WEEKLY JOURNAL-12

SUMMARY

Generation adequacy evaluation for single generation units and multiple generation units were discussed. Risk evaluation using probability method was found as useful in evaluating risk compared to reserve / capacity margin metrics.

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Power System Adequacy

Week-12

Summary: Generation adequacy evaluation for single generation units and multiple generation units were discussed. Risk evaluation using probability method was found as useful in evaluating risk compared to reserve / capacity margin metrics.

Introduction

Loss of load indices are also used to evaluate the generation adequacy.

Loss of load expectation -days (LOLE)

Expected number of days per year in which the available generation capacity is lower than the peak load.

$$LOLE = \sum_{i=1}^{n} P_i(C_i - L_i) \text{ days/period}$$

HLOLE- expected number of hours per year in which the generation capacity is lower than the peak load.

$$LOLE = \sum_{i=1}^{n} P_i(C_i - L_i) \text{ hours /period}$$

Question 1:

Following outage probability table and load details are given. Determine the LOLE.

Outage	Probability
0	1.0000
25	0.0588
50	0.0204
75	0.00079
100	0.0008

Daily peak	No. of days
77 MW	12
52 MW	83
46 MW	127
41 MW	116
24 MW	27

$$LOLE = \sum 12 \times P(C-77) + 83 \times P(C-52) + 127 \times P(C-46) + 116 \times P(C-41) + 27 \times P(C-24)$$

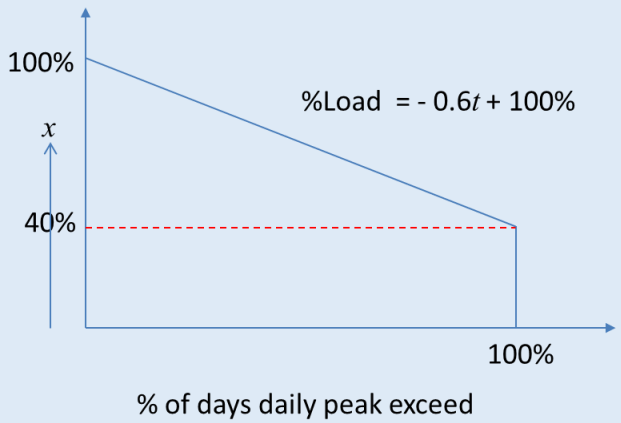
$$LOLE = \sum 12 \times P(23) + 83 \times P(48) + 127 \times P(54) + 116 \times P(59) + 27 \times P(76)$$

$$LOLE = \sum 12 \times 0.0588 + 83 \times 0.0204 + 127 \times 0.00079 + 116 \times 0.00079 + 27 \times 0.0008$$

Question 2

Outage probability of each generator and load characteristic curve is given below. If maximum peak load is 160 MW, determine the LOLE.

Capacity Outage	Individual Probability
0	0.9510
40	0.0480
80	0.00097
120	$9.8010e^{-6}$
160	$4.9500e^{-8}$
200	$1.0e^{-10}$



Capacity outage	Avail	lost load	Individual probability	lost time	P*t	LOLE
0	200	0	0.951	0	0.00E+00	
40	160	0	0.048	0	0.00E+00	
80	120	40	0.00097	41.66667	4.04E-04	4.08E-04
120	80	80	9.80E-06	41.66667	4.08E-06	
160	40	120	4.95E-08	83.33333	4.13E-08	
200	0	160	1.00E-10	83.33333	8.33E-11	

Generation expansion

Develop a generation expansion plan based on below data.

Load growth 10% per year. Required maximum risk 0.15 days/year. Available generators 50 MW with FOR 0.01. System peak load is 160 MW at current year.

LOLE table

Peak Load	LOLE (days/yr.)		
	200 MW	250 MW	300 MW
160	0.1506	0.0026	-
180	3.4459	0.0686	-
200	6.0821	0.1505	0.003
220	-	2.058	0.03615
240	-	4.853	0.1361
250	-	6.083	0.18

Year	Load (MW)
1	160.00
2	**176.00**
3	193.60
4	**212.96**
5	234.26
6	**257.68**
7	283.45
8	311.79

Generator addition should be done in 2nd year, 4th year and 6th year.

Problem of the week

A generating system consist of the following units

Unit	Capacity	FOR
1	10 MW	0.08
2	20 MW	0.08
3	30 MW	0.08
4	40 MW	0.06

Determine the LOLE for a single daily peak load of 60 MW

outage	available	probability	
0	100	0.73196672	0.999519
10	90	0.06364928	0.267552
20	80	0.06364928	0.203903
30	70	0.069184	0.140253
40	60	0.052256	0.071069
50	50	0.00959744	0.018813
60	40	0.00406272	0.009216
70	30	0.004416	0.005153
80	20	0.00035328	0.000737
90	10	0.00035328	0.000384
100	0	0.00003072	3.07E-05