POWER SUBSTATIONS RELIABILITY EVALUATION USING FUZZY SET

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INTRODUCTION

- The estimation of the reliability parameters of the components in the power substations contains a high level of insecurity and uncertainty, which are still given statistical character.

- It is more appropriate to assume that the unavailability of the components and the uncertainty belongs to a certain range

- The development of the fuzzy logics offers effective procedures and techniques that can include the imprecise and unavailability of the input data.

PROBLEM DEFINITION

- In this paper, the fuzzy logic theory is used for estimation of the reliability of power substations, considering the reliability of the power lines.

- The substation is divided into blocks, and each of the blocks has a certain impact on the substation's reliability.

PROBLEM DEFINITION

- This method, offers a wider range of scenario analysis that can cause the failure of the power substation.

- The main characteristic is that all input and output data are also fuzzy numbers, defined with proper membership function.
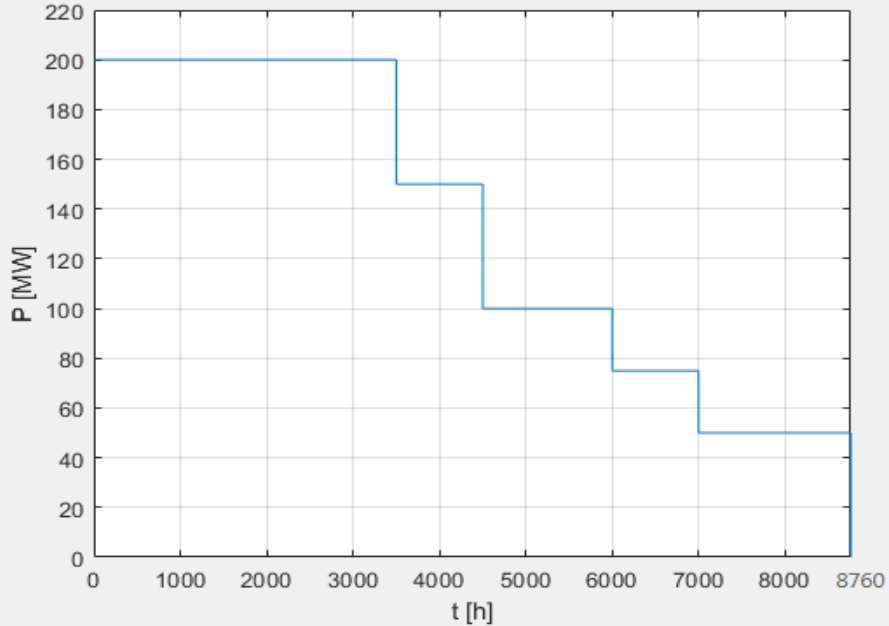
PROBLEM DEFINITION

- The components in the substations are grouped to form a functional whole with precisely defined function in normal operational condition.
- The experiences have shown that substations have high reliability rate, which depending on the components and the voltage rate, varies between 10^{-4} and 10^{-6}.
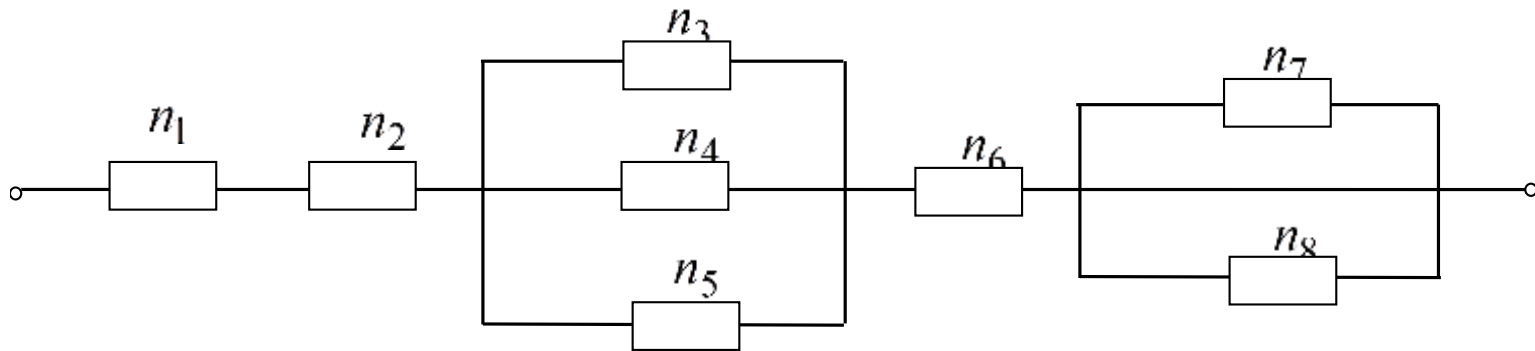
TEST EXAMPLE

Load duration curve of the analysed test example substation
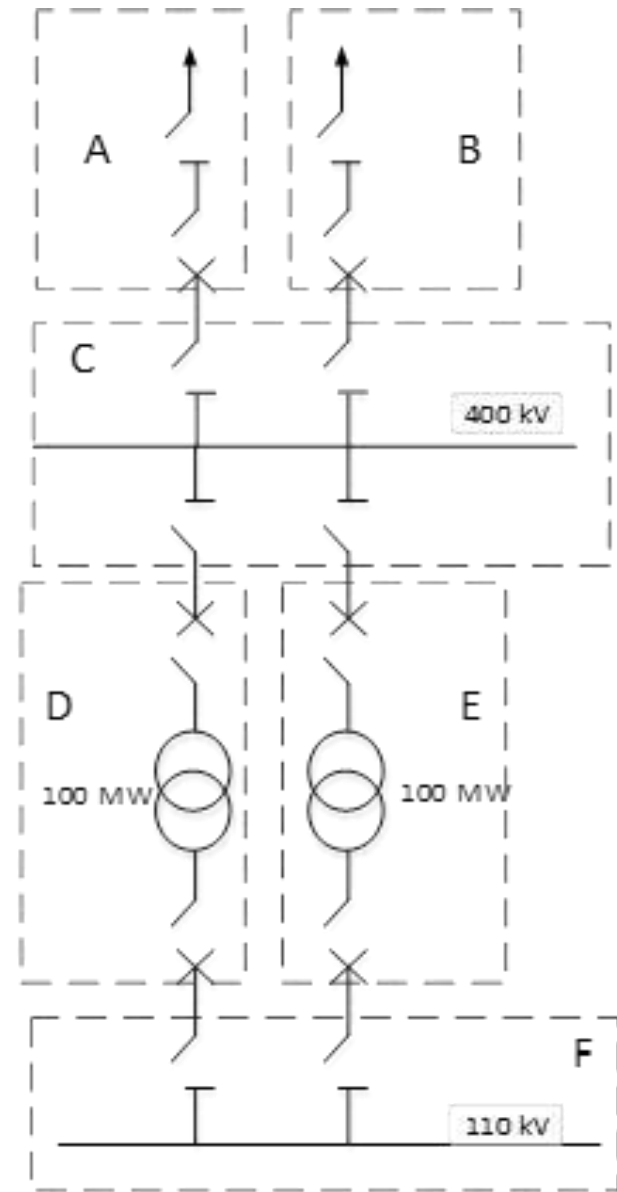
TEST EXAMPLE

- The unavailability of each of the components depends on the voltage level and is defined with a triangular fuzzy number

- The equivalent unavailability of the whole system is calculated with a combination of the expressions for series and parallel connected components.

- Considering the calculated unavailability rates and the load duration curve, the annual Energy Not Supplied (ENS) is calculated

TEST EXAMPLE- Energy Not Supplied

No.	A	B	C	D	E	F	Probability of occurrence	Power [MW]	ENS [MWh/year]
1	1	1	1	1	1	1	/	0	0
2	**0**	1	1	1	1	1	$[2.08;\quad 2.35;\quad 2.86]\cdot 10^{-5}$	100	$[9.36;\quad 10.58;\quad 12.87]$
3	1	**0**	1	1	1	1	$[2.08;\quad 2.35;\quad 2.86]\cdot 10^{-5}$	100	$[9.36;\quad 10.58;\quad 12.87]$
4	1	1	**0**	1	1	1	$[1.70;\quad 1.78;\quad 1.85]\cdot 10^{-5}$	200	$[29.78;\quad 31.24;\quad 32.46]$
5	1	1	1	**0**	1	1	$[5.36;\quad 5.58;\quad 5.84]\cdot 10^{-4}$	100	$[241.23;\quad 250.99;\quad 262.43]$
6	1	1	1	1	**0**	1	$[5.36;\quad 5.58;\quad 5.84]\cdot 10^{-4}$	100	$[241.23;\quad 250.99;\quad 262.43]$
7	1	1	1	1	1	**0**	$[1.05;\quad 1.10;\quad 1.15]\cdot 10^{-5}$	200	$[18.43;\quad 19.27;\quad 20.20]$
8	**0**	**0**	**0**	**0**	**0**	**0**	$[2.78\quad 2.91\quad 3.04]\cdot 10^{-5}$	200	$[48.72;\quad 51.06;\quad 53.26]$
							Total:		$[598.62\quad 625.26\quad 657.47]$

CONCLUSION

- The method presented is an upgrade of an excising method it shows that it is applicable for more complex substations.

- The results are characterized by a low percentage of error, which makes the method applicable to engineering calculations in the designing process.

- Also, the results provide a wider range of probabilities of failure, which can be analysed as case scenarios that cause power supply interruptions.

Thank you for your attention