CARBON CONSCIOUS HVAC DESIGN –

VARIABLE REFRIGERANT FLOW SYSTEMS

CITY MULTI

INTRODUCTION The continuous drive towards designing buildings and systems that significantly reduce our impact on the environment is pushing the innovation envelope within the HVAC industry.

The LEED (Leadership in Energy and Environmental Design) Green Building rating structure (bolstered by ASHRAE 90.1 2004 Standards) is now setting the standard for the industry and creating a design environment where technologies once considered alternate are now becoming mainstream. Variable Refrigerant Flow (VRF) Systems are gradually becoming commonplace in the North American Heating Ventilation and Air Conditioning (HVAC) market even though such systems were first developed in Japan nearly 30 years ago (in Japan VRF systems are used in approximately 33% of large commercial buildings over 70,000 ft^2). The term variable refrigerant flow refers to the capability of a system to control the amount of refrigerant flowing to each of the indoor units/evaporators, enabling the use of multiple evaporators of differing capacities and configurations, individualized comfort control, and simultaneous heating and cooling in different zones with heat recovery from one zone to another. Variable speed drive compressor technology dynamically adapts to the building load conditions by working in tandem with distributed linear expansion valves at each evaporator/indoor unit. With centralized M-NET control networks, it ensures precise temperature control within each conditioned zone (±1.5°C of set point) at optimum level of system energy efficiency.

ENERGY EFFICIENCY IN VRF SYSTEMS

ARI studies indicate that a typical HVAC system operates at full load for only 1-2% of its life cycle. More detailed analysis illustrates that the majority of operating hours actually fall in the 40-80% total capacity range. The auto-tuning variable speed drive scroll compressors yield high part-load efficiency and also offer excellent seasonal energy efficiency by dynamically matching building loads. The ability to simultaneously heat and cool adjacent zones by energy transfer is a distinct advantage the Mitsubishi Electric City Multi System has over other more conventional approaches to HVAC system design. It is also the only two-pipe system that can offer such a feature in the industry. The intermediate distribution compartment (BC Controller) facilitates the transfer of heat energy from the superheated refrigerant exiting the cooling zones to the refrigerant that is going to the heating zones. Simultaneous heating and cooling capabilities can be effectively applied on layouts where heat rejected from year-round cooling zones (such as data rooms, etc.) is transferred to heating zones. It is also very efficient during shoulder season cycles where heat is transferred between zones in a core vs. perimeter zone layout. In such scenarios the variable speed drive compressor can operate at part load while providing design heating and cooling levels to each conditioned zone served by the system.

VRF PERFORMANCE VS. CONVENTIONAL HVAC HEATING & COOLING SYSTEMS

The high part-load efficiency of VRF systems compares favorably to more conventional methods of cooling a building, such as chillers or packaged rooftop variable air volume systems. In temperate climates energy analysis between a 528-ton VRF compared to both screw and centrifugal chillers indicated cooling energy savings of approximately 30%.

Total heating and cooling building energy analysis for applications based on North American climatic conditions are ongoing. Mitsubishi Electric is currently developing an energy modeling tool (EnergyPro) to further assist in the comparison process of this dynamic system. Recently Mitsubishi Electric has launched the City Multi H2i Hyper Heating Inverter product range allowing highly efficient system operation in heating mode at ambient temperature as low as -25°C, while still delivering 75% of rated capacity. The system can now reduce the level of reliance on supplementary heating in winter and hence significantly improve overall annual system efficiency levels. The coefficient of performance (COP) for VRF systems when in heating mode is significantly higher than even the most efficient gas-fired heating equivalent. Typical VRF systems COP levels range from 1.5-3 when in heating mode vs. 0.95 for high-efficiency gas-fired systems. Considering the source of electrical generation and mechanical system configuration for any given application (hydro vs. coal-burning power stations), the carbon emissions associated with a two-pipe heating/cooling VRF system in many instances can prove to be significantly lower than that generated by more conventional four-pipe systems.

FACILITATING ENERGY-SAVING BEHAVIORISMS

The ease of applying sub-division metering strategies to VRF systems can further develop the energy-saving mindset, particularly in multi-use or multi-tenant applications. The de-centralized City Multi approach allows the end user to accurately monitor the energy profile of specific VRF systems/building areas (via the condensing unit) and optimize zonal usage patterns accordingly, thus reducing the annual building carbon footprint.