

Factors And Rates

Data Reporting Instructions – Appendix F

Module 11 - GADS Data Reporting Workshops

RELIABILITY | ACCOUNTABILITY



- In general, factors are based on period hours (PH)
 - They tell you how well you did during the period
 - They are additive: $WAF + WFOF + WMOF + WPOF = 100\%$
 - They end with an “F”: EAF
- In general, rates are based on service hours (SH)
 - They tell you how well you did when the unit ran
 - They are not additive
 - They end with an “R”: EUOR
- There are six (6) varieties of factor and rate calculations
 - Time based, single or grouped unit, w/ and w/o OMC (4)
 - Energy weighted, single/grouped unit, w/ and w/o OMC (2)
- For more on factors and rates see Appendix F

- The factors and rates defined by NERC are summarized below
 - Forced – WFOF, WEFOF, WFOR, WEFOR, WEFORD
 - Maintenance – WMOF, WEMOF, WEMOR
 - Planned – WPOF, WEPOF, WEPOR
 - Derated - WSDF, WUDF
 - Unplanned – WUOF, WEUOF, WEUOR
 - Available – WAF, WEAFF
 - Unavailable – WUF, WEUF
 - Scheduled – WSOF, WESOF
 - Other - SR, WSF, GCF, NCF, GOF, NOF
- We will examine some commonly used factors and rates

NERC 62: SR = Starting Reliability

$$SR = \frac{\sum_{n=1}^m ACTSU_n}{\sum_{n=1}^m ATTSU_n} \times 100$$

SR = probability of successful startup

Event types involved: none

ATTSU = count of attempted starts

ACTSU = count of actual starts

ATTSU – ACTSU = count of SF events

ATTSU >= ACTSU is always true

IEEE Std 762 9.22:

$$SR = \frac{\sum_{i=1}^n (\text{Number of actual unit starts})_i}{\sum_{i=1}^n (\text{Number of attempted starts})_i} \times 100$$

NERC 65: WFOF = Weighted Forced Outage Factor

$$\mathbf{WFOF} = \frac{\sum_{n=1}^m (FOH_n \times NMC_n)}{\sum_{n=1}^m (PH_n \times NMC_n)} \times \mathbf{100}$$

WFOF = percent of time on forced outage

Event types involved: U1, U2, U3, SF

IEEE Std 762 10.3:

$$WFOF = \left(\frac{\sum_{i=1}^n (FOH_i \times NMC_i)}{\sum_{i=1}^n (PH_i \times NMC_i)} \right) \times 100$$

- Problem: Unit 1 is a 500 MW gas fired unit. During the first half of April, it produces 90,000 MWH then it throws a high pressure turbine blade and goes on a U1 outage for the rest of the month.
- Question: What is the Weighted Forced Outage Factor for Unit 1 in April?
 - A. 40%
 - B. 50%
 - C. 60%

NERC 76: WEAFF = Weighted Equivalent Availability Factor

$$\mathbf{WEAF} = \frac{\sum_{n=1}^m [(AH_n - EFDH_n - EMDH_n - EPDH_n - ESEDH_n) \times NMC_n]}{\sum_{n=1}^m (PH_n \times NMC_n)} \times 100$$

WEAF = percent of time available without outages, derates or seasonal derates

Event types involved: U1, U2, U3, SF, MO, ME, PO, PE, D1, D2, D3, D4, DM, PD, DP

IEEE Std 762 10.11:

$$WEAF = \left(\frac{\sum_{i=1}^n [(AH_i \times NMC_i) - (EUNDH_i + ESDH_i) \times NMC_i]}{\sum_{i=1}^n (PH_i \times NMC_i)} \right) \times 100$$

NERC 78: NCF = Net Capacity Factor

$$\mathbf{NCF} = \frac{\sum_{n=1}^m \mathbf{NAG}_n}{\sum_{n=1}^m (\mathbf{PH}_n \times \mathbf{NMC}_n)} \times \mathbf{100}$$

NCF = percent of maximum net energy produced for the period

Note that NCF is inherently energy weighted; it is built in

NAG = Net Available Generation

IEEE Std 762 10.13:

$$NCF = \left(\frac{\sum_{i=1}^n (NAAG)_i}{\sum_{i=1}^n (PH_i \times NMC_i)} \right) \times 100$$

- Problem: Unit 1 is a 500 MW gas fired unit. During the first half of June, it produces 180,000 MWH then it goes on reserve shutdown for the rest of the month due to a new big unit coming online.
- Question: What is the Net Capacity Factor for Unit 1 in June?
 - A. 50%
 - B. 40%
 - C. 60%

NERC 88: WEFOR = Weighted Equivalent Forced Outage Rate

$$\mathbf{WEFOR} = \frac{\sum_{n=1}^m [(FOH_n + EFDH_n) \times NMC_n]}{\sum_{n=1}^m [(FOH_n + SH_n + Pump_n + Sync_n + EFDHRS_n) \times NMC_n]} \times \mathbf{100}$$

WEFOR = probability of being on forced outage or derate

Event types involved: U1, U2, U3, SF, D1, D2, D3

IEEE Std 762 10.17.1:

$$WEFOR_{\tau} = \left(\frac{\sum_{i=1}^n [FOH_i + EFDH_i] \times NMC_i}{\sum_{i=1}^n [(FOH_i + SH_i + (SHNG)_i + ERSFDH) \times NMC_i]} \right) \times 100$$

- Problem: Unit 1 is a 500 MW gas fired unit. During the first week of February 2019, it produces 84,000 MWH then it losses its main transformer and goes on a U1 outage for the rest of the month while a spare is located and brought in.
- Question: What is the Weighted Equivalent Forced Outage Rate for Unit 1 in February?
 - A. 75%
 - B. 50%
 - C. 60%

NERC 92: WEUOR = Weighted Equivalent Unplanned Outage Rate

$$\text{WEUOR} = \frac{\sum_{n=1}^m [(FOH_n + MOH_n + EFDH_n + EMDH_n) \times NMC_n]}{\sum_{n=1}^m [(FOH_n + MOH_n + SH_n + Pump_n + Sync_n + EFDHRS_n + EMDHRS_n) \times NMC_n]} \times 100$$

WEUOR = probability of being on unplanned outage or derate

Event types involved: U1, U2, U3, SF, MO, ME, D1, D2, D3, D4, DM

IEEE Std 762 not defined

NERC 89: WEFOR_d = Weighted Equivalent Forced Outage Rate Demand

$$\text{WEFOR}_d = \frac{\sum_{n=1}^m [(FOHd_n + EFDHd_n) \times NMC_n]}{\sum_{n=1}^m [(SH_n + FOHd_n) \times NMC_n]} \times 100$$

WEFOR_d = probability of being on forced outage or derate when demanded to run

Where:

- FOHd = f x FOH
- EFDHd = EFDH - EFDHRS if RSH > 0 or EFDHd = p x EFDH if RSH = 0
- p = SH/AH
- f = (1/r + 1/T)/(1/r + 1/T + 1/D)
- r = FOH/ #FO
- T = RSH/ATTSU
- D = SH/ACTSU

Event types involved: U1, U2, U3, SF, D1, D2, D3, RS

IEEE Std 762 10.17.2:

$$\text{WEFOR}_d = \left(\frac{\sum_{i=1}^n [(FOH_{di} + EFDH_{di}) \times NMC_i]}{\sum_{i=1}^n [(SH_i + FOH_{di}) \times NMC_i]} \right) \times 100$$

- Four (4) state model for a unit
 - All four states are active states
- Initially developed in the United Kingdom
- Now used in a number of countries that deregulate the power industry
- No equation for commercial availability
 - EFORd is also based on a four state model but is not the same thing
- What is it?
 - Marketing procedure
 - Increases profits while minimizing expenditures
 - Concept:
 - Have the unit available for generation during high income periods
 - Repair the unit on low income periods

Unit Available

Not needed for Generation

Not Competitive, -\$

Unit Available

Needed for Generation

Make Big Revenue, +\$

Unit Not Available

Not needed for Generation

Good Time for Repairs

Unit Not Available

Needed for Generation

Lost Opportunity, -\$



Questions and Answers