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Partial Binomial Distribution method for Generation capacity outage using Spreadsheets

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Abstract: *Reliability in large power system is a major concern in this modern age. There are various methods to find out the reliability for the generation capacity. Whenever a generator fails, the capacity of that particular generator is considered as outage. in this paper a major focus will be on the binomial distribution method which is useful when all generators have same generating capacity. A simple formula and Microsoft excel tables will be helpful to find out the generation outage for more number of generators. This will solve the human errors in calculations and fast results will be helpful for future planning in the power systems.*

Keywords - *Availability, Forced Outage Rate, Generation outage, Reliability of Power system, Spreadsheets*

I. INTRODUCTION

Large power systems mainly contains synchronous generator for power generation in bulk amount. Various nonrenewable power sources also contribute in the power generation nowadays, but as they are dependent on the season and daytime and other variables. Therefore, it is unpredictable and the reliability for such systems cannot be found very correctly. On other hands, as power stations operate with maximum reliable equipment's andcomputerized monitoring, these systems tend to be more reliable than the non-renewable one. Anyhow, the reliability of the system plays a major role in the economy of the country; therefore, the methods were developed to find out the reliability of the power system. There methods deal with the table formats and just with the help ofthese tables, one can find out that if any single generator or a pair of the generator will be failed then how it mayaffect the power generation.

II. PARTIAL BINOMIAL DISTRIBUTION METHOD

The partial binomial distribution method is used when there are generators having same FOR and one or two generators having different FOR than the previous ones. In such cases, the reliability of the generating system can be found with the help of the binomial distribution in first half and then by comparing the FOR of the generator with the reliability table of group of previous generators. In this reliability calculations, table is made for the outage. Outage stands for the failure of the particular generator and it is not in the service.

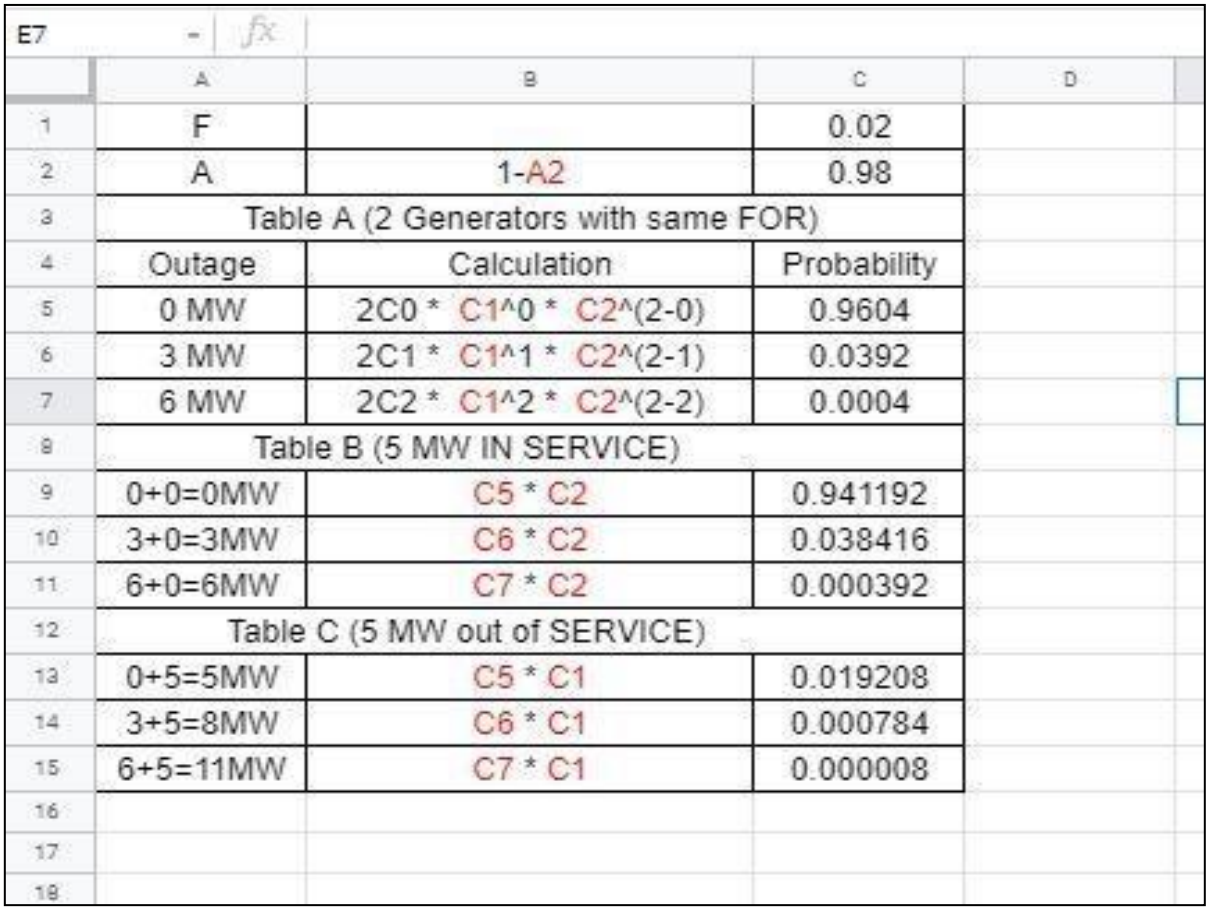
A simple formula for binomial distribution is

$$P_g = nC_g\,(F)^g\,(A)^{n-g} \quad \ldots (A)$$

Where
n= no of generator
g = state of the generator
F = FOR
A = availability (A=1-F).

III. METHODOLOGY

The methodology can be simply understood by the simple numerical. A generating system having 2 generators of 3 MW with FOR 0.02 and 1 generator of 5 MW with FOR 0.03. Calculate capacity outage table for the given pairs of generators.



	A	B	C	D
1	F		0.02	
2	A	1-A2	0.98	
3	Table A (2 Generators with same FOR)			
4	Outage	Calculation	Probability	
5	0 MW	2C0 * C1^0 * C2^(2-0)	0.9604	
6	3 MW	2C1 * C1^1 * C2^(2-1)	0.0392	
7	6 MW	2C2 * C1^2 * C2^(2-2)	0.0004	
8	Table B (5 MW IN SERVICE)			
9	0+0=0MW	C5 * C2	0.941192	
10	3+0=3MW	C6 * C2	0.038416	
11	6+0=6MW	C7 * C2	0.000392	
12	Table C (5 MW out of SERVICE)			
13	0+5=5MW	C5 * C1	0.019208	
14	3+5=8MW	C6 * C1	0.000784	
15	6+5=11MW	C7 * C1	0.000008	
16				
17				
18				

Figure.1: Methodology to solve Partial binomial method with spreadsheet

In the starting, Write down F as outage rate and clearly mention the value of that into the specific column, similarly we can find out availability of the generator with the formula. Now in table A, we can find out outage for 0, 3 and 6 MW with the help of binomial distribution formula. Note that the C1 C2 to C7 which are mentioned in red color are the cell numbers. For the convenience, the probability is given in the last column. Now in table b as 5 MW generator is in service therefore we will simply multiply the probability of table A with availability of 5 MW generator. Similarly in table C as 5 MW generator is out of service therefore we will simply multiply the availability or probability of table A with forced outage rate of the 5 MW generator.

IV. RESULTS

Here we need to just rearrange the table for final result and to show it in proper sequence.

Table 1. Final result with proper sequence

Outage (MW)	Probability	Outage (MW)	Probability
0	0.9604	6	0.0004
3	0.0392	8	0.000784
5	0.019208	11	0.000008

V. CONCLUSION

As explained, the reliability of the system can be find out very easily with the help of the above method. The spreadsheet allows you to calculate the reliability of the system for any forced outage rate. This gives simplicity and ease in calculations making it error free.

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