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Design of Multi Power Supply Switching System in Move Nucleic Acid Examination Lab

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Abstract

Existing mobile cabin nucleic acid laboratory hybrid power supply switching is not timely enough, there is a problem of poor electrical safety. A multi-source hybrid power supply switching system for the cabin nucleic acid laboratory is proposed, including the standby power supply switching module, the power generation switching module, and the municipal power supply switching module. The standby power supply switching module includes the standby power supply partition unit, the standby power supply switching analysis unit, and the standby power supply switching control unit. The standby power supply partition unit is used for the partition power supply of the standby power supply, and the standby power supply switching analysis unit is used to analyze the power consumption of the laboratory, and the partition power supply results of the standby power supply are obtained by processing. The switching control unit of standby power supply is used to control the partition power supply of standby power supply according to the partition power supply results of the switching analysis unit of standby power supply, which can judge the switching of hybrid power supply in detail, so as to ensure the timeliness of power supply switching access and improve power supply security.

Keywords

Mobile Shelter Nucleic Acid Laboratory; Multi-power Supply; Power Supply Switching System.

1. Introduction

Nucleic acid laboratories should have the conditions of biosafety level II and above and PCR laboratories. According to the relevant standards, laboratory power supply needs at least two or more power supply, and equipment power supply[1-2]. The laboratory is equipped with a large number of nucleic acid extractors and PCR amplification instruments, and the electricity demand is large[3-4]. Mobile nucleic acid laboratory is usually powered by diesel power generation, municipal power generation and battery hybrid power supply due to its use environment in remote areas[5]. In the existing technology, in the process of hybrid power supply by multiple power sources in the square cabin nucleic acid laboratory, the switching access control of multiple power sources is not timely and reasonable, resulting in lagging power supply switching and affecting the normal electricity safety of the laboratory.

2. System Overall Design

The multi-power hybrid power supply switching system of the mobile shelter nucleic acid laboratory includes the standby power supply switching module, the power generation

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switching module and the municipal power supply switching module. Generally speaking, the mobile nucleic acid laboratory is usually set on the mobile vehicle[6]. If there is municipal power supply in the parked detection area, the municipal power supply is preferred, because the municipal power is relatively stable and the power reserve is sufficient, and the standby power supply belongs to the basic supply unit, which is the basic power supply unit to ensure the power consumption of the laboratory. Power supply is used when there is no municipal power supply and the reserve power supply is insufficient. The overall structure of the system is shown in Fig. 1.

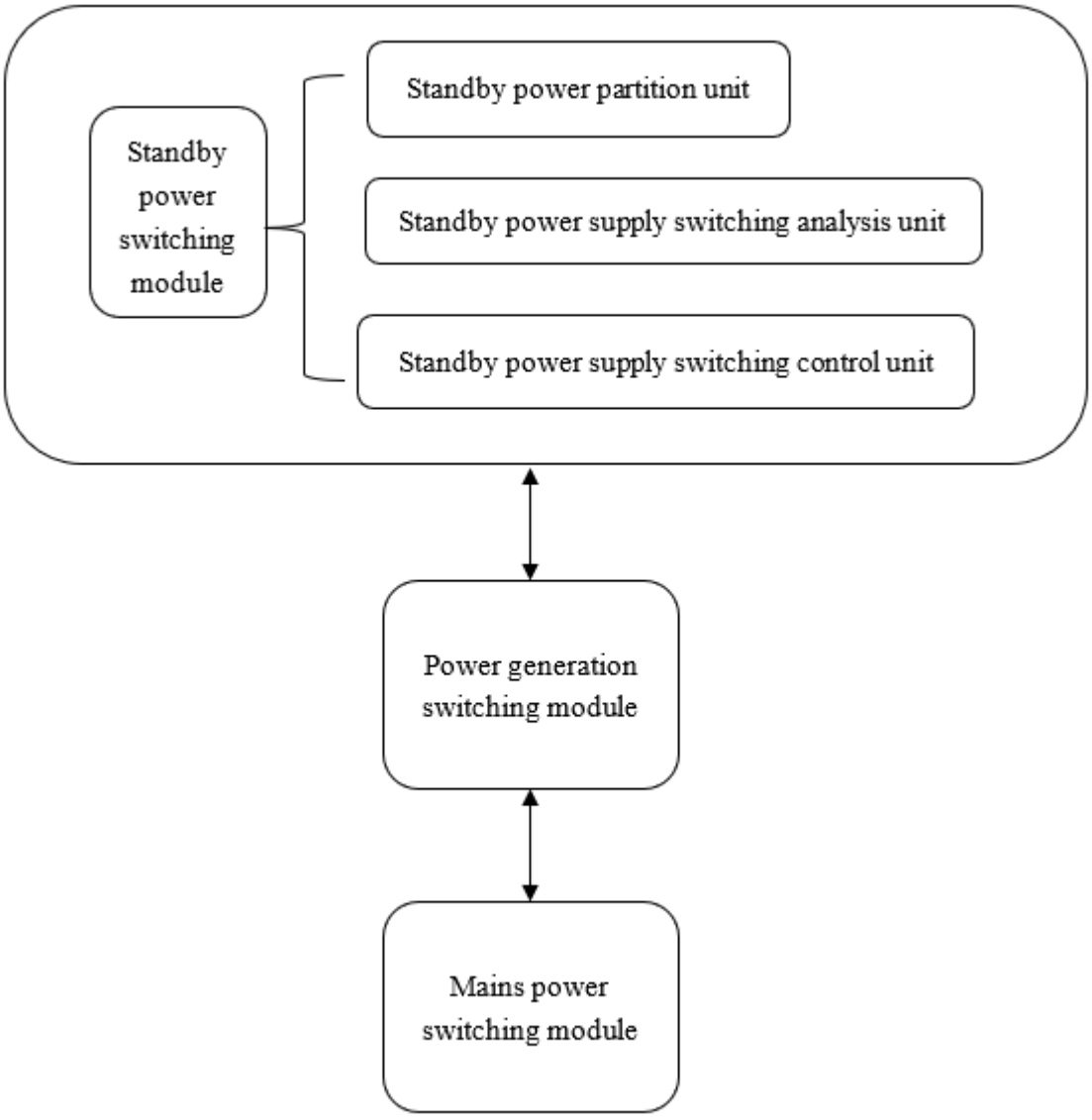

Figure 1. Overall structure of the system

3. Design of Standby Power Switching Module

As shown in Fig. 2, the standby power switching module includes the standby power partitioning unit, the standby power switching analysis unit and the standby power switching control unit. The standby power partitioning unit is used for partitioning the standby power supply, and the standby power partitioning unit is equipped with the standby power partitioning strategy. The standby power partitioning strategy includes : dividing the standby power supply into the common power supply area and the standby power supply area, and the energy storage capacity of the common power supply area is greater than that of the standby

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power supply area. Then connect the common power supply area to the distribution cabinet of the laboratory, connect the standby power supply area to the standby power switching control unit, and connect the standby power switching control unit to the distribution cabinet of the laboratory. In general, the output voltage and current of the standby power supply are stable. If the electricity is sufficiently stored, the standby power supply is preferentially selected for power supply. The system divides the standby power supply into districts, which can add a layer of protection on the basis of the standby power supply and can be used for emergency use in emergency situations. The commonly used power supply area belongs to the commonly used power supply unit, and the standby power supply area is used for emergency use, further ensuring the basic electricity safety of the laboratory.

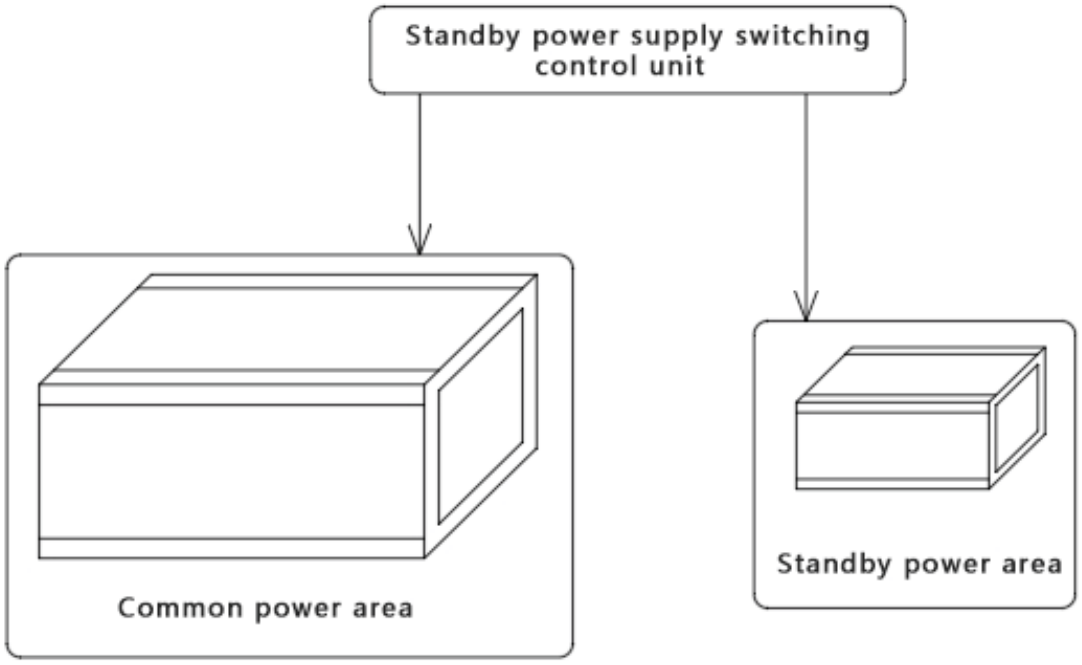

Figure 2. Standby Power Supply Switching Module

4. System Switching Control Strategy

In the process of using the common power supply area and the standby power supply area, we do not blindly pursue the priority of using the common power supply area, nor do we have to use up the power of the common power supply area before starting the standby power supply area[7-8]. If the power consumption of the laboratory increases sharply at a certain stage, and the power reserve of the common power supply area is not very large, it is not necessary to use up the power of the common power supply area before starting the standby power supply area. Because the capacity of the common power supply area is large, the range of power fluctuation that can be borne is large, and the charging speed of the common power supply area is also fast when it is not powered. At this time, stop the common power supply area and start the standby power supply area, It can provide a sufficient charging time for the common power supply area, so as to provide guarantee for subsequent power consumption. The specific scheme is as follows: the standby power supply switching analysis unit is used to analyze the power consumption of the laboratory and process the partition power supply results of the standby power supply, and the standby power supply switching control unit is used to control the partition power supply of the standby power supply according to the partition power supply results of the standby power supply switching analysis unit. The standby power supply switching analysis unit is configured with a standby power supply switching analysis strategy,

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which includes: obtaining the power consumption of the laboratory once every interval of the first power consumption time, and then substituting the obtained power consumption of the first power consumption times and the remaining energy storage in the common power supply area into the power consumption fluctuation trend formula to obtain the power consumption fluctuation index; When the power fluctuation index is less than or equal to the first power fluctuation threshold, continue to use the common power supply area for power supply; When the power fluctuation index is less than or equal to the second and greater than the first, continue to use the common power supply area for power supply and charge the common power supply area; When the power fluctuation index is greater than the second power fluctuation threshold, the standby power supply area is controlled by the standby power supply switching control unit to supply power, cut off the power supply of the common power supply area, and charge the common power supply area.

The power consumption fluctuation trend formula is:

$$R_{ydb}=\frac{C_{cy}\times c_1}{\left(D_{y_2}-D_{y_1}\right)+\cdots+\left(D_{y_n}-D_{y_{n-1}}\right)};$$

Where, R_{ydb} is the power consumption fluctuation index, C_{cy} is the residual energy storage of the common power supply area, c_1 is the energy storage fluctuation conversion coefficient of the common power supply area, where, c_1 refer to the setting of the proportion of the common power supply area in the whole standby power supply switching module, and the value of c_1 is greater than zero, D_{y_1} to D_{y_n} is the first obtained laboratory power consumption to the nth obtained laboratory power consumption, and n is the first power consumption times.

When there is a large demand for electricity, it is necessary to enable the power generation or municipal power supply at this time, and the municipal power supply is preferred. At this time, the power generation switching module is used to control the generator for switching power supply, and the municipal power switching module is used to control the municipal power for switching power supply. The generation switching module and the utility switching module are configured with a priority switching strategy. The hybrid switching strategy includes: when the laboratory has both the utility switching module and the generation switching module, the power supply analysis of the standby power switching module is carried out. When it needs to switch other hybrid power supply modules, the utility switching is preferred to be connected to the distribution cabinet of the laboratory. When the laboratory only has the generation switching module, Analyze the power supply of the standby power supply switching module, and then use the generator switching to connect to the distribution cabinet of the laboratory according to the analysis results.

There is also a certain reference for the switching of power generation and municipal power supply. It needs to be accessed when the power in the standby power supply area decreases rapidly and the storage of power is insufficient. The power generation switching module and municipal power switching module are configured with switching access analysis strategy. The switching access analysis strategy includes: when the standby power supply area is used for power supply, the remaining energy storage in the standby power supply area is obtained at the first residual power detection time every interval, The remaining energy storage in the standby power supply area of the first residual power detection times is substituted into the switching access index formula to obtain the switching access index; When the switching access index is less than or equal to the first switching threshold, continue to use the standby power supply area for power supply; When the switching access index is less than or equal to the second switching threshold and greater than the first switching threshold, the common power

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supply area is evaluated and the secondary switching access strategy is adopted; When the switching access index is greater than the second switching threshold, the power generation switching module or the municipal power switching module is used to connect to the distribution cabinet of the laboratory.

The formula of switching access index is configured as:

$$R_{tq}=\left[\left(B_{cy_2}-B_{cy_1}\right)+\ldots+\left(B_{cy_m}-B_{cy_{m-1}}\right)\right]\times\left(B_{cy_m}+b_1\right)$$

Among them, R_{tq} is the switching access index, B_{cy_1} to B_{cy_m} is the remaining energy storage in the standby power supply area obtained for the first time to the remaining energy storage in the standby power supply area obtained for the m time, m is the first residual power detection times, and b_1 is the compensation value of the remaining energy storage in the standby power supply area obtained for the m time. Among them, b_1 refer to the setting of the proportion of the standby power supply area in the standby power supply switching module, specifically, it is greater than zero.

Specifically, in the process of hybrid power supply switching, it is also necessary to evaluate the charging condition of the common power supply area. When the charging condition of the common power supply area is good, the common power supply area can be enabled again, so as to improve the stability of power supply. The secondary switching access strategy includes: substituting the remaining energy storage and charging speed of the common power supply area and the switching access index into the secondary switching formula to obtain the common power supply area access index; When the access index of the common power area is less than or equal to the first common access threshold, continue to charge the common power area; When the access index of the common power area is greater than the first common access threshold and less than or equal to the second common access threshold, switch the power distribution cabinet connected to the common power area to the laboratory, and continue to charge the common power area; When the access index of the common power area is greater than the second common access threshold, switch the power distribution cabinet connected to the common power area to the laboratory. The secondary switching formula is:

$$R_{cj}=\frac{R_{tq}}{C_{cy}+V_c\times v_1}$$

Where, R_{cj} is the access index of common power supply area, is the charging speed, V_c is the conversion coefficient of charging speed and charging amount, and v_1 is set with reference to the specific charging speed of common power supply area.

5. Conclusion

The existing hybrid power supply switching in the laboratory is not timely, and the power safety is poor. It is studied that the partition power supply of the standby power supply is carried out through the partition unit of the standby power supply, and then the power consumption of the laboratory can be analyzed through the partition power supply analysis unit of the standby power supply, and the partition power supply results of the standby power supply can be obtained, Then, the standby power supply switching control unit can control the partition power supply of the standby power supply according to the partition power supply results of the standby power supply switching analysis unit, so as to improve the timeliness of the standby power supply switching and ensure the safety of basic power consumption in the laboratory; Through the power generation switching module, the generator can be controlled

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to switch power supply, and then through the municipal power switching module, the municipal power can be controlled to switch power supply. On the basis of ensuring the safety of basic power supply, the power generation switching and municipal power switching are added to further improve the comprehensiveness of hybrid power supply and ensure the power safety of the laboratory.

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