The generator operating system automatically uses a motorized change over switch devices

D Muliyati1, *, F Bakri1, I Umami2, D Sumardani3 and D Ambarwulan3

1 Physics Education Department, Universitas Negeri Jakarta, Jl. Rawamangun Muka No.1, Jakarta 13220, Indonesia
2 Civil Engineering Department, Universitas Mercu Buana, Jl. Meruya Selatan No.1, Meruya Selatan, Kembangan, Jakarta 11650, Indonesia
3 Digital Laboratory Physics Education Department, Universitas Negeri Jakarta, Jl. Rawamangun Muka No.1, Jakarta 13220, Indonesia

*dmuliyati@unj.ac.id

Abstract. This system is carried out using two power between the National Electricity Company (PLN) as the main power and the generator as backup power. This system uses 30KVA power capacity for PLN and 45KVA for generator set (genset). This system relies heavily on the crucial role of the motorized change over switch device because the automatic transfer system can run properly without collisions when using the backup power supply and when the main power supplies return. The results provided by the observations on two power experiments between the power of the PLN and the power of the generator when there is a blackout at the PLN. The automatically performance of motorized change over switch works has a range of pauses of 18 seconds to be able to power the genset capable of taking on the role of PLN to back up the Building. Furthermore, when the PLN power returns the power is held for 30 seconds by a motorized change the over switch. It ensures that the main power of the PLN reconnected.

1. Introduction

The developing countries have a significant issue with frequent power failure [1,2]. Hospital, Data Centers, Internet, Government, Waste Water, Banking, Universities, Military Bases, and Industries needs electric power at all times to various processes efficiently [3]. Then, these public sectors should have an electric generator for backup power, for backup the power wherein such time there are not utility power [4,5]. In South Africa, there are state-owned enterprises whose task is to control the procurement and distribution of electricity for the public interest [6]. Also, in Indonesia the task was carried out by the National Electricity Company (PLN).

The desire for facilities that can provide power sustainably leads to innovations about the combination of generators and transfer switches. One such innovation is the automatic transfer switch (ATS) which can automatically turn on the generator and switch from the PLN power source to the generator when the PLN power is off [6-8]. ATS is also known as "Generator Transfer Switches" which have additional circuit components usually in the form of computers that can monitor incoming power supply [8,9]. Whenever a power failure is detected, the automatic transfer switch turns on the ATS emergency power supply connected to the power source and supplies the load with power that only comes from one source at a specific time [9,10].
This study using the ATS with changeover switch motorized method. The changeover switch motorized designed using two functions, automatic transfer using motorized and manual transfer using the ohm switch.

2. Methods

2.1. Operation mode
The Automatic Transfer Switch (ATS) supported by the Automatic Main Failure (AMF) and Change Over Switch Motorized (COSM) which can be used using two modes: manual and automatic mode. When the COSM in manual mode, the ATS system is not able to work on its major power outage, but the AMF system can provide a signal to a backup power supply so the genset will turn on the engine. However, in the automatic AMF mode, ATS will respond by the command mode at a specific time. Figure 1 and 2 show the AMF and ATS respectively.

![Figure 1. The Automatic Main Failure (AMF) system.](image1)

![Figure 2. The Automatic Transfer Switch (ATS) using change over switch motorized system.](image2)

2.2. Power supply transfer process
The automatic mode happens when the ATS must work and detect signals from failure or outages of the mains voltage to provide a signal to turn on backup power immediately. To detect any primary failure or blackout power ATS supported by AMF.

2.3. Starting backup power supply (Generator)
ATS gives a signal to backup voltage to be able immediately because the backup voltage based on Genset, then the operating system is given a 1-2 second delay time to anticipate and ensure that the primary voltage is completely lost, to avoid the different phase angles between the PLN and Genset phase angles.
2.4. Return of main voltage source
When the primary voltage returns to normal, the ATS system which supported by a timer will be active to find out or ensure that the primary voltage is back and running well. The length of time delay given by the timer ranges from 10-30 seconds. COSM works to backup voltage from genset to the primary voltage, PLN.

3. Results
The observation includes testing manual mode, testing manual mode with main voltage PLN, testing manual mode by transferring PLN voltage to genset voltage, testing automatic mode, testing the automatic mode on PLN power, testing of automatic transfer mode of PLN power to genset power and testing the automatic mode at PLN power back.

3.1. Testing manual mode
The ATS system using COSM is assisted by a push button to operate this manual mode as shown in Figure 3, and the selector enabled in the manual mode. COSM can work accurately, safely, and suitable if used in range small to medium power in 220V/50Hz shown in figure 4.

3.2. Testing manual mode with main voltage PLN
In this test, the selector leads to manual mode and main voltage PLN appears, in the manual mode operating system has a delay or pause about 1-2 seconds depending on the speed push button on PLN, from the other research the timing relay (with delayed action) waits 5s then closes the circuit through 15 – 18 contact [7].

3.3. Testing manual mode by transferring PLN voltage to genset voltage
In this testing process, the selector still leads to manual mode, but what distinguishes when the primary voltage of the PLN appears the backup voltage. The generator also appears, then to activate and move the Genset backup voltage can by pressing the pushbutton button OFF / 0 then pressing pushbutton ON Generator, time the gap between manual shifts is 1-2 seconds.

3.4. Testing automatic mode
In this test, the selector is directed to automatic mode. When the voltage appears between the PLN, the Genset will immediately work.

3.5. Testing the automatic mode on PLN power
When the automatic testing process uses PLN power, the ATS system will work and activate the timer with a delay of 10-30 seconds.

3.6. Testing of automatic transfer mode of PLN power to genset power
When a failure occurs at the PLN power voltage, the AMF system will respond and work to give a signal to the Genset power voltage to immediately turn on or active pause. Time to generator starting around 1-5 seconds and the transfer process from PLN power to power Genset ranges from 5 seconds after the generator voltage is stable. The ranges time for genset starting (5 seconds) similar to research from [7]. Automatic transfer mode transfers the power of the PLN automatically when a blackout to the generator power with a delay time of 10-15 seconds.
3.7. Testing the automatic mode at PLN power back
When the generator power is supplying the load, then a few moments later the PLN power appears or re-ignites. In this Automatic process, COSM will immediately give priority current to the power of PLN supplying the load on the move. There is work from the timer as a return delay. The return time of PLN when the load is supplied by genset power for 10-30 seconds, and after the delay time is exceeded, the COSM operates on the ATS system will work to move the genset power to the PLN power as the power priority which a displacement delay of 1-2 seconds. After the transfer between the generator power to the power of the PLN, the ATS system instructs the power of the generator to turn off by giving the engine cooling time for 60-120 seconds. The other result needs the average time to cool down is 20 seconds faster than this experiment, because of the experiment only for a local emergency in a small area.
The fuel used by the generator in this experiment comes from fossils, where fossils contribute to the Abiotic Depletion Potential (ADP fossil) [11]. For this reason, special attention needed as happened in recent years, the trend of research is making generators that have fuel from the environment and are renewable because of low cost and cleanliness [12]. The examples are electric heat pumps [12], liquid dielectric and double layer effect [13], and an efficient polymer [14] with these examples, it is expected that there will be an ATS generator that is from the environment and are renewable.

4. Summary
ATS can detect a failure when the main power is lost, extinguished and low voltage. ATS can give commands to Genset power to start when a failure, blackout or loss of PLN voltage occurs. ATS successfully transfers automatically when the power of the PLN experiences a blackout to move to the generator power with a delay time of 10-15 seconds. Then managed to transfer between the generator power to the power of the PLN when the PLN returned to normal with a 1-2 second pause and managed to turn off the generator when the power load has been backed up again by the PLN power.

References
[1] Azeem M Q, Rehman H U, Ahmed S, and Khattak A 2016 Design and analysis of switching in automatic transfer switch for load transfer 2016 International Conference on Open Source Systems & Technologies (ICOSSST)
[2] Hammons T J, Barroso L A, and Rudnick H 2011 Latin America: market mechanisms and supply adequacy in power sector reforms Energy Systems 2(1) pp 83-111
[3] Taufer J 2006 Emergency Power Supply Systems Codes, Standards, and Compliance Issues Square D Company pp 1-59
[4] Cutnell J D, Johnson K W, Young D, and Stadler S 2017 Physics (New Jersey: Wiley)
[5] Hotchkiss R W 2014 Surge Protection of Automatic Transfer Switches – Application Note Conference: 2014 IEEE Power & Energy Society General Meeting pp 1-4
[6] Baker L and Phillips J 2018 Tensions in the transition: The politics of electricity distribution in South Africa Environment and Planning C: Politics and Space 37(1) pp 177–96.
[7] Saracin C G, Saracin C G, and Zdrentu D 2013 Experimental Study Platform of the Automatic
Transfer Switch used to Power Supplies Back-Up *The 8th International Symposium on Advanced Topics in Electrical Engineering*

[8] Hasanah R N, Soeprapto S, and Adi H P 2018 Arduino-based Automatic Transfer Switch for Domestic Emergency Power Generator-Set A must for an area with frequent electricity service interruption *Information Management, Communicates, Electronic and Automation Control Conference (IMCEC 2018)*

[9] Agbetuyi A F, Adewale A A, Ogunluyi J O, and Ogunleye D S 2011 Design and construction of an automatic transfer switch for a single phase power generator *International Journal of Engineering Science 3(4)*

[10] Ransom D L 2013 Choosing the Correct Transfer Switch *IEEE Transactions on Industry Applications 49(6)* pp 2820-4

[11] Atilgan B and Azapagic A 2015 Life cycle environmental impacts of electricity from fossil fuels in Turkey *Journal of Cleaner Production 106* pp 555-64

[12] Dennis K 2015 Environmentally Beneficial Electrification: Electricity as the End-Use Option *The Electricity Journal 28(9)* pp 100-12

[13] Huynh D H, Nguyen T C, Nguyen P D, Abeyrathne C D, Hossain Md. S, Evans R, and Skafidas E 2016 Environmentally friendly power generator based on moving liquid dielectric and double layer effect *Scientific Reports 6* 26708

[14] Xu T, Ding X, Huang Y, Shao C, Song L, Gao X, Zhanga Z, and Qu L 2019 An efficient polymer moist-electric generator *Energy Environ. Sci. 12*(3) pp 972-8