



Business Case for
Natural Refrigerants

04/09/2018 – Singapore



Natural Refrigerant Growth In THAILAND

By

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Natural Refrigerant Growth in Thailand Industries

- Thailand was moving toward to Natural Five(5) **Green** Refrigerants (**Water, Air, HC, CO₂, and Ammonia**)
- Room A/C Industry. This interim situation were using **R-32**, appx. **800,000** Units Since Year 2013.
- Domestic refrigerator using **R600a**, appx. **450,000** units Since Year **2007**.
- Plug in Commercial refrigeration has using **R-290** Since 2007, For Island Freezer appx.**14,000** Units and Ice cream chest freezer appx. **130,000** Units.
- Other Commercial refrigeration still using R-134a, R404a/R507, and R-407F.
- Industrial Refrigeration, **97%** Mainly using **Ammonia** and less than **Ten(10)** installations using Low Charge Cascade **Ammonia/CO₂**.

Natural Refrigerant use in Thailand

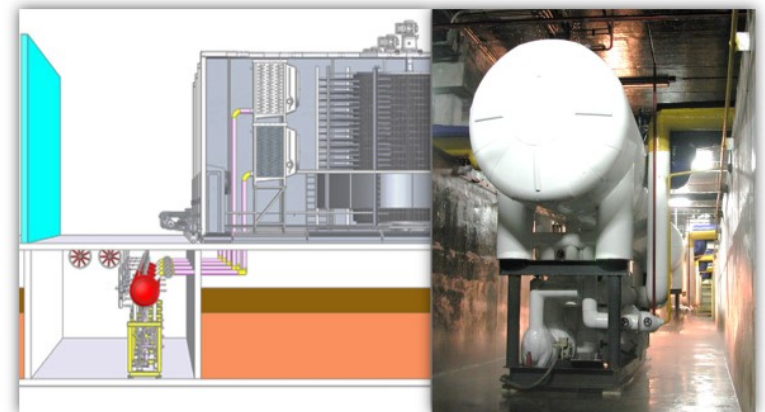
- **Very large installation was getting both 1st Place of “ASHRAE-2008” Technology Award and Thailand Energy Award.**



46 sets of NH₃ screw compressors with total power of 18,000 HP, 45 metric tons of NH₃

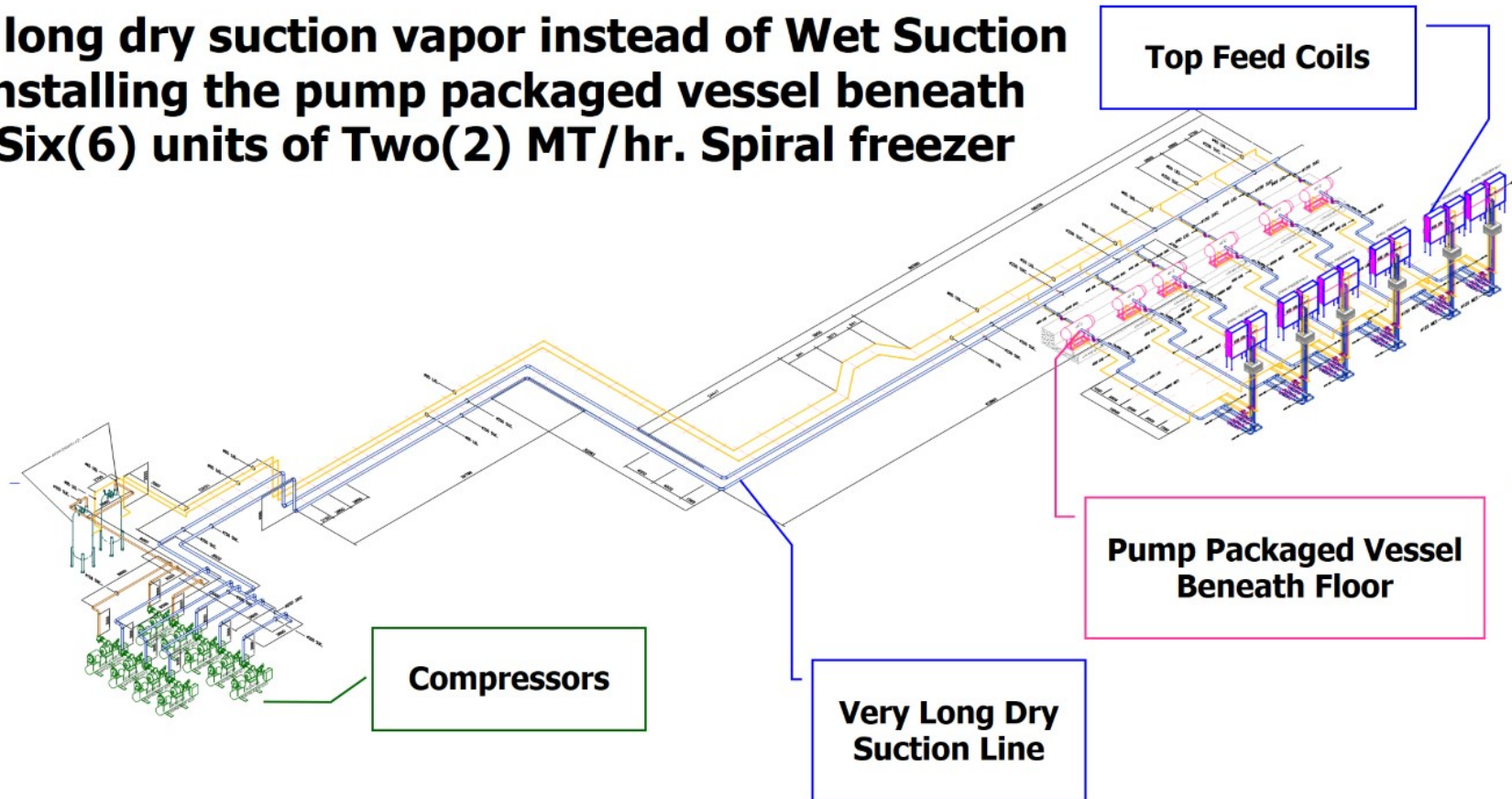


21 sets of SS Evaporative Condenser with total nominal heat reject of 50,000 kW



Eliminate long wet return line by install the pump package underneath the 6@2MT/Hr Fully Welded Spiral Freezers.

**The long dry suction vapor instead of Wet Suction
by installing the pump packaged vessel beneath
the Six(6) units of Two(2) MT/hr. Spiral freezer**



1. Low pressure drop induces draft evaporative condenser
: save 1,333,800 kW-hr/year
2. Low internal static air pressure design Spiral Freezer
:save 413,100 kW-hr/year
3. Top feed evaporator with sequential defrost ,eliminate the long wet return line :save 1,280,335 kW-hr/year

Total saving 3,027,235 kw-hr/year

As per ASHRAE standard-34 2007, ammonia falls in "B2" safety group highly toxic / lower flammability but it was the environmental friendly refrigerant. Our carefully design able to :-

- The eliminating of freezer wet return, we can reduce the ammonia charge amount of approximately **5,000 kg from 1.2 km of 8" diameter pipe.**
- Use Glycol as the Secondary Refrigerant and Zero use of HFC-based refrigerant or instead to introduce Ammonia unit cooler blow the air direct to the worker congestion area such as processing and packing, laying area, we also can reduce the ammonia charge amount of approximately **18,000 kg.**
- Extremely fast sequential defrost by installing the pump packed under the Six(2) Two(2) metric tons/hour each Freezers Floor.

Totally, we can reduce ammonia charge of 23,000 kg (50,700 lbs) from the system we designed.

Natural Refrigerant use in Thailand

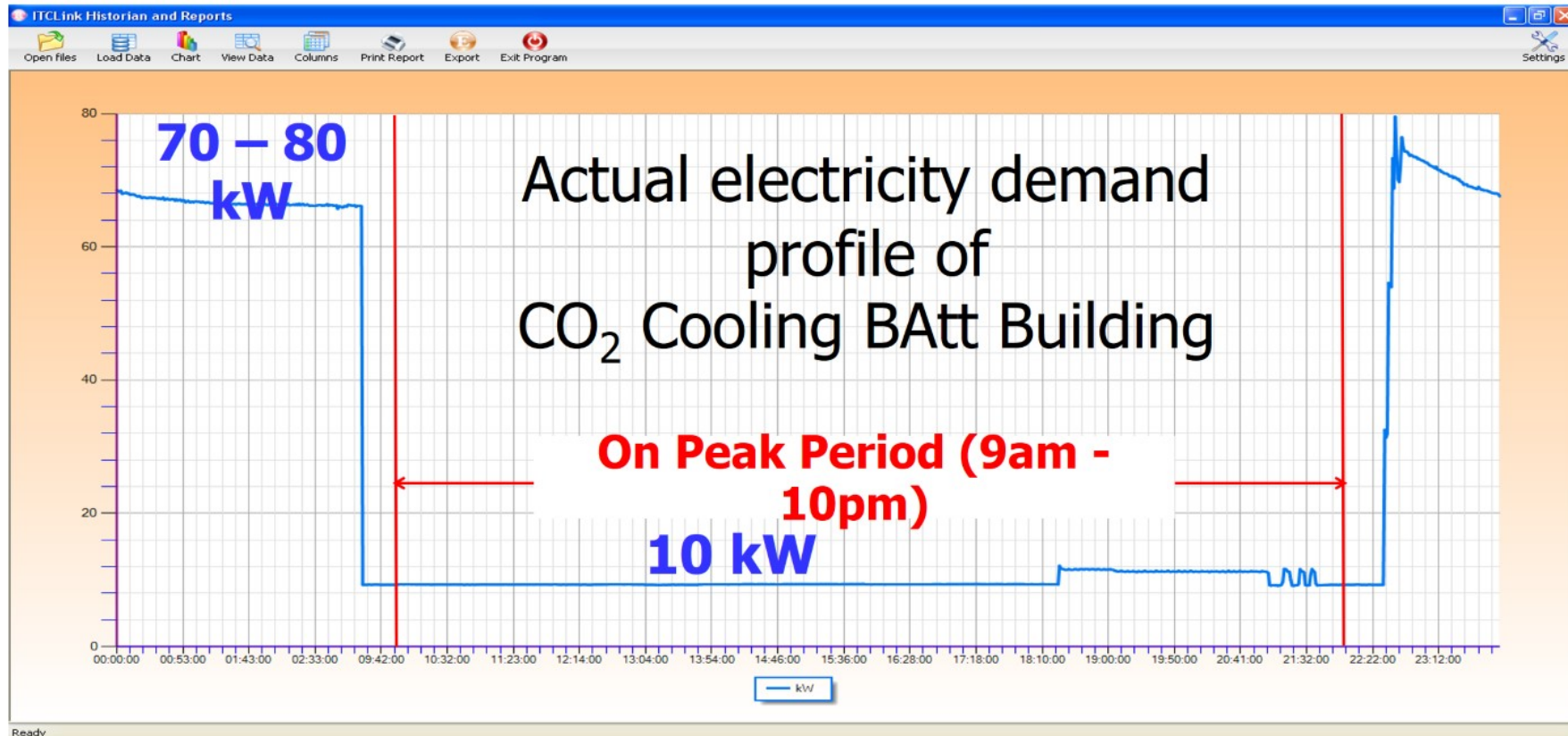
- **Cooling Batt with R507 / CO₂ Brine at ITC Head office in Year 2012.** *If 100Tr of 22,677 Office Building in Thailand replace with this TIS will be saving Of 140 MT of CO₂ footprint or equal to plant 6,700 of Trees.*



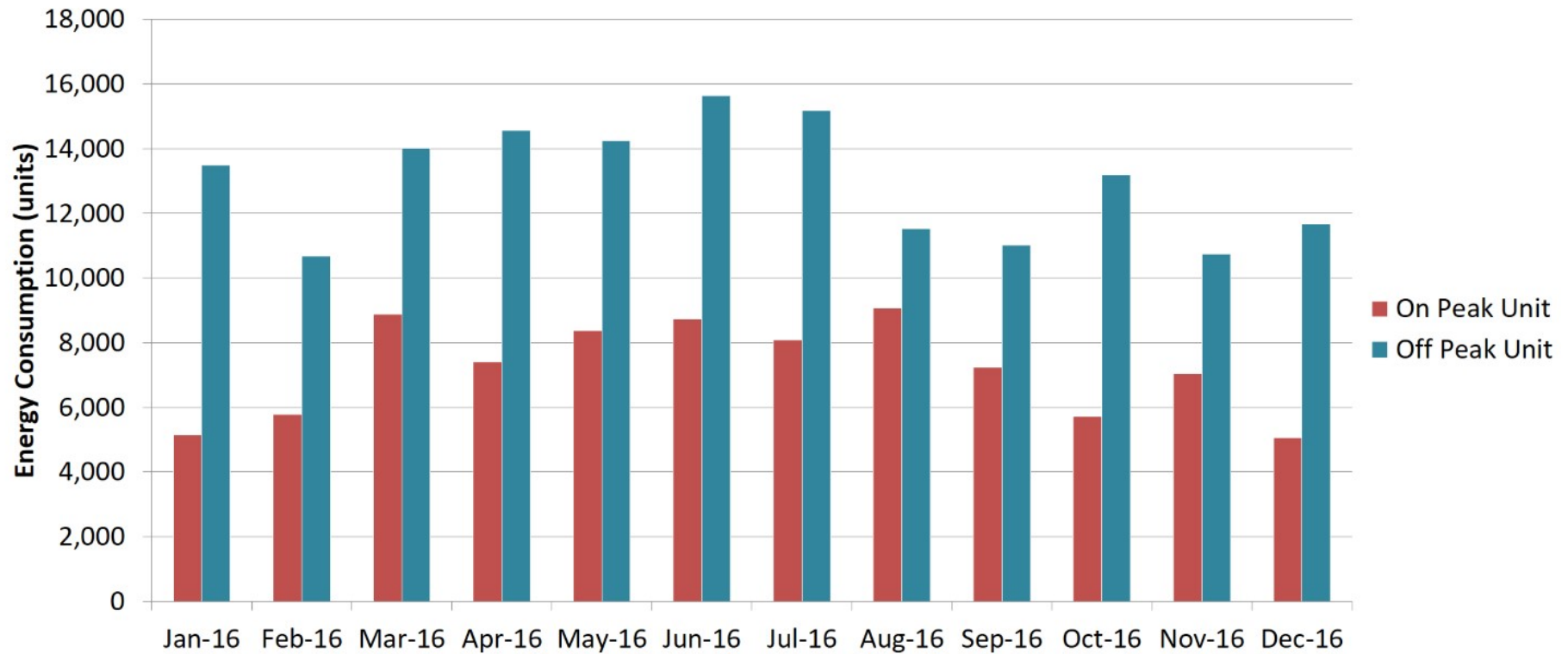
Estimated Payback Period

System Type	Unit	CO ₂ TIS	Package Recip. Chiller	Split Type (R22)
Max. Cooling Load	TR	100	100	100
Energy consumption	kWhr/yr	243,213	398,433	300,739
Electric cost	Baht/yr	970,762	1,814,177	1,697,783
Energy cost saving	Baht/yr	-	843,416	727,021
Maintenance cost	Baht/yr	383,600	440,500	447,600
Maintenance cost saving	Baht/yr	-	56,900	64,000
Investment	Baht	10,800,000	8,460,000	6,945,000
Differ investment	Baht	-	(2,340,000)	(3,855,000)
Payback period	Years	-	2.6	4.9

Exchange Rate on Nov. 2016: US\$1 ~ 35 Baht

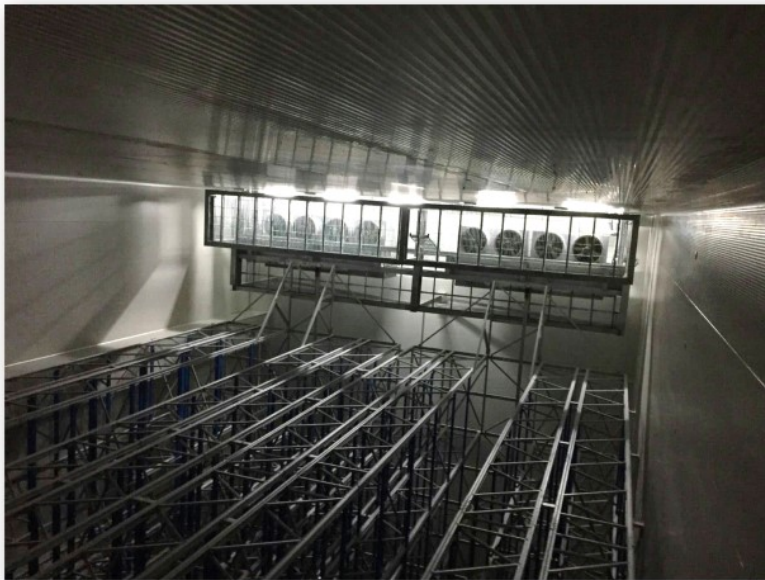


Energy Consumption of CO₂ Cooling BAtt system in 2016

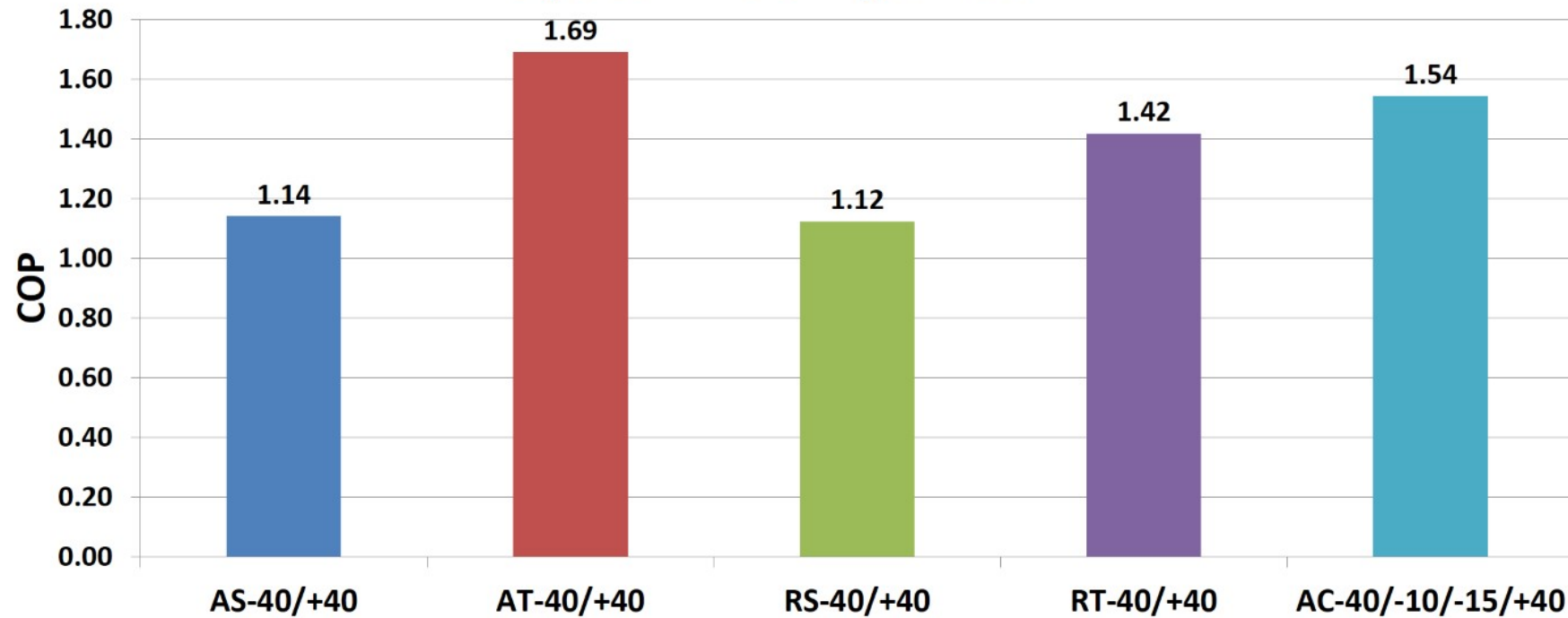


Natural Refrigerant use in Thailand

- **10,000 Pallets with 25 Meters Height ASRS Cold Storage in Thailand - Early 2018. Cascade **NH₃/CO₂** Pump Circulation**



System Comparison



AS: NH₃ single stage

AT: NH₃ two stage

RS: R22 single stage

RT: R22 two stage

AC: NH₃/CO₂ cascade

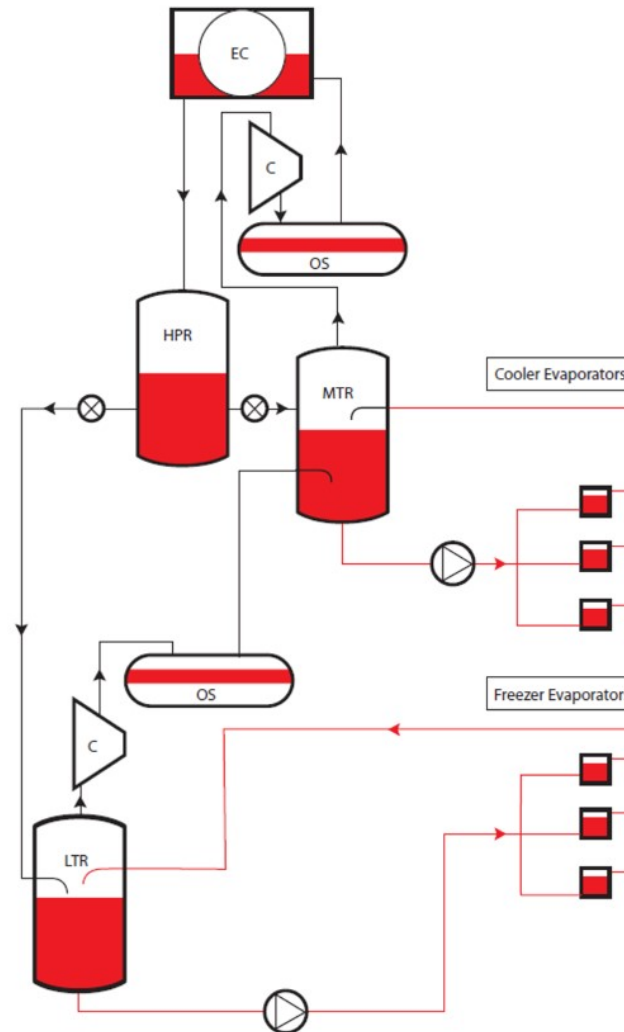
Expected energy savings, NH₃ charge reduction and other parameters.

CO₂/NH₃ cascade

“It do not better than Pure NH₃ two stage the only advantage is less NH₃ Charge and helping to save the planet with **Green refrigerant**”

Baseline System

(Pumped Recirculated Liquid (PRL) Refrigeration System)



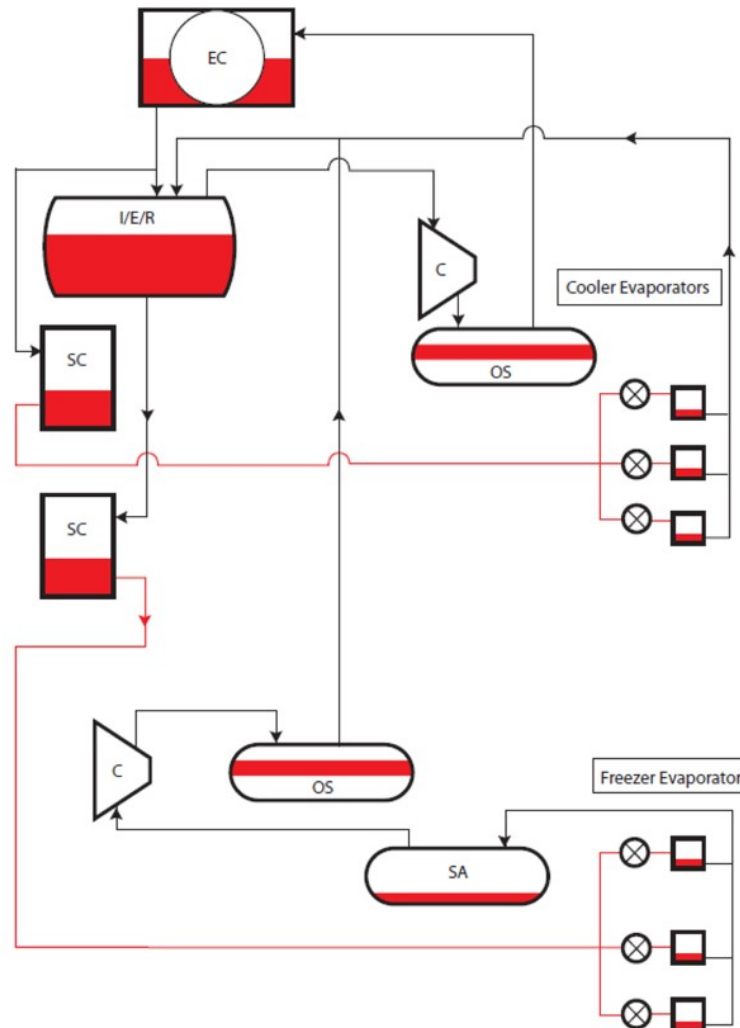
Nomenclature
 EC = Evaporative Condenser
 OS = Oil Separator
 MTR = Medium Temperature Recirculator
 LTR = Low Temperature Recirculator
 HPR = High Pressure Receiver
 C = Compressor

Ref: (White Paper) Low Ammonia Charge Refrigeration Systems for Cold Storage, October 2014 (Version 1), International Association for Cold Storage Construction (IACSC) and the International Association of Refrigerated Warehouses (IARW)

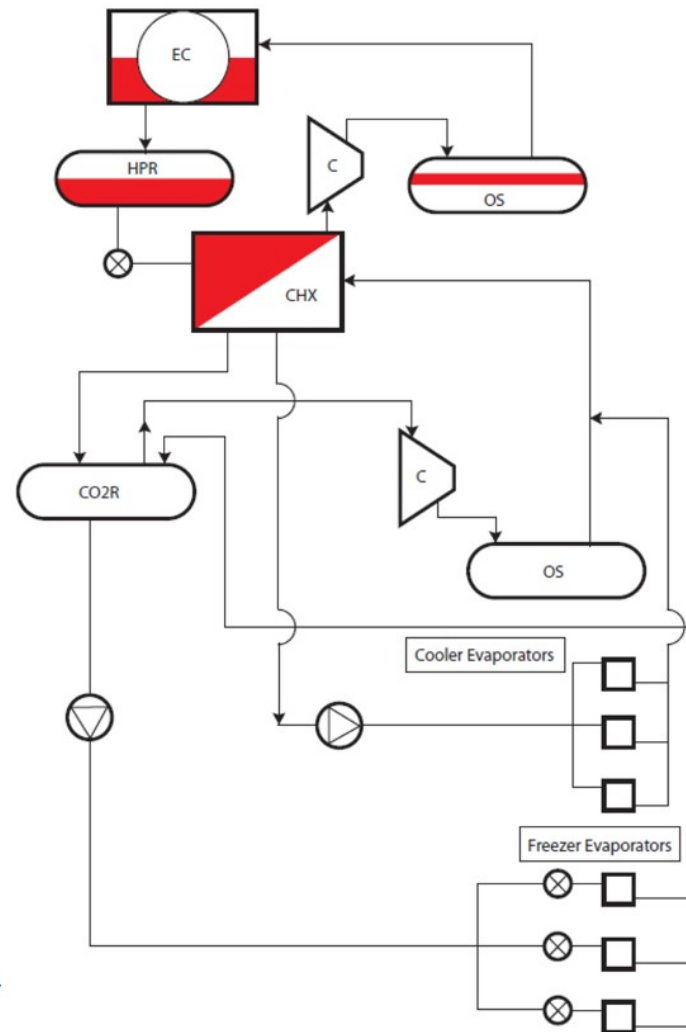
Direct Expansion

Nomenclature

EC = Evaporative Condenser
 I/E/R = Intercooler/Economizer/ Receiver
 OS = Oil Separator
 SC = Subcooler
 SA = Suction Accumulator
 C = Compressor



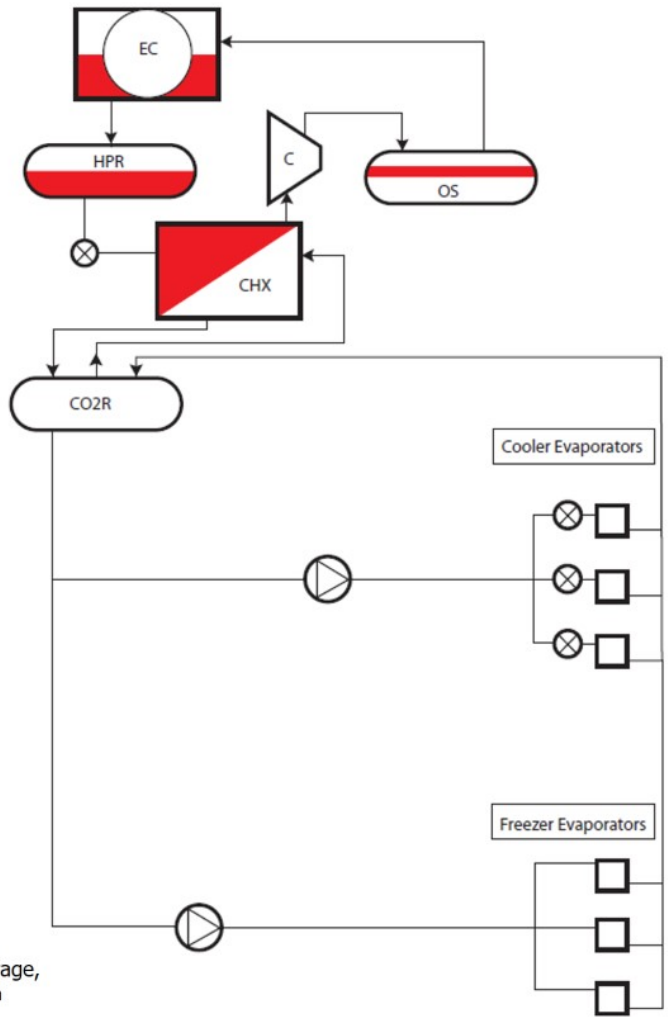
CO₂/NH₃ Cascade



Nomenclature	
EC	= Evaporative Condenser
OS	= Oil Separator
CO2R	= CO ₂ Receiver
CHX	= Cascade Heat Exchanger
HPR	= High Pressure Receiver
C	= Compressor

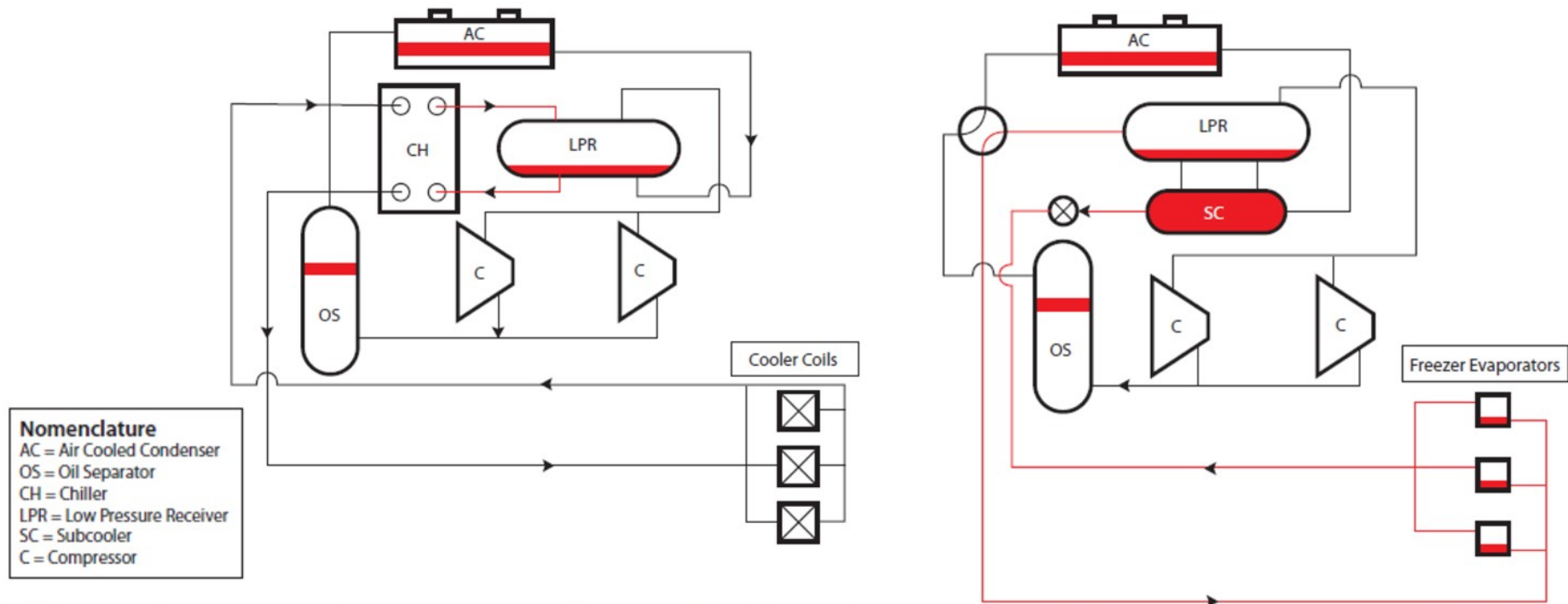
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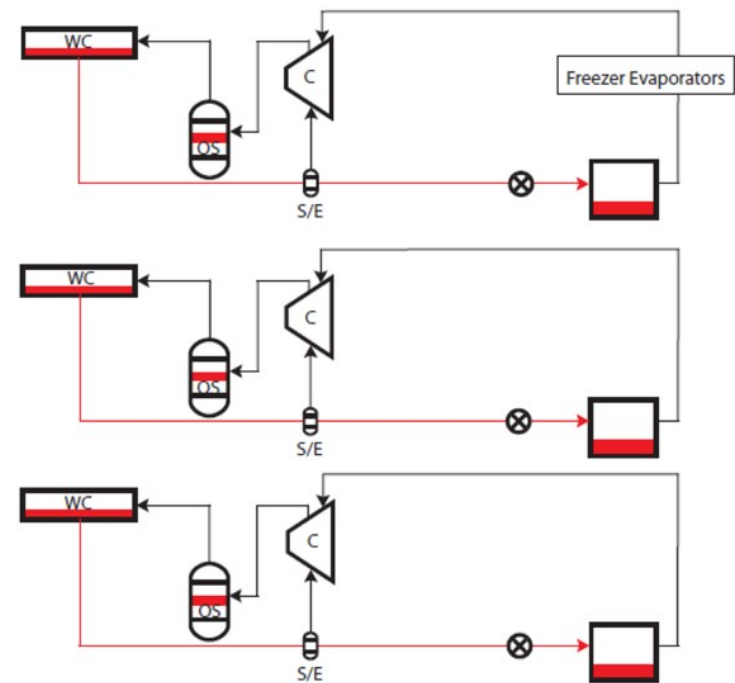
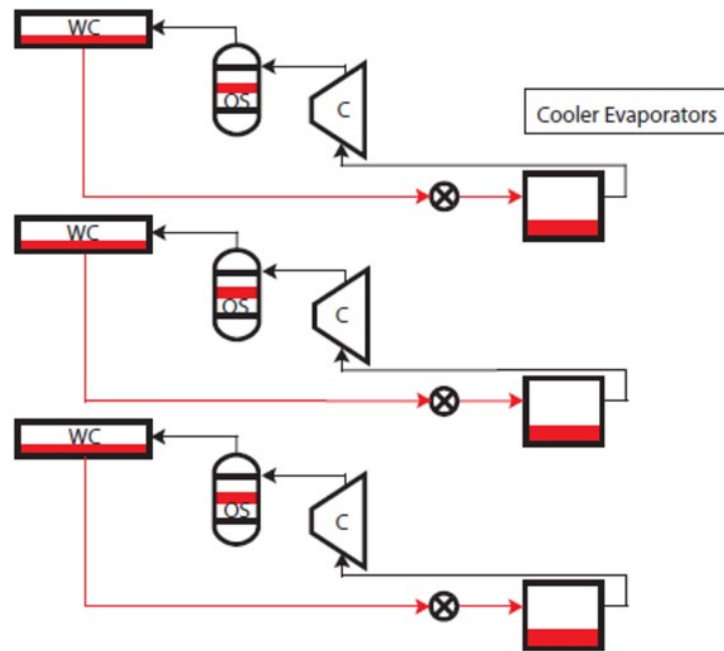


Ref: (White Paper) Low Ammonia Charge Refrigeration Systems for Cold Storage, October 2014 (Version 1), International Association for Cold Storage Construction (IACSC) and the International Association of Refrigerated Warehouses (IARW)

Package Air cooled



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Nomenclature
 WC = Water Cooled Condenser
 OS = Oil Separator
 C = Compressor
 S/E = Subcooler/Economizer

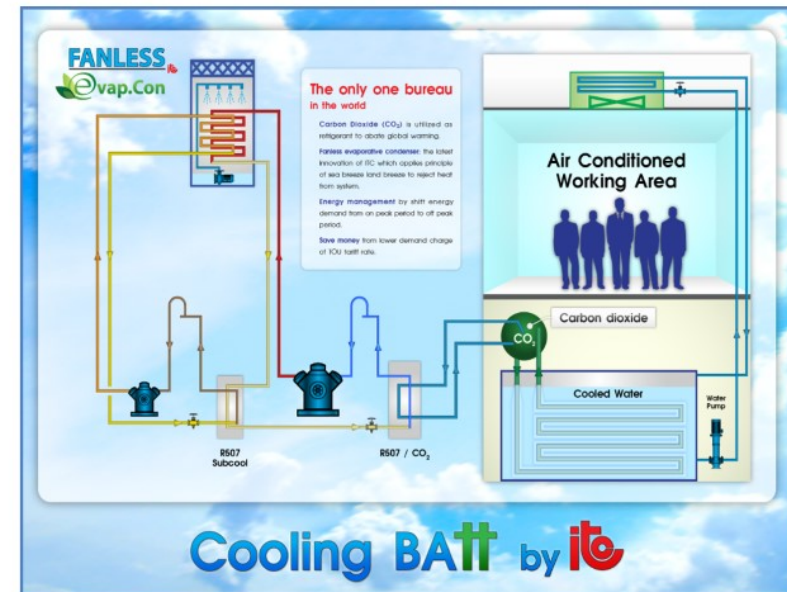
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Expected energy savings, NH₃ charge reduction and other parameters.

System	NH ₃ charge	Power installed	Investment cost	Maintenance cost
Baseline	23 lb/TR	2.5 kW/TR	\$7,000/TR	-
Direct Expansion	7.5 lb/TR	2.5 kW/TR	\$6,800/TR	Even
CO₂/NH₃ Cascade	6 lb/TR	2.5 kW/TR	\$7,400/TR	Even
CO ₂ /NH ₃ Brine	6 lb/TR	2.5 kW/TR	\$7,400/TR	Even
Package Air cooled	4.3 lb/TR	2.6 kW/TR	\$7,400/TR	Less
NXTCOLD	0.51 lb/TR	2.4 kW/TR	\$7,200/TR	Less

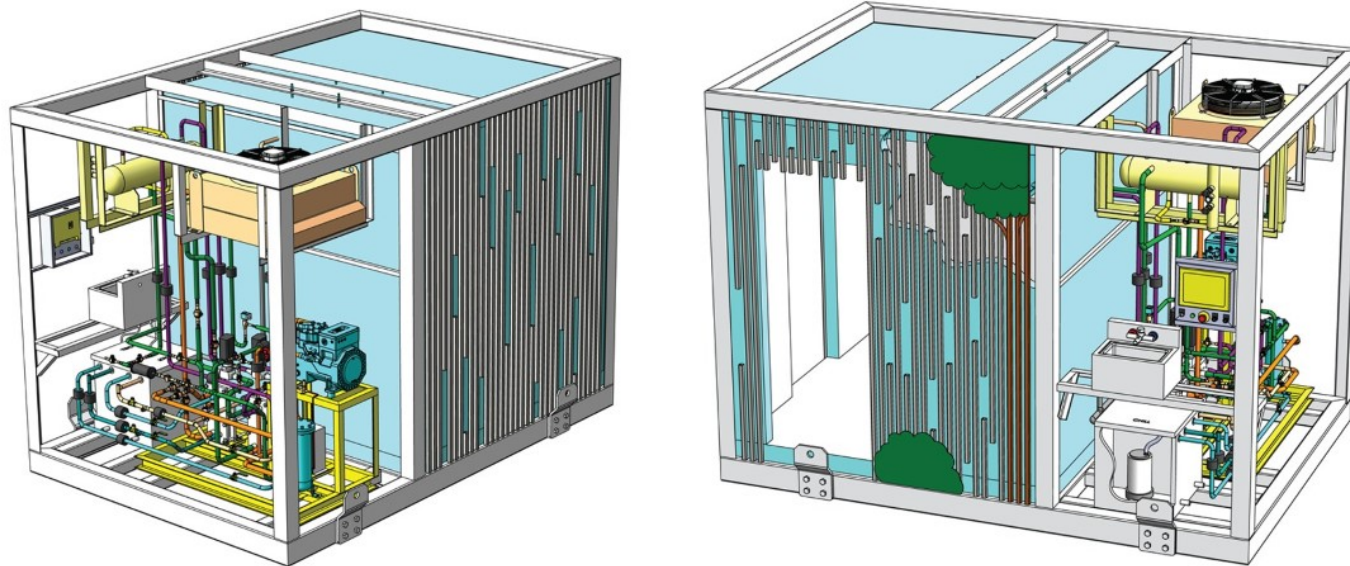
Latest Innovation in Thailand

- **20-60% Energy saving with Stainless Steel Fanless Evaporative Condenser-2012.**



Natural Refrigerant use in Thailand

- **On Going 1st Transcritical CO₂ Project in Thailand - Early 2019**





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Q & A

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Thank you for
listening!

