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An Innovative Safety Approach for Reliability Analysis of Hose Reel System

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Abstract:- Reliability evaluation of an engineering system or component or element is very important in order to predict its availability or unavailability and other important indices. Reliability is the parameter which tells about the availability or unavailability of the system or component under proper working conditions for a given period of time. In this paper a study based on reliability analysis of a Hose Reel system installed for safety purpose is evaluated and different parameter are obtained. A Hose Reel system installed for fire fighting and safety purpose of the educational institute was taken for study.

Keywords:- *Reliability, Availability, Hose Reel System, Fire Fighting, Safety.*

I. INTRODUCTION

Reliability evaluation of a system or component or element is very important in order to predict its availability and other relevant indices. Reliability is the parameter which tells about the availability of the system under proper working conditions for a given period of time. A Markov cut-set composite approach to the reliability evaluation of transmission and distribution systems involving dependent failures was proposed by Singh et al. [1]. The reliability indices have been determined at any point of composite system by conditional probability approach by Billinton et al. [2]. Wojczynski et al. [3] discussed distribution system simulation studies which investigate the effect of interruption duration distributions and cost curve shapes on interruption cost estimates. New indices to reflect the integration of probabilistic models and fuzzy concepts was proposed by Verma et al. [4]. Zheng et al. [5] developed a model for a single unit and derived expression for availability of a component accounting tolerable repair time. Distributions of reliability indices resulting from two sampling techniques are presented and analyzed along with those from MCS by Jirutitijaroen and Singh [6]. Dzobe et al. [7] investigated the use of probability distribution function in reliability worth analysis of electric power system. Bae and Kim [8] presented an analytical technique to evaluate the reliability of customers in a microgrid including distribution generations. Reliability network equivalent approach to distribution system reliability assessment is proposed by Billinton and Wang [9].

Customer and energy based indices consideration for reliability enhancement of distribution system using Improved Teaching Learning based optimization is discussed [10]. An Innovative Self-Adaptive Multi-Population Jaya Algorithm based Technique for Evaluation and Improvement of Reliability Indices of Electrical Power Distribution System, Tiwary et al. [11]. Jirutitijaroen et al. [12] developed a comparison of simulation methods for power system reliability indexes and their distribution. Determination of reliability indices for distribution system using a state transition sampling technique accounting random down time omission Tiwary et al. [13].Tiwary et al. [14] proposed a methodology based on Inspection-Repair-Based Availability Optimization of Distribution System Using Bare Bones Particle Swarm Optimization. Bootstrapping based technique for evaluating reliability indices of RBTS distribution system neglecting random down time was evaluated [15].

Volkanavski et al. [16] proposed application of fault tree analysis for assessment of the power system reliability. Li et al. [17] studies the impact of covered overhead conductors on distribution reliability and safety. Reliability enhancement of distribution system using Teaching Learning based optimization considering customer and energy based indices was obtained in Tiwary et al. [18]. Self-Adaptive Multi-Population Jaya Algorithm based Reactive Power Reserve Optimization Considering Voltage Stability Margin Constraints was obtained in Tiwary et al. [19]. A smooth bootstrapping based technique for evaluating distribution system reliability indices neglecting random interruption duration is developed [20]. Tiwary et al. [21] have developed an inspection maintenance based availability optimization methodology for feeder section using particle swarm optimization. The impact of covered overhead conductors on distribution reliability and safety is discussed [22]. Tiwary et al. [23] has discussed a methodology for reliability evaluation of an electrical power distribution system, which is radial in nature. Sarantakos et al. [24] introduced a method to include component condition and substation reliability into distribution system reconfiguration. Tiwary et al. [25] has discussed a methodology for evaluation of customer orientated indices and reliability of a meshed power distribution system. Reliability evaluation of engineering system is discussed [26]. Battu et al. [27] discussed a method for reliability compliant distribution system planning using Monte Carlo simulation. Application of non-parametric bootstrap technique for evaluating MTTF and reliability of a complex network with non-identical component failure laws is discussed [28]. Tiwary and Tiwary [29] have developed an innovative methodology for evaluation of customer orientated indices and reliability study of electrical feeder system.

Hose Reel system is very important in order to control fire at a particular place. In order to minimize the effect of fire at any location proper utilization along with the reliability of the system is very important aspect to look after. Therefore there is need for evaluation of reliability of the hose reel system. In this paper reliability evaluation of a Hose Reel system installed at an educational institution is done and different reliability parameters are obtained.

II. RELIABILITY EVALUATION OF THE SYSTEM AND ITS IMPLEMENTATION

If one assumes time independent reliability r1,r2…rn of each and every component present in the system, then reliability of the combination of the components connected in a series configuration is given as

$$R_s = \prod_{i=1}^{n} r_i \qquad (1)$$

The above relation is important in order to evaluate the value of the reliability when the components or elements in any practical system are connected in series manner.

The reliability of the system having constant failure rate is evaluated by using the following relation.

$$R(t)=e^{(-\lambda t)} \qquad (2)$$

Where R(t) represents the reliability of each component. λ represents the failure rate per year and t represents time period which is taken as one year.

Figure 1 provides the block diagram of the practical Hose Reel system taken for the evaluation purpose. It provides the detail of the different components which are a part of the hose reel system. The hose reel system consider consists of different components such as: Terrace Tank, Centrifugal Pump, Pipes, Accessories (NRV/Water flow control valve/Joints and Bends), Hose reel drum and mounting, Hose reel pipe and shut off nozzle and Electrical panel.

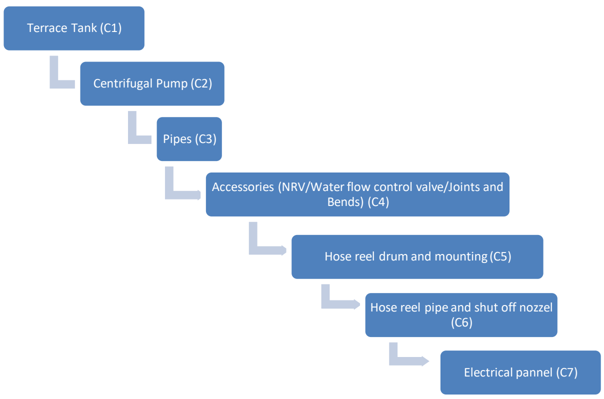

Fig. 1:- Block Diagram of the Hose Reel System

III. RESULTS AND DISCUSSION

Table 1 shows the initial data for the hose reel system. There are seven components in the hose reel system and are shown in Fig. 1. Table 2 provides the evaluated reliability for each and every component of the hose reel system. For components 1 to 7 evaluated reliability value is 0.9948, 0.9361, 0.9999, 0.9967, 0.9943, 0.9967 and 0.9333 respectively. Table 3 gives up the component level evaluated reliability for each component. Fig. 2 provides the magnitude of reliability of each and every component from 1 to 7. Fig. 3 gives magnitude of reliability at component level.

component	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Failure rate	0.0052	0.066	0.0000075	0.0033	0.0057	0.0033	0.069

Table 1: Initial data for different components of the hose reel system.

component	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Evaluated Reliability	0.9948	0.9361	0.9999	0.9967	0.9943	0.9967	0.9333

Table 2: Evaluated reliability for each and every component of the hose reel system.

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Component Level	C1	C2	C3	C4	C5	C6	C7
Evaluated Reliability	0.9948	0.9312	0.9311	0.9280	0.9227	0.9197	0.8583

Table 3:- Component level evaluated reliability for each and every component of the hose reel system.

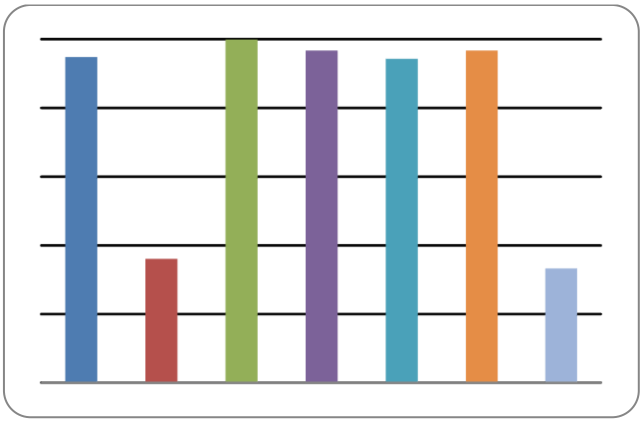

Fig 2: Magnitude of Reliability of each and every component from 1 to 7.

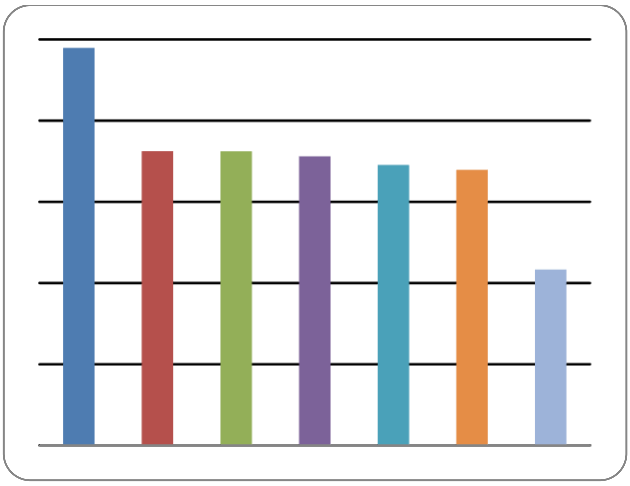

Fig 3:- Magnitude of Reliability at component level.

IV. CONCLUSION

Reliability evaluation of an engineering system or component or element is very important in order to predict its availability or unavailability and other important indices. In this paper reliability evaluation of a Hose Reel system installed at an educational institution is done and different reliability parameters are obtained. The reliability is evaluated based on the failure rate provided of each and every component. Reliability of each and every component is calculated and provided in the result section. Component level reliability is also evaluated and provided in result.

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