ABSTRACT

The Cogeneration Power Plant or Combined Heat-and-Power Systems (CHP) are systems that simultaneously generate both electricity and useful heat, besides reduction in the Green house Gas (GHG) emission. It is important to analyze the reliability of these systems in order to ensure lowest level of cost of system life cycle. CHP system installed in a sugar and textile mill are considered as case studies in order to assess its reliability through Fault Tree Analysis (FTA), Weibull Distribution Techniques, Integrating of Enhanced Ladder Control Logic and basic availability analysis using Taguchi Method.

In the FTA, common cause failures are evaluated using the $\beta$-factor model with the available data on the failure and restoration of the plant. On a detailed analysis, it is found that the unavailability of the CHP system in the sugar mill is 2.50E-3 and in the textile mill is 8.50E-03. It is noted that the CHP system unavailability is due to failures related to mechanical system, sub-systems of condenser, boiler and turbine. Besides determining the system unavailability, sensitive systems and sub-systems are identified through FTA. Such indentified systems and sub-systems failure data would help in selection and development of logical control system.

As FTA uses logical approach to determine of system unavailability, it is more appropriate to find a logical solution to improve
system availability and hence integration of enhanced ladder control logic to the existing distributed control system is envisaged.

While analyzing the results through Weibull distribution, it is found that the mean time between failure (MTBF) for the CHP System installed in Textile and Sugar mills are found to be 1811.82 h and 2317.71h respectively. Whereas the mean time to restoration (MTTR) for CHP System installed in Textile and Sugar mill is found to be 20.44h and 37.73h respectively. In this analysis, it could be noted that MTTR is higher in the case of CHP System installed in Sugar mill compared Textile mill.

Having determined the MTTR value, it is essential to analyze as to whether varying the MTTR value would enhance the system availability. Accordingly, a theoretical analysis through Taguchi method is envisaged and system optimum availability is determined.

The integration of enhanced ladder control logic to the existing distributed control system is envisaged for improving the system availability, whereas the process output points are determined using cause and effect matrix. Based on the cause and effect matrix, the process output points for CHP System installed in the Textile mill is reduced to 11167 from 26469 and for Sugar mill to 1194 from 3092. It is established that such an approach does improve the overall system functionality and availability.

Further, the Taguchi method as per Otto Kevin (1996) has been carried out to determine the optimum CHP system availability by varying the system mean time to restoration (MTTR). In this analysis, the MTTR value is
varied at the rate of +/- 5h and +/- 15h with the existing MTBF value of the CHP System. The MTTR value is considered individually for boiler, turbine and electrical of the CHP System. It is established that there is significant improvement in the availability CHP System at Textile and Sugar mill at 0.992 and 0.989 respectively.

Based on the analysis, it is recommended that implementation of reliability centered maintenance (RCM) features will significantly improve the reliability and availability of the CHP System. With the available data on MTTR and enhanced logical control system, implementation of RCM would be very effective. The failure and restoration data can be accessed from the central processing unit of the distributed control system, interfacing of computer maintenance management system is recommended. This would further reduce the time frame with respect to return on the investment.