

BEYOND THE REFRIGERANT

VRV/VRF System Design for the Electrified, High-Performance Building

Designing HVAC systems around the needs and performance goals of the building



Speaker | AP Sharma, Director of Product Marketing

NESEA | BuildingEnergy NYC Conference | Sponsored by Daikin Comfort Technologies Inc.



A project can change after the design is done

Imagine the project is approved, construction starts—and then the refrigerant rules change.



The question for today

How do we keep VRV/VRF practical, efficient and code-compliant as refrigerant safety requirements evolve?

Three forces are changing HVAC at the same time

01 REGULATION

The AIM Act targets an 85% HFC phasedown by 2036, accelerating the move away from high-GWP refrigerants.

02 ELECTRIFICATION

Building decarbonization is increasing demand for efficient all-electric heat-pump solutions.

03 TECHNOLOGY

Lower-GWP refrigerants such as R-32 enable manufacturers to optimize the complete system-not just the refrigerant.

And the design conversation now has a fourth dimension: refrigerant safety.

The goal is not simply to change refrigerant. It is to redesign confidently within the new rules.

Modern buildings are mosaics of different thermal environments



Multifamily • Hotel • School • Office

**Different loads.
Different occupancy.
Different schedules.**

One building does not mean one thermal condition.

VRV/VRF is relevant because its architecture is built around variable capacity and zoning: matching the diversity already inside the building.



ENGINEERED FOR
PERFORMANCE &
SERVICEABILITY



ADEQUATE SERVICE
CLEARANCE



ALL COIL FACES ORIENTED
FOR OPTIMAL AIRFLOW



DEDICATED MAINTENANCE
AISLES



PROPER SUPPORT RAILS
AND ROOF CURBS



ELECTRICAL DISCONNECTS
AND SAFE ROUTING

VRV remains relevant because the buildings are changing

Variable capacity

Modulates output to match actual demand instead of treating every zone as if it is at peak load.

Individual zoning

Responds to different thermal loads, schedules and comfort requirements across spaces.

Heat recovery

Where appropriate, can move energy between zones that need heating and zones that need cooling.

A HAVTECH/Spectrum Multifamily Case Study

Compared six electrified systems on energy cost, O&M, rebates and life-cycle cost

Technologies Compared:

- Air-Cooled Variable Refrigerant Flow
- Packaged Terminal Heat Pump
- Standard & High Efficiency Split System HP
- Standard & High Efficiency Water Source HP



Energy Cost

VRV is lowest in comparison

Annual O&M Cost

VRV is lowest in comparison

Utility Rebates

VRV – One of the highest in comparison

Total Life Cycle Cost
VRV is lowest in comparison

Application example - not a universal claim for every project.

The Plaza Hotel Pioneer Park, El Paso, TX Case Study

VRV technology helps preserve historic hotel character while supporting energy efficiency and guest comfort



Scan me!

Daikin VRV Testimonial
The Plaza Hotel
Pioneer Park



PROJECT INFORMATION

Building Type: Boutique Hotel
Year Built: 1930
Renovation: \$78M renovation completed in 2020*
Stories: 9
Rooms: 130 Rooms and Suites
Event Space: 7,600 Sq. Ft.
Square Feet: 147,650 Sq. Ft.
Cooling/Tons: 44 Tons

HVAC Challenge: Preserve historic architecture, space, and ambiance while modernizing HVAC for energy efficiency and guest comfort

HVAC Solution: Daikin VRV System

*Hotel Online



Scan me!

@7:25 time marker
Hotels ByDesign:
Season 4 | Episode 5

THE SOLUTION SUMMARY

Daikin VRV technology combines quiet operation, compact modular equipment, long piping flexibility, and inverter-driven compressor performance to help solve difficult HVAC challenges in new construction and retrofit applications. By matching output to actual building demand, VRV systems can provide comfort while limiting wasted energy. Their modular design can also make installation easy in projects where space, access, weight, noise, and architectural impact are important considerations.

But the design conversation has changed

The building may look familiar. The rules governing the refrigerant inside it do not.

Regulatory landscape

Lower-GWP refrigerants are becoming the pathway forward.

Safety standards

ASHRAE 15 and UL 60335-2-40 introduce A2L design and product-safety considerations.

Design challenge

Meet the new safety requirements without giving up the flexibility that made VRV attractive.

Code compliance is the starting point - not the finish line.

Three standards - Three different jobs

34

ASHRAE 34

What is the refrigerant?
Classification, designation and
refrigerant safety properties.

15

ASHRAE 15

How is it applied in the building?
Occupied-space limits, charge and
mitigation.

UL

UL 60335-2-40

How does the equipment address
A2L safety?
Product-level safety, detection and
mitigation provisions.

The practical takeaway

R-32 being A2L does not tell you how to design the building. ASHRAE 15 is where refrigerant charge starts interacting with the actual occupied space.

DOB- Local Law 77

There are three key concerns

Piping Requirements

Pipe-in-pipe and enclosures create unworkable installation conditions for mechanical contractors.

Air-Circulation/ EDVC

Restrictive Effective Dispersal Volume (EDV) room calculations impose severe ceiling space and layout constraints on tight residential footprints.

Shaft Requirements

Fire-rated, mechanically ventilated vertical risers add prohibitive structural costs and eliminate valuable real estate square footage in existing building renovations.

We brought up these concerns to NYC Department Of Building's attention.

Why R-32 as an A2L choice?

675

R-32 GWP

2,088

R-410A GWP

A2L

Lower flammability /
lower toxicity

300M+

Units installed worldwide

The design opportunity

- R-32 is not a blend, simplifying recovery/reuse compared with blended refrigerants.
- Daikin has global experience optimizing R-32 systems for compact, efficient designs.
- R-32 is already broadly manufactured and distributed.
- Consider the LCCP for the complete system.

**R-32 is one lower-GWP A2L pathway.
We need to understand what the A2L
classification means for design
validation.**

A2L does not replace the VRV design process, it adds a safety validation layer

What stays the same

Traditional VRV Design

- Start with building loads, climate, occupancy and zoning.
- Select indoor/outdoor units and system architecture.
- Design piping, branch components and controls.
- Optimize comfort, performance and constructability.

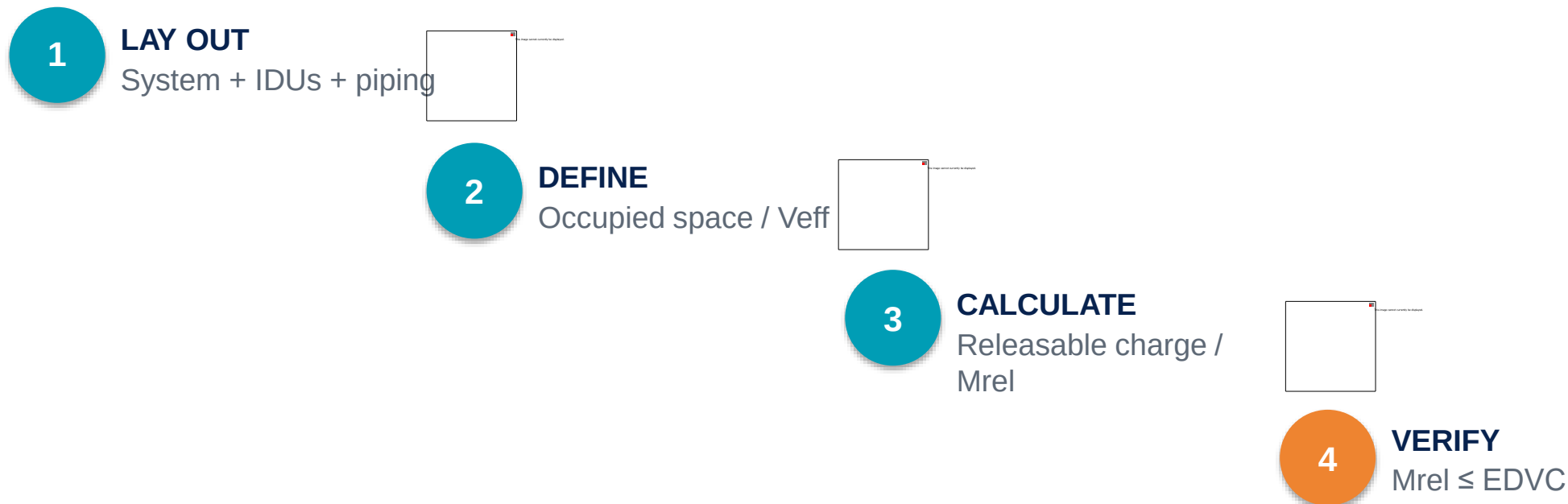
What changes

A2L Safety Validation

- Refrigerant charge is now tied more directly to the spaces affected by a release.
- Safety validation must be considered alongside system architecture - not after the design is finished.
- Mitigation strategies may be required when the initial design does not comply.

Design the system and validate the safety together.

The New design workflow is SIMPLE to remember



$$M_{rel} \leq EDVC \quad \text{If NO} \rightarrow \text{mitigate or redesign}$$

Why this matters

This is the bridge from code language to an engineer's actual workflow. The next slides make these four steps practical.

What is the TEST when applying based on this Design Shift

THE TEST

$M_{rel} \leq EDVC \rightarrow$ proceed | $M_{rel} > EDVC \rightarrow$ mitigate / redesign

$M_{rel} < EDVC$



A2L validation doesn't naturally mean redesign.
Start with the actual release scenario.

$M_{rel} > EDVC$



The answer is not "VRV doesn't work."
The answer is to use the design levers available.

1 REDUCE
 M_{rel}

2 OPTIMIZE
EDVC

3 MITIGATE

Daikin's WebXpress: Take the Guesswork Out of A2L Design

General

Refrigerant charge (factory + field piping): 36.67 lbs

These calculations are for non-institutional occupancy

Indoor Units

Room	Indoor unit	Model	Mrel	Min room volume for safe operation	Room area	Ceiling height	Calculated room volume
	Ind 3 (BS 1, port #A)	FXAA18AAVJU	1.47 lbs	154.1 ft³			-
	Ind 4 (BS 1, port #B)	FXAA18AAVJU	1.47 lbs	154.1 ft³			-
	Ind 5 (BS 1, port #C)	FXAA18AAVJU	1.47 lbs	154.1 ft³			-
	Ind 6 (BS 1, port #D)	FXAA18AAVJU	1.47 lbs	154.1 ft³			-
	Ind 7 (BS 2, port #A)	FXAA18AAVJU	1.47 lbs	154.1 ft³			-
	Ind 8 (BS 2, port #B)	FXAA18AAVJU	1.47 lbs	154.1 ft³			-
	Ind 9 (BS 2, port #C)	FXAA18AAVJU	1.47 lbs	154.1 ft³			-
	Ind 10 (BS 2, port #D)	FXAA18AAVJU	1.47 lbs	154.1 ft³			-

BS/SV-Boxes

(BS) Sv Box	Model	Mrel	Use enclosure
BS 1	BSF4A54AAVJ	36.67 lbs	☐
BS 2	BSF4A54AAVJ	36.67 lbs	☐

Making A2L Design Simple

- **Built-in A2L application calculations**
- Automatically evaluates **MREL, EDVC and room volume**
- Calculates allowable room sizes
- Evaluates Mrel based on the system configuration
- Helps identify when additional mitigation, such as **SSOVs or enclosure**, may be required
- **No manual calculations. No spreadsheets. No guesswork.**

From Code Requirements to Design Confidence

- Enter the system and room information
- Let WebXpress perform the calculations
- Quickly identify compliant and non-compliant configurations
- **Validate the design before it reaches plan review**
- Simplifies coordination between **engineering, architecture and installation**

Compliance is necessary - The design still has to make economic ~~sense~~

A code-compliant system can still be a poor project decision if it adds too much cost, space or maintenance burden.

FIRST COST

Consider mechanical-room space, shafts, structural requirements and installation labor.

OPERATING COST

Variable capacity and heat recovery can better match real-world loads.

LIFECYCLE VALUE

Evaluate energy, maintenance, serviceability, space and future refrigerant availability.

Future-proofing starts in schematic design.

Coordinate refrigerant charge, piping, equipment location, zoning, architecture, electrical and safety requirements early.

What should the OEM bring to the transition?

The equipment should make the new design process easier - not add another layer of uncertainty.

DETECT

Integrated refrigerant sensing and factory-designed safety functions.

DISPERSE

Full circulation / IDU fan operation and external outputs where applicable.

ISOLATE

SSOVs integrated into branch selector boxes for heat recovery; dedicated SSOV options for heat-pump applications when needed.

Optional BSB and SSOV enclosures for ventilation applications and backup power for BSB and SSOV.

Good A2L design is also about minimizing disruption

R-32 indoor units

Same IDU specification approach, ductwork connections, ceiling cutouts, space and maintenance clearances plus added safety functions.

The objective: make the refrigerant transition feel like an evolution of the system—not a restart of the project.

Lead the future without abandoning today's buildings

Two responsibilities must run in parallel.

1 MOVE FORWARD

Accelerate the transition to R-32 and lower-GWP technologies as regulations and market requirements evolve.

2 SUPPORT WHAT EXISTS

Continue supporting R-410A VRV systems already in operation, subject to applicable regulatory requirements.

Customers need an OEM that can help them design what is next - and support what they already own.

Featured Product: MEGA-Q

All-Electric Commercial Hot Water Generation system

MEGA•Q



Mega-Q | All-Electric Commercial Hot Water Generation system



Heat Source Unit

- High efficiency inverter air-cooled heat source
- R410A Refrigerant



Cascade Unit

- refrigerant-to-refrigerant HX
- refrigerant-to-water HX
- Built-in inverter water pump
- R-134A refrigerant



Tank Controller Kit

- Connects to the hot water storage tank using three water temperature sensors
- Controls up to 6 Mega-Q systems on the same hydronic loop

Mega-Q | Features & Benefits



*Based on heating conditions at the outdoor temperature of 77°F DB/69.8°F WB, the outlet water temperature of 149°F, and the inlet water temperature of 75.2°F.

- All-Electric Heat Pump Technology for Hot Water Generation
- 120,000 Btu/h (10 Ton) system. **Scalable and modular system design** allows for up to 6 Daikin Mega-Q systems to connect to the same hydronic loop, achieving **total nominal capacity of 720 MBH**.
- Dependable hot water generation at ambient temperatures from **-4F DB to 109F DB** (from -20C DB to 43C DB)
- Customizable high-leaving water temperatures from **140F to 194F** (from 60C to 90C) with inlet water temperatures from 41F to 176F (from 5C to 80C).
- Year-round high efficiencies with up to **4.6 COP** thanks to Daikin's inverter heat pump and cascade technologies
- Flexible application design with a separation of up to 65 ft. between the heat source unit and the cascade unit.
- **Built-in variable-speed water pump** increases waterside system efficiencies compared to single-speed pumps and can handle water **flow rates of up to 3.8 gallons per minute (GPM)**.



Daikin *ALTHERMA* 3 H HT

Daikin ALTHERMA 3 H HT | Decarbonize & Electrify Heating, Cooling, and DHW



- 3-in-1 solution for **heating, cooling, and DHW**
- Superior levels of **comfort, energy efficiency, reliability, and control**
- Wide range of applications, including low ambient temperatures
- Daikin's Signature technology, a combination of Daikin's very **high-efficient compressors** and **R-32 refrigerant**, to achieve **best in class seasonal efficiency**



- **Greener performance**
- **Replace** fossil fuels
- Maximize usage of **renewable** energy
- Ensure a healthy and **sustainable** environment and contribute to **carbon neutrality**



R-32 has a much lower Global Warming Potential (GWP), is equivalent in power to standard refrigerants, but achieves higher energy efficiency and lower CO₂ emissions. Easy to recover and reuse, R-32 is the perfect solution for attaining new CO₂ emission targets.

Daikin ALTHERMA 3 H HT | Decarbonize & Electrify Heating, Cooling, and DHW

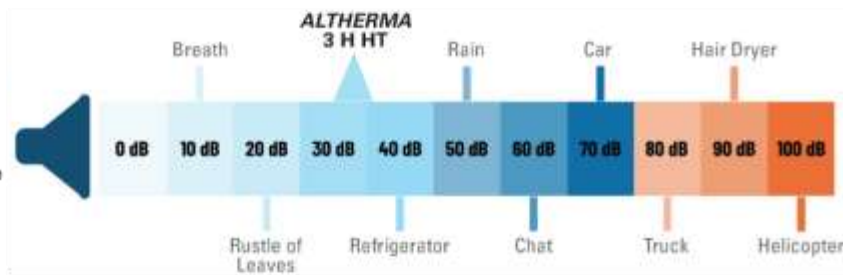


Outdoor unit + indoor unit + tank

 **Leaving Water Temp.**
up to 158°F / 70°C

 **Ambient down to**
-18°F / -28°C

Silent comfort:
38 dBA at 10 ft
and 35 dBA in
low sound mode



- Hydrosplit: all refrigerant contained outside
- No refrigerant work required: “PLUMB n PLAY”
- One Solution – Multiple Combinations
- Best in class performance: COP, LWT, and ambient conditions
- For new buildings, retrofit, and low energy houses
- Timeless design and space-saving installation

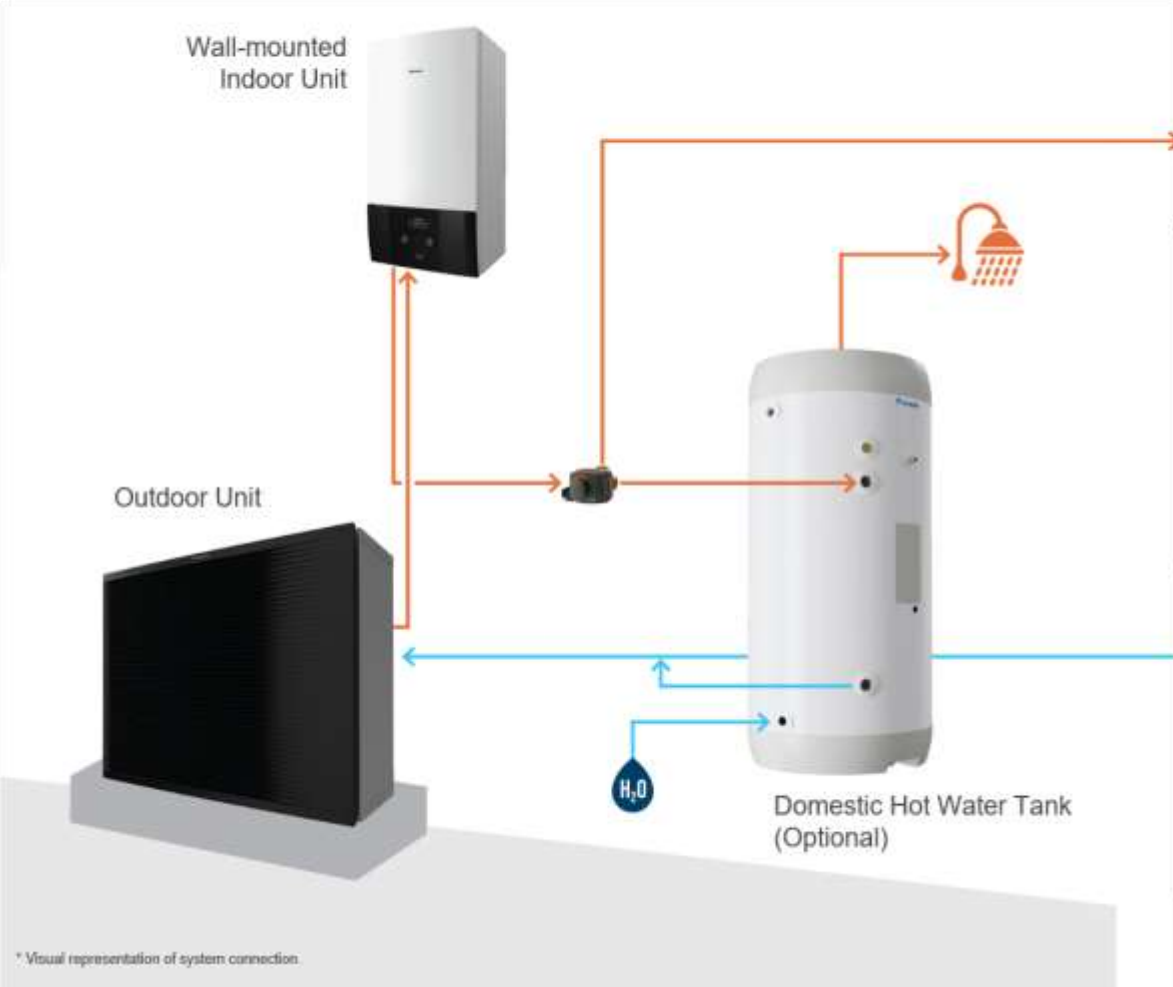


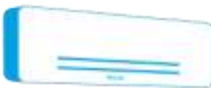
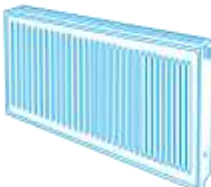
High heating capacities up to 158°F leaving water temperature
⇒ **The ideal boiler replacement**



Gas furnace, A/C unit, and Gas Water Heater replacement
⇒ **Whole home electrification**

Daikin ALTHERMA 3 H HT | Schematic & Emitter Options



Hydronic Distribution - Indoor Emitter Connections:		
USING FIELD SUPPLIED RADIANT FLOOR		
 Radiant flooring	 HEATING	
	ADVANCED EFFICIENCY	
	Low Temperature	
DAIKIN SUPPLIED		
 Hydronic Air Handler	 High-wall HP Convactor	 Floor-standing HP Convactor
 HEATING		
 COOLING		
ENHANCED EFFICIENCY		
Medium Temperature		
USING (EXISTING) RADIATOR(S) OR BASEBOARD(S)		
 Radiator	 Hydronic Baseboard / Fin-tube	 HEATING
STANDARD EFFICIENCY		
High Temperature		

VRV/VRF is more relevant than ever. The design process is evolving.

- ✓ Understand the code change.
- ✓ Validate Mrel against EDVC.
- ✓ Use the available design levers.
- ✓ Design for lifecycle value - not compliance alone.



**DESIGN FOR TOMORROW.
SUPPORT THE SYSTEMS OF TODAY.**

Questions & Discussion