**INTELLIGENT BUILDING MODEL/ SYSTEMS**

1. **HVAC**

 General

In Intelligent Buildings Systems the governing principle to be used in the selection of the HVAC system options must be to satisfy ventilation standards and occupant comfort control while optimizing, flexibility, energy efficiency and maintenance costs. An owning and operating cost analysis coupled to an energy simulation of each viable option is mandatory to determine the optimal HVAC solution. In intelligent buildings additional considerations must also address flexibility and modularity as well as state of the art Direct Digital Control (DDC ) Building Automation Systems to minimize future costs associated to tenant fit ups as well as incorporate centralized control to implement energy optimization routines, scheduling, monitoring and interface with other IB systems.

1. **All Office Buildings**

In new buildings or renovated buildings with sufficient ceiling space central VAV systems coupled to perimeter radiation heating remain the system of choice by designers because of their ability to diversify cooling loads, allow use of free cooling, building flushing and centralized maintenance. Unfortunately VAV systems present frequent drawbacks in terms of unreliable minimum outdoor air volume control and poor air diffusion patterns at the room or workstation level

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.1 Air Diffusion

The traditional VAV system design has been using VAV terminal boxes

with fixed diffusers to meet the individual room or work station load variations. Fixed diffusers are generally selected for the maximum air volume demand. At peak demand their air diffusion pattern generally performs as intended when not hindered by partitions or furniture. Under ideal conditions the cold supply air stream should theoretically blend with adjacent air and reach the occupant at tempered conditions . Too often partitions or furniture layouts (undefined at design time) create havoc with the intended air diffusion pattern. Furthermore when the air flow volume is reduced by more than 20 to 25% the intended air flow diffusion pattern no longer performs as intended and cold primary air is either “dumped ”directly on the occupant without going through the intended tempering process or, alternatively, it is short circuited directly to a return air grill due to reduced velocity. In either case the room occupant is negatively affected via excessive temperature variations, drafts or lack of air change because of the short circuiting. Since VAV systems, in our Canadian climate, operate at an average of 60 to 65% of peak capacity this problem becomes the rule rather than the exception.

A new technology involving the use of air jets coupled to “Personal

Environment Controllers” (PEC) is fast gaining credibility as the solution to VAV diffuser problems. The PEC concept was developed in the general context of Intelligent Building to provide occupants with full control over their particular office work station environment. PEC units allow the occupant to control temperature, air flow volume and direction as well as lighting through their local PC (where IB exists) or through hand held portable remote control units. In an PEC concept standard fixed position diffusers are replaced by one or more air jets strategically located to project cold air streams downward and away from the occupants. The occupant has control over the air volume and its direction.

Recent studies have also demonstrated that the use of Personal Environment Control (PEC) units at each Work Station in lieu of the traditional VAV terminals, with fixed diffusers, provides improved occupant satisfaction while maintaining the basic energy savings justifying the use of VAV systems in office buildings.

Other relevant studies have associated occupant satisfaction to productivity increases in the order of 1 to 3%. When factored into the cost to benefit analysis

this reported productivity increase can often help justify the use of the air jet option. This option deserves serious consideration in any Intelligent Building concept since it allows individual workers to adapt to their particular ambient environment, metabolism and preferences rather than be submitted to subjective average requirements dictated by international standards. This option can also compensate for air flow deficiencies associated workstation furniture and partition obstructions.

2 Minimum Air

The American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE) have documented, through numerous studies, that fixed minimum air damper positioning or supply and return fan flow tracking are inaccurate and unreliable techniques to control minimum outdoor air in VAV systems. VAV systems are used to supply cold tempered air which is modulated

via terminal units to track a building’s cooling load. In other words, as the cooling load decreases so does the VAV system’s air flow thus resulting in lower energy consumption through reduced fan horsepower and lower demands on the cooling or heating coils. In our Canadian climate, during occupancy hours, experience has shown that VAV air flow averages between 50 and 60% of peak design flow. ASHRAE studies have also confirmed that under these reduced air flow conditions fixed minimum air damper settings or supply and return fan flow tracking techniques cannot be relied on to insure that minimum outdoor air requirements are met.

Alternate control techniques such as resetting supply air temperature in VAV systems to artificially increase air volume defeats the basic principle of energy saving associated to the VAV system concept and often lead to reduced ambient temperature comfort particularly in interior zones. ASHRAE is now advocating the use of dedicated minimum outdoor air fans to insure that minimum air flow requirements are respected at all times.

1. Additional Considerations for Renovation Projects Additional selection considerations in retrofit or upgrade applications where limited ceiling or raised floor space availability precludes the possibility of integrating free cooling, dictate that HVAC terminal units integrating local heating and/or cooling coils be used to minimize distribution duct sizing. These terminal units use water to distribute heating or cooling energy to each terminal instead of air. Water requires approximately 50 times less volume than air to transfer an equivalent amount of energy.

4.Examples of terminal unit applications using water to transfer heating

and cooling energy to terminal units include:

•Closed loop water source heat pumps (WSHP),

•Fan coil units,

•Fan powered variable air volume (VAV)

•Powered terminal units terminal with integrated reheat or re-cool coils.

These terminal units, however, still require parallel central air units to supply outdoor air to individual rooms. The parallel air system and its distribution ductwork, however, are much smaller since they are sized to satisfy minimum outdoor air requirements only. These parallel air make-up systems also become the vehicle to provide humidification to the individual spaces. The terminal heating/cooling systems listed above allow individual room start/stop scheduling and increased flexibility to adapt to eventual basic load changes. They are also more likely to satisfy ventilation standards since outdoor air flow is no longer subject to variations. Additional energy savings can often be realized since supply and return air are no longer subject to air friction losses associated to long distribution duct lengths inherent to centralized HVAC systems.

On the negative side, however, terminal units tend to increase maintenance

cost for air filter changes and motorized equipment maintenance. Two or four pipe induction unit terminals offer another means to use water to distribute energy to individual rooms. Induction units, however, still require a high pressure central air system and do not lend themselves to individual room start/stop programming. Induction units cannot practically be used on interior zones because of the complexity associated to their primary air distribution. In IB installations the Building Automation System must interact with other systems to take advantage of specific sensors or programs affecting multiple systems such as motion detectors which may be used to the enhance security system , define the occupancy/non-occupancy mode for both HVAC and lighting.

**3.Lighting systems.**

The Lighting control system, in IB installations, must be integrated to the EMCS in order to facilitate interaction with the other systems. When used with multilevel lighting control and/or perimeter zone daylight systems certain zones may also be tied to the load shedding program in the Power distribution system. In IB installations occupancy mode, during extended hours, may be controlled from local PC terminals or from strategically located override switches.

1. Interior Lighting

The extent of lighting control distribution, the use of motion detectors or infrared sensors and the use of lighting level sensors, in perimeter areas, to allow use of natural lighting whenever possible must be evaluated on a project by project basis for each particular application or feature. In an IB project, however, the cost analysis must take into consideration the benefits ensuing to other systems. A pertinent example would have motion detectors turn the particular room\*s lights on or off through the lighting system but it could also interface with the HVAC system to change the room temperature from occupancy to non-occupancy mode. The same motion detector should also be interfaced with the security system. Interfacing between systems carries minimal or negligeable costs. IB installations lighting control should be extended to each room or work station in order to take full advantage of the energy savings associated to non-occupancy mode or the limited and localized occupancy activation during extended hours for the HVAC and Lighting systems. The lighting system and control strategy development in IB applications should seriously consider the use of “intelligent lighting control” systems which are compatible with the features associated to integrated Energy

Management Control Systems.

2Exterior Lighting

Exterior lighting control should be under regular or solar time of day

programming, In addition to exterior light level sensor or security system sensor activation.

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3.Task Lighting

Task lighting allows higher lighting levels in specific areas where its is needed and therefore allows reduced lighting levels from the ceiling lighting grid and it offers distinct advantages in terms of glare for video display terminals. Task lighting also offers the possibility of providing a friendlier environment with the possibility of no cost relocation when the work station layouts are modified. However, unless task lighting power outlets are under EMCS control, it increases the risk of leaving lights activated after occupancy hours since they may not be under a programmed control system.

**4. Power distribution**

The power distribution system generally deals with major electrical components and electrical energy monitoring. Key elements under monitoring and/or control include the emergency power generator, Uninterrupted Power Systems (UPS), the Emergency Lighting System, Individual tenant power metering units and other major electrical loads.

1.Emergency power

This system interfaces with other systems to annunciate normal power interruptions and initiate reactivation of emergency loads when emergency power becomes available. It performs similar functions upon restoration of normal power including preprogrammed orderly reactivation of heavy electrical loads.

6.4 Vertical transport

In IB installations this system interacts with other systems such as the life

support Fire Alarm or the Security systems to define the number of

elevators required, the mode of operation and in some instances the

accessible floor levels.

Specific programmed sequences may also be incorporated to prioritize

floors under fire alarm condition in order to facilitate the evacuation of the

handicapped.

To minimize energy consumption the number of activated elevators may

also be reduced on the basis of time of day schedules, week or weekend

days and statutory holidays.

**5 . Security**

The type of security system may vary depending on the application. Simple

systems involving automatic functions such access monitoring, card access control, guard tour monitoring or motion detectors can readily be accommodated by packaged EMCS manufacturer programs. More elaborate security systems involving intensive human intervention from guard stations and closed circuit TV and recording should be sourced from specialized security system manufacturers but should be designed to interface with the EMCS to take full advantage of the individual work station motion detectors. The card access security program may be interfaced with the Lighting and HVAC subsystems to define activation of the necessary lighting paths and the specific room occupancy mode. Similarly the Life Safety Fire Alarm program could interface with security to release specific locked doors under alarm conditions.

**6. Life Safety**

This system deals with the Fire Alarm system, the Emergency Lighting. the

Egress lighting system and the Smoke Evacuation system. Interfacing of the Life Safety system with other systems in an IB installations is critical to eliminate nuisance alarms and to initiate appropriate sequences such as stop HVAC systems and start the smoke evacuation system.

Interfacing may also allow temporary transfer of spare emergency power

not required at the time to other non-critical areas until such time as it is required. As an example during an extended normal power failure when the building has been fully evacuated emergency power assigned to elevators or fire booster pumps if not required could be transferred to perimeter heating pumps, UPS units, freezers or other pre-assigned loads.

**7. Communications**

General

The Communications system in the Intelligent Building differs from its predecessors in that communication is now possible among systems thatpreviously were independent “islands”, separately designed and administered. For example, the EMCS has traditionally been built with wiring that was completely separate from wiring for all other services in the building. In addition, there was no means of connecting the EMCS to non- EMCS equipment in the building, such as user workstations. In the intelligent building, integrated communications is possible. The systems that may communicate include traditional LAN-based (local area network) clients and servers, telephones and telephone switches, video conference

devices, and the full range of EMCS devices for HVAC, Security, Lighting, and Fire Alarms.