of the receipt of the request.
- As a submittal to the MRO model building process as required by the MOD standards and annual MAPP / MRO model building requirements.

- Upon each published update of the RPU System Data Book. The external distribution list as of July 2009 is:
 - Southern Minnesota Municipal Power Agency
 - MISO
 - MAPP
 - MRO
- The internal RPU distribution list as of July 2009 is:
 - System Operations
 - Transmission planning engineer
 - Transmission design engineer
 - Substation design engineer
 - Mgr. of Engineering
 - Director of Core Services
 - RPU Library
 - Engineering file

Review and comments of the RPU Facilities Ratings Methodology and RPU System Data Book are welcome. Parties wishing to review either document must contact RPU and place the request in writing. When a bona fide request is received, RPU will submit a written copy of the Facilities Ratings Methodology document and the RPU System Data Book to the requester within 15 business days. Alternatively, the requestor will be directed to the RPU website where a copy can be downloaded. When a bona fide review of the Facilities Ratings Methodology is received, RPU will submit a written response to the commenter within 45 calendar days. The response will indicate whether a change will be made to the Facility Ratings Methodology and, if no change will be made to that Facility Ratings Methodology, the reason why.

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Version Control:

Version	Date	Author	Change Description
1	July, 2009	N. Stiller	Compiled from empirical sources, Conformed to NERC standard FAC-008-1
2	October, 2009	N. Stiller	Improvements and updates as requested. Added distribution and review section to conform to NERC standard FAC-009-1