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Integration of Building Services in Intelligent Buildings

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Abstract—*Building services has always been a vital aspect of building design. Functions of these services are so essential that without them building seems to be incomplete and non-functional. Electrical System, Fire and Safety system, Heating, ventilation and air conditioning system and Plumbing systems make a building safe and fully functioning.*

In intelligent buildings, a centralized system monitor and control all the subsidiary services and integrates these different services to provide a singular control system to achieve better human comfort. Building Automation can centrally control building's HVAC, Lighting and other systems. The key component in a BA is BAS (Building Automation System) or BMS(Building Management System) is a small, specialized computer with various applications. Functions of Building Management Systems includes to create a central computer controlled method which has three basic functions mainly controlling, monitoring and Optimizing the building's facilities such as mechanical and electrical equipment for comfort, safety and efficiency.

This study will focus on integration aspects of various building services in Intelligent Buildings.

For example, integrating Fire fighting and HVAC system, we get an automated smokemanagement system which is very helpful at the time of building evacuation process.

(Keywords - Building Services, Building Automation System, Building Management System, Integrated Building Management System, Intelligent Buildings performance, Intelligent Technology)

Introduction

Intelligent Buildings are mainly composed of the Building Automation System (BAS), Communications Automation Systems (CAS) and Office Automation Systems (OAS). BAS core functionality keeps the building climate within a specified range, provides lighting based on an occupancy schedule, and monitors system performance and device failures and provides email and/or text notifications to building engineering staff. The BAS functionality reduces building energy and maintenance costs when compared to a non-controlled building. Building Automation System is the basic and important component in Intelligent Building. Building automation system is the use of computer and network technology, automatic control technology and communication technology to build a highly automated and integrated management and control systems, the interior of thebuilding control various devices connected to a network. Through its integrated network control these devices. The components and basic functions of building automation systems are often include air conditioning, lighting equipment, elevators, fire safety and prevention equipment, security equipment and other subsystems. It ensures the comfort and safety of the building's office environment, while achieving energy efficient requirements. The three basic functions of a central, computer-controlled BMS are: the building's facilities, mechanical, and electrical equipment for comfort, safety, and efficiency.(CUI Qingquan, 2014)

Intelligent buildings are buildings that through their physical design and IT installations are responsive, flexible and adaptive to changing needs from its users and the organizations that inhabit the building during its life time. The building will supply services for its inhabitants, its administration and operation & maintenance. The intelligent building accomplishes transparent 'intelligent' behaviour, have state memory, support human and installation systems communication, and be equipped with sensors and actuators.

Intelligent Buildings

Working Principle

The key processes involved in Intelligent Architecture are:

1. Input System that receives information by means of Information Receiver.
2. Processing and information analysis Performed in the building control system (BCS).BCS controls all systems as one unit and controls each system individually. It is the place where all systems integrate; it is called building system integrator (BSI).
3. Output System that reacts to the input in Form of a Response. Outputs of BCS are orders to the systems according to the decision.

These decisions form systems' responses and can take at least two different classes

- Internal Response is the class of response that covers all internal reactions and responses. An example of internal response is an intelligent structure that can react to wind load by internally changing its tension.
- External response is the result of internal responses formed according to processed information.

It can take two forms either Static or Kinetic.

a. *A static external response can be in form of temperature, visual, audio, or/and light change.*
b. *A kinetic response, is in the form of movement; example when a system decides to open or close a door.*

4. Time Consideration that makes the response happen within the required time.
5. Learning Ability.

Defined as a set of rules that increases probabilities of solving a problem. Ability to learn from experience. The ability to learn is very critical in case of fire and maintenance. Example: in a meeting room designed for 15 people the temperature is set at 75 Degree Fahrenheit. With the incoming of 20 people system resets the temperature to 65 Degree Fahrenheit. The user then sets the temperature at 55 Degree Fahrenheit. So the system should learn from this and maintain the temperature according to the previous experience

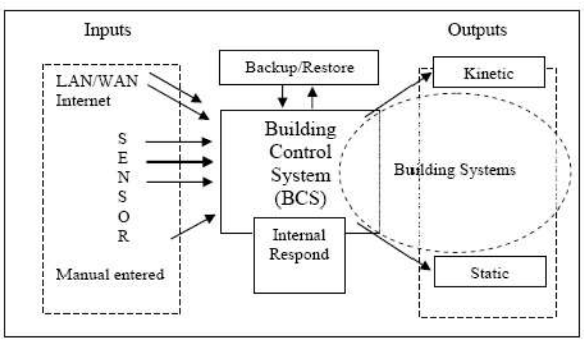

Figure 1 Intelligent System Architecture

Attributes of Intelligent Buildings

Intelligent buildings involves with technology which integrates various MEP services, network & telecommunication and security and life safety. This technology and network architecture performs various processes which altogether work as a whole system for any building envelope to make that building intelligent.

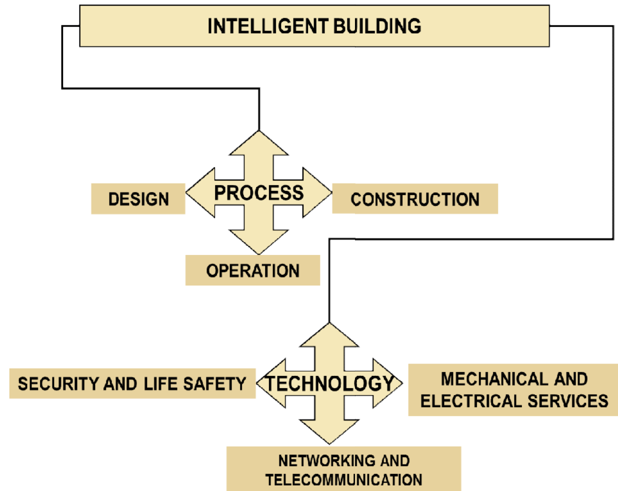

Figure 2: Network in Intelligent Building

Services to be integrated in any Intelligent Building

Fire Services and HVAC

In case of fire, by integrating fire fighting and HVAC system first thing which is found that an efficient smoke management system. An integrated smoke management system is a centrally monitored, operated and maintained system, in which building's HVAC system in integration with fire detection system works as a whole unit to manage the smoke evacuation process. A smoke control system is a system that is used to limit the migration of smoke within a building due to a fire. There are several methods to limit this migration, and some are designed to provide a tenable systems, or only mechanical systems to control the spread of smoke.

Dedicated and Non-dedicated systems

NFPA 92 Standard for Smoke Control Systems defines two types of smoke control systems: they are either dedicated or non-dedicated systems. Dedicated systems use equipment that is installed for the sole purpose of providing smoke control. Non-dedicated systems share components with some other systems, \such as the building HVAC system. A non- dedicated system changes the normal operation of the equipment to smoke control mode when a fire is detected. Dedicated systems typically are found where no other fans or dampers are used in the normal operation of the building, such as pressurization of stairwells or elevator hoist-ways. Non-dedicated systems are typically found where other equipment normally is installed, such as a HVAC system for climate control.

The following are Components of Smoke Management System

HVAC fan

HVAC system fans can be adapted to be used for smoke control purposes. There are several things to consider when using HVAC fans for smoke control:

- Make sure the motor and number of belts complies with minimum code requirements.
- The temperature rating of the fan needs to be adequate for smoke control use.
- Determine whether the fan has adequate capacity to deliver the performance criteria of the smoke control system, while operating at stable performance.

Smoke control fans are required to operate at elevated temperatures. This is especially true for exhaust fans because they exhaust air that has been heated due to the fire conditions in the space. Therefore, the code will require the fan to be rated for the probable temperature rise that can be expected. There are several ways to calculate the required temperature rating for the fan. The most common approach is to use the equations in the IBC or NFPA 92. These are based on the heat release rate of the fire and the exhaust rate. In certain conditions, this equation can produce high temperature rates that might not likely occur, especially in buildings with automatic sprinkler protection.

As noted above, one of the common issues associated with HVAC fans in smoke control systems is managing the airflow requirements for both uses. The required airflow for climate control may be more or less than that required for smoke control systems. Two-speed or variable-speed fans can be used to address this; however, the airflow rates must be within the overall range of the fan at stable performance.

Figure 3: HVAC Fan

Variable frequency drives

VFDs are typically designed with a touch screen or keypad that can accommodate VFD programming and controls. When the smoke control system is activated either automatically or manually at the fire-fighter's control panel, this keypad needs to be overridden and all control/programming functions disabled. In addition, the keypad may have an "off" feature. Although not required by code, it is recommended that the keypad be removed and stored in an approved location.

The variable frequency drive (VFD) is increasingly becoming a common component of modern smoke

Figure 4 Variable Frequency Drive

Smoke Dampers

Smoke dampers found in smoke control systems are generally located at smoke barriers or fireresistancerated walls. However, as defined they include any damper in the air distribution system, whether it is located in the field or at the unit. HVAC units often use control dampers to mix outside air, return air, and exhaust air. These dampers need to be configured when entering a smoke control mode to allow the system to perform under its expected operation. These dampers also need to be able to prevent the migration of smoke and, per NFPA 92 and IBC, be listed.

Figure 5: Smoke Damper

Ductwork

There is no real difference between ductwork in the distribution system used for HVAC and smoke control systems. The only changes are that the ductwork is required to be supported by fire-resistance rated structural elements using non-combustible supports. There is no specific requirement as to the type of material to be used, other than what is required for HVAC systems. Ducts can be made from sheet metal or can be made of drywall. Duct materials and joints are required by the IBC to be capable of withstanding the probable temperatures and pressures to which they will be exposed. They are required to be leak tested to 1.5 times the maximum design pressure. The designer needs to document the design pressure of the duct, which is often different than the fan static pressure. The measured leakage cannot exceed 5% of the design flow. While not specifically outlined in the code, leak testing is typically done only for exhaust systems that traverse other smoke zones to confirm they will not leak significant amounts of smoke when exhausting the fire zone. Ducts that are contained only within the zone or supply air systems do not have the potential to convey smoke outside of the initial zone. Therefore, it is typical to see the designer ducts traversing multiple floors to be leak tested, but not the portion of the duct that is isolated to the zone.

Another issue that has been encountered in the use of HVAC systems for smoke control is the use of ducts made of drywall materials. Leakage rates for HVAC systems may not be impacted for climate control the same as they are for smoke control. Experience has shown that when using dry wall ducts for smoke control systems, it is difficult at best to meet the leakage testing requirements. Often metal ductwork has had to be installed to replace the dry wall ducts to meet the leak testing. Therefore, metal ductwork should be used wherever possible to prevent impact by leak testing during commissioning of the system. Additional considerations should be taken when determining the location of exhaust/return fan discharge outlets and their associated fans. Fans used for exhaust in a smoke control or smoke removal system should not discharge at locations where the potential exists for reintroducing smoke into the building or any adjacent buildings.

Figure 6 Ductwork

Fire Alarm and Control System

A smoke control system requires input from the field to determine when to configure the system. This is done primarily through the fire alarm system's smoke detectors or monitoring of the building's automatic sprinkler system. When the fire alarm system detects one of these conditions, a signal is processed and the smoke control system is configured for its predetermined sequence for that zone in the building.

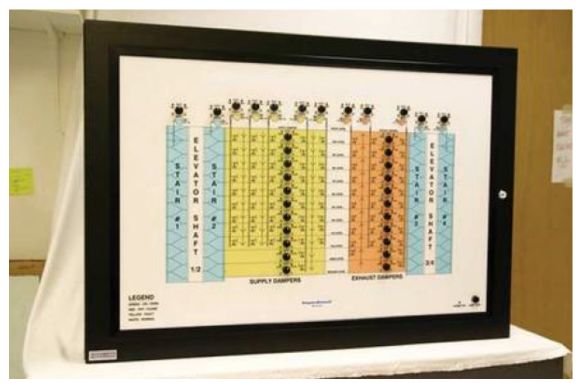

Figure 7 Fire Control System

Depending upon the control system concept employed, either the fire alarm system drives all sequences overriding the BAS or a handoff of signals occurs allowing the BAS to control all or a portion of the system. In a typical high-rise building, it is usually a combination of the BAS and fire alarm system controlling equipment.

Conclusion

In this study different components of Fire and HVAC services have been addressed. These two services integrates mainly to solve the smoke management issues in a building. Smoke management is become a priority in building's service part and needs to be dealt with precaution.

Many of other various service aspects such as plumbing with fire, telecommunication with fire and electrical with fire have not been covered in this study, which are also an essential part of any intelligent building's component. This study is limited to fire and HVAC services only.

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