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A Study on Emergency Power Systems in Hospital Buildings during Massive Power Outage to Ensure Maintenance of System Functions

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Abstract. The damages caused by natural disaster are unpredictable. It is almost out of control because its scale is entirely different from what we have experienced before. Natural disaster of climatic change is getting force. The effects of the disaster like flood block the energy supply route which is the municipal Lifeline. This is very dangerous and causes states of emergency. The blackout occurred in September 2011 showed that it causes extensive damage to the whole society. Especially important facilities like hospitals even suffer worse situations which cause casualty. This study selected twelve hospitals in Daegu city and inspected the selection of hospitals on power supply installation status, energy load model which we compared to the emergency power standards by a literature search. Considering the current equipment status and management status of the hospital buildings, we offer some suggestions for emergency maintenance functions.

Keywords: Blackout, Emergency Power Supply, Hospital Buildings

1 Introduction

In the Republic of Korea, a massive power outage occurred in September 2011, illustrating just how catastrophic the ramifications of such incidents can be to the society in general. The impact of any blackout can be fatal, with those buildings playing an important part in cities, such as national security facilities, social infrastructure, financial facilities, communication facilities, research institutes, and hospitals. Any problem with power supply can lead to social confusion as well as significant economic damages. Problems with power supply in large general hospitals are particularly risky in that such problems can lead to the failure of systems that are directly associated with life support. Hence, a technological base is indispensable for ensuring stable power supply during emergencies. This study examined, through field

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investigation, the actual conditions of large general hospitals' energy consumption and the status on their establishment of emergency power systems. Based on such investigation, analysis was made of the ways to establish emergency power systems capable of maintaining properly the functioning of hospital buildings and providing effective response during massive blackout.

2 Emergency Power Systems in Hospital Buildings

Major civic buildings refer to those having facilities or systems that are essential in managing cities and citizens' leading their social lives. Among such buildings, hospitals are particularly important in terms of functionality because they are intended for saving lives with their life supporting systems and operating systems. As shown in Fig. 1, power systems were found to be the most important facilities among the ones considered particularly important not only in hospitals but in major civic buildings as well.

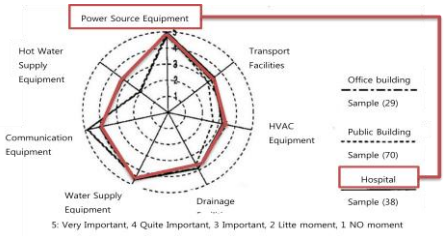

Fig. 1. Importance of power systems in hospital buildings during emergency

3 Analysis of Status on Surveyed General Hospitals' Electrical Load and Emergency Power Systems

3.1 Status on surveyed hospitals

For the purpose of this study, an investigation was made of 12 general hospitals located in Daegu Metropolitan City (Republic of Korea). Among the 12 hospitals, the data from seven hospitals feasible for analysis were examined. Table 1 summarizes the surveyed hospitals' facilities and the status on their power systems.

Results from the surveys show that the subjects (hospitals) had installed an emergency power system such that 33% of the subjects used only self-powered generating systems and UPSs, another 33% of the subjects used self-powered generating systems and UPSs along with backup power supply systems, with other cases counting for the remaining subjects (i.e., 17% each).

Table 1. Summary of surveyed hospitals and status on their power systems

Hospital	Year	Height of Buildings	Total floor aea(㎡)	Self-power generation system	Storage battery	Backup power supply system	UPS
A	1907	11	95642	12h/4163KW	-	2 line continue /8900KW	30m/1275KVA
B	1983	16	79000	15h/7900KW	6m/120V-200AH	Continue /9500KW	24m/450KVA*5
C	1980	12	66965	6h/1135KVA	10m/400AH	-	30m/250KVA
D	1983	9	61799	10h/1750KVA	-	2 line continue /5100KW	
E	2011	8	7436	24h/260KW	-	-	
F	1991	9	11946	4h/290KW	-		
G	1999	14	80900	None			

When calculated, the mean operation time of all the emergency power systems installed at the surveyed hospitals (excluding their backup power supply systems) was 12.36 hours. This figure is above what is required by the laws. For this number being slightly above the legally required level, the time would not be enough considering a period of power-grid recovery in case of power outages caused by massive disasters.

3.2 Analysis of electrical load at general hospitals surveyed

In order to identify the conditions under which emergency power supply systems can be operated efficiently during emergency, the amount of energy consumed in the surveyed hospital buildings was investigated, and the investigation was followed by a multi-faceted analysis of the electrical load models of the hospitals.

The monthly power consumptions at the hospitals from 2010 and 2012 were divided by the total floor area of the hospitals to obtain the estimated amount of power consumption per unit area. The analysis showed that the per-unit-area power consumption taking seasonal conditions into consideration was greater in summer when air conditioner overloads occur than winter when heater overloads occur more frequently. In spring and autumn when the air conditioner and heater overloads are relatively less frequent, the power consumption was found to be low. The analysis of time-specific electrical load for the year 2012 revealed different patterns as shown in Fig. 2. Similar patterns were found on a weekly basis, with peak load usually occurring at around 3 in the afternoon.

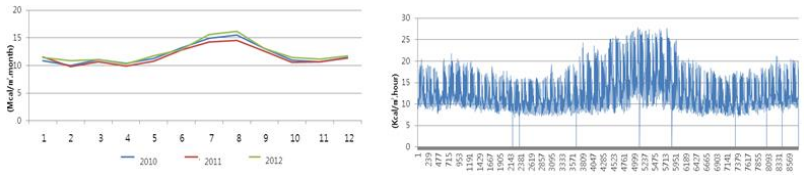

Fig. 2. (a)Year, month and (b)time-specific patterns of electrical load

4 Conclusion

According to the previous studies on the importance of civic buildings during emergency, hospitals were found to be the most important (except for fire station and police station). As for buildings, power systems were rated the most important facilities. The mean operation time of the surveyed hospitals' emergency power was calculated as 12.36 hours, which is greater than the legally required. This figure, however, is significantly lower than 50.7 hours which was proposed by other Korean studies or 120 hours, the corresponding figure from Japan. Analysis of the general hospitals' energy consumption revealed that more power was consumed in summer, winter, spring and autumn, in this order, with summer showing the highest power consumption and autumn the lowest power consumption. According to the analysis of time-specific power consumption, the largest power consumption occurred during outpatient service hours in normal weekdays.

Results of comparison of the electrical load in the surveyed hospital buildings provided information on seasonal patterns, periodicity on a weekly basis, difference in energy consumption during weekdays vs. weekends, and the peak hours of the day.

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