

**DAIKIN**

PT DAIKIN APPLIED SOLUTIONS INDONESIA



# CHILLED WATER

## Mini Air Cooled Chiller (Inverter)



2022

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Link materi training :

[shorturl.at/pqz23](https://shorturl.at/pqz23)

# CONTENT OF PRESENTATION

INTRODUCTION

PRODUCT FEATURE

HVAC EQUIPMENT DESIGN

COOLING & HEAT PUMP APPLICATION

QUESTION & ANSWER



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**INTRODUCTION**

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**QUESTION & ANSWER**

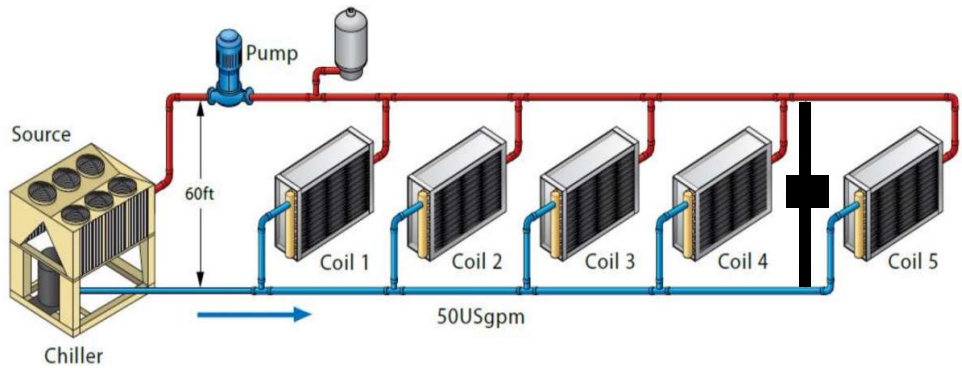


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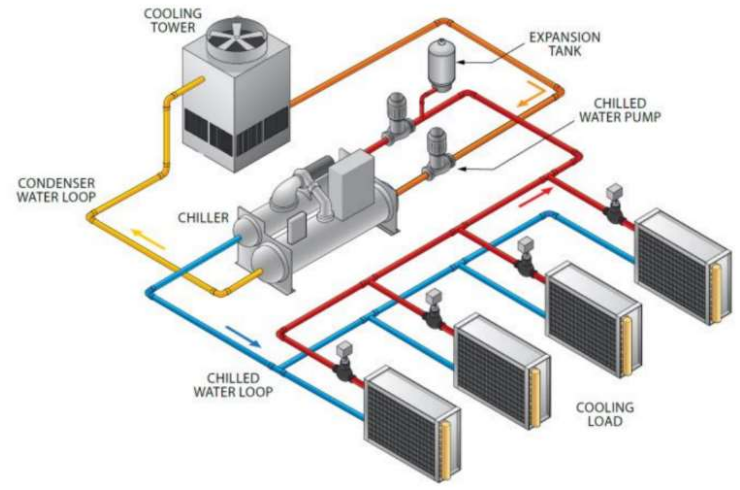
# Chiller Classification (Condenser Type)

## Air Cooled Chiller



Air-cooled chillers (ACC) perform heat rejection to ambient air via condenser coil & fans.

## Water Cooled Chiller

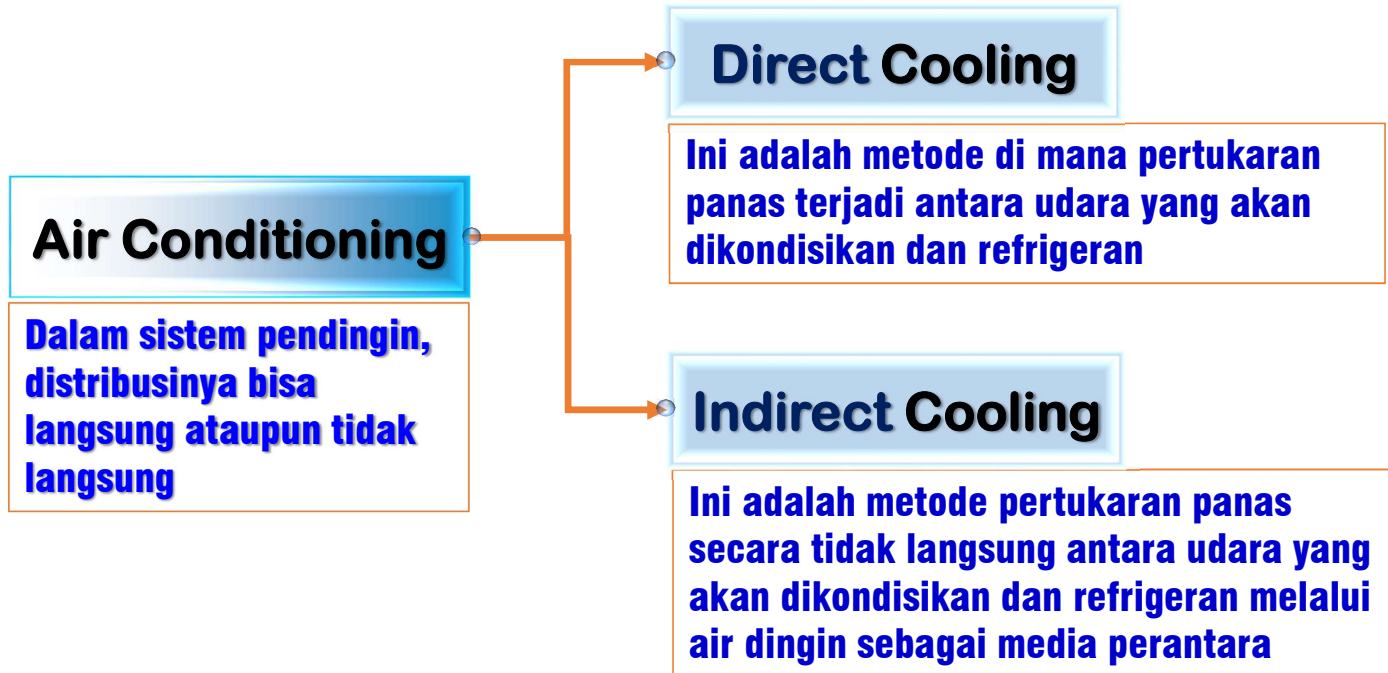


Water-cooled chillers (WCC) perform heat rejection to cooling tower's water via condenser & pumps.

# Air-Conditioning System

**Differentiate** between direct cooling & indirect cooling

## Classification of Air Conditioning System

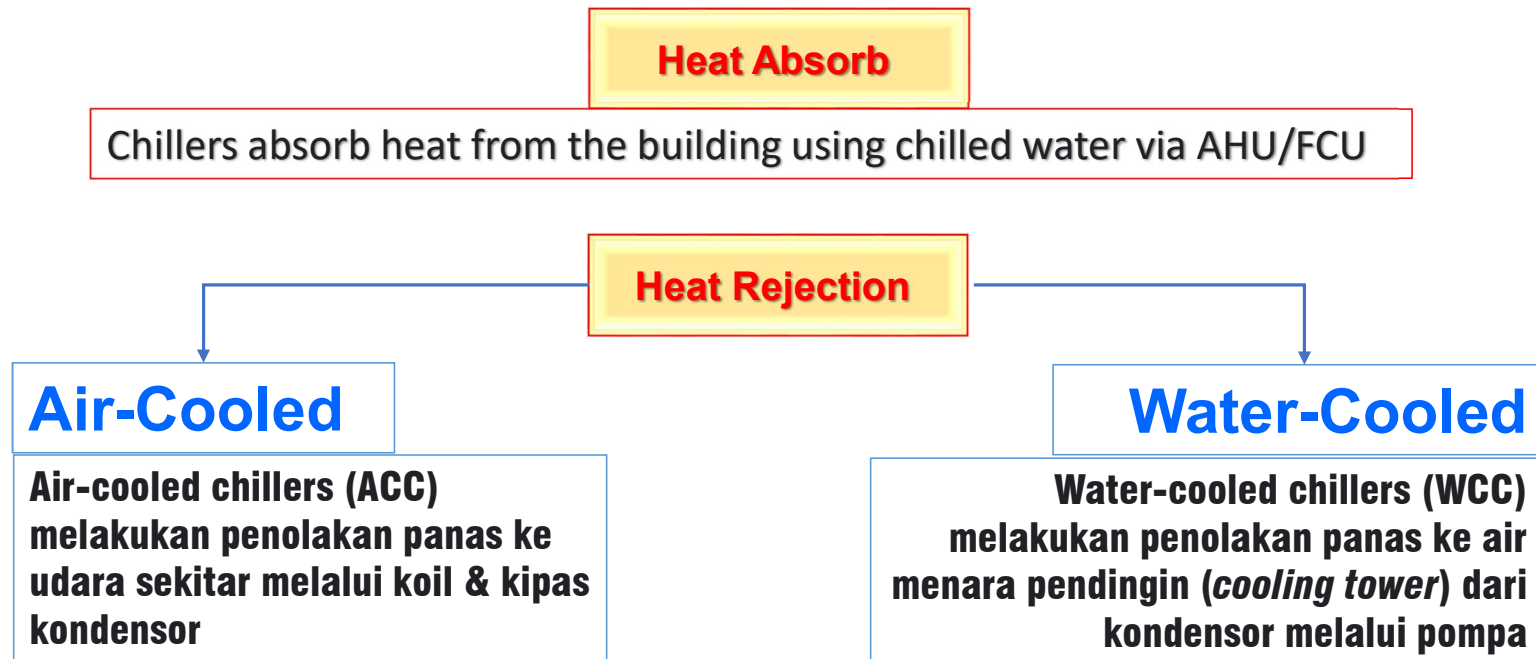


# Air-Conditioning System

**Differentiate** between Air-Cooled & Water Cooled System

**Air Conditioning System**, can be generally divided into :

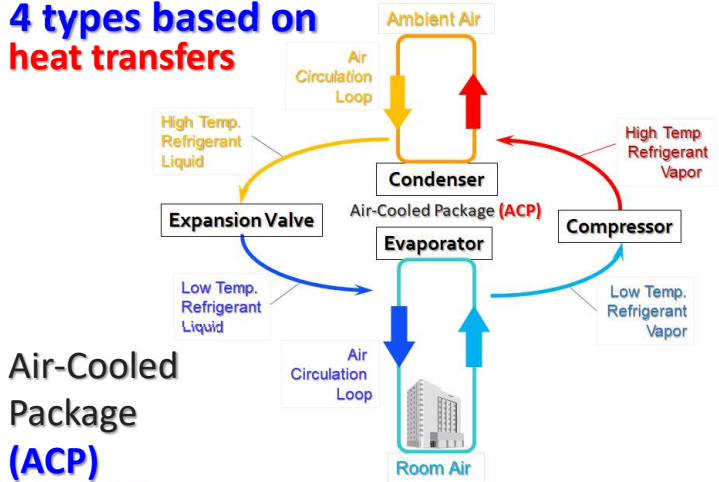
**4 types** based on their **heat transfers** medium on evaporator & condenser.



# Air-Conditioning System :

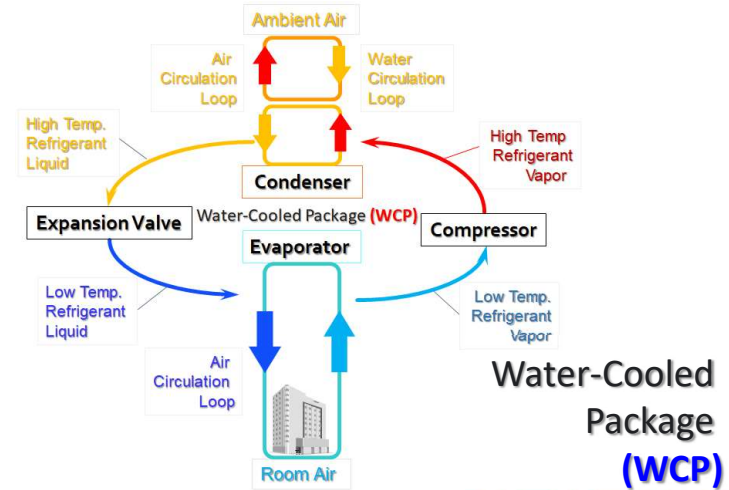
4 types based on heat transfers

1. (ACP) | 2. (WCP)

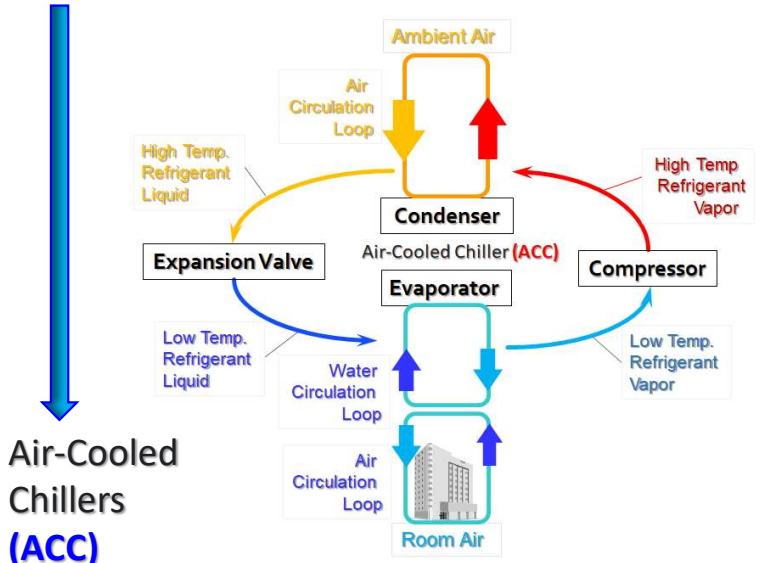


Air-Cooled Package (ACP)

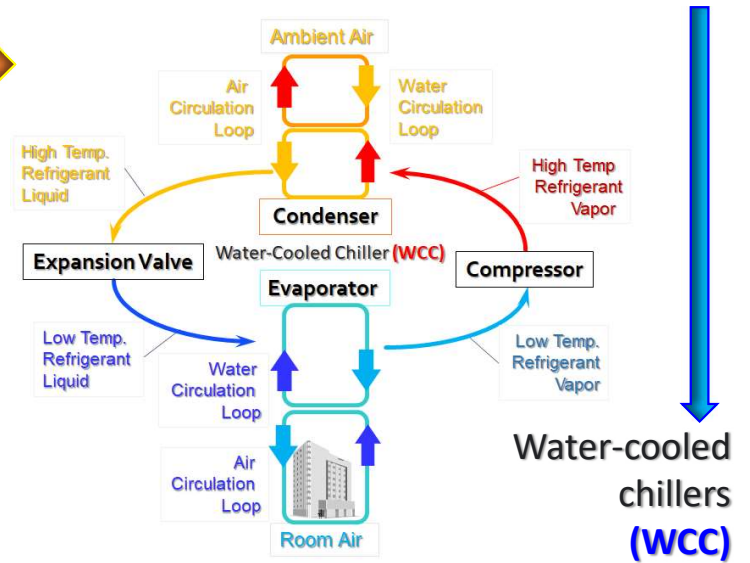
3. (ACC) | 4. (WCC)



Water-Cooled Package (WCP)



Air-Cooled Chillers (ACC)

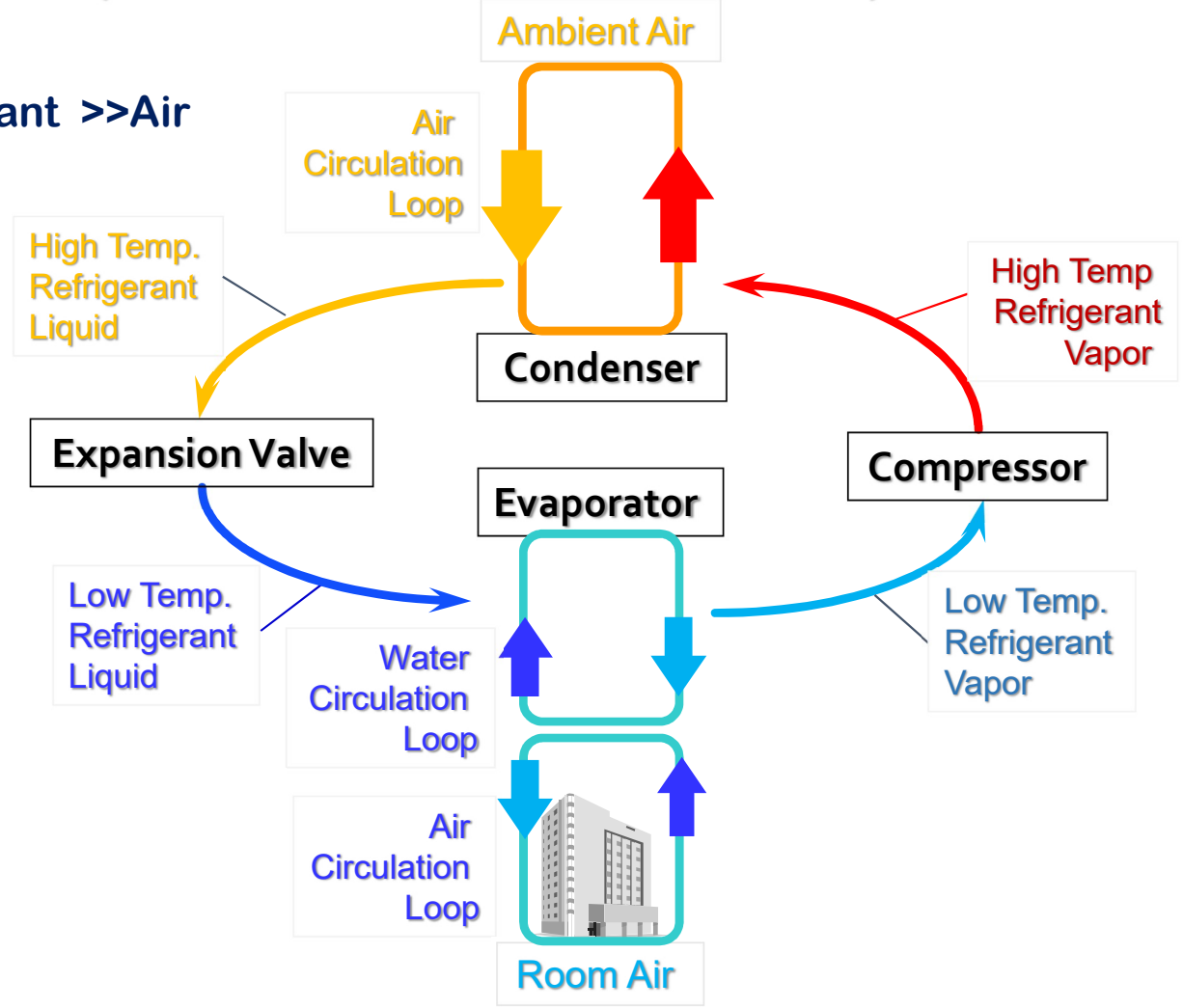


Water-cooled chillers (WCC)

# Air-Cooled Chiller System : (Indirect & Direct Heat Transfer)

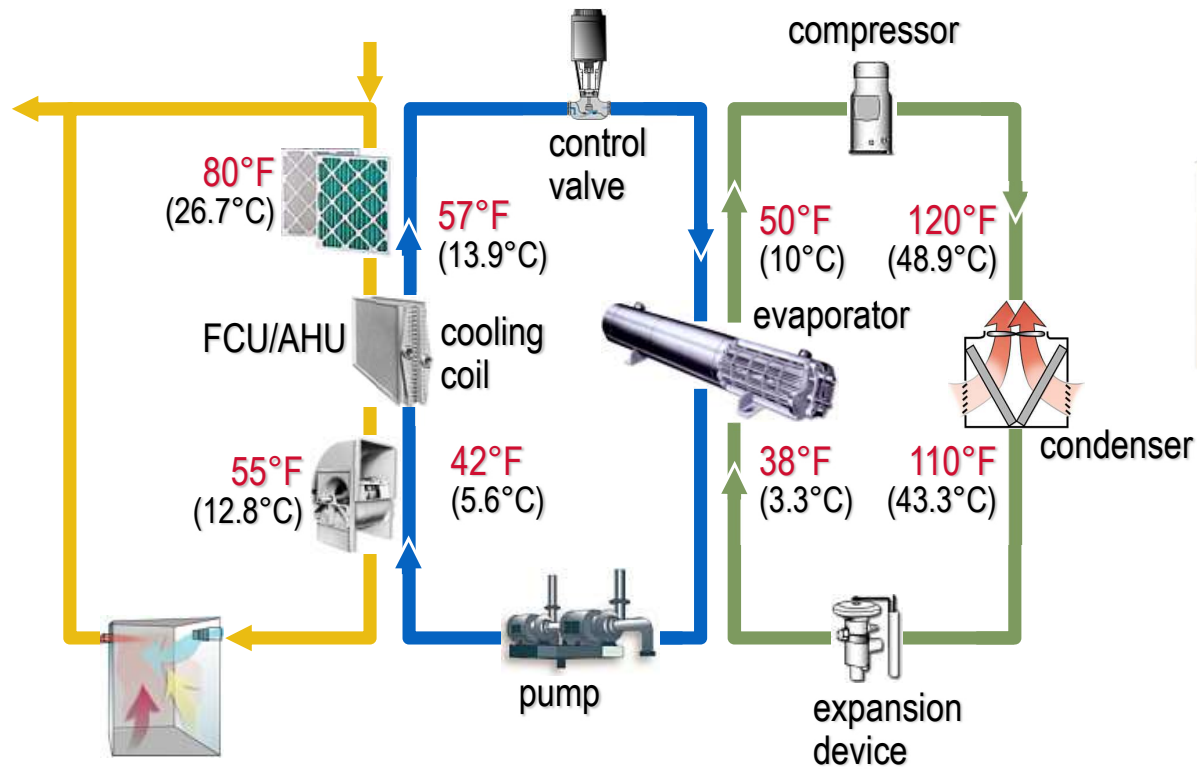
Air-Cooled Chiller (ACC)

Air >>Water >>Refrigerant >>Air



# INTRODUCTION

## System Heat Transfer / Ballance



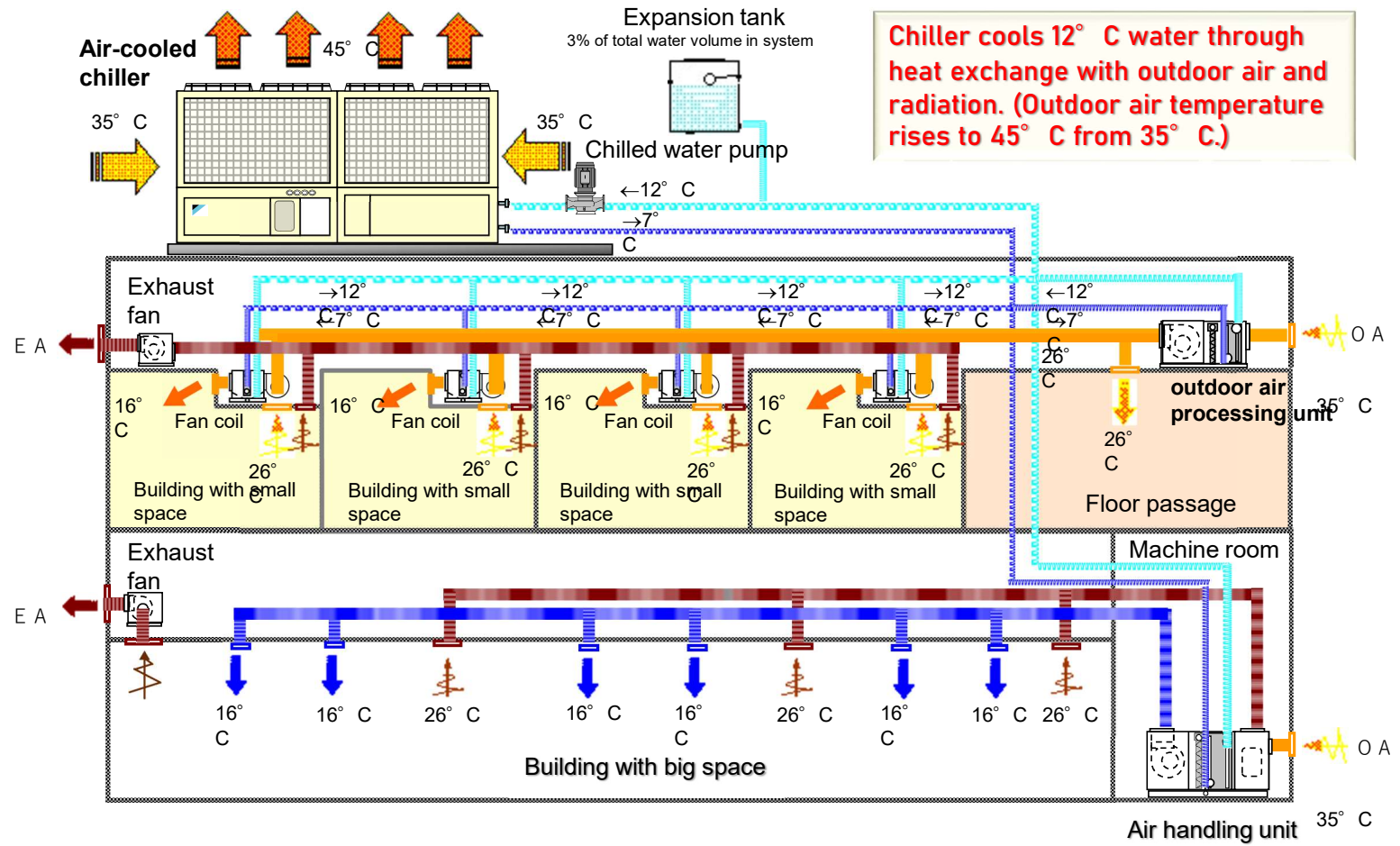
**Air Cooled (Condenser) Chiller**





# INTRODUCTION

## Air-cooled Chilled Water System (Cooling Operation)

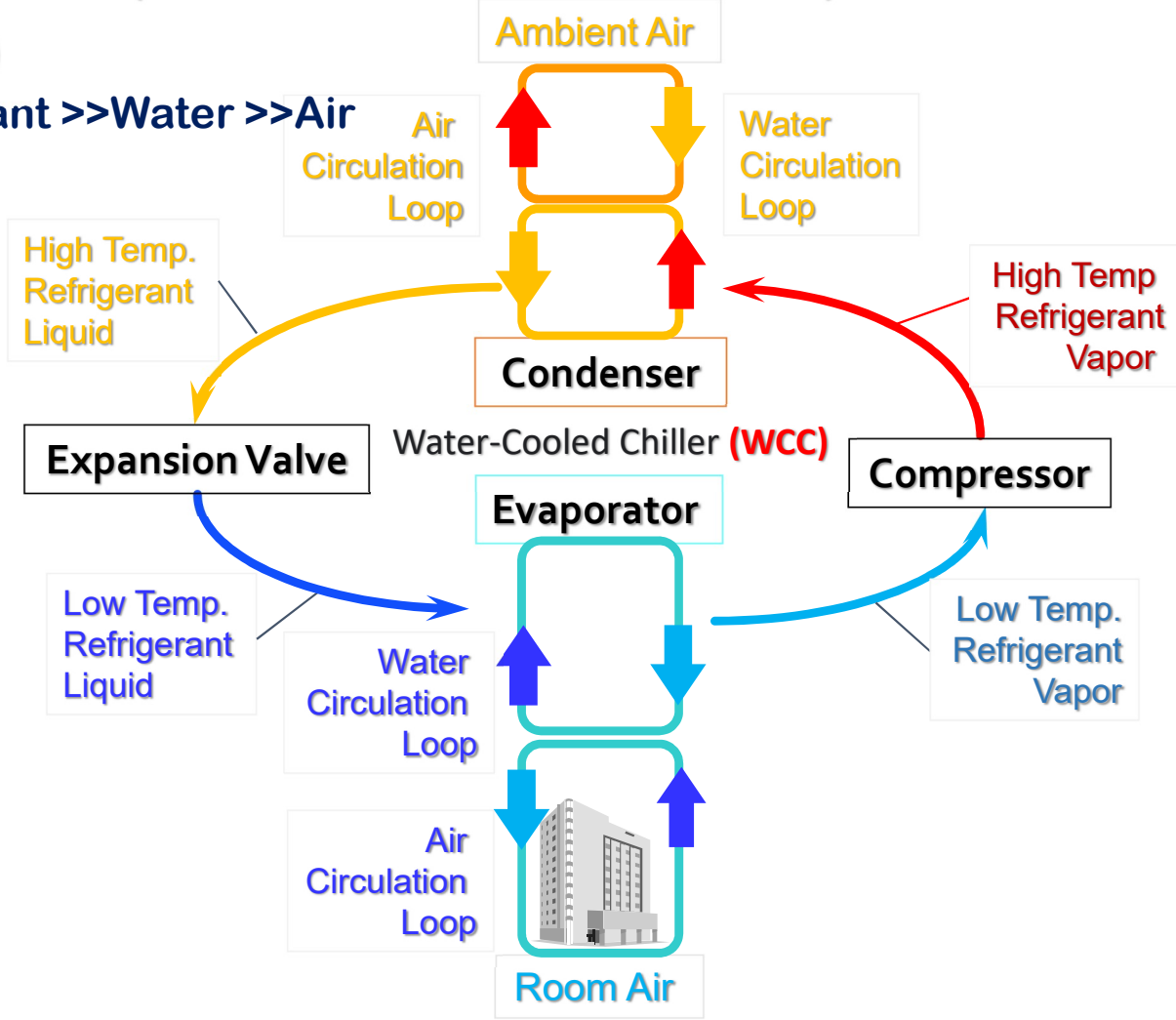




# Water-Cooled Chiller System : (Both Indirect Heat Transfer)

Water-Cooled Chiller (WCC)

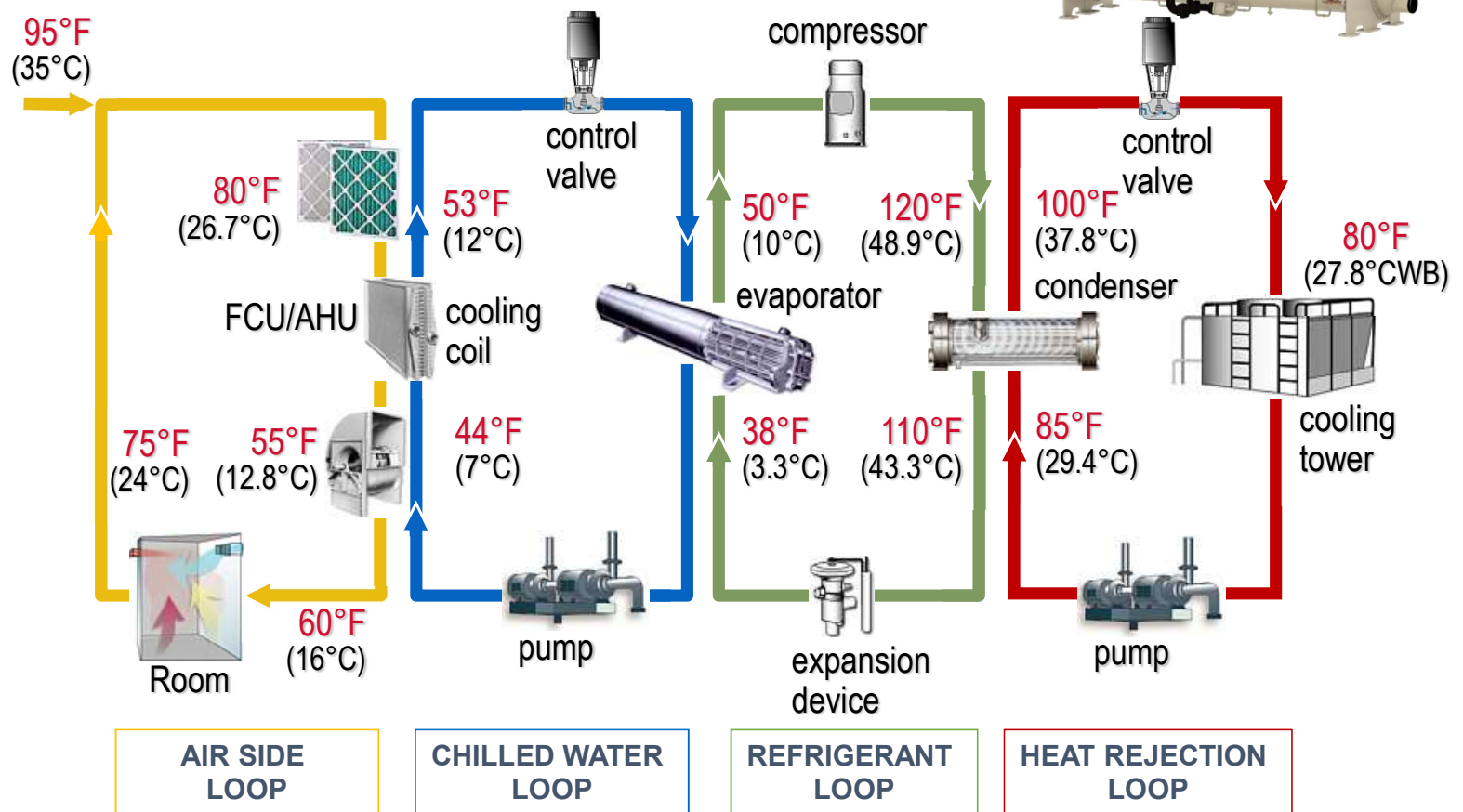
Air >> Water >> Refrigerant >> Water >> Air



**INTRODUCTION**

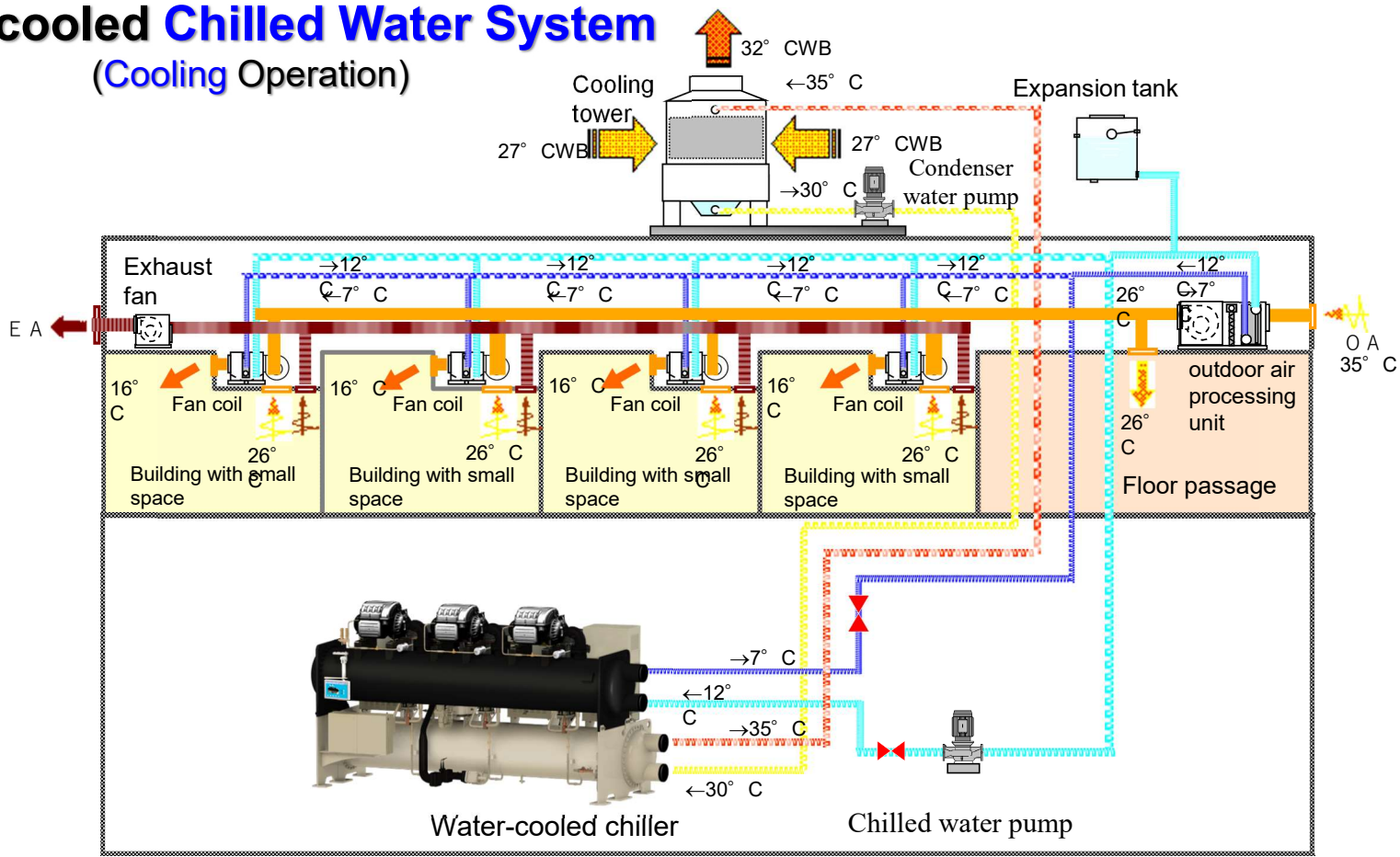
System Heat Transfer / Ballance

**Water Cooled  
(Condenser) Chiller**



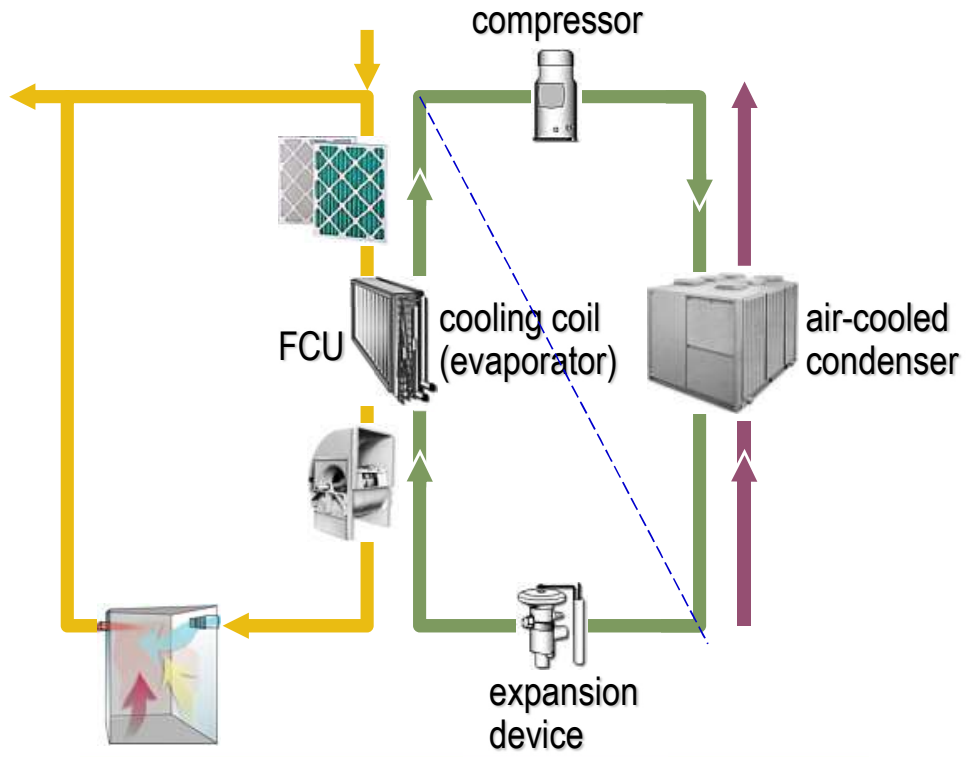
# INTRODUCTION

## Water-cooled Chilled Water System (Cooling Operation)



# INTRODUCTION

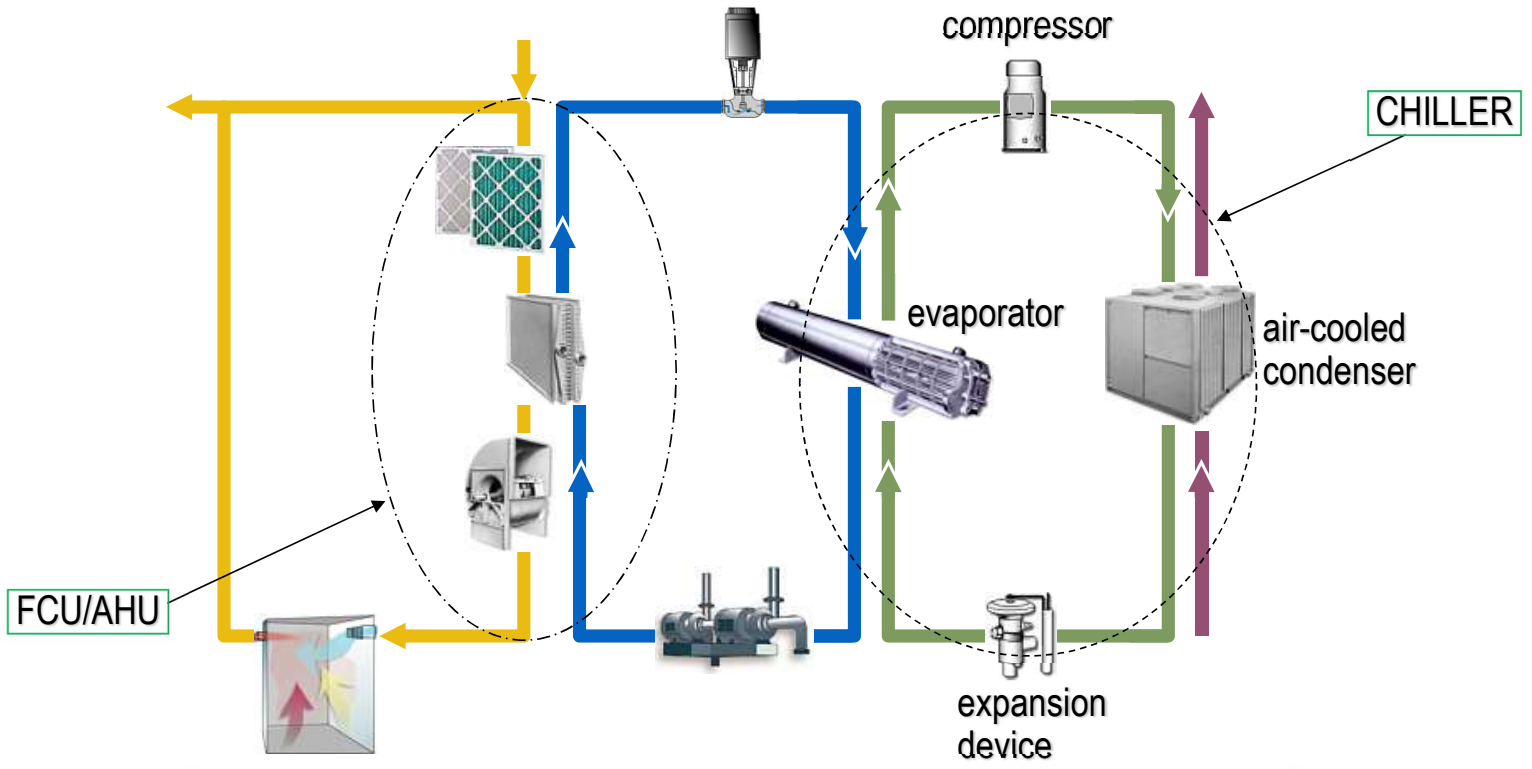
## NO Chilled-Water Loop



## DX System "UNITARY"

# INTRODUCTION

## Chilled-Water Loop



## Chilled-Water System "APPLIED"

## INTRODUCTION

**Air-cooled chiller umumnya mengkonsumsi lebih banyak energi (dibandingkan dengan pendingin berpendingin air) karena "Lift Compressor" yang lebih tinggi antara suhu evaporator dan suhu condenser.**

**Water-cooled chiller's condensing temperature dibawah 40°C berbanding dengan air-cooled chiller condensing pada 50°C**

Jika perbandingan dengan water-cooled chiller seharusnya kita "abaikan" condenser fan power (kW) pada condenser air-cooled chiller.

condenser pump kw/TR = 0.10

cooling tower fan kw/TR = 0.05

Bila water-cooled chiller menunjukkan kW/TR = 0.6

Air-cooled chiller pada daya 1.0 kW/TR **harus di sesuaikan dengan 0.85** (1.0 - 0.15) untuk membandingkan dengan water-cooled chiller's efisinsi pada 0.6 kW/TR.

## INTRODUCTION

### Air-Cooled Chiller System

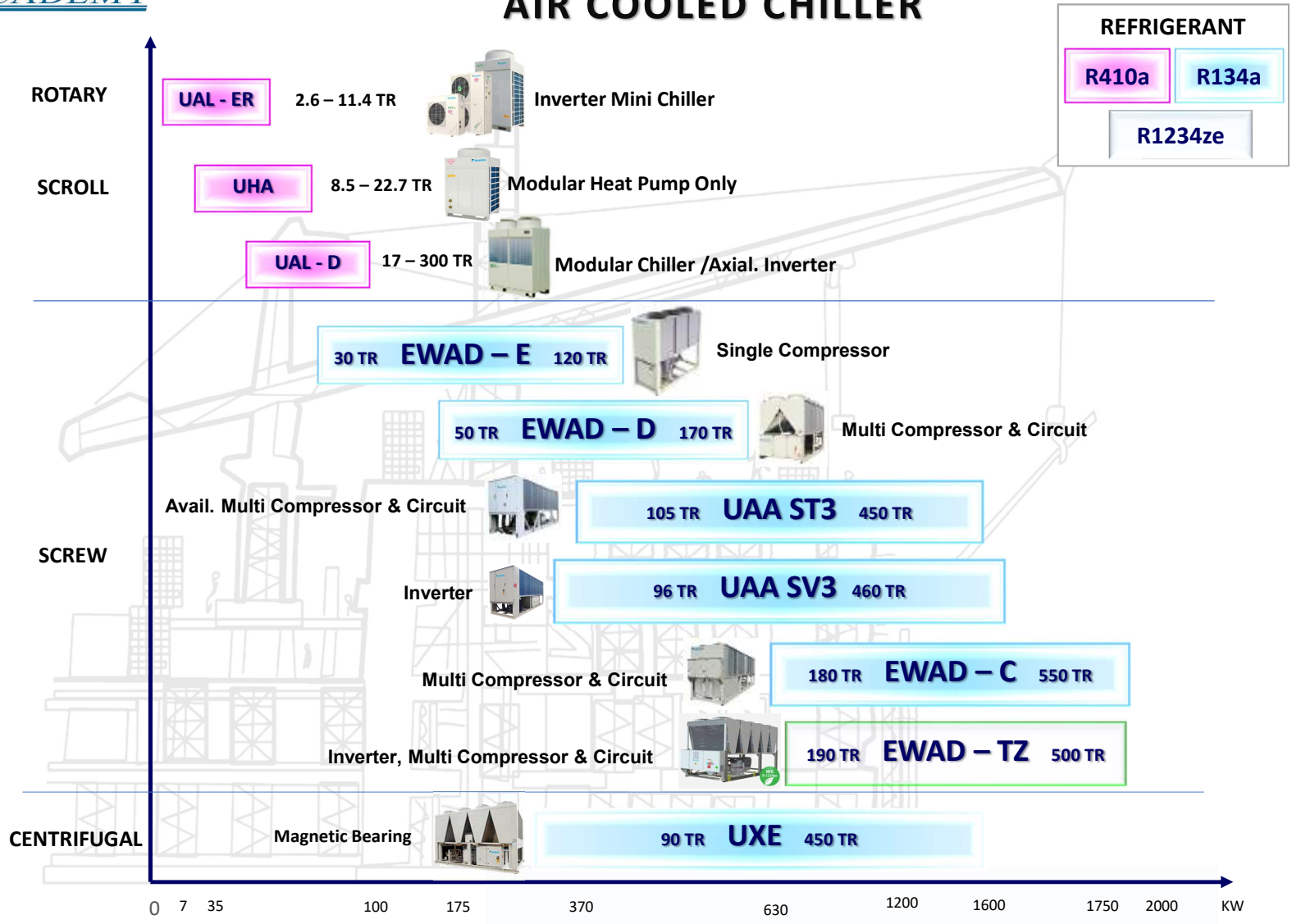
- Air-cooled sistem pendingin berpendingin udara lebih sederhana dan mudah dirancang, dipasang, dan dioperasikan dibandingkan dengan sistem pendingin berpendingin air.
- **Tidak diperlukan** menara pendingin (*cooling tower*) dan **pompa air** condenser
- Untuk bangunan komersial, umumnya dipasang diatap. Hal ini untuk menghemat ruang dan memiliki kualitas udara yang lebih baik (sedikit debu) dan sirkulasi udara buang panasnya sempurna.
- Kebisingan dari chiller (kipas & kompresor) menjadi perhatian utama.
- Untuk pabrik, mereka akan dipasang dibawah (*ground level*), Ini karena lebih mudah diakses, terkait operasional, ketersediaan cadangan dan kontrol keamanan yang lebih banyak.
- **Biaya pertama** (peralatan + instalasi) dan operasi berkelanjutan yang stabil Vs biaya pemeliharaan & operasi akan menjadi pertimbangan utama.



**INTRODUCTION****Difference** Between **Air Cooled** & Water Cooled Chiller

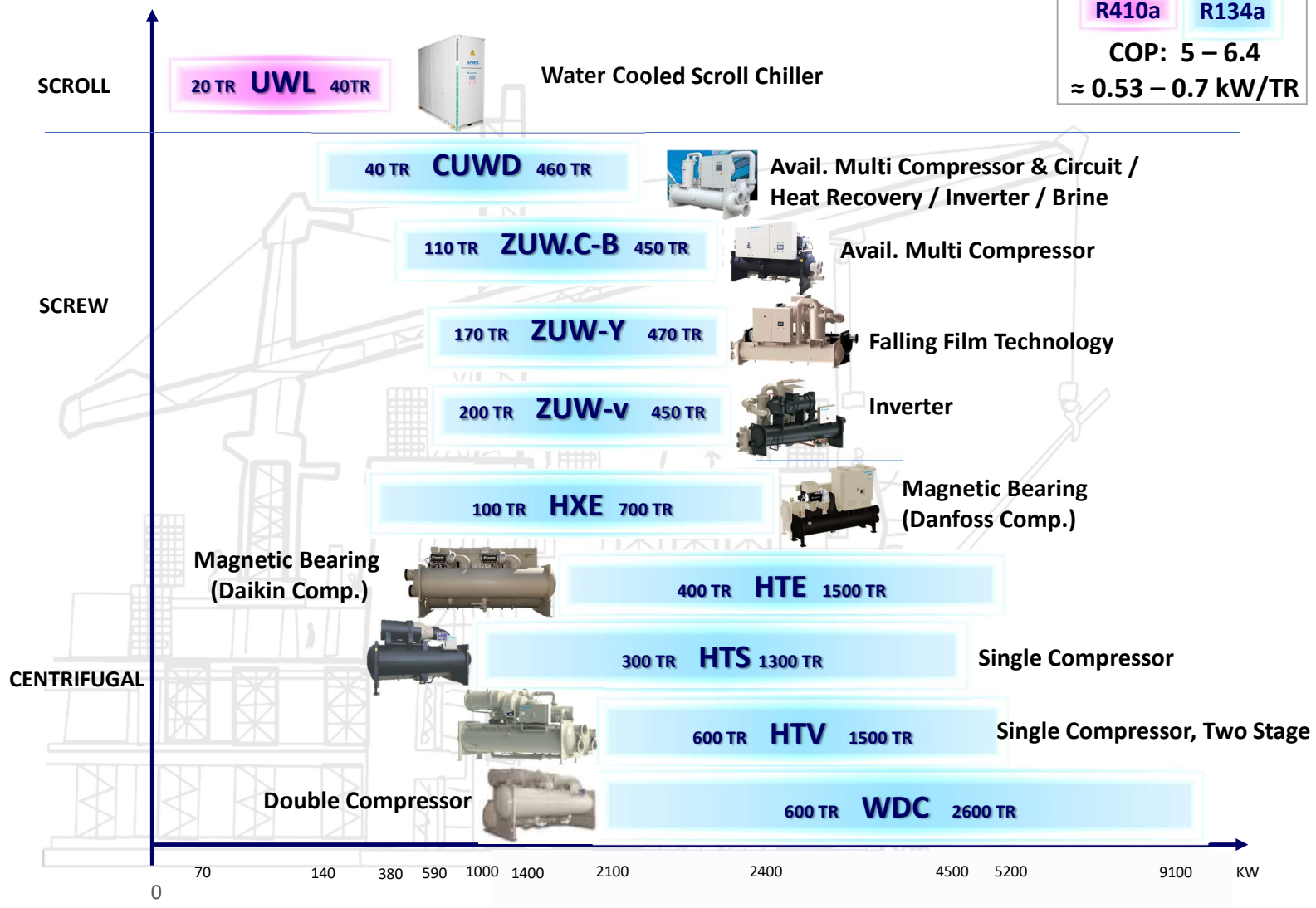
<b>Air Cooled Chiller</b>	<b>Water Cooled Chiller</b>
<b>Air Cooled Condenser</b>	<b>Water Cooled Condenser</b>
<b>No Condenser Water Pump</b>	<b>Required Condenser Water Pump</b>
<b>No Cooling Tower</b>	<b>Required Cooling Tower</b>
<b>Small to medium cooling capacity</b>	<b>Medium to large cooling capacity</b>
<b>Install in open space</b>	<b>Chiller Plant room</b>
<b>Low efficiency (e.g kW/RT = 1.2)</b>	<b>High efficiency (e.g kW/RT = 0.6)</b>
<b>Low installation cost</b>	<b>High installation cost</b>
<b>Acoustic problem</b>	<b>Less acoustic problem</b>
<b>Less controller operation</b>	<b>More controller operation</b>
<b>Does not required water treatment</b>	<b>Water treatment for CT</b>

# AIR COOLED CHILLER



# WATER COOLED CHILLER

**REFRIGERANT**  
**R410a**   **R134a**  
**COP: 5 – 6.4**  
**≈ 0.53 – 0.7 kW/TR**



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**Modular Air Cooled Mini Chiller  
(NON INVERTER)**

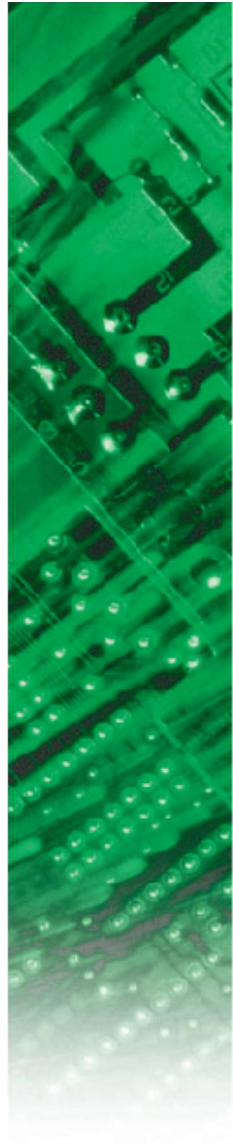
Series	Model	Modular	Cooling Capacity		Modular Capacity Range	
			kW	TR	kW	TR
<b>Cooling Only</b>	Name	Qty	kW	TR	kW	TR
	UAL230DS5	16	65	18	1040	296
	UAL340D5	16	100	28	1600	455
	UAL450D5	16	135	38	2160	614
	UAL1000D5	16	295	83.8	4720	1340

Series	Model	Modular	Cooling Capacity		Capacity Range	
			kW	TR	kW	TR
<b>Heat Recovery</b>	Name	Qty	kW	TR	kW	TR
	UAL230DR5	16	66	19	1056	300
	UAL450DS5	16	138	39	2208	628

Series	Model	Modular	Cooling Capacity		Capacity Range	
			kW	TR	kW	TR
<b>Heat Pump</b>	Name	Qty	kW	TR	kW	TR
	UAL230DR5	16	66	19	1056	300
	UAL340DS5	16	100	28	1600	455
	UAL450DS5	16	138	39	2208	628



**Model: UAL0230DR5 ~ UAL1000DR5**  
**Cooling Capacity: 65kW ~ 1340kW**  
**Heating Capacity: 6.6kW ~ 138kW**





## Mini Air Cooled Mini Chiller (INVERTER)

**Model: UAL030ER5 ~ UAL150ER5**  
**Cooling Capacity: 9.4kW ~ 40.0kW**  
**Heating Capacity: 9.8kW ~ 41.0kW**

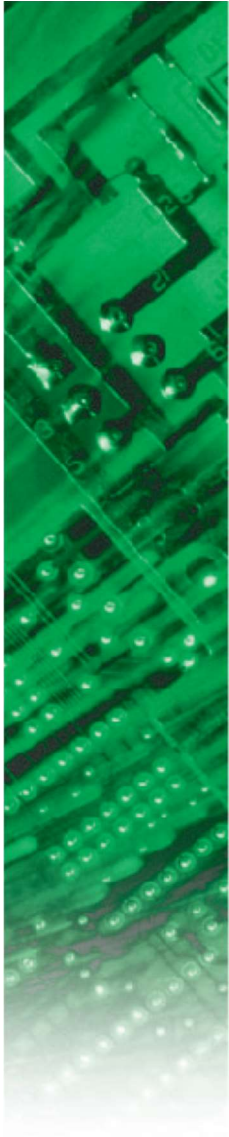
MODEL	COOLING CAPACITY (kW)	HEATING CAPACITY (kW)
UAL 030 ER	9.4	9.8
UAL 040 ER	11.4	12.0
UAL 050 ER	14.6	14.8
UAL 060 ER	16.8	17.0
UAL 070 ER	19.8	20.8
UAL 080 ER	24.9	26.0
UAL 100 ER	28.8	30.0
UAL 120 ER	33.5	34.0
UAL 150 ER	40.0	41.0



UAL030/040ER5

UAL050-080ER5

UAL100-150ER5



# NOMENCLATURE

**UAL 080 E R 5 LC F AA E**

**UAL** : Mini Air-cooled

**Capacity Index**  
Cooling cap 80 x 1000 Btu/hr

**Product Series**  
E : Design Series

**Function type**  
R : Heat pump

**Refrigerant Type**  
3 : R134a  
4 : R407c  
**5 : R 410a**

**Export Sales Code**

**Detail Description**

**Power supply**  
A : 220V/1Ph/50Hz  
**F** : 380-415V/3Ph/50Hz

**Product type**  
LC : Low Temp Cooling  
LH : Low Temp Heating  
SR : Total Heat Recovery



## UAL ER Series Inverter for Energy Saving



### FEATURES

#### ENERGY SAVING

- **4.23** The highest IPLV
- **3.19** The highest COP

#### STABLE

- **3°C** Anti freezing protection
- **-15~48°C** Ultimate operating range

#### SILENT

- **8** Noise reduction technologies
- **10dB (A)** Ultimate noise reduction

#### COMFORTABLE

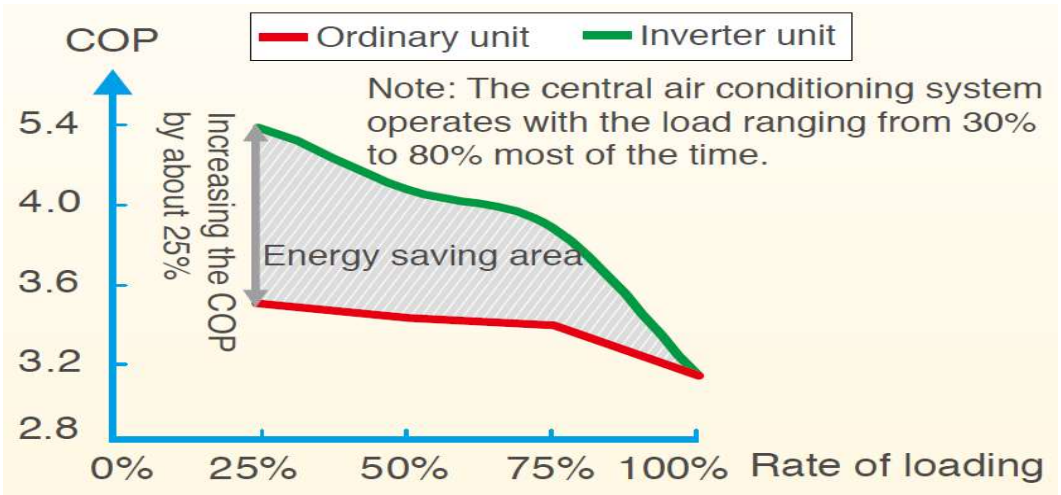
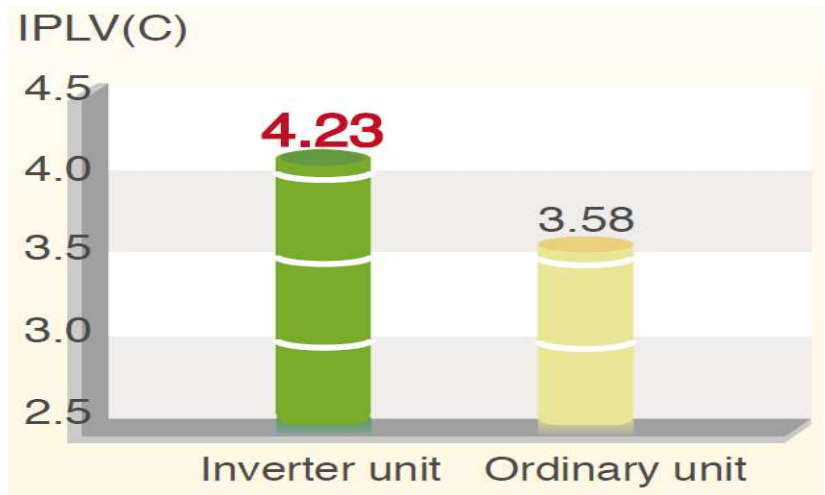
- **±1°C** Temperature fluctuation
- **15~100%** Output cooling

**FEATURES**

**ENERGY SAVING**

- **4.23** The highest IPLV
- **3.19** The highest COP

**One-key energy saving mode : Highest IPLV value of the industry**  
 Load Value (IPLV) bisa mencapai 4,23, yang merupakan level tertinggi dalam industri AC. Dengan ini penghematan biaya operasional bagi pelanggan yang pada akhirnya membawa keuntungan dari sisi konsumsi energi.  
 IPLV = 2.3% at COP 100% + 41.5% at COP 75% B + 46.1% at COP 50% + 10.1% at COP 25%



**TIPS:** Standar konvensional untuk mengukur kinerja hemat energi AC adalah COP pada beban penuh, tetapi **AC beroperasi dengan beban parsial untuk 90% dari waktu**. Oleh karena itu, COP pada beban penuh tidak benar-benar mencerminkan kinerja penghematan energi unit sepanjang tahun. Sebagai indikator efisiensi energi dari unit pada berbagai beban telah diperhitungkan dalam Nilai Beban Bagian Terpadu (IPLV), **IPLV mencerminkan system kinerja hemat energi AC secara lebih akurat dan objektif**.

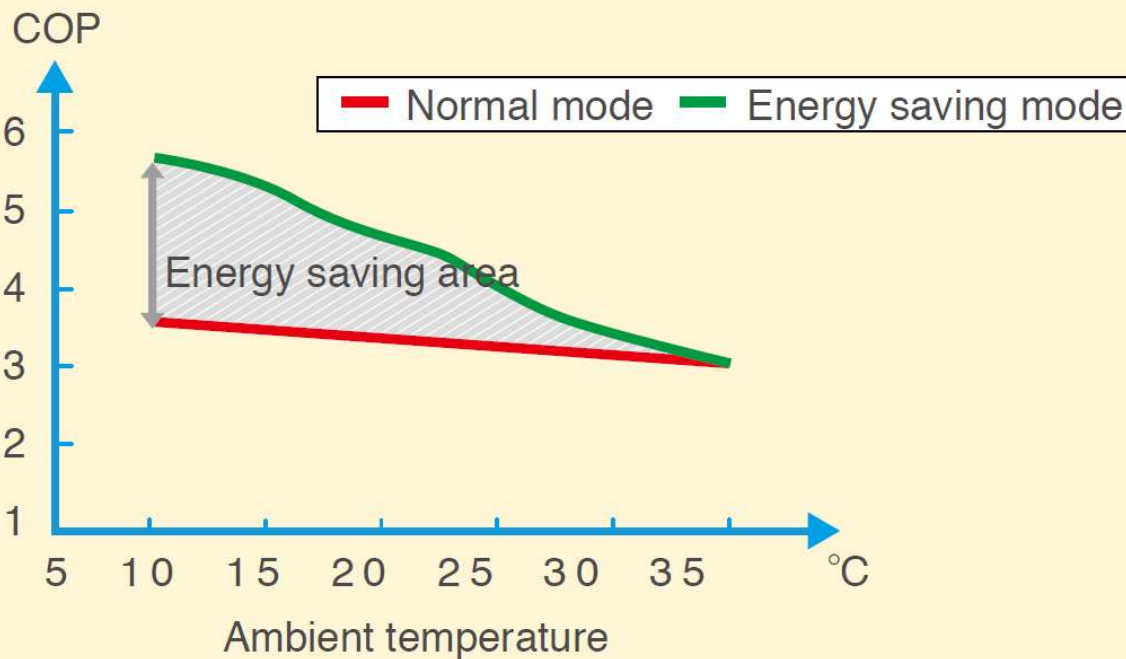
## FEATURES

### ENERGY SAVING

- 4.23 The highest IPLV
- **3.19** The highest COP

#### One-key energy saving mode :

Sistem secara otomatis menyesuaikan suhu air dingin dan secara cerdas mengoptimalkan efisiensi energi sebagian beban sesuai dengan perubahan suhu sekitar (*ambient*) dan permintaan beban (*part load*), mencapai kondisi hemat energi terbaik dan dapat menghemat energi lebih dari 15%.



#### Catatan:

Sebagai contohnya, semakin rendah suhu sekitar saat unit beroperasi, kinerja unit semakin baik dalam penghematan energinya.



**FEATURES**

*Chiller full load efficiency ratings dapat dinyatakan dalam satuan kW/ton, COP (Coefficient of Performance) or EER (Energy Efficiency Ratio).*

Chiller Eff = kW input / TR cooling

OR

C.O.P = kW cooling / kW input

OR

E.E.R = BTUh cooling / W input

Model UAL	Unit	030ER5	040ER5	050ER5	060ER5	070ER5	080ER5	100ER5	120ER5	150ER5	
Nominal cooling capacity	kW	9.4	11.4	14.6	16.8	19.8	24.9	28.1	33.2	40.0	
Nominal heating capacity	kW	9.8	12.0	14.8	17.0	20.8	26.0	30	34.0	41.0	
Capacity adjustment		15~100%									
Input power of cooling	kW	3.0	3.9	4.6	5.7	6.7	8.6	9.5	10.4	13.9	
Input power of heating	kW	3.1	3.9	4.8	5.5	6.6	8.3	9.9	10.8	13.1	
IPLV (GB)		4.21	4.23	4.16	4.13	4.15	4.23	4.9	4.71	4.45	
Power supply		220VAC/1P/50Hz					380VAC/3P/50Hz				

**EXAMPLE: C.O.P for cooling**  
**UAL 100ER = 33.2/10.4 = 3.19**

**EXAMPLE: C.O.P for heating**  
**UAL 100ER = 34.0/10.8 = 3.14**

**Chiller Efficiency**

UAL 120 ER			
Capacity (%)	Cooling Capacity (kW)	Power Input (kW)	COP
15%	5	1.3	3.85
20%	8.4	2.2	3.82
25%	9.25	2.5	3.70
30%	10.1	2.7	3.74
35%	11.75	3.2	3.67
40%	13.4	3.7	3.62
45%	15.1	4.2	3.60
50%	16.8	4.7	3.57
55%	18.45	5.3	3.48
60%	20.1	5.8	3.47
65%	21.8	6.6	3.30
70%	23.5	7.4	3.18
75%	25.15	7.7	3.27
80%	26.8	8.0	3.35
85%	28.5	8.6	3.31
90%	30.2	9.2	3.28
95%	31.8	9.8	3.24
100%	33.5	10.4	3.22

UAL120ER Part load LWT 7°C - Ambient 35°C					
Running Times	Hour/day	% Capacity Load	Capacity (kW)	Unit Power Input (kW)	COP kW/kW
		100%	33.50	10.4	3.22
7am - 8am	1	30 %	10.10	2.7	3.74
8am - 12pm	4	90 %	30.20	9.2	3.28
12am - 13pm	1	95 %	31.80	9.8	3.24
13pm - 16pm	4	90 %	30.20	9.2	3.28
16pm - 18pm	1	50 %	16.80	4.7	3.57
18pm - 19pm	1	30 %	10.10	2.7	3.74
<b>Total hours</b>	<b>12</b>	<b>64 %</b>	<b>Average</b>		<b>3.48</b>

**C.O.P at 100% LAOD = 3.22**  
**Average Building load 64% with COP 3.48**  
**The Highest COP at 30% load = 3.74**

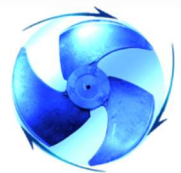
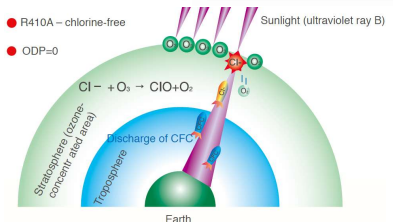
**Compare COP at 100% Load vs Actual Load Profile**

**Energy save : 7%**



# FEATURES

## HIGH QUALITY COMPONENT



Optimized fan blade



Dust and water protection grade reaching IP54  
Energy-saving variable speed fan motor  
(3-8HP three speed, 10-15HP BLDC)

Environment-friendly refrigerant R410A

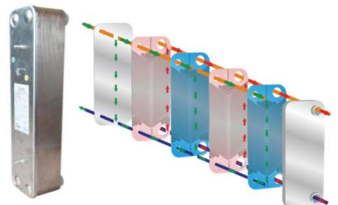
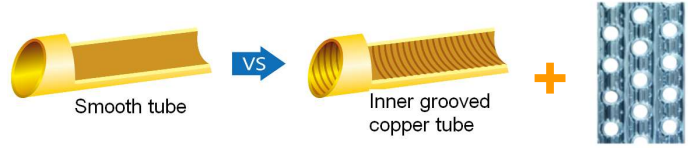


Plate heat exchanger with new type of heat exchange technology by cross forced convection



Imported 480-step Electronic expansion valve



Inner-grooved copper tube + hydrophilic aluminum foil  
High-efficiency tube&fin heat exchanger



Stainless steel multistage centrifugal pumps

# FEATURES

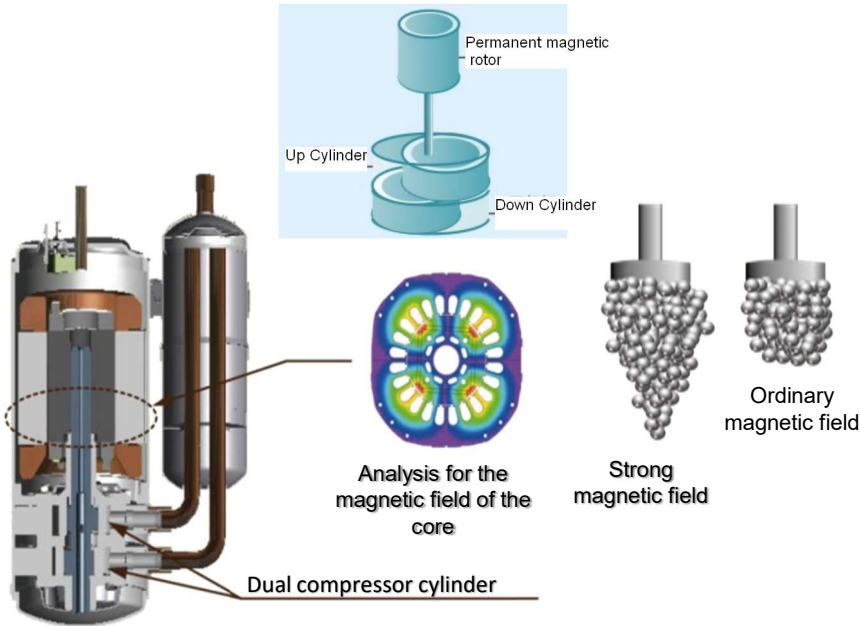
**ENERGY SAVING**

- **4.23** The highest IPLV
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**HIGH EFFICIENCY DC INVERTER COMPRESSOR**

**High efficiency dual rotors design :**

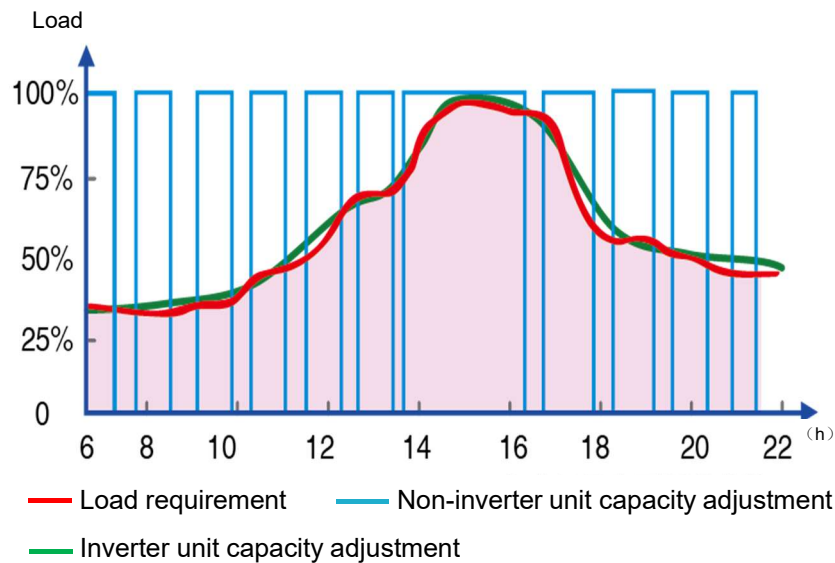
- Dengan **Neodymium magnet** rotor motor dapat menghasilkan medan magnet yang kuat. Dengan ini dapat meningkatkan torsi, kompresi dari kompresor saat beroperasi sehingga dapat dipastikan kinerja dan efisiensi menjadi optimal.
- **Mengoptimalkan** bentuk inti stator (*shape stator core*) yang berbentuk seperti gigi, hal ini akan meningkatkan kinerja dari motor compressor.





**FEATURES****ENERGY SAVING**

- **4.23** The highest IPLV
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**HIGH EFFICIENCY DC INVERTER COMPRESSOR****Stepless capacity control :**

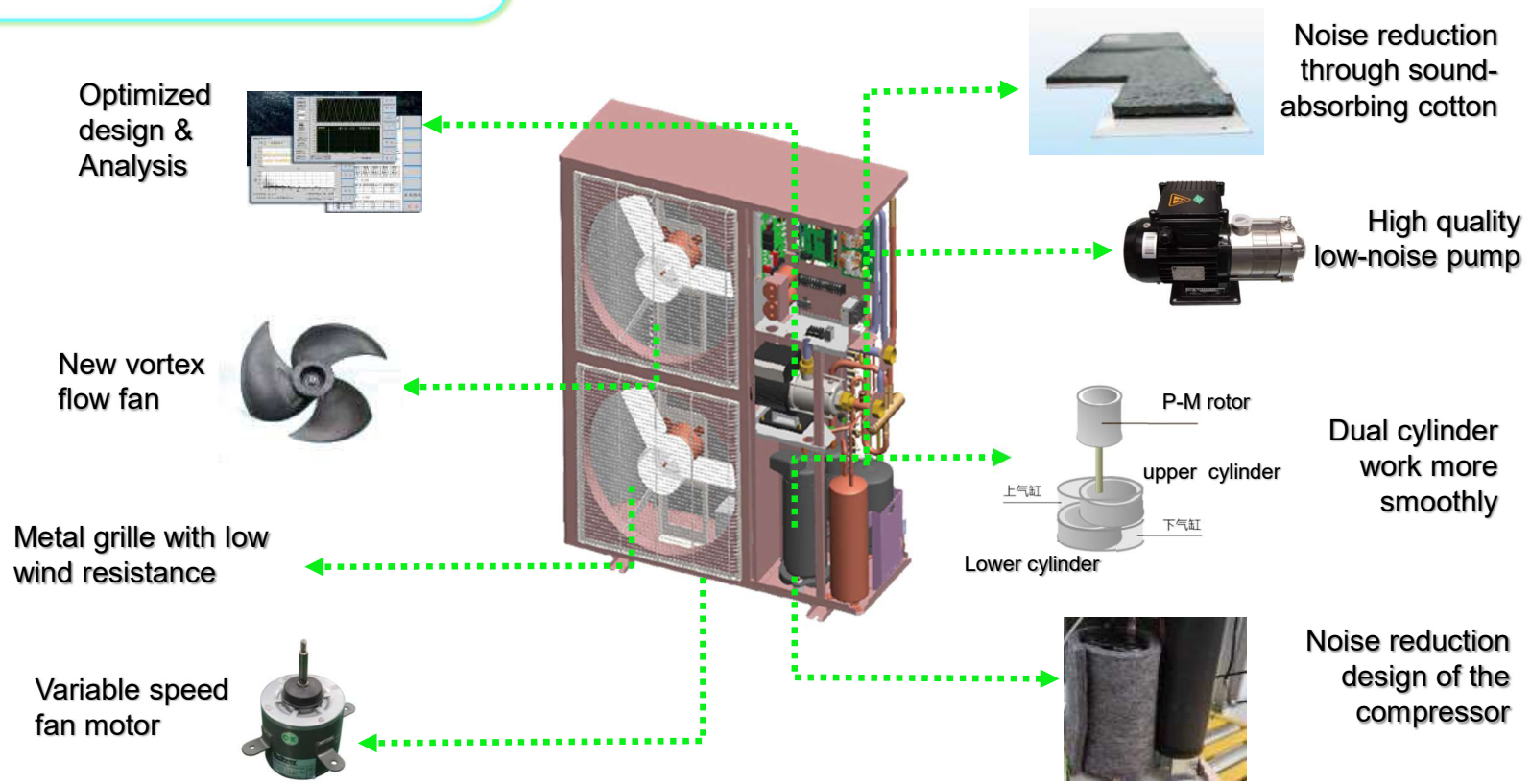
- Mencapai realisasi Load/Unload 100%~15% kapasitas secara stepless.
- Output menjadi **akurat, parsial** berdasarkan beban pendinginan mengurangi konsumsi energi compressor.
- Sangat **mengurangi** jumlah waktu Start - Stop, sehingga meminimalkan starting current compressor (*inrush current*)
- **Arus startup (DOL) biasanya 3 hingga 5 kali arus kerja maksimum (non inverter)**

# FEATURES

**SILENT**

- 8 Noise reduction technologies
- 10dB (A) Ultimate noise reduction

## SILENT AND LOW NOISE



## FEATURES

### SILENT

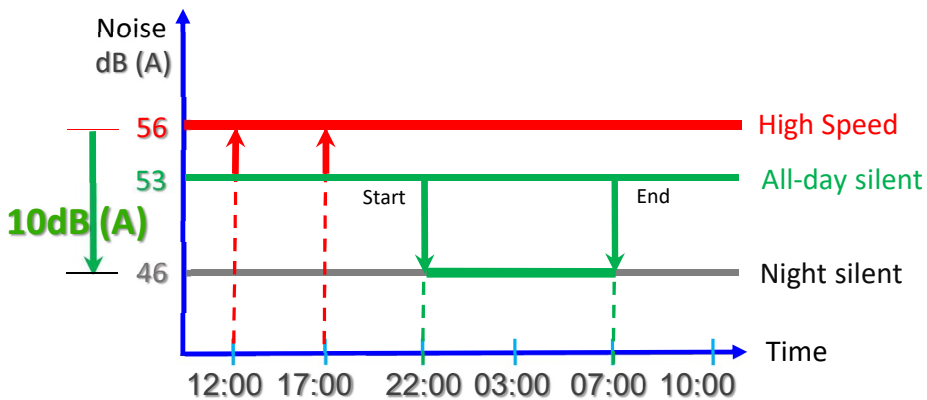
- **8** Noise reduction technologies
- **10dB (A)** Ultimate noise reduction



### NOISE REDUCTION DURING OPERATION

#### Low noise mode setting :

- **Night silent mode**, unit akan secara cerdas mengatur kecepatan kipas berdasarkan perubahan beban untuk mewujudkan operasi senyap yang efisien dan hemat energi.
- **All-day silent mode**, atur unit secara manual ke mode hening selama pengoperasian di siang hari untuk mengurangi kebisingan pengoperasian hingga 53dB(A) dan menciptakan lingkungan yang tenang.

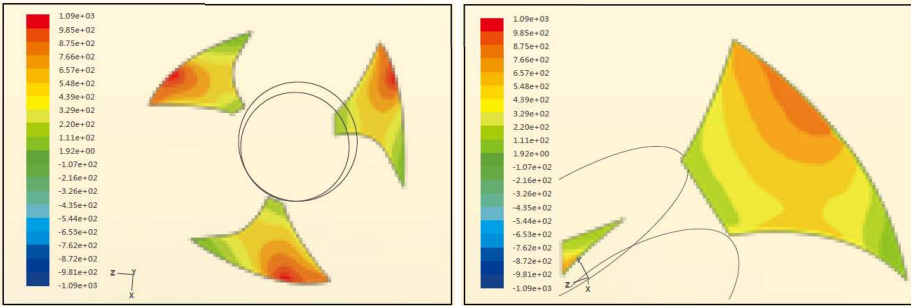
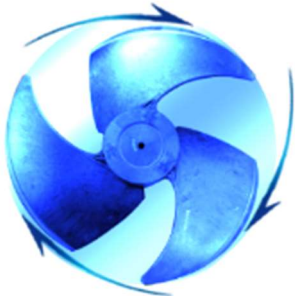


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- **10dB (A)** Ultimate noise reduction

● **NOISE REDUCTION DURING OPERATION**



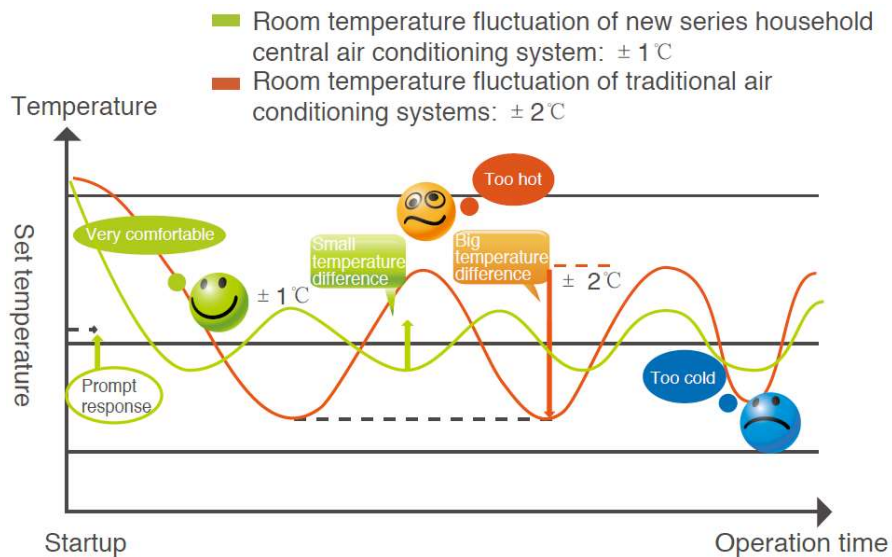
Simulation analysis diagram for the blade surface pressure

**Low noise fan blade, design :**

- Tepi bilah kipas dirancang khusus, agar dapat membentuk garis pusaran angin untuk meningkatkan efisiensi pertukaran panas di sisi udara.
- Dengan cara ini, **lebih banyak udara akan tersedia** bagi fan blade untuk menerapkan pertukaran panas dalam satuan waktu, sehingga memastikan efisiensi pertukaran panas yang dioptimalkan dari sisi condenser.

**FEATURES****COMFORTABLE**

- **$\pm 1^{\circ}\text{C}$**  Temperature fluctuation
- **15~100%** Output cooling

**ACCURATE WATER TEMP. CONTROL****Leaving water setting :**

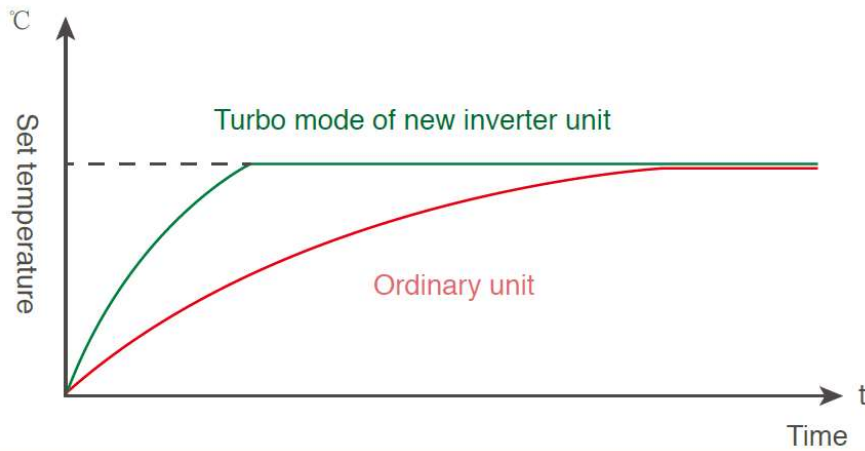
- **Standard leaving water temp**, unit dapat menghindari fluktuasi perubahan suhu air dingin.
- **Unit beroperasi menjadi lebih stabil**, automatic menyesuaikan beban/ruangan yang di kondisikan, dengan akurasi nilai thermistor ( $\pm 1^{\circ}\text{C}$ ) sehingga fluktuasi suplai air dingin tetap dapat dipertahankan.

**FEATURES****COMFORTABLE**

- $\pm 1^{\circ}\text{C}$  Temperature fluctuation
- **15~100%** Output cooling

**TURBO MODE FUNCTION****Turbo mode setting :**

- Ketika unit di operasikan, kompresor dengan cepat menyesuaikan status operasinya berjalan berdasarkan target pengaturan suhu dan suhu lingkungan aktual untuk menerapkan operasi dengan beban penuh 100%.
- Suhu ruangan dapat mencapai suhu pengaturan dalam waktu singkat dan cepat memenuhi kebutuhan AC dari pengguna.





## FEATURES

### COMFORTABLE

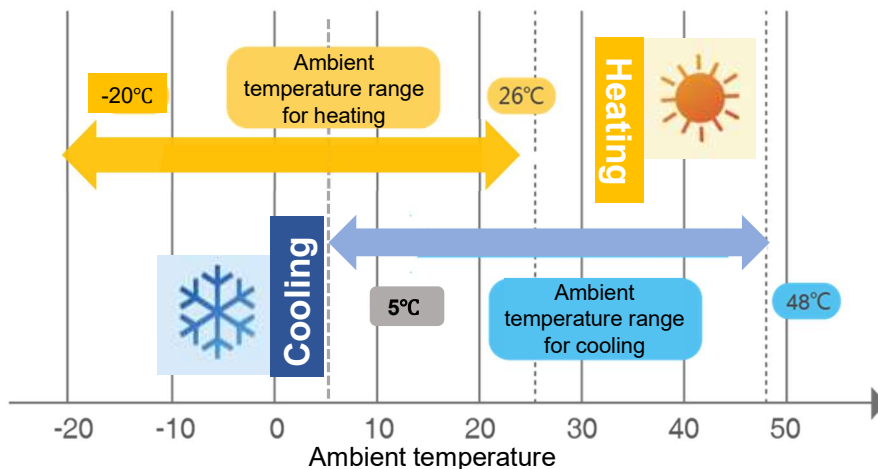
- $\pm 1^{\circ}\text{C}$  Temperature fluctuation
- **15~100%** Output cooling



### REALIBLE AND FLEXIBLE

#### Wide operating range :

- Mengadopsi technology air-cooled heat pump, kompresor dengan cepat menyesuaikan status operasinya berjalan berdasarkan target pengaturan suhu dan suhu lingkungan aktual untuk mencapai rentang suhu yang lebih luas.
- Mini air-cooled chilled dapat beroperasi secara normal pada rentang (LWT) temperature air dingin  $7^{\circ}\text{C}$ - $12^{\circ}\text{C}$ , sedangkan untuk air panas (heat pump)  $40^{\circ}\text{C}$ ~ $45^{\circ}\text{C}$ .



**FEATURES**

**FLEXIBLE INSTALATION**

**Combination of modules**

- Mengadopsi desain modular, setiap grup dapat terhubung secara parallel (group control) dengan kombinasi dari jumlah outdoor **1 ~ 16 unit**. Dengan cara ini dapat memenuhi kebutuhan total kapasitas pendinginan volume ruangan sebesar (500 hingga 2000 m2).



**Space saving design**

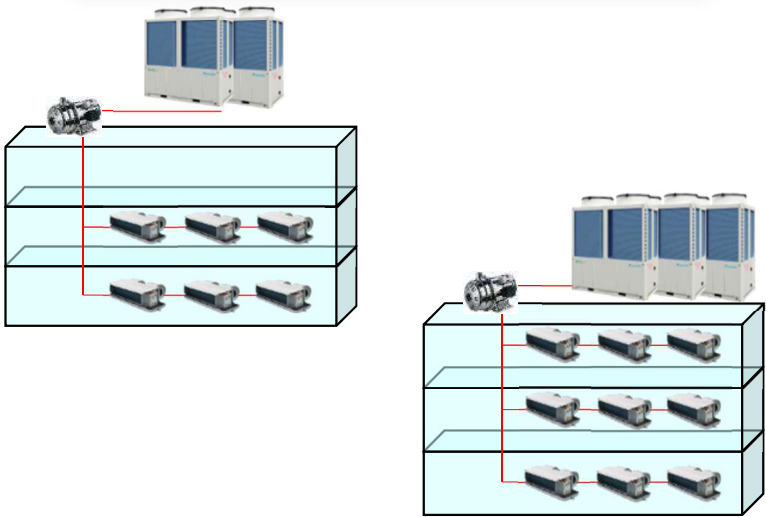
- Unit bisa diletakkan didepan atau belakang bangunan, di balkon atau atap. Dengan pipa yang dirancang untuk dihubungkan ke sisi unit, jarak antara unit dan dinding dapat diminimalkan untuk menghemat ruang pemasangan dan memungkinkan pemasangan dan perawatan menjadi lebih mudah dan fleksibel.



**Saving 35%** of the spaces compared with old models

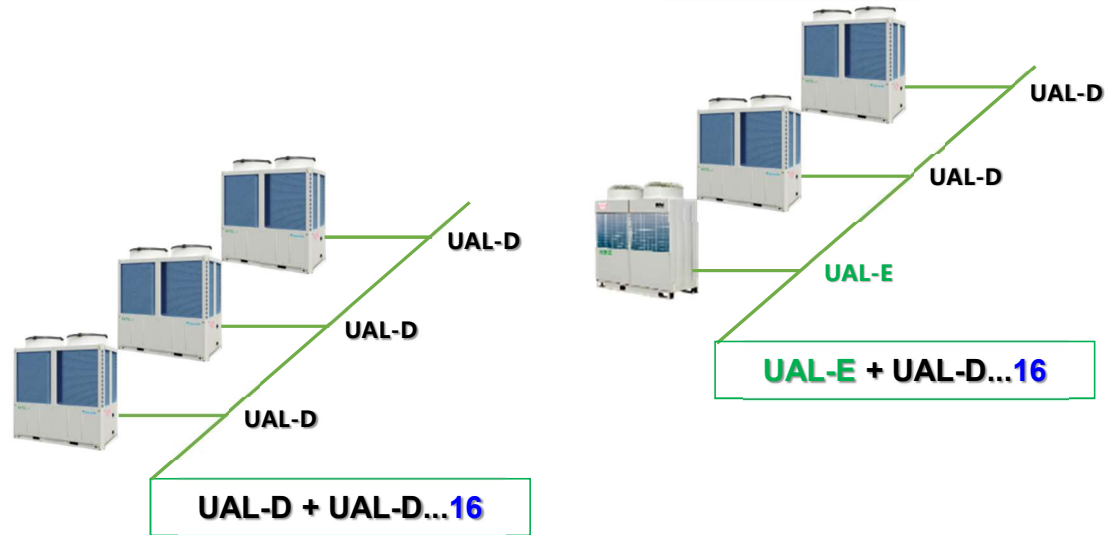
# FEATURES

## STAGED INVESTMENT



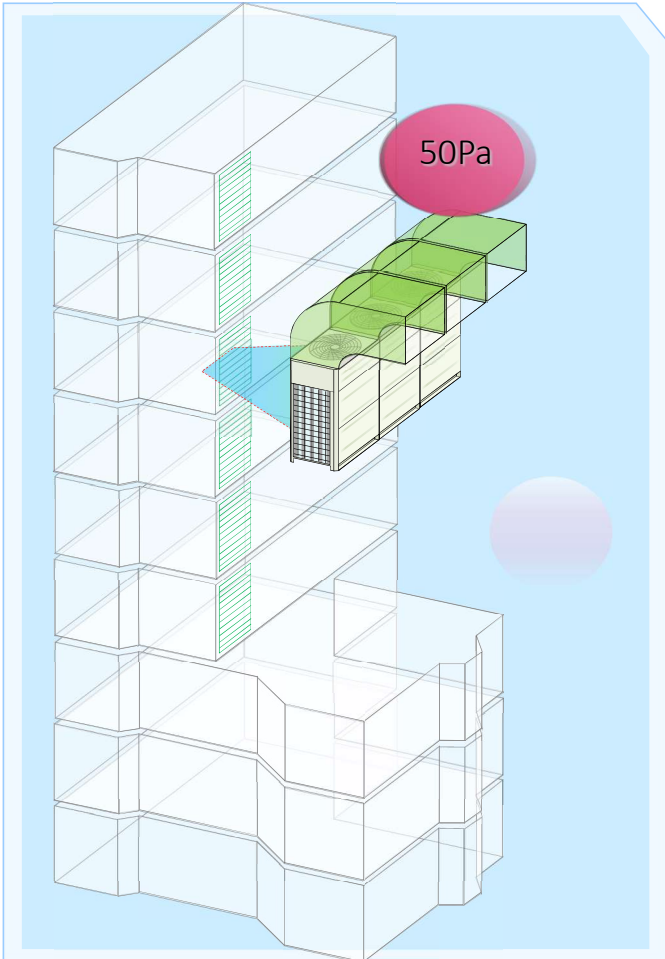
- Unit dapat dibeli dan dipasang dalam batch terpisah sesuai dengan kemajuan proyek yang berbeda waktu.
- Investasi awal yang lebih sedikit dan mudah untuk meningkatkan kapasitas di masa depan.

## FLEXIBLE COMBINATION



- Model UAL yang berbeda dengan kapasitas yang berbeda dapat digabungkan dalam sistem yang sama, maksimal 16 unit yang dapat digabungkan.
- **UAL-E** dan **UAL-D** dapat digabungkan menjadi satu sistem air juga, atur **UAL-E** sebagai unit **master**.

**FEATURES**

A 3D wireframe diagram of a room. A high ESP unit is shown at the bottom right. Blue arrows indicate the airflow pattern, showing air being drawn into the unit and then circulating within the room. A purple starburst with the text '50Pa' is located above the unit. A photograph of the physical high ESP unit is shown at the bottom right of the diagram.

**High ESP **option** to deal with installation space limit**

1. Can install at where limit discharge air
2. Avoid airflow short circuit.
3. Available for UAL450

**FEATURES**

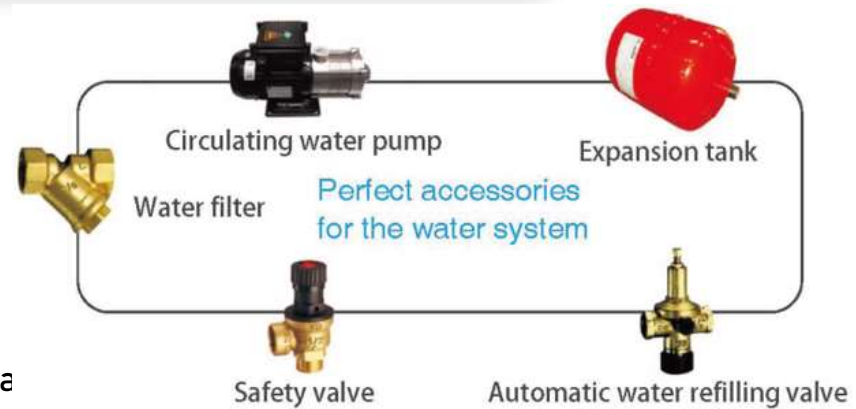
**COMPLETED CONFIGURATION**

**Hydronic system integrated**

- Desain terintegrasi dengan sistem air yang dilengkapi dengan satu set aksesoris lengkap. Pemasangan dapat dengan mudah diselesaikan dengan menghubungkan pipa air ke perangkat terminal.

◆ **Options:** to fully meet the requirement of different application occa

<b>Standard built-in</b>	Recycling pump, expansion tank
<b>Supplied accessories</b>	Water filter, automatic water refilling valve, safety valve



Note: The standard water pressure difference switch is configured for units of 10 to 15HP, but not needed for units of 3 to 8 HP. The water filter, safety valve and automatic water refilling valve are attached to the units.

\* UAL030~080ER5 supports variable frequency water pump.

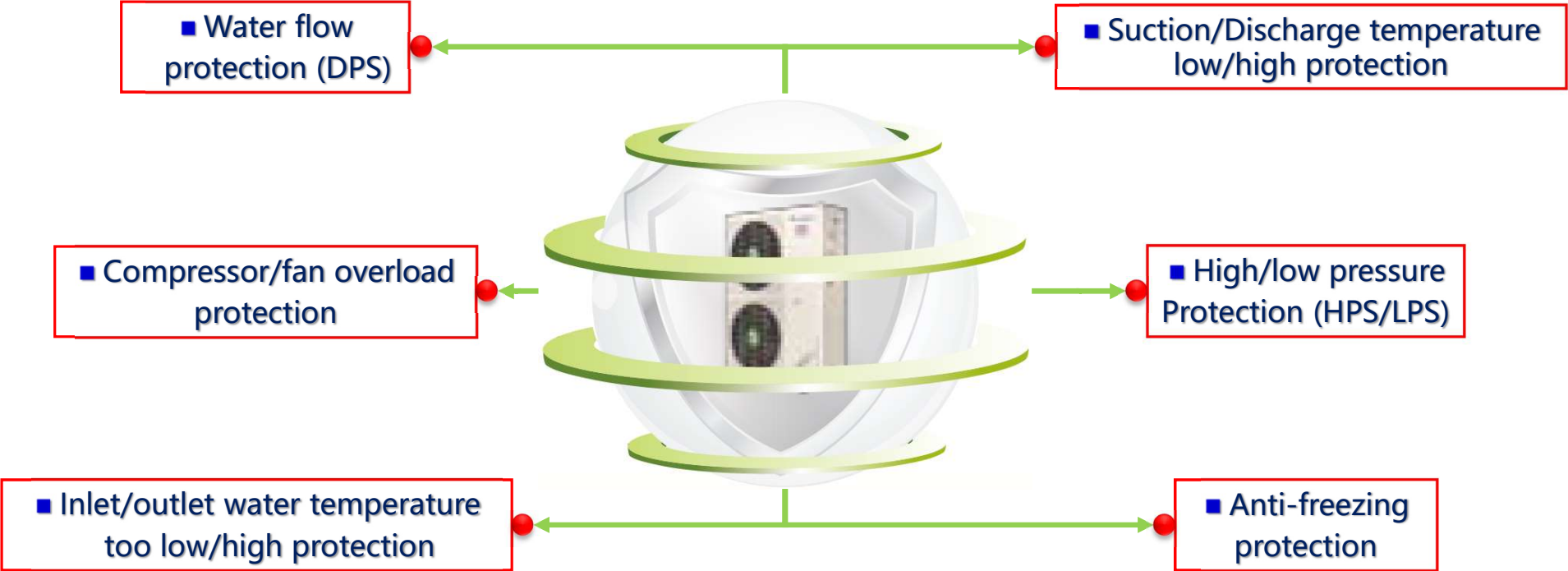
◆ **Optional pump external lift**

Unit model UAL	030ER5	040ER5	050ER5	060ER5	070ER5	080ER5	100ER5	120ER5	150ER5
<b>Standard lift head (m)</b>	15	14	18	14	23	21	22	18	18
<b>Optional lift head (m)</b>	—	—	—	—	—	—	31	28	26



# FEATURES

## ● COMPREHENSIVE SAFETY PROTECTION





**FEATURES**

**● COMPREHENSIVE SAFETY PROTECTION**

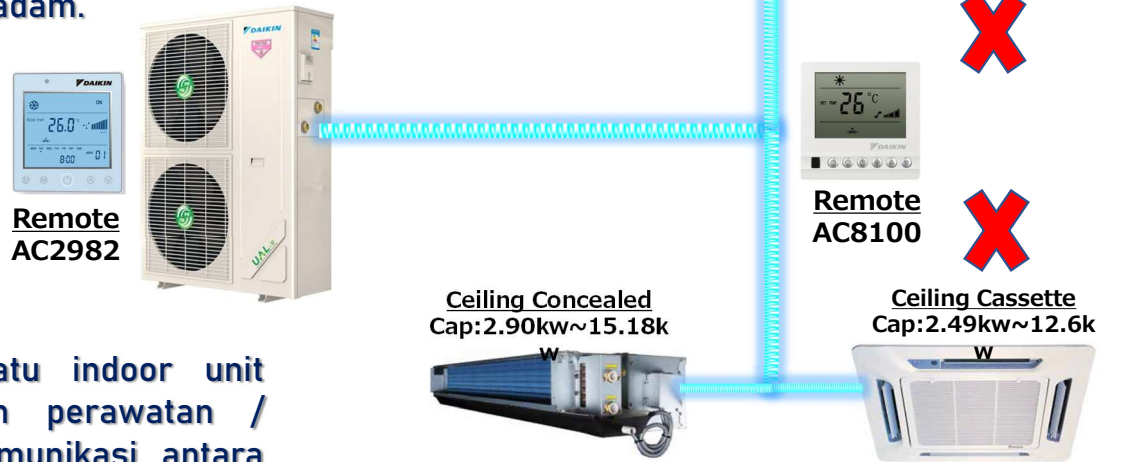
**Automatic startup after power restoration**

- Dalam kasus bila tiba-tiba daya listrik **OFF** darurat sistem pendingin akan **OFF**, sebelumnya sistem secara otomatis telah merekam mode operasi sebelum listrik **OFF**.
- Setelah daya listrik **ON**, sistem akan **ON** secara **otomatis** untuk memulihkan status pengoperasian sebelum listrik padam.

**⚡ Dual power failure protection function**

**Continuous operation of other indoor units in case of emergency one indoor unit and others**

- Sistem **masih dapat beroperasi** jika salah satu indoor unit mengalami gangguan, dalam kasus pekerjaan perawatan / perbaikan (unit di **OFF**). **Tidak akan terjadi error** komunikasi antara FCU & ODU unit chiller.



**FEATURES**

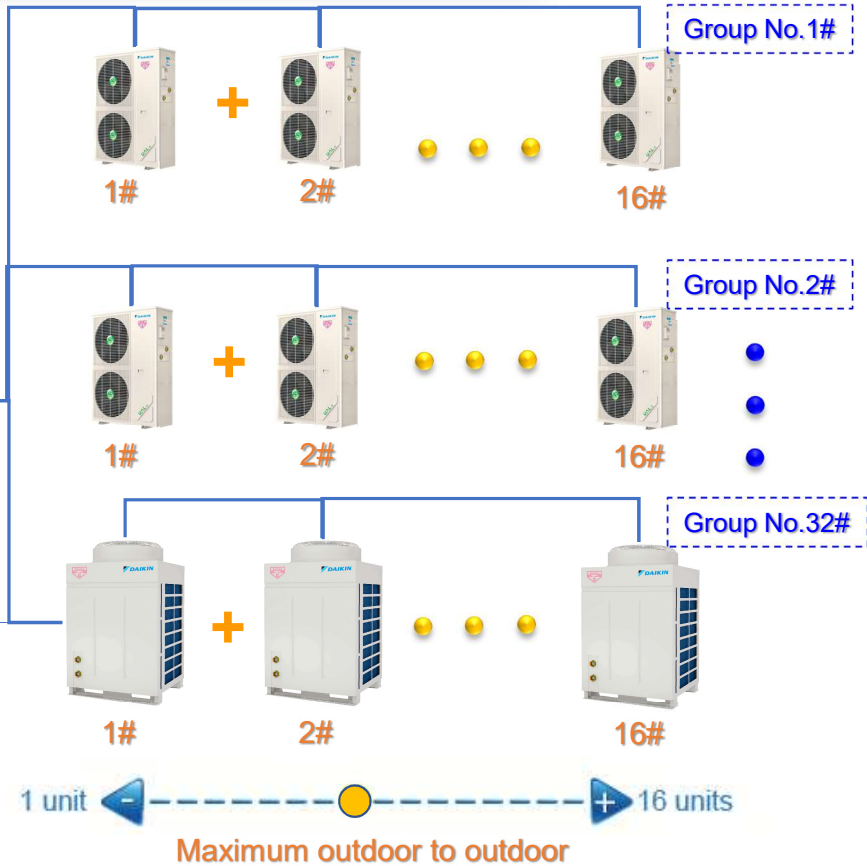
**INTELEGENT CONTROL MODBUS**

- Change operating mode from BMS
- Set Temperature from BMS
- Force Off Unit from BMS
  
- On/Off unit from BMS
- Operating mode status
- On/Off status
- Fault status



BMS

MODBUS  
PROTOCOL



Centralized controller



UC-HMI325AE

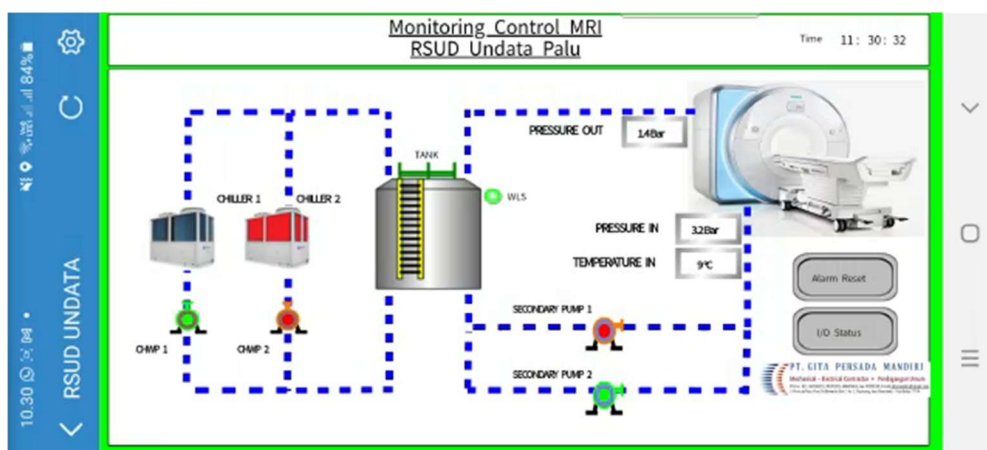
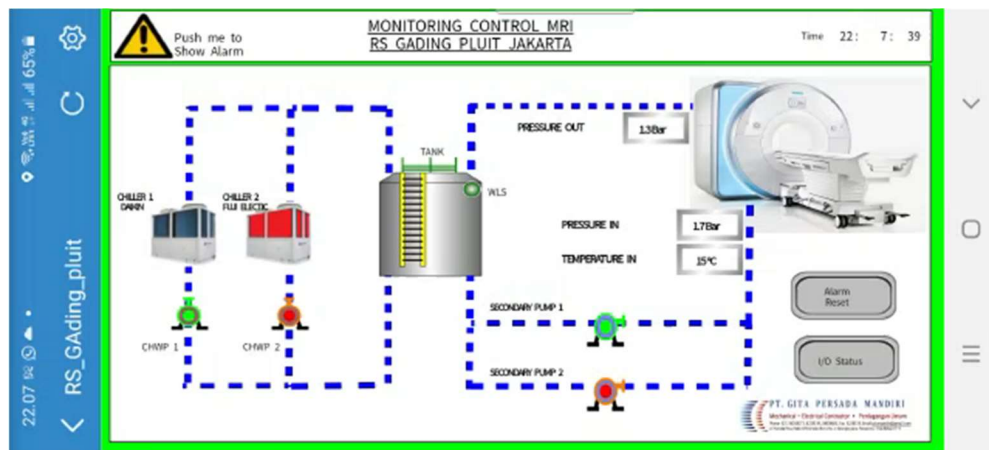
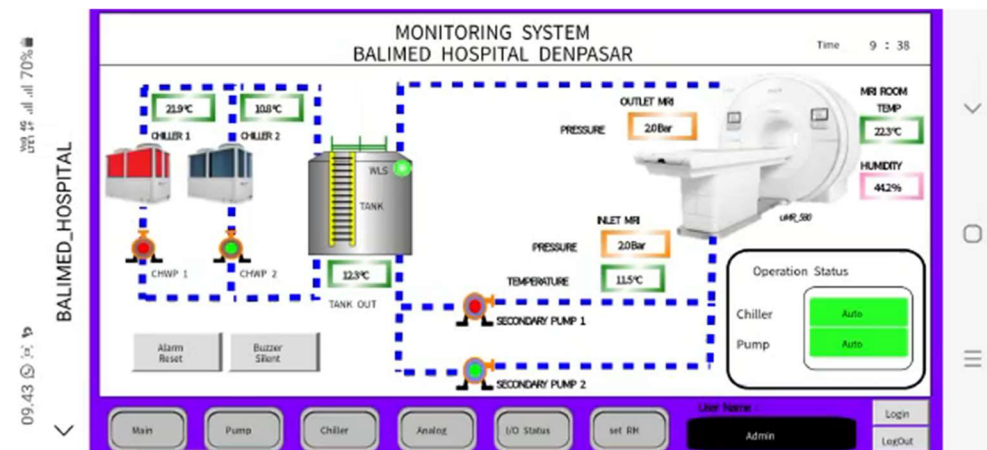
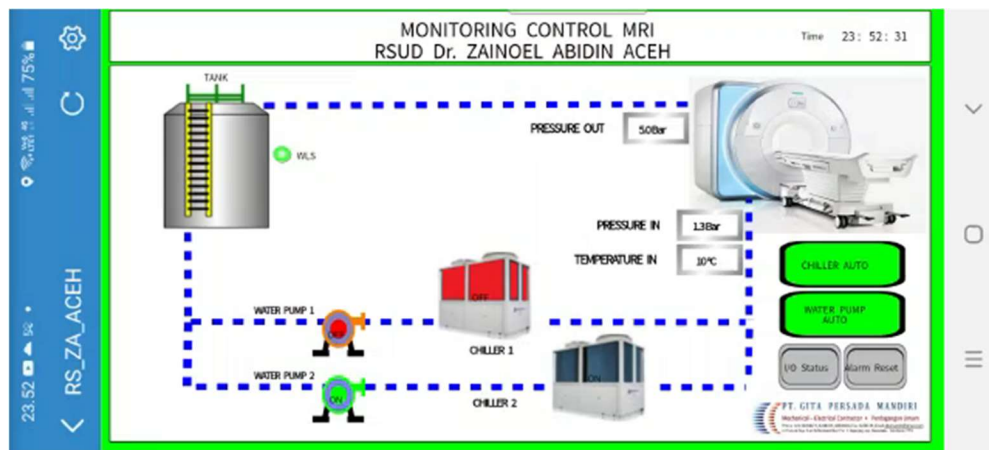
**Centralized Group Control**  
One Single Wired Controller can control a 8 group from 1 master + 15 slaves unit (8 x 16 unit)



MC325

**Master-Slave Group Control**  
One Single Wired Controller can control a group set unit 1 master + 15 slaves (16 unit)

# REMOTE MONITORING SYSTEM





**PT DAIKIN APPLIED SOLUTIONS INDONESIA**

**QUESTION?**



**JAKARTA OFFICE**

**L'Avenue Office Building Lt.25**

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**Indonesia**

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**Fax : +62-21-8066-7119**

# CONTENT OF PRESENTATION

INTRODUCTION

PRODUCT FEATURE

**HVAC EQUIPMENT DESIGN**

COOLING & HEAT PUMP APPLICATION

QUESTION & ANSWER

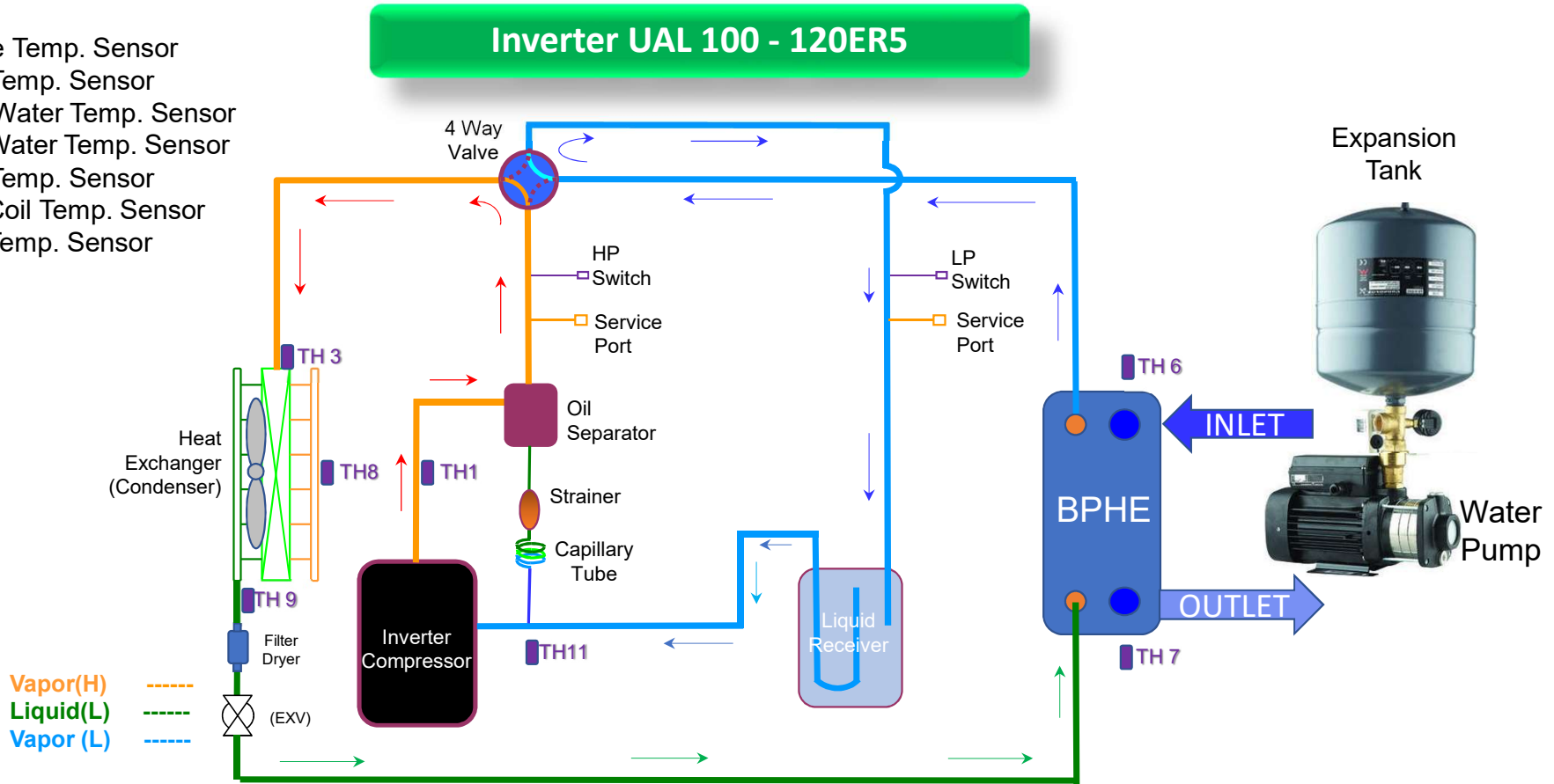


People and ideas you can trust.™



# Refrigerant Circuit Diagram

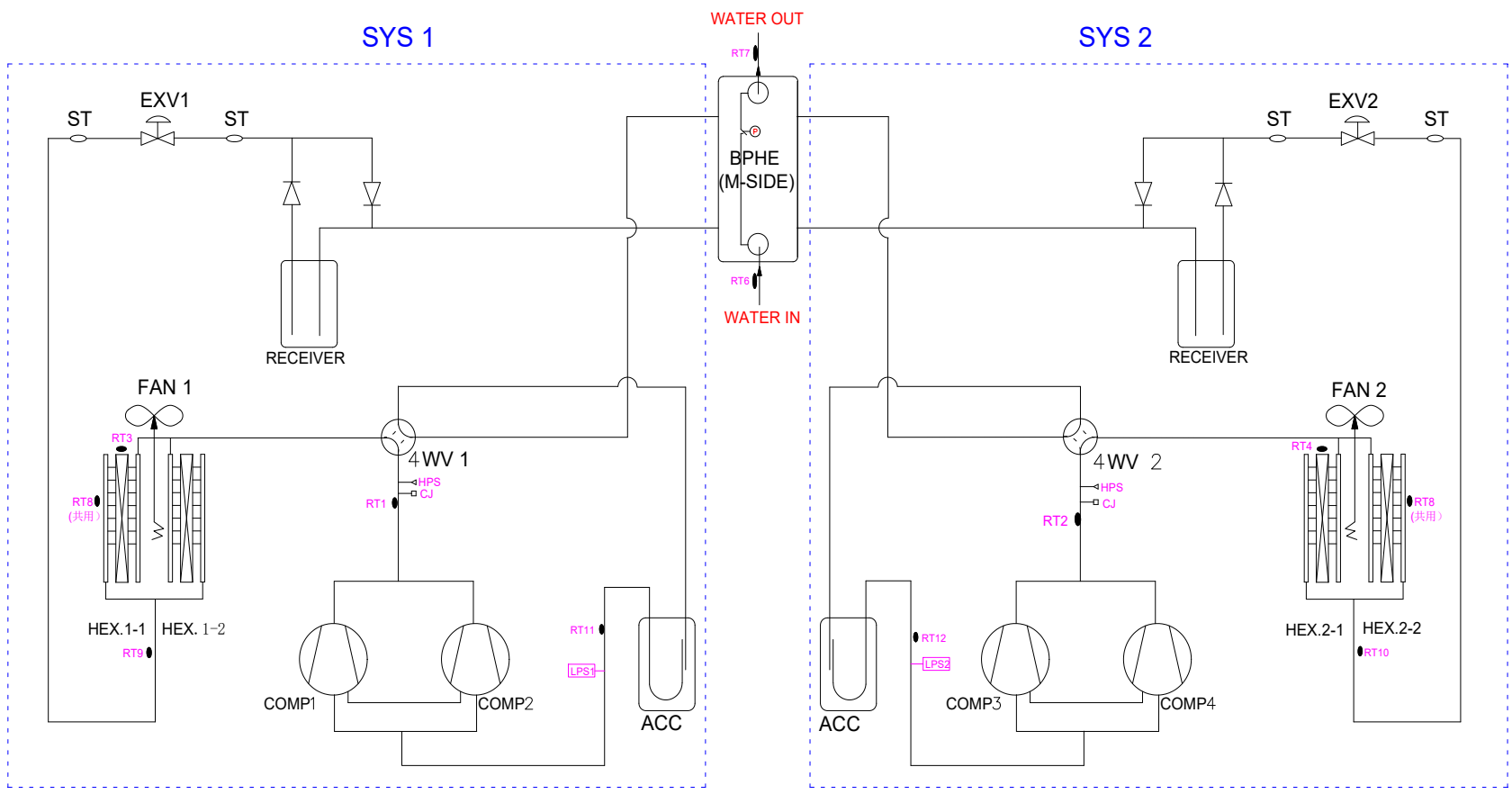
- TH 1 : Discharge Temp. Sensor
- TH 3 : Mid Coil Temp. Sensor
- TH 6 : Entering Water Temp. Sensor
- TH 7 : Leaving Water Temp. Sensor
- TH 8 : Ambient Temp. Sensor
- TH 9 : Leaving Coil Temp. Sensor
- TH 11 : Suction Temp. Sensor



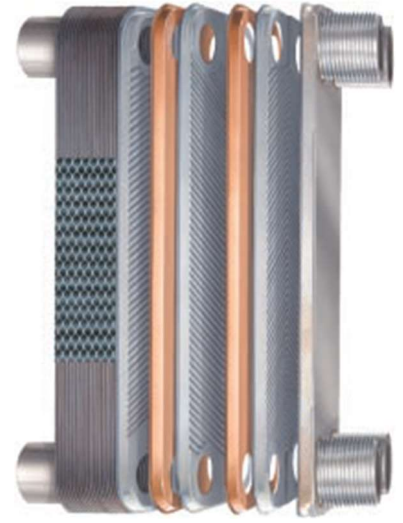
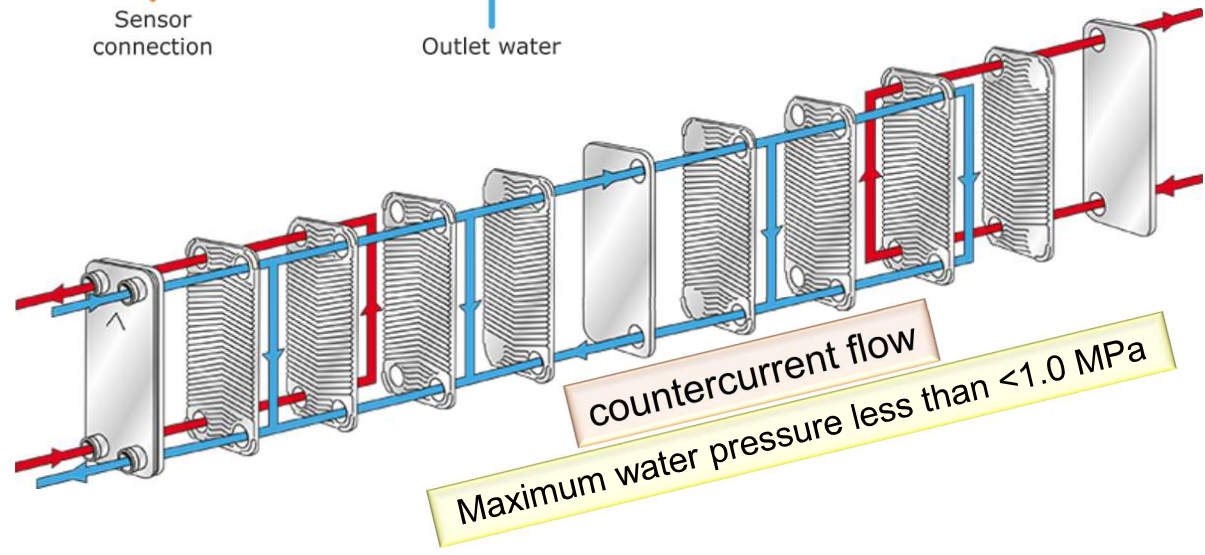
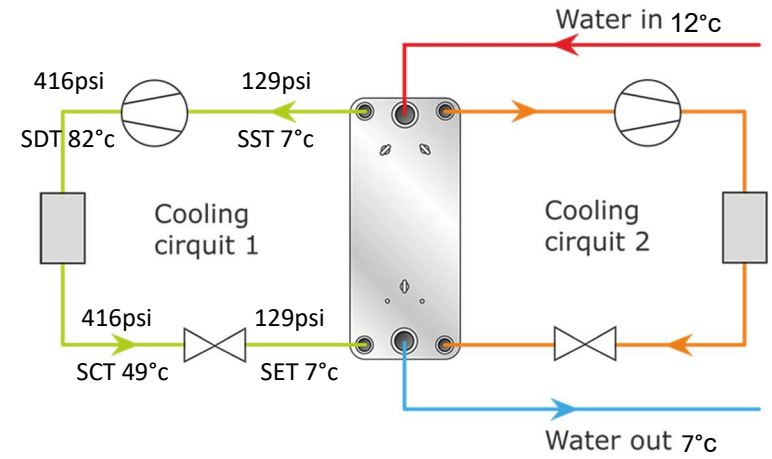
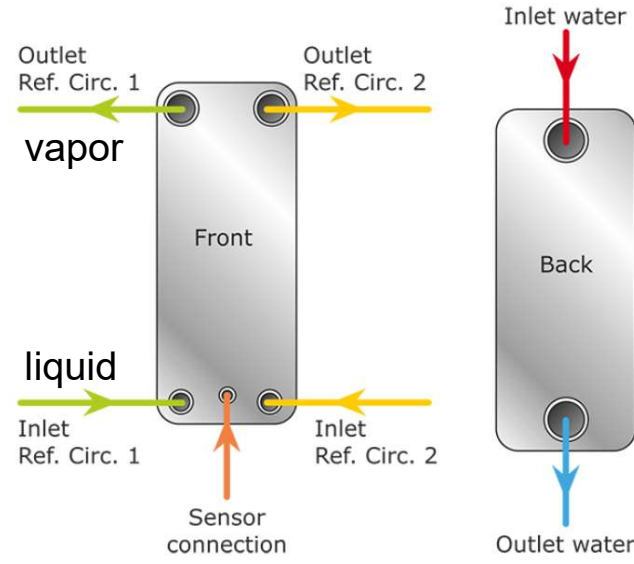


# Refrigerant Circuit Diagram

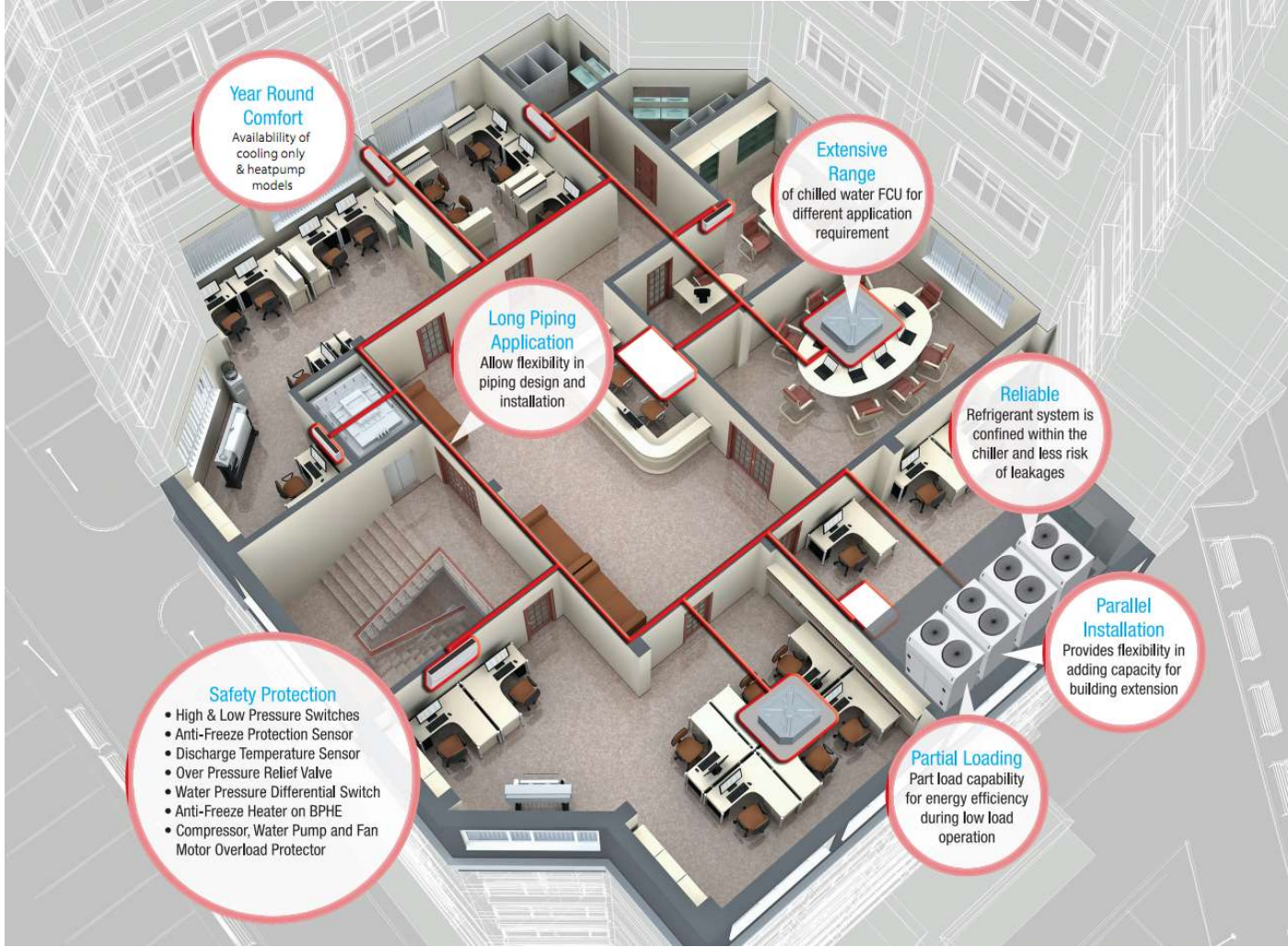
## MODULAR 450DR5



# BPHE Evaporator



# SMALL CHILLER SYSTEM



**Year Round Comfort**  
Availability of cooling only & heatpump models

**Extensive Range**  
of chilled water FCU for different application requirement

**Long Piping Application**  
Allow flexibility in piping design and installation

**Reliable**  
Refrigerant system is confined within the chiller and less risk of leakages

**Parallel Installation**  
Provides flexibility in adding capacity for building extension

**Safety Protection**

- High & Low Pressure Switches
- Anti-Freeze Protection Sensor
- Discharge Temperature Sensor
- Over Pressure Relief Valve
- Water Pressure Differential Switch
- Anti-Freeze Heater on BPHE
- Compressor, Water Pump and Fan Motor Overload Protector

**Partial Loading**  
Part load capability for energy efficiency during low load operation

**DESIGN CONCEPT****Consumer**

- High end residential
- Hospital operating room
- Not so big commercial/office building
- 2-3 star hotel
- etc..

"Mini chiller" memiliki keunggulan tersendiri dibandingkan dengan DX system. Kami ingin pasar dapat memilih sebagai alternative utama dengan aplikasi "Mini Chiller".

**Poin PENTING yang pasti menguntungkan :**

**Biaya lebih murah untuk peralatan serta pemasangannya**

**Lebih aman tidak membutuhkan refrigerant di sepanjang instalasinya.**

**Pengoperasian yang mudah dan perawatan mudah**

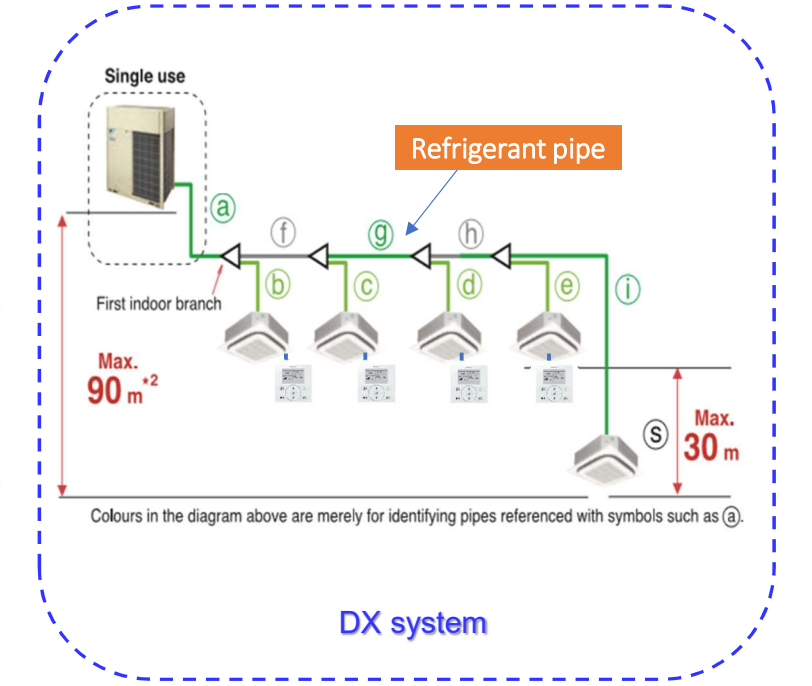
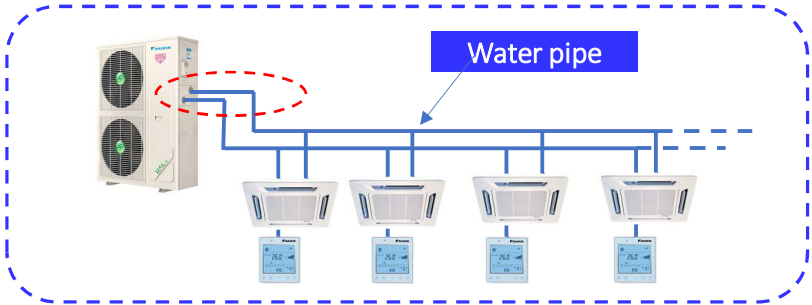
**Mudah dalam perencanaan dan pemasangannya**



**COMPARISON**

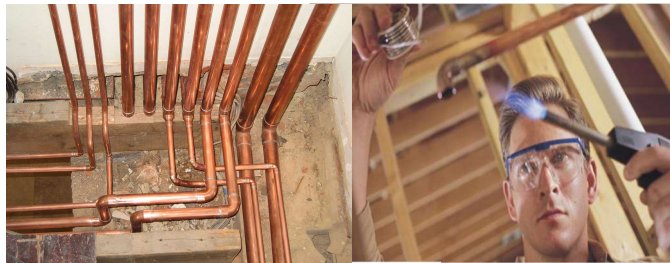
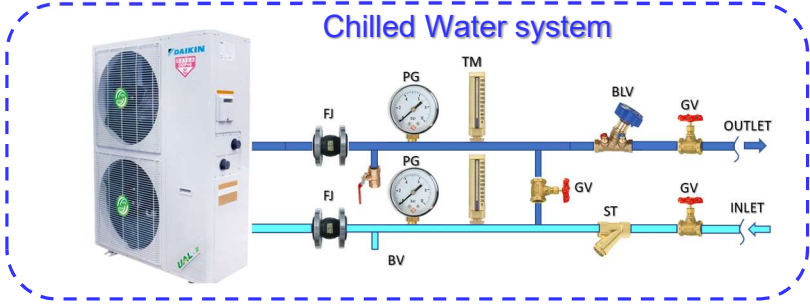
**SELECTION & OPERATION**

Item	Mini Air-cooled Chiller	DX system
<b>Selection unit</b>	<ul style="list-style-type: none"> <li>Tidak membutuhkan software</li> </ul>	<ul style="list-style-type: none"> <li>Membutuhkan selection software</li> </ul>
<b>Operation</b>	<ul style="list-style-type: none"> <li>Tidak membutuhkan oil return technology.</li> </ul>	<ul style="list-style-type: none"> <li>Membutuhkan oil return technology, 3x sehari All compressor akan bekerja 100% untuk mengembalikan oil yang terbawa dan terperangkap dari system.</li> </ul>
<b>Trouble shooting</b>	<ul style="list-style-type: none"> <li>Lebih mudah di atasi karena jumlah Error code yang sedikit.</li> </ul>	<ul style="list-style-type: none"> <li>Akan lebih sulit diatasi dengan jumlah error code yang banyak, membutuhkan special tools service cheker.</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>Sedikit biaya karena berpendingin air.</li> </ul>	<ul style="list-style-type: none"> <li>Banyak biaya karena dampak dari bahan pendingin refrigerant</li> </ul>



**COMPARISON**

**INSTALLATION**



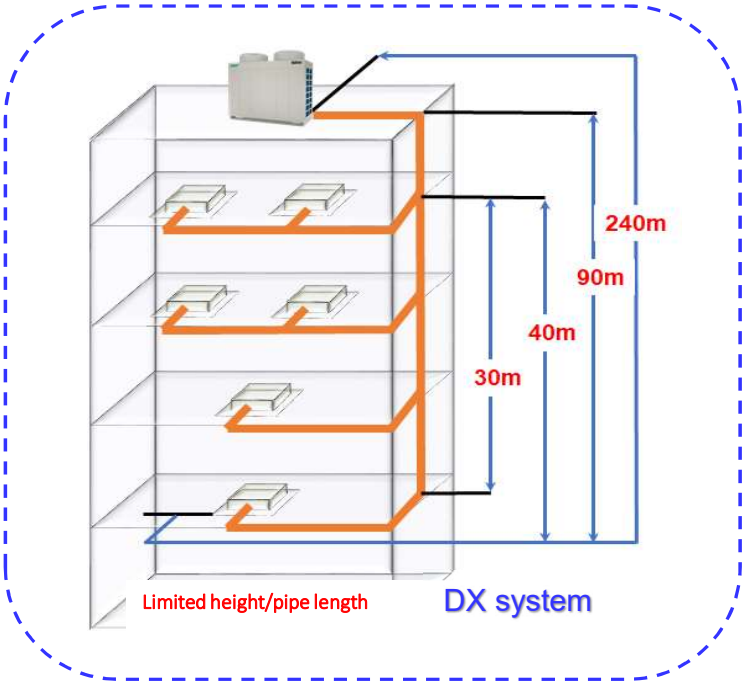
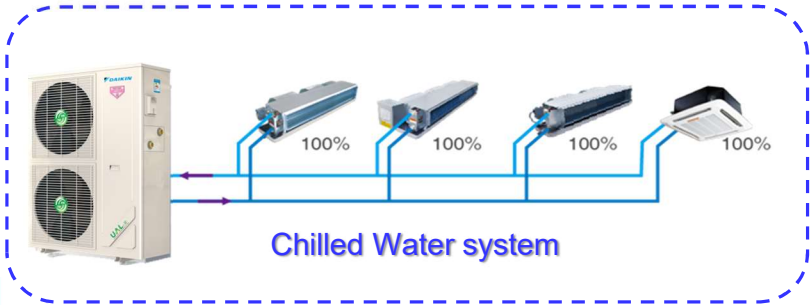
**DX system**

Item	Mini Air-cooled Chiller	DX system
<b>Material</b>	<ul style="list-style-type: none"> <li>• Low Operating pressure</li> <li>• PPR DN10 or PVC Hard (depending application)</li> </ul>	<ul style="list-style-type: none"> <li>• High operating Pressure</li> <li>• Hard material cooper tubing ASTM B280</li> </ul>
<b>Aksesories</b>	<ul style="list-style-type: none"> <li>• Standard Accessories, Valve, Water Strainer, Pressure gauge, Flow Switch</li> </ul>	<ul style="list-style-type: none"> <li>• High design pressure : Tee or Refnet joint</li> </ul>
<b>Proses</b>	<ul style="list-style-type: none"> <li>• Flashing, Leak test maximum 10 BAR, isi air pada tangki dan pipa</li> </ul>	<ul style="list-style-type: none"> <li>• Butuh skill khusus Brazing, Flaring, Swaging, Flashing N2, Leak Test 35BAR, Vacuum, Charging Refrigerant.</li> </ul>
<b>Waktu kerja</b>	<ul style="list-style-type: none"> <li>• Efektif prosedur / langkah kerja lebih sedikit.</li> </ul>	<ul style="list-style-type: none"> <li>• Menjadi kurang efektif, banyak procedure yang harus dilakukan</li> </ul>



**COMPARISON**

**SAFETY & PERFORMANCE**



Item	Mini Air-cooled Chiller	DX system
<b>Performance</b>	<ul style="list-style-type: none"> <li>Kinerja chiller tidak terpengaruh oleh panjang pipa air. Fokus terhadap kapasitas pompa air</li> </ul>	<ul style="list-style-type: none"> <li>Penurunan kinerja cukup jelas, penyebab jarak instalasi panjang dan tinggi.\</li> </ul>
<b>Indoor system</b>	<ul style="list-style-type: none"> <li>Mengisi air disepanjang instalasi pipa, tidak perlu lagi mengisi refrigerant</li> </ul>	<ul style="list-style-type: none"> <li>Akan ada biaya tambahan yang besar, karena instalasi pemipaan harus diisi oleh refrigerant</li> </ul>
<b>Safety</b>	<ul style="list-style-type: none"> <li>Chilled water system, ramah lingkungan dan aman</li> </ul>	<ul style="list-style-type: none"> <li>Ada kemungkinan besar terjadi kebocoran instalasi pipa refrigeran, yang dapat membahayakan lingkungan pada area indoor.</li> </ul>
<b>Pemeliharaan</b>	<ul style="list-style-type: none"> <li>Kebocoran sistem pipa air dapat dengan mudah dideteksi dan perbaikan dapat cepat diselesaikan.</li> </ul>	<ul style="list-style-type: none"> <li>Sulit untuk menemukan titik kebocoran pada instalasi pipa refrigeran, membutuhkan waktu yang lebih lama dalam proses perbaikannya.</li> </ul>

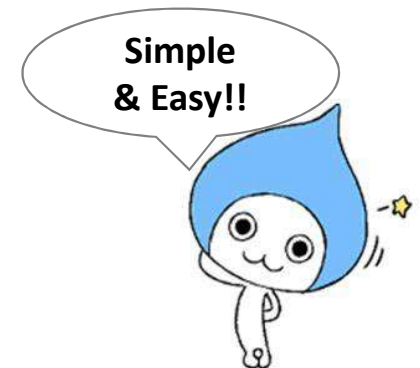
**SIMPLE MODEL SELECTION**

**Anda dapat dengan mudah melakukannya dengan 4 metode berikut :**

- ① Perhitungan beban AC. (Perhitungan beban pendinginan tiap ruangan)
- ② Pemilihan unit indoor (Fan coil) di setiap ruangan.
- ③ Pemilihan outdoor unit. (inverter Mini Chiller)
- ④ Pemilihan besaran pipa (chilled water pipe)

\*Bagian ini adalah panduan sederhana.

Jika Anda ingin tahu lebih banyak, kami dapat memberikan data tambahan.



**CALCULATION COOLING LOAD**

**SIMPLE MODEL SELECTION**

Room	Cooling Load (1 w = 3.412 BTU/hr)	Load w/m <sup>2</sup>	Load BTU/hr
Office			
Residence		170	580
Clinic (hospital)			
Store		180	614
Conference Room		270	921
Restaurant		300	1023

※ This load is a general condition.  
Please use flexibly according to the load of the room.

**① Air conditioning load calculation. (Cooling load of each room)**

- a) Volume beban per meter persegi dari tabel sesuaikan dengan jenis ruangan.
- b) Beban per meter persegi x Luas lantai dalam ruangan = Beban ruangan (W)
- c) Pilih tipe indoor (FCU) unit yang akan di aplikasikan
- d) Jumlahkan semua beban ruangan dan tentukan unit chillernya (UAL).

**Contoh :**

$$\begin{array}{r}
 \text{Office} \\
 \boxed{100 \text{ m}^2} \times \boxed{170 \text{ w/m}^2} = \boxed{17.0 \text{ kW}} \\
 \\
 \text{Conference room} \\
 \boxed{35 \text{ m}^2} \times \boxed{270 \text{ w/m}^2} = \boxed{9.45 \text{ kW}} \\
 \\
 \text{Load of outdoor unit} = \boxed{26.45 \text{ kW}}
 \end{array}$$



**CALCULATION COOLING LOAD**

**SIMPLE MODEL SELECTION**

**② Selection of indoor type (in each room)**

Specification for Ceiling Cassette Type ~ **FWK09E**


Cooling capacity : **8.79kW** (30.000 Btu/hr)  
 Water flow rate : **26.29 Liter/min**

Specification for Ceiling Concealed Type ~ **FWC12C**

Cooling capacity : **10.8kW** (3700 Btu/hr)  
 Water flow rate : **31.34 Liter/min**



**OFFICE LOAD 9.45kW**



**FWC03E**

Cap. **10.8kw**  
Wf. **31.34(L/min)**

**CONFERENCE Total Load 17.0kW**



**FWK09E \* 2 units**

Cap: 8.79kw \* 2 = **17.4kw**

Wf: 26.29\*2 = **52.58(L/min)**



Room	Cooling Load (1 w = 3.412 BTU/hr)	Load w/m <sup>2</sup>	Load BTU/hr
Office			
Residence		170	580
Clinic (hospital)			
Store		180	614
Conference Room		270	921
Restaurant		300	1023

※ This load is a general condition. Please use flexibly according to the load of the room.



- *Pilih model yang mendekati beban dari spesifikasi dan type unit dalam ruangan yang sesuai.*
- *Kapasitas dan water flow juga di butuhkan pada kondisi ini.*

**CALCULATION COOLING LOAD**

**SIMPLE MODEL SELECTION**

**Load perhitungan**

**26.45 kW**

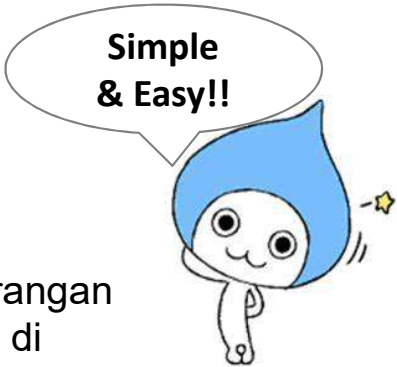
**③ Selection of outdoor units (Inverter mini chiller)**

MODEL	Cooling capacity kW or TR	Water Flow L/m or (USgpm)	Water Pipe Connection mm or (inch)
UAL030ER5	9.4   2.67	27.0   (7.13)	25.4   (1')
UAL040ER5	11.4   3.24	32.7   (8.63)	
UAL050ER5	14.6   4.15	41.8   (11.0)	
UAL060ER5	16.8   4.78	48.2   (11.30)	
UAL070ER5	19.8   5.63	56.8   (15.0)	32   (1 ¼')
UAL0800ER5	24.9   7.08	71.3   (18.83)	
UAL100ER5	28.8   8.19	82.5   (21.74)	
UAL120ER5	33.5   9.52	96.0   (25.36)	
UAL150ER5	40.0   11.37	114.7   (30.30)	



**UAL100ER**  
Cap.28.8kw  
WF.82.5 (L/min)

Pipe size mm (inch)	Max water flow L/min
10A (2/5')	~ 4
15A (1/2')	~ 7
20A (3/4')	~ 15
25A (1')	~ 30
32A (1-1/4')	~ 60
40A (1-1/2')	~ 80
50A (2')	~ 160



Setelah menentukan kapasitas unit, maka didapatkan juga keterangan jumlah aliran air yang di butuhkan untuk unit mini chillernya.

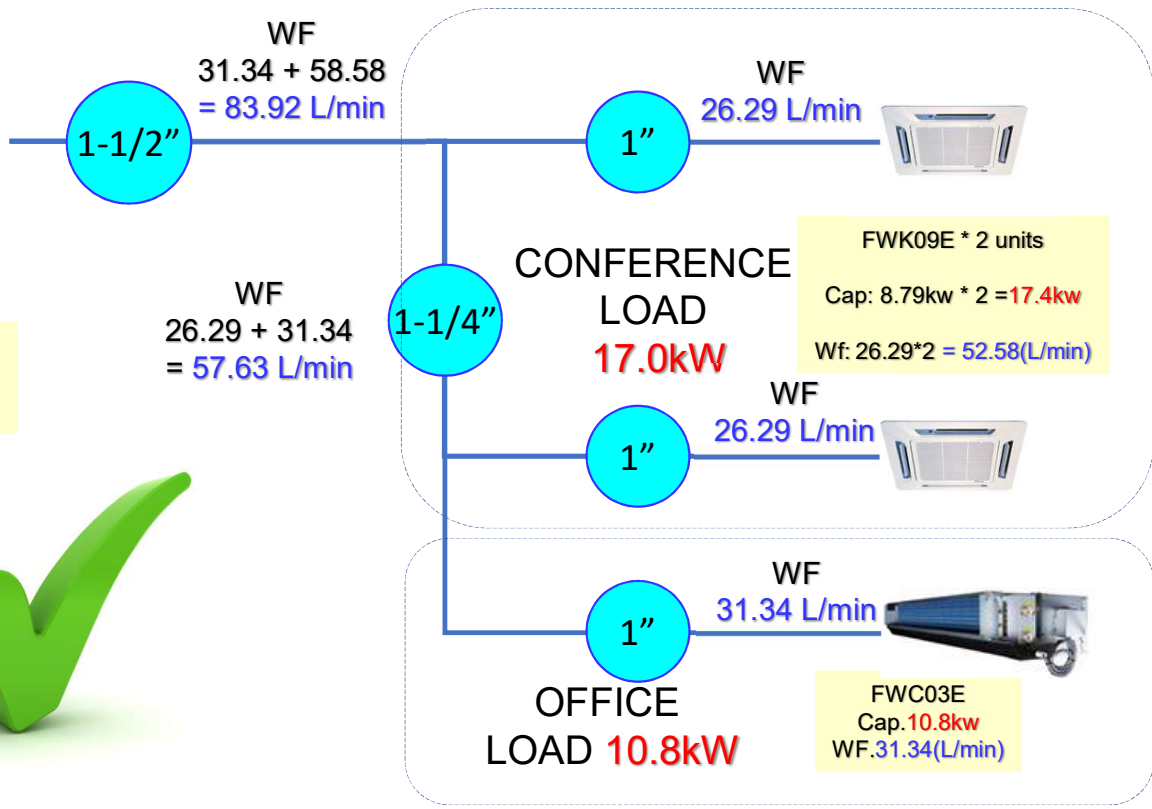
**CALCULATION COOLING LOAD**

**SIMPLE MODEL SELECTION**

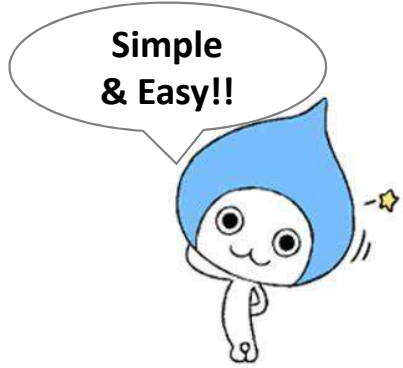
**④ Selection chilled water piping size**



**UAL100ER**  
Cap. **28.8kw**  
WF. **82.5 (L/min)**



Pipe size mm (inch)	Max water flow L/min
10A (2/5')	~ 4
15A (1/2')	~ 7
20A (3/4')	~ 15
25A (1')	~ 30
32A (1-1/4')	~ 60
40A (1-1/2')	~ 80
50A (2')	~ 160





# CHILLER WATER FLOW RATE



## Standard or Nominal Flow Rate for Chiller

For **IMPERIAL** Formula,  
 Chiller Capacity = TR or RT  
 TR : Tonnage of Refrigeration  
 Differential Temperature or Delta T -  $\Delta T$  in °F

**Chilled Water : Flow Rate in GPM**  
 For  $\Delta T = 10$  °F (5.5°C)  
 Required GPM per 1 TR =  $24 \times 1 / 10 = 2.4$  gpm/TR  
 For  $\Delta T = 9$  °F (5.0°C)  
 Required GPM per 1 TR =  $24 \times 1 / 9 = 2.67$  gpm/TR

*From the table we can check what is the maximum flow rate per pipe size and even the Chiller Tonnage if the pressure drop is designed to have 4% losses (4 ft of water / 100 ft pipe).*

For **1-1/2 inch** (40mm) pipe good for < 10 TR chiller  
**23gpm** =  $9.6 \times 2.4$  @  $\Delta T = 10$  °F (5.5°C)  
 For **1-1/2 inch** (40mm) pipe good for < 9 TR chiller  
**23gpm** =  $8.6 \times 2.4$  @  $\Delta T = 9$  °F (5.0°C)

$$TR = (GPM \times \Delta T) / 24$$

$$GPM = (TR \times 24) / \Delta T$$

## Chilled Water Close Circuit

Pipe Diameter		Max Flow		Selection Based on Frictional Loss of 4 ft of Water / 100 ft (Pipe dia ≤ 4 inches)			
				Ton of Refrigeration by max (USGpm)		Velocity	
Inch	mm	Usgpm	L/min	2.4 gpm / TR $\Delta T = 10^\circ F$	2.67 gpm / TR $\Delta T = 9^\circ F$	fps	m/s
1/2"	15	2	7	0.83	0.75	1.9	0.6
3/4"	20	4	15	1.67	1.50	2.3	0.7
1"	25	7	26	2.92	2.62	2.7	0.8
1 1/4"	32	15	56	6.25	5.62	3.3	1
<b>1 1/2"</b>	<b>40</b>	<b>23</b>	<b>87.</b>	<b>9.6</b>	<b>8.6</b>	<b>3.7</b>	<b>1.1</b>
2"	50	45	170	18.8	16.9	4.4	1.3
2 1/2"	65	73	276	30.4	27.3	4.9	1.5
3"	80	<b>130</b>	492	54.2	48.7	5.7	1.7
4"	100	268	1014	111.7	100.4	7.6	2.3

# CONTENT OF PRESENTATION

INTRODUCTION

PRODUCT FEATURE

HVAC EQUIPMENT DESIGN

COOLING & HEAT PUMP APPLICATION

QUESTION & ANSWER



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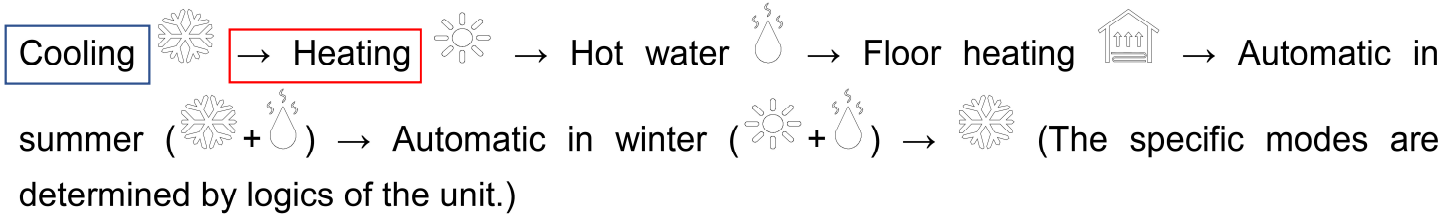
**COOLING OR HEAT PUMP**



**COOL** **HEAT**

**Mode Setting**

In power-off status, press " (M) " to switch the mode as follows:



**CHILLED WATER SYSTEM**

**Cooling Mode**

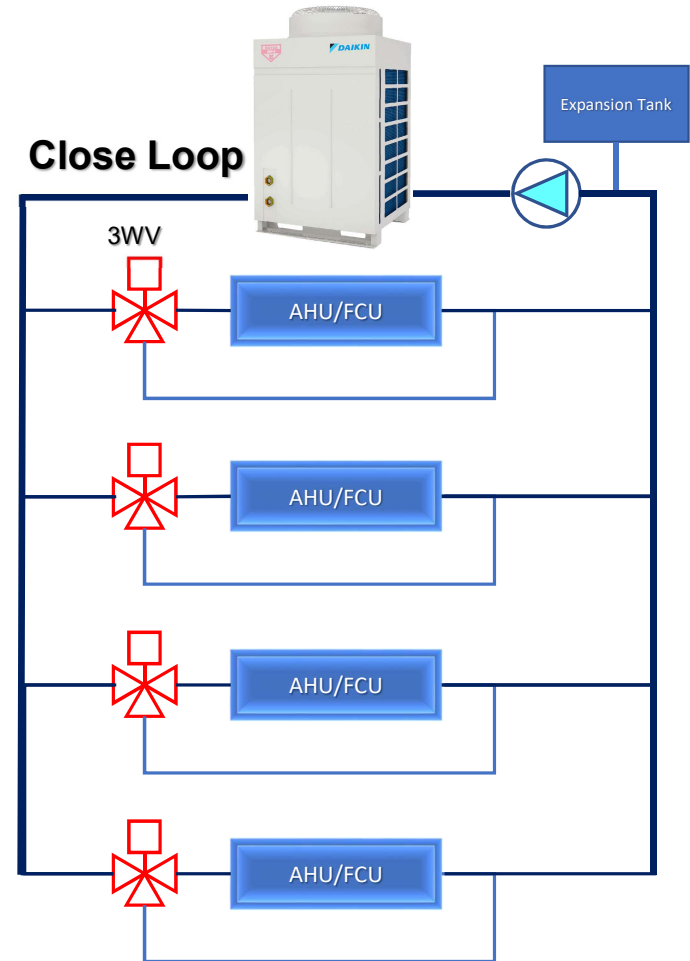
**Chiller Water System Loops : CLOSE vs OPEN**

**No Additional Static Pressure Head**

Dalam sistem loop tertutup, pompa tidak diperlukan untuk mengatasi perbedaan elevasi (*static head*) karena lokasi dari semua AHU & FCU.

Thus the static pressure head is zero.

**Pompa** hanya diperlukan untuk mengatasi **head tekanan dinamis**, kehilangan tekanan karena gesekan (*Pressure loss due to fiction*) aliran dalam sistem perpipaan



**CHILLED WATER SYSTEM**

**Cooling Mode**

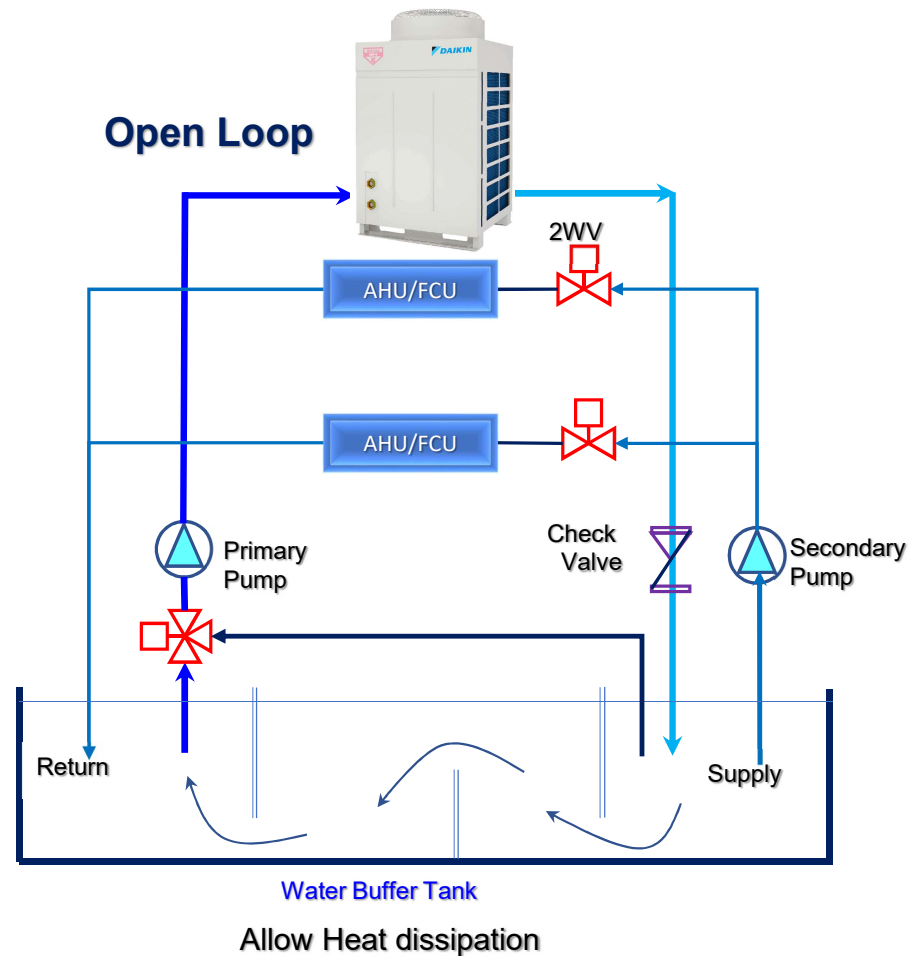
**Chiller Water System Loops : CLOSE vs OPEN**

**Additional Static Pressure Head**

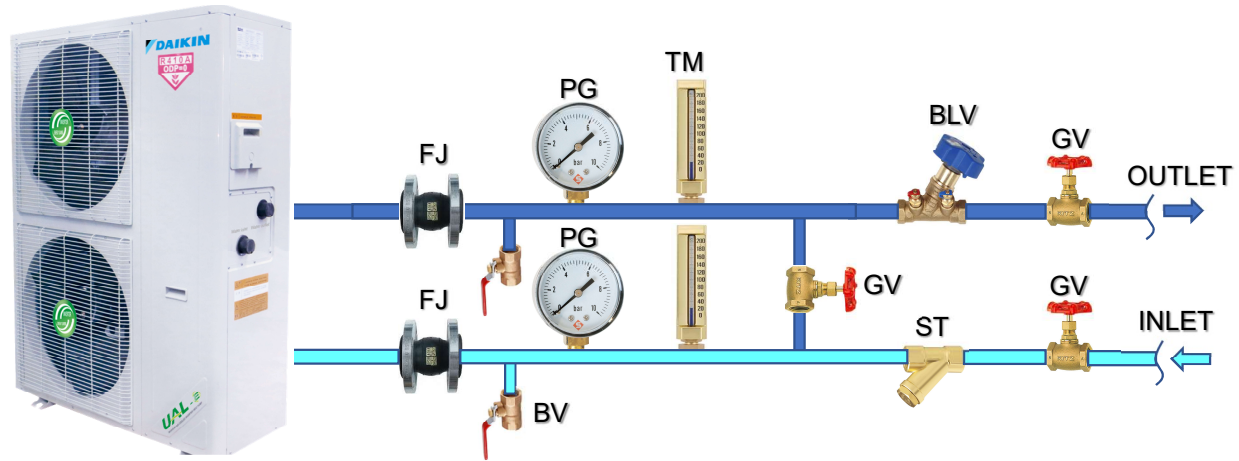
Dalam sistem loop terbuka (*Open Loops*) yang mirip dengan sistem *condenser water system*, tekanan statis head tambahan (*static pressure head*) harus dipertimbangkan karena kehilangan tekanan dalam *water buffer tank* mirip dengan perbedaan ketinggian pada menara pendingin tipe terbuka (cooling tower).

**Pompa tambahan** (*secondary*) diperlukan untuk mensirkulasikan air ke seluruh AHU & FCU.

**Additional static head** diperlukan pompa untuk mendorong ke aliran air ke atas.



**CHILLER ACCESSORIES**



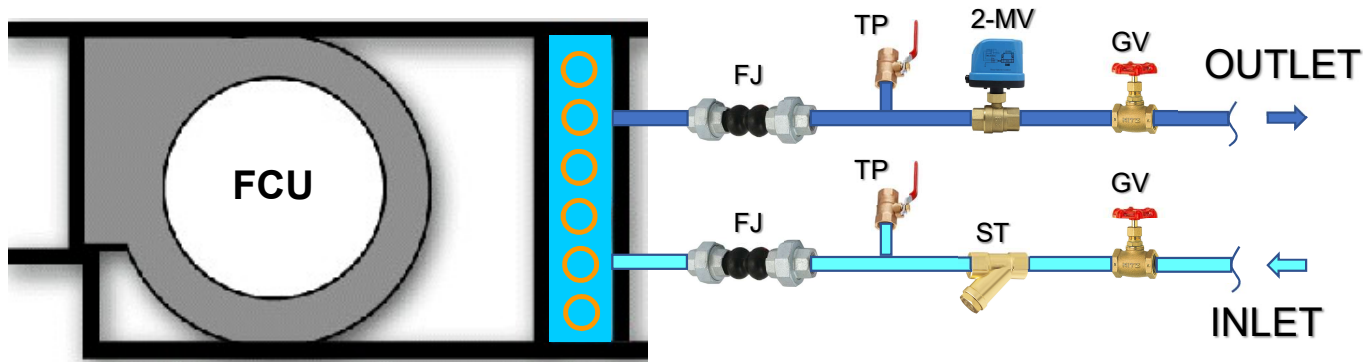
- |                              |                                 |
|------------------------------|---------------------------------|
| FJ : Flexible Joint          | GV : Gate Valve                 |
| BV : Service Ball Valve 3/4" | ST : Water Strainer             |
| PG : Pressure Gauge          | 3MV : Three Way Motorized Valve |
| TM : Thermometer             | BLV : Balancing Valve           |

**AHU with Three-way control valve :**

- Type Modulating or On/Off
- Constant water flow
- Variable return water temperature
- **No need PDV** (Pressure Differential Valve)



**FCU ACCESSORIES**

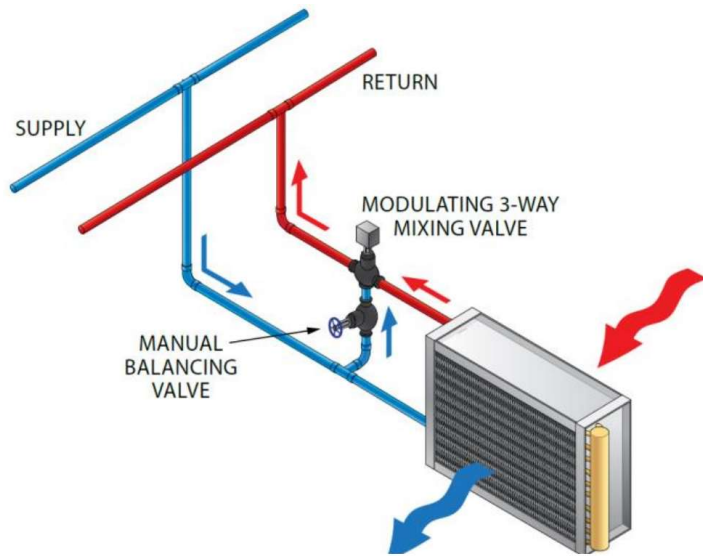


- FJ : Flexible Joint
- TP : Test Point - Ball Valve 1/2"
- ST : Water Strainer
- 2MV : Two Way Motorized Valve
- GV : Gate Valve

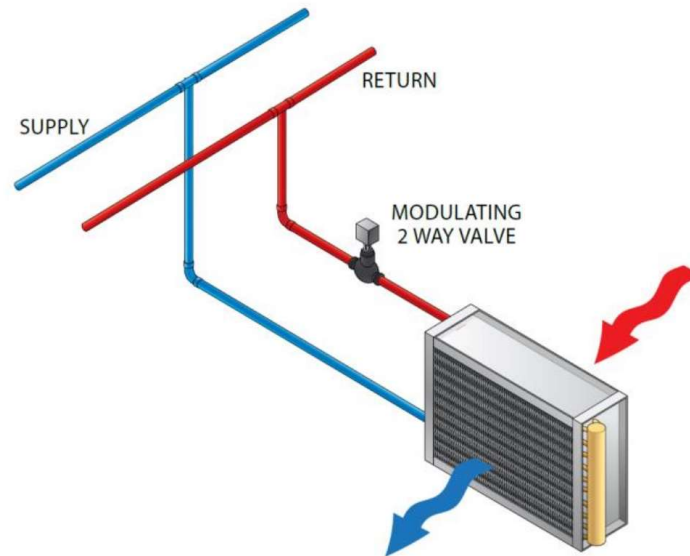
Note :  
 Apabila AHU & FCU menggunakan Two Way Motorized Valve semua,  
 maka pada sisi Main Pipe Supply chilled water **harus dipasang PDV**  
 untuk auto bypass chilled water ke suction pompa (Main Return Pipe)

**CONTROL VALVES**

**Three Way Valve**



**Two Way Valve**



**Note :**  
 Apabila AHU & FCU menggunakan **Two Way** Motorized Valve semua, maka pada sisi Main Pipe Supply chilled water **harus dipasang PDV** untuk auto bypass chilled water ke suction pompa (Main Return Pipe)

# 2-WAY vs 3-WAY VALVE

Cooling Mode

**MODULATING 2-WAY VALVE**

**VARIABLE FLOW**  
One inlet \_ One Outlet  
modulating for variable water flow  
Constant return-water temp

Load 20%      Opening valve Position 20%

Water Flow Rate 20%

**Flow rate changes**

- Header Bypass valve is **required (PDV)**
- In recent years, this has been widely adopted from the viewpoint energy saving.

**MODULATING 3-WAY VALVE**

**CONSTANT FLOW**  
Two inlet \_ One Outlet  
Temp range varies with load  
Variable return water temp

MANUAL BALANCING VALVE

Load 20%      Opening valve Position 20%

Water Flow Rate 80%

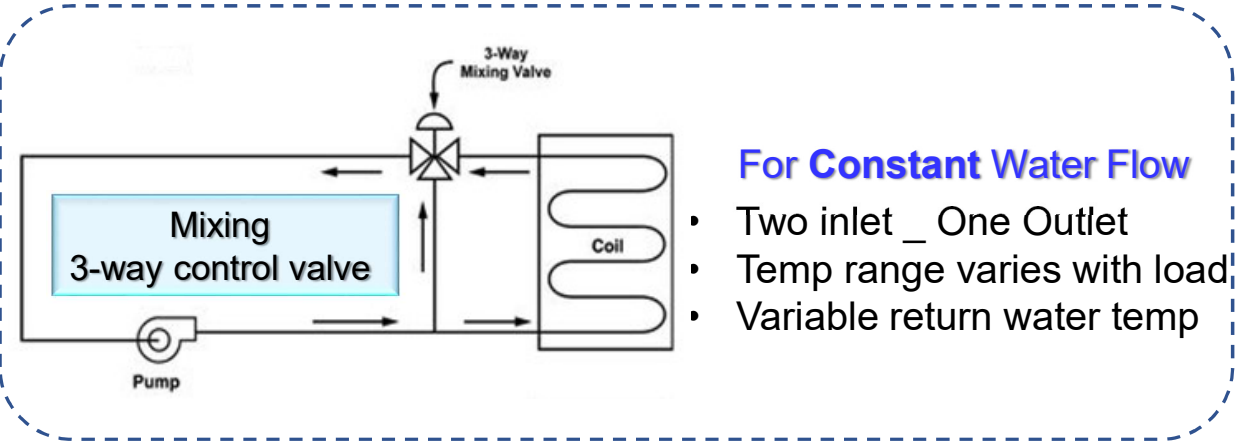
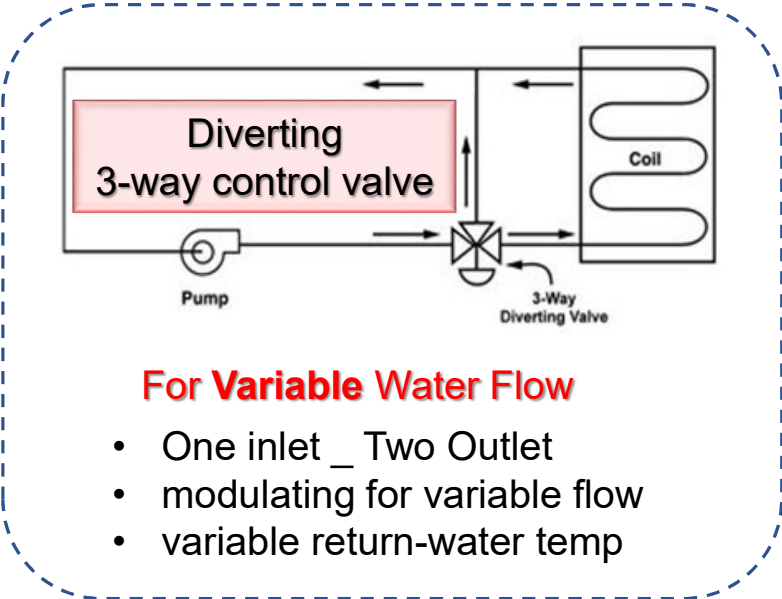
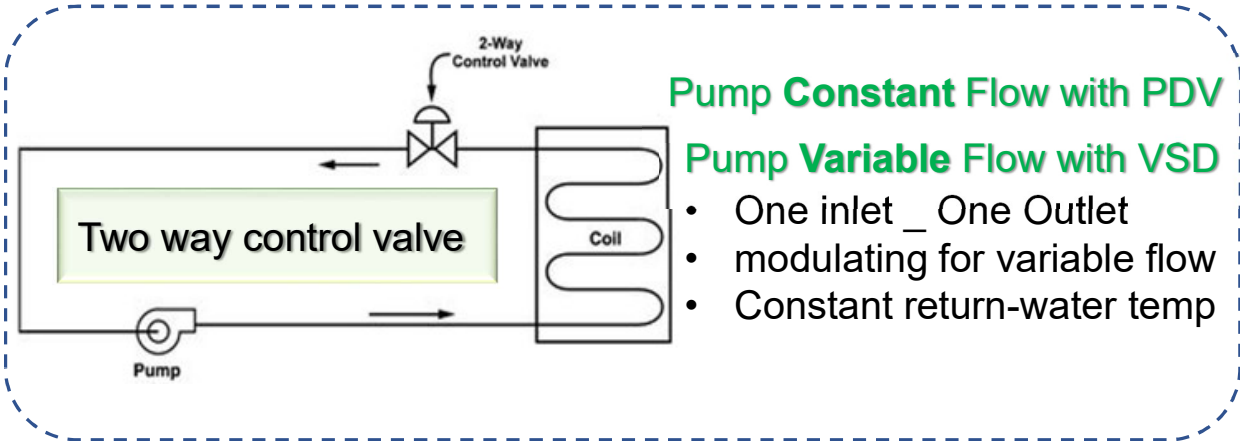
Water Flow Rate 100%

**The flow rate is constant**

- Adopted in small-scale system to maintain the minimum flow rate requirement

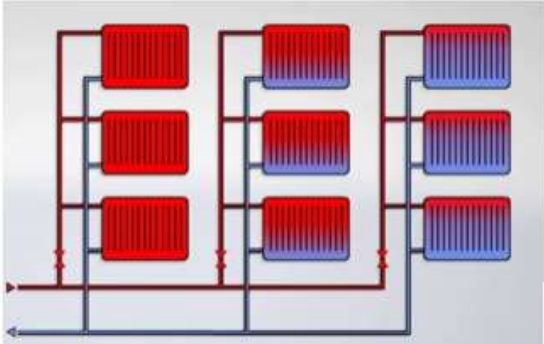
**2-WAY vs 3-WAY VALVE**

**Cooling Mode**

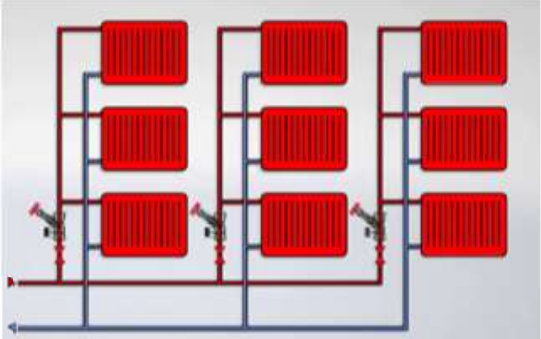


# ISOLATING VALVE vs BALLANCING

Gambar dibawah ini adalah perbandingan antara aliran air untuk aplikasi pada isolating valve dengan balancing valve

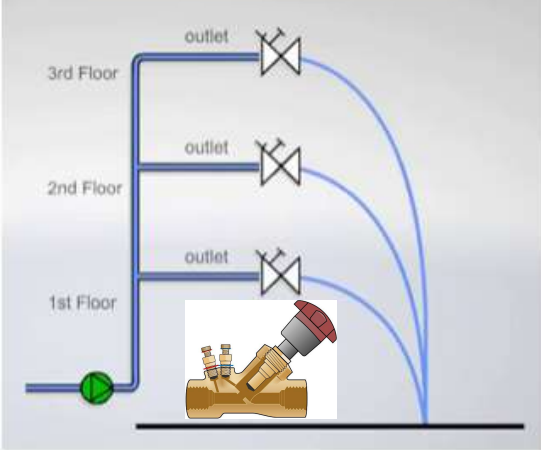
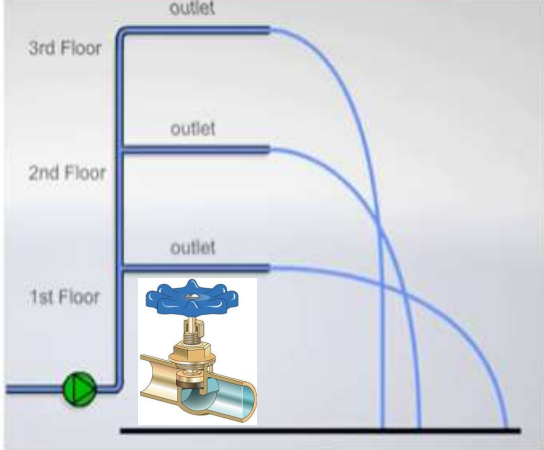


Direct Return



**ISOLATING VALVE**

**BALANCING VALVE**



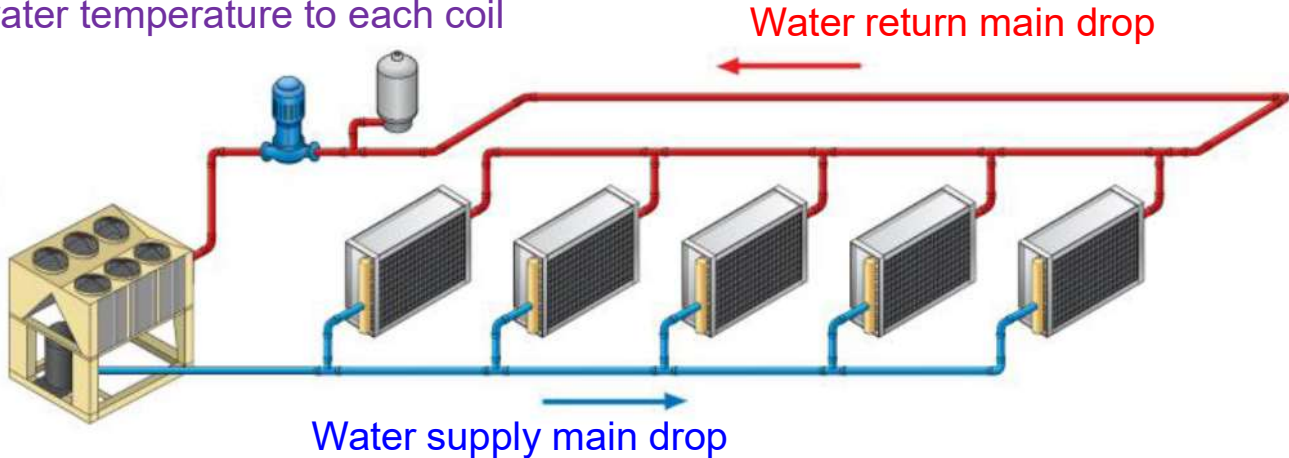
**REVERSE RETURN ARRANGEMENT**



- Karena jumlah panjang pipa air **supply** dan **return** ke masing-masing AHU/FCU menjadi sama, jumlah (**friction loss**) akan menjadi sama. Oleh karena itu, laju aliran menjadi sama (**balance**) maka suhu air dingin **return akan lebih stabil**.
- **Kerugiannya** adalah bahwa total pipa panjang dan membutuhkan ruang instalasi pipa yang besar. Di sisi lain, keuntungannya adalah mudah untuk menyesuaikan laju aliran selama pengujian & commissioning.

*Characteristics, remember Ohm Law :*

- Same water flow to each coil
- Same water temperature to each coil

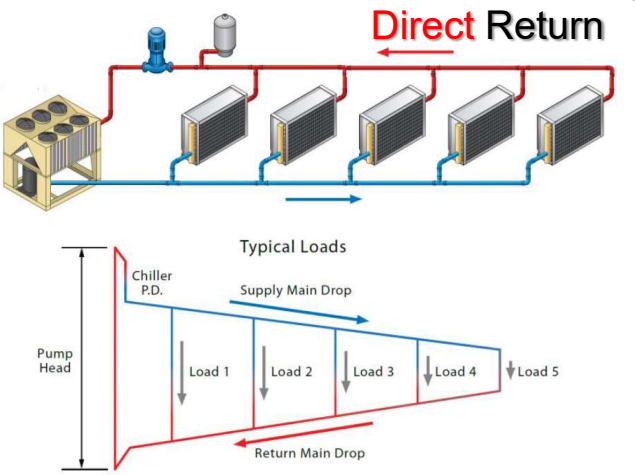




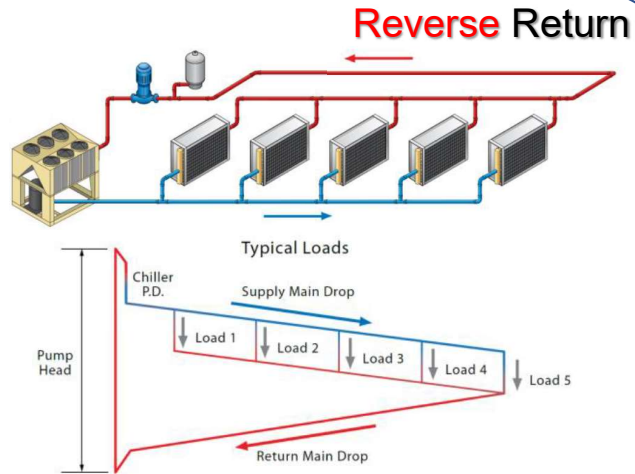
# DIRECT RETURN vs REVERSE RETURN

Cooling Mode

Pros	Cons
<ul style="list-style-type: none"> <li>Bahan material pipa yang lebih sedikit karena jarak instalasi pipa yang pendek</li> <li>Tata letak pemipaan lebih sederhana, tidak memakan banyak ruang</li> </ul>	<ul style="list-style-type: none"> <li>Laju alir air menjadi tidak seragam, karena panjang dan resistansi pemipaan berbeda untuk setiap AHU/FCU.</li> <li>Membutuhkan pemasangan balancing valve, untuk memastikan jumlah aliran air sesuai di setiap unitnya</li> </ul>



Pros	Cons
<ul style="list-style-type: none"> <li>Laju aliran seragam karena panjang pipa yang sama dampak dari nilai resistansi untuk setiap AHU/FCU</li> <li>Lebih mudah melakukan penyesuaian laju aliran air</li> </ul>	<ul style="list-style-type: none"> <li>Nilai investasi bertambah, karena jarak membutuhkan jarak pipa yang lebih Panjang</li> <li>Tata letak jalur pemipaan menjadi lebih rumit dan membutuhkan ruang yang lebih besar</li> </ul>



## MINIMUM WATER VOLUME



Semua sistem air chiller memerlukan waktu yang cukup untuk mengenali perubahan beban untuk menghindari siklus terlalu seringnya **on-off** pada kompresor (unit **NON INVERTER**).

Berikut adalah beberapa hal potensi ini terjadi ketika :

- Jarak instalasi pemipaan yang pendek
- Volume air sangat sedikit di dalam instalasi pemipaan
- Beban pendinginan (load profile) sangat rendah di bawah kapasitas minimum.

Estimasi Volume Air Minimum : Untuk chiller dengan panjang pipa pendek (terutama chiller scroll & screw air-cooled chiller kurang dari 200TR), sangat penting untuk memenuhi persyaratan minimum volume air chiller.

Kami rekomendasikan **3 hingga 6 galon (galon AS) per Ton kapasitas** pendinginan. Ketika beban **fluktuatif sangat tinggi** dan nilai **akurasi temperatur sangat penting**, agar dapat terpenuhi dalam operasional yang lebih stabil, **diperlukan 6 hingga 10 galon per TR.**



**Chilled 10 TR required 6 bottle, with total 30 gallon or 113.7 liters or 0.11356 m3 of chilled water**

1 US gallon = 3.79 Liter = 0.00378 m3  
 5 US gallon = 18.92 Liter = 0.01892 m3

Application Duty	Effective Loop U.S. Gallons/Ton & Liters/Cooling kW			
	Minimum		Prefered * More	
Chilled minimum water volume recommendation (for reference)	Gal/Ton	(Liters/kW)	Gal/Ton	(Liters/kW)
Air Conditioning	3	3.3	5.0 to 8.0	5.4 to 8.6*
Process	6	6.5	7.0 to 11.0	7.6 to 11.9*

**MINIMUM WATER VOLUME**

MODEL	Water Flow (l/m)   (Usgpm)	External Pump Head (mH2O)	Min Storage Vol. (L) (Cooling)	Min Storage Vol. (L) (Heating)
UAL030ER5	27.0   7.13	27.0	67.0	40.4
UAL040ER5	32.7   8.63	14.0	82.0	49.0
UAL050ER5	41.8   11.0	18.0	106.0	62.8
UAL060ER5	48.2   11.30	22.0	121.0	72.3
UAL070ER5	56.8   15.0	24.0	142.0	85.2
UAL0800ER5	71.3   18.83	22.0	179.0	107.1
UAL100ER5	82.5   21.74	25.0	207.0	123.9
UAL120ER5	96.0   25.36	22.0	240.0	144.1
UAL150ER5	114.7   30.30	18	278.0	172.1

Conversion base : 1 l/min = 0.26 USgpm

**WATER BUFFER TANK CAPACITY**

Cooling Mode

- 1) Kami merekomendasikan bahwa **kompresor tidak boleh on-off terlalu sering** tidak lebih dari **9 kali** dalam satu jam.
- 2) Itu berarti siklus berjalan min kompresor adalah  $60/9 = 7$  menit, yang meliputi 2 menit berhenti dan 5 menit berjalan.
- 3) Untuk unit UAL, maka volume air untuk menjaga unit tetap berjalan min 5 menit dapat dihitung sebagai dengan rumus berikut ini :



MODEL	Water Flow (l/m)   (Usgpm)	External Pump Head (mH2O)	Min Storage Vol. (L) (Cooling)
UAL060ER5	48.2   11.30	22.0	121.0
UAL070ER5	56.8   15.0	24.0	142.0
UAL0800ER5	71.3   18.83	22.0	179.0

**Example:** UAL80ER5 water flow rate is 4.28m<sup>3</sup>/h.

$$V = (4.28 \times 1000 \times 5) / 60 = 357L$$

Normally, **Water Buffer Tank Capacity** is about **1/2** of whole water volume, so the **water buffer tank capacity** needed :

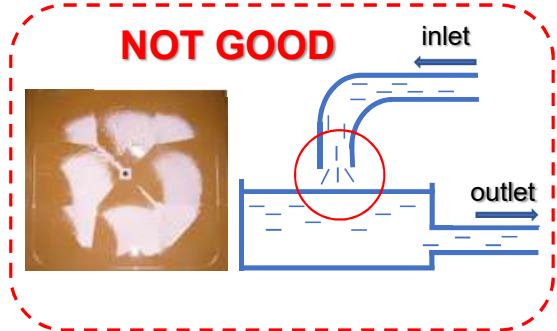
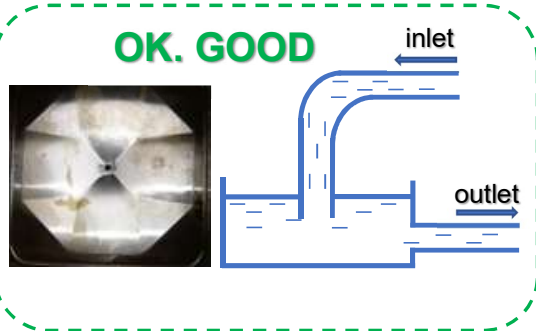
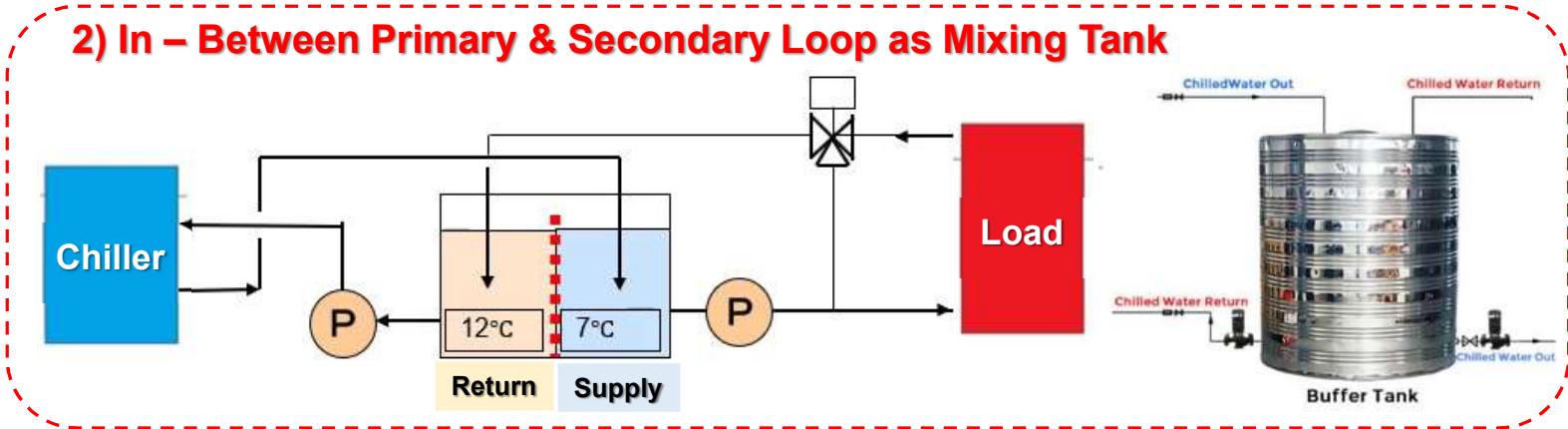
$$\text{UAL080ER5 is : } 365L / 2 = 178\text{Liter}$$

**BUFFER TANK**

**Cooling Mode**

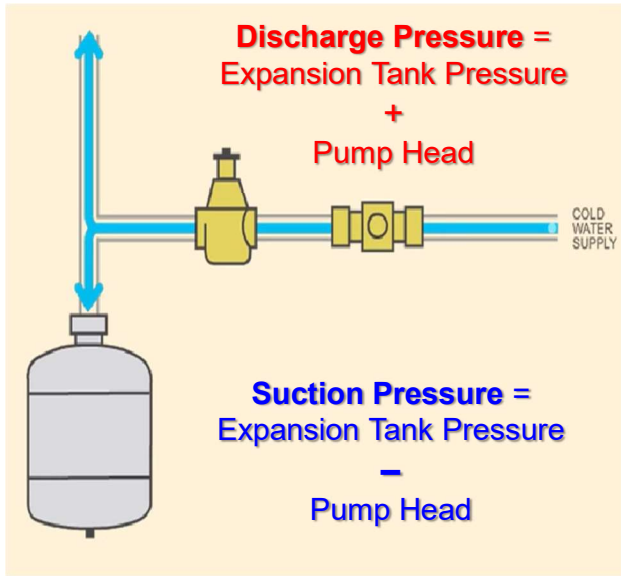
**OPEN Type as Mixing Tank**

- Below is Open Type Buffer Tanks and it is common used for system with primary and second water loop
- **Avoid fresh air and dust** being introduced in the chilled water with proper cover and piping connection

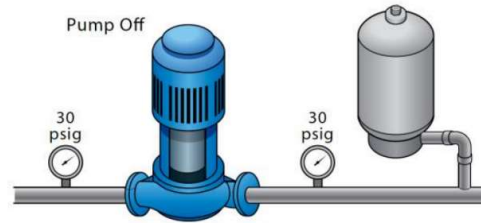


# EXPANSION TANK

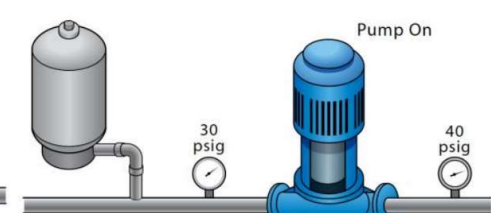
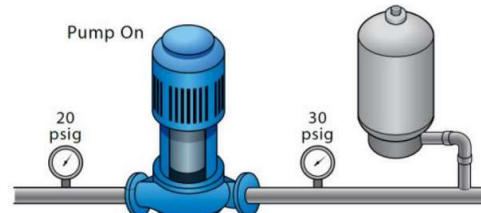
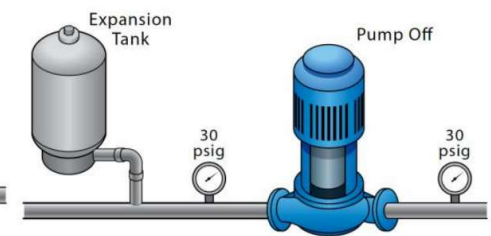
Cooling Mode



*Expansion on Discharge*



*Expansion on Suction*



Expansion Tank dibutuhkan di dalam siklus chilled water untuk menyerap cairan yang memuai karena perubahan temperature dan membatasi tekanan di system. Expansion tank berjenis close type dengan menggunakan diafragma.

Expansion tank berjenis Open Type tidak umum digunakan dalam desain sistem HVAC, tetapi di sini diaplikasikan untuk kelengkapannya. Tangki terbuka terdiri dari tangki besar dengan bukaan ke atmosfer (berlokasi di paling atas dari system). Saat suhu dalam sistem meningkat, fluida berekspansi ke dalam tangki dengan demikian akan meningkatkan volume level air di dalam tangki ekspansi. Untuk unit UAL ER Series sudah terpasang di dalam unitnya.

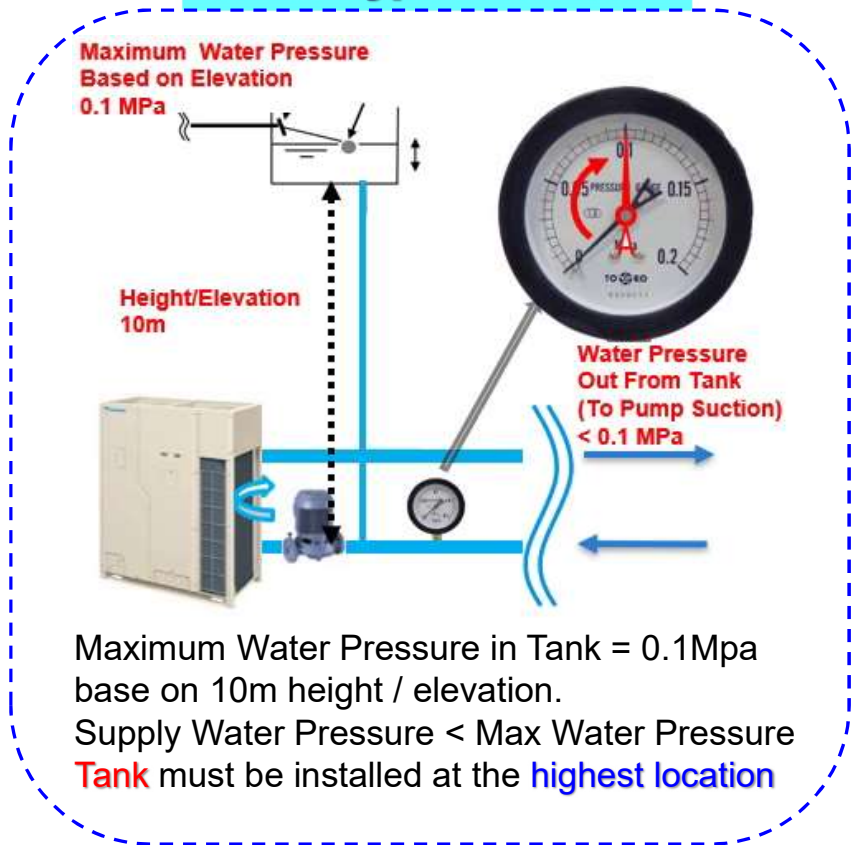


# EXPANSION TANK

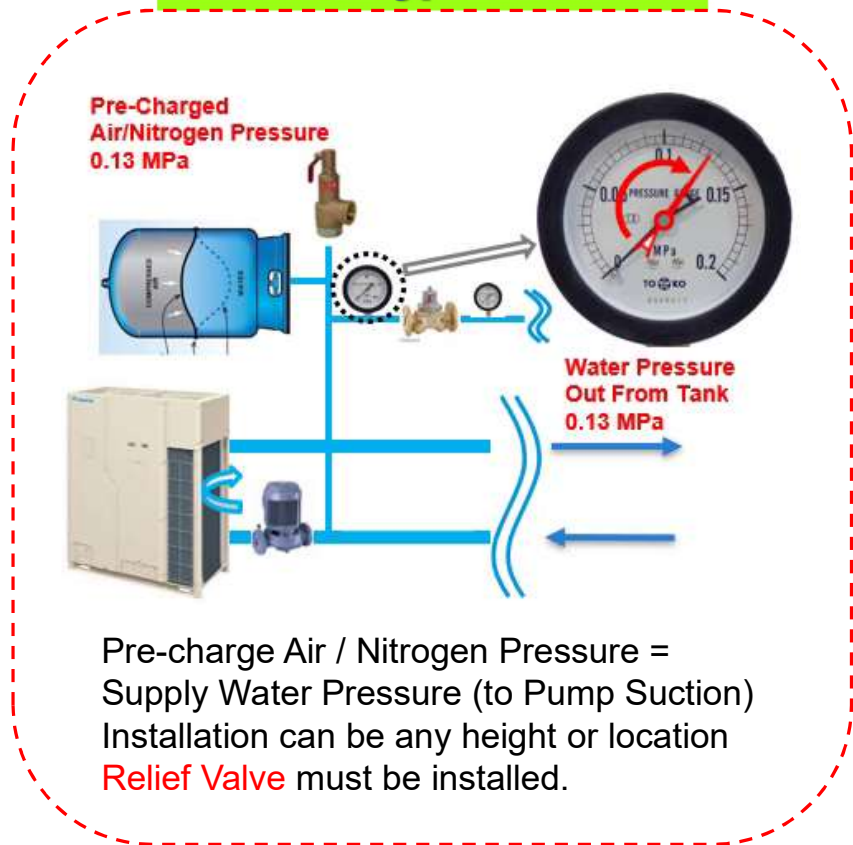
## Open Type vs Close Type

Perbandingan antara Tangki Ekspansi Tipe Terbuka & Tipe Tertutup  
Harap perhatikan tekanan dalam tangki ekspansi dan tekanan suplai ke pompa.

### OPEN Type FEATURE

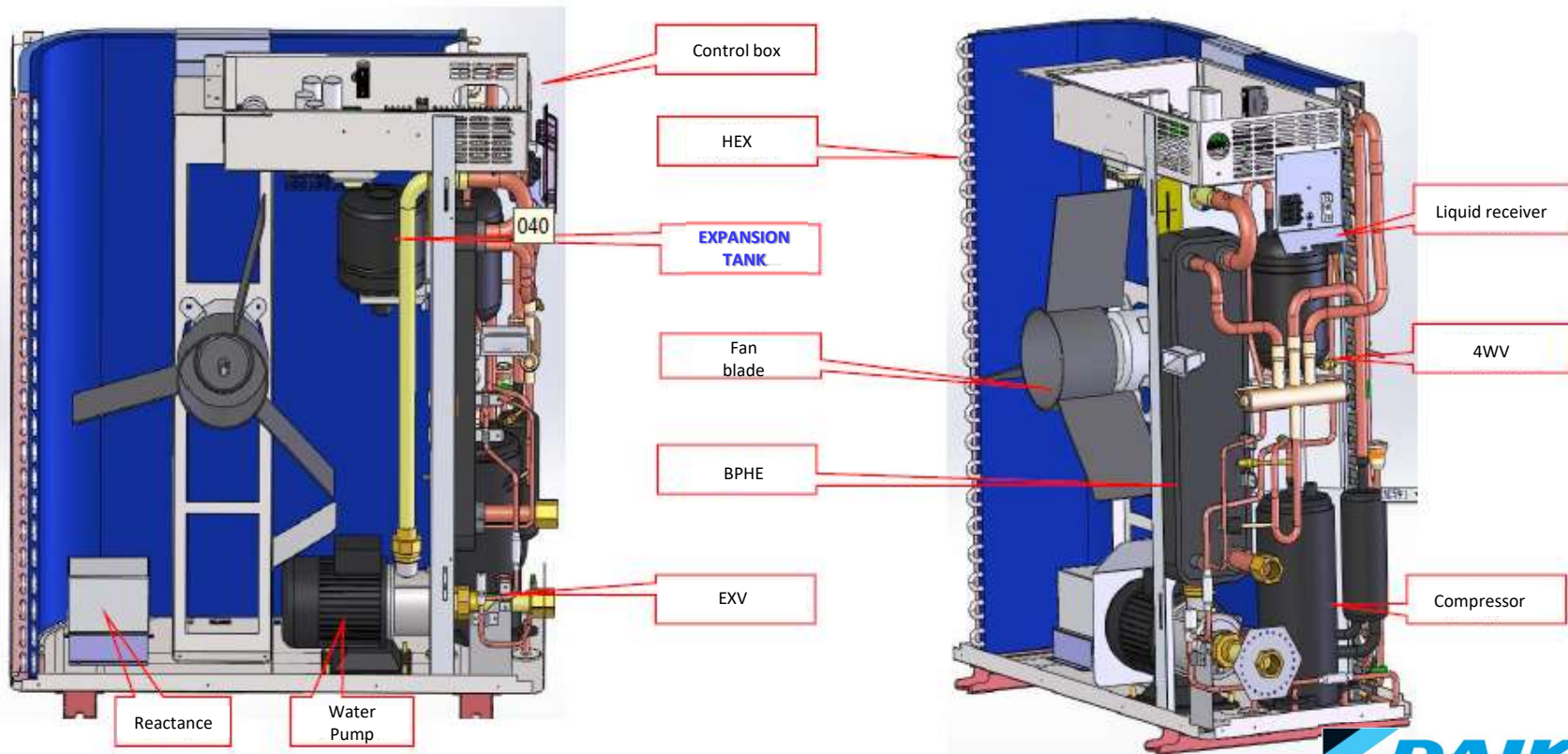


### CLOSED Type FEATURE



# MAIN PART

## MINI CHILLER INVERTER UAL030/040ER5

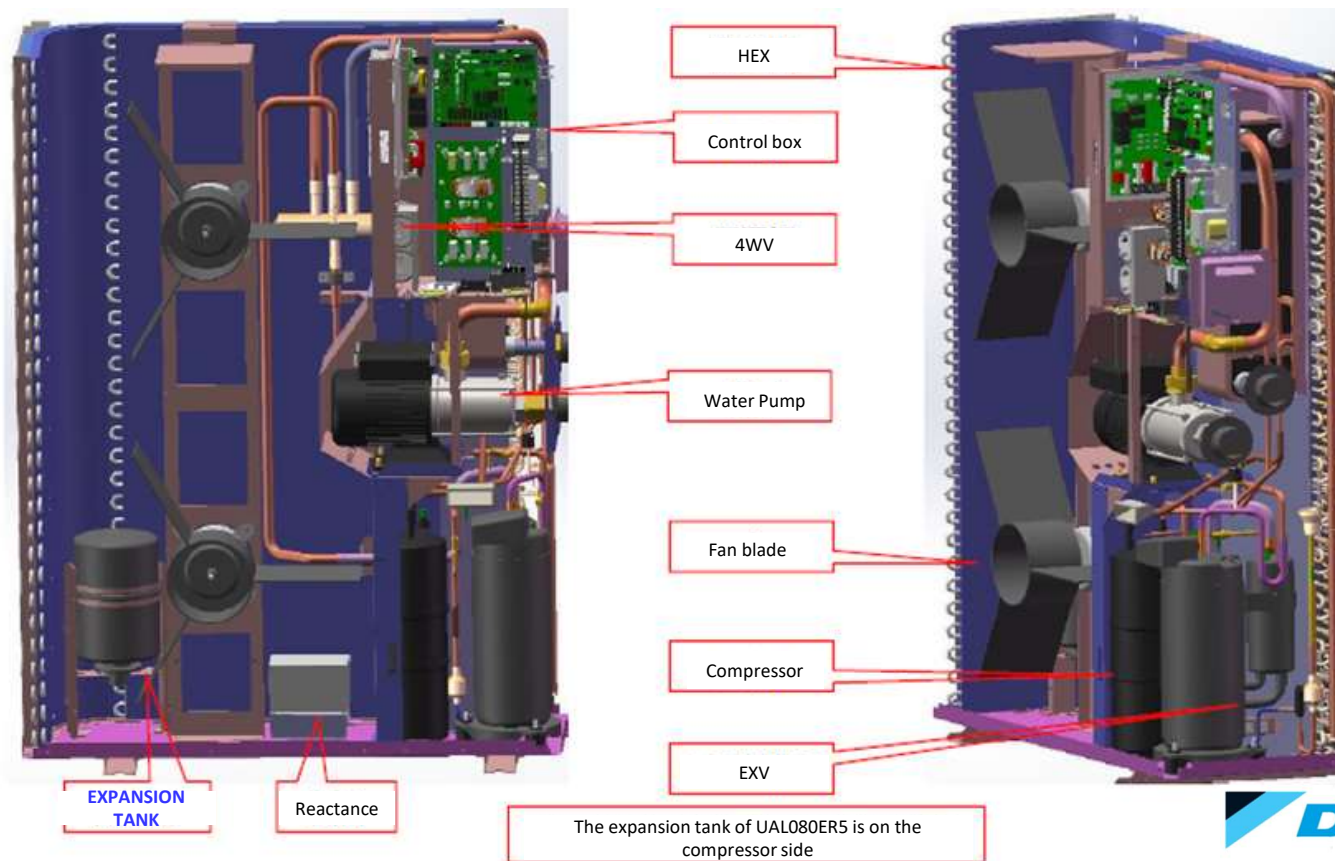


**DAIKIN**

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# MAIN PART

## MINI CHILLER INVERTER UAL050-080ER5

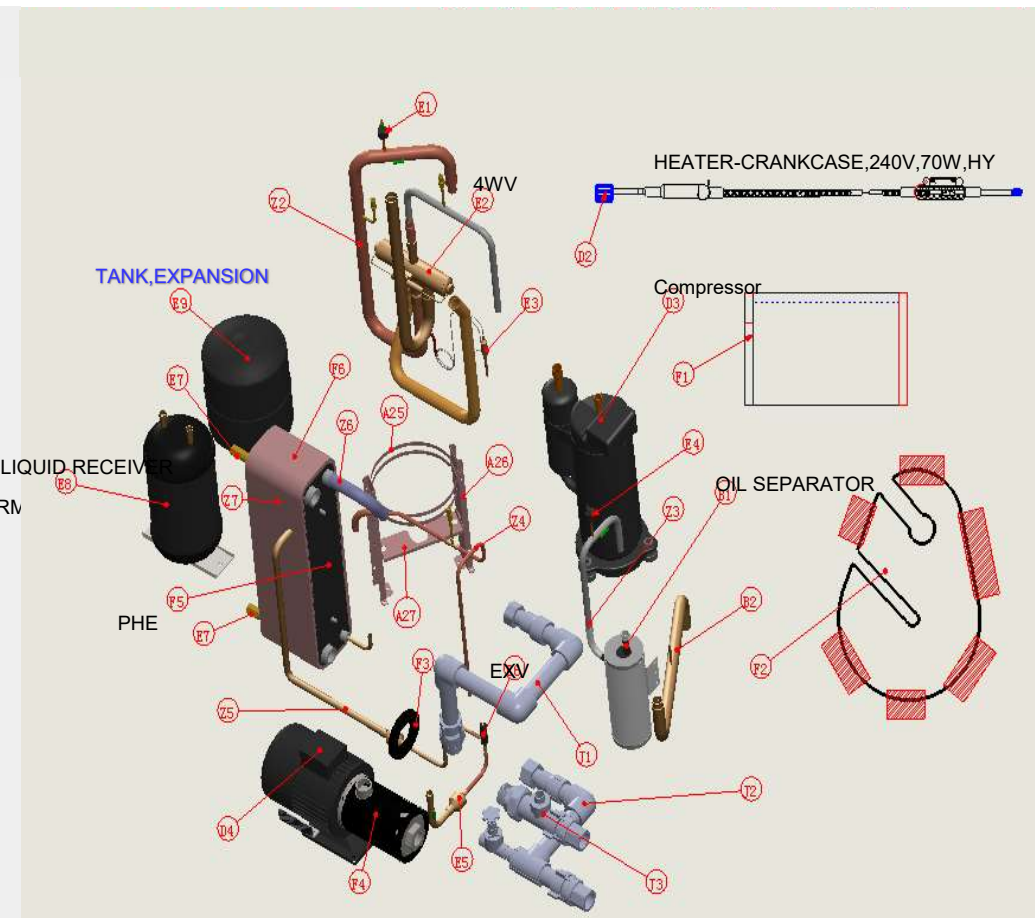
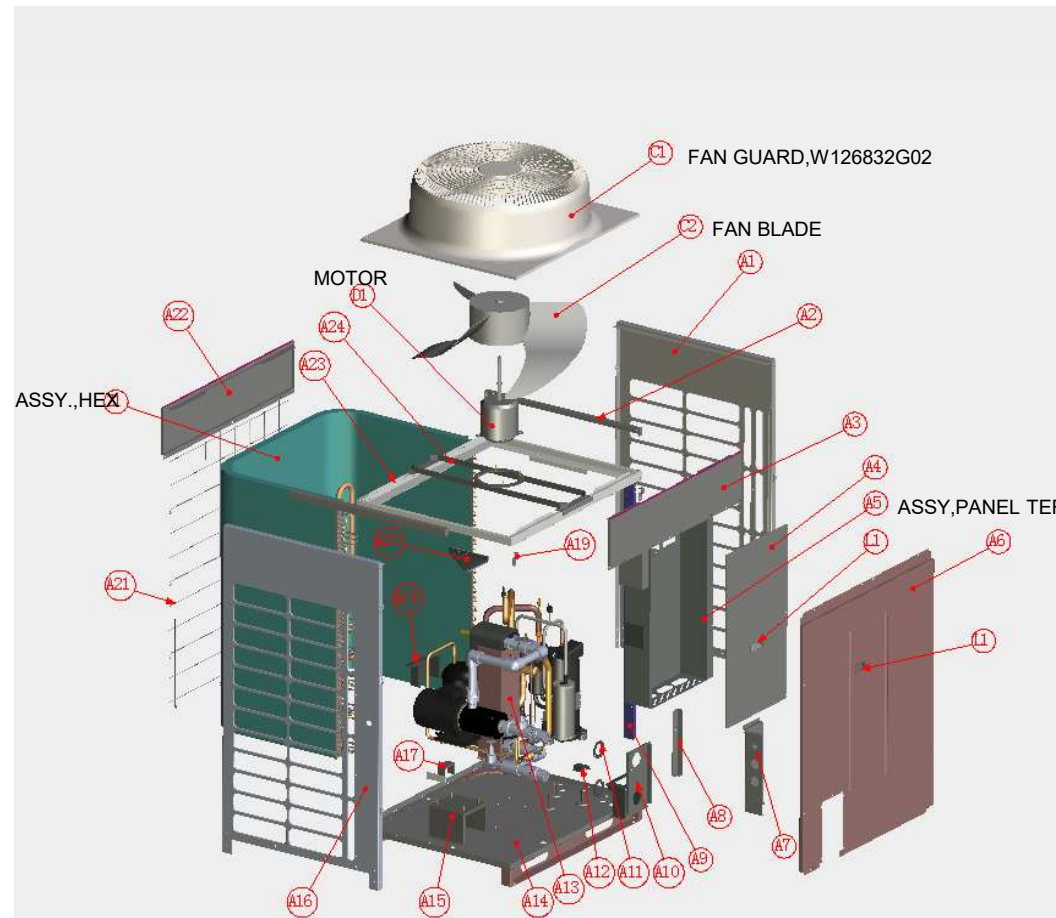


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# MAIN PART

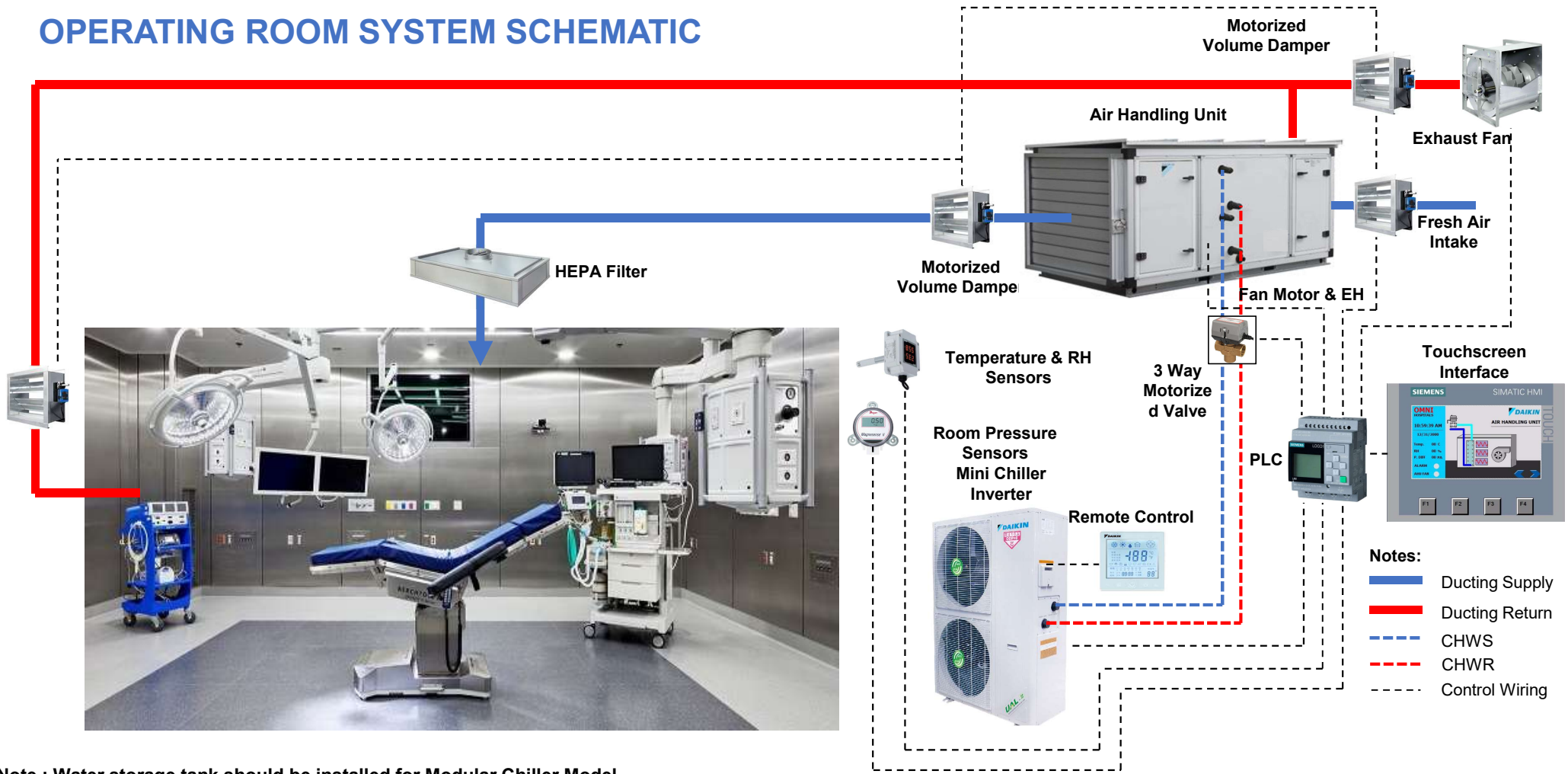
## MINI CHILLER INVERTER UAL100-120ER5



# MINI CHILLER APPLICATION

Cooling Mode

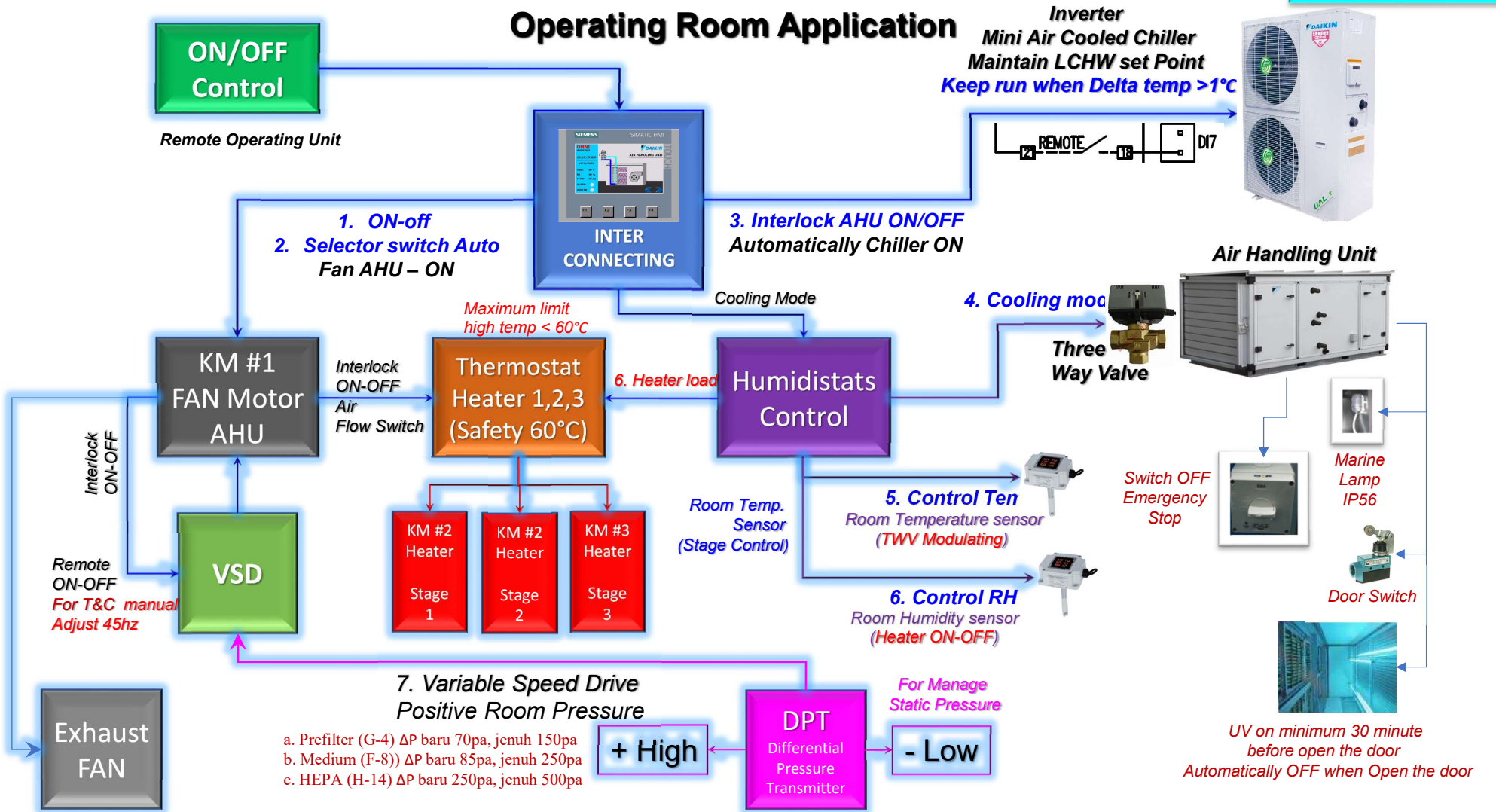
## OPERATING ROOM SYSTEM SCHEMATIC



Note : Water storage tank should be installed for Modular Chiller Model

# Logic Wiring Diagram Operating Room Application

**Cooling Mode**





## GENERAL HOT WATER SYSTEM

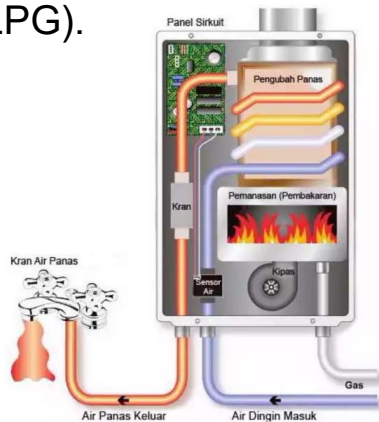
### 1. Electric Water Heater

Alat pemanas air ini menggunakan listrik sebagai sumber energi panasnya.



### 3. Gas Hot Water

Alat pemanas ini menggunakan pemanas air berupa kompor kecil dengan tenaga gas elpiji (LPG).



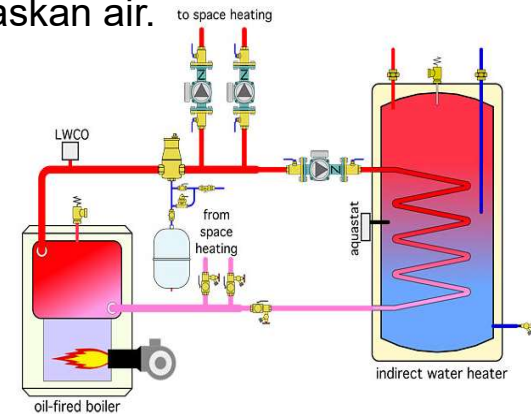
### 2. Solar Hot Water

Alat pemanas ini menggunakan energi panas matahari, BUKAN menggunakan BBM solar!



### 4. Boiler Hot Water

Alat pemanas ini menggunakan bahan bakar minyak (BBM) jenis solar untuk memanaskan air.

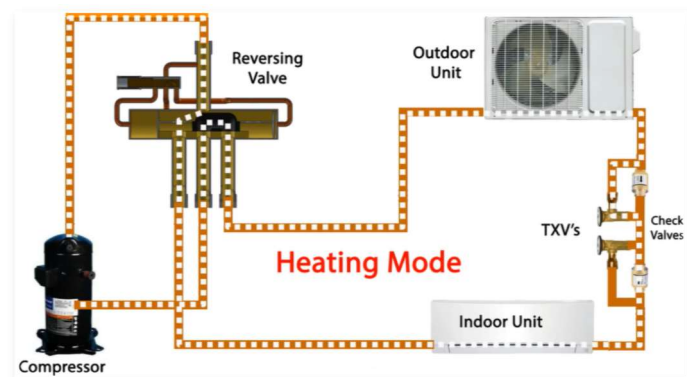
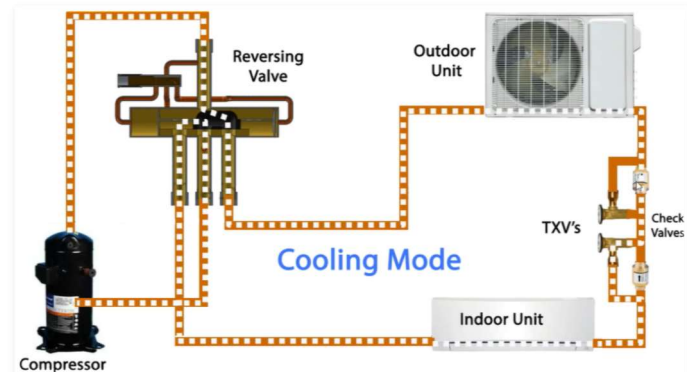


**HOT WATER SYSTEM**

**Heating Mode**

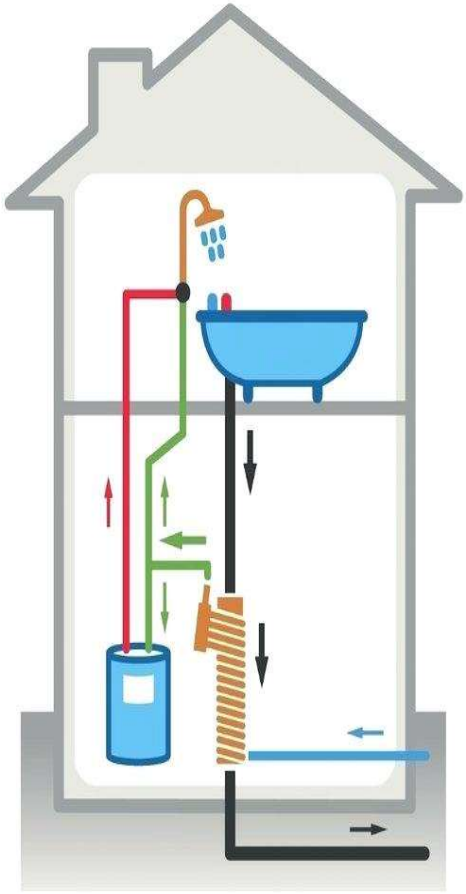
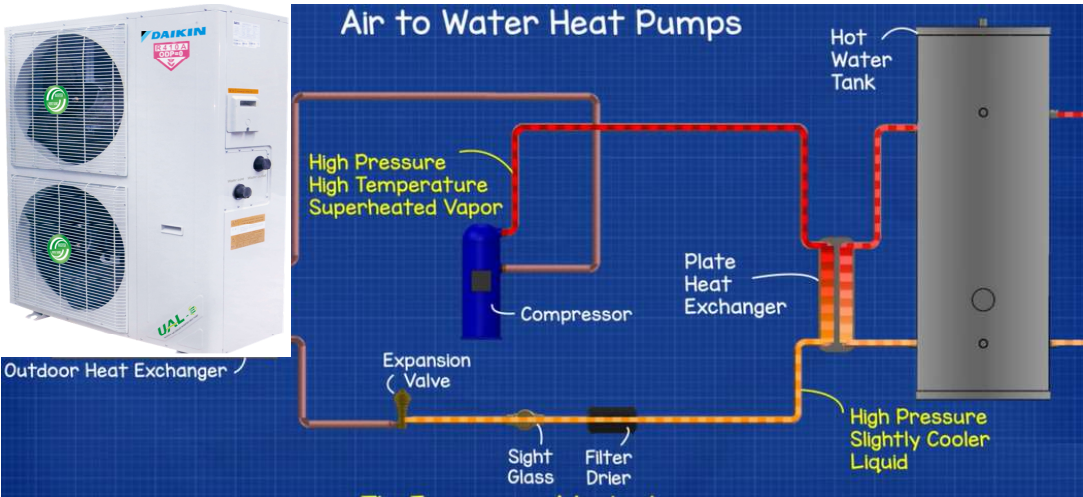
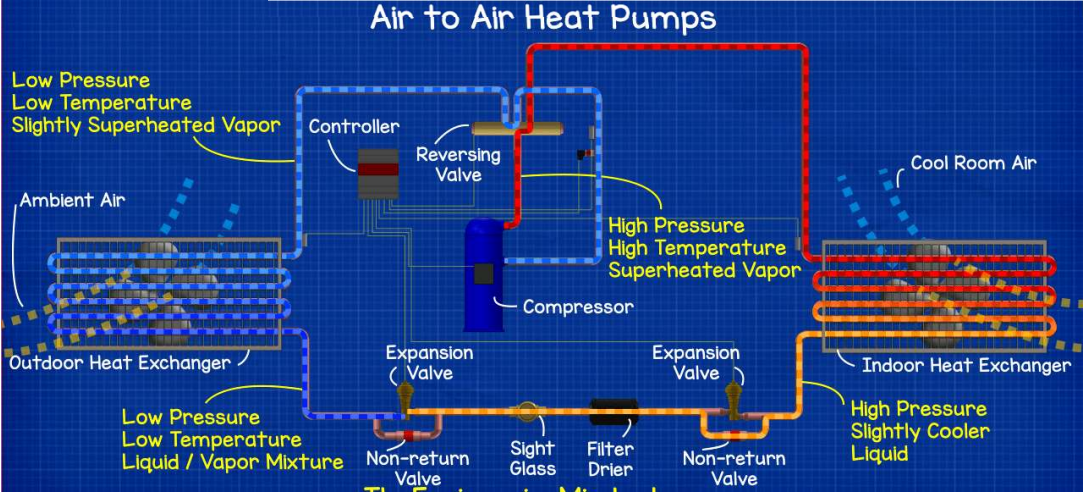
**5. Heat Pump, Hot Water**

Alat pemanas air ini menggunakan perangkat dengan sirkulasi refrigerant untuk memanaskan air. Refrigerant yang dikompresi oleh kompresor akan meningkat temperaturnya. Melalui sebuah heat exchanger, energi panas ini digunakan untuk memanaskan Air Kemudian di sirkulasi dengan pompa.



# AIR to AIR vs Air to Water Heat Pump

**Heating Mode**



— Cold Water      — Hot Water  
— Pre-Heated Water      — Drain Water



# Hot Water for Shower

Heating Mode



## Usage Time

1. Bathtub
  - Male → 6 min
  - Female → 7 min
2. Shower
  - Male → 8 min
  - Female → 8 min



## Worldwide water shower flow regulations

Singapore 5 L/m, Australia 9 L/m, European Union 8 L/m, U.S.A & Canada 9.5 L/m, China 9 L/m, Hong Kong 9 L/m, Taiwan 10 L/m, Japan 8.5 L/m

## Shower design for full body relaxation

- The best temperature of **hot water** shower is 40°C
- The average water consumption for shower is 9.0 liter/min.
- The time usage per person is 8 min.

**TATA CARA PERENCANAAN  
SISTEM PLAMING****SNI**

Standar Nasional Indonesia

**SNI 03-0765-2005****Pemakaian Air Panas  
Sesuai Penggunaan Gedung****BSN**

Badan Standardisasi Nasional

**ICS 91.140.60**

No	Penggunaan Gedung	Pemakaian Air (L/org/Hr)	Kapasitas Tangki Penyimpana (per hari)
1	Rumah Tinggal	50 dan 100	1/5
2	Rumah Susun	50 dan 100	1/5
3	Hotel	110	1/5
4	Rumah Sakit	130	1/5
5	Kantor	20	1/10
6	Pabrik	20	2/5
7	Restoran	10	2/5
8	Kamar Mandi Umum ( 1x mandi per orang)	30	1/5

- Rumah tinggal / rumah susun pemakaian air 50 (L/org/hari)
- Bila menggunakan bak mandi rendam di tambah 100 (L/org/ hari)
- Bila ada mesin cuci piring di tambah 60 (L/hari)
- Untuk hotel dalam satu hari tergantung kepada jenis dan kelas dari hotel tersebut
- Hotel berbintang relatif lebih besar
- Hotel komersial relatif lebih sedikit
- Rumah sakit ada yang menggunakan kolam berendam untuk FISIOTERAPI di hitung terpisah sesuai ukuran kolam

**TATA CARA PERENCANAAN  
SISTEM PLAMBING**Pemakaian Air Panas  
Sesuai Penggunaan Gedung

No	Alat Plambing	Pemakaian Air (Liter)
1	Bak cuci tangan pribadi	7,5
2	Bak cuci tangan umum	5
3	Bak mandi berendam ( <i>bath tub</i> )	100
4	Pancuran mandi ( <i>shower</i> )	150
5	Bak cuci, dapur ( <i>kitchen sink</i> )	15
6	Bak cuci kecil, dapur ( <i>pantry sink</i> )	10

**CATATAN**

- Faktor pemakaian alat plambing untuk rumah sakit dan hotel 25%
- Rumah pribadi, rumah susun, dan kantor 30%
- Pabrik dan sekolah 40%



**TATA CARA PERENCANAAN  
SISTEM PLAMBIN**

**SNI**

Standar Nasional Indonesia

**SNI 03-0765-2005**

**Pemakaian Air Panas  
Sesuai Penggunaan Gedung**

**BSN**

Badan Standardisasi Nasional

**ICS 91.140.60**

No	Penggunaan Gedung	Pemakaian Air (°C)
1	Kolam Renang	16 – 40
2	Spa	< 40
3	Pemandian Umum	15 – 35

[http://hukor.kemkes.go.id/uploads/produk\\_hukum/PMK No. 32 ttg Standar Baku Mutu Kesehatan Air Keperluan Sanitasi, Kolam Renang, Solus Per Aqua .pdf](http://hukor.kemkes.go.id/uploads/produk_hukum/PMK_No.32_ttg_Standar_Baku_Mutu_Kesehatan_Air_Keperluan_Sanitasi,_Kolam_Renang,_Solus_Per_Aqua_.pdf)

# Calculation of Heating load

Heating Mode

Contoh : Perhitungan Kebutuhan untuk **HOTEL**. Hot water supply for **SHOWER**

Deskripsi	Volume	Satuan
Tingkat Hunian	100	% Occupancy
Suhu Air Dingin (SAD)	26	°C
Suhu Air Hangat (SAH)	40	°C
Suhu Air Panas (Hotel)	60	°C
Volume Mandi Shower	54	Liter (shower volume 6.0 l/m x 9 menit)
Jumlah Kamar (shower )	1	Kamar
Jumlah Penghuni / Kamar	3	Kamar
Jumlah Mandi Shower / Kamar	1	kali / hari / orang
Total volume air untuk mandi	162	Liter x Jumlah Shower
Total kebutuhan air (L/day * 4%)	180	Liter/hari (Storage Tank)

**Air Panas** yang harus di sediakan ??

(SAH-SAD) / (SAP-SAD) x Total volume Air Mandi

**Step 1 :** (40-26) / (60-40) \* 162 = **67** L/day

**Step 2 :** 67 L/day / 60 = **1.11** l/m

**Step 3 :** 1.11 l/m\*4.18 = **4.65** kJ/kg °C

**Step 4 :** 4.65 kJ/kg \* 5 ΔT°C = **23.24** kw

**Step 5 :** (23.24 kw \* 0.42 BTU/lb) / 3.516

**Unit Capacity = 2.78 TR**

**Step 6 :** 2.78 TR \* 3.516 = **9.76** kW



**Nominal Heating Capacity = 9.80 KW**

**UAL30ER5**

*See detail unit Specifications Outdoors*

## Calculation of ENERGY Cost

Heating Mode

**Example : Heating Capacity 9.76 kW**

RATE Heating Power Input (KW)	3.1	UAL30ER5
UNIT Nominal Heating Capacity (KW)	9.8	UAL30ER5
HEATING Mode	3.16	COP

RATE Heating Power Input (KW)				DAIKIN UAL30ER5		With <b>ELECTRIC</b> Heater	
<b>6.61</b>	x	30	=	3.61 kW		9.76 kW	
Electric Consumption/month				=	93 kWh		292 kWh
Estimate Electric Cost/Day				1,435 Rp/kWh			
1	x	1,435	=	133,455 Rp		420,128 Rp	
Electric Cost/Month (30 days)				=	4,003,650 Rp		14,004,266 Rp
TOTAL OPERATIONAL COST/MONTH				=	8,599,302 Rp		12,603,839 Rp
Operational Cost saving / month				=	8,600,190 Rp		(8,600,190)
Operational Cost / year				=	<b>48,043,800</b> Rp		(151,246,076)

With mini **air cooled mini chiller** Energy used **32%** = **20%** + **12%** if any Electric Heater backup **PERBANDINGAN** dengan **Electric Heater**, penggunaan energinya selisih **68% lebih tinggi** dari heat pump UAL ER

*NOTE : Back up with Heater to get (60°C) = add 36% from unit supply Heating kW Capacity*

**Chilled Pump Efficiency**

OFFICE Load Profile ASHRAE				
Operating Unit	Hour	Load	Unit Power Input (kW)	Energy Pump (kW)
<b>1 x UAL 450 (none Inv.)</b>	Day	%	39	11%
7am - 8am	1	30%	11.7	4.29
8am - 12pm	4	90%	35.1	4.29
12am - 13pm	1	80%	31.2	4.29
13pm - 16pm	4	90%	35.1	4.29
16pm - 18pm	1	50%	19.5	4.29
18pm - 19pm	1	30%	11.7	4.29
	12	62%	144.3	25.74
Total operating Hour / day	12		Total Electrical kW/Days	170.0
Avarage Load	62%		Electrical Cost / Month	7,524,270
Unit Power kW/Days	144.3		Electrical Cost / Years	90,291,240
Pump kW/Days	25.7		Unit Initial Cost	200,000,000
Total kW/Days	170.0		Installation Cost (45%)	90,000,000
Electrical Cost /kWh (Rp)	1,475		<b>Break Even Point (Years)</b>	<b>3</b>

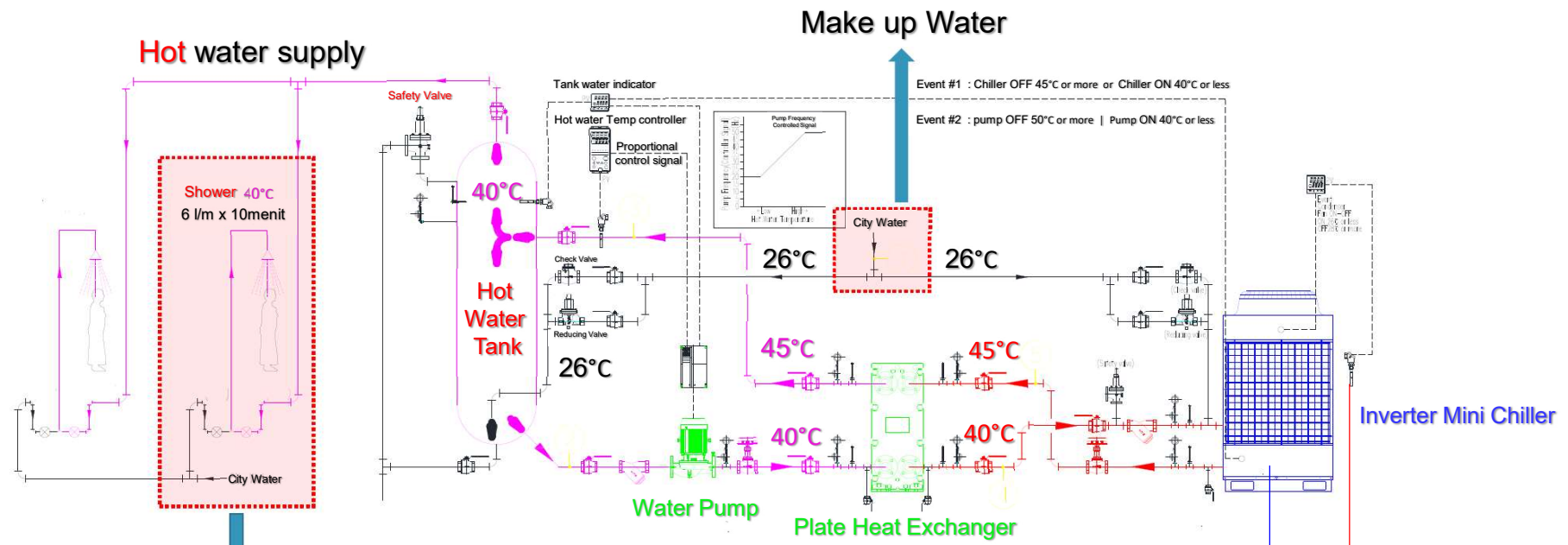
102	102	gpm
90	50	feet head
3960	3960	kostanta
80%		Pump Eff
65%		Motor Eff

Pump kW =  $0.746 \times \text{USGPM} \times \text{ft head}$   
 $3.960 \times \text{pump eff} \times \text{Motor Eff}$

**Reduction of pump head =**  
**energy saving :**  
**90 to 50 = 56 %**

# Hot Water FOR Shower Installation

**Heating Mode**



The water shower is one-pass  
(not circulating water)

**Separate hot water & Heat pump water**

>> The maximum outside air temperature is 26°C.

>> Condenser fan will automatically stop at 28°C or higher.

# Heat Pump for Swimming Pool

Heating Mode

## SWIMMING POOL

### 1) Pool water temperature >> 30°C or less

✘ Legionella bacteria breed when water temperature 30°C or higher

Legionella adalah bakteri yang dapat berkembang biak pada tempat penampungan air dengan kondisi yang hangat dan lembab, yakni pada suhu 35 ~ 45 °C.

Bakteri ini dapat menyebabkan demam Pontiac, infeksi saluran pernafasan.



### 2) Make-up water temperature >> 20.9°C

### 3) Water quality standard

Water Quality	pH (25°C)	Residual Chloride
Tendency	Corrosion and scale deposit	Corrosion
Pool Water	5.8 ~ 8.6	0.4 ~ 1.0mg/L
Chiller Hot Water	7.0 ~ 8.0	0.25mg or Less

Chlorine is added as a countermeasure against Legionella bacteria



<<< Pool water corrodes Chiller evaporator

Separate Pool water and Chiller heat pump water >>>





# Heat Pump for Swimming Pool

Heating Mode

## POOL HEATING LOAD

1) Heat dissipation from Pool surface

>> 160W/m<sup>2</sup> (Ambient temp and humidity : 26°C 70%)

2) Make-up water volume

>> Temporary water: Effective water volume x 3.6%

>> Make-up: Effective water volume x 3.0%

>> Usage Time: 10 hours

3) Make-up water temperature 20.9°C

4) Pool water temperature 30°C

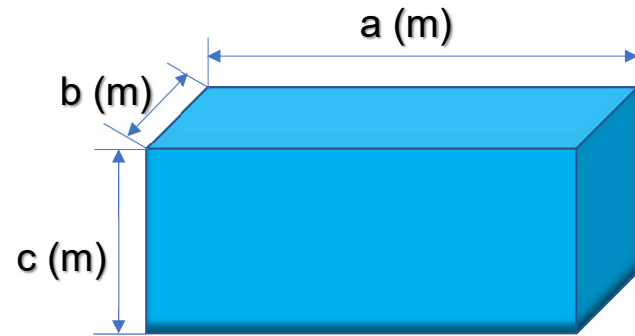
5) Heating Load :

- **Heat dissipation**

$$Q = A \times B \times 0.16 \text{ kW/m}^2$$

- **Make-up water**

$$Q = A \times B \times C \times 1000 \text{ kg/m}^3 \times 4.2 \text{ kJ/kg } ^\circ\text{C} \times (30^\circ\text{C} - 20.9^\circ\text{C}) / (10 \times 3600 \text{ s})$$



# Calculation of Heating load

Contoh : Perhitungan Kebutuhan  
Hot water supply untuk KOLAM RENANG

▪ **Heat dissipation (penyerapan panas)**  
 $Q = A \times B \times 0.16 \text{ kW/m}^2$

▪ **Make-up water**  
 $Q = A \times B \times C \times 1000 \text{ kg/m}^3 \times 4.2 \text{ kJ/kg } ^\circ\text{C} \times (30^\circ\text{C}-20.9^\circ\text{C}) / (10 \times 3600 \text{ s})$

- Q : Heat in (kW)
- V : Volume [m3]
- P : Density [for water it will be 1000kg/m3]
- C : Specific Heat Capacity for water 4.187 [kJ/kg °C]
- ΔP : Water Temp [°C]

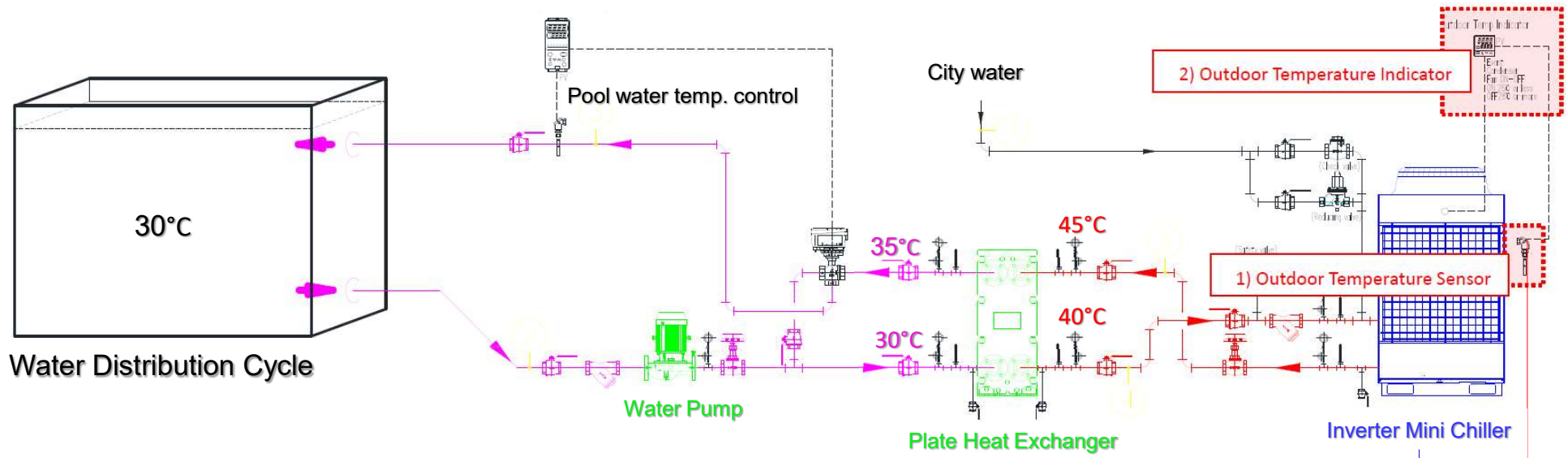


**Nominal Heating Capacity = 10.84 KW**  
**UAL30ER5**

Description	Volume	Satuan
Make - Up Water	20.9	°C
Pool Water Temp	30	°C
Panjang (a)	3	m
Lebar (b)	3	m
Tinggi (c)	1	m
Heat dissipation	0.16	kW/m2
Specific Heat Capacity for Water ( C )	4.187	kJ/kg °C
Density for water ( P )	1000	kg/m3
hour	10	h
second	3600	s
Delta Temp	9.1	°C
Volume	9	m3
<b>Make Up water Heat (Q)</b>	<b>9.52</b>	<b>kW</b>
<b>Heat dissipation (Q)</b>	<b>1.44</b>	<b>kW</b>
<b>TOTAL (Q)</b>	<b>10.96</b>	<b>kW</b>

# Swimming Pool Installation

**Heating Mode**



**Separate pool water & Heat pump water**

**HEATING MODE**

>> The outside air temperature is 26°C.

>> Condenser fan will automatically stop at 28°C or higher.

**Note: Item numbers 1-2 included in the package unit**

## SUMMARY General Hot Water Systems

Comparative Equations	Max Hot. temp	Installation Location	Initial Cost	Running Cost	Energy Saving	Safety	Weather	Total Score
<b>Electric Water Heater</b>	60°C	☆☆☆☆	☆☆☆☆	☆	☆	☆☆	☆☆☆☆☆	<b>17</b>
<b>Solar Hot Water</b>	40 ~ 70°C	☆	☆	☆☆☆	☆☆☆☆☆	☆☆☆☆☆	☆	<b>16</b>
<b>Gas Hot Water</b>	80 °C	☆☆☆☆	☆☆☆☆	☆☆	☆☆	☆	☆☆☆☆☆	<b>18</b>
<b>Air Cooled Mini Chiller</b>	40~45°C	☆☆	☆☆	☆☆☆☆	☆☆☆☆	☆☆☆☆	☆☆☆☆☆	<b>21</b>

Comparative Equations	REMARK
<b>Electric Water Heater</b>	Sulit untuk di bersihkan dan di perbaiki
<b>Solar Hot Water</b>	Sulit untuk di bersihkan dan di perbaiki
<b>Gas Hot Water</b>	Sulit untuk di bersihkan dan di perbaiki
<b>Air Cooled Mini Chiller</b>	Hanya menyediakan air panas yang tergantung pada volume tangki



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