NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Factors And Rates

Data Reporting Instructions – Appendix F

Module 11 - GADS Data Reporting Workshops
June, 2019

RELIABILITY | ACCOUNTABILITY




Factors and Rates

- 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

Summary of Factors and Rates

- 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, WEAF
  - Unavailable – WUF, WEUF
  - Scheduled – WSOF, WESOF
  - Other - SR, WSF, GCF, NCF, GOF, NOF
- We will examine some commonly used factors and rates

Starting Reliability

NERC 62: SR = Starting Reliability

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

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:

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

Weighted Forced Outage Factor

NERC 65: WFOF = Weighted Forced Outage Factor

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

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

- 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%
- Answer: B. 50%
- Explanation: WFOF = (FOH x NMC) / (PH x NMC) = FOH / PH = (15 x 24) / (30 x 24) = 15 / 30 = 50%

Weighted Equivalent Availability Factor

NERC 76: WEAF = Weighted Equivalent Availability Factor

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

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:

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

Net Capacity Factor

NERC 78: NCF = Net Capacity Factor

$$\textbf{NCF} = \frac{\sum_{n=1}^{m} NAG_n}{\sum_{n=1}^{m} (PH_n \, x \, NMC_n)} \textbf{ x 100}$$

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:

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

Problem

- 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%
- Answer: A. 50%
- Explanation: NCF = NAG / (PH x NMC) = 180,000 / [(30 x 24) x 500] = (180,000 / 30) / (24 x 500) = 6,000 / 12,000 = 50%

Weighted Equivalent Forced Outage Rate

NERC 88: WEFOR = Weighted Equivalent Forced Outage Rate

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

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:

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

Problem

- 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%
- Answer: A. 75%
- Explanation: WEFOR = (FOH x NMC) / [(FOH + SH) x NMC] = FOH / (FOH + SH) = (21 x 24) / [(21 x 24) + (7 x 24)] = 21 / 28 = 75%

Weighted Equivalent Unplanned Outage Rate

NERC 92: WEUOR = Weighted Equivalent Unplanned Outage Rate

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

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

Weighted Equivalent Forced Outage Rate Demand

NERC 89: WEFORd = Weighted Equivalent Forced Outage Rate Demand

$$\textbf{WEFORd} = \frac{\sum_{n=1}^{m}[(FOHd_n + EFDHd_n)\ x\ NMC_n]}{\sum_{n=1}^{m}[(SH_n + FOHd_n)\ x\ NMC_n)]}\ \textbf{x 100}$$

WEFORd = 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:

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

Commercial Availability

- 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

Commercial Availability

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