COST-BENEFIT ANALYSIS OF POWER PLANT CONSISTING OF STEAM AND GAS TURBINE WITH RANDOM INSPECTION AND WITH TWO TYPES OF REPAIRMAN

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Abstract: The current paper deals with benefits of a power plant consisting of steam and gas turbine with two types of repairman carried out with maintenance of different types (Path, Major or Minor) randomly. At preliminary stage steam as well as gas turbine are operative. When gas turbine fails, steam turbine cannot work and system goes to down state; while when steam turbine fails, it may be put to down state or stay in upstate accompanying gas turbine working only if power's buyer is willing to pay more than usual rates. There are two types of repairman, firstly ordinary repairman repair the unit but if he is not able to completely restore the unit expert repairman will definitely repair the unit. System is analyzed through through technique of regenerative point by using semi-Markov process. Several interesting conclusions are drawn through graphs by using various reliability measures and calculating profit.
Key Words: Power Plant consisting of Steam and Gas Turbine, Down State, Cost-Benefit, Random Inspection

I. INTRODUCTION

Technology in today's world has become integral part of our life, it gives competition in every field whether it is electric, mechanical, electronics, computer and several others. That's why consumer demanded products which survive for long time with quality, which signifies the word 'Reliability'. As a result, there is dire demand reliable products in every field which impress various researcher to research reliability of various model including Mahajan and Singh [1], Malhotra and Taneja [2], Singh [3], Parashar and Taneja [4]. Barson and Shah [5] also contributed through making reliability analysis with arbitrary repair-time distribution. Baohe [6], Tuteja, Vashistha and Taneja [7], Goyal, Singh and Taneja [8], Singh and Taneja [9] analysis the reliability models with two dissimilar units. Tuteja and Taneja [10] analysis the reliability model with two identical repairman. Here in this paper we use two different types of repairman.

The current paper deals with benefits of a power plant consisting of steam and gas turbine with two types of repairman carried out with maintenance of different types (Path, Major or Minor) randomly. At preliminary stage steam as well as gas turbine are operative. When gas turbine fails, steam turbine cannot work and system goes to down state; while when steam turbine fails, it may be put to down state or stay in upstate accompanying gas turbine working only if power's buyer is willing to pay more than usual rates. There are two types of repairman, firstly ordinary repairman repair the unit but if he is not able to completely restore the unit expert repairman will definitely repair the unit. When we work in a situation where the only gas turbine is operative is said to be in single cycle; when steam and gas turbine both are operative then it is said to be in combined cycle.

Some more Assumptions of the Model

- After every completely repair, the unit we receive is sensible as newly one.
- Random variables are independent.
- When both units fails, system fails.
- System is in single cycle if only gas turbine is operative
- Firstly ordinary repairman repair the turbine, if not possible by ordinary repairman then expert repairman repair the turbine.
- Exponential distribution followed by failure times and time to carry random inspection and arbitrary distributions are followed by the repair times, time of doing inspection and maintenance.

II. Notations

O_{gt} : Gas turbine is in operation

O_{st} : Steam turbine is in operation

u_{rgt1} : Gas turbine is being repaired by ordinary repairman

u_{rgt2} : Gas turbine is being repaired by expert repairman

u_{rst1} : Steam turbine is being repaired by ordinary repairman
u_{rst2} : Steam turbine is being repaired by expert repairman
d_{gt} : Gas turbine is in down mode
d_{st} : Steam turbine is in down mode
W_{rgt} : Gas turbine waits to restore
U_{Rst1} : Steam turbine under repair continued from previous state by ordinary repairman
U_{Rst2} : Steam turbine under repair continued from existing state by expert repairman
λ : Gas turbine's failure rate
α : Steam turbine's failure rate
a : Probability that the ordinary repairman completely repair the failed unit
b : Probability of not repairing the failed unit completely by ordinary repairman
p : Probability that customer is wants to pay extra than normal rates
q : 1-p i.e. Probability that the customer is not willing to give more than the standard rates
$g_1(t)$, $G_1(t)$: c.d.f and p.d.f of restore time of gas turbine by ordinary repairman
$g_2(t)$,$G_2(t)$: c.d.f and p.d.f of restore time of steam turbine by ordinary repairman
$g_3(t)$, $G_3(t)$: c.d.f and p.d.f of restore time of gas turbine by expert repairman
$g_4(t)$,$G_4(t)$: c.d.f and p.d.f of restore time of steam turbine by expert repairman
h(t), H(t) : p.d.f and c.d.f of time when system is under inspection
p_1 : Probability of need of minor maintenance unveil by inspection
p_2 : Probability of need of path maintenance unveil by inspection
p_3 : Probability of need of major maintenance unveil by inspection
i(t) : p.d.f of inspection time, to find the maintenance required is of which type
M_{Nm} : Minor maintenance
P_m : Path maintenance
M_{Jm} : Major maintenance
$h_1(t)$: p.d.f of time for acting minor maintenance
$h_2(t)$: p.d.f of time for acting path maintenance
$h_3(t)$: p.d.f of time for acting major maintenance
U_i : To disclose the type of failure under inspection of failed unit

III. State Transition Diagram and Transition Probabilities

The transition diagram shown in Figure.1 express that 0, 1, 2, 3, 4, 5, 6, 9, 10, 11, 12 and 13 are regenerative points and hence 0, 1, 2, 3, 4, 5, 6, 9, 10, 11, 12 and 13 are regenerative states. And 7, 8 and 9 are failed states. States 10, 11, 12 and 13 are down states as the inspection is going on. State 1, 3, 4, and 6 are down states as operable unit is put to down mode. State 2 and 5 are in upstate but working is going on in single cycle.

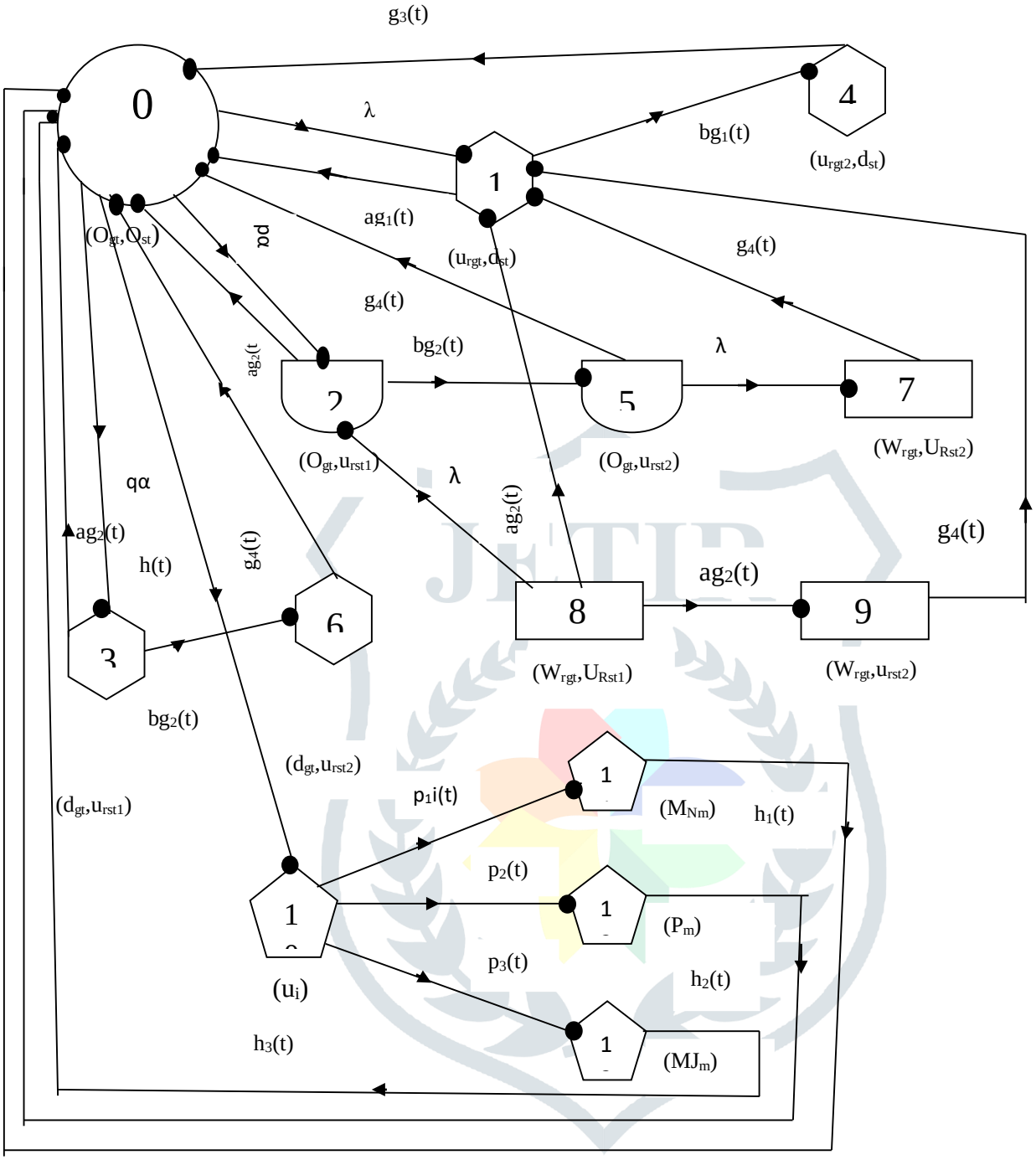

Figure.1 State Transition Diagram

The probabilities of transition are:

$dQ_{01}(t) = e^{-(\lambda+\alpha)t}\ \overline{H}(t)\,dt,\ dQ_{02}(t) = p\alpha e^{-(\lambda+\alpha)t}\ \overline{H}(t)\,dt,\ dQ_{03}(t) = q\alpha e^{-(\lambda+\alpha)t}\ \overline{H}(t)\,dt$

$dQ_{0,10}(t) = e^{-(\lambda+\alpha)t}h(t)dt,\ dQ_{14}(t) = bg_1(t)\,dt,\ dQ_{10}(t) = ag_1(t)dt,\ dQ_{25}(t) = bg_2(t)e^{-\lambda t}dt$

$dQ_{20}(t) = ag_2(t)e^{-\lambda t}dt,\ dQ_{21}^{(8)}(t) = (\lambda e^{-\lambda t}\copyright 1)ag_2(t)dt,\ dQ_{29}^{(8)}(t) = (\lambda e^{-\lambda t}\copyright 1)bg_2(t)dt$

$dQ_{28}(t) = \lambda e^{-\lambda t}\ \overline{G}_2(t)\,dt,\ dQ_{30}(t) = ag_2(t)dt,\ dQ_{36}(t) = bg_2(t)dt,\ dQ_{40}(t) = g_3(t)dt$

$dQ_{50}(t) = g_4(t)e^{-\lambda t}dt,\ dQ_{51}^{(7)}(t) = (\lambda e^{-\lambda t}\copyright 1)g_4(t)dt,\ dQ_{57}(t) = \lambda e^{-\lambda t}\overline{G}_4(t)\,dt$

$dQ_{60}(t) = g_4(t)dt,\ dQ_{71}(t) = g_4(t)dt,\ dQ_{91}(t) = g_4(t)dt,\ dQ_{10,11}(t) = p_1i(t)dt$

$dQ_{10,12}(t) = p_2i(t)dt,\ dQ_{10,13}(t) = p_3i(t)dt,\ dQ_{11,0}(t) = h_1(t)$

$dQ_{12,0}(t) = h_2(t)\ ,\ dQ_{13,0}(t) = h_3(t)$

and $p_{ij} = \lim_{t\to\infty} Q_{ij} = \lim_{s\to 0} Q_{ij}^{**}(s)$ are given as

$p_{01} = \lambda\left[\frac{1-h^*(\lambda+\alpha)}{\lambda+\alpha}\right]$, $p_{02} = p\alpha\left[\frac{1-h^*(\lambda+\alpha)}{\lambda+\alpha}\right]$, $p_{03} = q\alpha\left[\frac{1-h^*(\lambda+\alpha)}{\lambda+\alpha}\right]$, $p_{0,10} = h^*(\lambda+\alpha)$

$p_{14} = b$, $p_{10} = a$, $p_{25} = b\,g_2^*(\lambda)$, $p_{20} = a\,g_2^*(\lambda)$, $p_{21}^{(8)} = a - a\,g_2^*(\lambda)$, $p_{29}^{(8)} = b - b\,g_2^*(\lambda)$

$p_{28} = 1 - g_2^*(\lambda)$, $p_{30} = a$, $p_{36} = b$, $p_{40} = 1$, $p_{50} = g_4^*(\lambda)$, $p_{57} = 1 - g_4^*(\lambda)$

$p_{51}^{(7)} = 1 - g_4^*(\lambda)$, $p_{60} = 1$, $p_{71} = 1$, $p_{91} = 1$, $p_{10,11} = p_1$, $p_{10,12} = p_2$

$p_{10,13} = p_3$, $p_{11,0} = 1$, $p_{12,0} = 1$, $p_{13,0} = 1$

Now from these transition probabilities, we verify the following

$p_{01}+p_{02}+p_{03}+p_{0,10} = 1$, $p_{10}+p_{14} = 1$, $p_{20}+p_{25}+p_{21}^{(8)}+p_{29}^{(8)} = 1$, $p_{20}+p_{28}+p_{25} = 1$

$p_{30}+p_{36} = 1$, $p_{40} = 1$, $p_{50}+p_{57} = 1$, $p_{50}+p_{51}^{(7)} = 1$, $p_{60} = 1$, $p_{71} = 1$, $p_{91} = 1$

$p_{10,11}+p_{10,12}+p_{10,13} = 1$, $p_{11,0} = 1$, $p_{12,0} = 1$, $p_{13,0} = 1$

"The mean sojourn time(μ_i) in the regenerative state 'i' is defined as the same time of stay in that state before transition to any other state". If T sojourn in the regenerative state 'i' is denoted by T,

$\mu_i = E(T) = P_r(T > t)$

$\mu_0 = \frac{1-h^*(\lambda+\alpha)}{\lambda+\alpha}$, $\mu_1 = -g_1^{*'}(0)$, $\mu_2 = \frac{1}{\lambda} - \frac{g_2^*(\lambda)}{\lambda}$, $\mu_3 = -g_2^{*'}(0)$, $\mu_4 = -g_3^{*'}(0)$

$\mu_5 = \frac{1}{\lambda}\left[1-g_4^*(\lambda)\right]$, $\mu_6 = -g_4^{*'}(0)$, $\mu_9 = -g_4^{*'}(0)$, $\mu_{10} = \int_0^\infty ti(t)dt$,

$\mu_{11} = \int_0^\infty th_1(t)dt$, $\mu_{12} = \int_0^\infty th_2(t)dt$, $\mu_{13} = \int_0^\infty th_3(t)dt$

When it counted from entrance into state 'i' **the unconditional mean time** to transit for any regenerative state 'j' taken by the system is mathematical given by :

$m_{ij} = \int_0^\infty t\, q_{ij}(t)\, dt = -q_{ij}^{*'}(0)$

$m_{01}+m_{02}+m_{03}+m_{0,10} = \mu_0$, $m_{10}+m_{14} = \mu_1$, $m_{20}+m_{25}+m_{28} = \int_0^\infty te^{-\lambda t}[g_2(t)+\lambda\overline{G_2}(t)]dt = K_2$

$m_{20}+m_{25}+m_{21}^{(8)} = \int_0^t t[e^{-\lambda t}g_2(t)+[\lambda e^{-\lambda t}\copyright 1]ag_2(t)]dt = K_1$, $m_{20}+m_{25}+m_{29}^{(8)} = \int_0^\infty t(1-e^{-\lambda t})bg_2(t)dt = K_8$

$m_{30}+m_{36} = \mu_3$, $m_{40} = \mu_4$, $m_{50}+m_{57} = \int_0^t te^{-\lambda t}[g_4(t)+\lambda\overline{G_4}(t)]dt = K_5$, $m_{50}+m_{51}^{(7)} = \mu_6$

$m_{60} = \mu_6$, $m_{91} = \mu_6$, $m_{10,11}+m_{10,12}+m_{10,13} = \mu_{10}$, $_z m_{11,0} = \mu_{11}$

$m_{12,0} = \mu_{12}$, $m_{13,0} = \mu_{13}$

IV. Analysis of Mean Time to System Failure

To decide the reliability and MTSF of system, we treat the absorbing states as failed state. Probabilistic indication are used for the recursive relation of $\phi_i(t)$. At any time t the reliability is :

R(t) = inverse Laplace transform of (1- ϕ_0^{**}(s) / s),
where ϕ_0^{**}(s) is the Laplace-Stieltjes Transform of Φ_0(t).

MTSF of system start from state '0' is given by

$T_0 = \lim_{s\to 0} \frac{1-Q_0^{**}(s)}{s} = \frac{N}{D}$

$N = \mu_0+p_{01}\mu_1+p_{01}p_{14}\mu_4+p_{03}(p_{36}\mu_6+\mu_3)+p_{02}(K_2+p_{25}K_5)+p_{0,10}(\mu_{10}+p_{10,11}\,\mu_{11}+p_{10,12}\mu_{12}+p_{10,13}\mu_{13})$

$D = p_{02}(1-p_{20}-p_{25}p_{50})$

V. Availability Analysis at Full Capacity

$A_i(t)$ is the probability of unit entering into up state at time t by using probabilistic argument, assuming the unit penetrate into regenerative states i at t=0, and the Laplace transform of availability $A_0(t)$ is :

$A_0^*(s) = \frac{N_1(s)}{D_1(s)}$

$N_1(s) = M_0^*(s)$

$$D_1(s) = 1 - q_{01}^*(s)q_{10}^*(s) - q_{02}^*(s)q_{20}^*(s) - q_{03}^*(s)q_{30}^*(s) - q_{10}^*(s)q_{02}^*(s)q_{21}^{(8)*}(s) - q_{02}^*(s)q_{25}^*(s)q_{50}^*(s)$$
$$-q_{40}^*(s)q_{01}^*(s)q_{14}^*(s) - q_{60}^*(s)q_{36}^*(s)q_{03}^*(s) - q_{10}^*(s)q_{02}^*(s)q_{25}^*(s)q_{51}^{(7)*}(s)$$
$$-q_{02}^*(s)q_{40}^*(s)q_{14}^*(s)q_{21}^{(8)*}(s) - q_{10}^*(s)q_{02}^*(s)q_{29}^{(8)*}(s)q_{91}^*(s) - q_{40}^*(s)q_{02}^*(s)q_{14}^*(s)q_{25}^*(s)q_{51}^{(7)*}(s) - q_{91}^*(s)q_{29}^{(8)*}(s)q_{40}^*(s)q_{02}^*(s)q_{14}^*(s)$$
$$-q_{11,0}^*(s)q_{0,10}^*(s)q_{10,11}^*(s) - q_{12,0}^*(s)q_{0,10}^*(s)q_{10,12}^*(s) - q_{13,0}^*(s)q_{0,10}^*(s)q_{10,13}^*(s)$$

Full capacity availability in steady state of the system is given by

$$A_0 = \lim_{s\to 0}(sA_0^*(s)) = \lim_{s\to 0}(s\frac{N_1(s)}{D_1(s)}) = \frac{N_1(0)}{D_1'(0)} = \frac{N_1}{D_1}$$

where, $N_1 = \mu_0$

$D_1 = \mu_0 + p_{01}\mu_1 + p_{01}p_{14}\mu_4 + p_{03}\mu_3 + p_{03}p_{36}\mu_6 + p_{02}[K_3 + \mu_1(p_{21}^{(8)} + p_{25}p_{51}^{(7)}) + p_{14}\mu_4(p_{21}^{(8)} + p_{29}^{(8)} + p_{25}p_{51}^{(7)}) + p_{29}^{(8)}(\mu_6 + \mu_1) + K_8 + p_{25}\mu_6] + p_{0,10}[p_{10,13}\mu_{13} + p_{10,12}\mu_{12} + p_{10,11}\mu_{11} + \mu_{10}]$

Similarly, Availability in Single Cycle $A_0^{(s)} = \frac{N_{11}}{D_1}$

, $N_{11} = p_{02}(\mu_2 - p_{25}\mu_5)$

D_1 = is already specified above

VI. Expected Time for Minor Inspection

Expected time for minor inspection in the steady state, given as

$$MI_0 = \lim_{s\to 0}(sMI_0^*(s)) = \frac{N_2(0)}{D_1(0)} = \frac{N_2}{D_1}$$

where, $N_2 = p_{0,10}p_{10,11}\mu_{11}$

D_1 = is already specified above

VII. Expected Time for Path Inspection

In the steady state the expected time for path inspection is given by:

$$PI_0 = \lim_{s\to 0}(sPI_0^*(s)) = \frac{N_3(0)}{D_1(0)} = \frac{N_3}{D_1}$$

where, $N_2 = p_{0,10}p_{10,12}\mu_{12}$

D_1 = is already specified above

VIII. Expected Time for Major Inspection

Expected time for major inspection in the steady state, given as

$$MJ_0 = \lim_{s\to 0}(sMJ_0^*(s)) = \frac{N_4(0)}{D_1(0)} = \frac{N_4}{D_1}$$

where, $N_4 = p_{0,10}p_{10,13}\mu_{13}$

D_1 = is already specified above

IX. Analysis of Busy Period by the Ordinary Repairman, I

$B_i^I(t)$ = Probability that the repairman is buzy at the moment when the unit penetrate into regenerative state i at t=0, the Laplace transform of $B_0^I(t)$ is :

$$B_0^{I*}(s) = \frac{N_5(s)}{D_1(s)}$$

$$N_5(s) = w_1^*(s)\left[q_{01}^*(s) + q_{02}^*(s)q_{21}^{(8)*}(s) + q_{02}^*(s)q_{25}^*(s)q_{51}^{(7)*}(s) + q_{91}^*(s)q_{02}^*(s)q_{29}^{(8)*}(s)\right] + q_{02}^*(s)w_2^*(s) + q_{03}^*(s)w_3^*(s)$$

$D_1(s)$ = already described above

The time fraction in steady state in which system is under repair is

$$B_0^I = \lim_{s\to 0}(sB_0^{I*}(s)) = \lim_{s\to 0}(s\frac{N_5(s)}{D_1(s)}) = \frac{N_5(s)}{D_1(s)} = \frac{N_2}{D_1}$$

$N_5 = \mu_1[p_{01} + p_{21}^{(8)} + p_{02}p_{29}^{(8)} - p_{02}p_{25}p_{51}^{(7)}] + p_{02}\mu_2 + p_{03}\mu_3$

D_1 = already described above

Similarly, Busy Period Analysis by the Expert Repairman, II $B_0^{II}(s) = \lim_{s\to 0}(sB_0^{II*}(s)) = \frac{N_{51}}{D_1}$

$N_{51} = p_{01}p_{14} + p_{02}p_{14}\mu_4[p_{29}^{(8)} + p_{21}^{(8)} + p_{25}p_{51}^{(7)}] + \mu_6[p_{02}p_{25} + p_{03}p_{36} + p_{02}p_{29}^{(8)}]$

D_1 = is already described above

X. Number of Expected Visits of the Ordinary Repairman, I

$V_i^I(t)$ = number of expected visits by the ordinary repair man in (0, t], when unit starts from the regenerative state i at t=0, the Laplace transform of $V_0^I(t)$ is:

$$V_0^{I**}(s)=\frac{N_6(s)}{D_1(s)}$$

$N_6(s) = Q_{01}^{**}(s)+Q_{02}^{**}(s)+Q_{03}^{**}(s) +Q_{0,10}^{**}(s)$

$D_1(s)$ = already described above

Visits number per unit time in steady state is given by

$$V_0^I = \lim_{s\to 0}(sV_0^{I*}(s)) = \frac{N_6}{D_1}$$

$N_6 = 1$

D_1 = is already specified above

Similarly, Number of Expected Visits of the Expert Repairman, II $V_0^{II} = \frac{N_{61}}{D_1}$

$N_{61} = p_{03}p_{36}+p_{01}p_{14}+p_{02}(p_{25}+p_{29}^{(8)})+p_{02}p_{14}(p_{21}^{(8)}+p_{29}^{(8)}+p_{25}p_{51}^{(7)})$

D_1 = is already defined above

XI. Cost- Benefit Analysis

The total profit run into steady state of the system is given by

Profit = $C_0A_0+C_{01}A_0^{(s)}-C_{11}MI_0-C_{12}PI_0-C_{13}MJ_0-C_{21}B_0^I - C_{22}B_0^{II} -C_{31}V_0^I -C_{32}V_0^{II}$

C_0 = Revenue per unit time when system's work is in full capacity

C_{01} = Revenue per unit time when system's work is in single cycle

C_{11} = Expenditure per unit time when system works under minor inspection

C_{12} = Expenditure per unit time when system sustains for path inspection

C_{13} = Expenditure per unit time when system works under major inspection

C_{21} = Expenditure per unit time when an ordinary repairman repair

C_{22} = Expenditure per unit time when expert repairman repair

C_{31} = Expenditure per visit by ordinary repairman

C_{32} = Expenditure per visit by expert repairman

XII. Numerical Results for Special Cases

Particular cases are as follows:

$h(t) = \beta e^{-\beta t}$, $g_1(t) = \delta_1 e^{-\delta_1 t}$, $g_2(t) = \delta_2 e^{-\delta_2 t}$, $g_3(t) = \delta_3 e^{-\delta_3 t}$, $g_4(t) = \delta_4 e^{-\delta_4 t}$,

$i(t) = \gamma e^{-\gamma t}$, $h_1(t) = \gamma_4 e^{-\gamma_4 t}$, $h_2(t) = \gamma_5 e^{-\gamma_5 t}$, $h_3(t) = \gamma_6 e^{-\gamma_6 t}$

and, hence we have

$p_{01}=\frac{\lambda}{\lambda+\alpha+\beta}$, $p_{02}=\frac{p\alpha}{\lambda+\alpha+\beta}$, $p_{03}=\frac{(1-p)\alpha}{\lambda+\alpha+\beta}$, $p_{0,10}=\frac{\beta}{\beta+\lambda+\alpha}$, $p_{10} = a$, $p_{14} = 1-a$

$p_{25}=\frac{(1-a)\delta_2}{\lambda+\delta_2}$, $p_{29}^{(8)}=\frac{(1-a)\lambda}{\lambda+\delta_2}$, $p_{20}=\frac{a\delta_2}{\lambda+\delta_2}$, $p_{21}^{(8)}=\frac{a\lambda}{\lambda+\delta_2}$, $p_{28}=\frac{\lambda}{\lambda+\delta_2}$,

$p_{30} = a$, $p_{36} = 1-a$, $p_{40} = 1$, $p_{50}=\frac{\delta_4}{\lambda+\delta_4}$, $p_{60} = 1$, $p_{57}=\frac{\lambda}{\lambda+\delta_4}$, $p_{71} = 1$, $p_{12,0} = 1$,

$p_{51}^{(7)}=\frac{\lambda}{\lambda+\delta_4}$, $p_{91} = 1$, $p_{10,11} = p_1$, $p_{10,12} = p_2$, $p_{10,13} = p_3$, $p_{11,0} = 1$, $p_{13,0} = 1$

Also, the mean surjoun time (μ_i) in state 'i', we have

$\mu_0=\frac{1}{\lambda+\alpha+\beta}$, $\mu_1=\frac{1}{\delta_1}$, $\mu_2=\frac{1}{\delta_2+\lambda}$, $\mu_3=\frac{1}{\delta_2}$,

$\mu_4=\frac{1}{\delta_3}$, $\mu_5=\frac{1}{\delta_4+\lambda}$, $\mu_6=\frac{1}{\delta_4}$, $\mu_9=\frac{1}{\delta_4}$

$\mu_{10}=\frac{1}{\gamma}$, $\mu_{11}=\frac{1}{\gamma_4}$, $\mu_{12}=\frac{1}{\gamma_5}$, $\mu_{13}=\frac{1}{\gamma_6}$

and, $K_1=\frac{a}{\delta_2}+\frac{(1-a)\delta_2}{(\lambda+\delta_2)^2}$, $K_2=\frac{1}{\delta_2+\lambda}$, $K_5=\frac{1}{\delta_4+\lambda}$

$K_3=\frac{a}{\delta_2}-\frac{a\delta_2}{(\lambda+\delta_2)^2}$, $K_8=\frac{(1-a)}{\delta_2}+\frac{a\delta_2}{(\lambda+\delta_2)^2}$

XIII. GRAPHICAL ANALYSIS

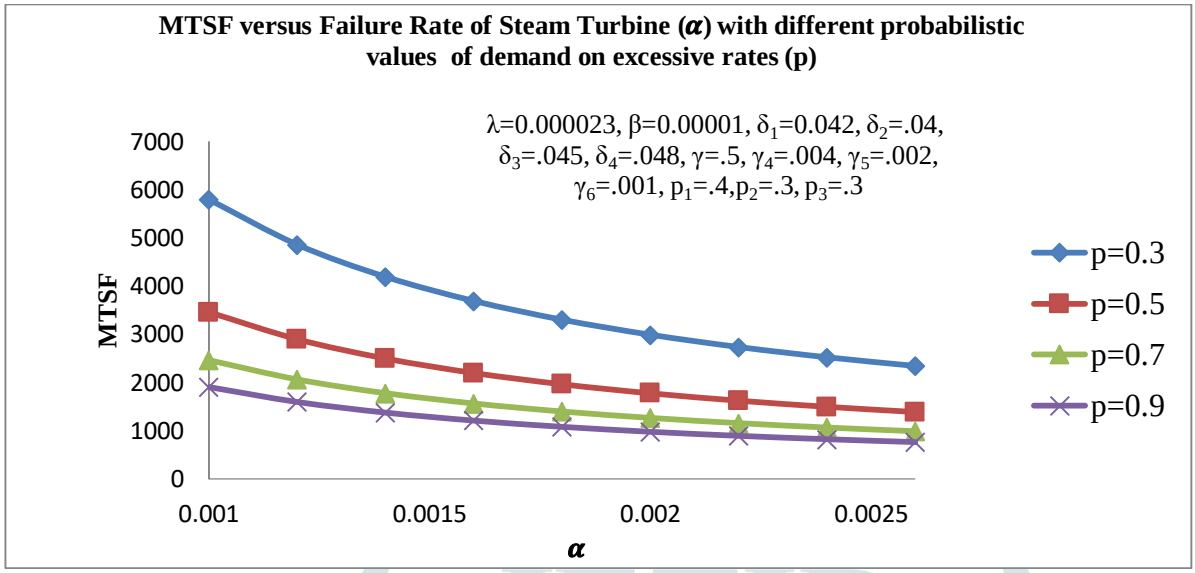

Figure. 2

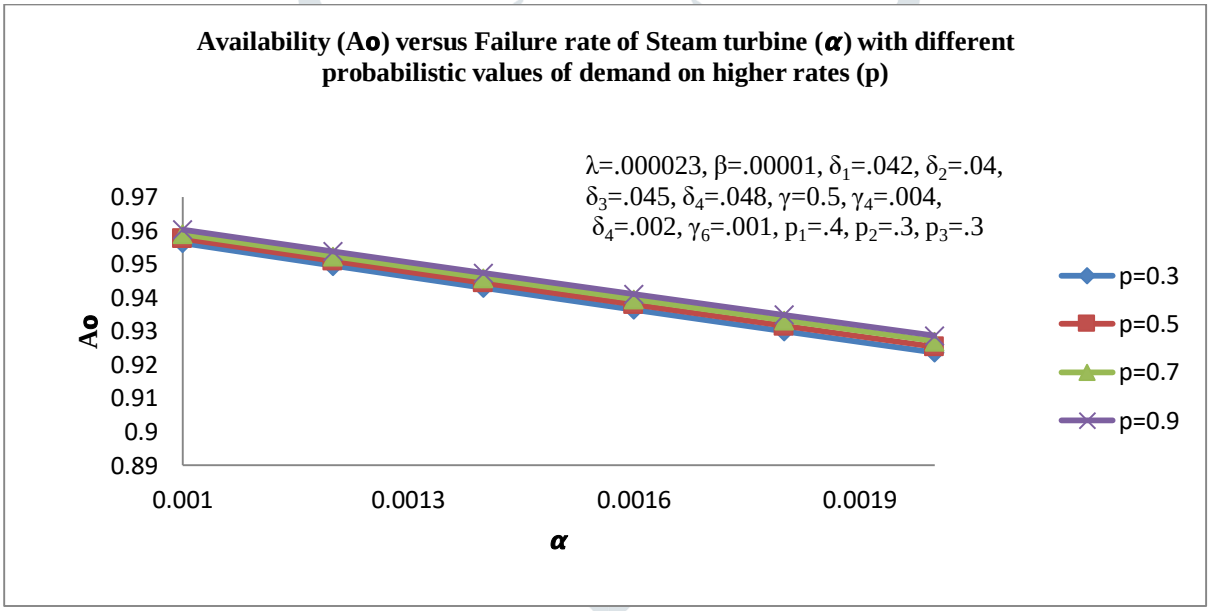

Figure. 3

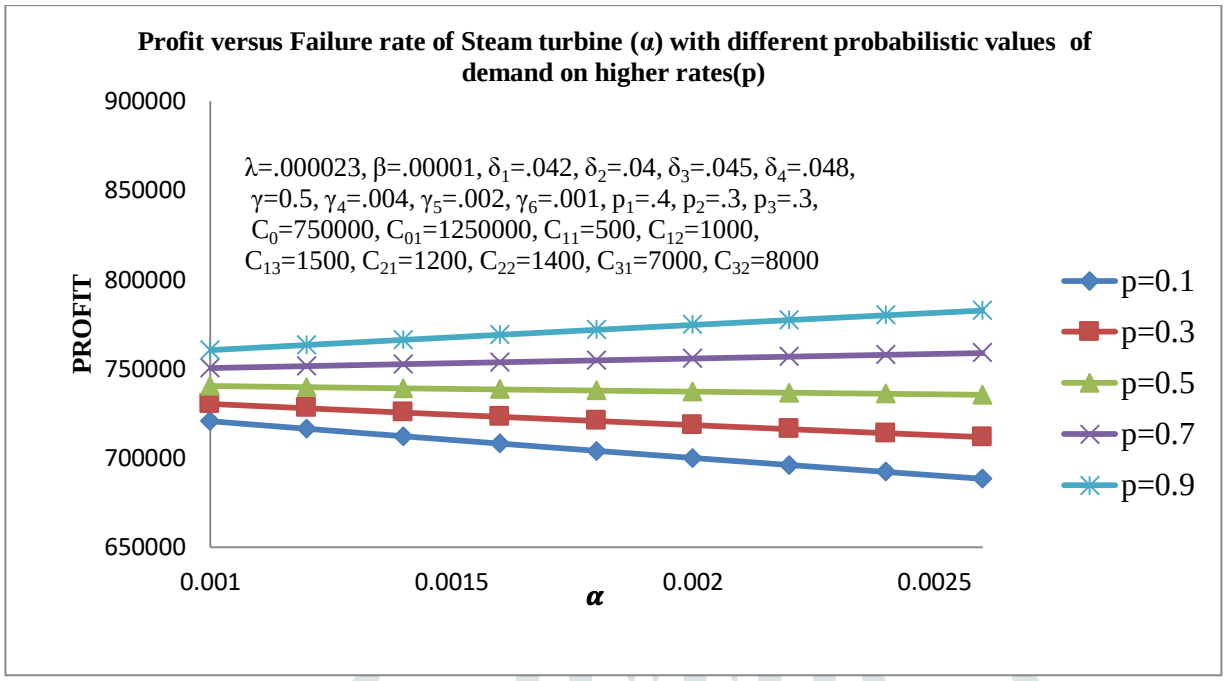

Figure.4

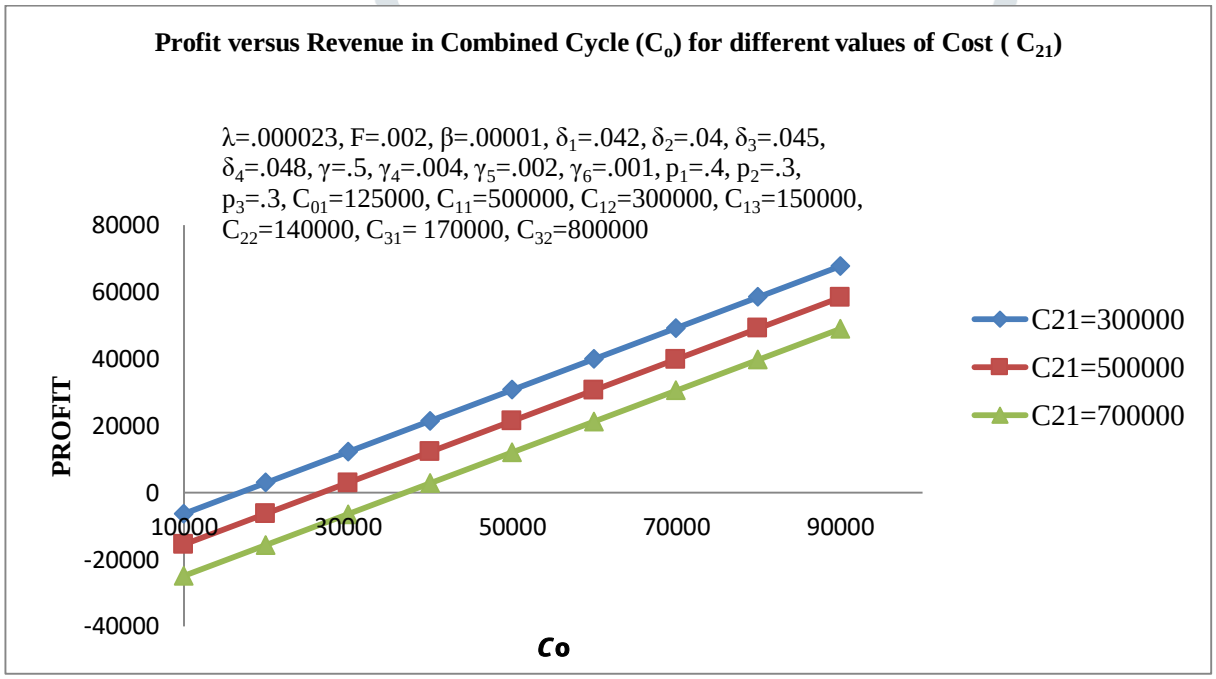

Figure. 5

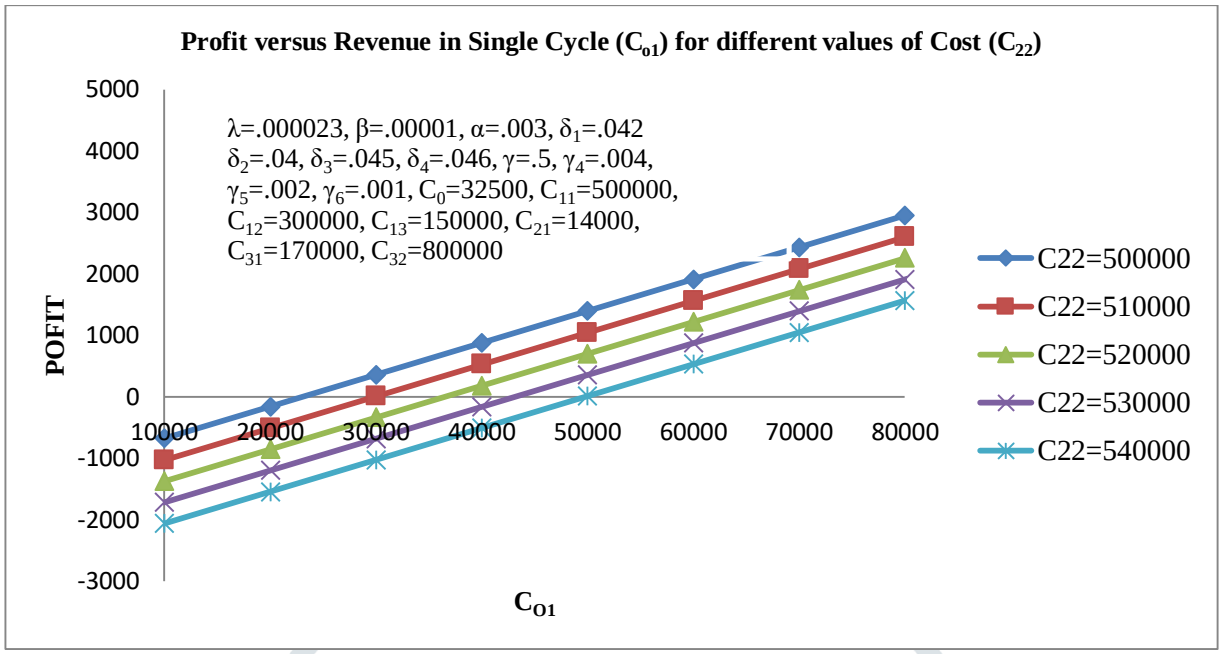

Figure. 6

XIV. CONCLUSION

From above discussed model we can calculate various reliability measures like MTSF, full capacity availability, single cycle availability and benefit of the system. Graphically analysis is made in figures 2 to 6. Figure. 2 conveys that mean time to system failure decrease when steam turbine's failure rate get strengthen. Figure. 3 illustrates that when steam turbine's failure rate increases full capacity availability decreases. From figure. 4, we can conclude that with small probabilistic values profit decreases when steam turbine's failure rate increases, but with higher probabilistic values profit increases when steam turbine's failure rate increases and figure.5 and figure.6 denote as the revenue cost per unit increases the profit increases.

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