The Process of VRF

Greg Drensky
VP
Jacco & Assoc.

Who is Jacco

- Established 1968
  - Hudson, Ohio
  - Columbus, Ohio
  - Toledo, Ohio

- Focused on the Engineered Environment

- Systems Knowledgeable
  - HVAC Systems
  - Service & Maintenance
  - Parts

JACCO

Purpose Statement

The purpose of our Company is to solve our customers problems, in the most economical way, at all times optimizing the owning experience.

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Who is Jacco

- Operations
  - –Brenda Homjak
  - –Mike Spangler
  - –Chad Russell
  - –Mike Mueller
- Contractor Owning Experience
  - –Maggie Sawicki
  - –Rick Baker
- Engineering Owning Experience
  - –Greg Drensky
  - –Jerry Cohen
- Owning Experience
  - –Steve Leister
  - –Gloria Schwartz
  - –Jeff Watson

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Who is Jacco

- 30 Minute Design
  - Unit Performance
  - Drawing
  - Weights
  - Electrical
  - Specifications?
  - Sequence of Operation?
  - Cartoon?
  - Narrative?

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Who is Jacco

2016 Seminars

Psychrometrics	Jerry Cohen	13-Jan
The Refrigeration Cycle	Jerry Cohen	10-Feb
Best Practices for VRF Systems - Design	Greg Drensky	9-Mar
Best Practices for VRF Systems - Installation	Steve Leister	13-Apr
Best Practices for Applied Rooftop Systems, Applications & Installation	Jerry Cohen	11-May
Applying Energy Recovery Systems	Greg Drensky	14-Sep
OFCC Applicable Systems - Pro's & Con's	Greg Drensky	12-Oct
Applying Building Pressure & Air Flow Measurement Instrumentation	Greg Drensky	9-Nov
Controlling HVAC Systems with Special Emphasis on Sequence of Operations	Jerry Cohen	14-Dec

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The Process - Design

- Load
  - Think Heating
- Diversity
  - 50% to 150%
- Piping
- Safety

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The Process - Installation

- Training
- Follow The Rules
- Verification
- Commissioning

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Samsung DVM S and Mini DVM S Eco System Training

Option A (Recommended): 2-Day Training - *Carlisle, PA*

This course will provide an installing contractor or engineer with all the necessary information to design, layout, install and start Samsung DVM S and Mini DVM S Eco Systems.

- Jacco will pay for the class for up to three employees from the same company.

This NOT include accommodations (travel/hotel).

Training includes:

- Samsung service tool
- Training binder with all applicable training information

Classes are held once a month.

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Samsung DVM S and Mini DVM S Eco System Training

Option B: Online/Onsite Technical Training

Required for those who cannot attend the 2-Day Training

This is a three-step training course designed to train an individual who wants to purchase a Samsung DVM S System on how to install and start the system.

Steps include:

Step 1: Take online four-hour training course

Step 2: Design phase

- Meet with your sales representative and operations engineer onsite to review the design and layout of your system

Step 3: Final Installation Training

- Meet with your sales representative and Jacco's Service Manager to review the unique features of your system/building and to ask/answer any specific remaining questions.

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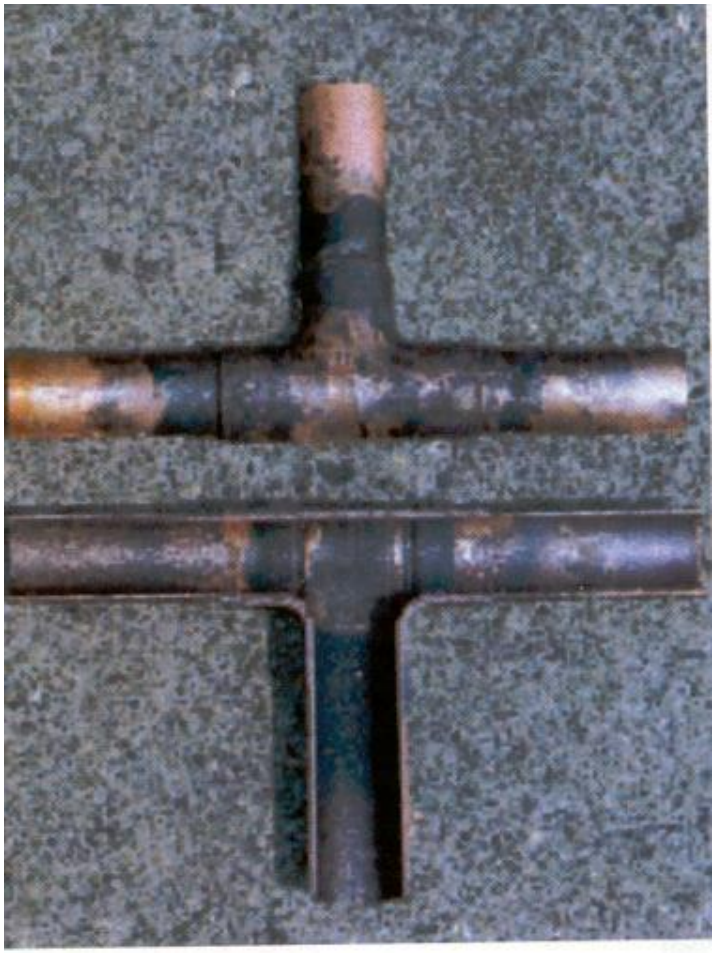
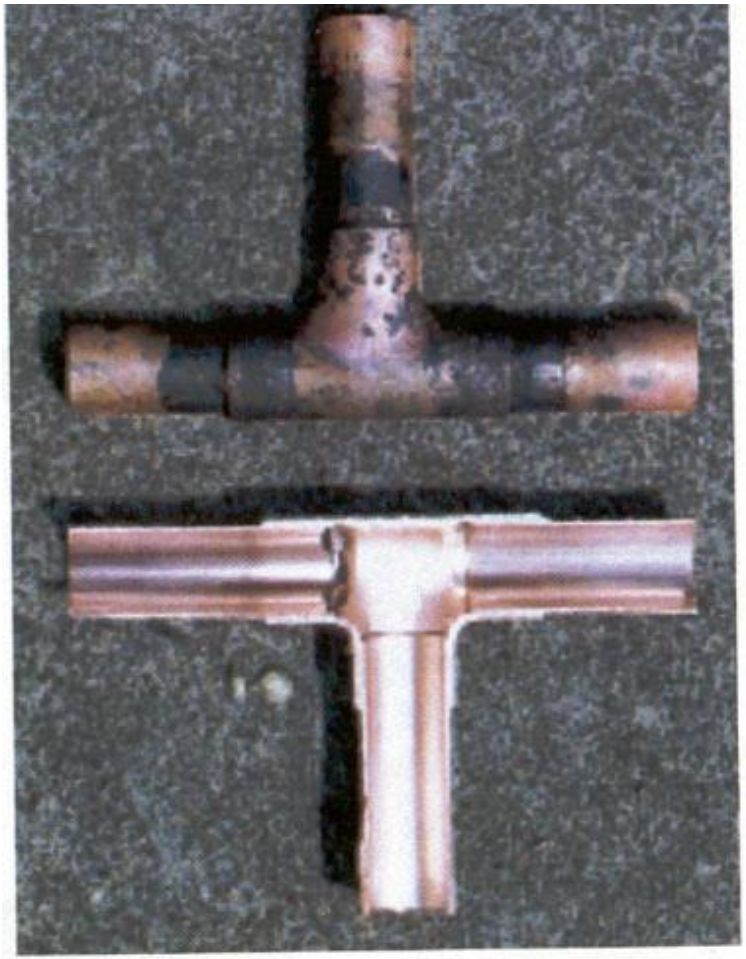
Samsung VRF Piping

- During brazing, use low pressure nitrogen to prevent carbon buildup, which can cause contamination of the system.

Purging with Nitrogen





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Requirements Before a Jacco Service Technician Arrives:

- All refrigerant piping must be installed, brazed/connected.
- **Pressure test:** 75 psi for 5 min.
  - 220 psi for 5 more min.
  - 590 psi for 24 hrs.
  - Bring back down to 145psi and leave ready to begin vacuum process.
- Accurate pipe lengths must be recorded and sent to our Operations Engineering Dept. for refrigerant calculations.
- All refrigerant piping must be completely insulated.
- All drain lines must be installed, insulated, and terminated.
- All high voltage power must be connected and ready for operation.
- All low voltage and communication wire connections must be complete.
- All covers and panels must be in place and installed properly.
- The jobsite must allow access to all Samsung equipment and a mechanical representative must be available to address any issues.
- All Jacco DVM S Startup Assistance Service forms must be signed and submitted to Jacco by fax or email 7 – 10 days before requested Startup.

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Jacco's Services

- Visually review system installation before initial equipment startup.
- **Triple evacuate the system per the manufacturer specifications.**
- Connect PC to system to view and log all system operations during commissioning.
- **Charging of the proper refrigerant levels in each system. Refrigerant supplied by the installing contractor.**
- Diagnose and help remedy any error codes that may occur during system startup procedures.
- Instruct building owner, building occupants, installing contractor representatives, and/or building manager how to use all HVAC wireless and/or wired controllers and any centralized control devices.
- Show building owner, building occupants, installing contractor representatives, and/or building manager how to clean all Samsung air filters.
- Provide a detailed report for each system (delivered at a later date) including a digital and hard copy. The digital copy will also contain all backed up startup data that was recorded with the Jacco representative's PC for later review if needed.

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The Process - Product

- 10-10-1 Samsung Warranty Because…
- Some Nice Things…

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Balanced Compressor Operation

- Samsung Dual VFD system provides balanced compressor operation (Lead-Lag) for improved durability and longevity.

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High Oil Storage Capacity

- With its large oil storage capacity and low Oil Circulation Ratio (OCR), DVM S can ensure reliable performance even for installations with long piping and high elevation.

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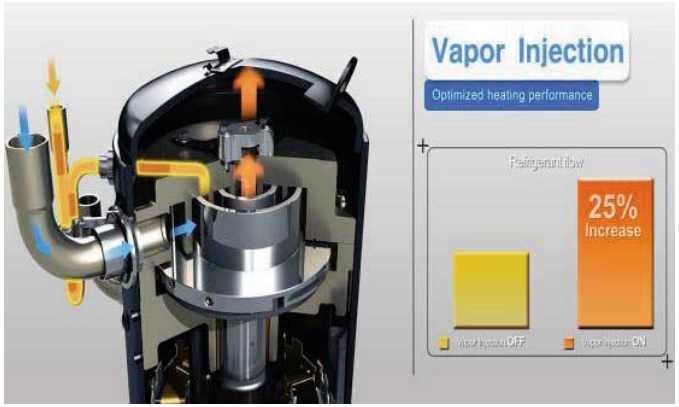
Vapor Injection

- Samsung's Vapor Injection (Pumping Wet Gas) provides improved performance in frigid conditions.
- Flash Injection (100% Heating Capacity at -13F) Available Now to 24 Tons



Intelligent Defrost

- DVM S system considers not only conventional factors but also air resistance to intelligently judge the defrost operation.

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Rotating Defrost

- DVM S operate continuously in heating mode with rotational defrost operation.

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Samsung VRF

- Jacco's processes are there to make sure you can't fail!!!
- Samsung provides a 10-year "bumper-to-bumper" warranty.

So easy, even a “Caveman Can Do It!”

Todays Discussion Topics

1. Samsung HVAC
2. VRF Market Opportunity
3. Why Would you select a VRF system?
4. AHRI1230 // ASHRAE 15//34
5. VRF System & Lay Out
   - Controls
   - Cond Unit
   - Fan Coils
6. Samsung VRF/DVM Product

Introduction to Samsung

Samsung consists of many different companies

ELECTRONICS	CHEMICAL INDUSTRIES	FINANCIAL SERVICES	TRADE & SERVICES	MACHINERY & HEAVY INDUSTRIES
Consumer Electronics	Fine Chemicals	Life Insurance	C&T Trading	Building Construction
Business Displays	BP Chemicals	Fire & Marine Insurance	Hotels	Ship Building
Semi Conductors		Payment Services	Fashion	Engineering
LCD Panels		Securities	Medical	
		Asset Management	Food Services	
		Venture Investment		

- **FOUNDED IN 1938**
- **420K EMPLOYEES GLOBALLY**
- **$300B IN ANNUAL SALES**

Introduction to Samsung

Global Product Leadership

1st

Refrigerator

1st

TV

1st

Smartphone

1st

Large Format Display

1st

DRAM

1st

NAND Flash

#1 market share in multiple categories

SAMSUNG / QuietSide HVAC

RAC

Samsung RAC

QuietSide RAC

SAC

VRF

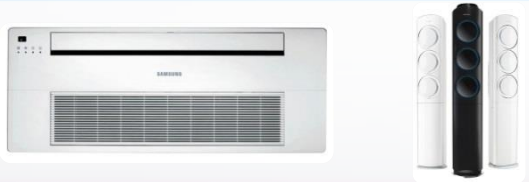
FJM

CAC

Indoor Unit

4 Way Cassette / 4 Way Mini

1 Way Cassette / Vertical



Duct / Slim Duct

High-Wall / Floor-Ceiling

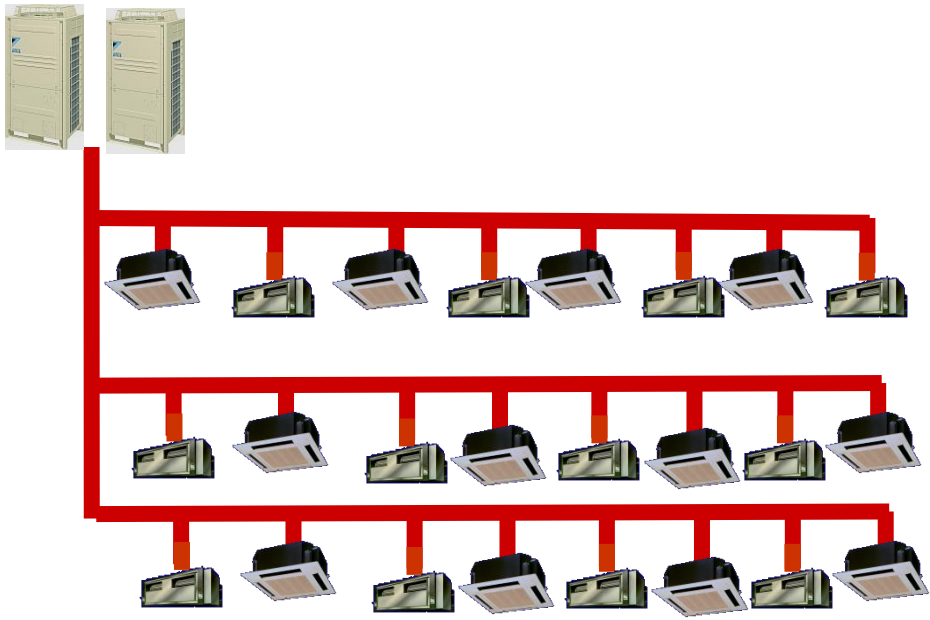
What is VRF?

Variable Refrigerant Flow

- Inverter-driven variable speed scroll compressors
- Modulating electronic expansion valves (EEV’s) on indoor units
- The system’s heating / cooling output varies to match the load in the conditioned space

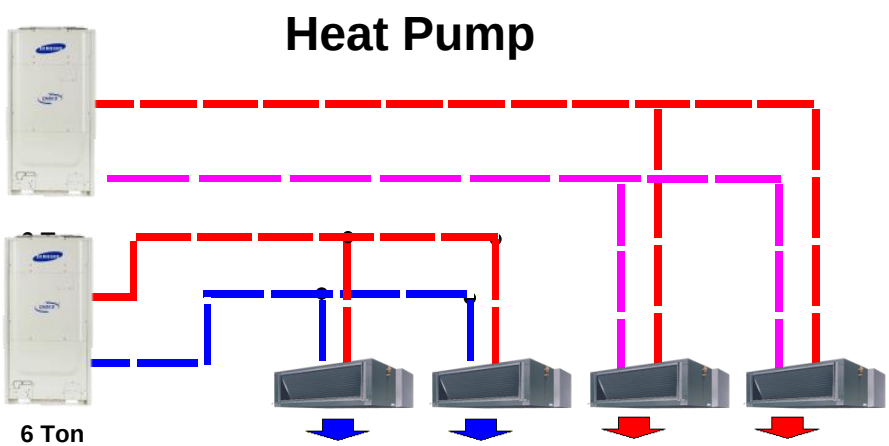
VRF Concept –

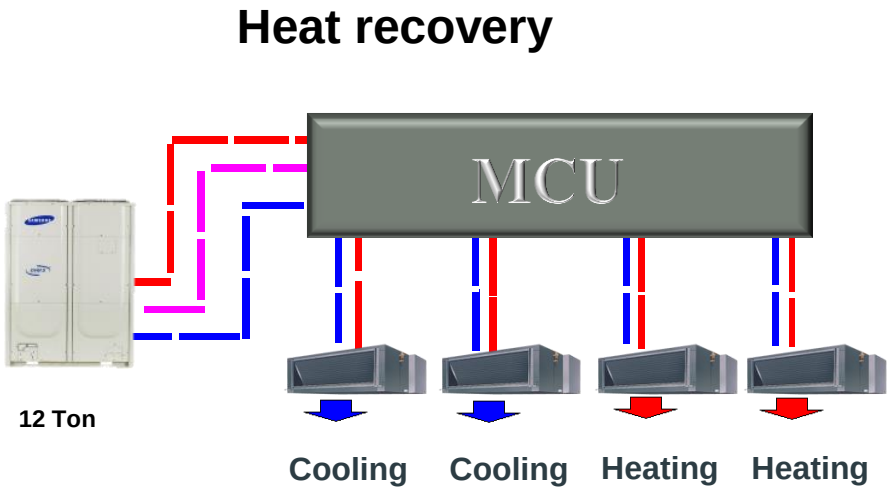
- Multiple indoor units connected to one outdoor unit
- Up to 64 on **a single** refrigerant piping network
- Available in either **air cooled** or **water cooled**



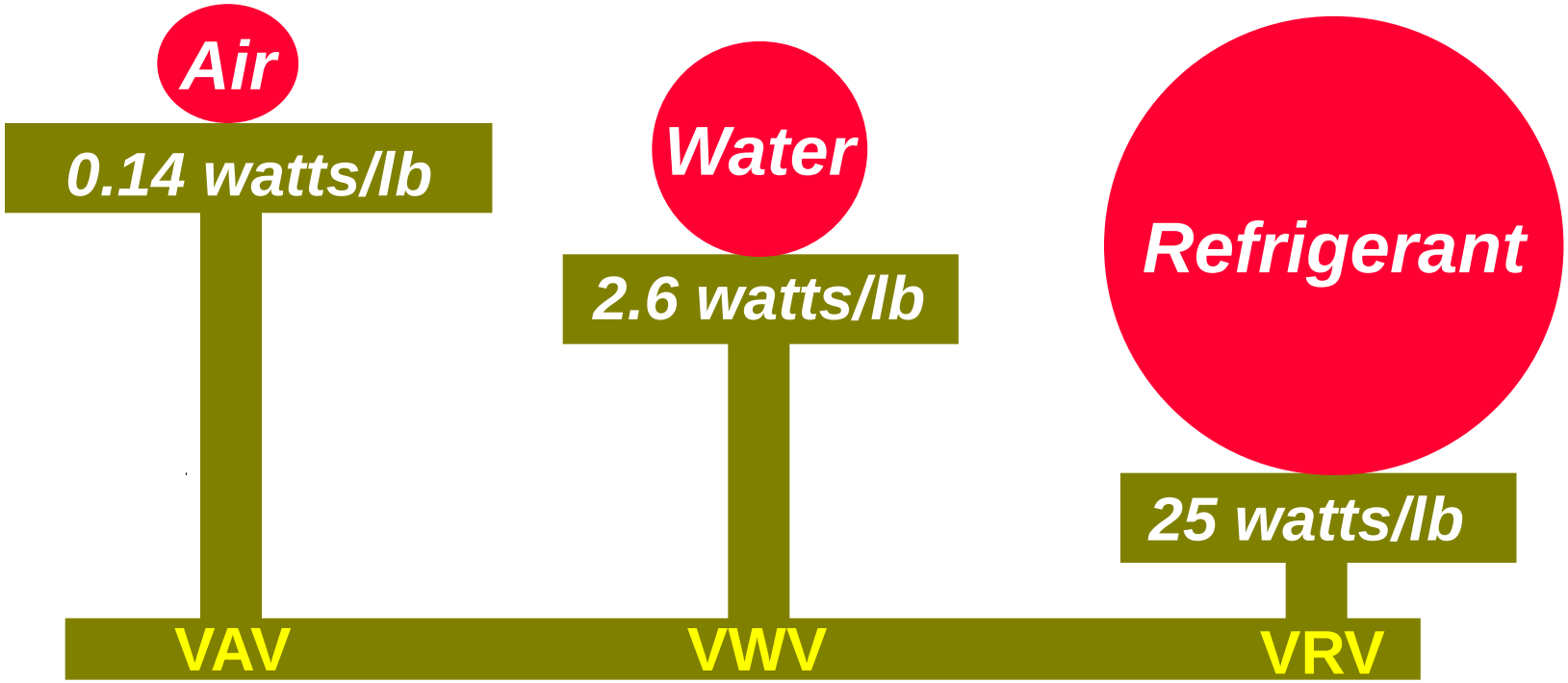
VRF Concept –

- Think of a VRF system as a heat pump chiller that circulates refrigerant to each zone instead of water
- A VRF heat pump system is equivalent to a 2 pipe chiller
  - Smaller heat/cool changeover zones
- A VRF heat recovery system is equivalent to a 4 pipe chiller system

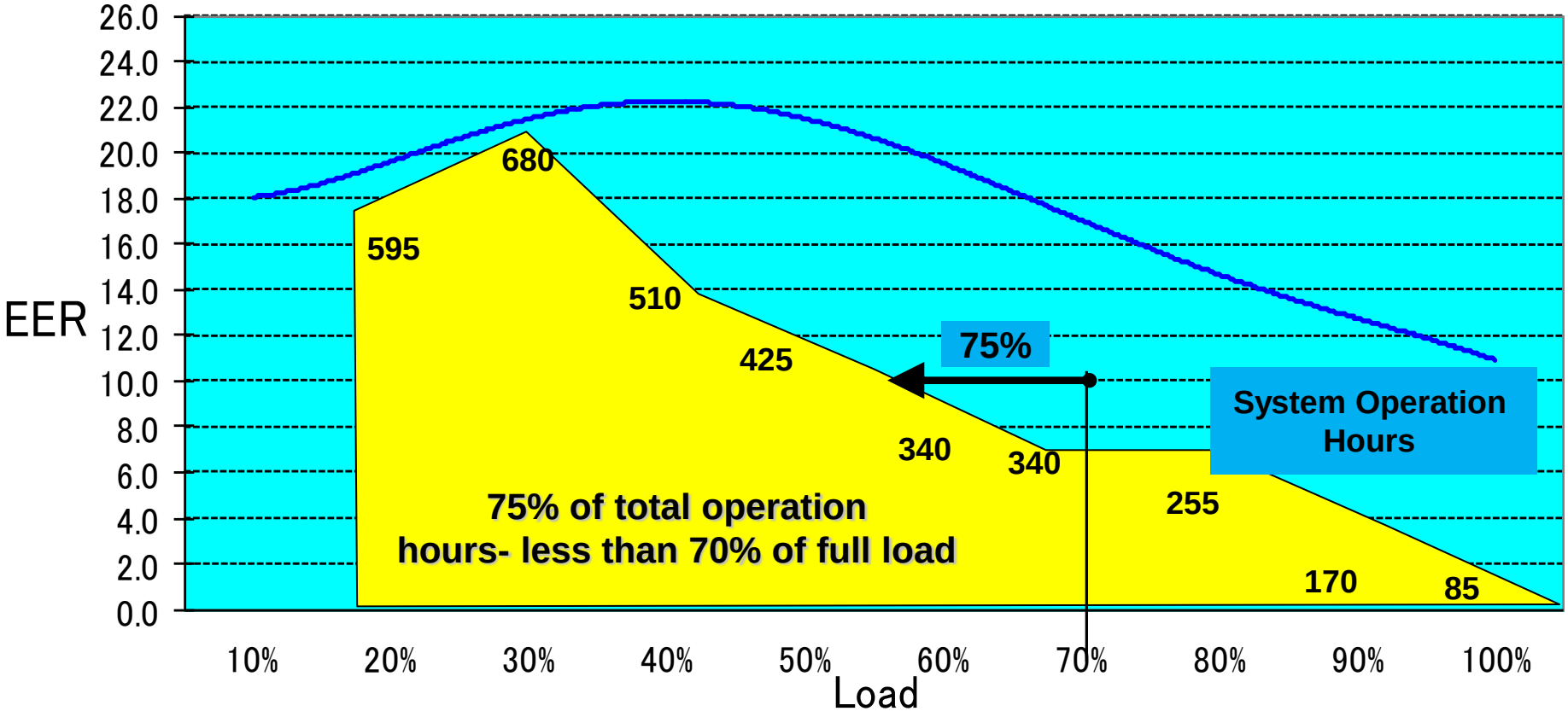




Heat Transfer Media



Average VRV System Performance



Why VRF

- Energy Efficiency - INVERTER-driven compressor technology, can simultaneously heat and cool, virtually eliminating duct loss.
- Zoned Comfort - Each individual zone can have personalized comfort as the system delivers the right amount of refrigerant to precisely meet the load in a space.
- Quiet Operation - Indoor and outdoor units are so quiet that they can be placed just about anywhere, giving you more flexibility on how to use indoor and outdoor space. Outdoor units can even be placed directly under a window , quiet indoor units are perfect in environments that require minimal disruption like schools, places or worship, libraries and more.
- System Simplicity – Samsung 2/3- Pipe System simpler to install and service. Routine maintenance consists of changing filters and cleaning coils.
- Aesthetics - HVAC systems don't have to get in the way of design. Small outdoor units provide for flexibility of placement and indoor units can be painted to blend in with your environment.
- Lower Lifecycle Cost - Operate with minimum energy usage. Only service the zones that need it, which allows for less required maintenance.
- Safety - Zoned structure does not recirculate air into other zones, reducing the spread of airborne contaminants and allergens.

Where does VRF Fit ???

BUILDING SIZE						
	<50 TONS	<100 TONS	<250 TONS	<500 TONS	<1000 TONS	>1000 TONS
VRV	✓	✓	✓	✓	✓	✓
PTAC	✓	✓				
SPLIT SYSTEM	✓	✓				
CV RTU	✓	✓				
VAV ROOFTOP		✓	✓			
AIR COOLED CHILLER		✓	✓	✓		
WATER COOLED CHILLER				✓	✓	✓
CENTRAL AHU	✓	✓	✓			
CUSTOM AHU				✓	✓	✓
FAN COIL		✓	✓			
UNIT VENTILATOR	✓	✓	✓			

Where does VRF Fit ???

VERTICAL MARKETS

	DATA CENTERS	DORMS	HEALTH	OFFICES	RES HOUSING	SCHOOLS	SKILLED CARE	CHURCH	HOTELS	LIBRARIES
VRV		✓	✓	✓	✓	✓	✓	✓	✓	✓
PTAC		✓		✓	✓		✓		✓	
SPLIT SYSTEM		✓		✓	✓		✓	✓		
CV RTU				✓		✓		✓		
VAV ROOFTOP				✓		✓	✓	✓		✓
AIR COOLED CHILLER	✓	✓	✓	✓		✓	✓	✓	✓	✓
WATER COOLED CHILLER	✓	✓	✓	✓		✓	✓		✓	✓
CENTRAL AHU	✓		✓	✓		✓	✓	✓		✓
CUSTOM AHU	✓		✓	✓		✓				
FAN COIL		✓		✓	✓	✓	✓	✓	✓	
WATER SOURCE HP		✓		✓	✓	✓	✓		✓	
UNIT VENTILATOR				✓		✓				

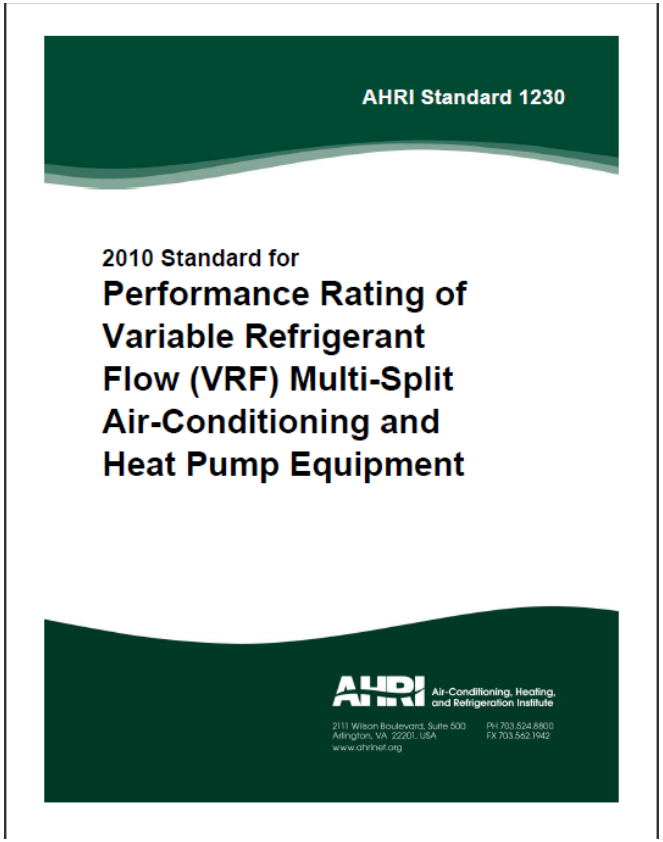
Why does VRF Fit ???

ATTRIBUTES

	DORMS	OFFICES	RES HOUSING	SCHOOL	SKILLED CARE	CHURCH	HOTELS	LIBRARY
EFFICIENCY	✓	✓	✓	✓	✓	✓	✓	✓
LEED, TAX CREDITS, ETC.	✓	✓		✓		✓	✓	✓
SOUND	✓	✓		✓		✓	✓	✓
MAINTENANCE	✓		✓	✓	✓	✓	✓	✓
INSTALLATION EASE	✓		✓	✓	✓	✓	✓	✓
ELECTRICAL BENEFITS	✓	✓	✓	✓	✓	✓	✓	✓
STRUCTURAL BENEFITS	✓	✓	✓	✓	✓	✓	✓	✓
1ST COST	✓	✓	✓	✓	✓			✓

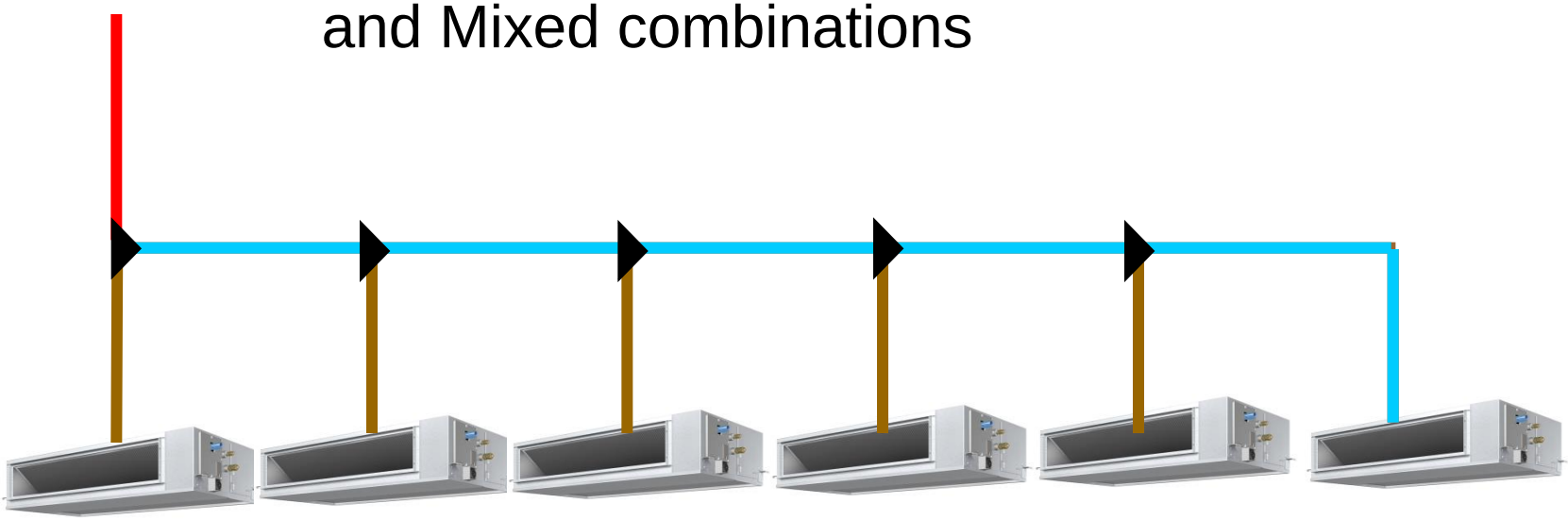
What is AHRI 1230?

- AHRI 1230 is a testing and rating standard specially designed for VRF systems
- This allows manufacturer's to show VRF efficiency levels for:
  - Full Load
  - Part Load/Seasonal Cooling Performance
  - Heat Recovery



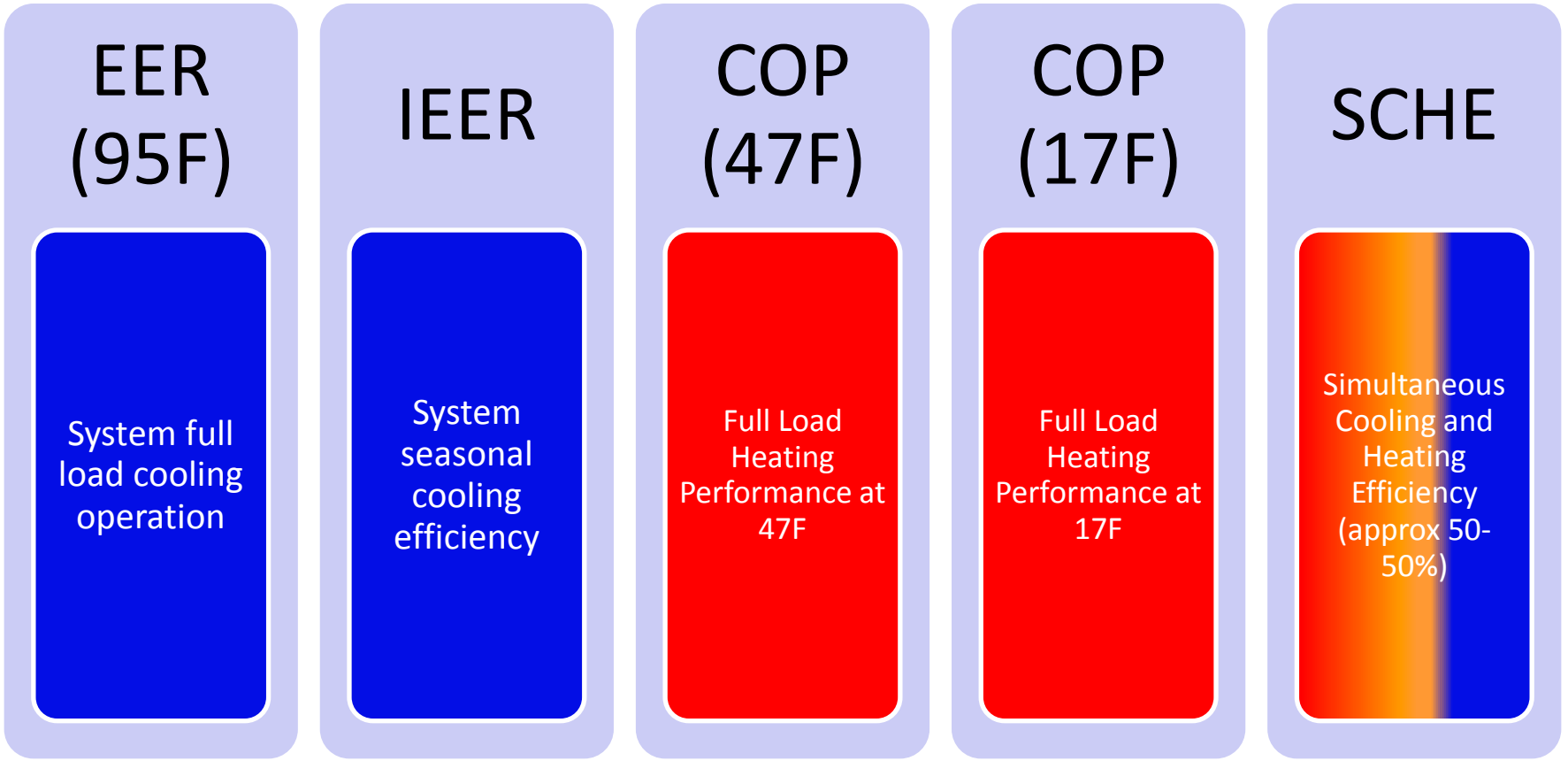
Efficiency Metrics

- All efficiency values are based on the entire system performance including
  - Outdoor unit energy input/output
  - Energy input/output of indoor units
  - Piping loss correction factors to reflect real life building performance (longer piping for larger capacity systems)
- We are able to show efficiency levels for Ducted, Ductle and Mixed combinations



Efficiency Metrics

How are we going to measure this?



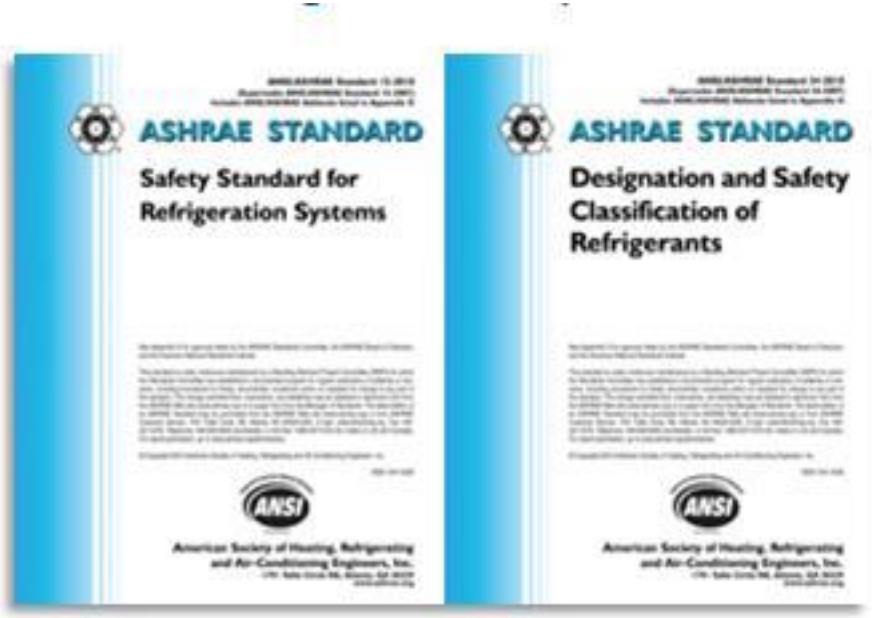
Metrics - IEER

- IEER vs. IPLV
  - **IPLV** did not consistently set part load capacities.
    - Not accurate for multi-stage or VFD compressors
  - **IEER** requires ratings at specific load conditions
    - Uses sliding ambient temperature scale (IPLV was fixed at 80°F)

Stage	Ambient	Actual % Load
	(F)	(Net Cap)
4	95.0	100
3	81.5	75
2	68.0	50
1	65.0	25

ASHRAE – Standards 15 & 34

Safety Requirements for Refrigerating Systems



ASHRAE 15

The purpose of Standard 15 is to ensure the safe design, construction, installation and operation of refrigeration systems by establishing safeguards for, health, and property and prescribing specific safety requirements.

(The standard was originally recognized in October 1930 to address Dangers to 1000 lbs of Ammonia and Refrigerants, 1978 it was issue by ASHRAE as standard 15)

ASHRAE Standard 15 for VRF

- When designing a refrigerant pipe system for VRF, refrigerant safety must be considered
- Local codes and ASHRAE Standard 15 (in conjunction with ASHRAE Standard 34) provide guidelines to assist in designing safe VRF refrigerant systems

Article – Section D

Occupied Spaces

Addendum L to ASHRAE Standard 34-2010 has established the maximum RCL to 26lbs of room volume for occupied spaces.

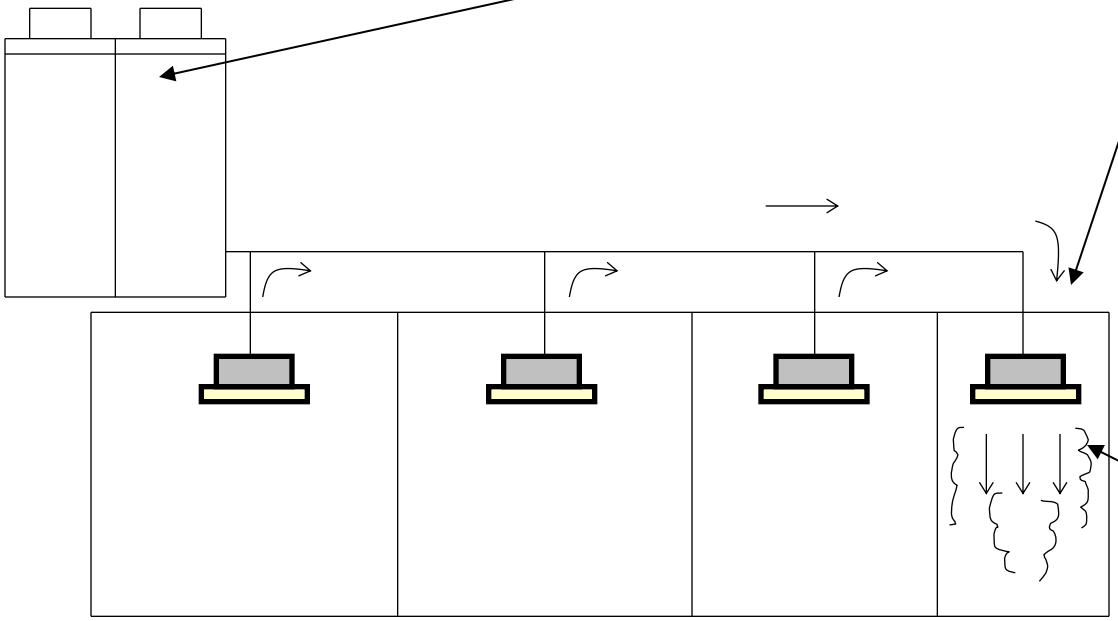
ASHRAE 15/34

- **Establishes maximum allowable volume of R410A refrigerant concentration level (RCL) in an occupied space**
- **26 lbs per 1000 cubic feet for commercial and residential occupancies**
- **13 lbs per 1000 cubic feet for institutional occupancies**

Occupied Space

- Occupied space is the smallest room volume.
- Other spaces not air tight to the smallest room are considered as part of it.
  - Example:
    - False ceiling voids.
    - Crawl ways.
    - Ducts.
    - Movable partitions.
    - Doors with transfer grilles.
    - Undercut Doors

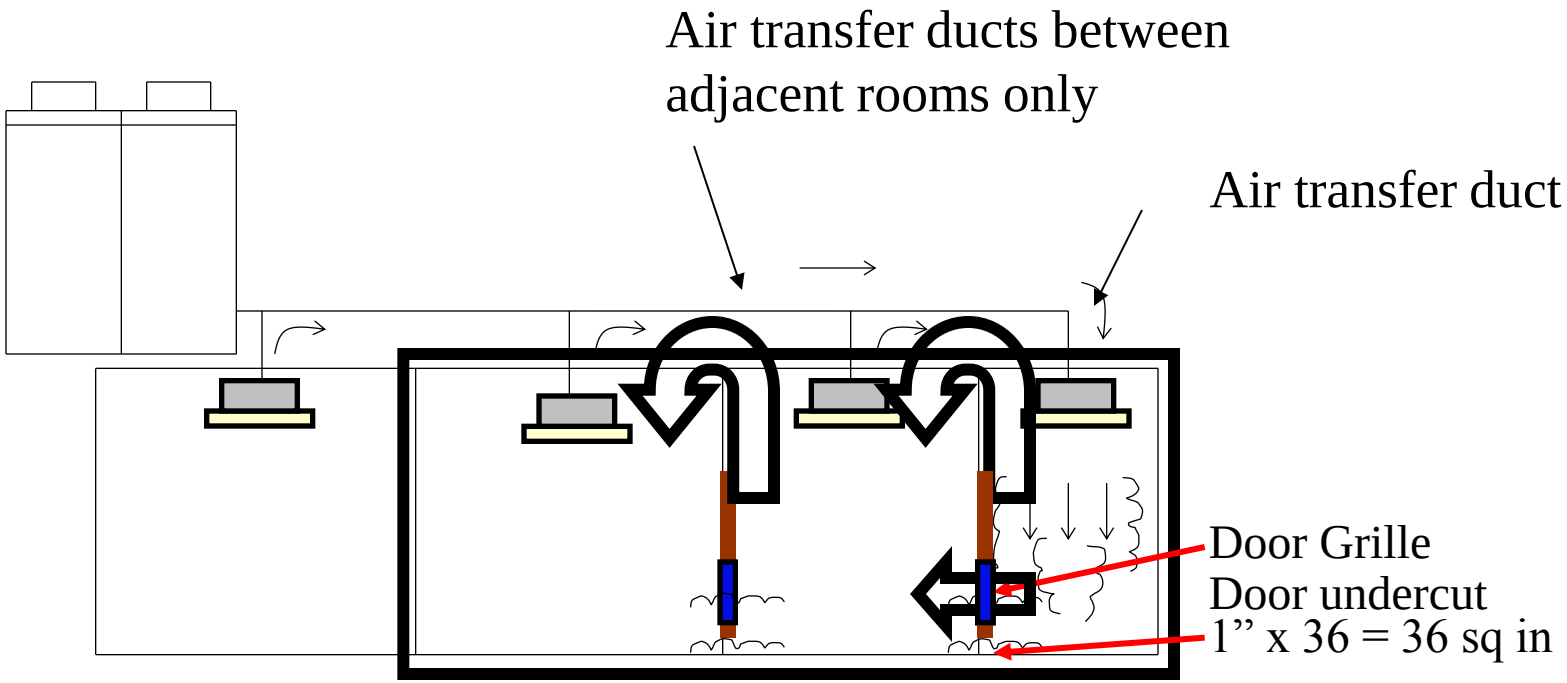
Example


8 Ton VRF A/C CU
12000 btu/h VRF FCU
Occupied space
12 x 12 x 9 ft
= 1296 ft3

Calculation

- R410A Refrigerant (proposed limit)
  - Max ref charge = max concentration x vol small space.
  - Max ref charge = .026lb x 1296 ft3.
  - Max ref charge = 33.69 lbs
  - VRF 8 ton system – 16.3lbs. cond charge + additional piping for another 10.9 lbs. = 27.2lb total charge
  - This application would comply unless it were institutional which would only allow 16.85 lbs.

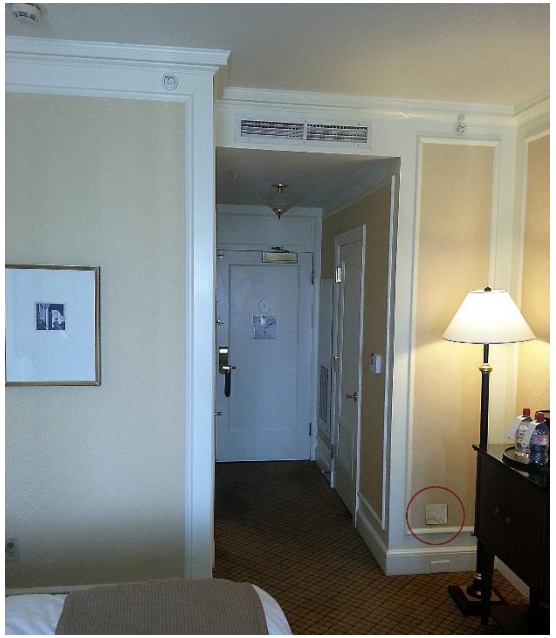
Transfer Grille Example



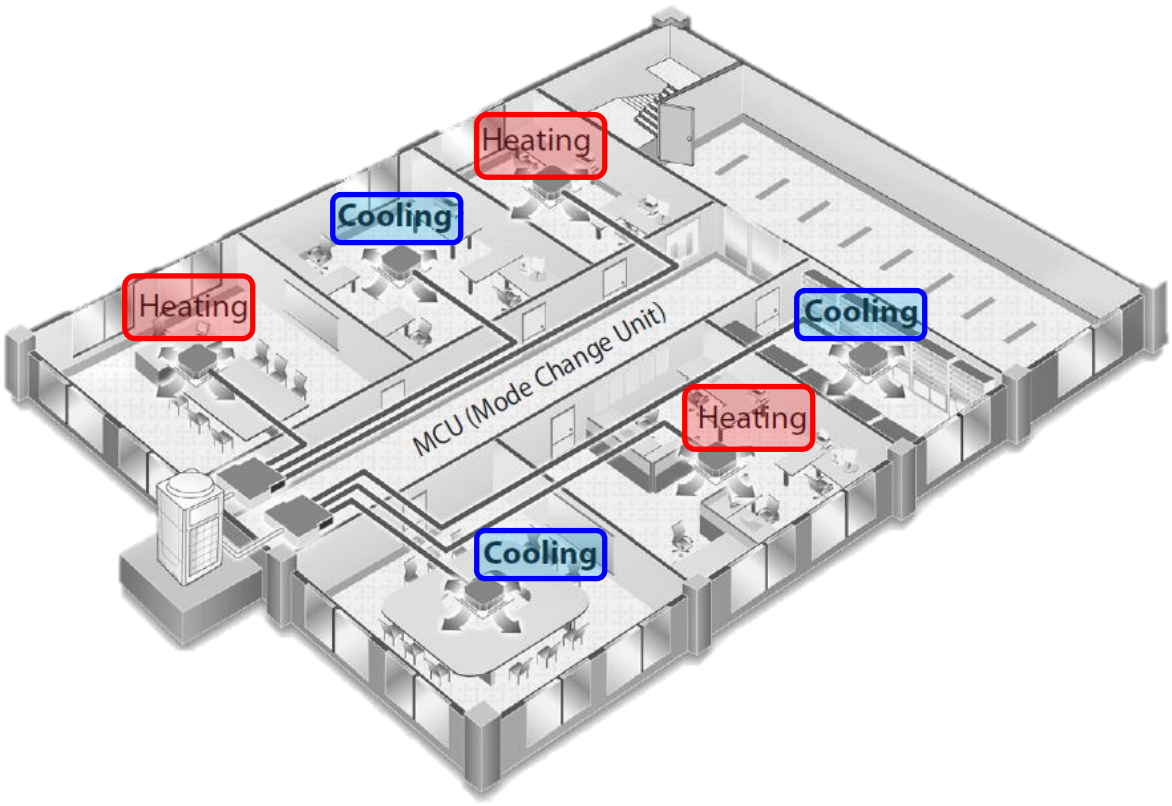
Occupied space = ?

Refrigerant Alarms

- Refrigerant detectors and alarms are permitted by the standard.
- Detectors and alarms must be appropriately maintained.
- Refrigerant detectors cost about $500 each.
- Generally not feasible due to high cost.



Zoning System Lay Out



VRF Zoning & System Layout

- Make you think about all variables..
  - **Considerations before you begin**
  - Listen to what the customer is asking for…
  - Common VRF misconceptions
  - Controls / CU/FC Selections
  - Building diversity & zoning overview
  - Efficiency benefits of heat recovery
  - Practical example exercise

Before You Begin - Back to Basics

- Listen first, then take the time to evaluate the possible options that can be offered to the customer
  - Do they need individual control in every zone/room?
  - Are they more concerned about first cost or system efficiency/operating cost?

Before You Begin - Back to Basics

- Make sure you understand both the customer's needs and wants for their particular project
  - Do they need simultaneous heating and cooling?
    - If yes, is there load diversity in the building to take advantage of this?

Total First Cost

Zone Control

Quiet Operation

DVM S Controls

Centralized Control // Individual Control

S NET3
Software

MIM-B17N
BACnet Gateway

MIM-B18N
LON Gateway

MIM-D00AN
DMS 2.0 Data
Management Server

MCM-A300N
Touch Controller

Characteristics of Outdoor Units

DVM-S ECO
DIGITAL VARIABLE MULTI

Heat Pump

208-230V / 1Ø

3 – 5 Tons

Up to 16.0 SEER

DVM S
DIGITAL VARIABLE MULTI

Heat Pump & Heat Recovery

208-230V / 3Ø 460V / 3Ø

6 – 44 Tons

Up to 38.2 IEER

DVM S WATER - GEO™
DIGITAL VARIABLE MULTI

Heat Pump & Heat Recovery

208-230V / 3Ø 460V / 3Ø

6 – 48 Tons

Up to 30.1 IEER

VRF Indoor Units

Available Indoor
Unit Configurations

From .6 ton to 8 ton

VRF Indoor Units

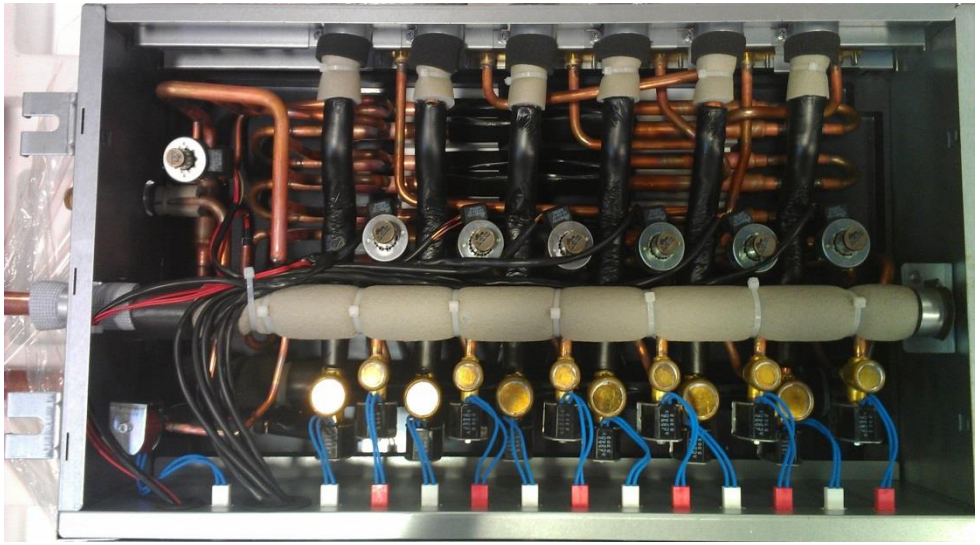
- Reasons for using particular indoor units
  - Ducted units
    - Common areas
    - Open plan areas
    - Offices or cubicle farms on one heat/cool changeover group
    - Think “VAV” approach

VRF Indoor Units

- Reasons for using particular indoor units
  - Non-ducted units
    - Single rooms, offices or zones requiring individual temp. and/or operation mode control
    - Equipment rooms, electrical risers or IT rooms (RAC single split or CAC one-to-one systems)
    - Zones where ductwork is impractical or cost prohibitive

Mode Change Units (Heat Recovery)

3 Sizes available – 2, 4 & 6 port



Common Misconceptions

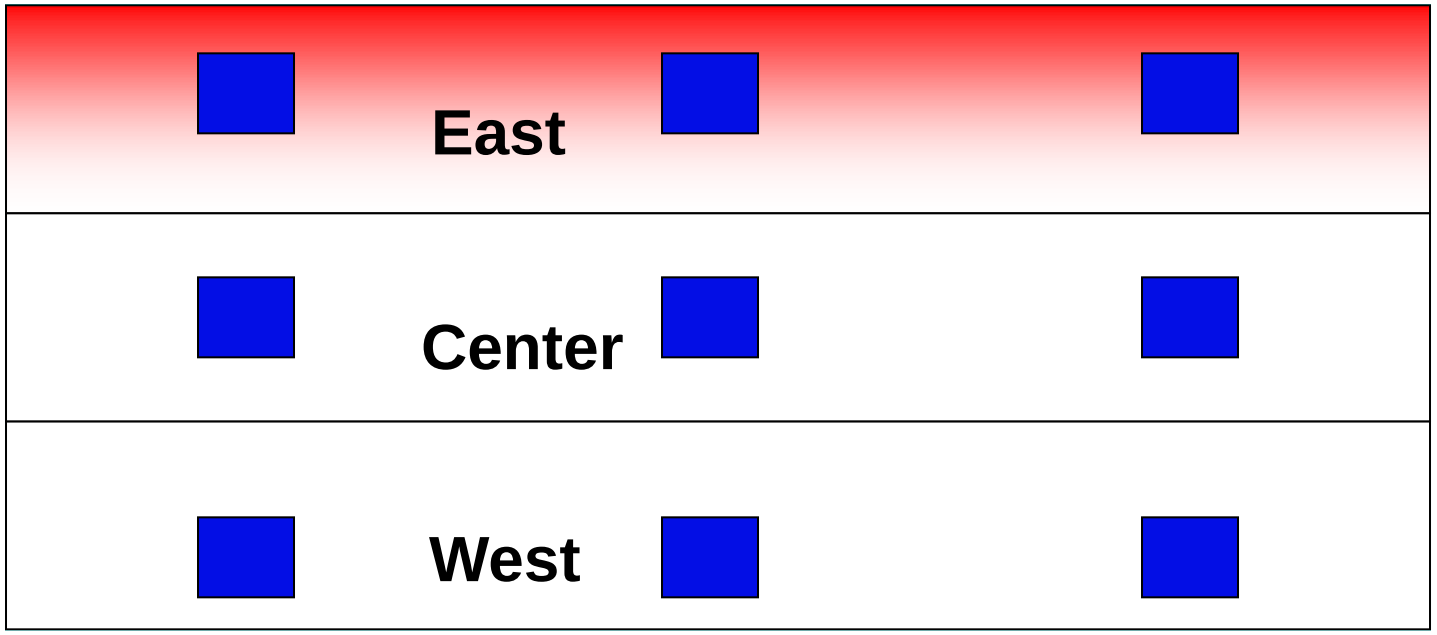
- ***VRF just a large multi-split system***
  - VRF is a modular heat pump chiller that is circulating refrigerant instead of water
- ***I have to put an indoor unit in every room***
  - Think about the design layout the way you would design a VAV system

Common Misconceptions

- ***VRF is only good if I need ductless***
  - This can leads to an indoor unit in every room/zone
  - Over 50% of VRF indoor units sold in North America are actually ducted units
- ***The whole application must be VRF***
  - Combine VRF with rooftop units for large open plan spaces or large amount of outside air
  - Mix and match HP and HR to suit the application

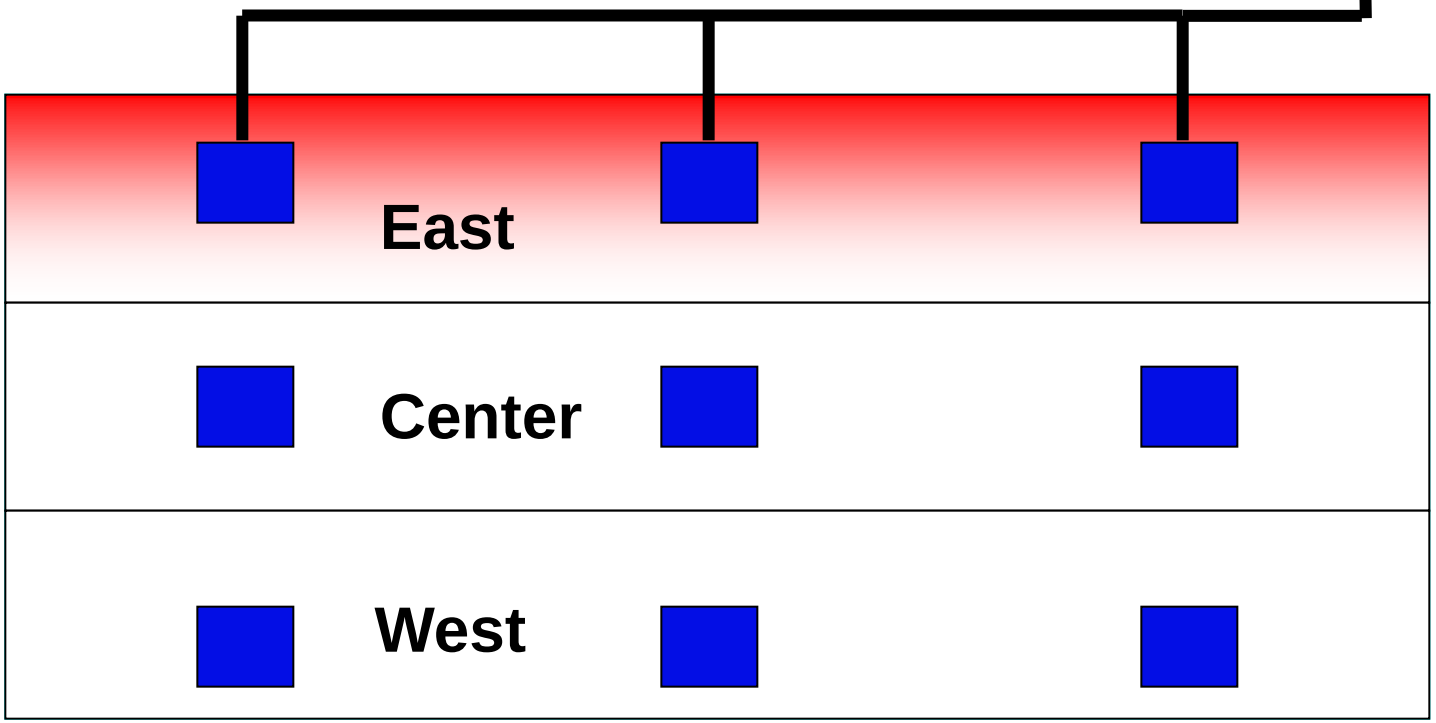
Diversity & Zoning

- Clarify zoning of each floor level



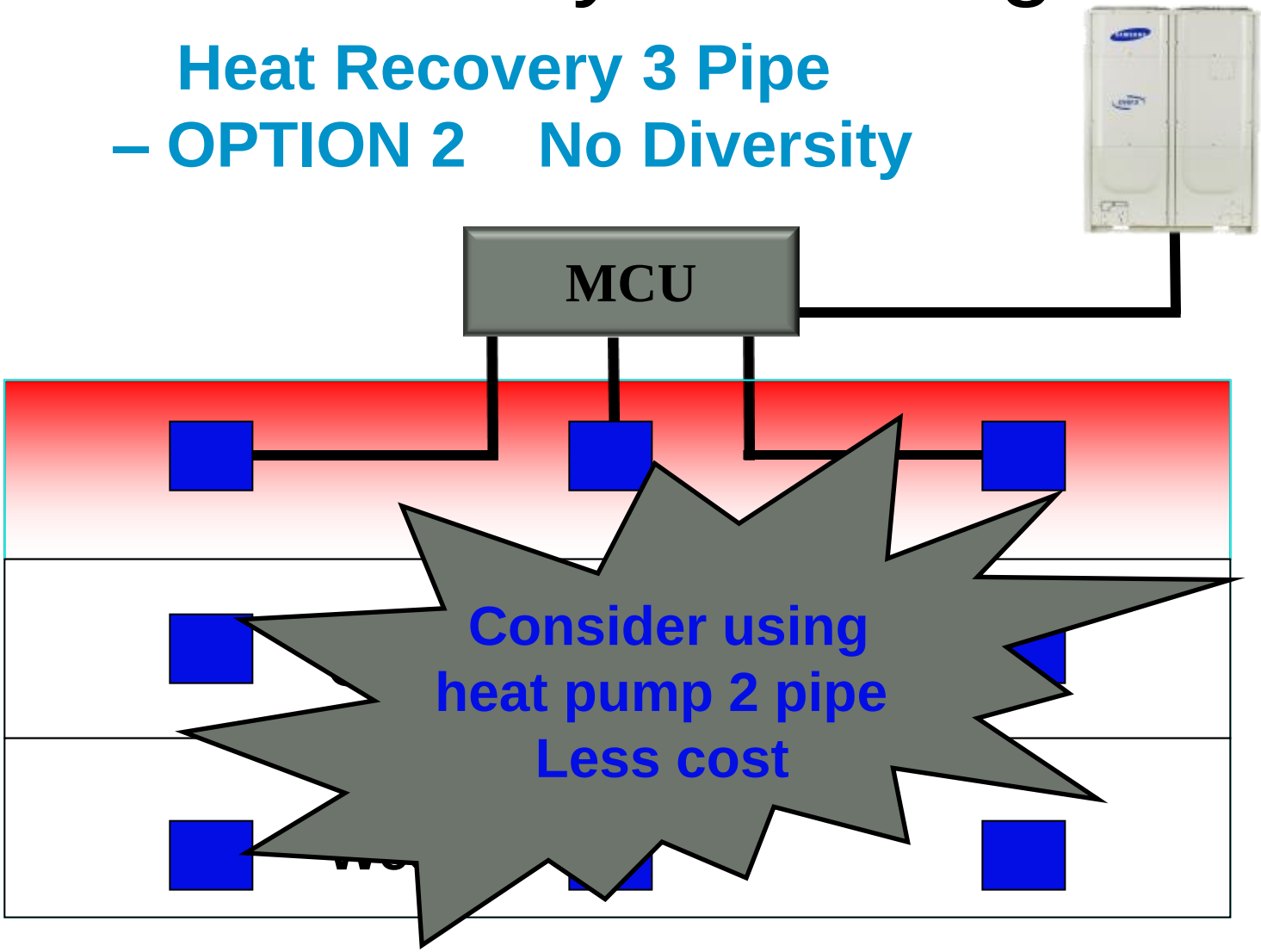
Diversity & Zoning

Heat Pump 2 Pipe – OPTION 1 No Diversity



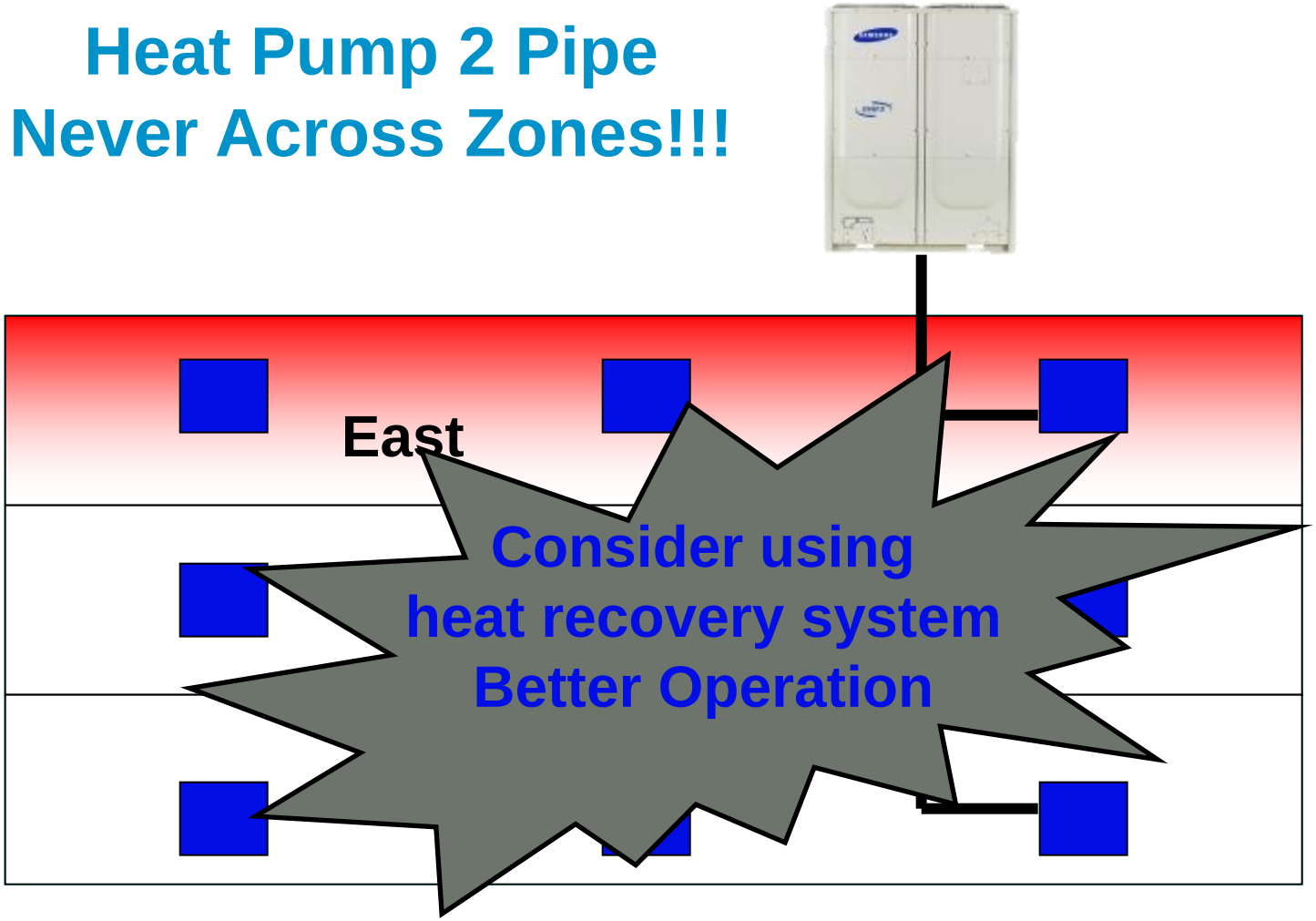
Diversity & Zoning

Heat Recovery 3 Pipe
– OPTION 2 No Diversity



Diversity & Zoning

Heat Pump 2 Pipe
Never Across Zones!!!



“Block Load” Review

- Systems selections are based on indoor peak loads and overall system block loads
- The system block load can be defined as the largest sum of all zone loads at any one time of day (year)

9:00 a.m.

Zone A 6,000 BTU/hr	Zone B 4,000 BTU/hr
Zone C 10,000 BTU/hr	Zone D 14,500 BTU/hr

Total: 34,500 BTU/hr

12:00 p.m.

Zone A 13,000 BTU/hr	Zone B 7,000 BTU/hr
Zone C 13,000 BTU/hr	Zone D 22,000 BTU/hr

Total: 55,000 BTU/hr

3:00 p.m.

Zone A 14,500 BTU/hr	Zone B 4,000 BTU/hr
Zone C 17,000 BTU/hr	Zone D 10,000 BTU/hr

Total: 45,500 BTU/hr

  - Here are load calculations for three different times of day. The largest total load occurs at 12:00pm. This would then be your block load used to size the ODU.

“Block Load” Review

- You’ll notice zones A and C have a higher load at a different time of day

9:00 a.m.

Zone A 6,000 BTU/hr	Zone B 4,000 BTU/hr
Zone C 10,000 BTU/hr	Zone D 14,500 BTU/hr

Total: 34,500 BTU/hr

12:00 p.m.

Zone A 13,000 BTU/hr	Zone B 7,000 BTU/hr
Zone C 13,000 BTU/hr	Zone D 22,000 BTU/hr

Total: 55,000 BTU/hr

3:00 p.m.

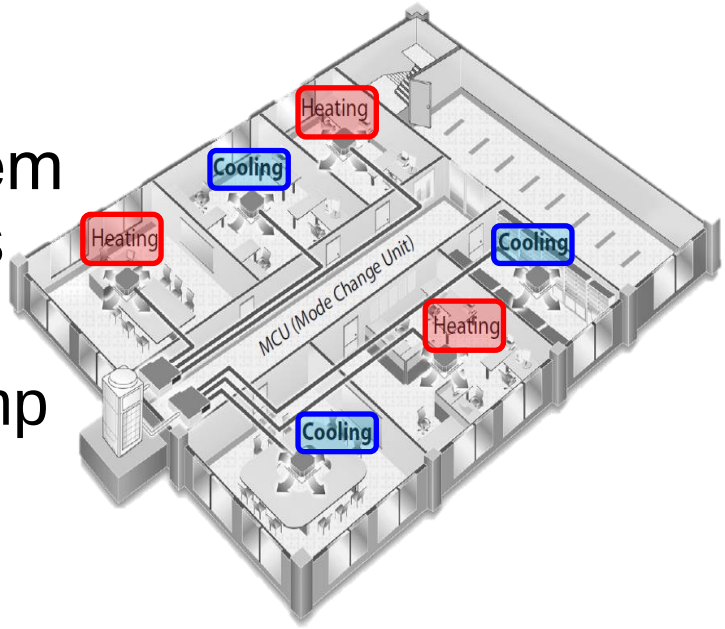
Zone A 14,500 BTU/hr	Zone B 4,000 BTU/hr
Zone C 17,000 BTU/hr	Zone D 10,000 BTU/hr

Total: 45,500 BTU/hr

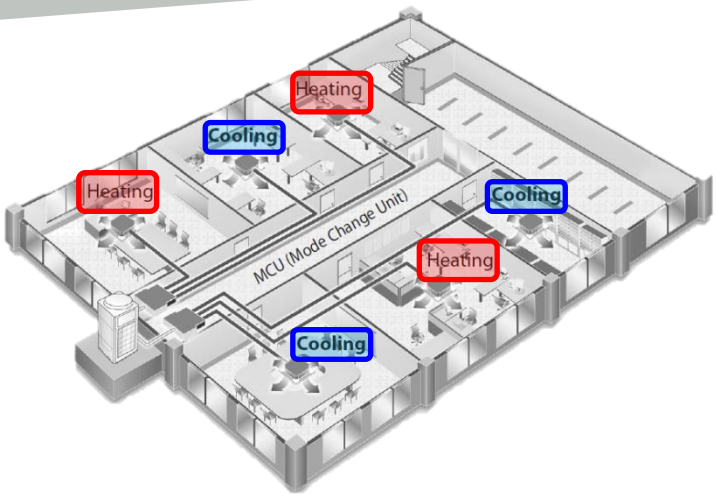
  - These would then be considered your zone peak loads
  - Sum of the peaks = 60,500

“Block Load” Review

- Zone peak and system block loads need to be determined before beginning
- Piping lengths need to be determined or estimated to account for adequate capacity de-rates
- You wouldn’t size a chiller system without this information and this shouldn’t be any different
  - VRF is simply a small heat pump chiller that is circulating refrigerant instead of water



Connection Ratio



=Sum of nominal Fan Coil Capacity / Nominal Condenser (ODU) Capacity

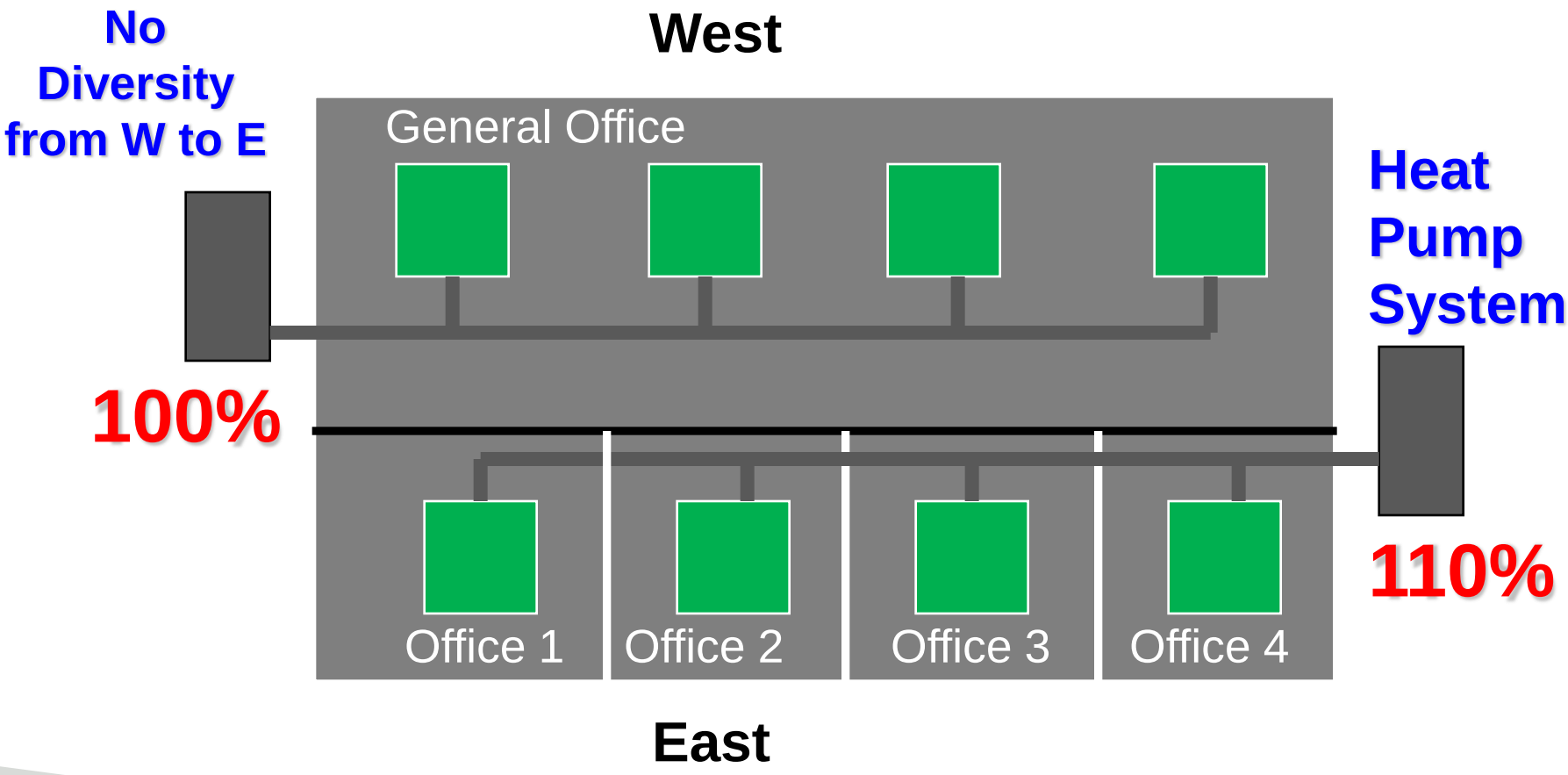
Minimum – 50%

Recommended Maximum – 130%*

***Larger connection ratios are available – consult manufacturer**

Common Zoning Issues

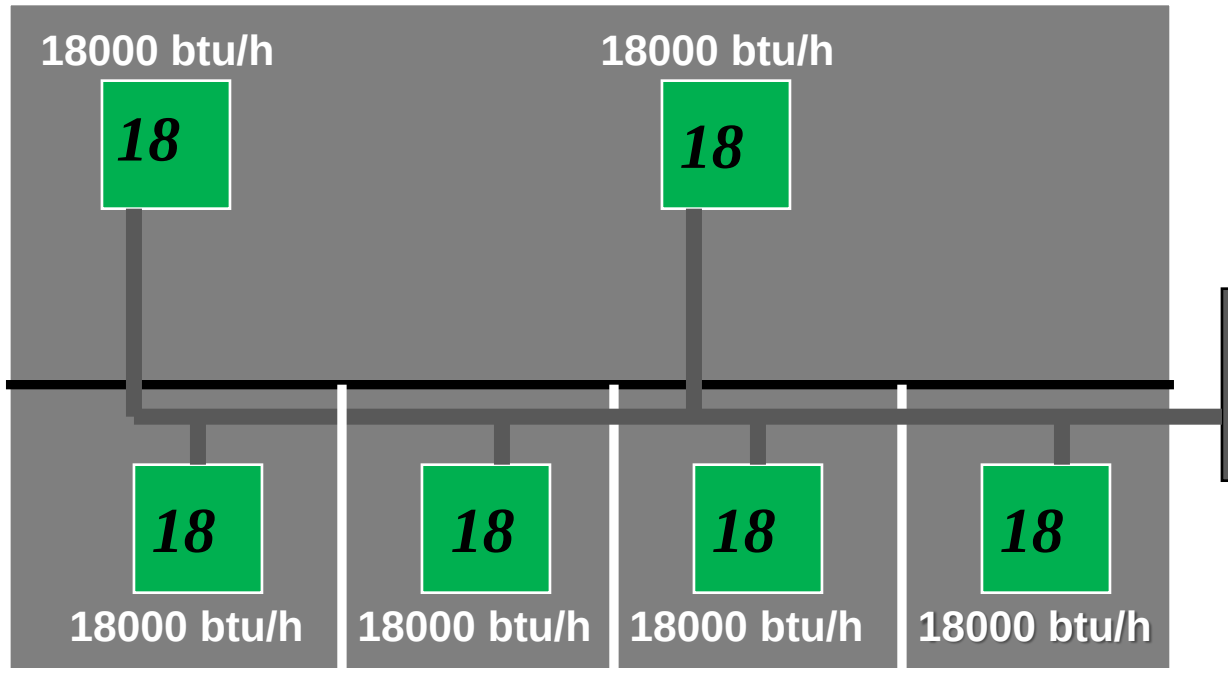
Using Heat Pump Diversity



Common Zoning Issues

Heat Recovery Example

(AM096FXV, 8 ton Condenser)



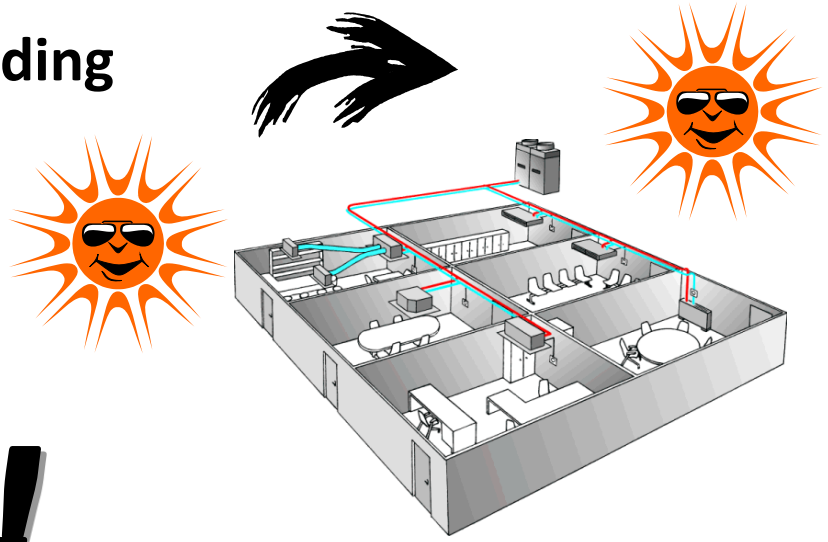
Sum of Peaks
6 x 18000 = 108000
Combination Ratio
= 112.6%
Capacity = 96000
CU too small

Block Load
Load = 90000
Combination Ratio
= 112.6%
Capacity = 96000
CU capacity OK
operates <100%

Considerations for higher connection ratio's

Higher connection ratio's are suitable in the case of:

- **A high diversity factor of your building**
- **Small required capacity**
  - **e.g. small office or hotel room**



Caution!

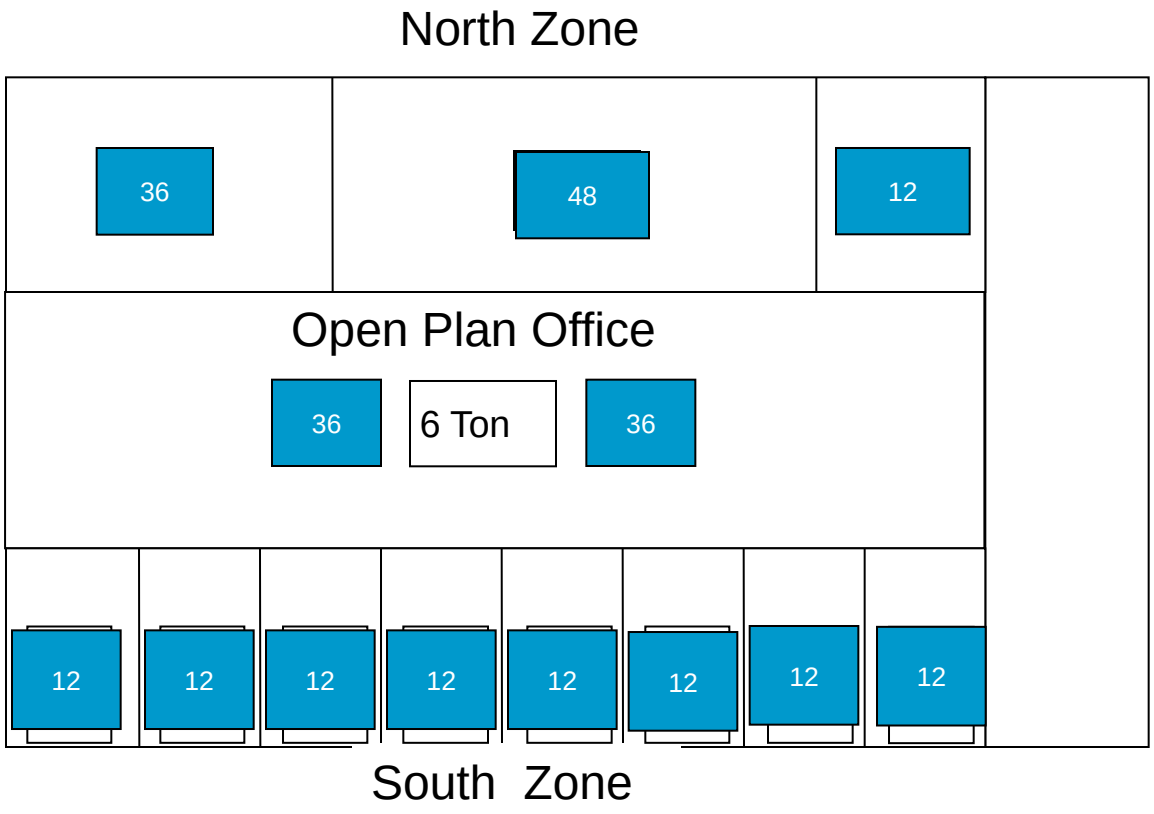
The outdoor unit must be able to meet the system block load

Heat Recovery Systems

- Guidelines on when and where to use heat recovery mode change units
  - Conference rooms
  - Hotel applications
  - Multiple tenant/shared condenser applications
  - Nursing Homes
  - Building areas with usable diversity

Building Example

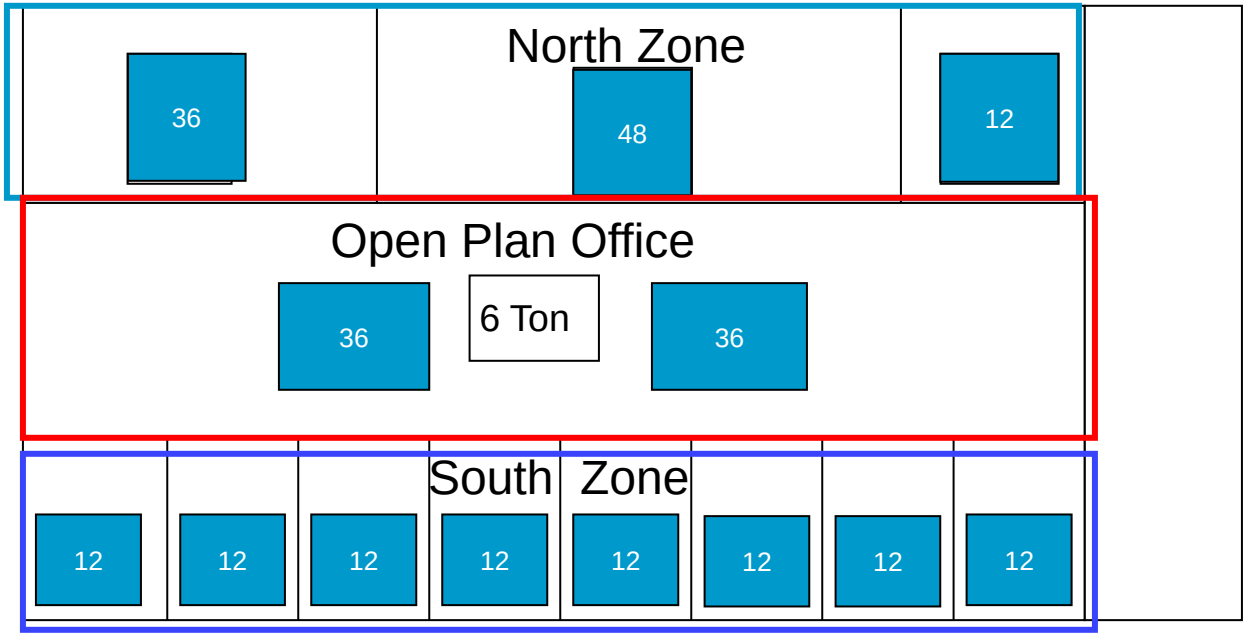
- 10,000 ft² single floor office space
  - 4 open plan office spaces, 8 single offices & a server room
  - Office Space has a peak load of 26 tons & block load of 20 tons
- Customer requests temperature control in each room



*Nominal conditions with no correction factors have been used for example purposes only

Building Example - HP

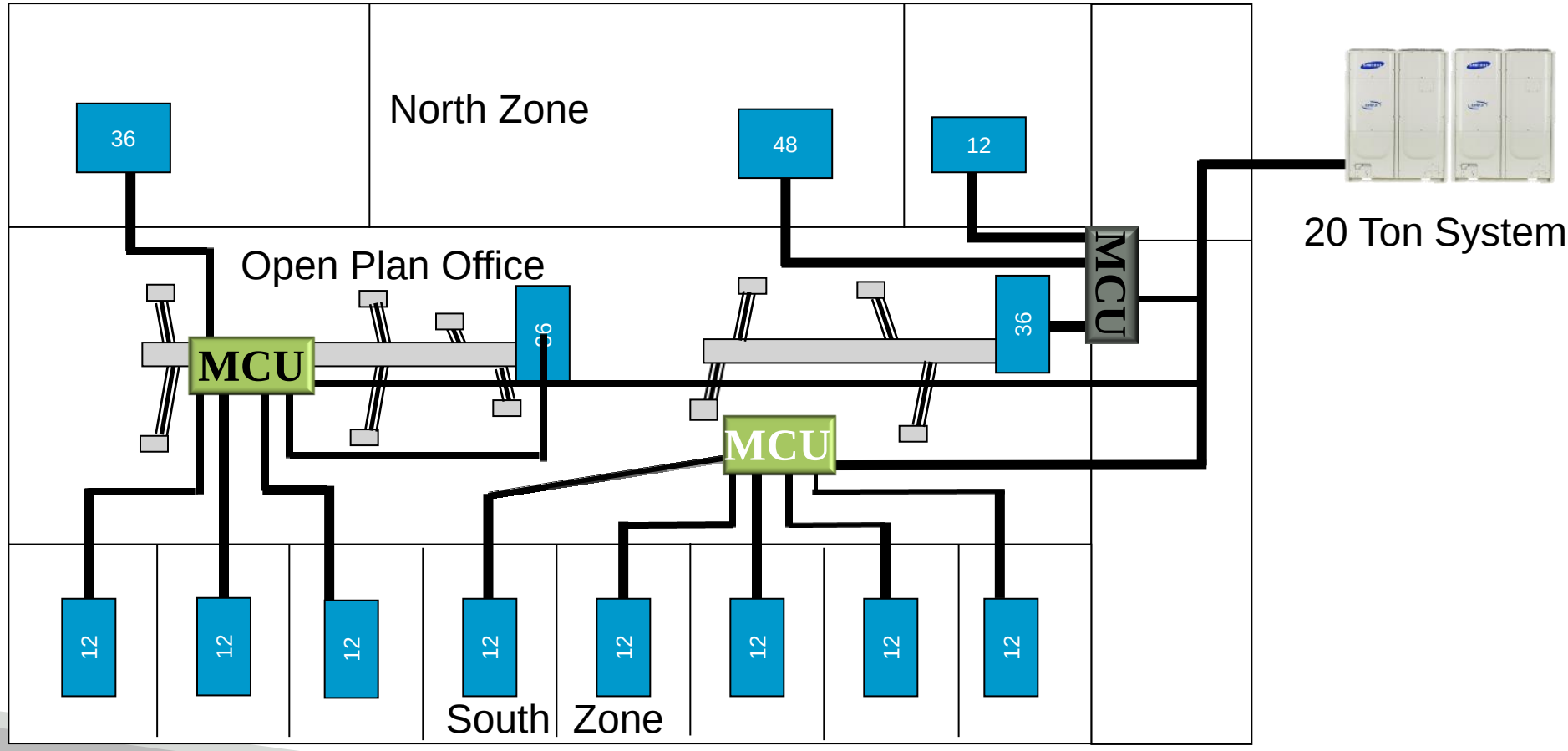
- The most cost effective way is to design around heat pumps, right?
- This project consists of 3 main heat cool changeover groups
  - This would mean 3 VRF heat pump outdoor units
  - Approximate VRF Installed Cost = 100% (this will be used as the baseline cost)



*Nominal conditions with no correction factors have been used for example purposes only

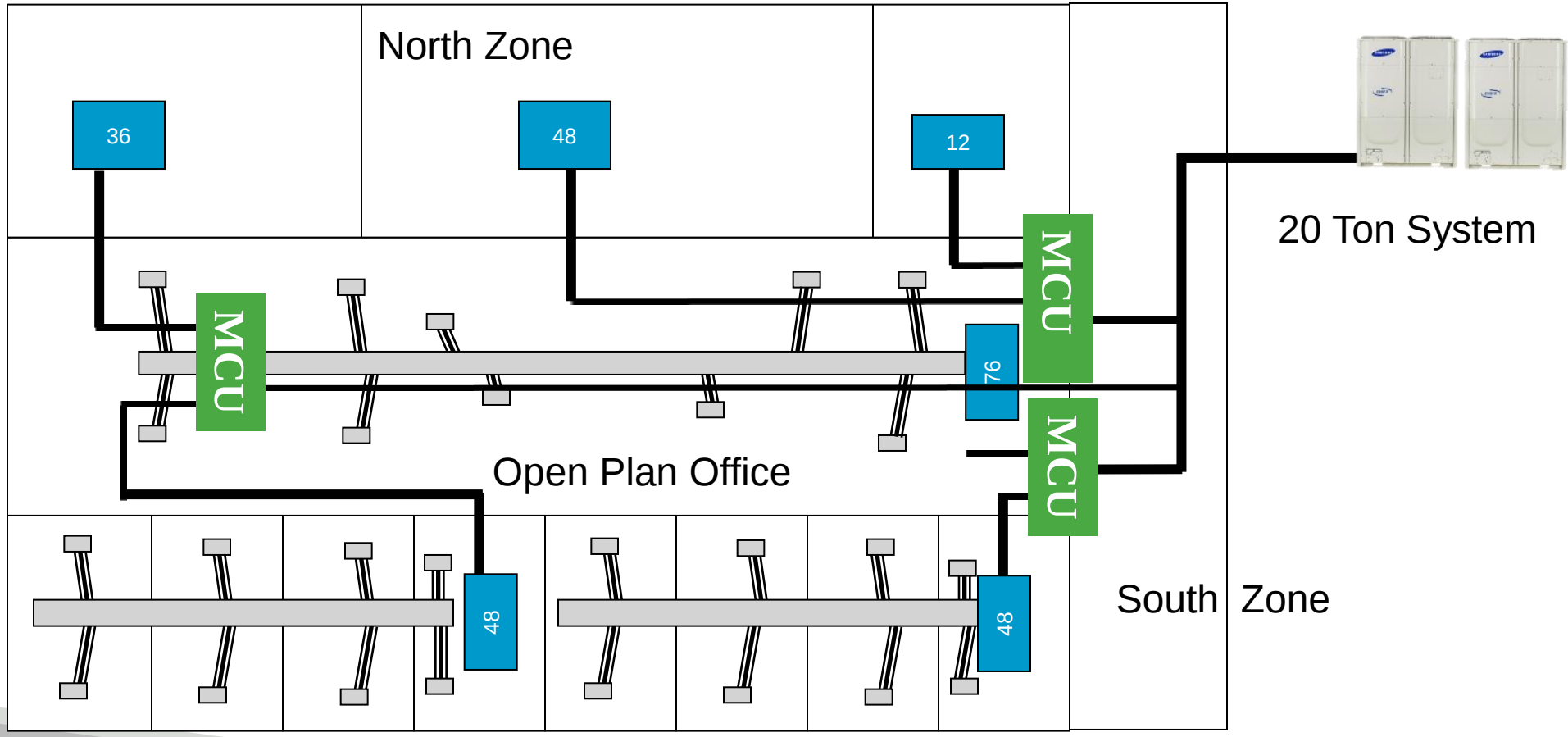
Building Example - HR

- As the customer is looking for temperature control per zone this would mean a mode change unit port for each indoor unit
- This is an effective, efficient solution but can increase first cost
  - Approximate VRF installed cost – 110%



Building Example - HR

- The most cost effective solution would be to zone the system as you would a VAV system
- This reduces overall equipment and installation costs
  - Approximate VRF installed cost – 73%
  - This does not meet the customers requirements of temperature control per zone



Ventilation Market Requirements

The ventilation requirements are very different based on

1. **Vertical market** type
    1. Project classification & occupancy density
2. **Climate**
    1. Temperature & humidity
3. **Project budget constraints**
4. **Engineers preference**

OA Integration Methods

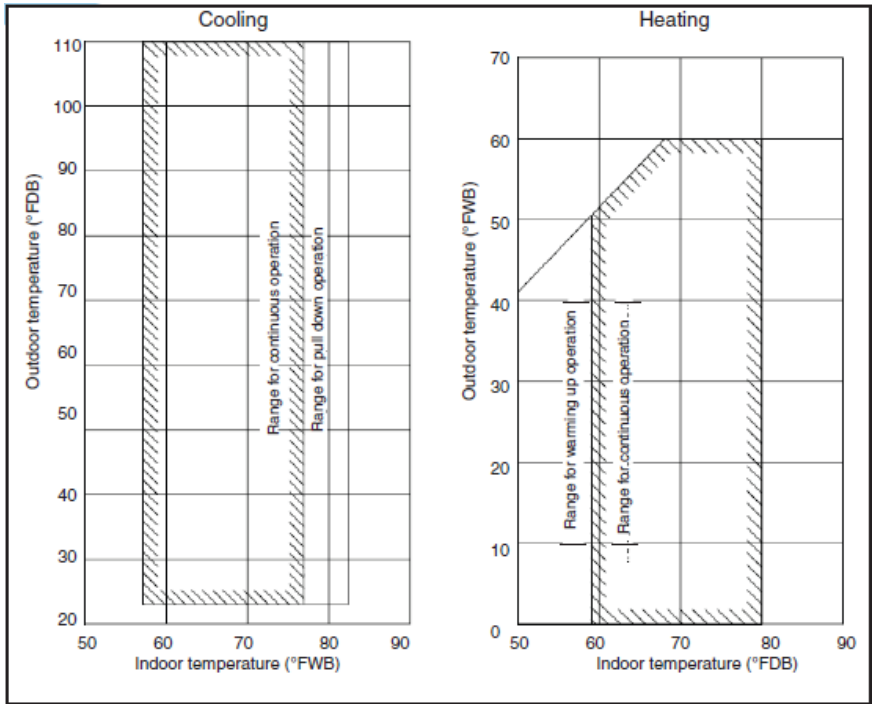
- Direct Method
- Integrated Method
- Separate Method (Decoupled)

Direct Method

- Untreated ventilation is supplied directly to the indoor unit
- Small projects where low cfm volumes are required
- Projects with budget constraints
- Suitable for mild climates

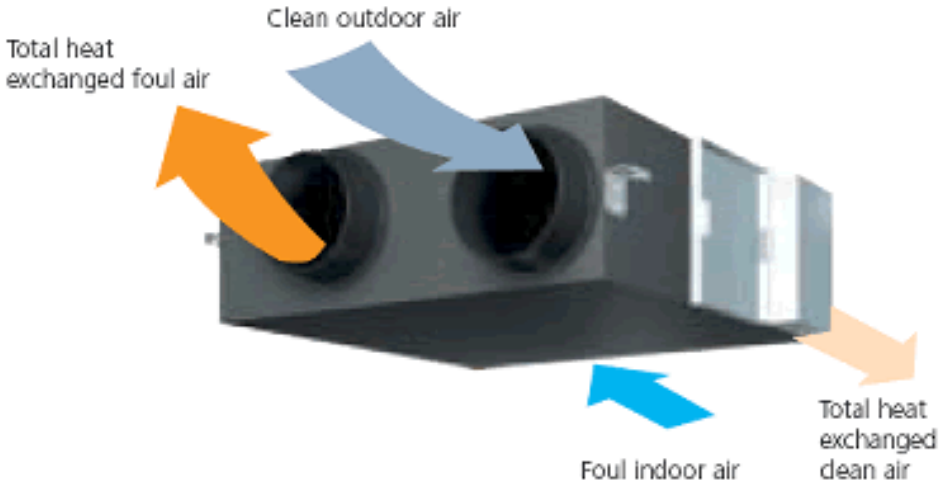
Direct Method

- Checklist
  - Indoor unit type must have ventilation capability
    - Ducted
    - Cassettes
  - A booster fan may be required
    - If using a booster fan Interlock with indoor unit
  - Mixed air must be within the indoor unit limitations
  - Unit control must be from the space temperature not return air
  - Indoor unit must be sized for both space and ventilation loads
  - Ventilation % should be considered



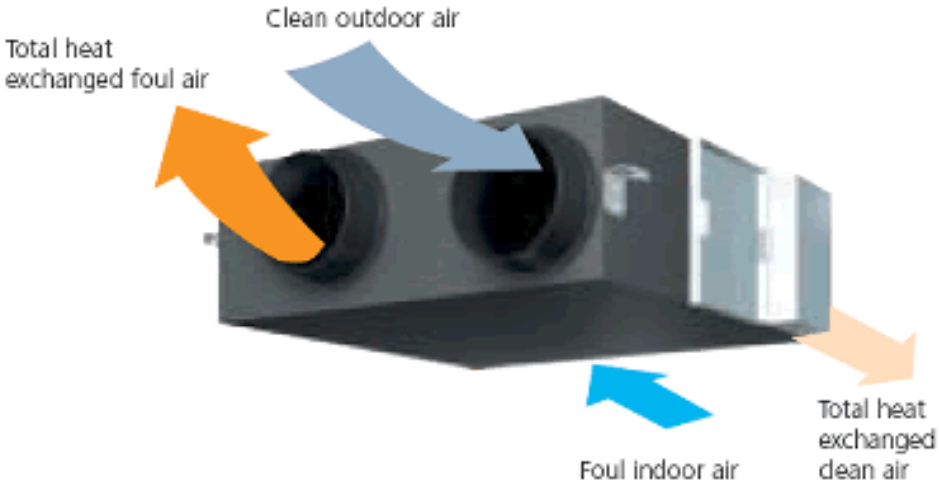
Integrated Method

- Pretreated ventilation is supplied directly to the indoor unit
- Small to medium applications
- Suitable for all climates
- Allows for sharing load between ventilation system and VRF system



“NEW” ERV The Basics

- Pre-condition the ventilation air by capturing waste heat from the exhaust air stream
- Powered Energy Recovery
  - Supply fan
  - Exhaust fan
- Total Energy Recovery
  - Sensible - temperature
  - Latent - moisture
- Flexible control strategies



Separate Method (decoupled)

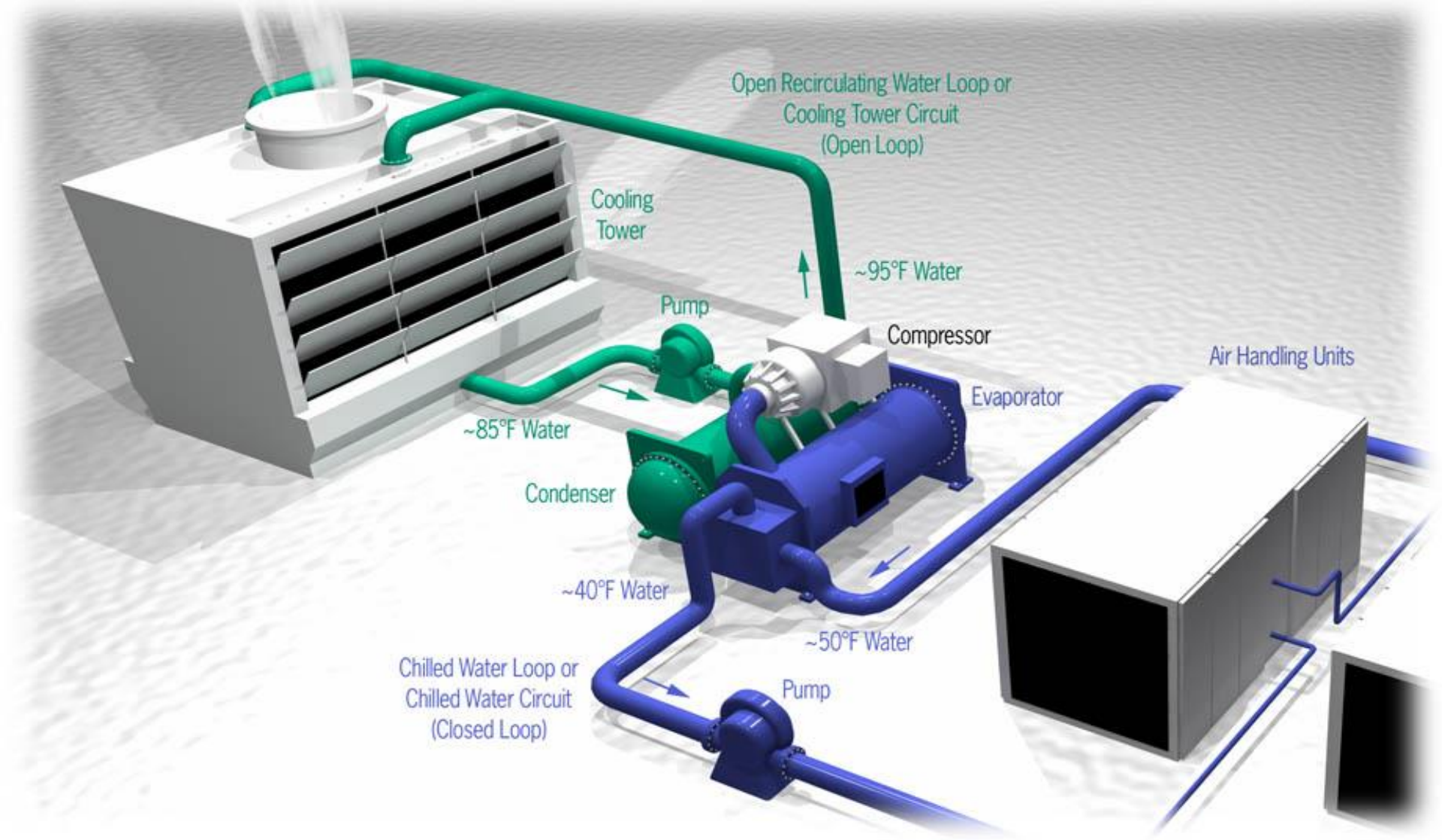
- Pretreated ventilation directly to the space
- Suitable for all applications and climates
- Allows for sharing load between ventilation system and VRF system
- Most flexible layout

Other VRF Attributes / Savings

- Maintenance
- Demolition
- Mechanical Shafts
- Roof Penetrations

Owners need alternatives . . .

simpler systems to maintain . . .



Reducing Building Footprint

VRF Refrigerant Pipe chase

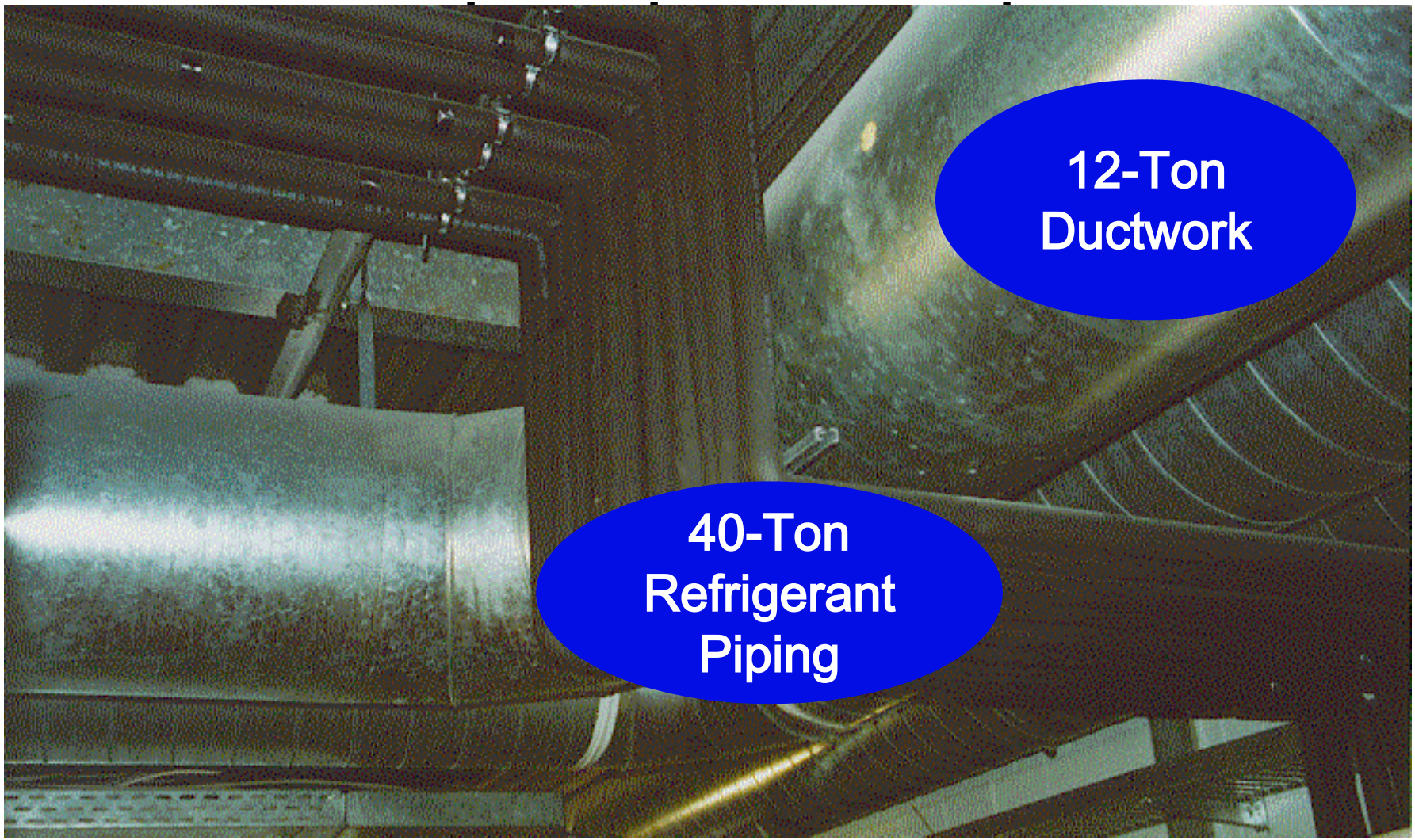
Duct chase

Reduced mechanical chases
No mechanical rooms!

200 tons of Refrigerant Piping

20 tons of Ductwork

“ VRF meets VAV”



Other Installation Cost Savings

- Roof penetrations can be reduced or eliminated
- Roof structure can be downsized
- Some trades can be eliminated or reduced such as test and balance & controls

Closing

- VRF provides excellent zoning flexibility
- Getting Back to Basics
  - The key is understanding both the customer's needs and wants for their particular project
  - Optimize your zoning to ensure both cost & comfort
- Recognize opportunities to combine appropriate systems
  - VRF heat pump
  - VRF heat recovery
  - Outside air solutions
  - Mini Split Systems for odd zones

SAMSUNG

DVM S™
DIGITAL VARIABLE MULTI

What is DVM S

System Types – Single and Modular

- AIR COOLED EQUIPMENT

D Digital
V Variable
M Multi

Characteristics of Outdoor Units

DVM-S ECO
DIGITAL VARIABLE MULTI

Heat Pump

208-230V / 1Ø

3 – 5 Tons

Up to 16.0 SEER

DVM S
DIGITAL VARIABLE MULTI

Heat Pump & Heat Recovery

208-230V / 3Ø 460V / 3Ø

6 – 44 Tons

Up to 38.2 IEER

DVM S WATER - GEO™
DIGITAL VARIABLE MULTI

Heat Pump & Heat Recovery

208-230V / 3Ø 460V / 3Ø

6 – 48 Tons

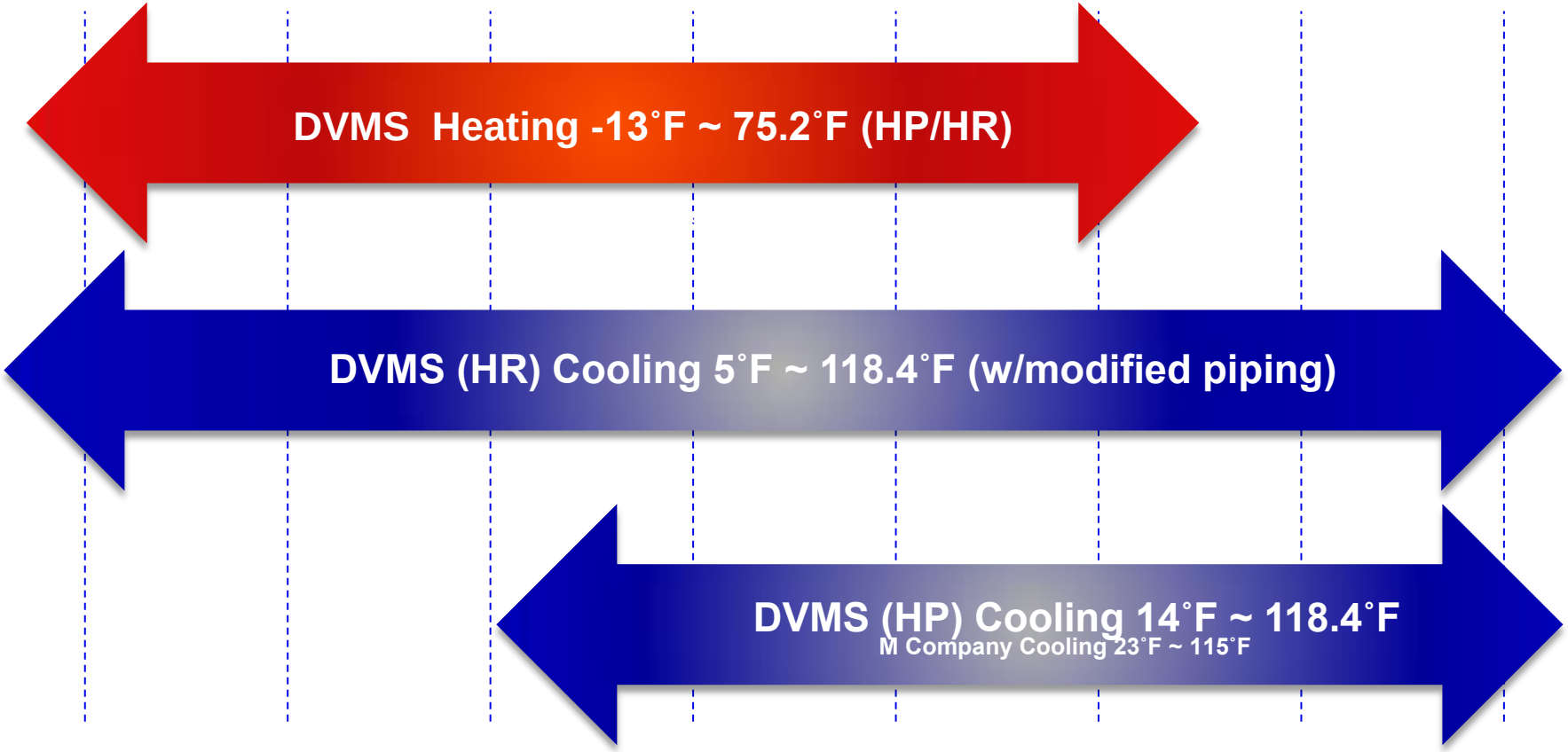
Up to 30.1 IEER

Why VRF & Samsung
Efficiency

- Highest IEER rating in the industry at **38.2**
- Also leads in EER (20.2)
- Highest SCHE (34.1) ratings for HR Systems

Why VRF & Samsung

DVMS VRF System Operating Temperature Range



DVM S

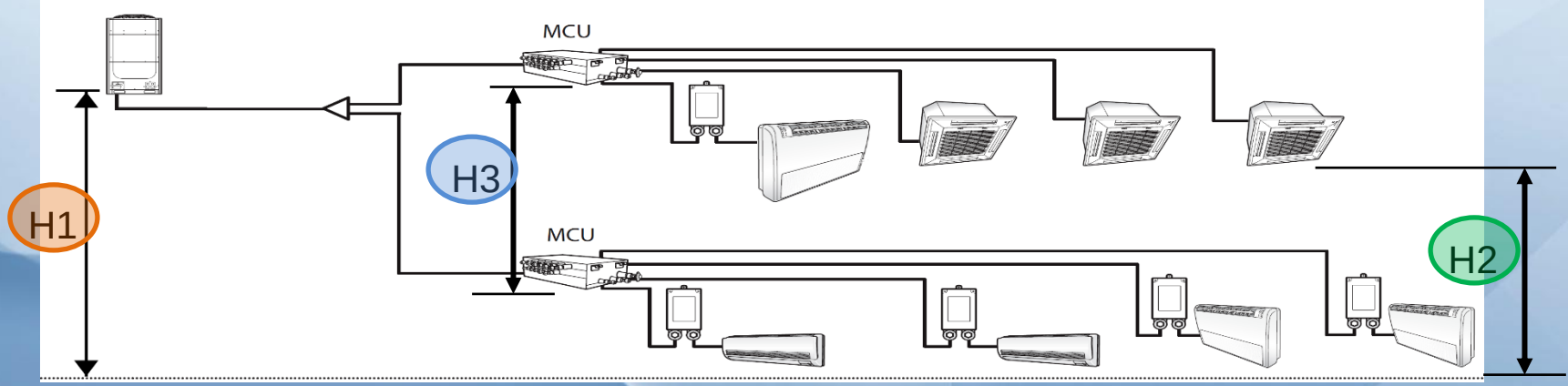
Maximum Piping Lengths – Heat Recovery Vertical Separation

Maximum height difference from outdoor unit to lowest indoor unit (H1):

- When condenser is above indoor units (ex: rooftop): 164’ (standard), 360’ with PDM kit
- When condenser is below indoor units (ex: ground level): 131’

Maximum height difference between indoor units (H2): 49’

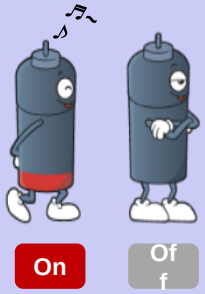
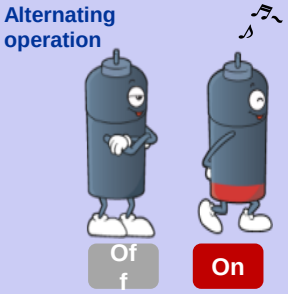
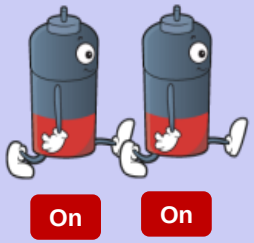
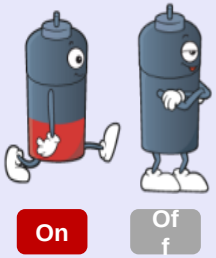
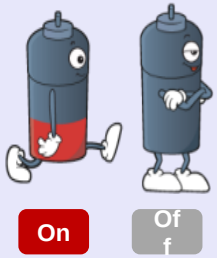
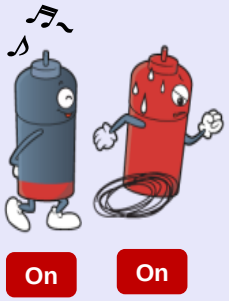
Maximum height difference between MCU’s (H3): 49



- If vertical separation is ≥ 164’ but ≤ 360, contact Quietside for modified pipe design with PDM kit.
- When vertical separation is >295 a PDM kit is required. Use Samsung’s DVM E-Solution software to select PDM kit

Samsung Smart Inverter Technology

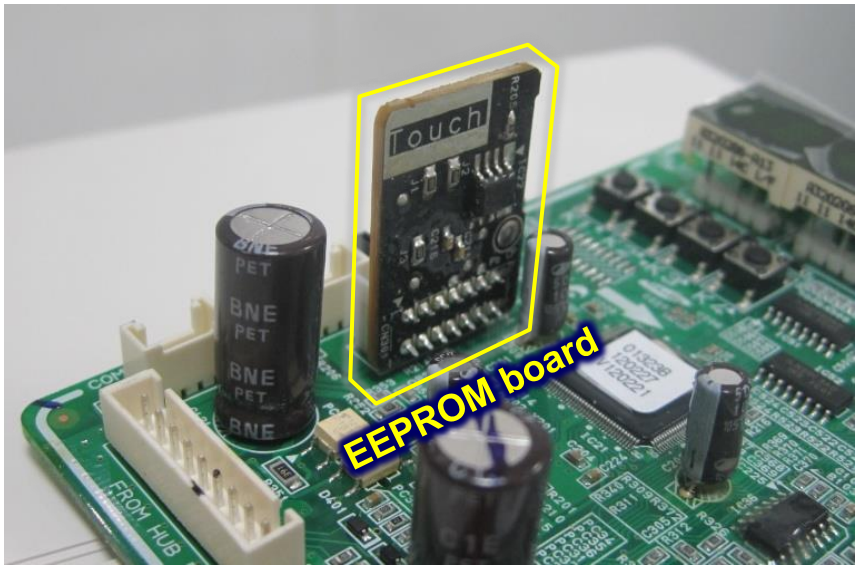
Alternating Compressor Operation

	Case 1	Case 2	Case 3
DVM S (INV+INV)			
INV+FIXED Or Vari. +Fixed			

By Alternating compressor starts, it evens each compressors share of load for enhanced compressor reliabilit

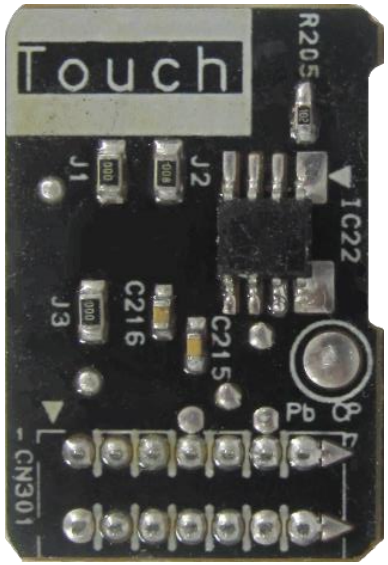
Indoor and Outdoor PCB Removable EEPROM

Keep system information during service or PCB replaceme



Outdoor unit main PCB

Front



Back

- **Model/Serial Number/Unit Name/Tag Number Storage**
- **No Dip Switches**
- **Error back up data (30min)**
- **Allows Updates Without Disturbing Tenant/Classroom/Workers**
- **Open-Ended, Accepts New Programming**

Snow Removal Function

- Snow prevention function removes accumulated snow
- Outdoor units will blow away covered snow every 30 minutes to prevent any damage that can be caused by snow accumulation
- Upon start of this feature, the PCB will detect if snow is actually present to proceed with snow blowing or not.

Samsung Scroll inverter Compressor

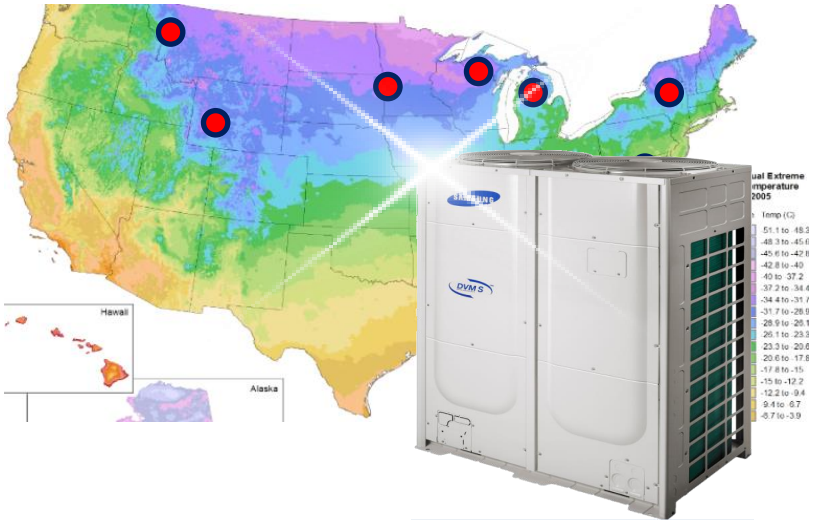
- By using vapor Injection heating performance increases up 20%
- Improves sub cooling to reduce capacity drop during cooling operation
- Reduces refrigerant noise at indoor equipment

NEW Q2 2016

Samsung Electronics

DVM S Max-Heat

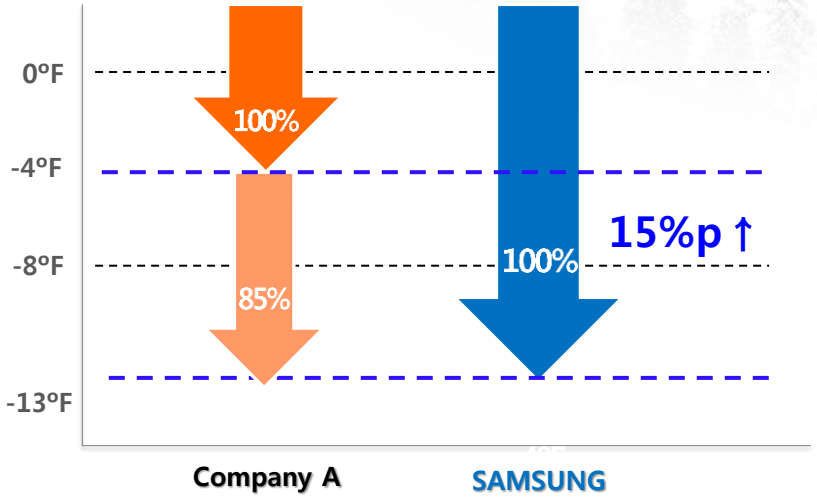
DVM S Max-Heat 6/8Ton



DVM S Extreme provides 100% performance even in -13°F climates.

The Extreme Heating Performance

- Performance provides up to 100% heating output at -13°F with bigger heat exchanger.



NEW Q2 2016

Samsung Electronics

DVM S 18Ton

Q2 2016

VRF History

- World's Largest Capacity VRF for Large-sized and High-rise Building with High Energy Efficiency

Top Class Energy Efficiency

Inverter for Energy Efficiency

2011 ~ 2014

World's Largest Capacity

16 Ton

2015

18 Ton

2016 ~

※ Air-cooled VRF

03. Key Feature

World's Largest Capacity

- **Maximum capacity 18 Ton of Single Unit**
  - Company A is available to 18 Ton with 2 modular system

DVM S 18 Ton

	DVM S 18 Ton	Conventional
Capacity	18 Ton	18 Ton (12+6)
Size	10.65 ft² (40%↓)	17.86 ft²
Weight	750 lbs (31%↓)	1082 lbs
IEER	25.5 (9%↑)	23.4
		

[NA standard]

Confidential

New Q2 2016

Samsung Electronics

DVM Chiller

Version 2.0

SAMSUNG Internal Use Only

DVM Chiller KEY Features

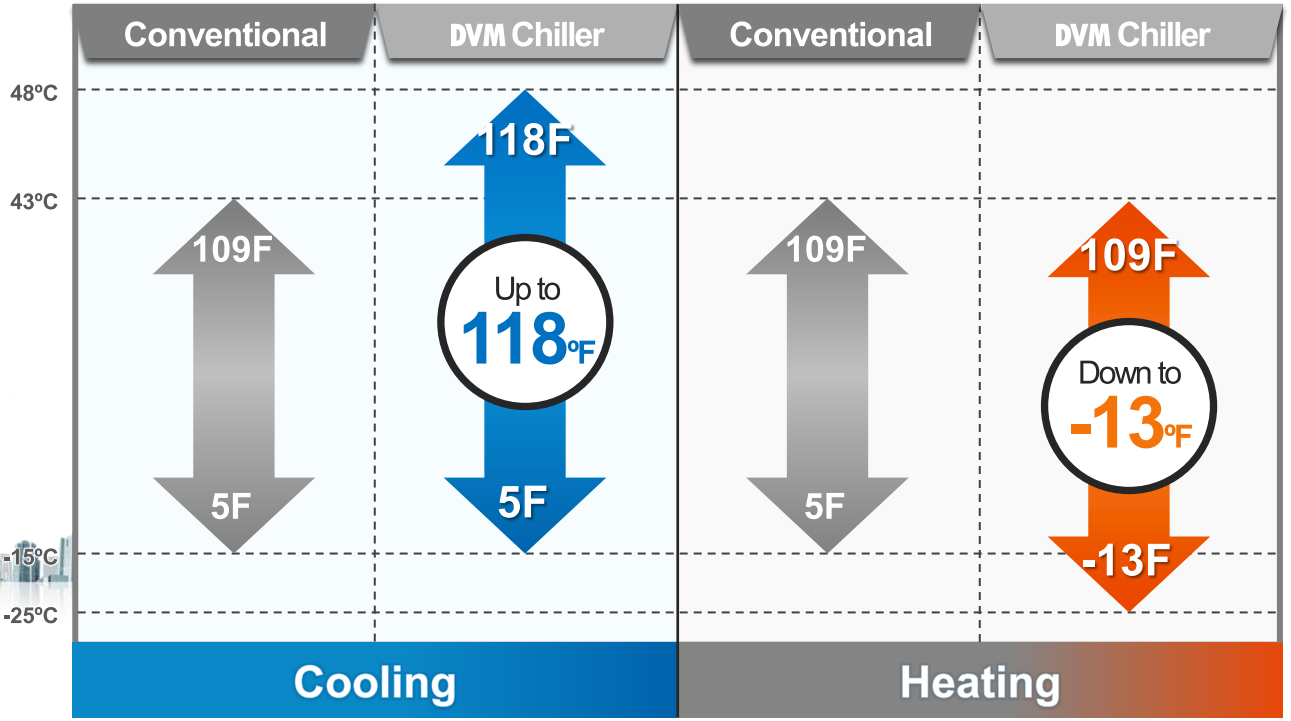
01
Economic Operation

02
Easy Installation & Maintenance

03
Integrated Control System

POD 2 Easy Installation & Maintenance

- Wide Temperature Range of Operation



POD 1 World-class Energy Efficiency

- **IPLV 20.5**
  - Saves 54% of Annual Utility Fees

IPLV **20.5**

54%

IPLV **13.2**

Conventional

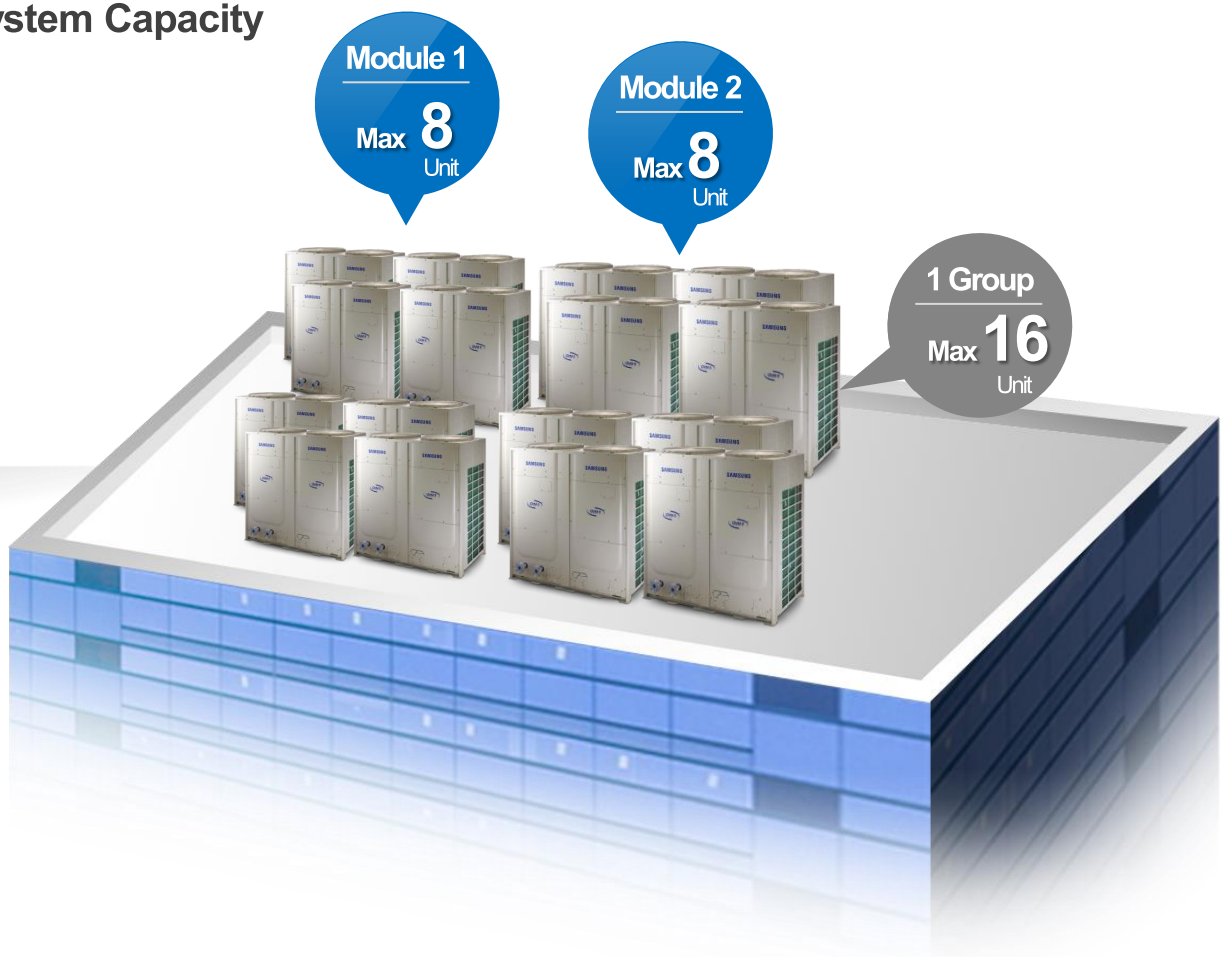
POD 2 Easy Installation & Small Space

- **Combination Expansion of System Capacity**

Modular Combination

12 ton | 16 ton | 20 ton | … | 320 (ton)

※ Up to 16 units can be combined as single Group



What is DVM S

System Types – Single and Modular

- WATER COOLED EQUIPMENT

D Digital
V Variable
M Multi

What is DVM S

System Types – Single and Modular (Water Cooled)

- Single – One outdoor unit
- Modular – Two or three outdoor units piped together

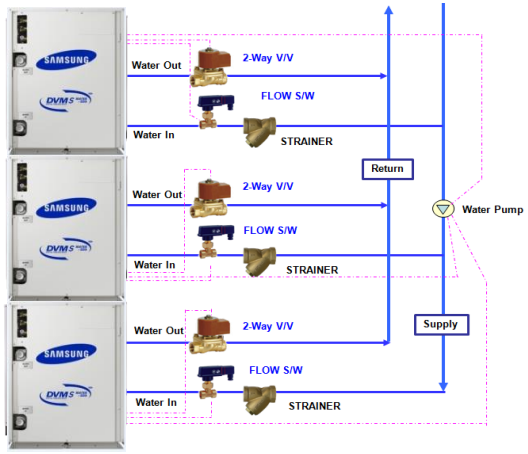
System Outdoor Unit Quantity	Nominal System Capacities (Tons)	Outdoor Unit Quantity				Max Connectable Indoor Unit Quantity
		6 Ton	8 Ton	10 ton	16 Ton	
	6	1				12
	8		1			16
	10			1		20
	12	2				25
	14	1	1			29
	16				1	33
	18		1	1		37
	20			2		41
	22	1			1	45
	24		1		1	49
	26			1	1	54
	28	2			1	62
	30	1	1		1	64
	32				2	64
	34		1	1	1	64
	36			2	1	64
	38	1			2	64
	40		1		2	64
	42			1	2	64
	48				3	64

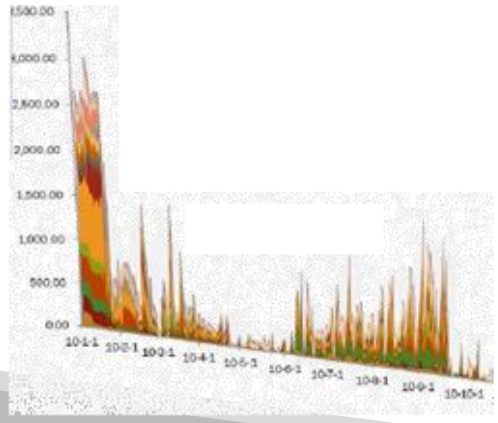
Features & Benefit

Variable Water Flow Control

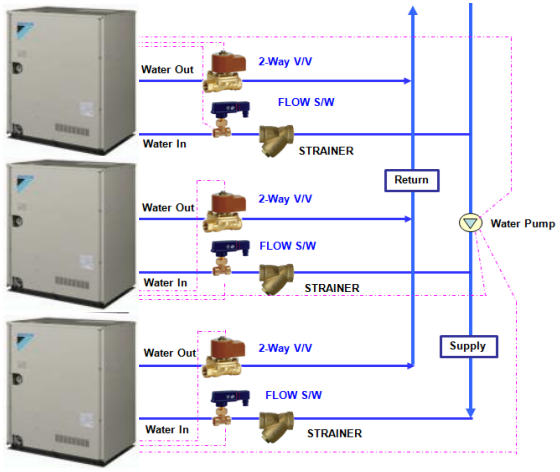
- Not only open/close control, but also variable water flow control.(optional)

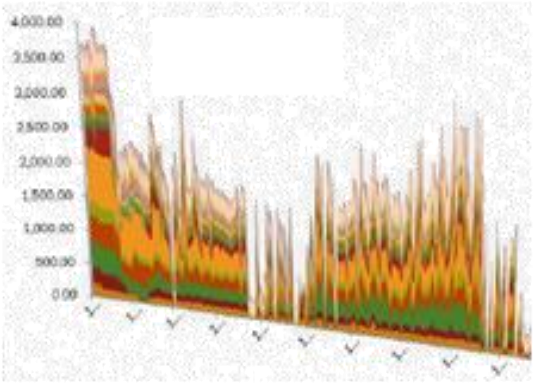
Samsung VWF Control



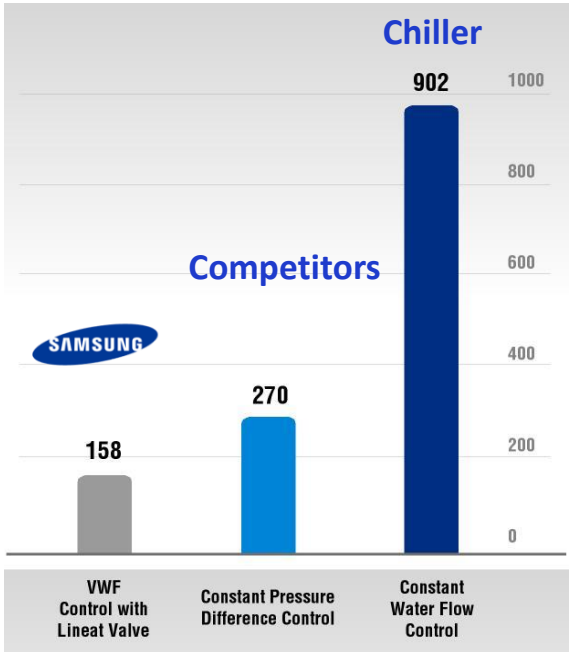


Competitors On/Off





Benefit



- 82% pump power saving to Conventional Chiller
- 42% Saving to competitors

Why you would consider DVMS water

- Higher Energy Efficiency (10-15% over air-cooled)
- Cold Climates (no need to oversize system)
- Flexibility (Taller & Wider Buildings)
- “Green” or “Renewable” when applied to a geothermal application
- Modular style system approach can reduce mechanical room size
- Add on to existing systems

Mini DVM S Eco

Mini DVM S Eco – Heat Pump 3 Ton, 4 Ton and 5 Ton

- **Can connect up to 9 indoor units, same mixed lineup to blend with any interior design up to 130% design diversity**
- **Same control system as DVM-S**

	3Ton	4Ton	5Ton
DVM mini	●	●	●
D	●	●	X
M	●	●	●

Characteristics of Indoor Units

Ductless

Ducted

360 Cassette

Sales Guide

SAMSUNG BUSINESS

SAMSUNG ELECTRONICS., LTD.

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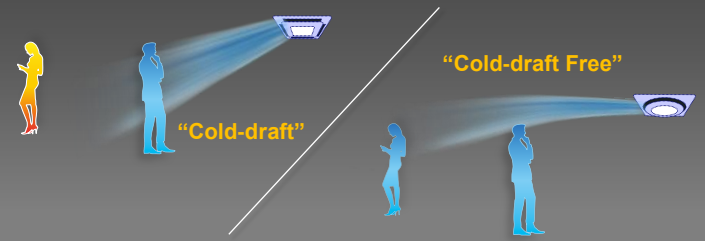
Product Feature Summary
360 Cassette

Innovative Features

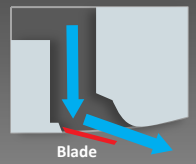
Cold-draft Free

Comfortable Airflow, Free From Cold-draft



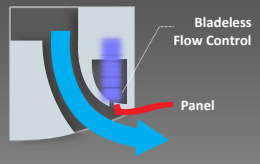
Fast Cooling

Improved Cooling Speed by 25%



Up to **25%** *Loss*

Conventional CST

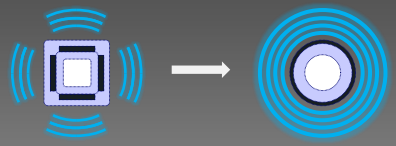


0% *Loss*

SAMSUNG 360 CST

Perfect Even Cooling

Circular Air Wave Ideally Controls Room Air Temperature



Conventional *360 CST*

"360º even discharge"

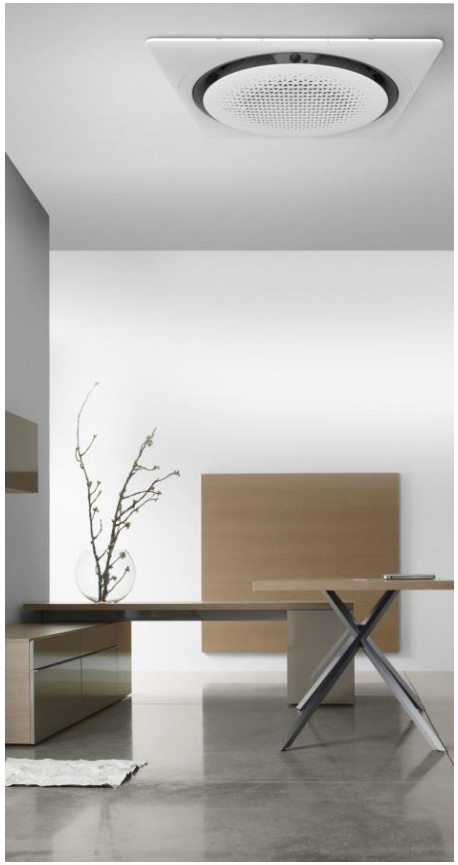
Functionality meets Design

Superior Design and Various Applications

DVM

360 Cassette - Panels

“Ceiling Type”



“Open Type”

DVM Systems

360 Cassette – Flow Control Mechanism

- Due to the shape of the coil and chassis, booster fans are required to provide even flow from the 360 cassette

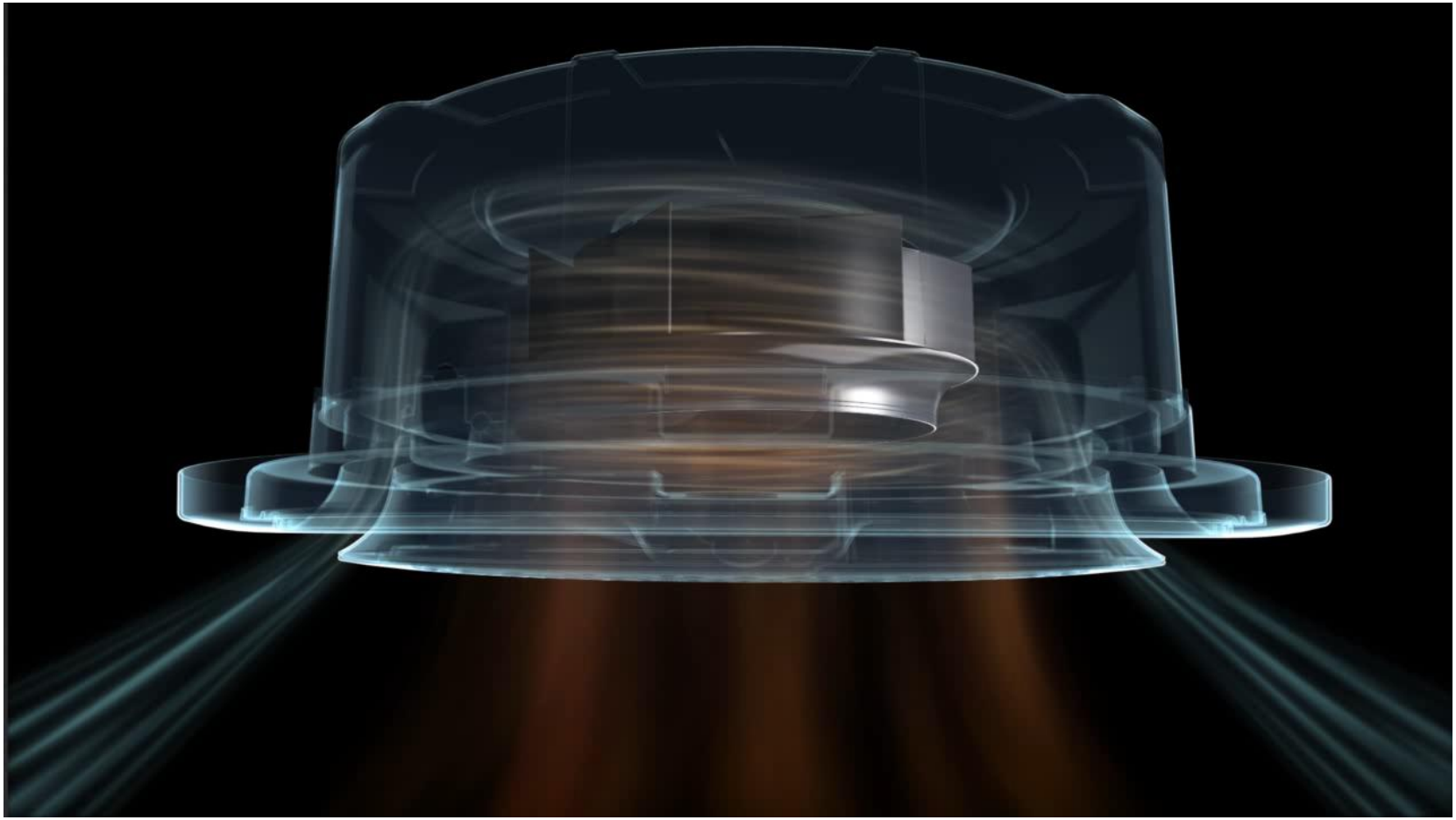
- Each 360 Cassette has 3 boost ~ 2,000 RPM
- These booster fans also provide air direction control similar to a standard 4-way cassette's louvers.
- Individual air direction control is also possible (3 directions)

DVM Systems

360 Cassette – Flow Control Mechanism

Controlling Flow Direction Using Coanda Effect (*Patented*) → **Allows Horizontal Flow Discharge**

As booster fan inside makes low-pressure area nearby outlet, air flow is dragged to the low-pressure area.

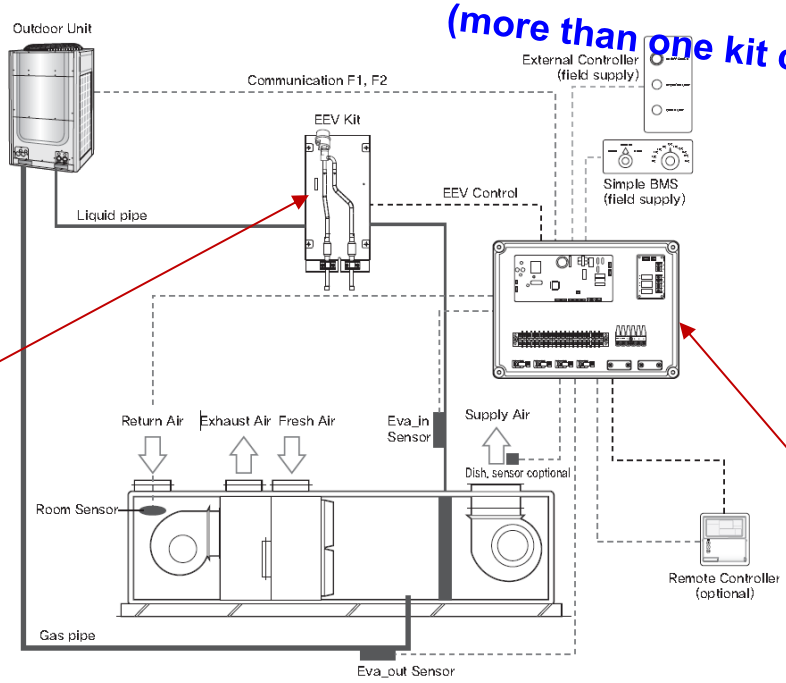


Definition of DVM AHU-KIT

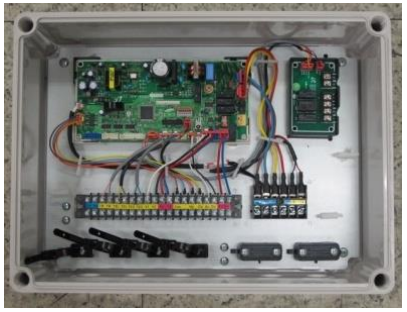
- **One AHU Kit = One indoor unit**

(more than one kit can connect to a single AHU)

EEV-KIT

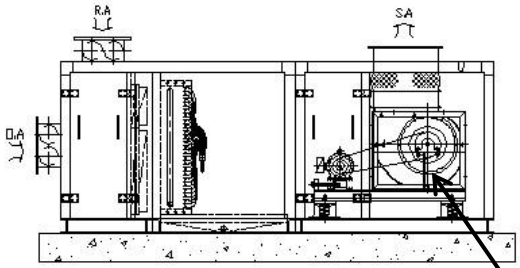
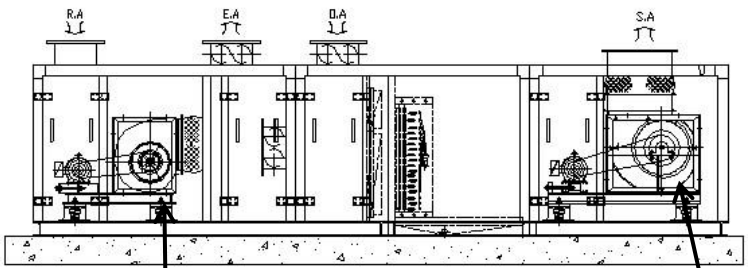


Control-KIT (PBA)



To control refrigerant flow

Definition of DVM AHU

Supply Fan only	Supply & Return Fan
	

Vertical type

Horizontal Type

Mixed type

Definition of DVM AHU-KIT

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Current Samsung Controls and New Options

Centralized Control System

Centralized Controller

- **MIM-H03UN Multi Wi-Fi KIT**
  - **Easy Mobile Control and Monitoring**

Mobile Solution

Controlling all indoor units remotely

by installing Multi Wi-Fi KIT

Up to 16 indoors with NASA communication

Key Features for APP.

Simple DMS function supports

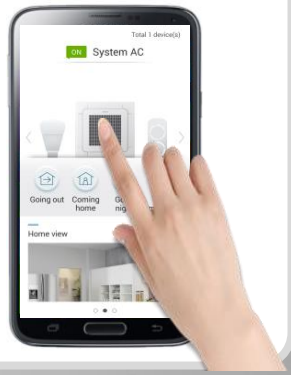
Scheduling

Seven-day

Grouping

for turning on/off instantaneously

(Android, iOS)



- You can download the Samsung Smart Home App by searching "Samsung Smart Home" on Play store, Galaxy Apps and iPhone App Store.

Centralized Controller

- **MIM-H03UN Multi Wi-Fi KIT**

Control all indoor units anywhere, anytime

"I bet it is too cold at home for my cat…"

In the office

"I can turn it on now, my house will be cool before I get there"

On the way

"No need to look for the remote controller"

On the bed

- 1way
- 4way
- Ducted
- Ceiling
- EHS

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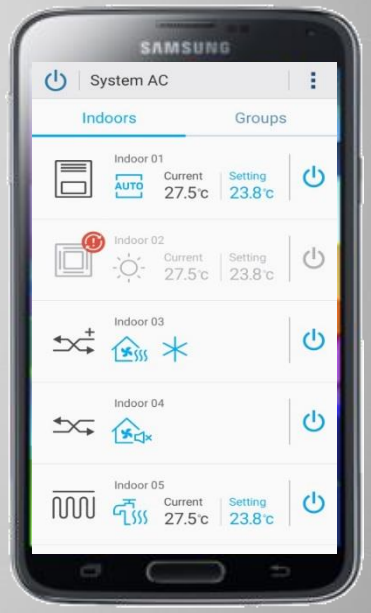
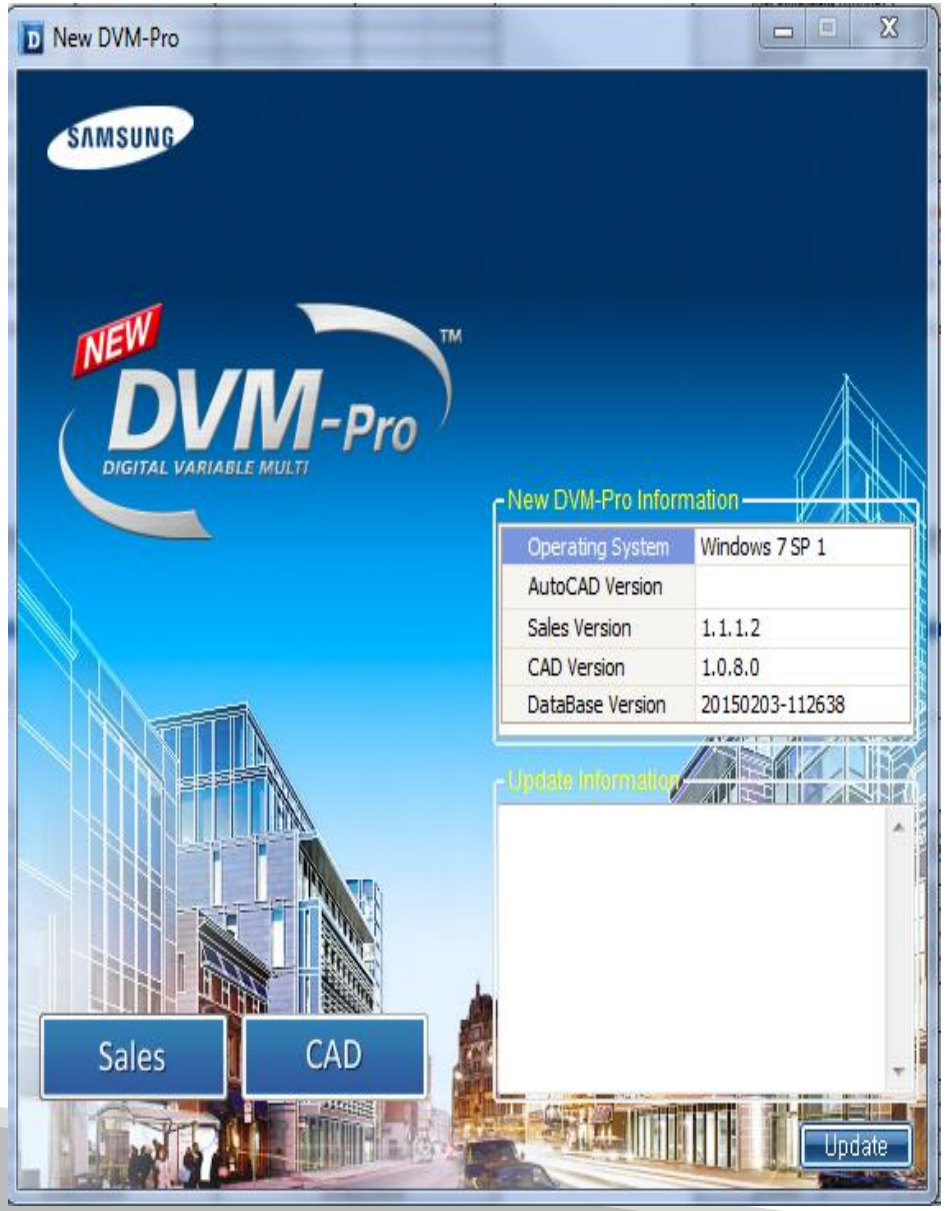
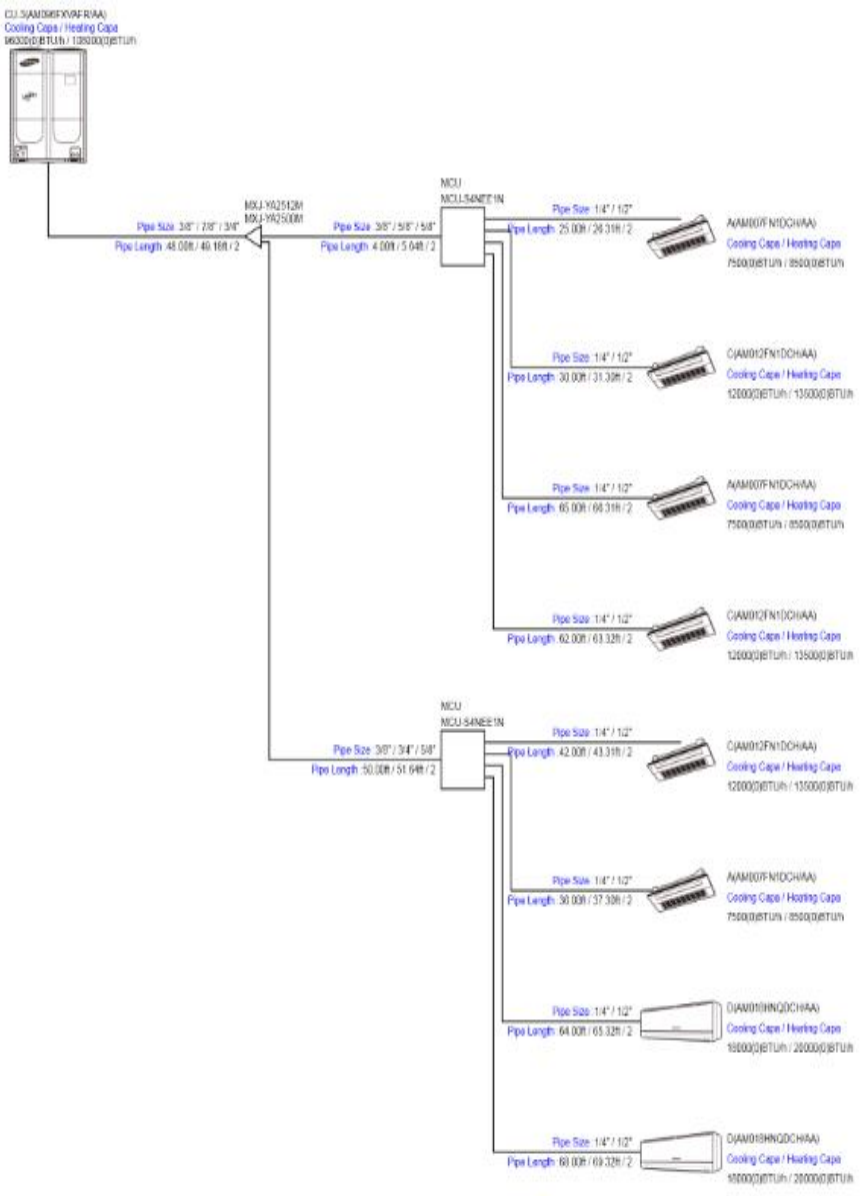


※ Max. 16 indoors

DVM Pro Selection Software





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10 Year Compressor

&

10 Year Parts