ISSN No:-2456-2165

Reliability Evaluation of Fire Extinguisher – An Innovative Safety Approach

Aditya Tiwary
Associate Professor, Dept. of Fire Technology & Safety Engineering, IPS Academy, Institute of Engineering and science, Indore (M.P), India

Rohit Patel
UG Final year students, Dept. of Fire Technology & Safety Engineering, IPS Academy, Institute of Engineering and science, Indore (M.P), India

Saiyam Jain
UG Final year students, Dept. of Fire Technology & Safety Engineering, IPS Academy, Institute of Engineering and science, Indore (M.P), India

Shreyansh Jain
UG Final year students, Dept. of Fire Technology & Safety Engineering, IPS Academy, Institute of Engineering and science, Indore (M.P), India

Shivam Rathore
UG Final year students, Dept. of Fire Technology & Safety Engineering, IPS Academy, Institute of Engineering and science, Indore (M.P), India

Sagar Soni
UG Final year students, Dept. of Fire Technology & Safety Engineering, IPS Academy, Institute of Engineering and science, Indore (M.P), India

Seejan Khan
UG Final year students, Dept. of Fire Technology & Safety Engineering, IPS Academy, Institute of Engineering and science, Indore (M.P), India

Sami Shaikh
UG Final year students, Dept. of Fire Technology & Safety Engineering, IPS Academy, Institute of Engineering and science, Indore (M.P), India

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 related to the component or system as a whole. Reliability is the variable which tells about the availability or unavailability of the component under proper working conditions for a given period of time. In this paper a study based on reliability analysis of fire extinguishers installed for safety purpose is evaluated and different variable are obtained. A Fire Extinguisher is very important to control in case of fire for safety purpose.

Keywords:- Reliability, Availability, Fire Extinguisher, Fire Fighting, Safety.

I. INTRODUCTION

A Markov cut-set composite approach 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 DS simulation studies. New indices based on probabilistic models and fuzzy concepts were presented by Verma et al. [4]. Various reliability indices studies were presented [5-9]. Different methods for reliability of distribution system were discussed [10-15]. Studies based on fault tree, safety, DS reliability are presented [16-24]. 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 using MCS. Various reliability assessment has been presented [28-31].

Fire Extinguisher 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 equipment is very important aspect to look after. Therefore there is need for evaluation of the reliability. In this paper reliability evaluation of Fire Extinguishers installed for safety is done and different reliability parameters are obtained.

Fig. 1(i) Fire Extinguisher

Fig. 1(ii) Fire Extinguisher

ISSN No:-2456-2165

II. RELIABILITY EVALUATION OF COMPONENTS AND ITS IMPLEMENTATION

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

$R(t)=e^{(-\lambda t)}$ (1)

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.

The mean time to failure (MTTF) can be obtained as follows:

$MTTF=1/\lambda$ (2)

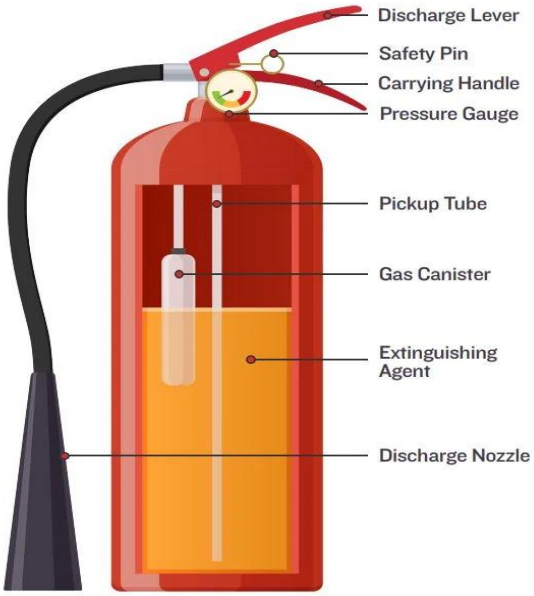

Fig. 2 Component description of Fire Extinguisher

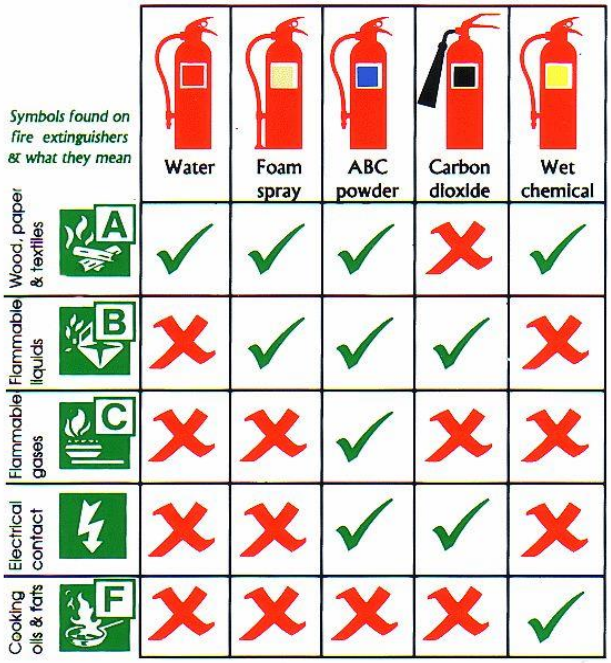

Fig. 3 Description of different types of Fire Extinguisher

III. RESULTS AND DISCUSSION

Table 1 shows the initial data for the fire extinguishers. Total number of seven fire extinguishers was taken for the study purpose. Table 2 provides the evaluated reliability for each and every fire extinguishers. For fire extinguishers 1 to 7 evaluated reliability value are 0.991536, 0.992528, 0.992032, 0.998002, 0.996606, 0.994615 and 0.995212 respectively. Table 3 gives up the value of MTTF of each and every fire extinguishers taken for the study. Fig. 1 provides the magnitude of reliability of each and every fire extinguisher from 1 to 7. Fig. 2 gives magnitude of MTTF.

Table 1: Initial data for different fire extinguishers.

fire extinguisher	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Failure rate($*10^{-4}$)	85	75	80	20	34	54	48

Table 2: Evaluated reliability for different fire extinguishers.

fire extinguisher	**1**	**2**	**3**	**4**	**5**	**6**	7
Evaluated Reliability	0.991536	0.992528	0.992032	0.998002	0.996606	0.994615	0.995212

Table 3: Evaluated MTTF for different fire extinguishers.

fire extinguisher	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Evaluated MTTF	117.64	113.33	125.00	500.00	294.11	185.18	208.33

ISSN No:-2456-2165

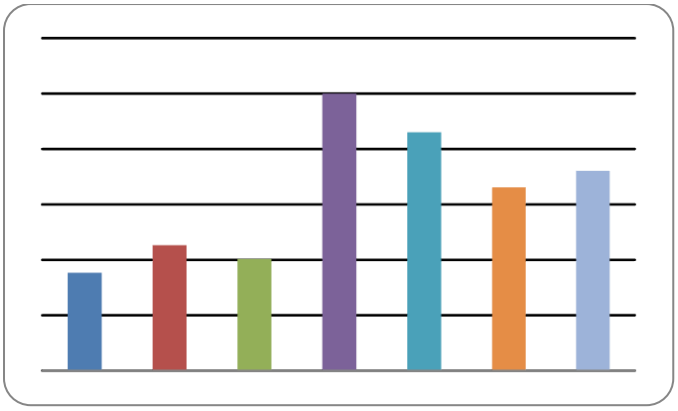

Figure 1: Magnitude of Evaluated reliability for different fire extinguishers.

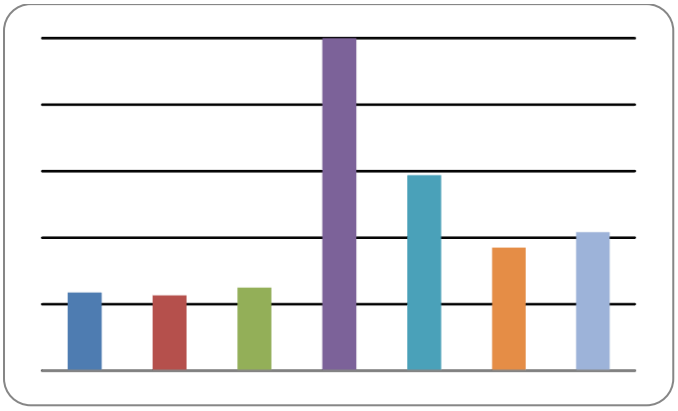

Figure 2: Magnitude of Evaluated MTTF for different fire extinguishers.

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 fire extinguishers is done and different reliability parameters are obtained. The reliability is evaluated based on the failure rate provided. Mean time to failure (MTTF) an important indices is also obtained for the each and every fire extinguisher.

REFERENCES

[1]. C. Singh, "Markov cut-set approach for the reliability evaluation of transmission and distribution systems", IEEE Trans. on Power Apparatus and Systems, Vol. PAS-100, No. 6, 1981, pp. 2719-2725.

[2]. R. Billinton, "Composite system reliability evaluation", IEEE Trans. on Power Apparatus and Systems, Vol. PAS-88, No. 4, 1969, pp. 276-281.

[3]. E. Wojczynski, R. Billinton, "Effects of distribution system reliability index distributions upon interruption cost/reliability worth estimates", IEEE Trans. on Power Apparatus and Systems, PAS-104, Vol. 11, 1985, pp. 3229-3235.

[4]. A. K. Verma, A. Srividya, H. M. R. Kumar, "A framework using uncertainties in the composite power system reliability evaluation", Electric Power Components and Systems, Vol.30, No. 7, 2002, pp. 679-691.

[5]. Z. Zheng, L. Cui, Alan G. Hawkes, "A study on a single-unit Markov repairable system with repair time omission", IEEE Trans. on Reliability, Vol. 55, No.2, 2006, pp. 182-188.

[6]. P. Jirutitijaroen, C. singh, "Comparison of simulation methods for power system reliability indexes and their distributions", IEEE Trans. on Power Systems, Vol.23, No.2, 2008, pp. 486-493.

[7]. O. Dzobe, C. T. Gaunt, R. Herman, "Investigating the use of probability distribution functions in reliability-worth analysis of electric power systems", Int. J. of Electrical Power and Energy Systems, Vol. 37, 2012, pp. 110-116.

[8]. I. S. Bae, J. O. Kim, "Reliability evaluation of customers in a microgrid", IEEE Trans. on Power Systems, Vol. 23, No. 3, 2008, pp. 1416-1422.

[9]. R. Billinton, P. Wang, "Reliability-network-equivalent approach to distribution-system-reliability evaluation", IEE Proc. generation, transmission and distribution, Vol. 145, No. 2, 1998, pp. 149-153.

[10]. Aditya Tiwary, "Customer and energy based indices consideration for reliability enhancement of distribution system using Improved Teaching Learning based optimization", International Journal of Latest Trends in Engineering and Technology, Vol. 9, No. 1, Sept. 2017, pp. 254-258.

[11]. Aditya Tiwary, "An Innovative Self-Adaptive Multi-Population Jaya Algorithm based Technique for Evaluation and Improvement of Reliability Indices of Electrical Power Distribution System", International Journal on Future Revolution in Computer Science & Communication Engineering, Vol. 4, No. 2, Feb. 2018, pp. 299-302.

[12]. Jirutitijaroen P, singh C. "Comparison of simulation methods for power system reliability indexes and their distribution", IEEE Trans Power Syst, 23(2), 2008, pp. 486-92.

[13]. Aditya Tiwary, R. Arya, S. C. Choube and L. D. Arya," Determination of reliability indices for distribution system using a state transition sampling technique accounting random down time omission", Journal of The Institution of Engineers (India): series B (Springer), Vol. 94, No. 1 , 2013, pp. 71-83.

[14]. Aditya Tiwary, "Inspection-Repair-Based Availability Optimization of Distribution System Using Bare Bones Particle Swarm Optimization", Chapter in Book Series Computational Intelligence: Theories, Applications and Future Directions – Volume II, Advances in Intelligent Systems and computing 799, Springer, 2019.

[15]. Aditya Tiwary, R. Arya, L. D. Arya and S. C. Choube, "Bootstrapping based technique for evaluating reliability indices of RBTS distribution system neglecting random down time", The IUP Journal of Electrical and Electronics Engineering, Vol. X, No. 2, April 2017, pp. 48-57.

[16]. Volkanavski, Cepin M, Mavko B. "Application of fault tree analysis for assessment of the power system reliability", Reliab Eng Syst Safety, 94(6), 2009, pp. 1116-27.

[17]. Li BM, Su CT, Shen CL. "The impact of covered overhead conductors on distribution reliability and safety" Int J Electr Power Energy Syst, 32(4). 2010, pp. 281-9.
[18]. Aditya Tiwary, "Reliability enhancement of distribution system using Teaching Learning based optimization considering customer and energy based indices", International Journal on Future Revolution in Computer Science & Communication Engineering, Vol. 3, No. 10, Oct. 2017, pp. 58-62.
[19]. Aditya Tiwary, "Self-Adaptive Multi-Population Jaya Algorithm based Reactive Power Reserve Optimization Considering Voltage Stability Margin Constraints", International Journal on Future Revolution in Computer Science & Communication Engineering, Vol. 4, No. 1, Jan. 2018, pp. 341-345.
[20]. R. Arya , Aditya Tiwary , S. C. Choube and L. D. Arya, "A smooth bootstrapping based technique for evaluating distribution system reliability indices neglecting random interruption duration", Int. J. of Electrical Power and Energy System, (ELSEVIER), Vol.51 , 2013,pp. 307-310.
[21]. A. Tiwary, "Inspection–Maintenance-Based Availability Optimization of Feeder Section Using Particle Swarm optimization", Soft Computing for Problem Solving-Advances in Intelligent Systems and Computing, 816, 2018, pp. 257-272.
[22]. M. Bin Li, C. Tzong Su, C. Lung Shen, "The impact of covered overhead conductors on distribution reliability and safety", Int. J. of Electrical Power and Energy System, (ELSEVIER), Vol. 32, 2010, pp. 281-289.
[23]. Aditya Tiwary, "Reliability evaluation of radial distribution system – A case study", Int. J. of Reliability: Theory and Applications, 14, 4(55), 2019, pp. 9-13.
[24]. I. Sarantakos, D. M. Greenwood, J. Yi, S. R. Blake, P. C. Taylor, "A method to include component condition and substation reliability into distribution system reconfiguration", Int. J. of Electrical Power and Energy System, (ELSEVIER), Vol. 109, 2019, pp. 122-138.
[25]. Aditya Tiwary, "Customer orientated indices and reliability evaluation of meshed power distribution system", Int. J. of Reliability: Theory and Applications, 15, 1(56), 2020, pp. 10-19.
[26]. Aditya Tiwary and Praveen Patel, "Reliability Evaluation of Hose Reel System - A Practical Approach", Journal of Industrial Safety Engineering, Vol. 7, No. 2, September 2020, pp. 30-34.
[27]. N. R. Battu, A. R. Abhyankar, N. Senroy, "Reliability Compliant Distribution System Planning Using Monte Carlo Simulation", Electric power components and systems, Vol. 47, 2019, pp. 985-997.
[28]. Aditya Tiwary, "Application of Non-Parametric Bootstrap Technique for evaluating MTTF and Reliability of a Complex Network with Non-Identical Component Failure Laws", Reliability: Theory and Applications, Vol. 15, No. 3(58), September 2020, pp. 62-69.
[29]. Aditya Tiwary and Swati Tiwary, "Evaluation of Customer Orientated Indices and Reliability Study of Electrical Feeder System", Reliability: Theory and Applications, Vol. 15, No. 3(58), September 2020, pp. 36-43.
[30]. Aditya Tiwary, Ritik Yadav, Praveen R. Patel, Praveen K. Patel, Satish Patle, Rahul Gurjar, Shivam Dabli, "An Innovative Safety Approach for Reliability Analysis of Hose Reel System", International Journal of Innovative Science and Research Technology, Vol. 5, No, 10, Oct. 2020, pp. 870-873.
[31]. AdityaTiwary, RitikYadav, Praveen R. Patel, Praveen K. Patel, SatishPatle, Rahul Gurjar, ShivamDabli, Shailendra Raghuwanshi "Reliability Assessment of Practical Hose Reel System a contemporary Perspective", International Journal of Innovative Science and Research Technology, Vol. 6, No. 3, March 2021, pp. 1318-1321.