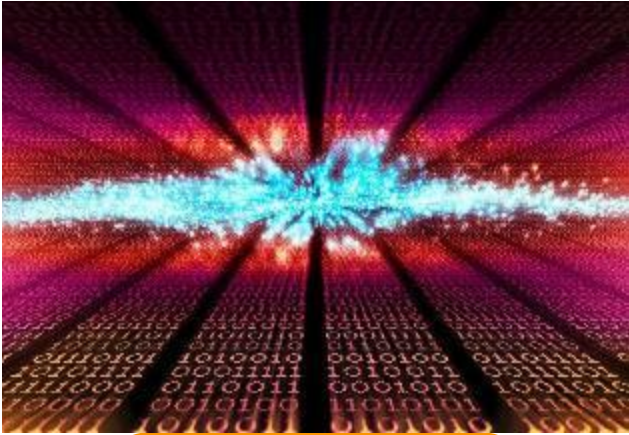


Liebert® CRV4

Technical Presentation

Market Drivers



Data consolidation & migration of data center operations increase density per rack



Eliminates 'hot spot' - Row cooling systems create a shorter airflow path.



Lesser footprint for cooling unit creates more space for IT infrastructure



Increased inlet temperature to servers saves electrical consumption

Liebert® CRV4 : Product Highlights

Liebert® CRV4



Key Features and Benefits

- **More capacity than legacy series in same footprint**
- Variable capacity based system allow to provide optimum cooling effect
- **Extended cooling capacity up to 45 kW**
- Elevated Efficiency than legacy series & other vendors
- **Partial load EER can reach >5.0**
- Precise mass flow of refrigerant creates optimum cooling capacity
- **User friendly controller & 7" touch screen based display**
- **Hot swappable EC fan design enables easy maintenance**
- With integrated intelligent controls make smarter decisions for critical infrastructure
- Uses only environment friendly cooling medium
- **In built condensate pump provides easy drainage solution**
- Heater & Humidifier are in-built options can be offered
- Dual power, Low temp kit, water cooled version, water leak detector etc. can be offered on request

Liebert® CRV4 : Application

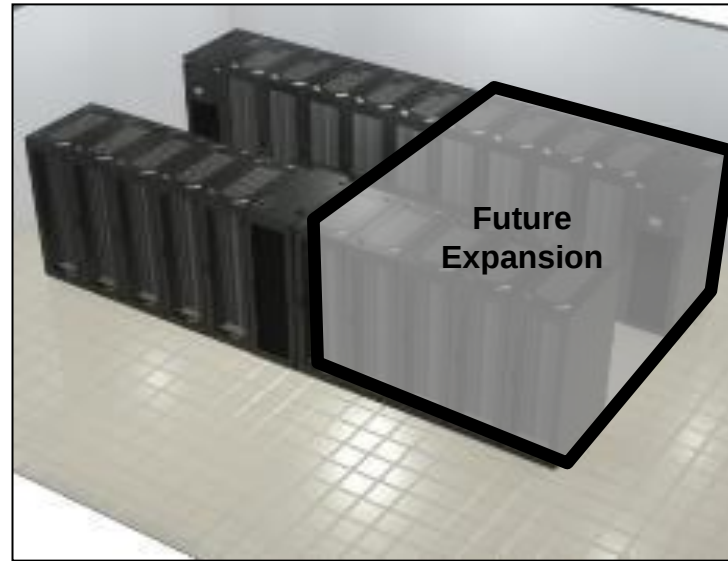
<i>Vertical</i>	<i>Applications</i>	<i>Key features</i>
IT	• Critical servers • Networking equipment • Data storage	• 5 kW/Rack and above • Compact and integrated solution • Elevated Efficiency
Colo Data Center	• High Density zone • Critical servers • Containment Solution	• Space Saver • Handle high density • Higher efficiency
Telecom	• 4G-5G Mobile stations • SDN and NFV • Control rooms	• Without raised floor • Elevated Efficiency • Integrated solution
Industry	• Manufacturing sites • Control equipment and PLCs • Data and networking equipment	• Suitable to cool architecture • Higher airflow • Without raised floor

Wide and cross applications potential:
Transport, networking equipment, mission critical servers, ...

Liebert® CRV4 : Application



High Density (5G)



Modular expansion



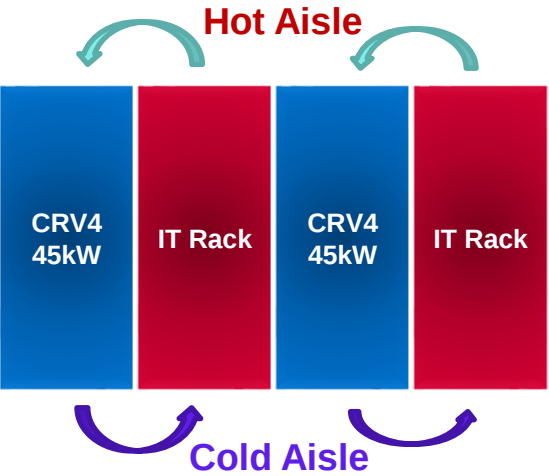
High Performance Computing

Potential Applications

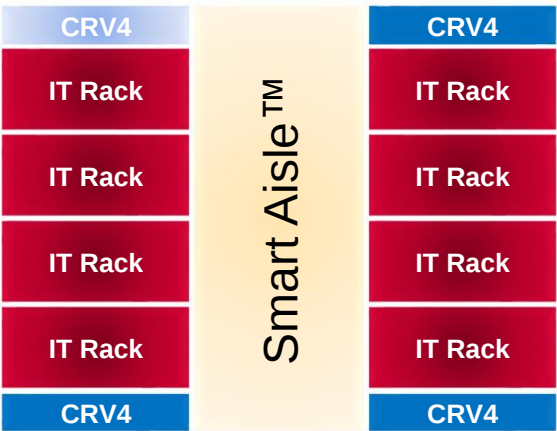
- **High density cooling (>10kW/rack) – 5G racks, high performance computing**
- **No raised floor required**
- **Modular Expansion**
- **Small footprint required**

Liebert® CRV4 : Typical Configurations

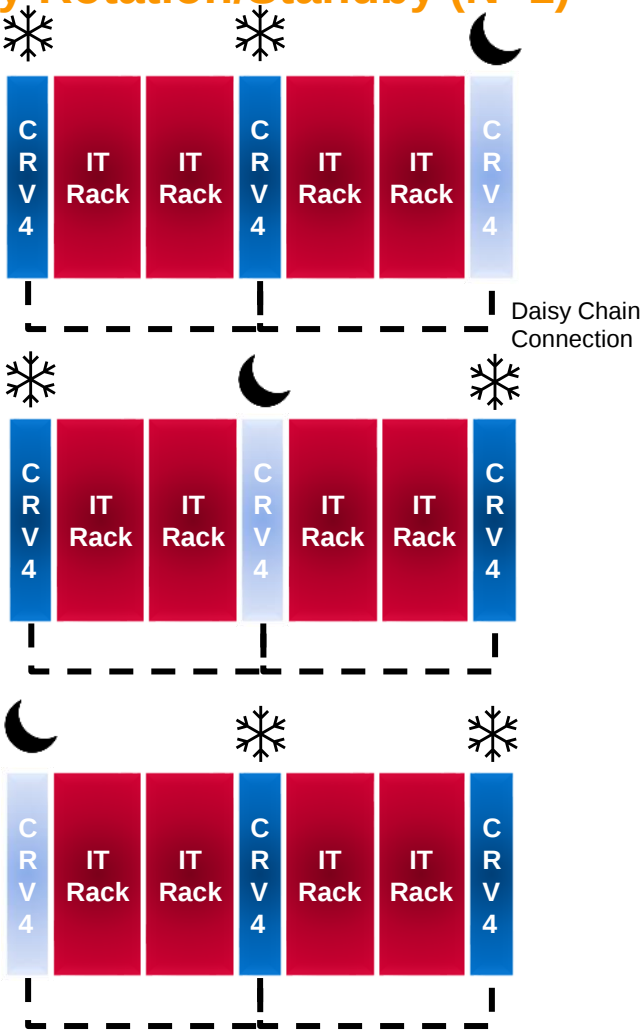
High density cooling



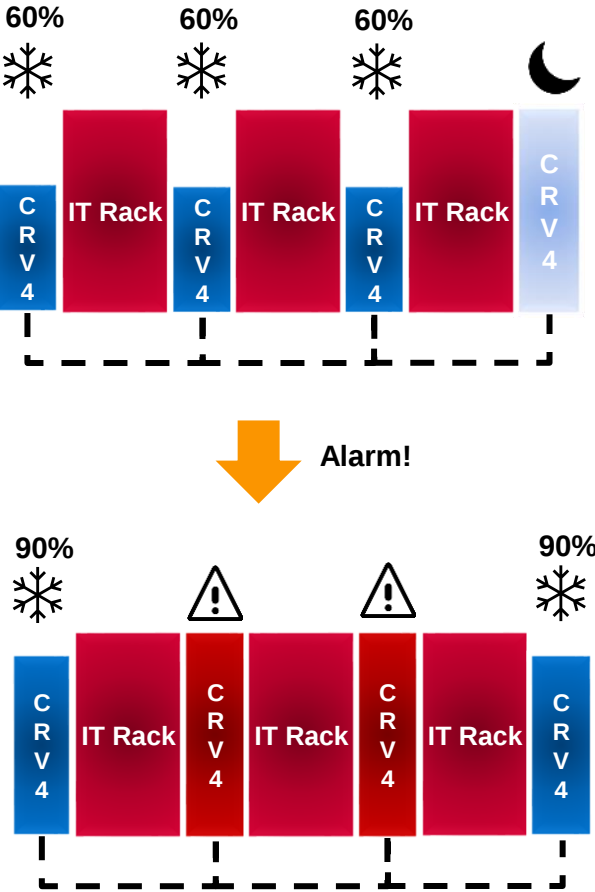
POD Configuration



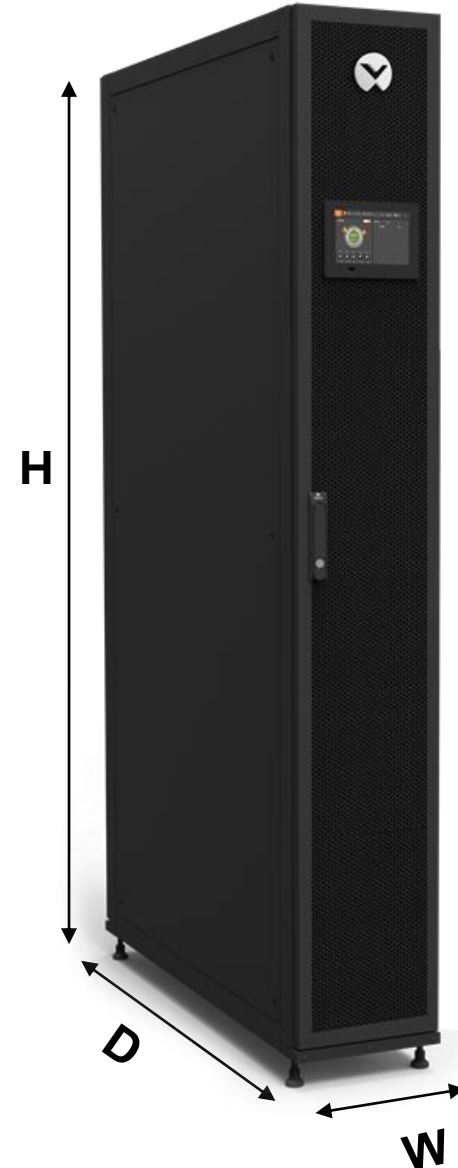
Duty Rotation/Standby (N+1)



Hot Standby/ Emergency



Liebert® CRV4 : 12 kW



- **Footprint :**

HXDXW (mm) – 300 X 1100 X 2000 (RA version)

HXDXW (mm) – 300 X 1200 X 2200 (HA version)

RA – Std model HA – Telecom Model

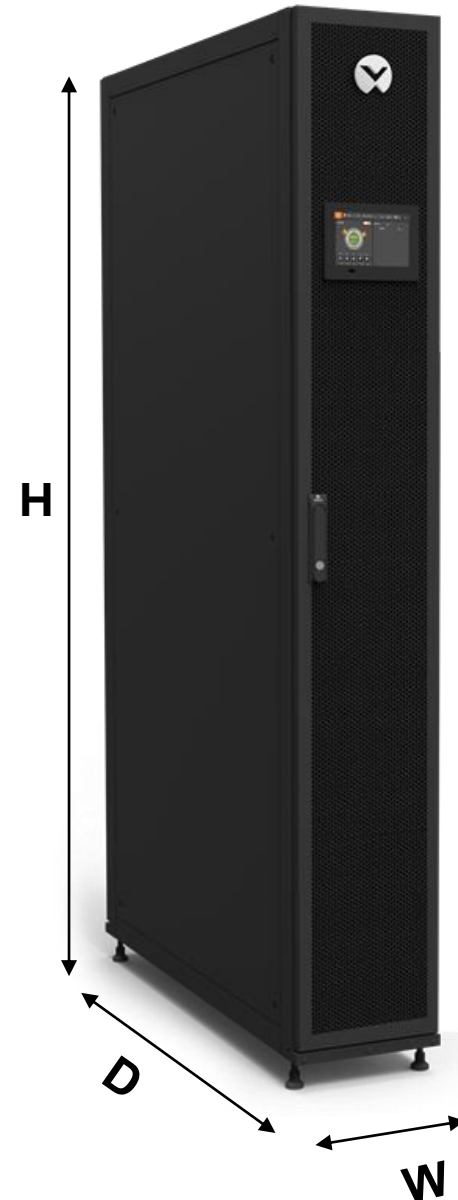
- **Capacity : 13.9 kW**

(Performance based on 37 °C return air temperature, 24% relative humidity and 45 °C condensing temperature)

- **Max EER : 4.4**

@ 10.2 kW (85% partial load)

Liebert® CRV4 : 25 kW



- **Footprint :**

HXDXW (mm) – 300 X 1100 X 2000 (RA version)

HXDXW (mm) – 300 X 1200 X 2200 (HA version)

RA – Std model HA – Telecom Model

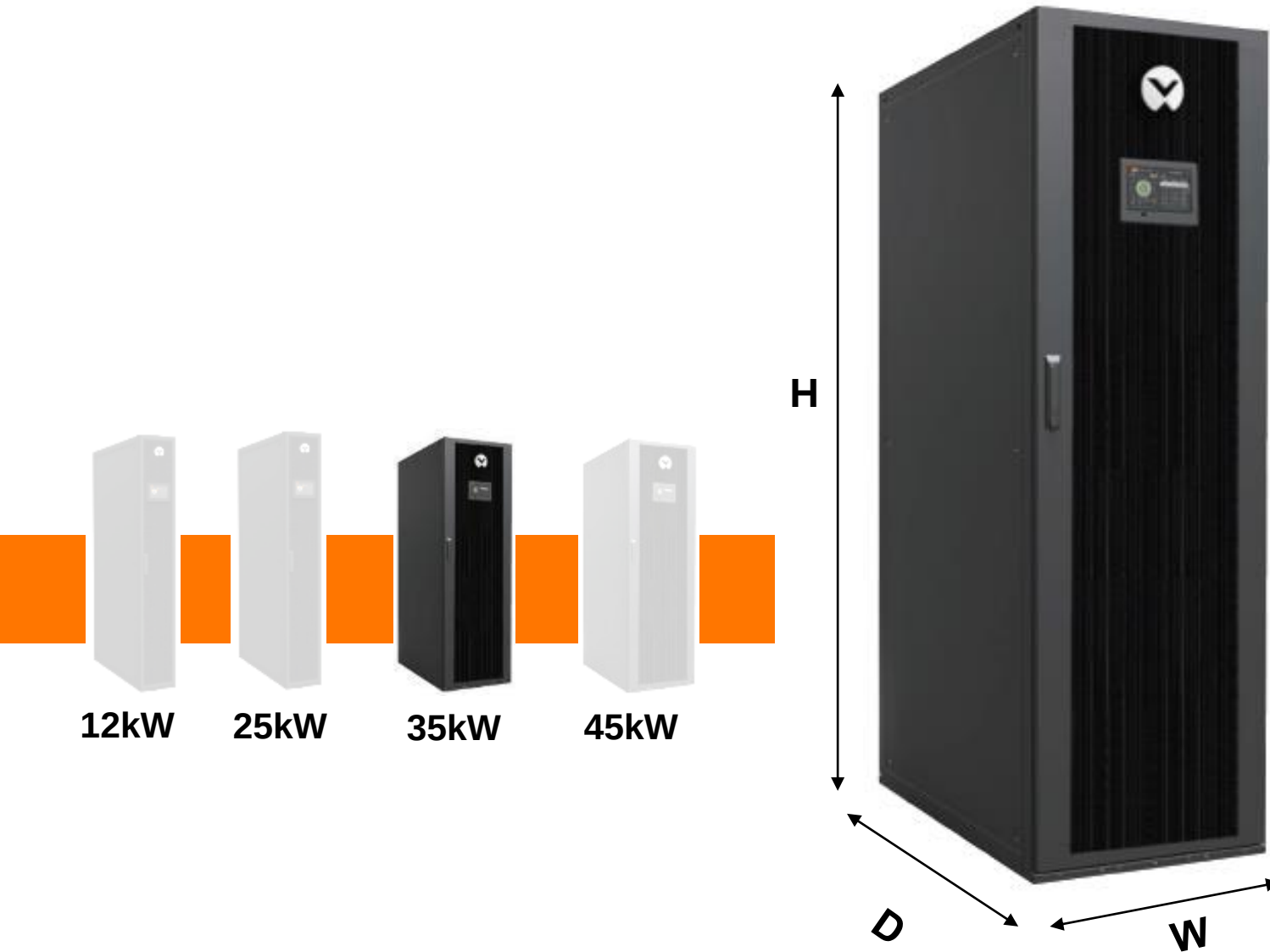
- **Capacity : 28.8 kW**

(Performance based on 37 °C return air temperature, 24% relative humidity and 45 °C condensing temperature)

- **Max EER : 4.8**

@ 20.2 kW (80% partial load)

Liebert® CRV4 : 35 kW



- **Footprint :**

HXDXW (mm) – 600 X 1100 X 2000 (RA version)

HXDXW (mm) – 600 X 1200 X 2200 (HA version)

RA – Std model HA – Telecom Model

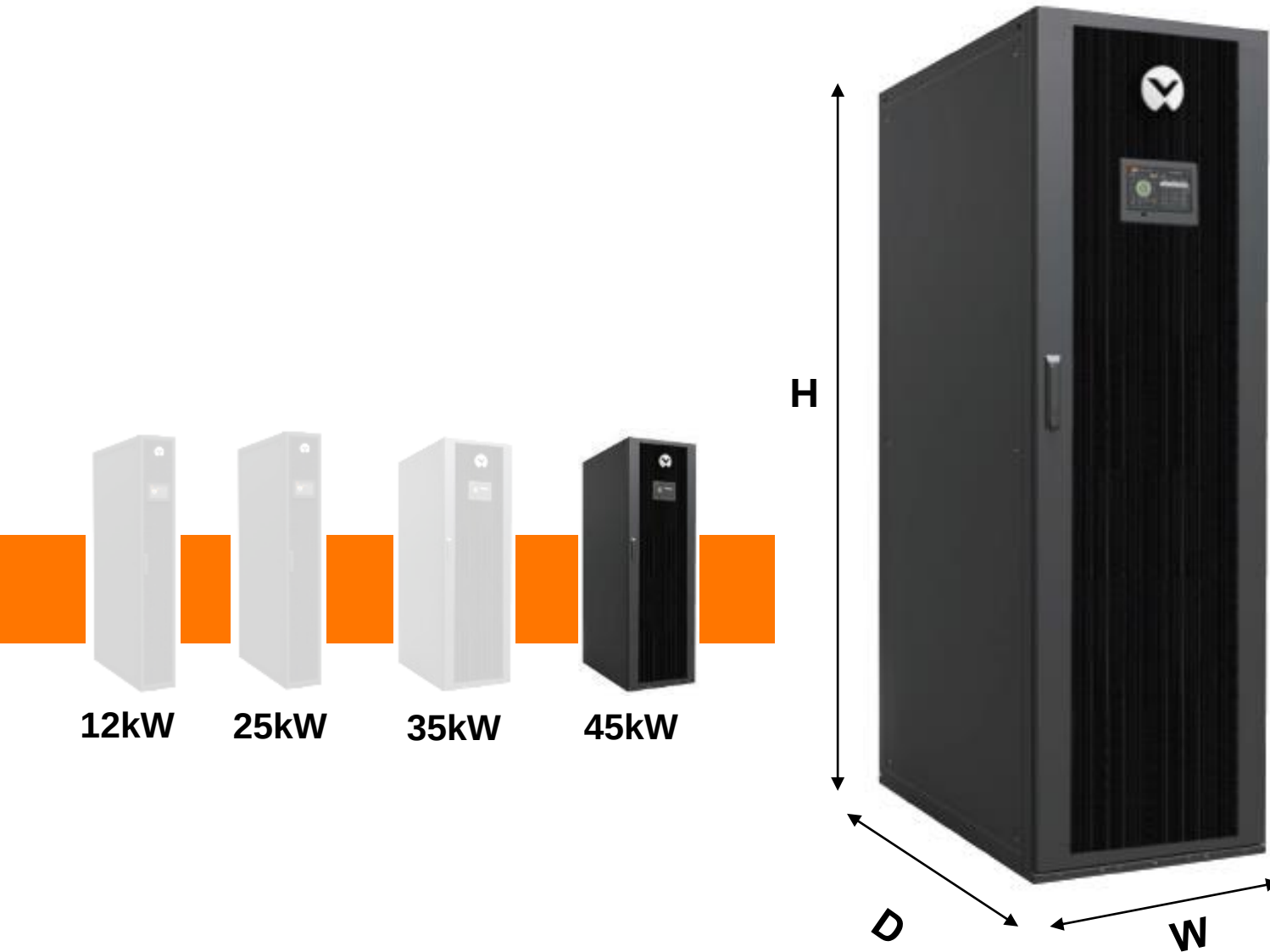
- **Capacity : 40.9 kW**

(Performance based on 37 °C return air temperature, 24% relative humidity and 45 °C condensing temperature)

- **Max EER : 5.0**

@ 25 kW (71% partial load)

Liebert® CRV4 : 45 kW



- **Footprint :**

HXDXW (mm) – 600 X 1100 X 2000 (RA version)

HXDXW (mm) – 600 X 1200 X 2200 (HA version)

RA – Std model HA – Telecom Model

- **Capacity : 47.5 kW**

(Performance based on 37 °C return air temperature, 24% relative humidity and 45 °C condensing temperature)

- **Max EER : 5.1**

@ 25 kW (55% partial load)

Liebert® CRV4 standard configuration



- ✓ Capacity range: 12kW, 25kW, 35kW & 45kW
- ✓ Performance: Max EER >5.0 in partial load
- ✓ Refrigerant: Eco friendly, R410A
- ✓ Compressor: Copeland ZPV & JPV series
- ✓ EEV: Danfoss EEV valve and Eunicum EEV controller
- ✓ EBM EC fan with hot swappable design
- ✓ Evaporator: Newly optimized cooling coil
- ✓ 1 stage PTC heater & Steam Humidifier as optional offering
- ✓ Controller : 7" Comprehensive touch screen color HMI

Liebert® CRV4 Additional Features

Air Pressure Difference Switch

The switch is used to detect if the unit filter is clogged, and send alarm signals to the control board

Water leakage detection kit

The kit is used to detect water-under-floor, and send alarm signals to the control board

Remote temperature sensor kit

The sensor is used to monitor the temperature of other devices in the equipment room, and the temperature can be used as the control temperature of the unit

Monitoring Card

The RDU-SIC monitoring card is used, and it provides an RJ45 port and a USB port. SNMP, TC/IP options are also available

Dual Power Module

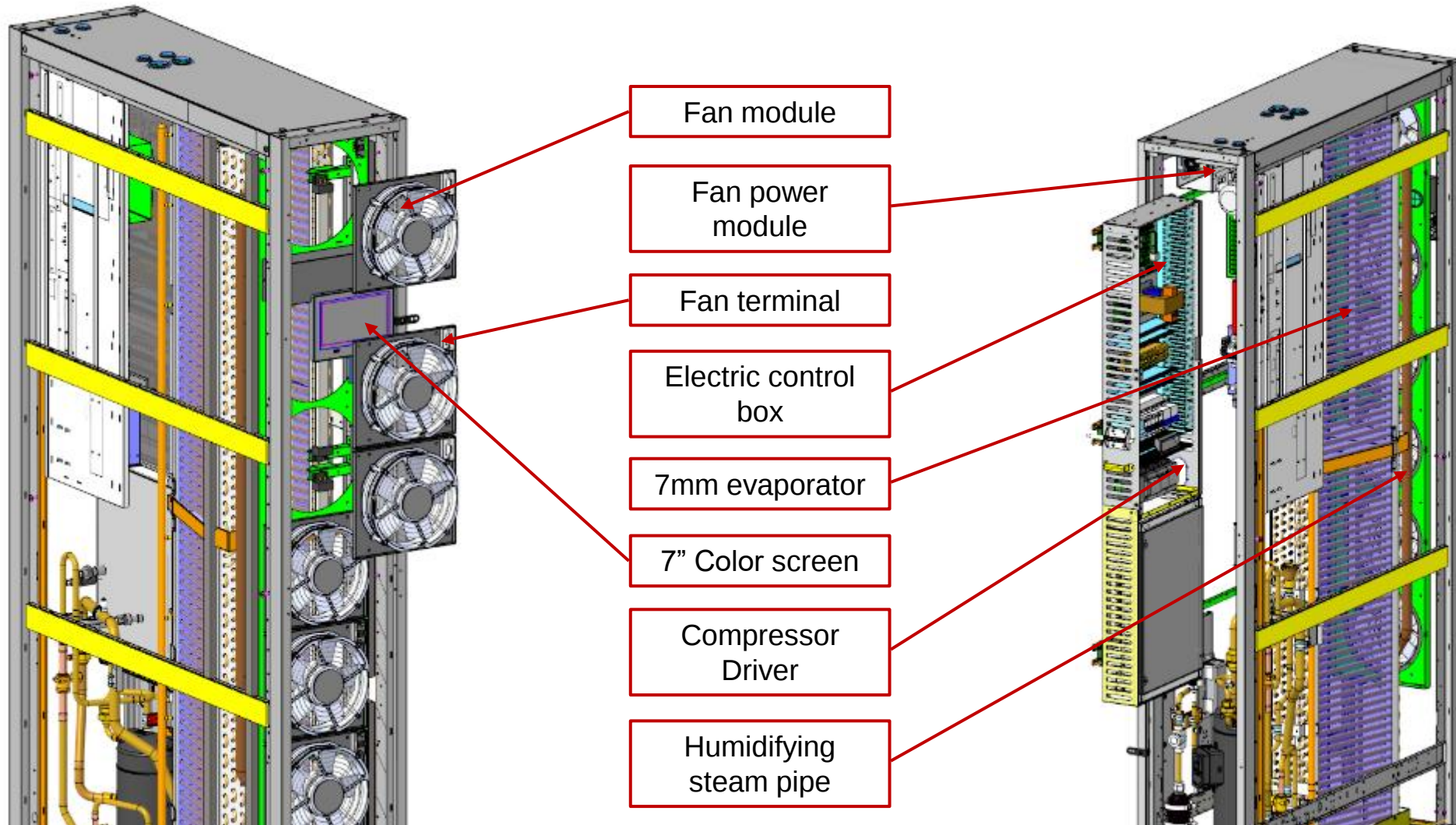
CRV4 unit is equipped with a highly efficient dual power module with minimum electrical losses

Long Piping Kit

The long pipe kit can prevent the refrigerant from returning and concentrating after the compressor is turned off, to ensure the normal start of the compressor and to make the system safer.

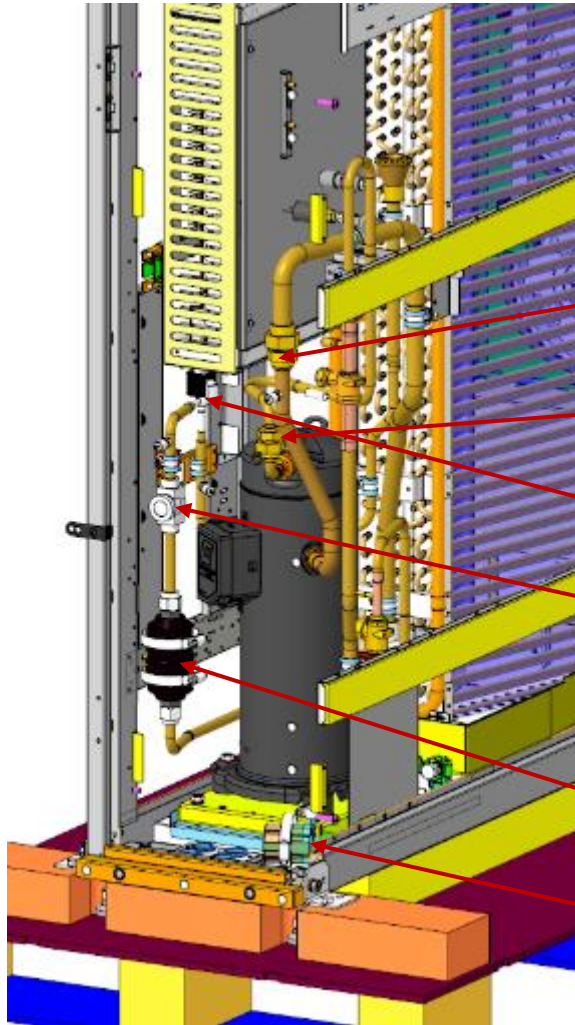
Liebert® CRV4 (300mm) – Internal Architecture

Layout of components for CR025RA (CRV4)



Liebert® CRV4 (300mm) – Internal Architecture

Layout of components for CR025RA (CRV4)



Water tray filter

High water level
detection board

Compressor suction
thread

Compressor discharge
thread

Humidification tank

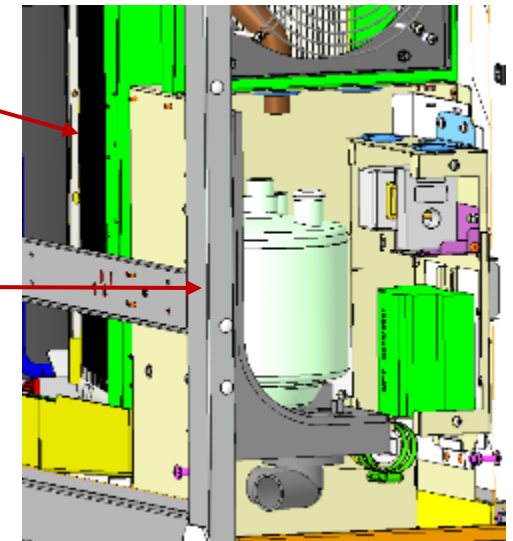
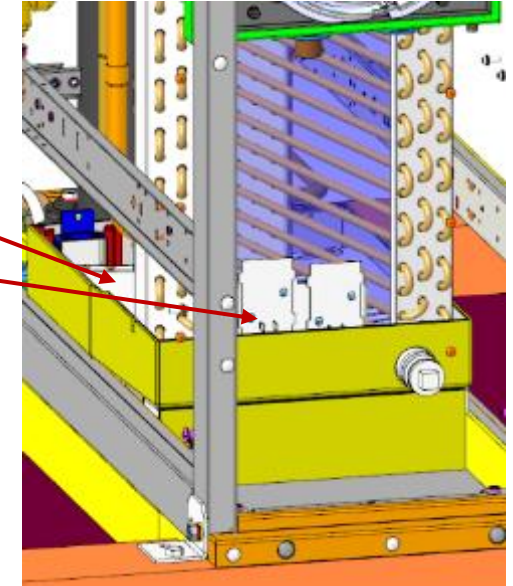
EEV

Sight glass

Humidification electric
control box

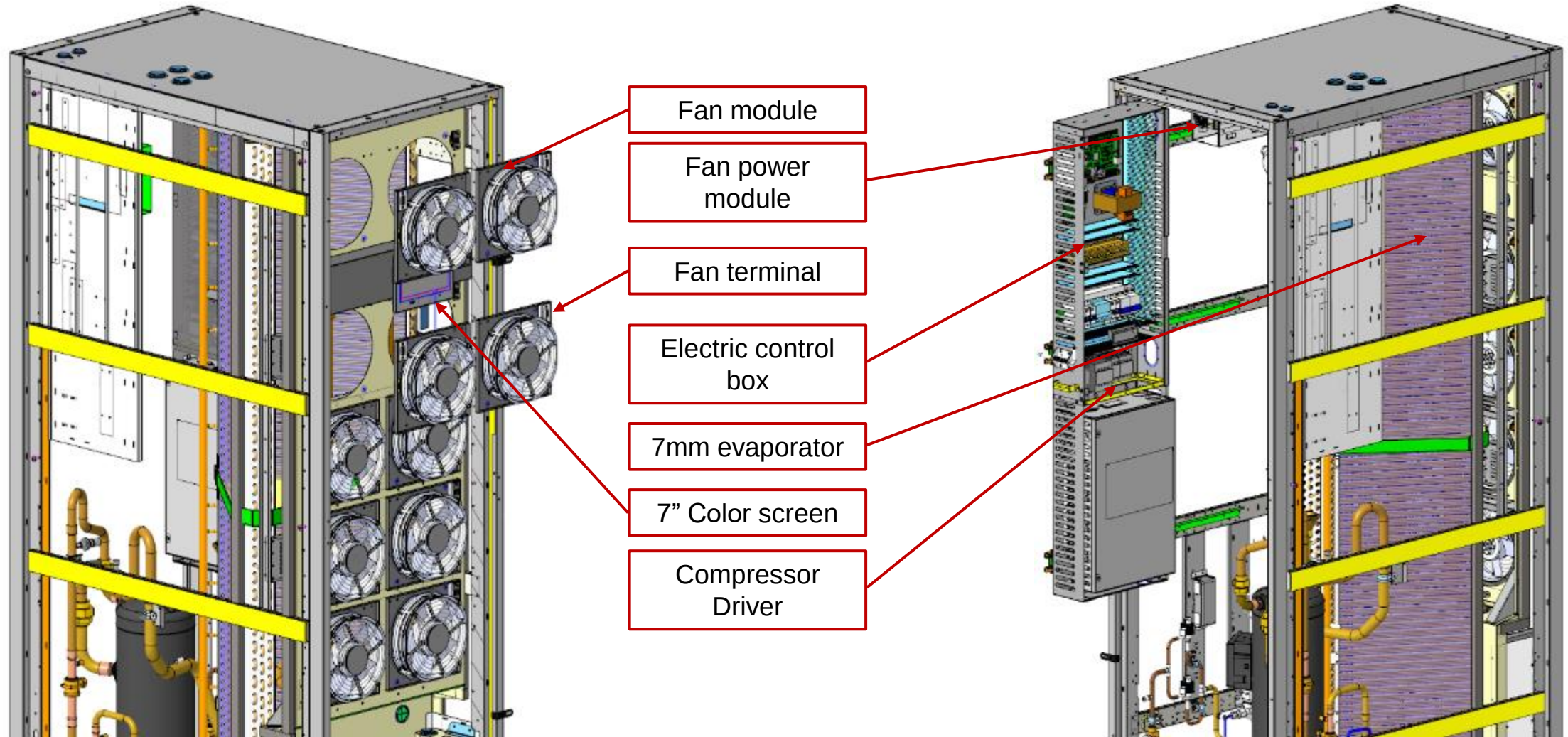
Dry filter

Water pump



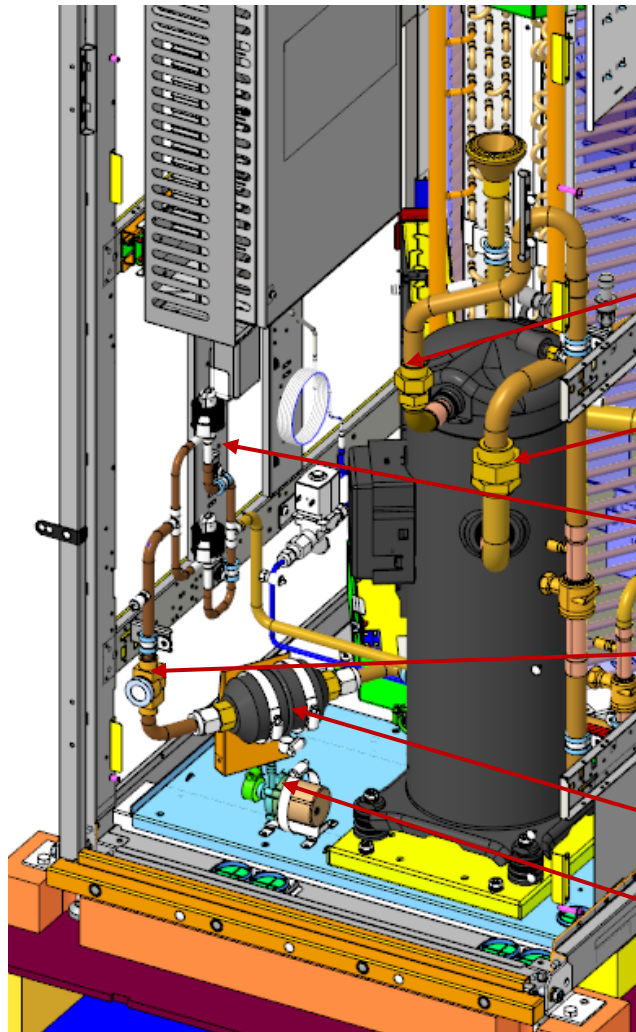
Liebert® CRV4 (600mm) – Internal Architecture

Layout of components for CR045RA (CRV4)



Liebert® CRV4 (600mm) – Internal Architecture

Layout of components for CR045RA (CRV4)



High water level
detection board

Compressor discharge
thread

Compressor suction
thread

Humidification tank

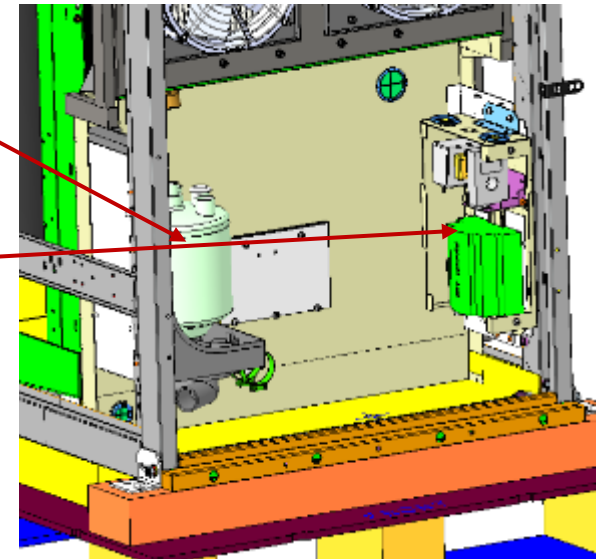
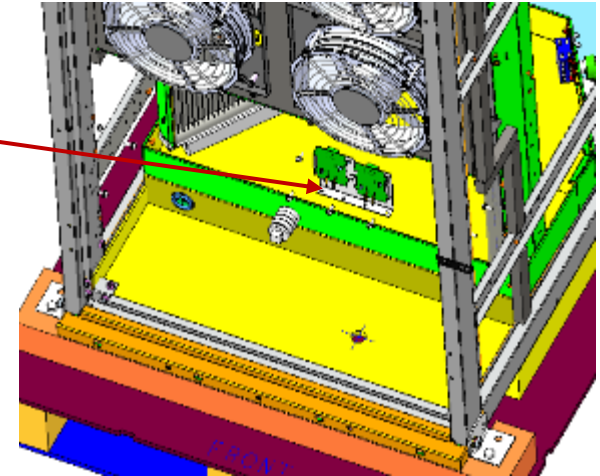
EEV

Sight glass

Humidification electric
control box

Dry filter

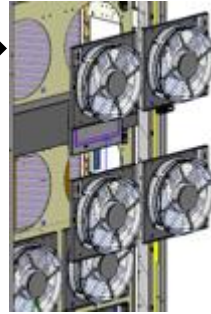
Water pump



Liebert® CRV4: Main Features

Liebert® EC Fan

- EBM EC axial fan
- Hot Swappable design
- More no EC fan in frame



CR012, CR025

Vertiv Smart Control

- 7" Comprehensive touch screen color HMI
- Multiple control modes (six) for fan and compressor



CR035, CR045

Variable Compressor

- DC inverter compressor technology provides infinite variable capacity modulation between 30% to 100%
- Environment friendly refrigerant (R410A) based



CRV4 Cooling Coil

- Compact structure, higher heat transfer area
- 7mm dia coil introduced in CRV4



Liebert® CRV4 comprises with Modulating Compressor

DC brushless scroll compressor

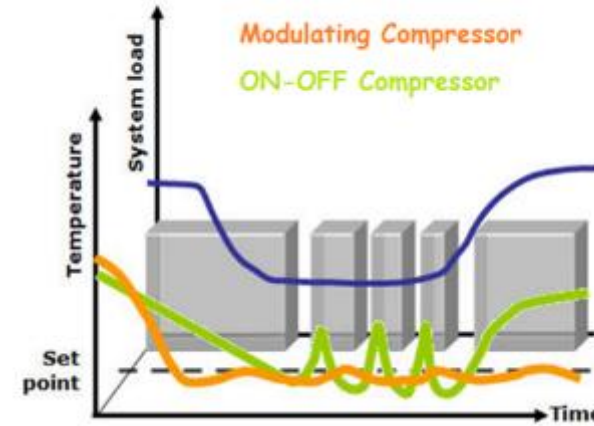


	Supplier	CRV4
CR012RA	Mitsubishi	MNB36FABMC
CR025RA	Copeland	ZPV050
CR035RA	Copeland	JPV066
CR045RA	Copeland	ZPV096

Compressor driver



	Supplier for CRV4
CR012RA	Shenzhen Eunicum Electric
	ACRC-T36822
CR025RA	Megmeet
	Inovance
CR035RA	Megmeet
	Inovance
CR045RA	Megmeet
	Inovance



Key Advantages

- ✓ Optimized variable speed design through efficient BPM motor, wide speed range 1000 ~ 7200 RPM for part load efficiency.
- ✓ Expanded operating envelope for a **wide range of cooling application** also contributes to premium efficiency.
- ✓ Coupled with environment friendly refrigerant (R410A) & EEV, premium efficiency is achieved as compared to legacy solution; **part load EER as high as > 5.0**

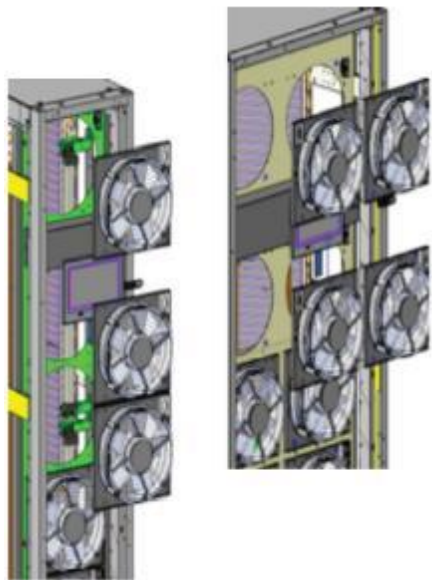
Liebert® CRV4 comprises with EC fan with hot swappable design

EC Fan



Key Advantages

- ✓ The EC fan speed is automatically regulated by the CRV4 smart controller
- ✓ The EC fan has the characteristics of high efficiency, energy saving, space saving
- ✓ In CRV4 fans are with hot swappable feature which enables user to do easy maintenance without interfering unit's operation



Configuration

Model	CR012RA	CR012HA	CR025RA	CR025HA	CR035RA	CR035HA	CR045RA	CR45HA
Fan type	EC Axial Fan (Hot swappable)-EBM2218							
Number of fans	4		6		8		10	

Liebert® CRV4 comes with Smart Controller

Smart Controller



6 modes are available, as given in below table

Fan Comp	Supply	Remote	Return
	Supply	Remote	Return
Supply	√	√	√
Remote	x	√	√
Return	x	x	√

Key Features

- ✓ 7" large touch screen colour display with HMI version
- ✓ Up to 16 Liebert® CRV4 units can be networked together (One master unit and up to 15 slave units)
- ✓ Advanced control algorithms allow the airflow and cooling to be modulated independently, enhancing performance and eliminating excessive operations
- ✓ Multiple control modes (six) for fan and compressor of CRV4 series
- ✓ Comes standard with RS485 interface, optional SNMP and TCP/ IP interface
- ✓ Connects up to 6 remote temperature sensors

Liebert® CRV4 : Controller Section (Display)



Liebert CRV4 Colour Screen Display

Liebert® CRV4 : Group Control

Intelligent Thermal Controls for Smarter Management

Via Liebert RDU*



Rotation
Control

Cascade
Control

Alarm
Standby Control

Unified
Control

Remote
Sensor Control

- Monitoring infrastructure and alarm management: Cooling unit, UPS, gensets, etc.
- Ability to network with other perimeter units, including other 3rd party cooling units
- Management environmental conditions i.e. temperature and humidity, leak, smoke, thermal group control, and digital inputs and outputs.

Via Daisy Chain



Rotation
Control

Alarm Standby
Control

- Up to 16 units can be configured in a team to rotate based on day and time.
- Units which are idle but ready become active in the event of an alarm condition in one of the operating units or based on a rotation schedule.



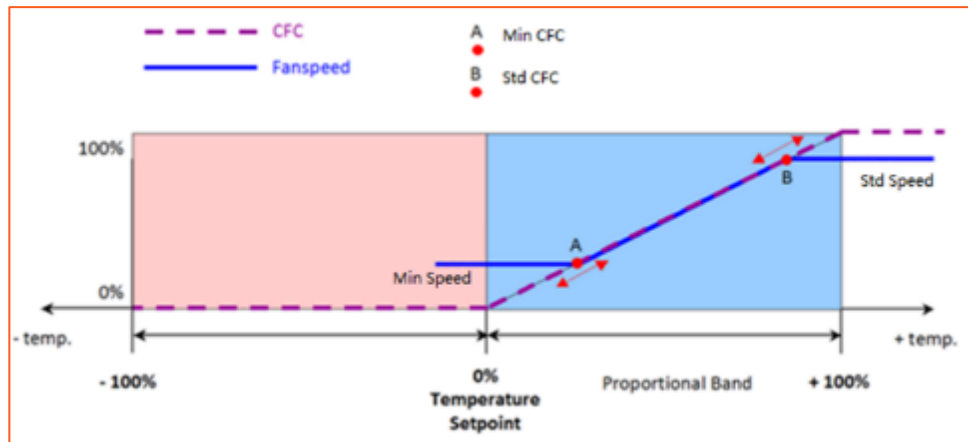
VERTIV

* To be ordered separately

Liebert® CRV4 Smart Controller Features

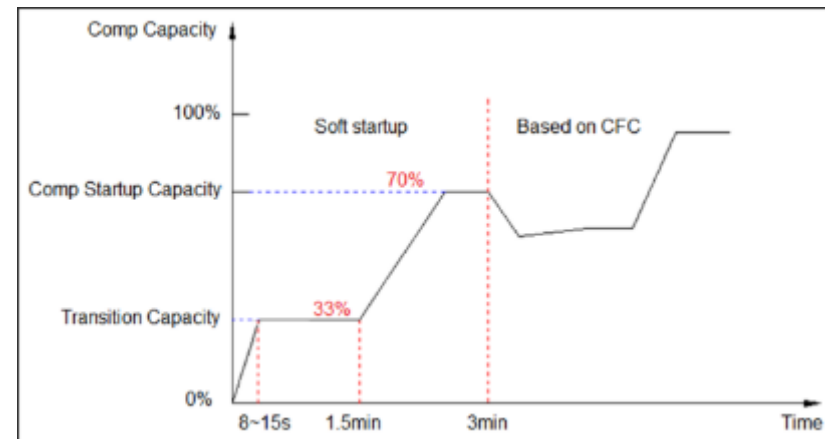
Fan Control

- ✓ Normally, the fan is always running when the unit status is ON.
- ✓ Fan turns on after “Start Delay” when the unit running. Fan turns off after “Stop Delay” when the unit status is off or standby.
- ✓ Once the fan startup, it runs at the “Min Speed” within the first 60 seconds. Then it can be controlled by choose mode.

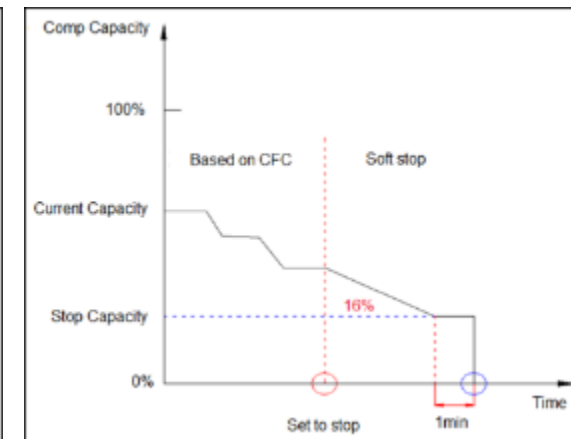


Compressor Control

- ✓ Compressor capacity adjusts based on CFC.
- ✓ Once the compressor startups, compressor contactor closes first. Then controller sends control instructions (On/Off, Capacity) to compressor drive, and the drive controls compressor motor.
- ✓ Once the compressor stops, then controller reduces the compressor capacity firstly, then stop the compressor. The contactor is disconnected after the compressor is closed for 11 minutes.



Compressor control - Start



Compressor control - Stop

Liebert® CRV4 : General Specification

Operating Environment

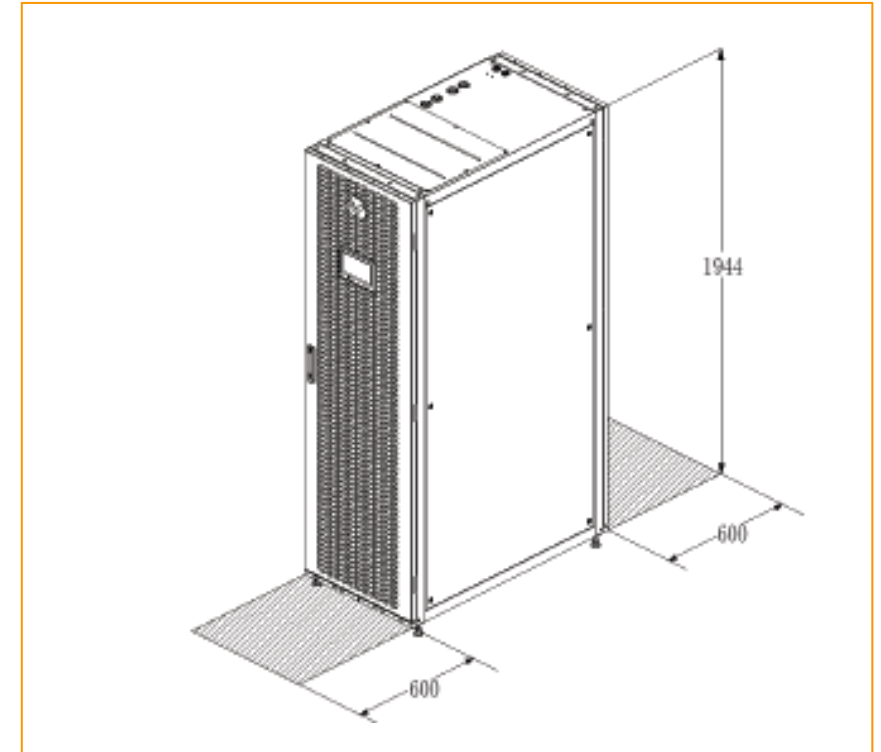
Item	Requirement	
Ambient temperature	Indoor	18 °C to 40 °C, 20% to 60% RH
	Outdoor	-20 °C to +45 °C, if a low temperature kit is configured, the lowest outdoor operation temperature is -34 °C.
Protection level (outdoor unit)	IP20	
Altitude	<1000 m, Derating is required when located altitude is above 1000 m.	
Operation voltage range	380 V to 415 V±10%, 3 Ph+N ~50Hz / 60Hz	

Noise Level Parameter

Model	Air Volume (m³/h)		Unit SPL (1m away from the Unit Front, dBA)	Unit SPL (2m away from the Unit Front, dBA)
CR025	Rated air volume	5200	78.3	75.4
CR035	Rated air volume	8000	80.8	77.5
CR045	Rated air volume	9500	82.2	80.5

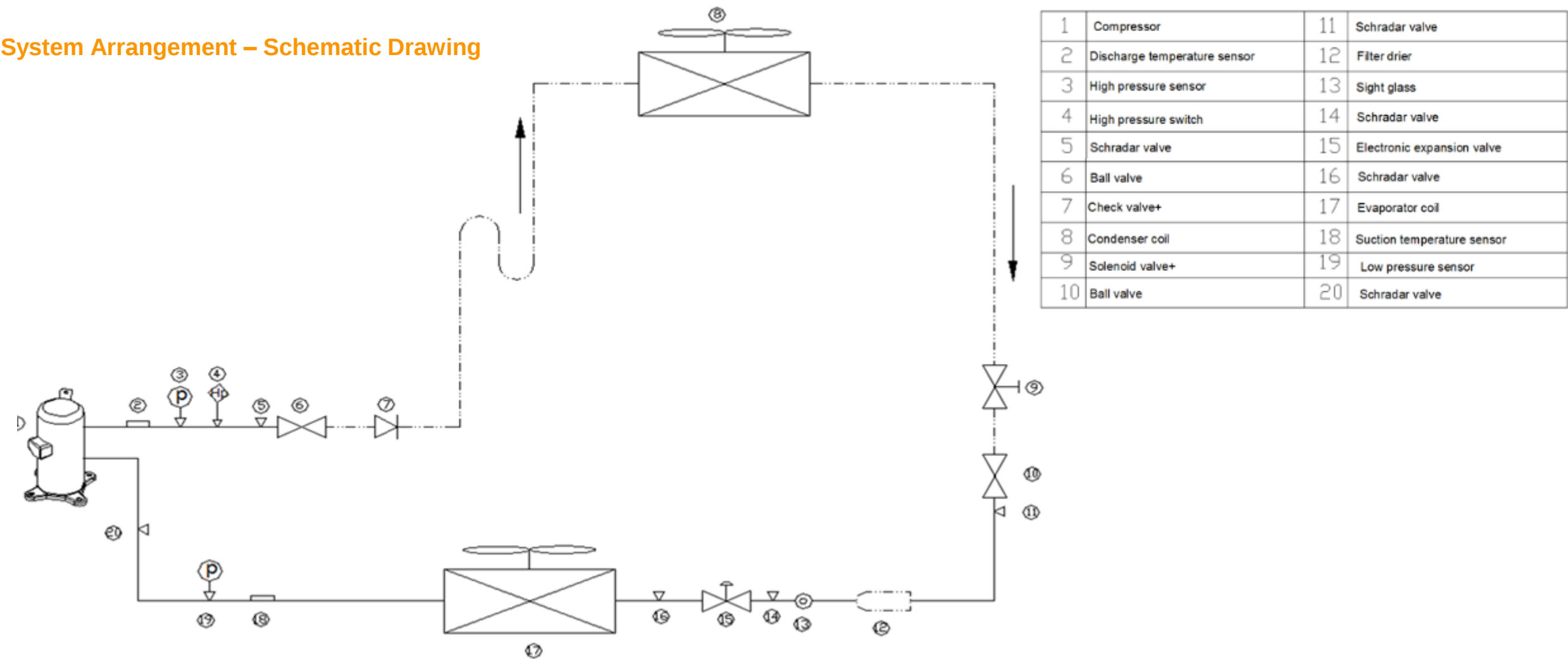
* SPL : Sound Pressure Level

Maintenance Space



Liebert® CRV4 : Mechanical Specification

System Arrangement – Schematic Drawing



Liebert® CRV4 : Mechanical Specification

Refrigerant Pipe sizing chart

Model	CR012		Model	CR025		CR035		CR045	
Pipe length	D	L	Pipe Length	D	L	D	L	D	L
10m	16	12.7	10m	19	12.7	19	16	22	16
20m	16	12.7	20m	19	16	22	16	25	19
30m	19	12.7	30m	22	16	25	16	28	19
40m*	19	16	40m*	22	16	25	19	28	22
50m*	19	16	50m*	22	19	25	22	28	22

- ✓ long piping kit is required for Equivalent Length marked with *.
- ✓ D: Discharge line; L: Liquid Line
- ✓ If the pipe length exceeds 50 m or drops over 30 m, please consult Vertiv representative for details.
- ✓ If the outdoor environment temperature is lower than -20°C, a low-temperature kit is needed, and consult Vertiv representative for details.

Recommended Refrigerant Charging Amount of the Indoor Unit (unit: kg)

Indoor Unit	CR012	CR025	CR035	CR045
Std Charging amount	2.41	2.47	3.12	3.44

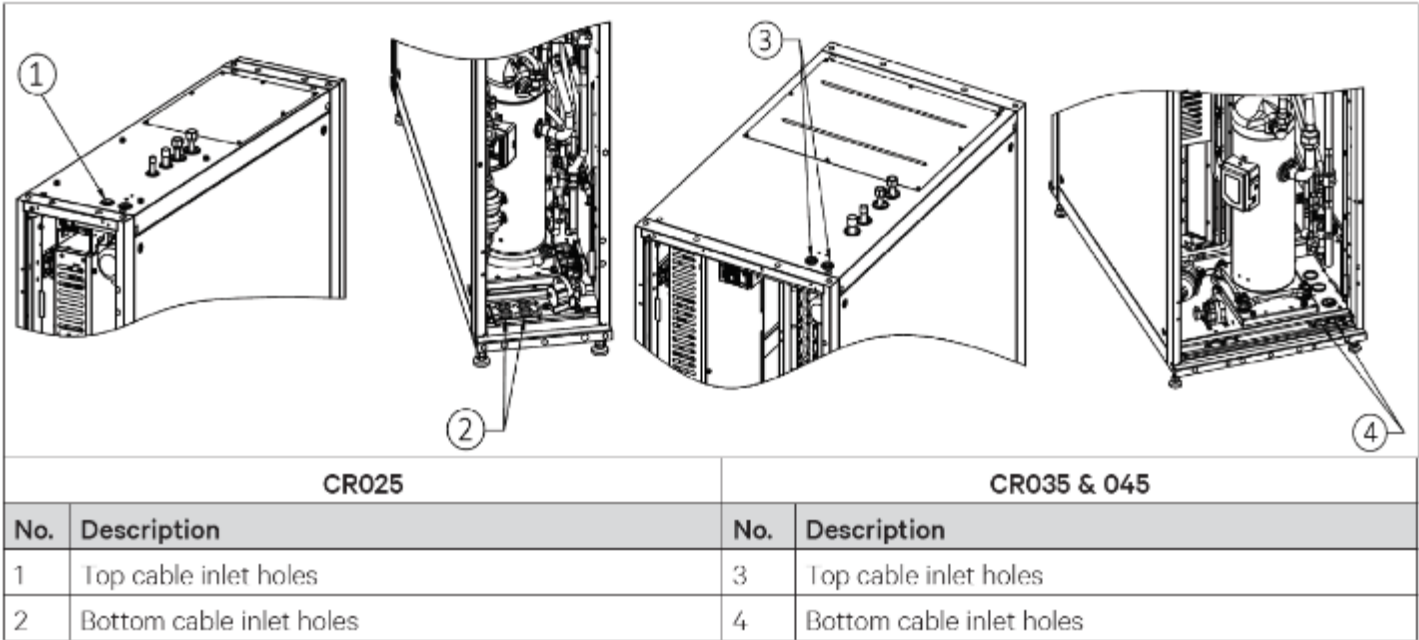
- ✓ Refrigerant refilling amount (kg) = Recommended refrigerant charging amount of outdoor unit+ recommended refrigerant charging amount of indoor unit+ refrigerant refilling amount of per meter liquid pipe (kg/m) × total length of liquid pipe (m)

Unit model	Types of refrigeration oil
CR012	POE (32-3MAF)
CR025	POE (32-3MAF)
CR035	PVE (FVC68D)
CR045	POE (32-3MAF)

Liebert® CRV4 : Electrical Specification

Model	Standard Model	Standard Model with Electrical Heater	Standard Model with Humidifier	Standard Model with Electrical Heater and Humidifier
CR025R/HA	21.7	22.7	23.4	23.4
CR035R/HA	29.3	36.9	30.8	36.9
CR045R/HA	39.1	44.3	39.1	44.3

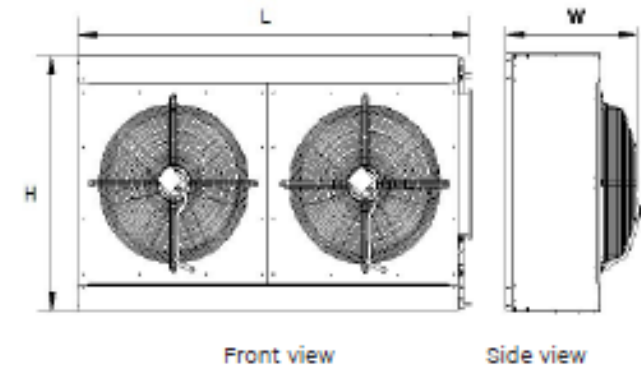
Rated Full load Ampere (FLA) chart



Liebert® CRV4 : (Matching) Condenser Specification

Liebert LSF Condenser (LxWxH)

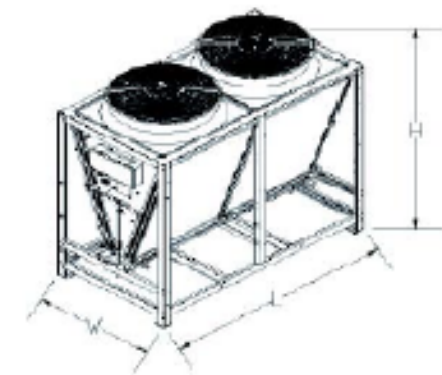
Model	35 °C	40 °C	45 °C
CR012	LSF12-R3 (787x352x1240)	LSF12-R3 (787x352x1240)	LSF12-R3 (787x352x1240)
CR025	LSF38-R3 (1384x695x990)	LSF42-R3 (1584x695x1273)	LSF52-R3 (1584x695x1273)
CR035	LSF42-R3 (1584x695x1273)	LSF52-R3 (1584x695x1273)	LSF76-R3 (2384x695x1273)
CR045	LSF52-R3 (1584x695x1273)	LSF76-R3 (2384x695x1273)	LSF85-R3 (2384x695x1273)



Liebert® LSF™ Unit

Liebert LVC Condenser *Each LVC must pair with 2 identical CRV (LxWxH)

Model	35 °C	40 °C	45 °C
CR012	/	/	/
2 x CR025	/	LVC088 (2330x1100x1744)	LVC106 (2330x1100x1744)
2 x CR035	LVC088 (2330x1100x1744)	LVC106 (2330x1100x1744)	LVC152 (2330x1250x2222)
2 x CR045	LVC106 (2330x1100x1744)	LVC152 (2330x1250x2222)	LVC170 (2330x1250x2222)



Liebert® LVC™ Unit

Liebert® CRV4 Innovation over Liebert® CRV+



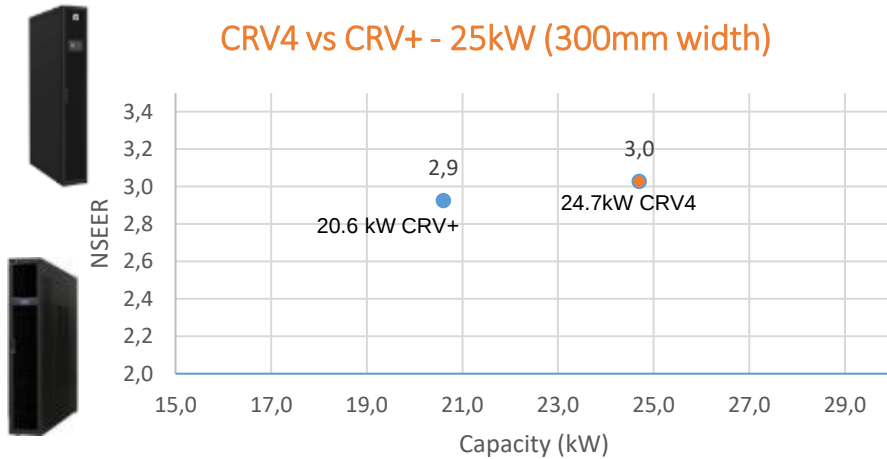
	Liebert® CRV+ (DX)	Liebert® CRV4 (DX)	Benefits
Capacity Output	Limited up to 35kW	Extended up to 45kW* 5~15% more capacity	Capacity improvement
Air volume	Lesser than CRV4 series	Both rated & max air quantity higher	15~24% increase
Indoor Fan Design	EBM EC fan (less nos)	More nos EBM EC fan with hot swappable design	Better performance & ease of maintenance
Evaporator Coil	Legacy design with standard Cu tubes	Improved design with new coil design	Better heat transfer, capacity & efficiency improvement
Controller	Standard Display	Smart Controller with 7" touch screen display	HMI enables CRV4 controller more user friendly
Efficiency	Moderate	Efficiency improvement ranges 10~20% (model specific)	Elevated efficiency of CRV4 improves overall PUE of data center

* Can be extended up to 60 kW in DX version on request

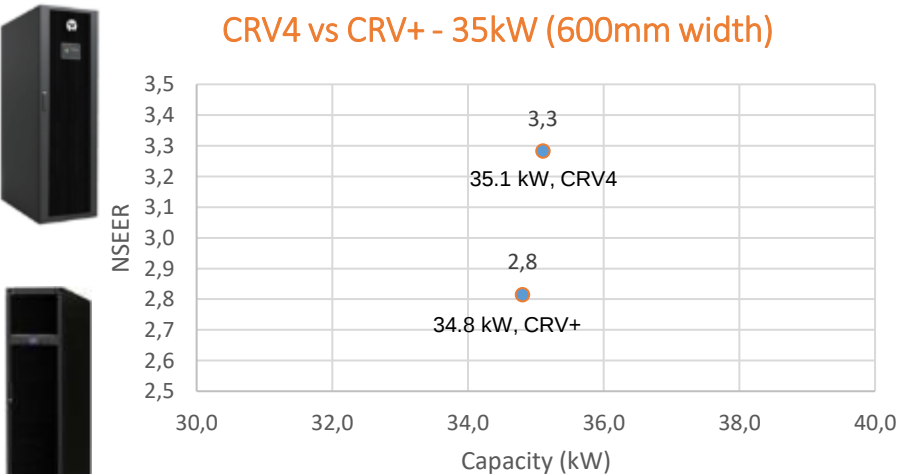
Liebert® CRV4 Performance

Elevated Efficiency of CRV4 over CRV+

CRV4 vs CRV+ - 25kW (300mm width)



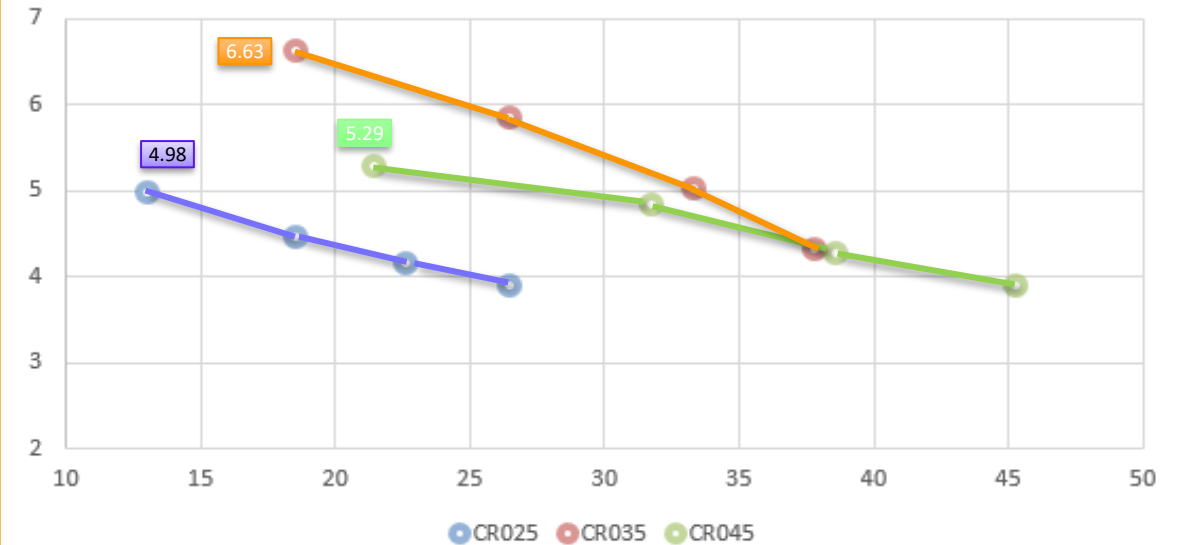
CRV4 vs CRV+ - 35kW (600mm width)



* Considering RAT 35° C/26% RH & 45° C Condensing temperature

CRV4 Performance

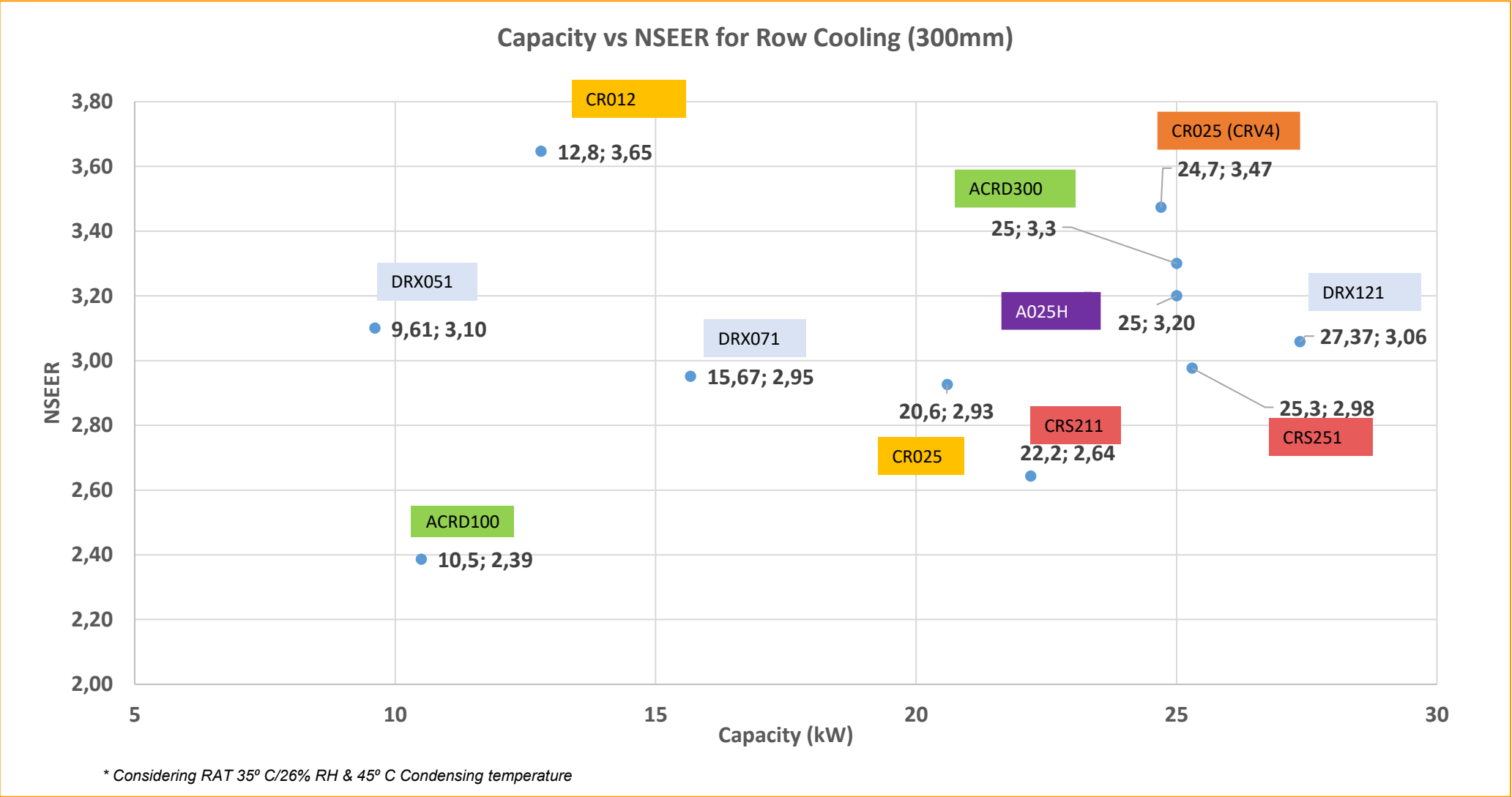
Liebert CRV4 Performance



This capacity vs EER (without condenser power) graph is drafted considering indoor return air temperature at 37 °C DBT & relative humidity of 24%, while condensing temperature is 45 °C.

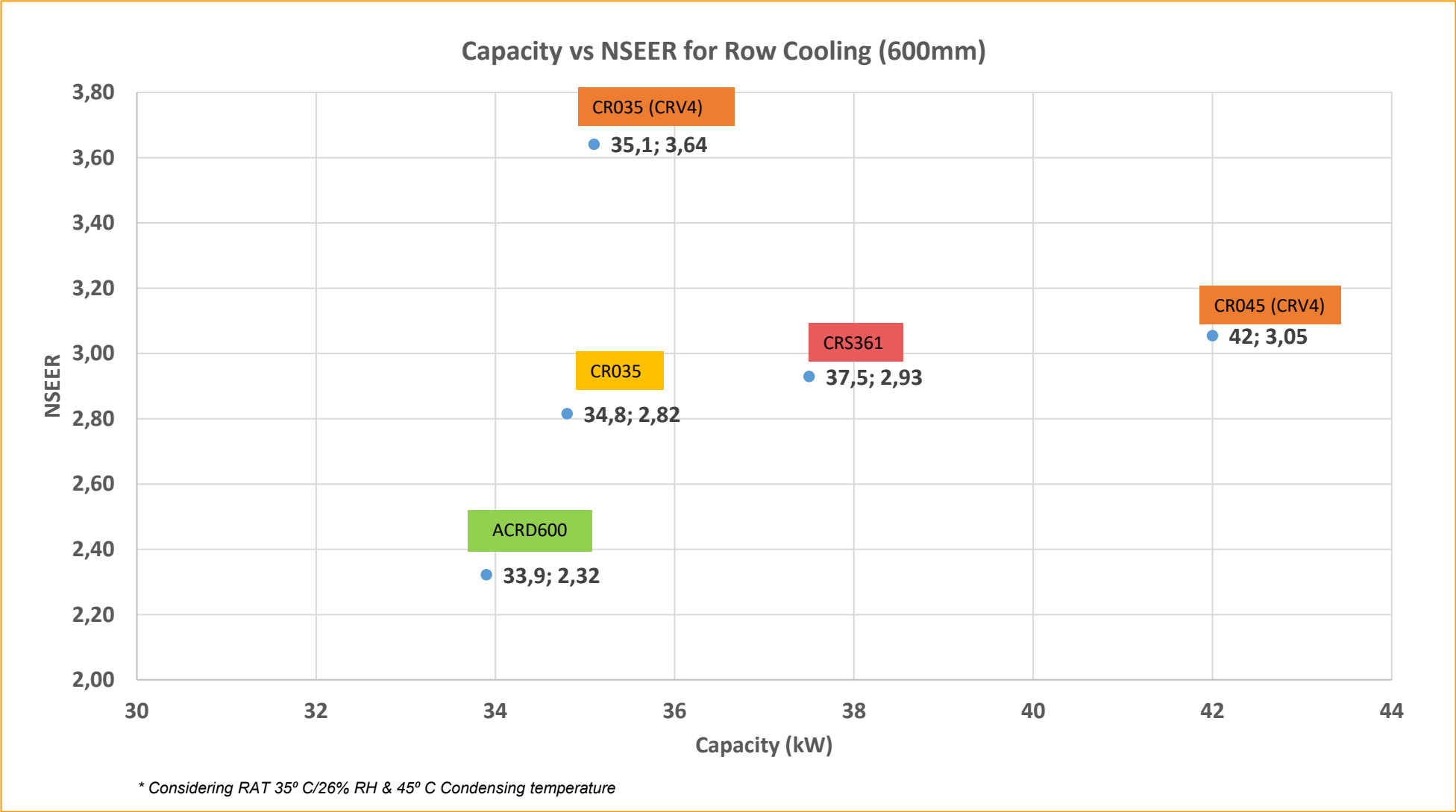
It is observed that during partial load condition (around 60% to 80% capacity), EER value is maximum for any model and energy efficiency is much better

Liebert® CRV4 : Competition Landscape (300 mm width)



Brand	Model
Vertiv CRV+	CR012
Vertiv CRV+	CR025
Vertiv CRV4	CR025
APC InRow	ACRD100
APC InRow	ACRD300
Stulz CyberRow	CRS211
Stulz CyberRow	CRS251
Denco Row-Denco	DRX051
Denco Row-Denco	DRX071
Denco Row-Denco	DRX121
Huawei Netcol5000	A025H (300)

Liebert® CRV4 : Competition Landscape (600 mm width)



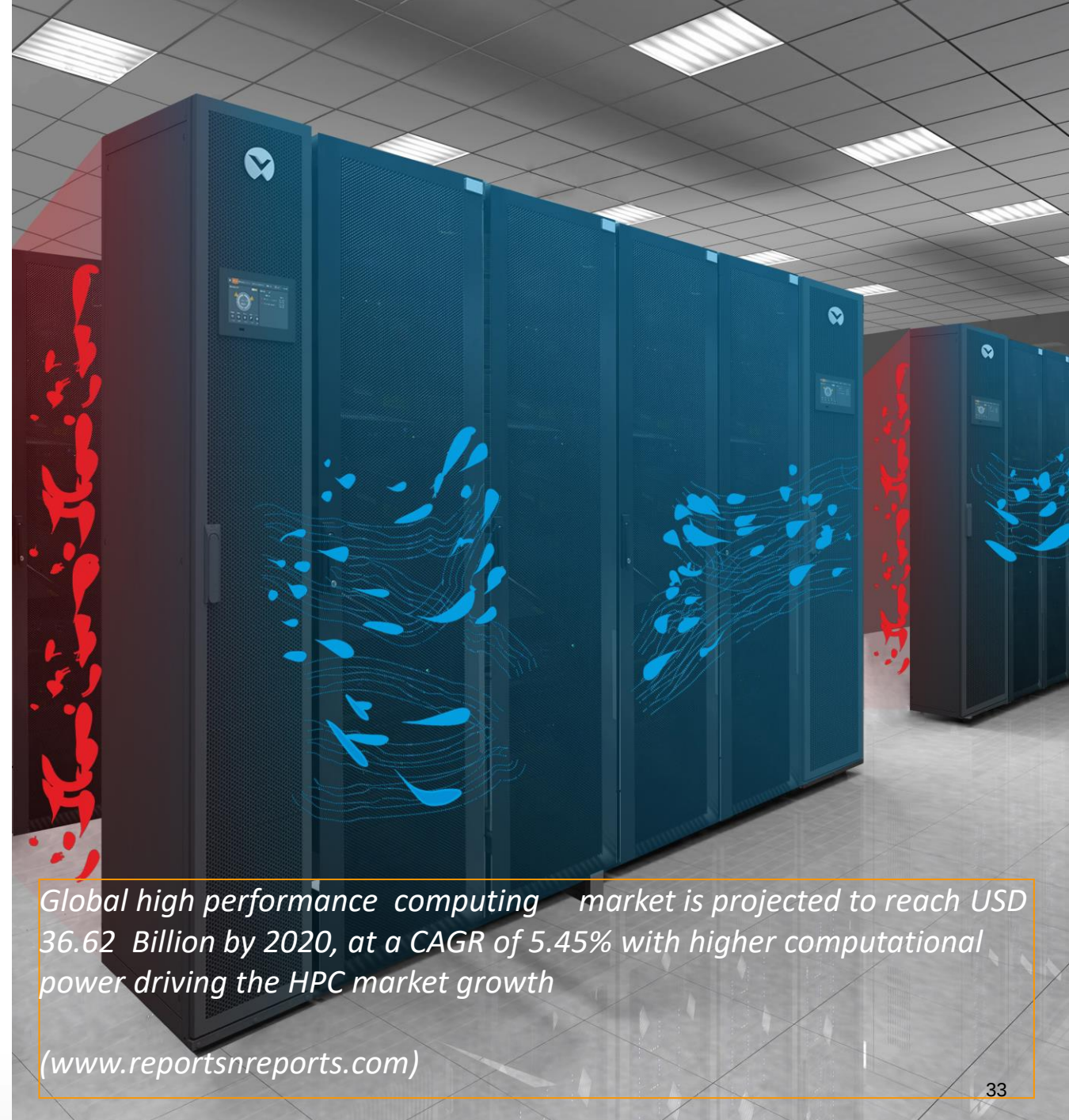
Brand	Model
Vertiv CRV+	CR035
Vertiv CRV4	CR035
Vertiv CRV4	CR045
APC InRow	ACRD600
Stulz CyberRow	CRS361

Product Positioning

For small, medium sized server rooms in the IT & Telecom Data center segment who need higher processing capabilities of 8 kW per rack and beyond that. CRV4 provides a controlled cooling environment featuring high efficiency contributing to low power consumption & super low carbon footprint.

In short, the CRV4 provides

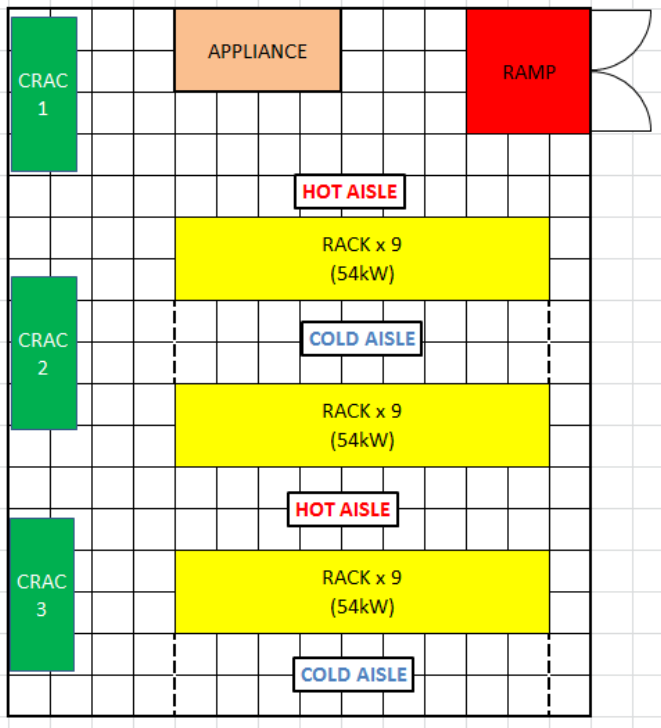
- ✓ High efficiency in the row cooling segment
- ✓ Wide range of cooling capacities – 12 kW, 25kW, 35kW, 45kW
- ✓ An absolutely easy access to the major components from both the sides of the unit
- ✓ Hot swappable fan makes maintenance easier



Global high performance computing market is projected to reach USD 36.62 Billion by 2020, at a CAGR of 5.45% with higher computational power driving the HPC market growth

(www.reportsnreports.com)

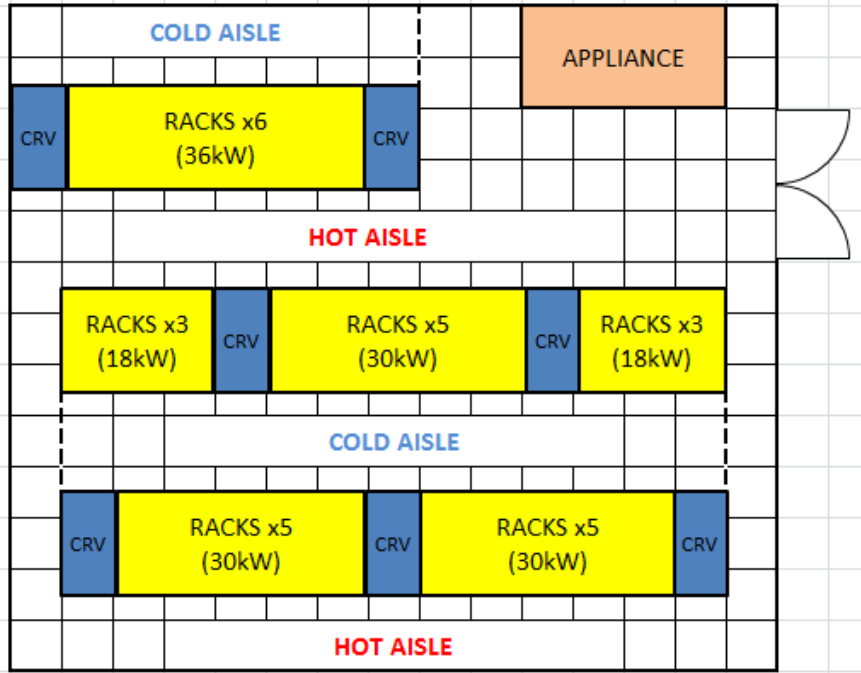
Liebert® CRV4 vs Room Cooling



Space savings :
 $(85.68 - 70.20) \text{ m}^2$
 $= 15.48 \text{ m}^2$
 $= 15.48 \text{ m}^2 / (0.72 \text{ m}^2/\text{rack})$
 $= 21.5 \sim 21 \text{ RACK SPACE}$

Room Cooling

Items	Cost / Savings
Raised Floor + Ramp (\$20-\$25psqf)	\$ 18,445
Footprint used	85.68 m²



Row Cooling

Items	Cost / Savings
Raised Floor + Ramp (\$20-\$25psqf)	\$0 \$ 18,445
Footprint used	70.20 m² (18.1% savings)

Summary of Application & Benefits

Liebert CRV4 is suitable both for new and existing Data Centres

- ✓ Minimum height raised floor
- ✓ Addressed in particular to Data Centre from 1 to 25 racks

On larger applications

Liebert CRV4 can be combined together with other high density Liebert cooling systems, in order to achieve the most efficient cooling effect. Liebert CRV4 has such small footprint that can be squeezed even in the limited space Data Centres.

Increasing the RAT by putting the CRV4 nearer to heat source will significantly increase cooling capacity and reduce the number of cooling units required.

4th Generation Row Cooling with Elevated Performance

