Green Upgrade: Research on the Renovation and Reconstruction Engineering of Traditional Data Centers

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Abstract—The traditional data center built in the early stage has gradually no longer adapted to modern green requirements and performance requirements, so it needs to be updated. This paper takes a data center in Shanghai, China as an example, through the author's practical engineering research, summarizes the engineering measures of transforming a traditional data center into a modern green data center, and proposes the update of the ceiling, ground, wall, air, waterproof and fire protection system in the data center. Suggestions for renovation.

Keywords-Data center; Renovation; Engineering measures

1 Introduction

With the vigorous development of modern science and technology, information technology has penetrated the lives of residents, the construction of data centers has increased exponentially, and the energy-saving measures of data centers have been iteratively increased. Due to the limitations of equipment and technology, the traditional data centers built in the early days have gradually become outdated equipment with high energy consumption and low performance. Therefore, the renewal and transformation of data centers has gradually attracted the attention of the academic community. Scholars such as Weerts updated the cooling system of the data center and found that a properly transformed data center can reduce cooling energy consumption by 70%-90% [1].

At present, the upgrading of traditional data centers mainly focuses on the transformation of cooling systems. Many scholars have proposed a natural cooling system that uses outdoor ambient temperature to assist data center cooling [2-3]. Scholars such as Battaglia proposed three measures for the transformation of traditional data centers, including installing hot aisle insulation shells, increasing indoor temperature, optimizing the installation location of cooling systems, etc. [4]. Scholars such as Choo proposed to reduce air conditioning units, increase return air temperature, and increase cooling. Four measures such as channel enclosures and implementation of natural air cooling are used to transform traditional data centers [5].

To sum up, in the current research on data center renewal, because the cooling system is one of the main energy-consuming equipment in the data center, it is the focus of the academic community. The research on the renewal of cooling system has been very mature, but for data There are few research on another environmental optimization of the center. This research

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focuses on 6 major engineering optimization directions other than the cooling system, and supplements other projects that are currently neglected in the renewal and transformation of the data center.

2 Current characteristics and function planning

A data center in Shanghai is in Pudong New District, Shanghai. It was built in 2008 and has a total area of about 2,000 ㎡. With the deepening of modern informatization and the continuous expansion of the information business of enterprises, traditional equipment can no longer meet the current business needs. Therefore, it is necessary to replace equipment in its data center to meet the requirements of new equipment in load, power consumption, energy saving, and environmental protection. Waiting for demand. The renewal and reconstruction of the data center of this project is divided into the following 6 items.

2.1 Ceiling project

Considering the technical requirements of the computer room and the height requirements of the computer room, the ceiling of the central computer room is prioritized for optimization to save construction costs. First, paste thermal insulation cotton on the upper part of the ceiling to prevent moisture, dust, and heat preservation. Secondly, use all-aluminum-plastic sprayed microporous ceiling at the lower part, which has the functions of fire-proof, moisture-proof, easy-to-clean and noise reduction.

In terms of material selection, metal anti-static suspended ceilings are used. It not only has the advantages of low price and high quality, but also has the characteristics of high flatness and uniform color. To keep the style of the lamps consistent with the metal ceiling, the lighting system uses grating lamps, and the lamps are evenly distributed on the ceiling, which has the effect of coordinated decoration.

In addition, in the specific construction process, the ceiling part needs to be waterproof and leak-proof. After the overall construction of the ceiling is completed, a layer of dust-proof paint can be applied to ensure that the foundation of the ceiling does not accumulate dust. In addition, the ceiling and the wire ducts on the upper part of the ceiling should be grounded to prevent electrostatic dust collection. Due to the traditional data center with open refrigeration system, in the air exchange process, tiny dust will be exposed in the space of the entire host room, which has the risk of hiding dirt and affecting the safety of the working and operating environment of the host room. Therefore, in the ceiling project Dust-proof design is added to reduce the impact of dust pollution.

2.2 Ground Engineering

According to the needs of the construction of the data center of this project, the anti-static floor adopts all-steel anti-static materials. The anti-static floor is made of steel plate, which has high durability. At the same time, it also has the functions of fire prevention and moisture resistance. In addition, the surface adopts imported antistatic paint, which has a good antistatic effect. And the matching precision of the borderless floor is high, which avoids the gap between the floor connections and prevents the floor from hiding dirt (Fig.1).

During the construction of the anti-static floor of the data center, the ground needs to be pre-treated. First, the floor of the computer room should be flat to prevent dust and humidity, then start to paint moisture-proof paint to prevent dampness and mildew, then paint anti-static cement paint, and finally lay insulation cotton on the ground, which can effectively serve as the floor of the data center. Heat preservation, heat insulation, and moisture resistance, then install a layer of galvanized steel plate on the thermal insulation layer, then complete the equipotential grounding copper bar construction on the galvanized steel plate, and finally complete the installation and fixation of the elevated antistatic floor and the equipment load-bearing base. To the functions of anti-seismic, fireproof, clean, equipotential, and shielding, in addition, color spraying protection is carried out in the cold and hot aisle areas, and visual management signs are realized by color distinction.

Fig.1 Data center ground engineering construction (Image source: taken by the author)

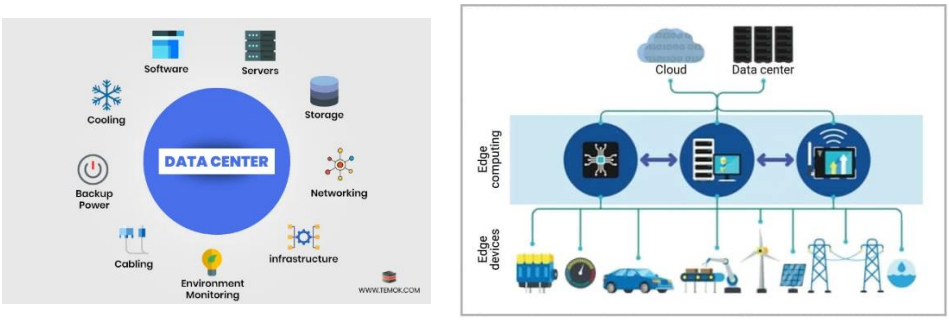

Fig.2 Data Center Workflow and Principles (Image Source: https://www.colocationamerica.com/blog/different-types-of-data-centers)

The elevation of the floor is 500 to 600 mm. There is enough space under the floor to form a static pressure cabin and a sound-absorbing air distribution duct, which is combined with the design and construction of the power supply and distribution system to facilitate the laying of strong and weak electricity, fire protection and other pipelines. Related electrical facilities. In addition, a waterproof socket for the computer room is newly added on the floor, dedicated to terminals and other equipment, which can be opened or closed at any time to ensure

convenient and safe use, and overcome the shortcomings of the previous wiring flipping the floor.

2.3 Wall engineering

The wall of the traditional data center is based on gypsum board, and the wall needs to be optimized, including wall treatment, plastering, and sound-proof mask treatment. The wall surface should be maintained with dust-proof paint, moisture-proof paint and waterproof paint, etc., and then 40 mm thick aluminum foil glass fiber insulation cotton is used on the inner wall of the wall. The plastering paint needs to be smeared with sand or cement mortar on the surface of the walls and pillars of the building to make the interior of the building smooth, and to enhance the performance of heat preservation, heat insulation, sound insulation, dust resistance, etc., and finally add terrazzo and terrazzo on the surface, Spraying and other materials and processes. The soundproof wall is mainly processed by the color coated steel plate around the main computer room of the data center. Due to the high cleanliness requirements of the data center computer room, this project adopts color-coated steel plate decoration, which has the function of moisture-proof and moisture-proof and can also have a good protective effect on the wall in a humid environment.

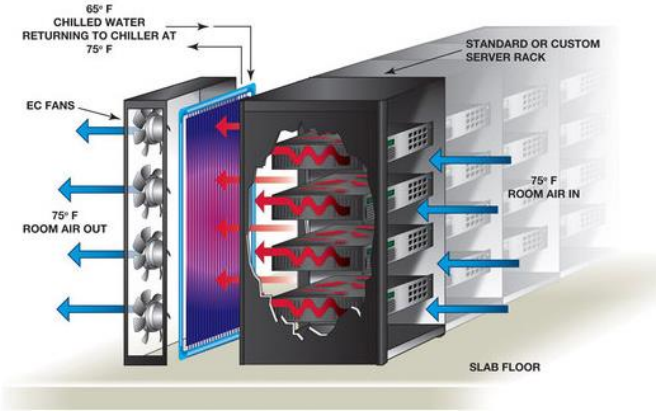

Fig.3 Data Center Design & Operation for Efficiency (Image Source: Strategic Media Asia (SMA))

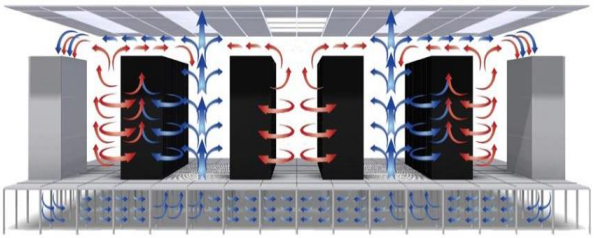

Fig.4 Air engineering (Image Source: HVAC Systems)

2.4 Air engineering

In terms of air purification design, based on the principle of air pressure difference, a positive pressure fresh air system was designed to isolate the dust from entering the room from the outside. First, the positive pressure fresh air system is used to make the indoor air pressure 9.8Pa higher than the outdoor air pressure, effectively isolating the dust, and the fresh air dust filtering efficiency is controlled above 70%. Secondly, the return air volume of the precision air conditioner is controlled at 16,200 m^3/H. Under the specific conditions of the amount of dust in the urban atmosphere, the return air volume of the air conditioner used in this project can filter indoor air more than 85 times per hour. When the air circulation cycle of the air conditioner is 20 times/H, the dust filter of the precision air conditioner The efficiency reaches more than 95%, and the dust content in the computer room can be controlled at a level.

2.5 Waterproof works

Usually, the cause of water leakage in the data center computer room is the leakage of condensate water from the air conditioner and the water seepage from the floor. The solutions to these two situations are: prevent the fresh air from condensing due to temperature differences. The fresh air in the machine room area is directly introduced from the outdoor atmosphere. In the high temperature and high humidity season, when the incoming fresh air reaches 23 ℃ ± 2 ℃ in the equipment room, a small amount of condensed water will be generated. To solve this phenomenon, fresh outdoor air can be introduced into a new fan. After the new fan is pressurized, the air duct leads to the upper return air outlet of the air conditioner. The fresh air flow and return air flow passing through the air conditioner are simultaneously used for temperature adjustment, humidity adjustment and dust removal through the air conditioner, and then sent into the room space by the large air flow of the air conditioner, for example, a little water is generated, which accumulates in the "water basin" of the air conditioner body, and discharged to the outside through the air-conditioning drain pipe. Prevent water leakage due to damage to the humidifier of the air conditioner, the inlet and outlet pipes.

Install a thermal insulation layer on the floor of the precision air-conditioning area to buffer the temperature difference between the upper and lower floors. Secondly, the environmental monitoring system is used to establish an automatic water leakage monitoring system on the ground of the air-conditioned room. It can monitor the ground water leakage in real time and prevent accidents caused by pipe rupture and water leakage in time. More importantly, set up 100mm high waterproof ground ridges around the computer room and around the precision air conditioner host. After a water leakage accident occurs, the computer room has a certain redundancy mechanism, and a certain amount of time is reserved for maintenance personnel to repair in time. Install waterproof baffles at the entrance of the equipment room to prevent other external floods or accidental water sources from fire pipes from entering the equipment room and causing flooding.

2.6 Fire Engineering

The redundant disaster system of this project is mainly controlled by automatic and manual methods:

1. Automatic start mode. Under normal circumstances, the fire extinguishing system maintains

automatic operation. In the event of a fire, the temperature monitor and the smoke detector will simultaneously transmit the fire alarm to the fire alarm, light alarm, fire extinguishing controller, etc. and automatically correspond to the equipment. Among them, the sound alarm and light alarm are helpful to remind people to evacuate. At the same time, the system automatically cuts off the power supply system of the non-redundant system and enters the countdown to start the fire extinguishing device, leaving a certain time for the staff to evacuate. After the countdown, the gas fire extinguishing system was quickly activated, releasing heptafluoropropane to extinguish the fire. At the same time, light up the warning lights at the entrance of the data center to prevent personnel from entering by mistake.

2. Manual start mode. When the data center is under maintenance, in order to prevent accidentally touching the fire alarm system, it can be set to manual start mode. When a data center fire occurs, it is necessary to manually press the button of the gas fire extinguishing control panel to enter the countdown to prepare for the fire. If there is an emergency, you can break the glass cover of the emergency fire extinguishing system button outside the data center to activate the emergency fire extinguishing in time under the condition that there are no staff in the data center.

3 Conclusion

Through the practice and application of six projects for the renovation and renovation of traditional data centers, this research has expanded the direction and ideas of traditional data center renovation. As the problems of traditional data centers are revealed, there are more parts that can be renovated in the future can be further explored and researched.

In recent years, in response to national policies, many computer rooms have continuously reduced their average annual energy consumption to the level of second-class energy-saving computer rooms. In the context of promoting smart city development goals, the concept of "green" has also been implemented in all key links of data center planning and design, equipment procurement, computer room construction, and daily operation and maintenance. It can not only assess and constrain the operation and maintenance department to achieve a continuous reduction in energy consumption index, but also ensure that every aspect of the design and construction of the data center is fully emphasized. Through continuous digging and improvement of the specific design details of the data center, the concept of a green data center is finally realized. Continue to reduce the energy consumption of the data center, and even fundamentally reduce the operation and maintenance costs of the data itself, thereby alleviating the economic burden of information technology and accelerating the construction and popularization of smart cities.

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