RELIABILITY PARAMETER ESTIMATION AND ANALYSIS FOR ELECTRICAL UPS SYSTEM

Upendra Joshi[1], Taranjeet Singh Huda[2], Sumeet Sehrawat[3]

[1, 3]EEE Department, Amity School of Engineering and Technology, Noida, (India)

[2] ECE Department, Patel College of Science and Technology, Indore, (India)

ABSTRACT

This paper mainly concentrates on reliability analysis of electrical components. The scope of reliability is not limited to any one ofthe engineering discipline as it is a multi-disciplinary subject. In this paper reliability analysis is included with probability and statistics to provide better understanding of reliability, stress and risk analysis. Also some conventional methods have been used to frame proper estimation of practical performance analysis of replaceable and repairable electronics components. Reliability is the key feature of achieving high performance of any system. This paper is useful to calculate overall performance of a reliable system in both was i.e. quantitatively and qualitatively.

Keywords: Reliability Analysis, Failure Mechanism, Risk Analysis, Estimation, Performance Analysis

I. INTRODUCTION

Reliability Engineering is the systems probability of performing adequate function for a particular operating time, under operating conditions. It is concerned at high risk conditions. The achievements of reliability are derived from reliability engineering. The integration of reliability engineering with other engineering disciplines add throughout the systems overall development. Reliability prediction provides a quantitative baseline to assess reliability engineering in various disciplines. By focussing on reliability prediction after selecting a design we can predict rate of failures and its stress analysis completely.

II. FAILURE MECHANISMS FOR ELECTRICAL DEVICES

It is usually divided into three type's i.e. electrical stress, intrinsic and extrinsic. Higher voltage level causing damage to electrical devices or due to any human error is involved in damage then it is considered as electrical stress failure. If poor manufacturing or design procedure error takes place then it is categorised as intrinsic failure. If any error in device packaging or interconnections takes place along with environmental effects on electrical devices then it is termed as extrinsic failure.

III. AVAILABILITY ANALYSIS

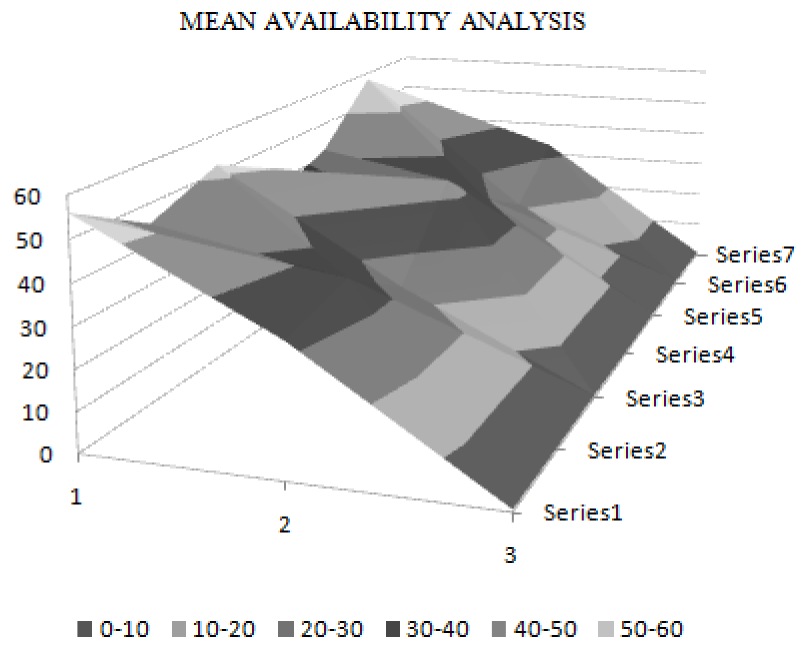
It is performed to verify operational probability of a system. Here we consider inherent availability of different system parts at operational condition during an interval of time 'T' can be expressed by,

$$A = \frac{u}{u+d} \quad [1]$$

Where 'u' is the mean uptime during time T and d is the mean downtime during time T, T= u + d.

u	**d**	**A**
56	32	0.636364
45	36	0.555556
52	24	0.684211
36	44	0.45
42	31	0.575342
58	21	0.734177
28	33	0.459016

Table 1 Availability Data of a Power UPS System Components



Graph 1. Comparison analysis of Availability data of power UPS system components

IV. ESTIMATING PARAMETERS VIA ARRHENIUS MODEL ANALYSIS

Let us consider an electronic device to be tested under elevated temperatures of 30^{o}C, 40^{o}C and 50^{o}C. Now we are assuming some data of 10 electrical components which we can take in consideration through practical performances as follows:

30°C	40 °C	50 °C
1940	605	58
3518	633	64
4593	670	82
5563	750	78
7536	1290	132
10799	1398	188
11632	1856	231
15698	2096	244
19785	2163	314
22987	2855	326

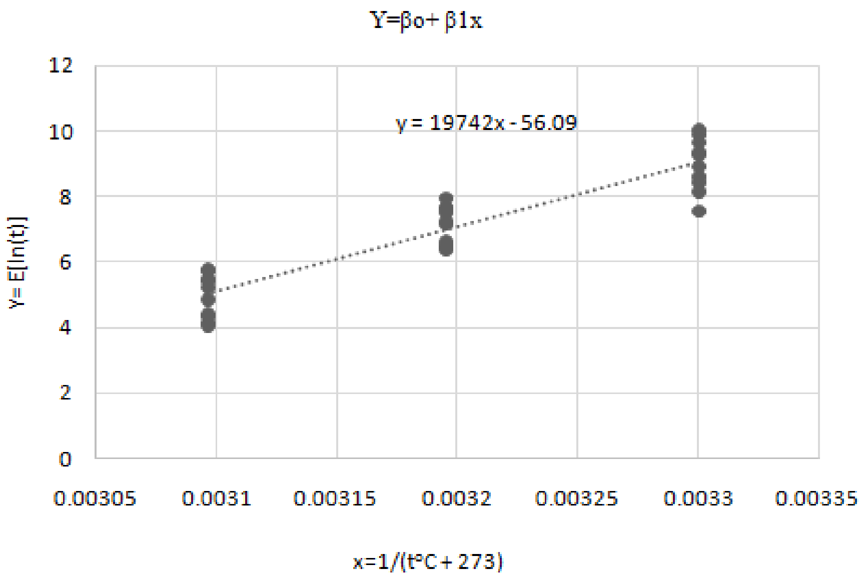
Table 2. Time to failure (t) in hours

According to Arrhenius model we have,

$$E(\ln t) = A + \frac{B}{T} \qquad [2]$$

S.no.	30°C	40 °C	50 °C
1	7.570443	6.405228	4.060443
2	8.165648	6.45047	4.158883
3	8.432289	6.507278	4.406719
4	8.623893	6.620073	4.356709
5	8.927447	7.162397	4.882802
6	9.287209	7.242798	5.236442
7	9.361515	7.526179	5.442418
8	9.661289	7.647786	5.497168
9	9.892679	7.679251	5.749393
10	10.04268	7.956827	5.786897
Σ E[ln(t)]/10	8.99651	7.119829	4.957787

Table 3. Logarithm Values of time ‘t’ as ln (t)



Graph 2. Arrhenius model – Regression analysis graph

Using transformations Y=ln t, x=1/T, β_o=A, β_1=B we have,

Y=E[ln(t)]	t °C	x=(t °C+273)$^{-1}$
8.99651	30	0.0033
7.119829	40	0.003195
4.957787	50	0.003096

Table 4 Data Transformation of Arrhenius model

Now by using above transformed data and line equation $Y=\beta_o+\beta_1 x$ we can find estimates of parameters A and B as,

$\hat{A}$=exp (β1)= exp (-56.091) = 4.36504* 10^{-25} $h^{-1}$and $\hat{B}$ = 19742°K [3]

V. PROBABILITY RISK ASSESSMENT

PRA is a systematic procedure to investigate operational and building aspects of complex systems. By estimating and reducing major errors we can increase strength of any system. To analyse these errors we follow this process. Here are some major changes in this approach which have been taken place while studying this system:

1. Objectives and methodologies
2. Familiarization information
3. Logic modelling
4. Uncertainty analysis
5. Sensitivity analysis
6. Interpretation of results
7. Consequence determination

VI. CONCLUSION

Hence we have estimated parameters A and B using Arrhenius model and after analysis of Arrhenius model we can approach for risk assessment analysis and follow the above approach related to PRA. After PRA this detailed analysis can be combined with system reliability confidence limits based on component failure data. For this using Lloyed-Lipow method or Maximus method we can predict uncertainity of the system. System reliability statics via trends in observed failure events can be calculated through binomial distribution method. In future aspects we can determine Root cause analysis of the observed data and perform risk analysis of this system.

REFERENCES

[1] Reliability Engineering and Risk Analysis, A Practical Guide (CRC Press), by Modarres, Kaminskiy and Krivtsov, published 2010
[2] Military Handbook, Reliability Prediction of Electronic Equipment, Department of Defense, USA, published 2 December 1991
[3] Accelerated Testing: Statistical Models, Test Plans and Data Analyses (Wiley Series in Probability and Mathematical Statistics-Applied Probability), by Wayne Nelson, Published 1990
[4] Analysis of Failure and Survival Data, by Peter J. Smith, Published 2002
[5] Applied Life Data Analysis, by Wayne Nelson, Published 1982
[6] Applied Reliability (Second Edition) by Paul A. Tobias and David C. Trindade, Published 1995
[7] Burn-In Testing: Its Quantification and Optimization (Reliability Engineering), by Dimitri Kececioglu and Feng-Bin Sun, Published 1997
[8] Effective FMEAs: Achieving Safe, Reliable and Economical Products and Process Using Failure Mode and Effects Analysis), by Carl Carlson, Published 2012
[9] Environmental Stress Screening: Its Quantification, Optimization and Management, by Dimitri Kececioglu and Feng-Bin Sun, Published 1995
[10] Handbook of Reliability Engineering and Management, 2nd Edition, by William Grant Ireson, Clyde F. Coombs and Richard Y. Moss, Published 1995
[11] Maintainability, Availability and Operational Readiness Engineering Handbook, by Dimitri Kececioglu, Published 1995
[12] Methods for Statistical Analysis of Reliability and Life Data (Wiley Series in Probability and Mathematical Statistics), by Nancy R. Mann, Ray E. Schafer and Nozer D. Singpurwalla, Published 1974
[13] Practical Reliability Engineering, 4th Edition, by Patrick D. T. O'Connor, Published 2002
[14] Recurrent-Events Data Analysis for Product Repairs, Disease Recurrences, and Other Applications, by Wayne Nelson, Published 2003
[15] Reliability and Life Testing Handbook, Vol 1, by Dimitri Kececioglu, Published 1993