

Variable Refrigerant Flow (VRF) – A Better Option Through Technology

Let's Find Out Why

Keith Pyatt

Sales Engineer

LG Electronics, USA

CAC Division-Central Region

ND, SD and MN

keith.pyatt@lge.com

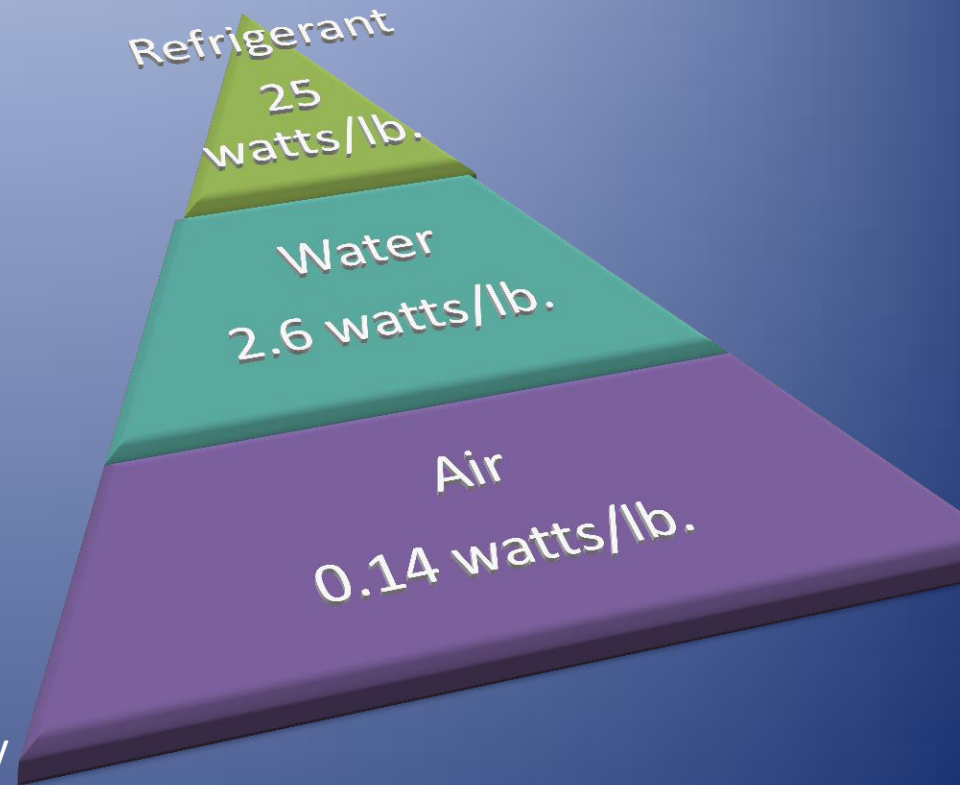
Office (636) 828-4337

Mobile (636) 577-6450



VRF Technology Overview

- A VRF system is a chiller that circulates refrigerant instead of water
- The outdoor unit controls multiple indoor units on the same refrigerant circuit (up to 64 IDU)
- The technology uses inverter, variable speed compressors and fans for nearly unrivaled load matching
- Soft start allowing for less stress on compressor and longer equipment life
- Superior part load performance (up to 36 SEER-28.2 IEER)
- Heat Pump (2-pipe chiller) or Heat Recovery (4-pipe chiller) available
- Air or water cooled available
- Direct Digital Control of the VRF system allowing precise comfort and control
- Easy Controls Integration
- Currently all VRF R-410A Refrigerant



The VRF Benefits

The modular design of VRF system results in superior energy savings giving occupants the choice to air condition or heat only the zones in use. A VRF system provides exceptional dehumidification and temperature control by rapidly adapting to changing loads.

Efficient Design:

Without using large distribution ducts, the VRF system removes losses that are unavoidable in other systems. In addition, the use of optimized scroll or rotary compressors, specially designed heat exchangers, and inverter technology, the VRF system minimizes energy consumption to levels previously unattainable by non-VRF systems. The modular design offers comfort on demand allowing the choice to use the system only in the zones where it is needed further promoting reduced energy consumption.

The VRF Benefits

Zoned Comfort Control & Dehumidification:

With the use of inverters and dual compressor outdoor units, the VRF system offers superior load matching, preventing constant cycling or large temperature swings. Tight temperature control through precise load matching ensures maximum comfort, efficient operation, and superior dehumidification. The modular design of VRF results in superior energy savings giving occupants the choice to air condition or heat only the zones in use.

Sustainability:

The architectural and engineering community is adopting a balanced design approach that considers energy and water consumption, repetitive maintenance costs, the impact of development on the environment, and the building's initial cost as equally important factors in developing high performance, sustainable buildings that will increase building value. VRF systems help achieve points for sustainability programs.

The VRF Benefits

Stylish Design:

VRF indoor units are available in a wide range of styles to fit any interior design. With indoor unit choices including cassettes that mount flush to the ceiling, ducted units that hide completely concealed in the ceiling, and wall mounted units that fit into any décor.

Quiet:

Work without distraction. Sleep without noise. With indoor units that can operate at sound levels as low as 23dB(A) and outdoor units that operate as low as 50dB(A) and lower with night quiet operation, VRF creates a comfortable environment so quiet it's almost undetectable. For additional sound level control, a night quiet mode can be set to limit fan speed during off peak hours.

System Types and Capacities

- Air Source
 - Heat Pump and Heat Recovery
 - 6 to 42 tons
 - 208-230v 3 ϕ and 460v 3 ϕ
 - Single, Double and Triple Frames
- Water Source
 - Heat Pump and Heat Recovery
 - 6 to 48 tons
 - 208-230v 3 ϕ and 460v 3 ϕ
 - Boiler/Tower or Geothermal applications
 - Variable flow pump option
 - Single, Double and Triple Frames
- DOAS, ERV and AHU Kits Options
- Hydro Kit System
 - Heating/cooling a space
 - Domestic hot water and Ice melt

VRF Advanced Technological Features

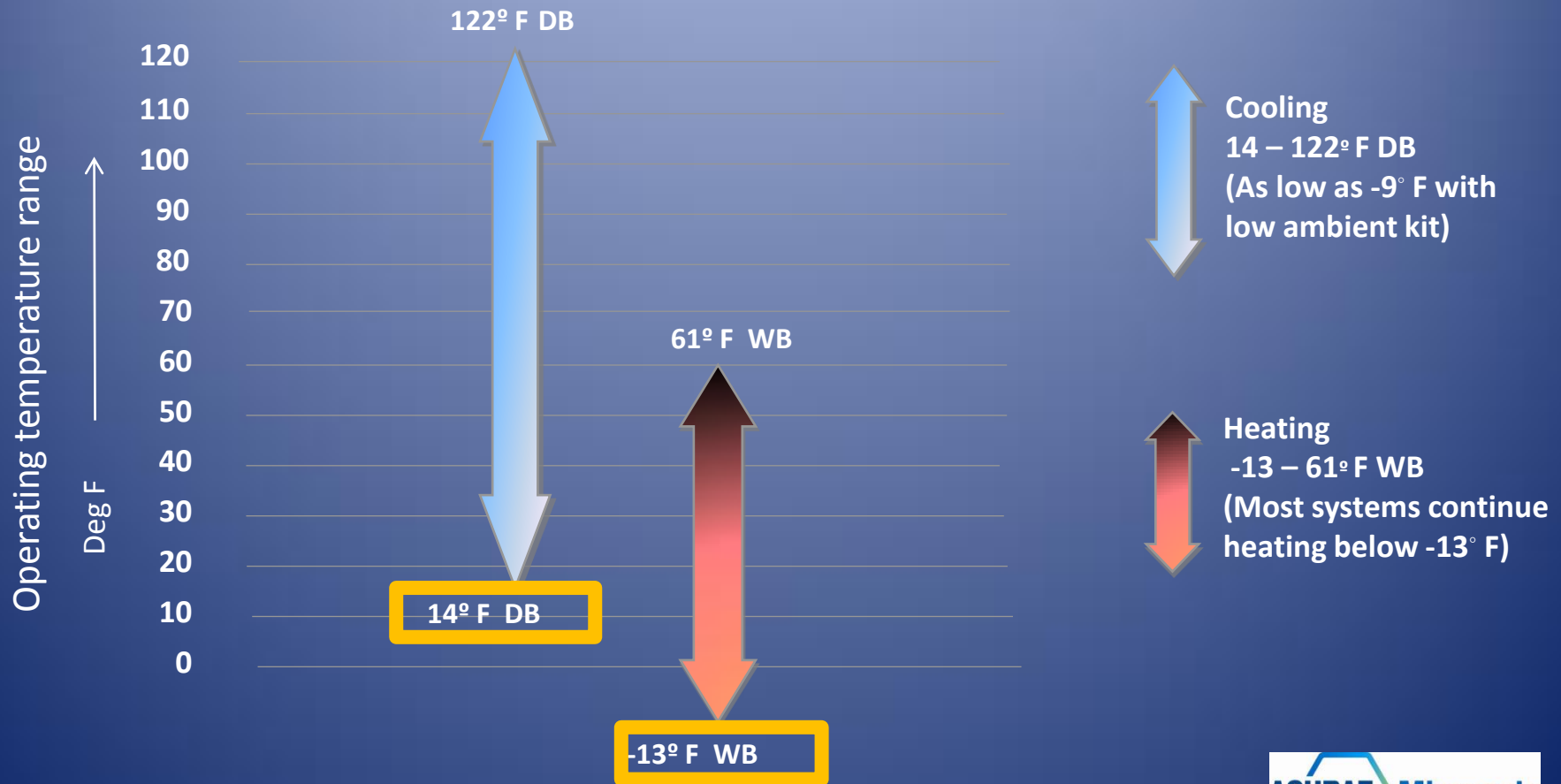
VRF Advanced Technological Features

- Operational Range
- Piping Capabilities
- Heat Exchanger technology
- Oil Management
- Low ambient heating/cooling
- All Inverter Control
- Active refrigerant control
- Defrost Methods
- Snow Throw Option

Typical Operating Range

Typical Operating Range

Cooling / Heating / Heat Recovery



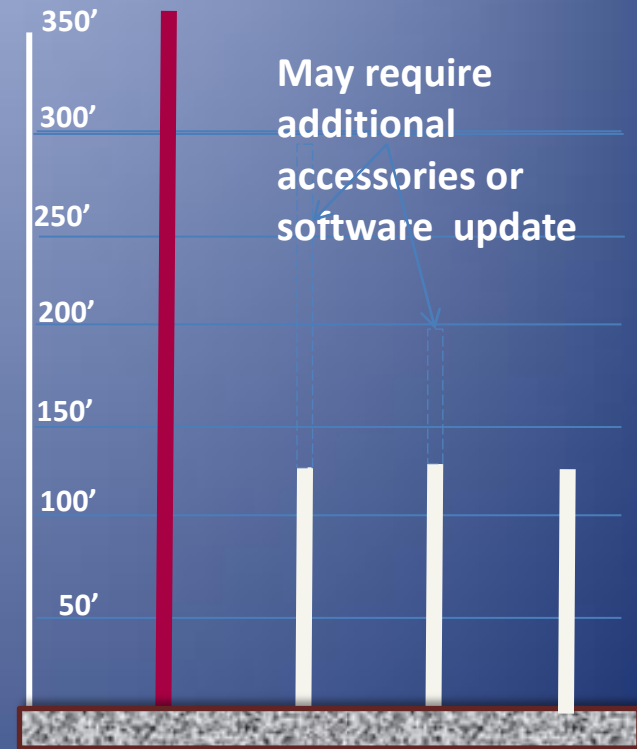
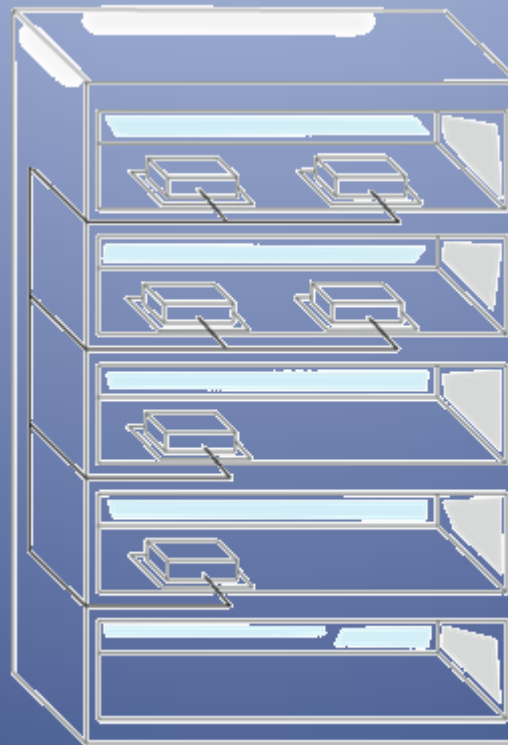
VRF Piping Capabilities

Current Piping Capabilities

Reach more of your building with fewer systems

As High as 360' elevation with
single system

Total pipe length over 3,000 ft.
possible



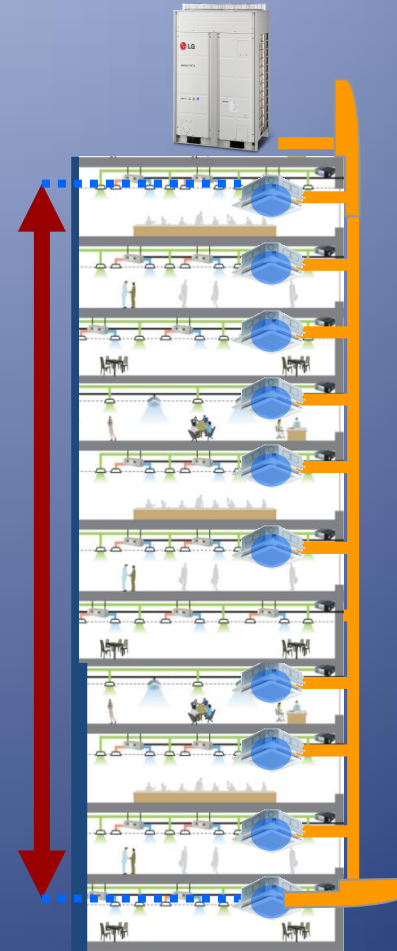
Varies slightly by manufacturer

Current Piping Capabilities

(Varies slightly by manufacture)

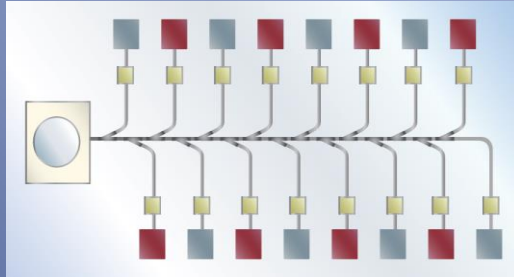
IDU-IDU height difference as high as 131'

ODU to furthest IDU up to 164'



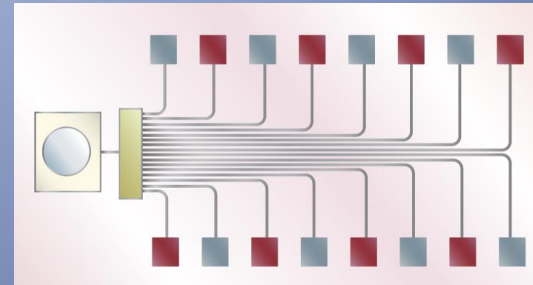
Piping Application Capabilities

3 pipe with 16 - Single port boxes



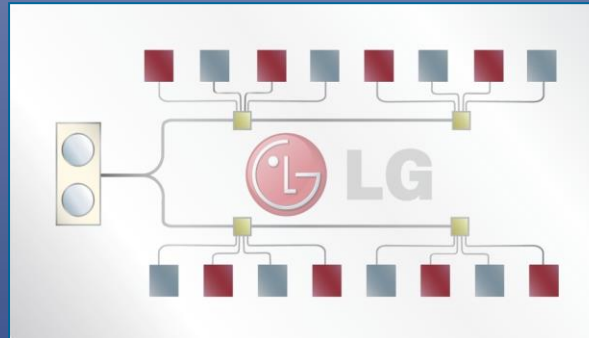
1795 lineal feet of copper 32 flare connections
230 braze connections 45 branch fittings

2 pipe with 1 - 16 port box



3560 lineal feet of copper 64 flare connections
12 braze connections 0 branch fittings

3 pipe with 4 - 4 port boxes

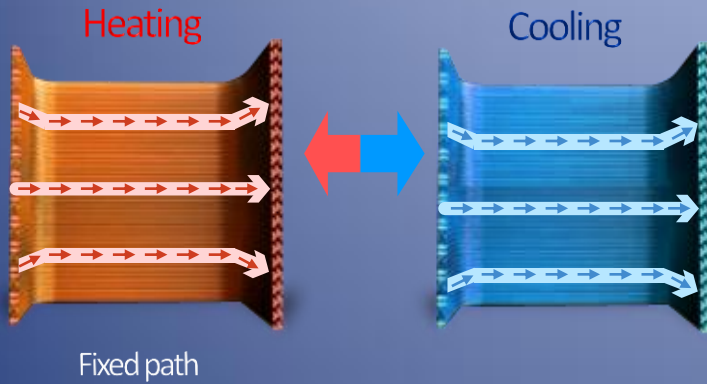


1585 lineal feet of copper 32 flare connections
76 braze connections 3 branch fittings

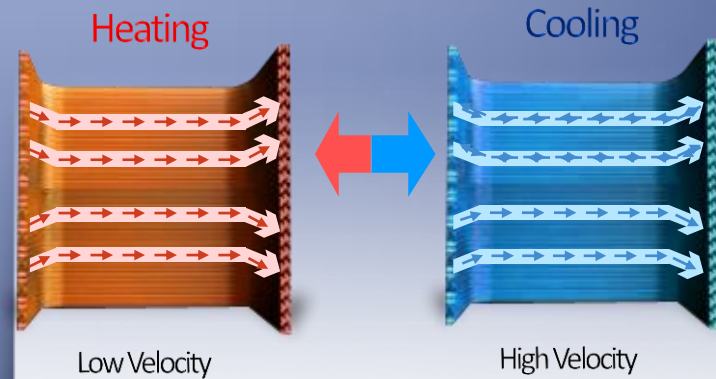
VRF Heat Exchanger Technology

Heat Exchanger Technology

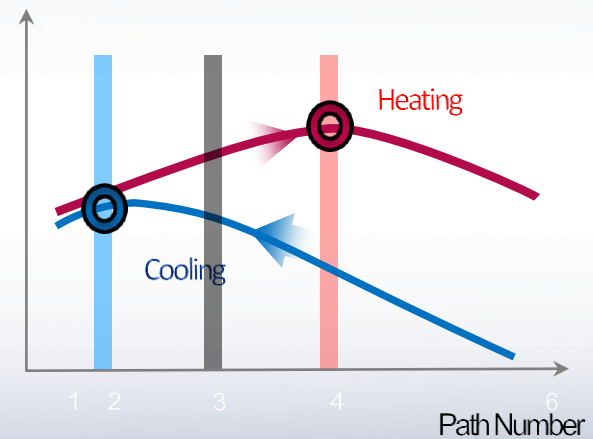
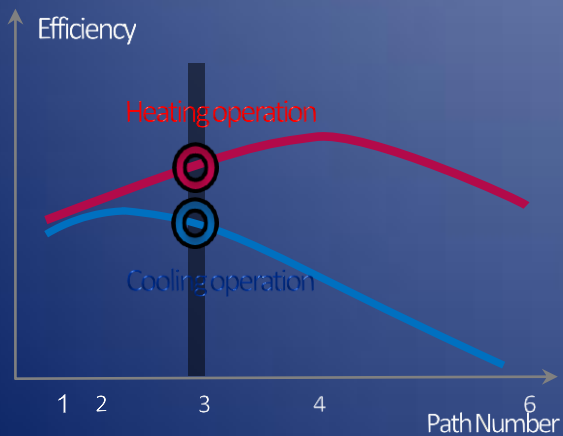
Fixed Path



Variable Path



- Variable Path number according the operation mode



Oil Management Technology

Oil Management Technology

- Conventional Oil Return Method
 - Oil return mode initiated every 6-8 hrs. of run time
 - All system valves open & compressor speed increases
 - Oil return terminated in 6-8 minutes

- Improved Oil Return Method
 - Oil return mode initiated by oil level sensor
 - All system valves open & compressor speed increases
 - Oil return mode terminated in 6-8 minutes. If sensor not satisfied, another oil return initiated in 30 minutes

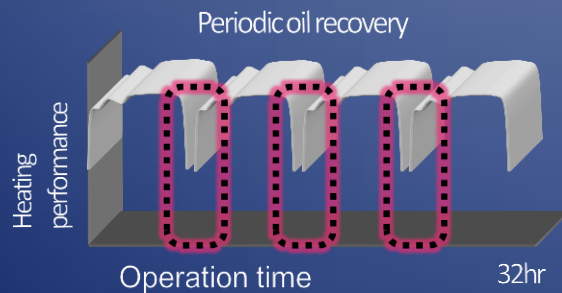
Oil Management Technology

Oil Return Methods



Conventional Oil Return

- Periodic oil recovery operation (6-8 hr)



Oil level sensor

Improved Oil Return

- Direct oil level sensing

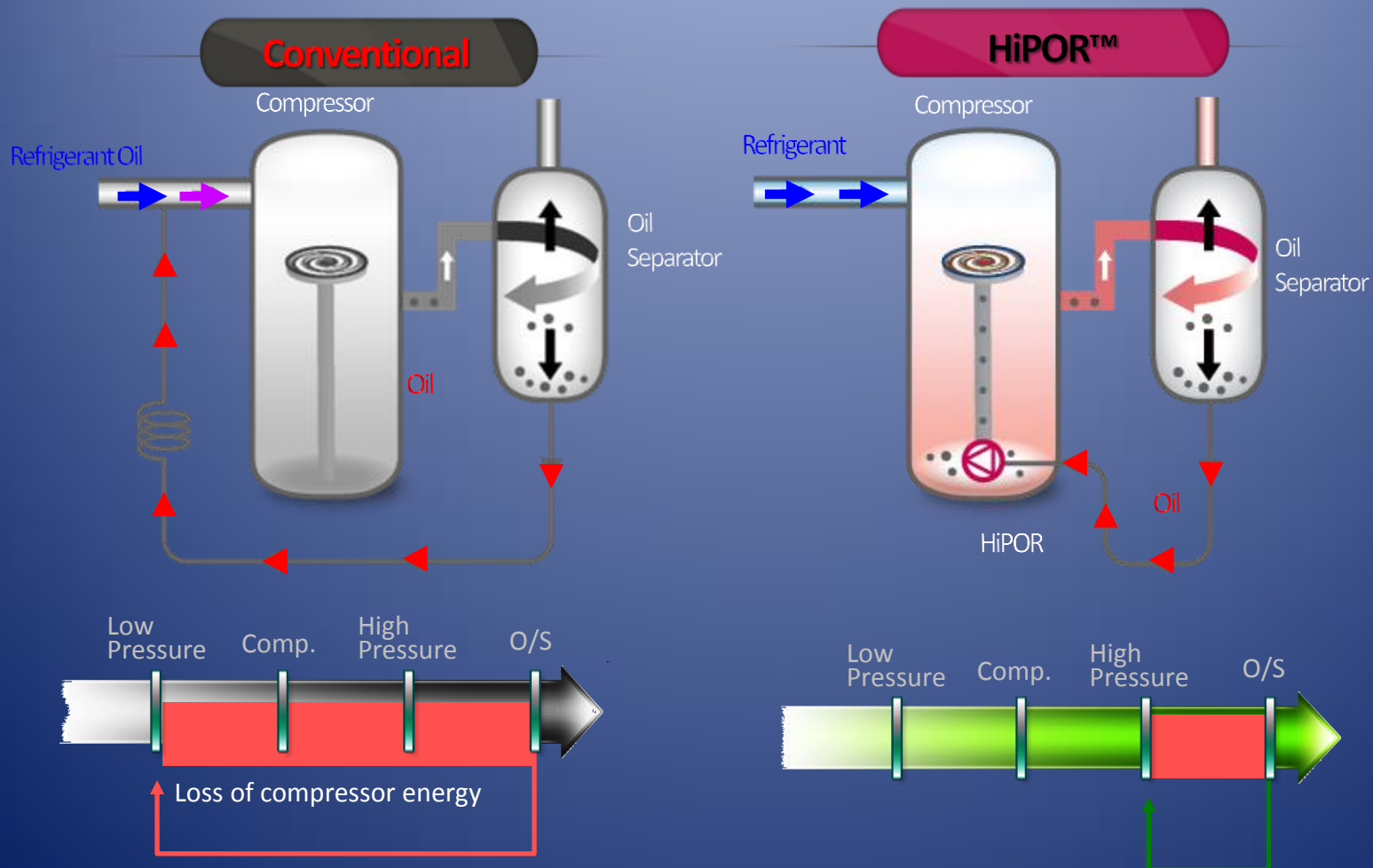


• R&D test resulted in **200** days with no oil recovery cycle

Oil Management Technology

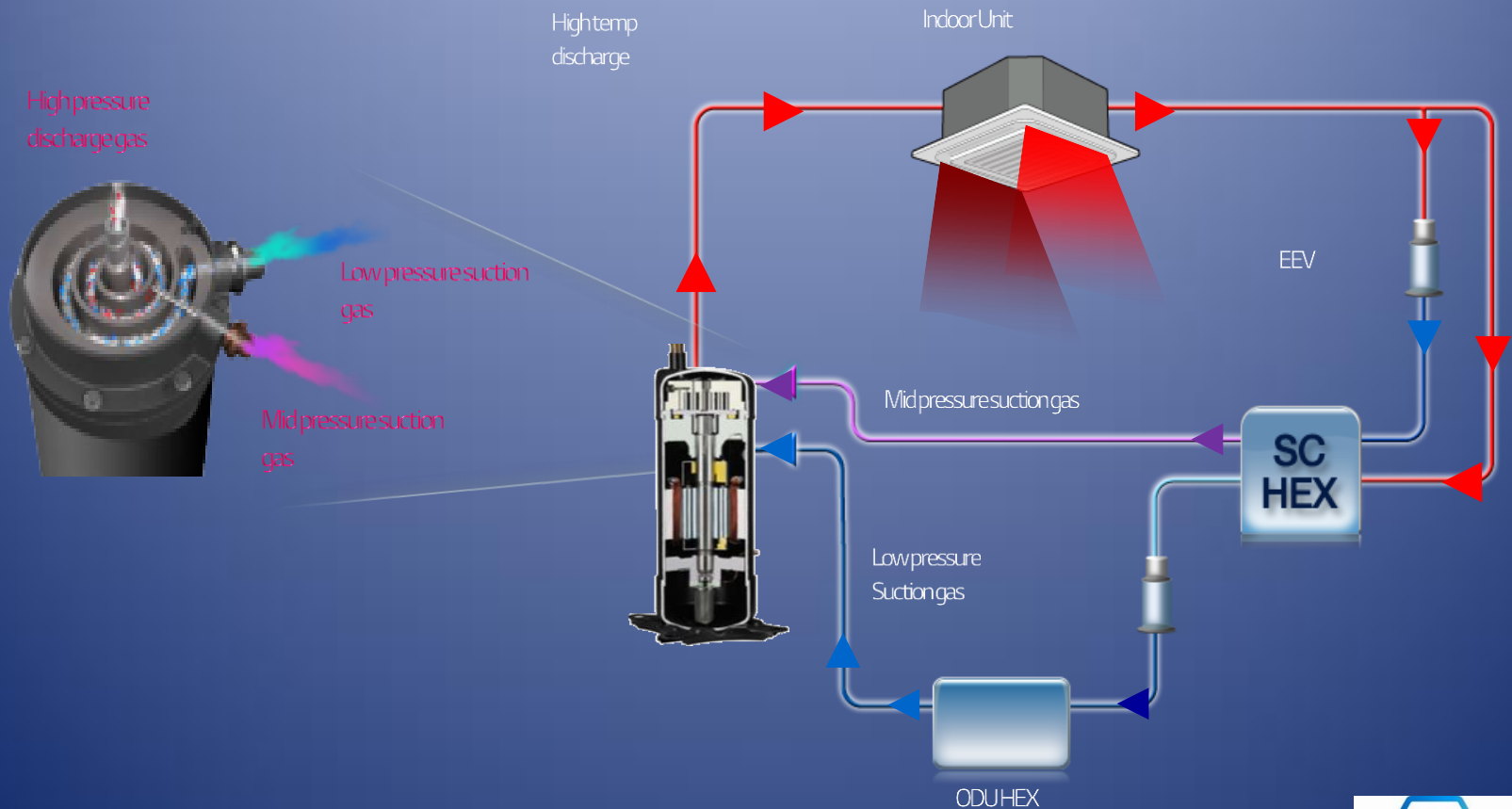
HiPOR™ (High Pressure Oil Return)

- Oil is returned to compressor thru separate inlet pipe
- Mixing of oil and refrigerant is reduced
- Compressor energy is used to compress refrigerant only



Low Ambient Heating Technology

Low Ambient Heating Technology (Vapor Injection)



Low Ambient Kit

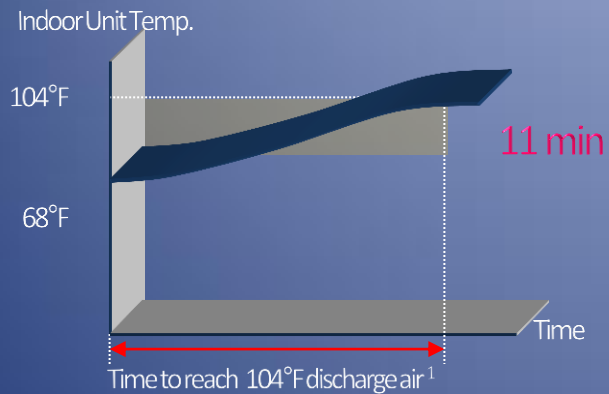
Keeps active precipitation off the coil and fan(s).

- Lessens frost build up in harsh winter conditions
- Does not effect defrost operation logic.
- In heating mode, low ambient damper is always open.

All inverter Control Technology

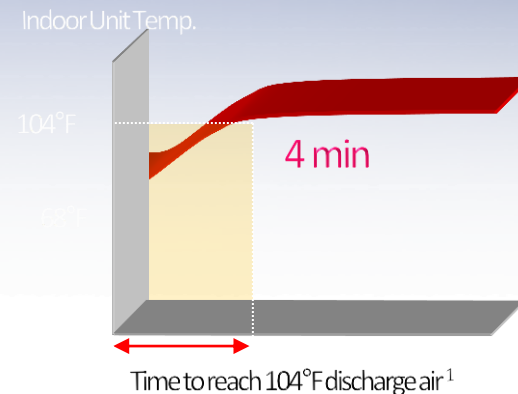
All Inverter Control Technology

Staged-Fixed/Inverter



Staged Inverter/Constant compressor sequence control

Simultaneous Inverter



All inverter simultaneous control

- Heating response time is reduced by 64%

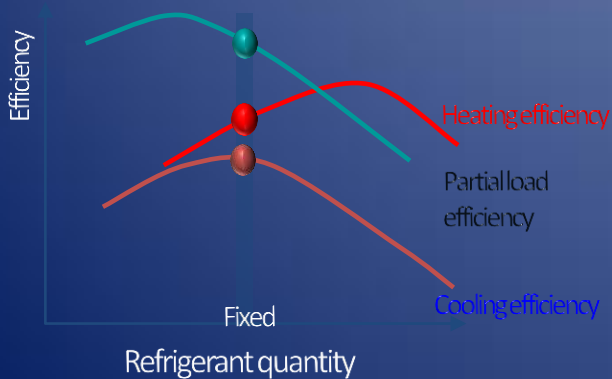
¹ Based on 16 ton outdoor unit at 23° F outdoor temperature and 68° F indoor temperature

Active Refrigerant Control Technology

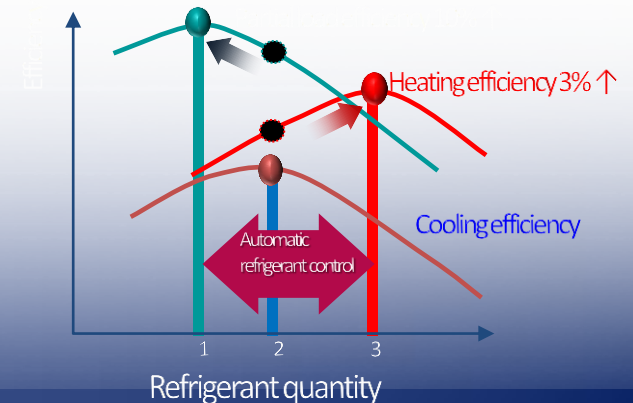
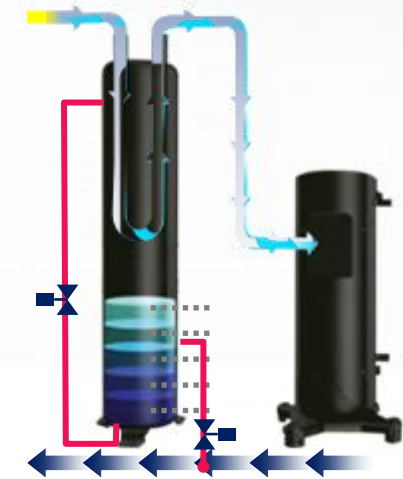
Active Refrigerant Control Technology

With Active Refrigerant Control
Efficiency & heating performance increase

Conventional



Active Refrigerant Control



Defrost Methods

- Mode Selection
- Method Selection
- Snow Throw Option

Defrost Mode Selection

- Normal Defrost
- Fast Defrost

“Normal” Defrost

➤ Application

Ideal for locations that experience mild winter temperatures with light to moderate humidity levels.

➤ Operation Strategy

Maximize heating run-time

- Allows frost to build longer before defrost
- Fewer defrost cycles
- Traditional VRF frost removal method

“Fast” Defrost

➤ Application

Ideal for locations with adverse winter weather. Cold and very cold temperatures and/or high humidity levels

- Lake effect snow (i.e.: Buffalo, NY)
- River shore area (i.e.: Minneapolis, MN)
- Heavy fog

➤ Operation Strategy

Avoid excessive ice build-up

- Maintains maximum system heating performance
- Less stringent defrost cycle trigger requirements
- More frequent defrost cycles

Split Coil/Frame Method

Application

Ideal for locations with mild winter temperatures and light to moderate humidity levels.

Operation Strategy

Some VRF system continue to heat in defrost

Split Coil/Frame Method

Cycle Characteristics

- Available when outside air temperature $>32^{\circ}\text{F}$
- If two partial defrost cycles don't clear the frost, next cycle is full defrost.
- Single frame split coil: clear frost on bottom coil first, then top.
- Multiple frame systems: Clear frost from frame tagged "Slave 2", then "Slave 1", then the "Master"
- Time to defrost =12 minutes or less

Full Frame Method

Application

Ideal for locations with adverse winter weather. Cold and very cold temperatures and/or high humidity levels

- Lake effect snow (i.e.: Buffalo, NY)
- River shore area (i.e.: Minneapolis, MN)
- Heavy fog

Operation Strategy

Minimize total defrost cycle time.

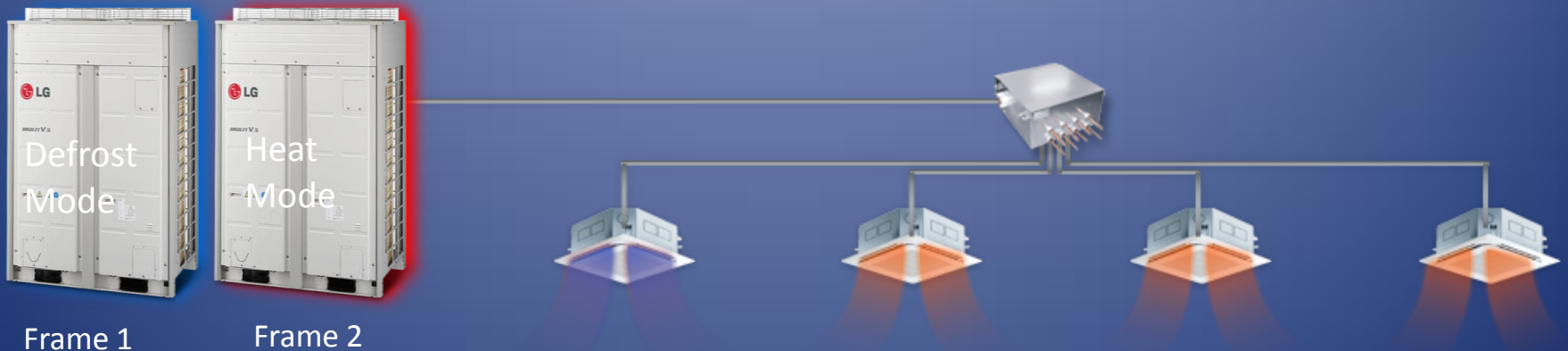
Most effective defrost method below 32°F

Defrost Operation (Varies by Manufacturer)

Continuous Heating During Defrost

Heat Pump and/or Heat Recovery (Varies by Manufacturer)

- First (2) defrost cycles
 - Heating mode IDU fans to stay on (Low-Low Speed)
- Third defrost cycle will be full defrost
 - Heating mode IDU fans turn off
 - Defrost cycle will last a maximum of 10 minutes (normal is 5 minutes)
 - Ensures outdoor heat exchanger is completely cleared of ice



IDU – all fans go to low speed

Snow Throw Mode

Application

Use in locations with moderate to heavy snowfall

Operation Strategy

Spins fan blades every $\frac{1}{2}$ hour to clear snow buildup

- Minimize system malfunction errors resulting from ice interfering with fan rotation.

Snow Throw Mode

Cycle Sequence

1. ODU fan(s) and compressor(s) are off for 30 minutes.
2. Temperature drops below 37°F
3. ODU fan(s) start and run on medium speed for 2 minutes
4. ODU fans cycle off
5. Repeat every 30 minutes until temperature >37°F

Thank You

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