US Market Development of Inverter Driven Ductless HVAC Products

VRV – Variable Refrigerant Volume
VRF – Variable Refrigerant Flow

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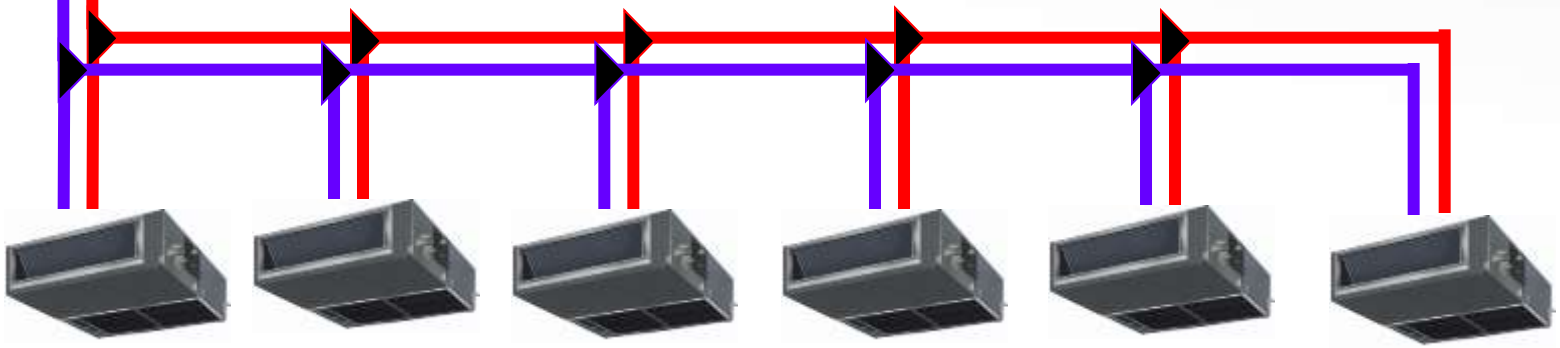
VRV/VRF Heat Pump Systems

Air cooled

- Air cooled condenser units from 3 to 30 tons configurations Water cooled condenser units from 5 to 21 tons - Heat Pump or Heat Recovery
- Up to 3280 ft of reticulated refrigerant piping system (540 ft max CU to FCU)
- Multiple fan coil unit (up to 60 possible) with each FCU capable of individual operation and set point setting
- All zones cooling or heating on Heat Pump
- Digital 2 wire control system with full programmability and diagnostics inherent.
- Complete systems automation requires only interface panel or PC. Third Party BMS connection possible.

Water cooled



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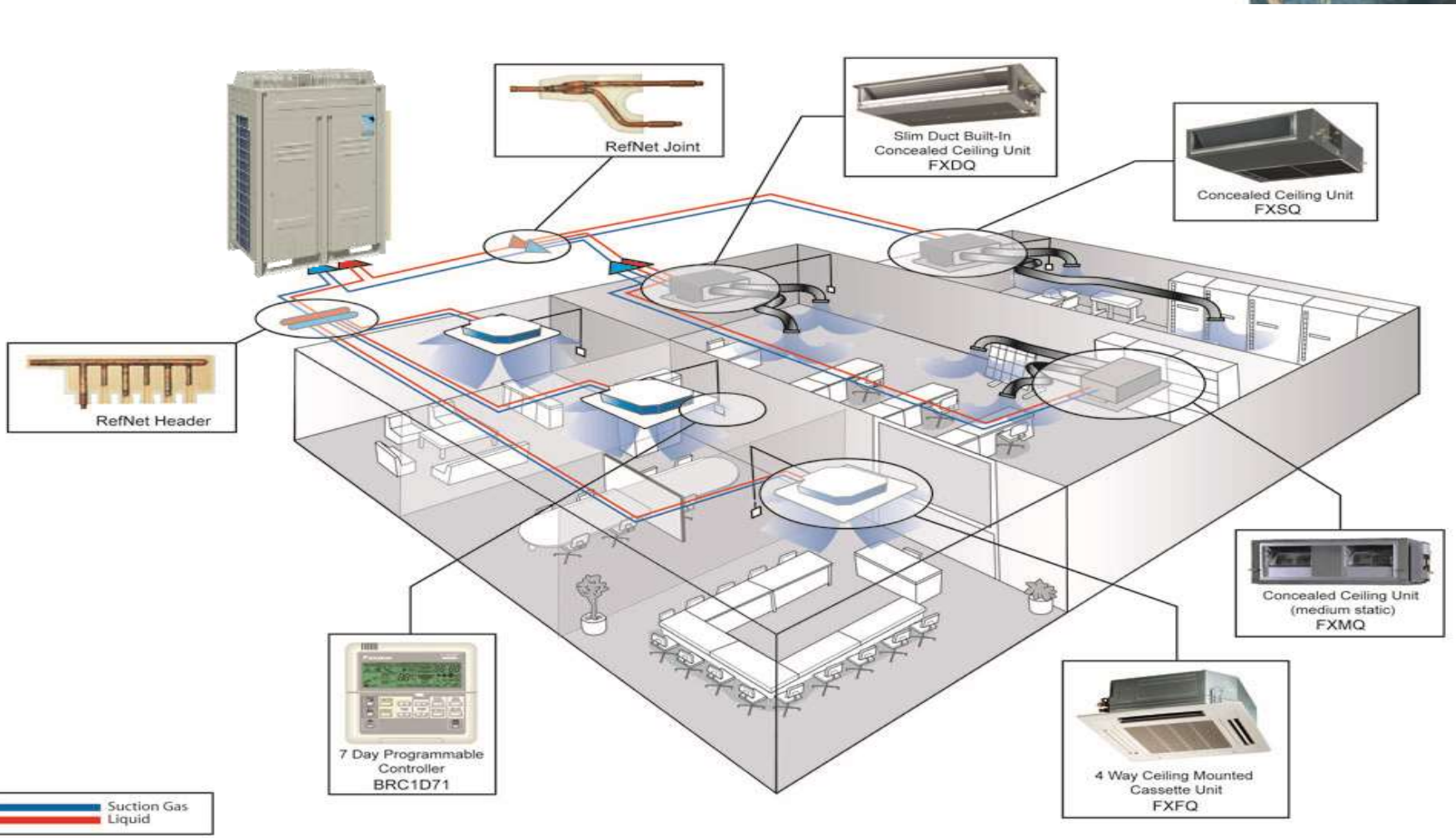
VRV Heat Pump Components



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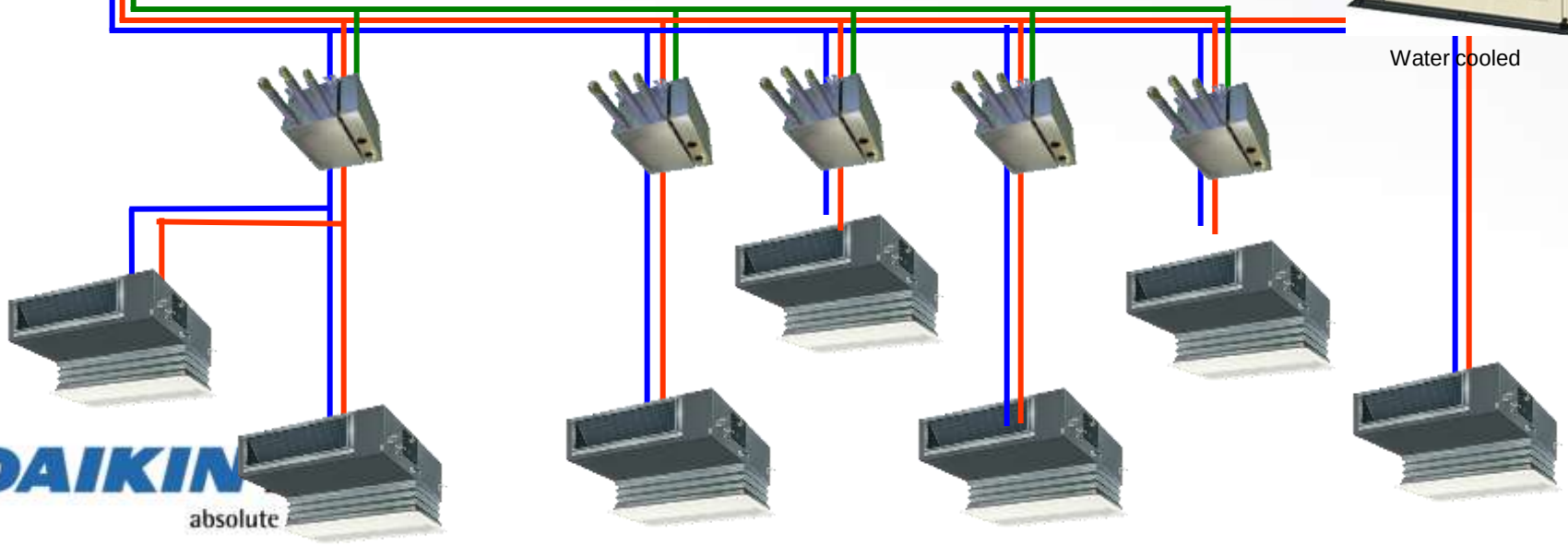
VRV/VRF Heat Recovery System

- Air cooled condenser units from 6 to 30 tons configurations Water cooled condenser units from 5 to 21 tons - Heat Pump or Heat Recovery
- Heat Recovery Systems enable simultaneous Heating and Cooling from the same refrigeration circuit.
- The application of Branch Selector Boxes and the addition of a Hot Gas refrigerant line enable the selection of heating or cooling on a zone by zone user basis.
- Fan coils that are connected to a Heat Recovery Loop without the Branch Selector Box would then be cooling only.
- Same Piping and FCU capabilities as Heat Pumps

Water cooled



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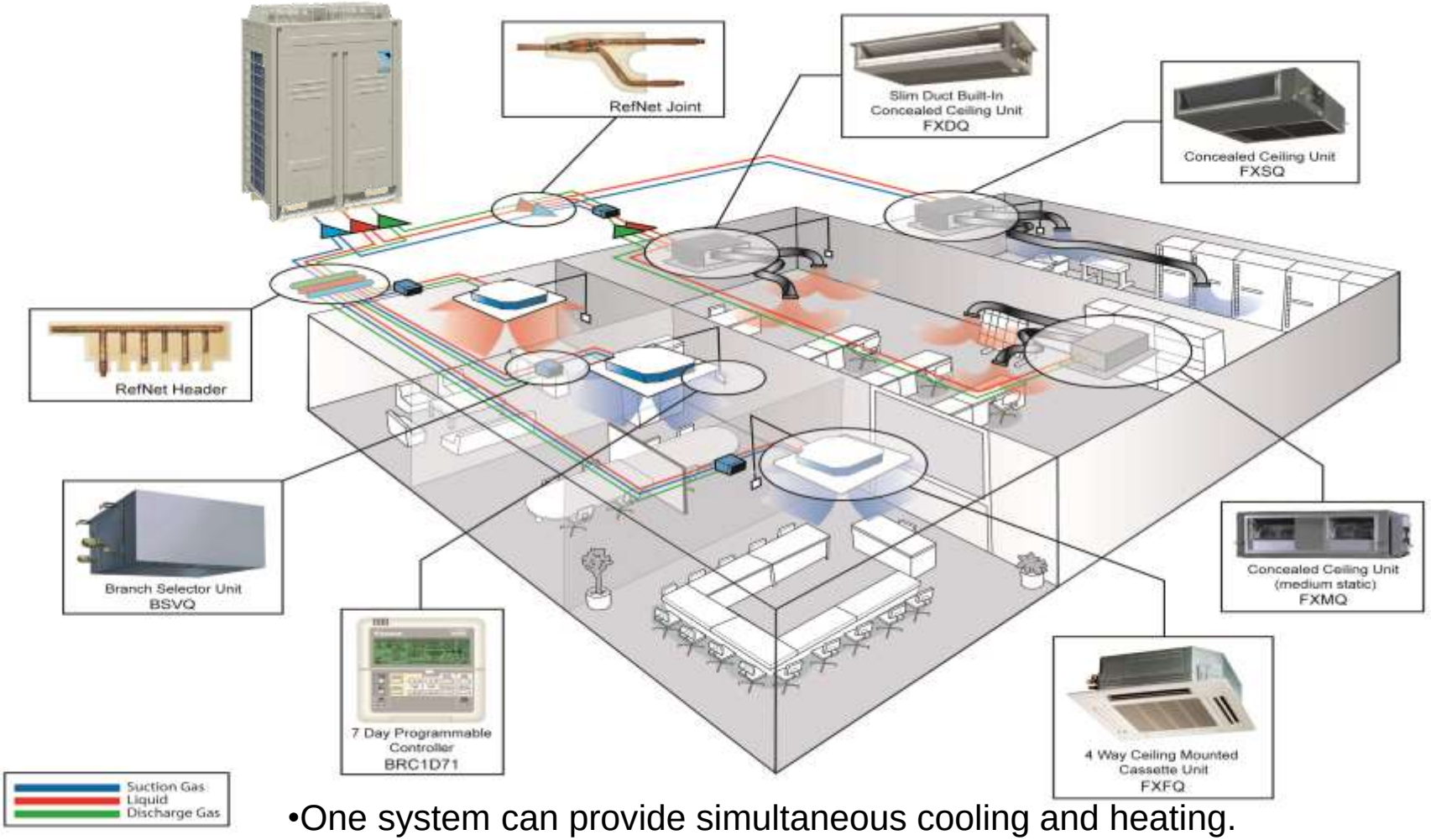
Heat Recovery System
Simultaneous Heat and Cool



- One system can provide simultaneous cooling and heating.
- Heat absorbed by Indoor Units in Cooling Mode is used in areas that require Heating.
- EER of over 20 can be expected in Total Heat Recovery mode.

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Ducted and Ductless Indoor units that range in size starting at 7,000BTU enable applications to meet zone sizes and facilitate a low cost installation.

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INVERTER BENEFITS

- Compressor Starts at Minimum Frequency
  - Very Low Starting Amperage - Quiet Start - No Light Flicker
  - No Inrush current or Locked Rotor Amps – Reduces/Eliminates impact to demand charge
  - No Stress on Windings or Compressor Frame – Long Life with compressor warranty failure rates 300% lower than conventional compressors.
  - Compressor Allows Bearing lubrication to increase before speed increases
  - System pressures increase gradually reducing noise and stress on piping
- Changes electrical frequency from 60 Hz to:

  28 – 108 Hertz for RA Series

  52 – 210 Hertz for VRV Series
- Frequency changes are influenced by:
  - Diversity of Indoor Units Loads Operating
  - Compressor Discharge Gas Temperature
  - Suction Pressure, Suction Gas Temperature
- Reduces energy usage 30 to 50% over all non-inverter systems.

INVERTER BENEFITS

- Electronic Control of the Compressor Under a Wide Variety of Operating Conditions
  - During high outdoor ambient temperatures:
    - **Discharge gas temp sensors identify high temp**
      - **Electronically reduces compressor speed to limit**
        - » **High Side Pressure**
        - » **Energy usage**
    - **Reduces energy usage at peak conditions**
- Great Heating Performance
  - Allows compressor to increase speed during cold outdoor ambient conditions.
    - **Generates higher**
      - **Head pressure**
      - **Discharge gas temperatures**
      - **Discharge air temperatures**
  - Attains same heat output as competitive systems with Electric Booster Heat, but doesn't use the extra energy.
  - Improves performance throughout the entire run sequence.

INVERTER SYSTEMS

- **Longer Run Periods at Lower Capacities**
  - Better Dehumidification
  - Fewer compressor starts mean less wear and tear on the compressor = longer life!
  - Lower compressor speeds = higher system efficiency since the condenser coil surface remains large in relation to reduced capacity
- 80% of the systems in outside of US now operate on inverters.
- The USA Market for Inverter based systems started with Daikin's introduction to the market in 2004 and has continuously grown an average of 30% - year while the overall market shrank.
- 2012 the USA Market applied 60,000 VRV/VRF type systems and today every manufacturer in the HVAC Systems Market is developing Inverter based systems offering or private labeling foreign manufactured systems.
- VRV/VRF systems are now moving into production/manufacturing in the USA and conventional system components are being updated to digital compatibility.
- 2015 is expected to realize 250,000 Systems installed in the USA and 2020 is forecasted to realize in excess of 1,500,000.

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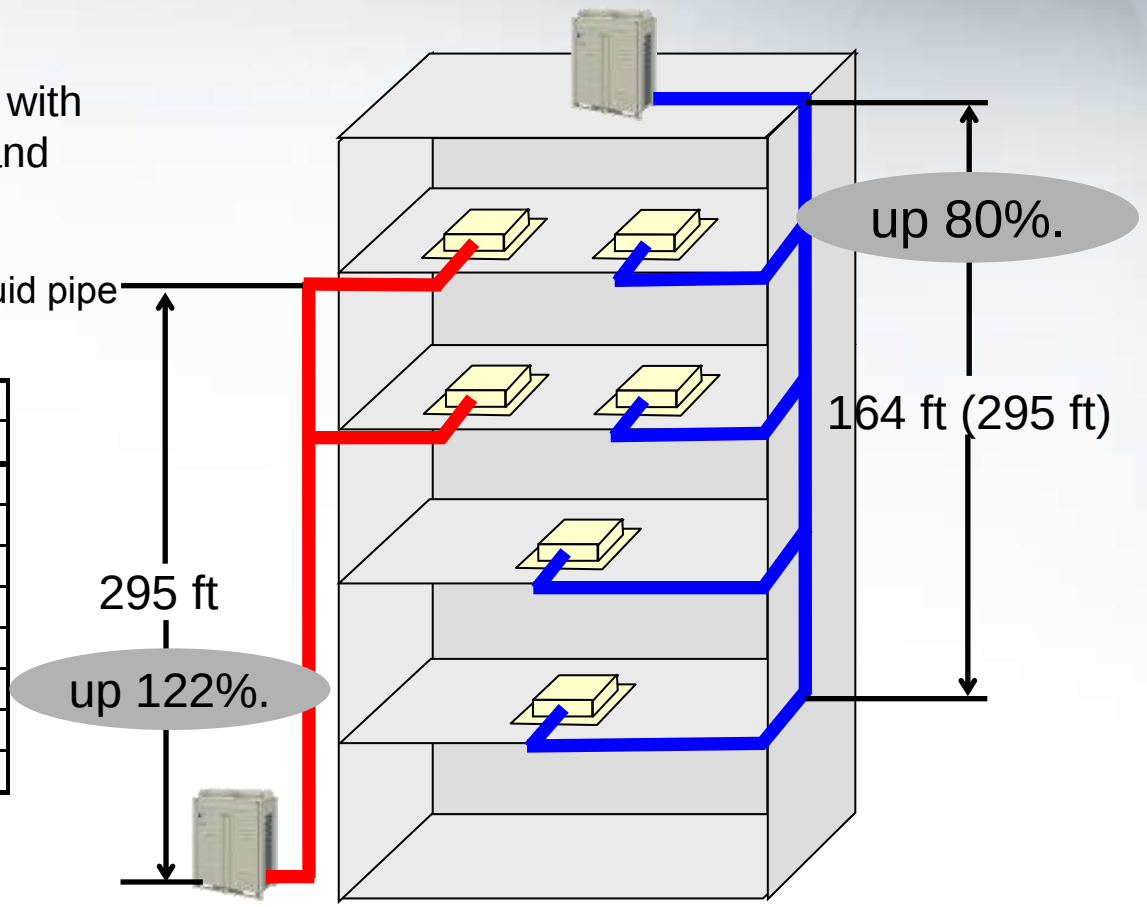
Increase of Level Difference Up to 295ft

- Outdoor unit above = 164ft, up to 295 ft.
- Outdoor unit below = 295ft

Ability to serve a 600ft building with outdoor units placed at roof and ground level

If the level difference is ≥164 the main liquid pipe must be increased by one size

		Liquid	
		Std	One Size Up
RXYQ72	REYQ72	φ 3/8	φ 1/2
RXYQ96	REYQ96	φ 3/8	φ 1/2
RXYQ120	REYQ120	φ 1/2	φ 5/8
RXYQ144	REYQ144	φ 1/2	φ 5/8
RXYQ168	REYQ168	φ 5/8	φ 3/4
RXYQ192	REYQ192	φ 5/8	φ 3/4
RXYQ216	REYQ216	φ 5/8	φ 3/4
RXYQ240	REYQ240	φ 5/8	φ 3/4



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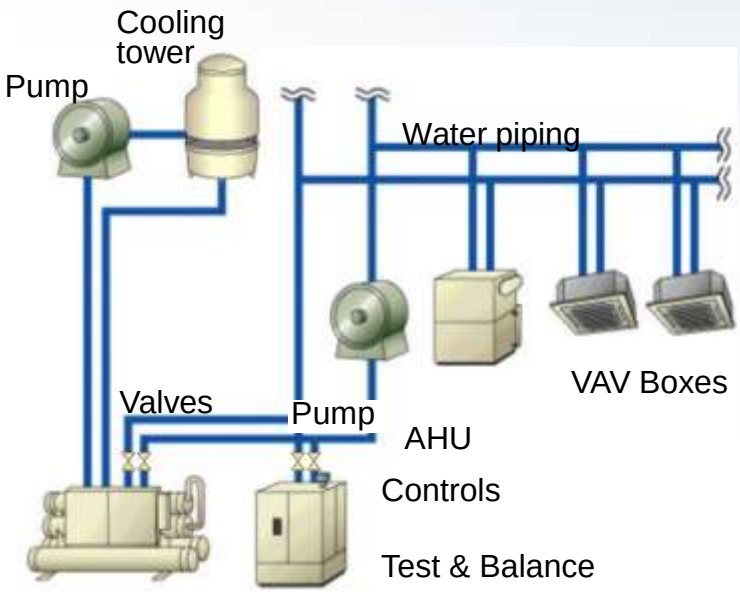
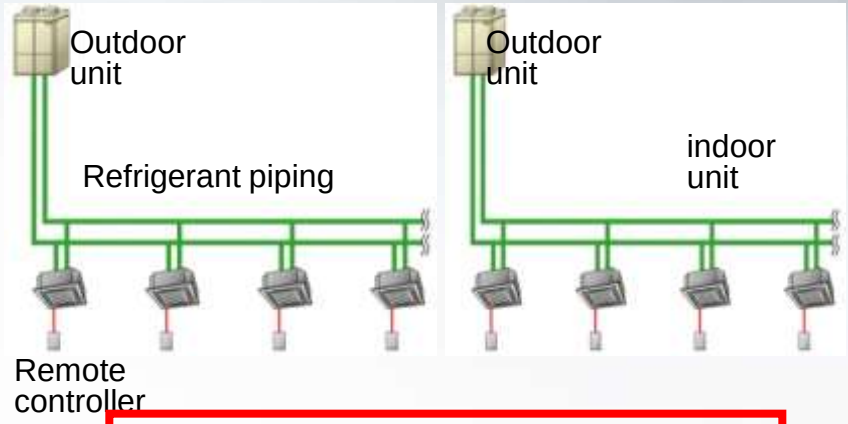
Central Chiller System



VRV Modular DX Chiller System



VRV/VRF One source

- Central Condenser location possible
- Small Diameter Copper Lines
- Long piping lengths possible
- Multiple zone control built in
- Complete digital diagnostics integral
- Centralized control possible/integral

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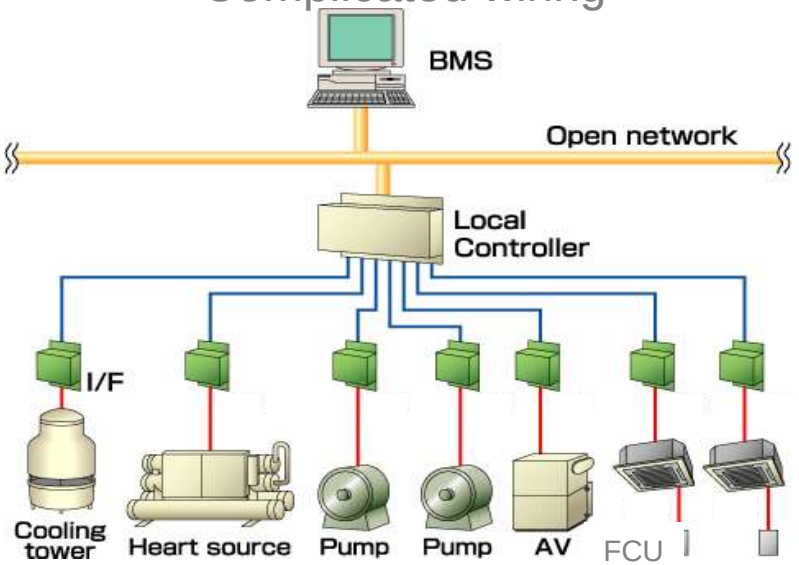
Easy Network Wiring

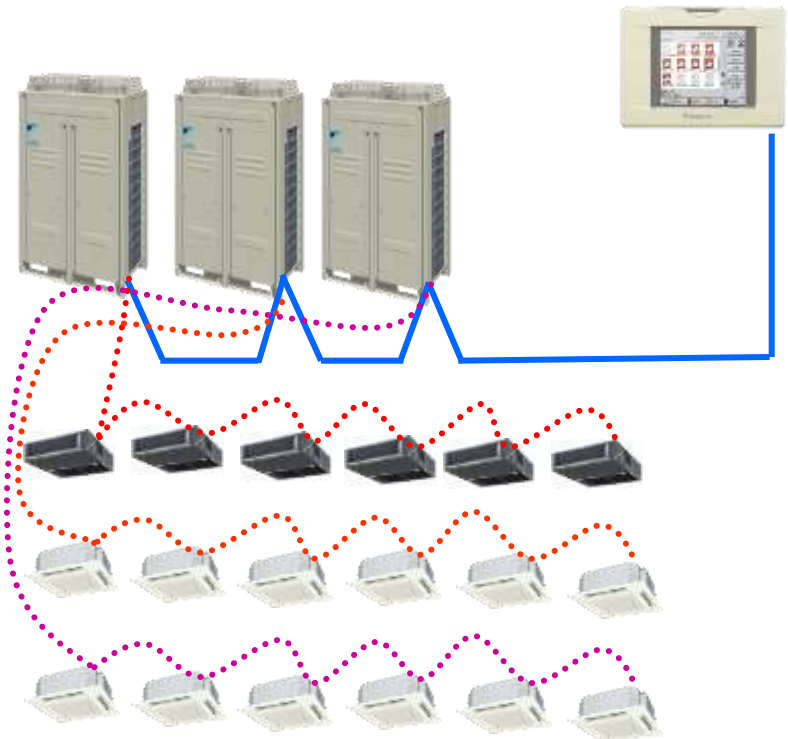
Central A/C System

Complicated wiring



$ 200 / 300 per point
2-6 points / piece of equipment

VRV/VRF System



All monitoring points included at no cost

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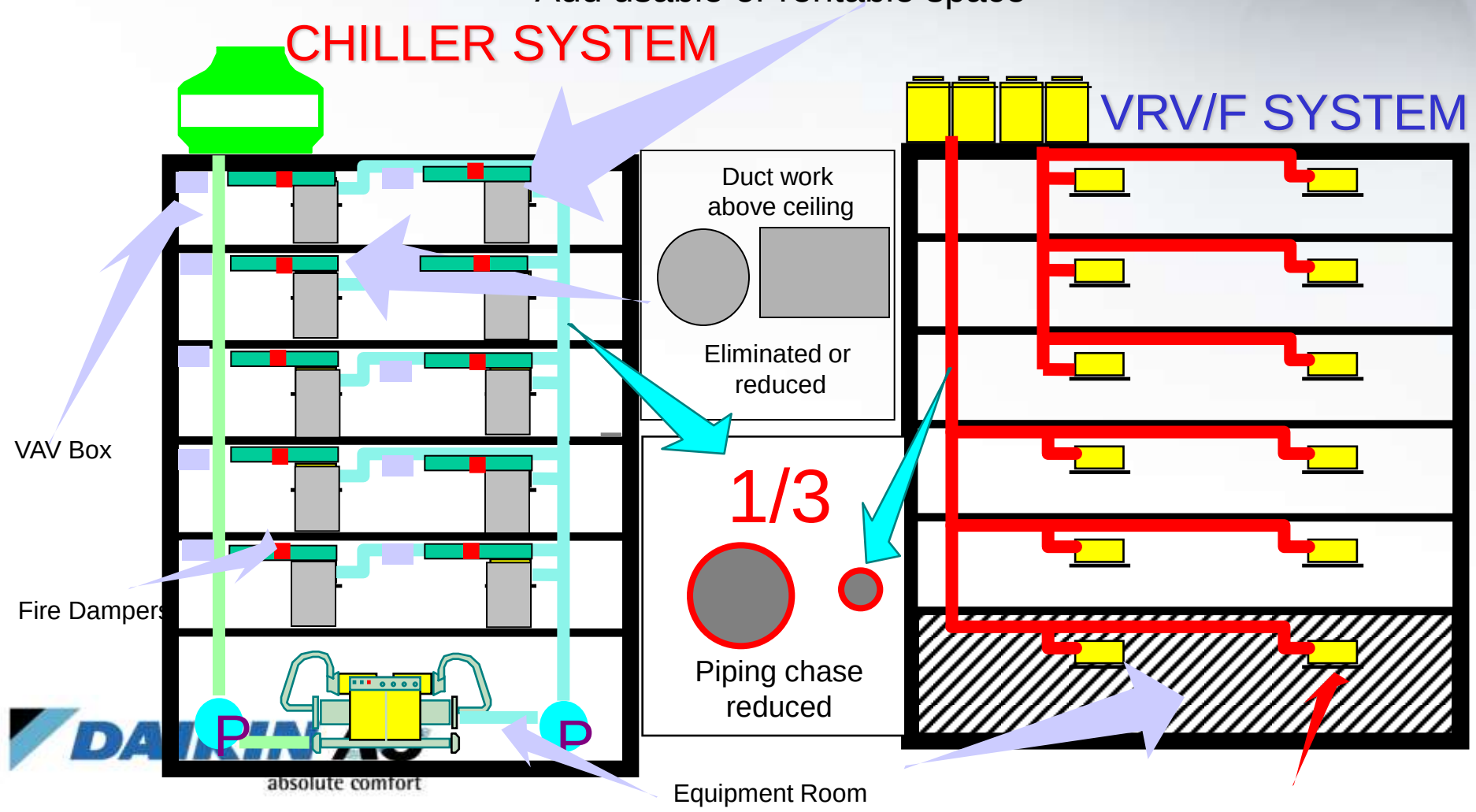
Efficient use of space

Air Handlers requiring equipment rooms
Reduce building height or add a floor
Add usable or rentable space



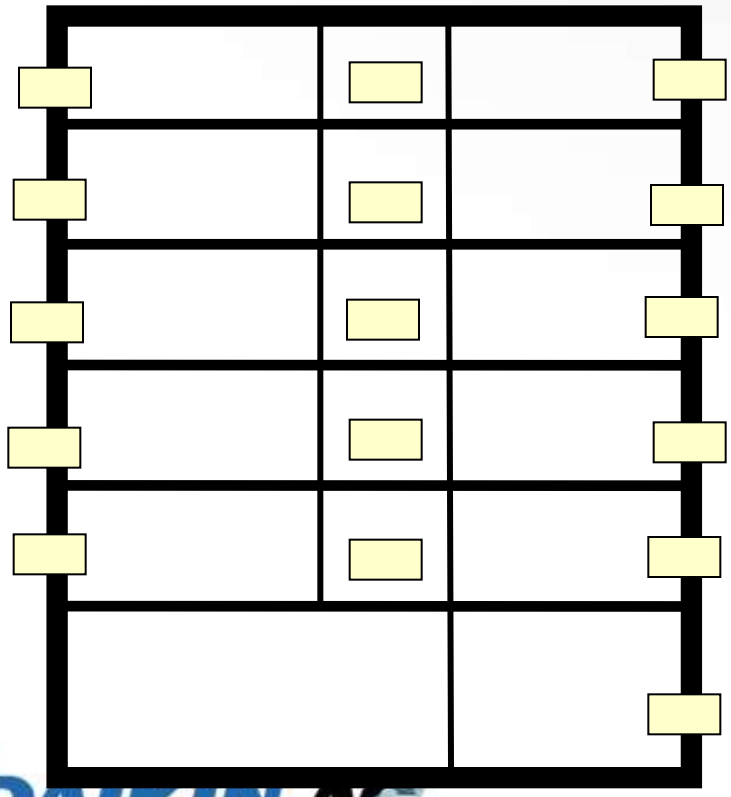
Efficient use of Electric Budget – 80 Room Hotel

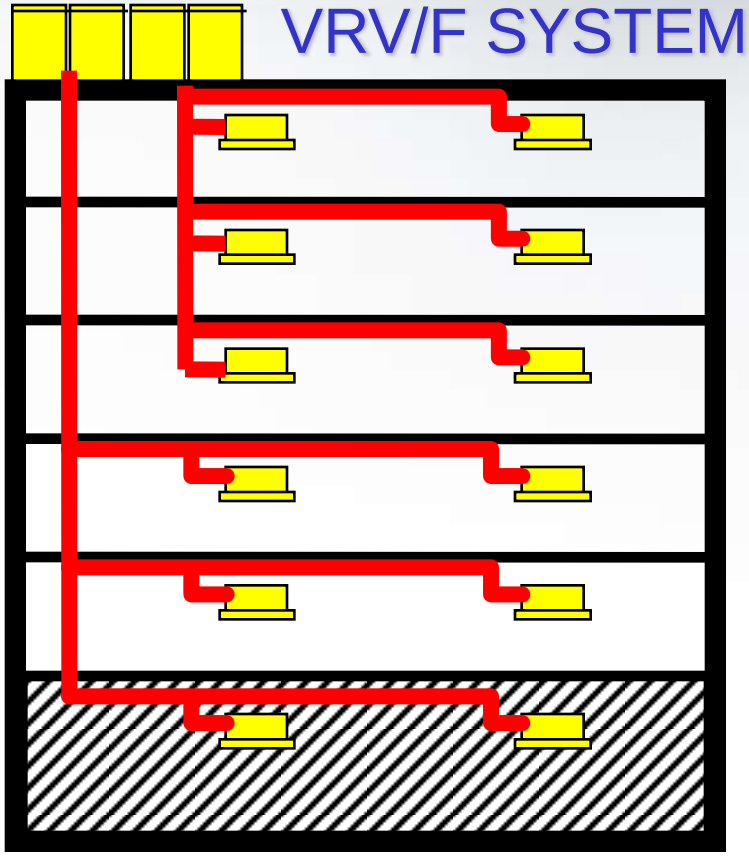
80 PTAC's

1 ton with 3.5kw heat = 18 amps
Power service requirements 20 amp X 80 = Total 1600 amp service for rooms

VRV/VRF System

10 – 8 ton VRV @ 500amps
80 FXDQ12 @ 200amps
TOTAL Only 700 amp service for rooms





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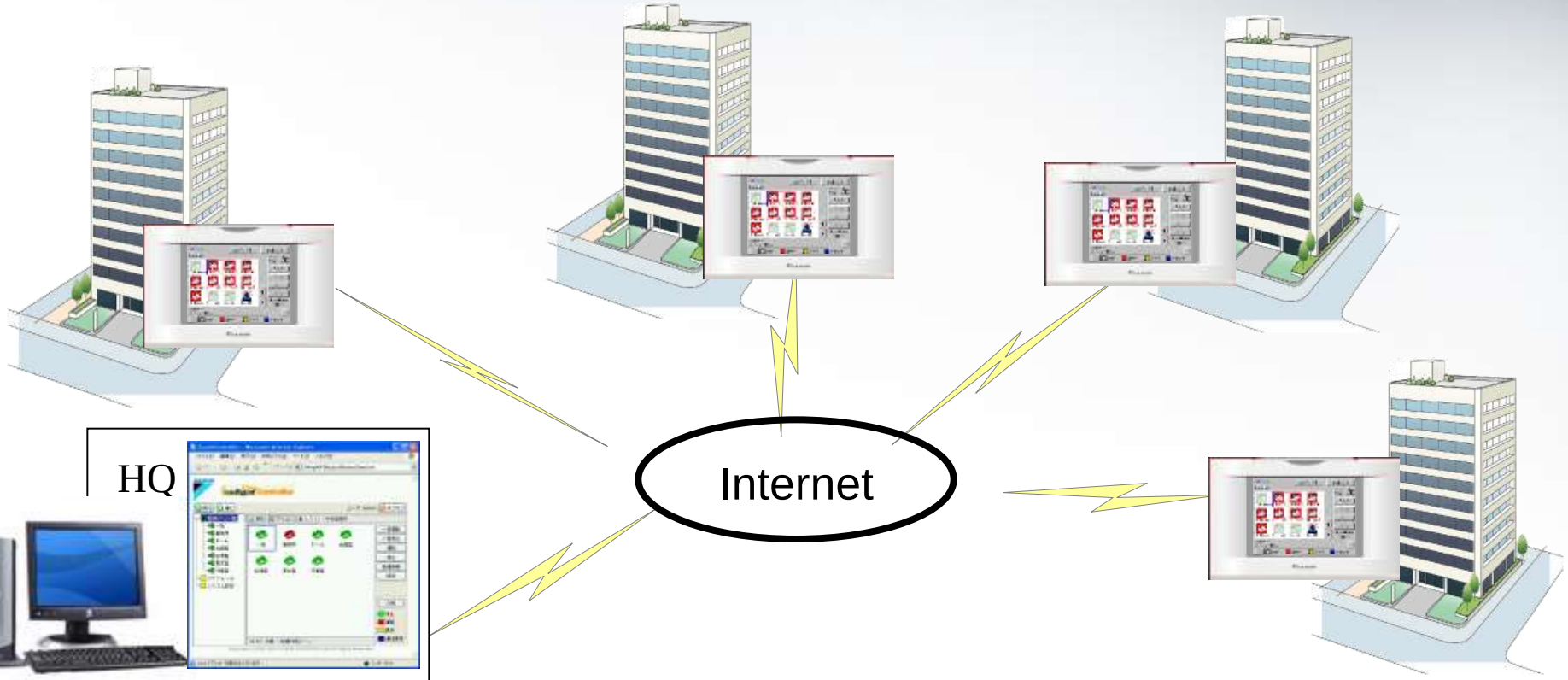
Centralized Monitoring and Control via a Web Browser

Remote monitoring of more than one building

Allows for management of more than one building via the web from one central location



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Where does it fit?

VRV/VRF has the following attributes:-

- Energy Efficient - VRV/VRF Ductless Systems offer the single largest reduction in energy consumption versus all conventional HVAC systems. (30 to 50% reductions

- Tight Control – Each Zone/FCU is able to realize complete capacity control. No zone is over conditioned.

- Very quiet – Outdoor units can be located in area's that previously would have resulted in nuisance complaints.

- Many zones – Single zones as small as 250sqft up to large public areas.

- Modular Systems accommodate very small to very large capacity needs

- Eliminate Centralized Plant infrastructures due to VRV/VRF long piping capabilities with very small pipe sizes.

- Advanced BAS control allows for complete system management without significant investment to 3rd party integrations.

- Lowest Total Cost of Construction

- THE BEST USE OF YOUR INCENTIVE/REBATE FUNDS POTENTIAL SINCE THE INTRODUCTION OF HEAT PUMPS IN THE 1970's.

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Thank you.

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