Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 12 Issue 9 Version 1.0 Year 2012
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Reliability Evaluation of Composite System with Aging Failuire

By Tanay Lakshman
Assistant Professor, EEE, SETGOI, Durgapur, West Bengal

Abstract - Reliability is concerned with the system capability of survival. In the past forty years, customer expectations have been increasing in response to evolving new technologies. As part of these evolutions, they are demanding from their suppliers: products with higher quality, low initial cost, improved customer support and products that are easy and inexpensive to maintain. For a supplier to survive, succeed and be profitable in today's market, It must do the following:

a) Constant improvement in the quality of the products.
b) Minimization of the cost.
c) Be flexible and responsive to the customer's requirement.

This deals with reliability evaluation of combined generation and transmission system known as composite system. It describes a technique calculate composite system reliability with aging failure.

Keywords : *Power System Reliability, Transmission, Generation.*

GJRE-F Classification : *FOR Code: 090601*

Strictly as per the compliance and regulations of:

Reliability Evaluation of Composite System with Aging Failuire

Tanay Lakshman

Abstract - Reliability is concerned with the system capability of survival. In the past forty years, customer expectations have been increasing in response to evolving new technologies. As part of these evolutions, they are demanding from their suppliers: products with higher quality, low initial cost, improved customer support and products that are easy and inexpensive to maintain. For a supplier to survive, succeed and be profitable in today's market, It must do the following:

a) Constant improvement in the quality of the products.
b) Minimization of the cost.
c) Be flexible and responsive to the customer's requirement.

This deals with reliability evaluation of combined generation and transmission system known as composite system. It describes a technique calculate composite system reliability with aging failure.

The reliability evaluation deals with the

a) Calculation of aging failure rate & aging repair rate of all Components of the system.
b) Calculation of EENS value of all Components of the system by performing Reliability Analysis using SKM'S PTW 6.5.

Keywords : Power System Reliability, Transmission, Generation.

I. Introduction

Reliability is concerned with the system capability of survival. In the past twenty years, customer expectations have been increasing in response to evolving new technologies. As part of these evolution, they are demanding from their suppliers:

Products with higher quality, low initial cost, improved customer support and products those are easy and inexpensive to maintain. For a supplier to survive, succeed and be profitable in today's market, it must do the following:

a) Constant improvement in the quality of the products.
b) Minimization of the cost.
c) Be flexible and responsive to the customers' requirement.

Previously the criteria and techniques used for reliability assessment were all deterministically based. The essential weakness was that they did not account for the probabilistic or stochastic nature of system behaviour and component failures. However, the probability theory alone cannot predict either the reliability or safety of the equipment. It is only a tool available to the engineer in order to transform his knowledge of the system for the prediction of future behaviour of the system.

II. Objectives

So basic Objective is to calculate EENS value of loads connected to the system with Skm's PTW 6.5 .

III. Methods

The RBTS is a 6 bus system composed of two generator buses, 5 load buses, 9 transmission lines and 11 generating units. The total installed capacity is 240 MW and the system peak load is 185 MW.

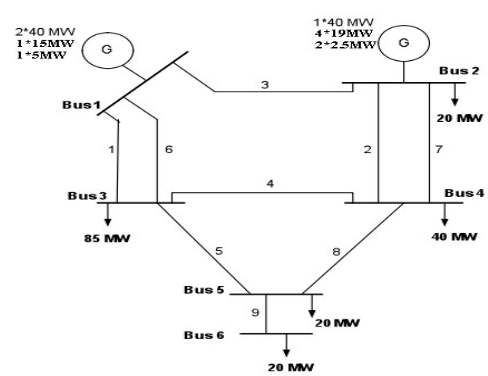

Figure 1 : Single Line Diagram of RBTS system

Author : Assistant Professor, EEE, SETGOI, Durgapur, West Bengal.
E-mail : tana_lakshman@yahoo.co.in

a) Rbts Data

Table 1 : Bus Data for RBTS system

Bus	Peak Load,MW		PG	Q VAR Limit,MVAR		Voltage Limits,pu	
	Active	Reactive		Max	Min	Max	Min
1	0	0	1.00	50	-40	1.05	0.97
2	20	0	1.20	40	-75	1.05	0.97
3	85	0	0.00	0	0	1.05	0.97
4	40	0	0.00	0	0	1.05	0.97
5	20	0	0.00	0	0	1.05	0.97
6	20	0	0.00	0	0	1.05	0.97

b) Generation Data

Table 2 : Generator data for RBTS system

Bus No.	Rating(MW)	Failure Per Year	Repair Time(hours)
1	40	6	45
1	40	6	45
1	10	4	45
1	20	5	45
2	5	2	45
2	5	2	45
2	40	3	60
2	20	2.4	55
2	20	2.4	55
2	20	2.4	55
2	20	2.4	55

c) Rbts-Transmission Data

The relevant reliability data for the nine 110 kV lines in Fig. 1 in terms of the permanent and transient failure rates and the permanent outage repair times are given in [11]. The outage duration of a transient outage is considered to be less than one minute. Outages of substation components which are not switched as a part of a line are not included in the line data.

Table 3 : Line Data For RBTS system

From Bus	To bus	R	X	B	Current rating	Failure Per Year	Repair Time
1	3	0.0342	0.18	0.0212	0.49	1.5	10
2	4	0.1140	0.60	0.0352	0.409	5	10
1	2	0.0912	0.48	0.0564	0.409	4	10
3	4	0.0228	0.12	0.0142	0.409	1	10
3	5	0.0228	0.12	0.0142	0.409	1	10
1	3	0.0342	0.18	0.0212	0.49	1.5	10
2	4	0.1140	0.60	0.0352	0.409	5	10
4	5	0.0228	0.12	0.0142	0.409	1	10
5	6	0.0228	0.12	0.0142	0.409	1	10

Table 4 : Elements reliability data

Element	Failure rate		Duration		
	Permanent	Active	Permanent	Maintenanc e	Switching
Busbar	0.001	0.001	2.0	1.0	0.0
Cir.Breaker	0.02	0.02	24	1.0	0.0
Transformer	0.015	0.015	15	1.0	0.0
Disc.Switch	0.002	0.002	4.0	1.0	0.0

Table 5 : Load Reliability Data

Load at	Failure Frequency[1/yr]	Duration[h]
Bus 2	0.47	**1**
Bus 3	0.216	**1**
Bus 4	0.855	**1**
Bus 5	0.002	**5**
Bus 6	1.002	**9.989**

d) Aging Failure Rate

The Value of η is calculated from the following formula:

η = 1000000/ (FailureRate*EXP(GAMMALN(1+1/ShapeParameter (β))))

Failure Rate Calculation Formula= $\left(\frac{\beta}{\eta}\right)\left(\frac{t}{\eta}\right)^{\beta-1}$

Where β = Shape parameter

η= Scale parameter

Table 6 : Aging Failure rate for Aging of Tx's

Time(hr)	β=0.5	β=1.0	β=1.5
t=8760$\times$1	0.087	0.015	0.00236
t=8760$\times$5	0.039	0.015	0.00527
t=8760$\times$10	0.027	0.015	0.00746
t=8760$\times$15	0.022	0.015	0.00913
t=8760$\times$20	0.019	0.015	0.0105
t=8760$\times$25	0.017	0.015	0.0118
t=8760$\times$30	0.016	0.015	0.0124
t=8760$\times$35	0.015	0.015	0.0139
t=8760$\times$40	0.014	0.015	0.0149

e) Aging Repair Rate

The Value of θ is calculated from the following formula:

θ = 1000000/(Failure Rate*EXP(GAMMALN(1+1/Shape Parameter(α))))

Repair Rate Calculation Formula = $\left(\frac{\alpha}{\theta}\right)\left(\frac{t}{\theta}\right)^{\beta-1}$

Where α = Shape parameter

θ = Scale parameter

Table 7 : Aging Repair rate for Aging of Tx's

Time(hr)	θ=0.5	θ=1.0	θ=1.5
t=8760$\times$1	2.73	15	0.000115
t=8760$\times$5	1.22	15	0.000257
t=8760$\times$10	0.866	15	0.000363
t=8760$\times$15	0.707	15	0.000445
t=8760$\times$20	0.612	15	0.000513
t=8760$\times$25	0.547	15	0.000574
t=8760$\times$30	0.500	15	0.000629
t=8760$\times$35	0.463	15	0.000679
t=8760$\times$40	0.433	15	0.000726

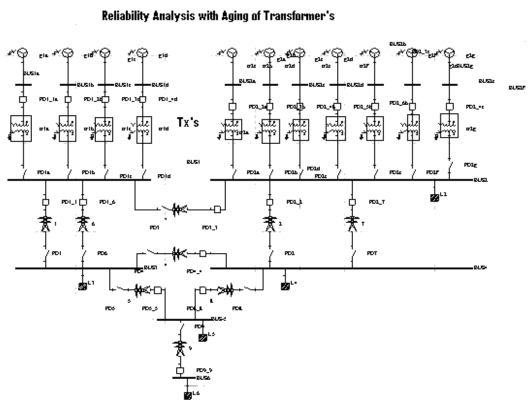

Figure 2 : One line diagram of RBTS system in SKM's PTW 6.5 for aging of Tx's

f) Case 3a : Non repairable aging failure for β =0.5

A nonrepairable aging failure for β =0.5 refers to a random fatal failure in the normal operating stage of the life basin curve. Obviously, it corresponds to a decreasing failure rate and therefore can be modeled using an exponential distribution.

Table 8 : EENS Value for Aging of Tx's for β=0.5

Time (hr)	Reliability Analysis EENS (Kwh/year) Value for Aging of Tx's for β=0.5				
	L2	L3	L4	L5	L6
0	8855688.94	820.60	7000745.07	81967029.91	85576849.91
1	8855688.93	820.56	7000464.56	81966403.38	95575902.39
5	8855688.89	820.39	6999336.69	81963884.14	95572092.43
10	8855688.83	820.16	6997913.76	81960705.56	95567285.30
15	8855688.78	819.92	6996476.30	81957494.17	95562428.51
20	8855688.71	819.66	6995024.31	81954249.97	95557522.07
25	8855688.65	819.38	6993557.79	81950972.97	95552565.98
30	8855688.59	819.12	6992358.74	81948293.37	95548513.37
35	8855688.59	819.12	6992358.74	81948293.37	95548513.37
40	8855688.59	819.12	6992358.74	81948293.37	95548513.37

g) Case 3b : Chance Failure for β=1

A nonrepairable chance failure refers to a random basin curve. Obviously, it corresponds to a constant failure rate and therefore can be modeled using an exponential distribution. fatal failure in the normal operating stage of the life.

Table 9 : EENS Value for Aging of Tx's for β=1

Time(hr)	Reliability Analysis EENS(Kwh/year) Value for Aging of Tx's for β=1				
	L2	L3	L4	L5	L6
0	8855688.94	820.60	2065266.86	81867494.39	95477314.39
1	8855688.94	820.60	2065266.86	81867494.39	95477314.39
5	8855688.94	820.60	2065266.86	81867494.39	95477314.39
10	8855688.94	820.60	2065266.86	81867494.39	95477314.39
15	8855688.94	820.60	2065266.86	81867494.39	95477314.39
20	8855688.94	820.60	2065266.86	81867494.39	95477314.39
25	8855688.94	820.60	2065266.86	81867494.39	95477314.39
30	8855688.94	820.60	2065266.86	81867494.39	95477314.39
35	8855688.94	820.60	2065266.86	81867494.39	95477314.39
40	8855688.94	820.60	2065266.86	81867494.39	95477314.39

h) Case 3c : Wear Out Period for $\beta = 1.5$

A nonrepairable wear out failure refers to a random fatal failure in the normal operating stage of the life basin curve. Obviously, it corresponds to a increasing failure rate and therefore can be modeled using an exponential distribution.

Table 10 : EENS Value for Aging of Tx's for $\beta = 1.5$

Time(hr)	Reliability Analysis EENS(Kwh/year) Value for Aging of Tx's for β=1.5				
	L2	L3	L4	L5	L6
0	8855688.94	820.60	2065266.86	81867494.39	95477314.39
1	8855689.41	822.60	2065267.87	81867494.89	95477314.89
5	8855690.81	828.56	2065270.89	81867496.40	95477316.40
10	8855691.82	832.84	2065273.07	81867497.49	95477317.49
15	8855692.49	835.69	2065274.51	81867498.21	95477318.21
20	8855693.24	838.87	2065276.12	81867499.02	95477319.02
25	8855694.36	843.63	2065278.54	81867500.23	95477320.23
30	8855696.03	850.74	2065282.14	81867502.03	95477322.03
35	8855698.31	860.43	2065287.06	81867504.49	95477324.49
40	8855701.13	872.40	2065293.13	81867507.52	95477327.52

IV. Results & Discussion

From the Reliabilty analysis we get the life basin curve by plotting EENS value with time for $\alpha = 0.5$, $\alpha = 1.0$, $\alpha = 1.5$.

V. Discussion and Conclusions

In this work, method has been presented to calculate reliability of composite system by calculating probability and frequency of failure of system under different conditions. This area of composite power system reliability evaluation is least developed and also one of the most complicated but in view of environmental, ecological, societal and economic constraints faced by most of power utilities, this area is developing and getting attention in international market.

References

1. A.K. Mehta, Dipak Ray, Kesab Bhattacharya "Application of Reliability Analysis In Expansion Of Transmission System" Vol 1, Academy Publisher, May, 2009.
2. A.K. Mehta, Dipak Ray, Kesab Bhattacharya "Application of Reliability Analysis In Expansion Of Transmission System" Vol 1, Academy Publisher, May, 2009.
3. Maintenance Management In Power Systems-Matti Lehtonen, July 2007, Kungliga Tekniska Hogs kolan, Helsinki Univeristy Of Technology.
4. Verification Of The Transmission System Model Rbts Using Monte Carlo Simulation Methods-KTH, The Royal Institute Of Technology, School Of Electrical Engineering,2008
5. Power System Reliabilityassessment Using The Weibull-Markov Model- Jasper Van Casteren, Chalmers University Of Technology,2001
6. Optimization And Implementation Of Maintenance Schedules Of Power- Yang Fan, National University Of Singapore, 2011
7. Incorporating Station Related Maintenance And Aging Outages In Composite System Reliability Evaluation- Hua Yang, University Of Saskatchewan, 2005.
8. Bulk System Reliability Evaluation In A Deregulated Power Industry- Yifeng Li, University Of Saskatchewan, 2003
9. Deterministic/Probabilistic Evaluation In Composite System Planning- Ran Mo- University Of Saskatchewan, 2003.
10. Incorporating Substation And Switching Station Related Outages In Composite System Reliability Evaluation- Rajesh U Nighot- University Of Saskatchewan, 2003.
11. Reliability Of Substation Configurations-Daniel Nack, Iowa State University, 2005
12. Test Systems For Reliability And Adequacy Assessment Of Electric Power Systems- Roy Billinton, Dange Huang,University Of Saskatchewan, 2010.
13. Composite System Reliability Evaluation-Lovleen Gupta- Thapar University, Patiala, 2009
14. Reliability Analysis And Economic Equipment Replacement Appraisal For Substation And Sub-Transmission Systems With Explicit Inclusion Of Non-Repairable Failure-Ghavameddin Nourbakhsh, Queensland University Of Technology, 2011
15. Power System Reliability Enhancement by Using Powerformers-Rahmat-Allah Hooshmand1, Majid Moazzamil, Ali Akbar Nasiri,2009.

16. Development of Test System for Distribution System Reliability Analysis, Integration of Electric Vehicl into the Distribution System-Pramod Bangalore-Chalmers University Of Technology Goteborg, Sweden 2011.
17. Reliability Assessment of Complex Power Systems and the Use of NEPLAN Tool-Shima Mousavi Gargari- Royal Institute of Technology, KTH, 2006.
18. Adequacy Assessment Of Composite Generation And Transmission Systems Incorporating Wind Energy Conversion Systems- Yi Gao- University Of Saskatchewan, 2010.
19. Composite Power System Planning In A Competitive Environment-Mohammed Taher Al-Saba-King Fahd University Of Petroleum & Minerals, 2007.
20. Composite System Based Multi-Area Reliability Evaluation- Ramya Nagarajan- Texas A&M University, 2009.