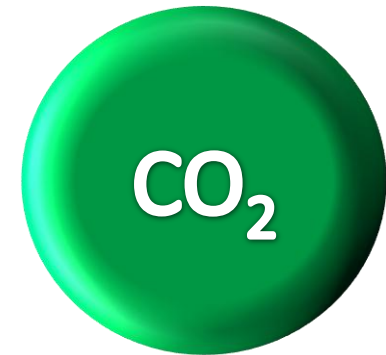


# Development of CO<sub>2</sub> Cooling System for Supermarket

Nihon Netsugen Systems CO., LTD

February 3<sup>rd</sup> 2014 Tokyo

ATMOsphere Asia 2014<sup>S</sup>



# About Nihon Netsugen Systems

- Partnership with GEA refrigeration Germany since 1999
- GEA Bock has CO2 compressors
- CO2 system in Europe has become standard since 2005
- Nihon Netsugen started CO2 project in 2011



Nihon Netsugen System Shiga Factory

GEA Headquarter Dusseldorf  
Germany



# European CO2 Cooling System

- European Standard installed at 3000 stores.
- CO2 Transcritical booster system.
- One rack consists of multiple low and high compressors.
- For medium and large size supermarket.



Coop Supermarket; Basel Switzerland



Supermarket Inside



Bock CO2 Standard Unit

## One Unit Standard Specification

LT                    2.5HP x 3  
Compressor

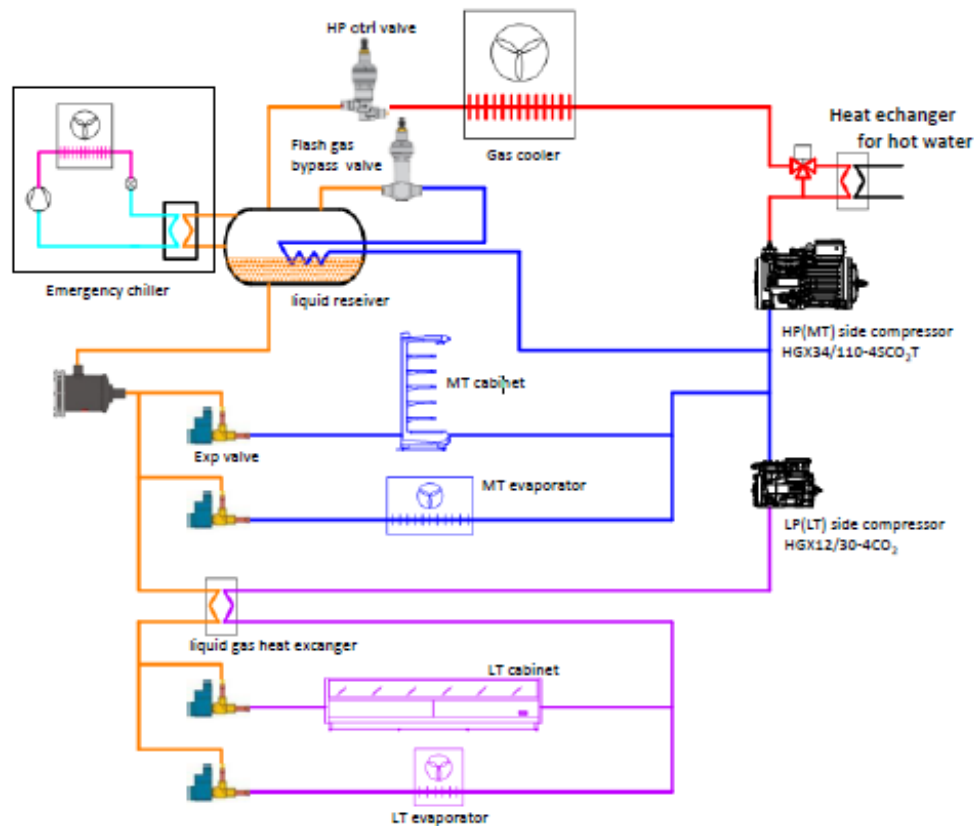
MT                    25HP x 4  
Compressor

## Cooling Capacity

LT =15kW        8 Cabinets

MT=18kW        27 Cabinets

# Features and Advantages of CO<sub>2</sub> Transcritical Booster System



- One system can cool both LT and MT cabinets.
- CO<sub>2</sub> liquid is directly sent to cabinets.
- CO<sub>2</sub> liquid pressure is 3.5MPa. Cabinets and refrigerant pipe at the store are same as HFC's like R410A.
- Hot water 50°C can be taken out with heat recovery.

\*System diagram of test unit in our factory.

PHASE  
1

# Test in our factory

Test was started in May 2013

Test subjects

- ✓ Check COP value.
- ✓ Cooling speed.
- ✓ Operation condition in hot summer time.
- ✓ Heat recovery function. 20°C→50°C
- ✓ CO<sub>2</sub> safety devices activation.

### Specification of test unit

MT Capacity	14kW ET=-10°C
MT Compressor	20HP x 1
MT Cabinet	3.6kW
LT Capacity	5kW ET=-30°C
LT Compressor	2HP x 1
LT Cabinet	12kW
DHW Capacity	33kW 50°C



CO2 Alarm



CO2 Unit



CO2 Cabinet MT & LT

PHASE  
2

# Development of Japanese CO<sub>2</sub> cabinet

Working together with **FUKUSHIMA INDUSTRIES.**

Test started in September 2013.



Connecting with New developed Fukushima CO<sub>2</sub> cabinets.

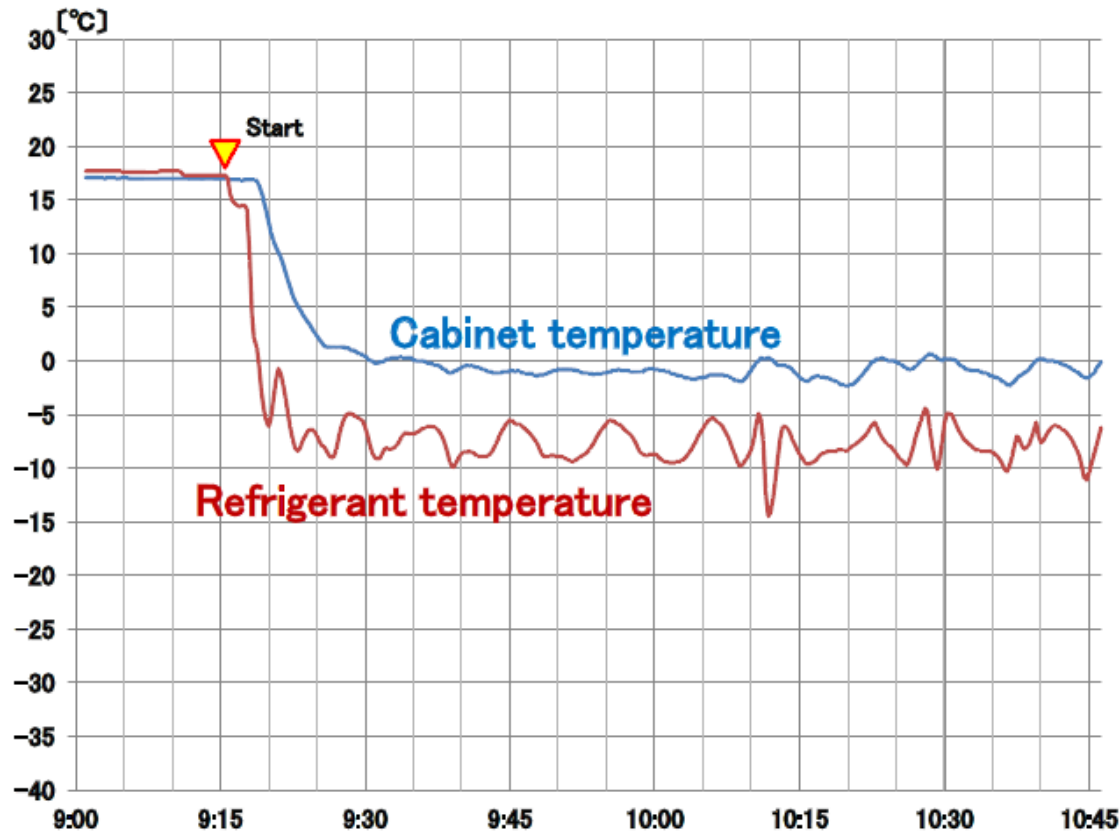
- MT cabinet x 2    4.4kW    2.0kW
- LT cabinet x 2    0.9kW    0.8kW
- Check points / cooling down , defrost condition  
expansion valve control & long operation test



Ambient temperature of cabinets and gas cooler are not controlled.

PHASE  
2

# Result data of MT cabinet

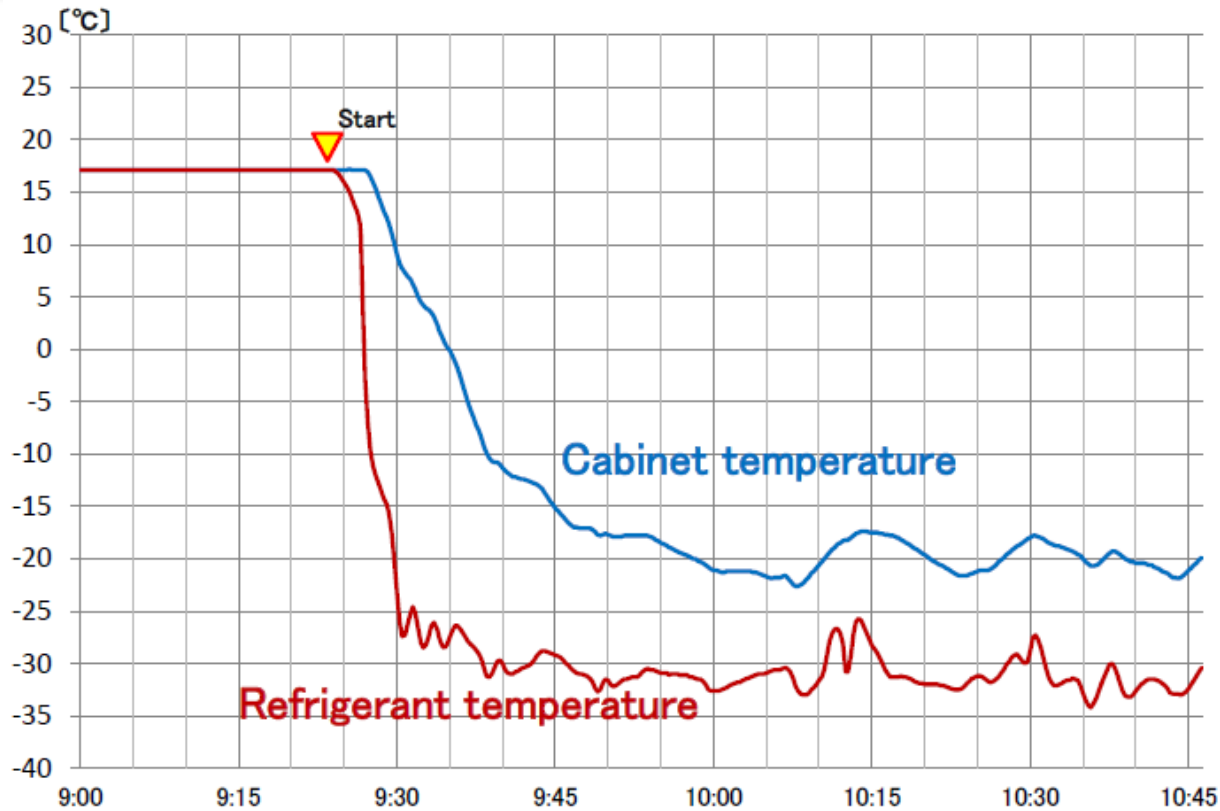


MT cabinet temperature

The cabinet controller is Fukushima original made.

PHASE  
2

# Result data of LT cabinet



LT cabinet temperature

The cabinet controller is Fukushima original made.



PHASE  
2

 CO<sub>2</sub> vs HFC's

Refrigerant			R404A*	R410A*	CO <sub>2</sub>
MT Condensing Unit (Legal Cap x Q'ty)			6.84RTx1	6.85RTx1	17.6RTx1
LT Condensing Unit (Legal Cap x Q'ty)			6.84RTx1	5.79RTx1	
COP	Summer	day	1.22	1.65	1.23
		night	1.49	2.01	1.31
	Spring & Autumn	day	1.60	2.15	2.05
		night	1.79	2.41	2.61
	Winter	day	2.35	3.16	4.49
		night	2.36	3.18	5.43
Ratio of Energy Consumption**			100	75.4	72.6
Ratio of Max Demand of Power**			100	90.2	124.4

\* According to catalog 2014 Japanese products

\*\* Number of days in the season Summer : 92 Spring and autumn : 152 Winter : 121


 PHASE  
2

# Subjects of R&D

## Subjects to be solved

- Summer in Japan is much hotter than Europe.
- Summer COP value dramatically goes down.
- Demand of Electricity pushed up by low Summer COP.

## Target of Development

- Spray water to outside gas cooler.
- Gas temperature down → Summer COP improved
 

Summer Daytime	1.23 → 1.48
Summer Nighttime	1.31 → 2.0

## Down annual energy consumption and demand

- Energy Consumption CO<sub>2</sub> /R404A 72.6%/100% → 65%/100%
- Electricity Demand CO<sub>2</sub>/R404A 124%/100% → 95%/100%

PHASE  
3

# Test at Fukushima factory

Test at Fukushima factory since December 2013.

- 1 MT and 1 LT cabinet
- Cabinets set at environment test lab; temp and humid controlled.
- Gas cooler set also test lab; temp up to 40°C simulate hot summer condition.



Gas Cooler Test



Cabinet Test

PHASE  
4

# Plan of New Prototype Unit

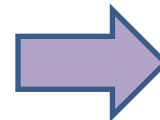
Start in May 2014.

Focus on real supermarket installation.

Size is matched to KHK approval notification below legal 20RT.



Location	Suburb of Tokyo
Floor Area	320 m <sup>2</sup>
MT Capacity	31 kW
LT Capacity	12 kW
Cabinet Length (total)	125 ft
MT Cabinet	84 ft
LT Cabinet	41 ft



## Specification of New Prototype Unit

MT Compressor	25HP x 2 ET=-10°C
LT Compressor	2.5HP x 2 ET=-40°C
DHW Capacity	58kW 50°C



第48回  
スーパーマーケット・トレードショー-2014  
SUPERMARKET TRADE SHOW

Please visit **SUPERMARKET TRADE SHOW 2014**

Exhibit Test Unit in **REAL OPERATION!!**

Tokyo Big Sight East Hall 1

February 12-14 at **Fukushima**  booth.

Thank you