



42. MEĐUNARODNI KONGRES O GREJANJU, HLAĐENJU I KLIMATIZACIJI  
42nd INTERNATIONAL CONGRESS ON HEATING, REFRIGERATING AND AIR - CONDITIONING  
30. XI - 2. XII 2011. Beograd, Srbija

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**LINE-UP NATURAL 5**

## "Natural Five" Refrigerants and Product Solutions

Refrigerant (Natural Five)	NH <sub>3</sub> R-717	CO <sub>2</sub> R-744	HC Hydrocarbon	H <sub>2</sub> O R-718	Air R-728
90°C		Utility hot water			
60°C	Utility hot water	Utility hot water	Utility hot water Heating HVAC	Heat recovery	
10°C	Chilled water Ice making	Chilled water Ice making		Chiller	
-15°C	Cold storage, Freezer, Fish boat				
-25°C	Specific Refrigeration needs				
-40°C	Freezer, Freeze-dry, Super Low temp storage				
-50°C			Cryogenics		Cryogenics
-60°C					
-100°C					
Notes	<ul style="list-style-type: none"> <li>•Conventional system</li> <li>•National Projects</li> </ul>	<ul style="list-style-type: none"> <li>•Eco-Cute</li> </ul>	<ul style="list-style-type: none"> <li>•Nat'l Proj.</li> <li>•Butane + Propane</li> </ul>	<ul style="list-style-type: none"> <li>•Nat'l Proj.</li> <li>•Adsorption</li> <li>•Heat recovery</li> </ul>	<ul style="list-style-type: none"> <li>•Nat'l Proj.</li> <li>•Air-cycle</li> </ul>

# Air Cycle Refrigeration Packaged Unit

2003 Developed at [Technical Strategy for Rationalization of Energy Consumption Project]  
~2005 NEDO



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**MAYEKAWA Europe nv/sa** DOC.2011-304 R3

**ULTIMATE NATURAL REFRIGERANT  
'AIR'  
FOR ULTRA LOW TEMPERATURE  
REFRIGERATION**

Mayekawa Mfg.Co,Ltd  
A.Machida

**MAYEKAWA**

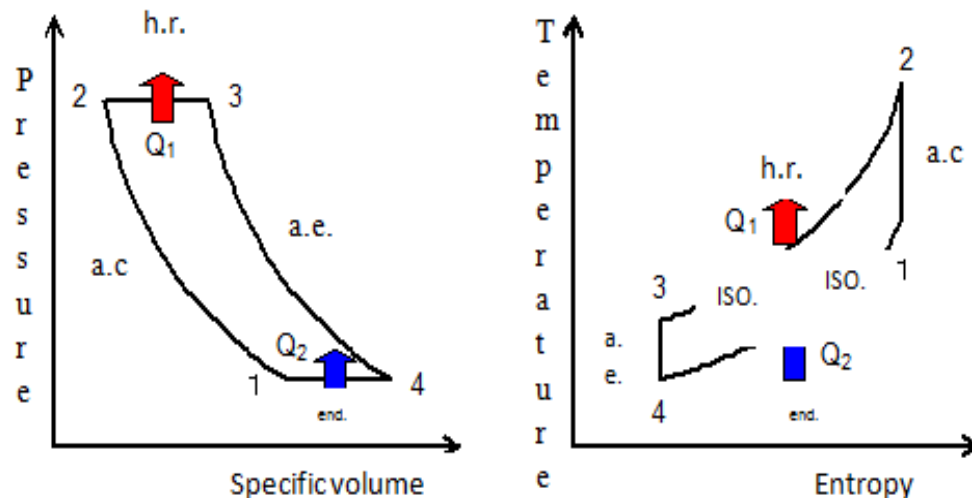
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## PRINCIPLES OF AIR REFRIGERATION SYSTEMS

AIR = most natural refrigerant  
 ODP, GWP, TOXICITY, FLAMMABILITY = 0  
 Air cycle = transcritical as  $T_{critical} (-140.7^{\circ} C)$ ,  
 uses only gas without phase transition.  
 Principle : cooling down of compressed air  
 before expanding resulting in  
 low temperatures in range of  $-50$  to  $-100^{\circ} C$ .

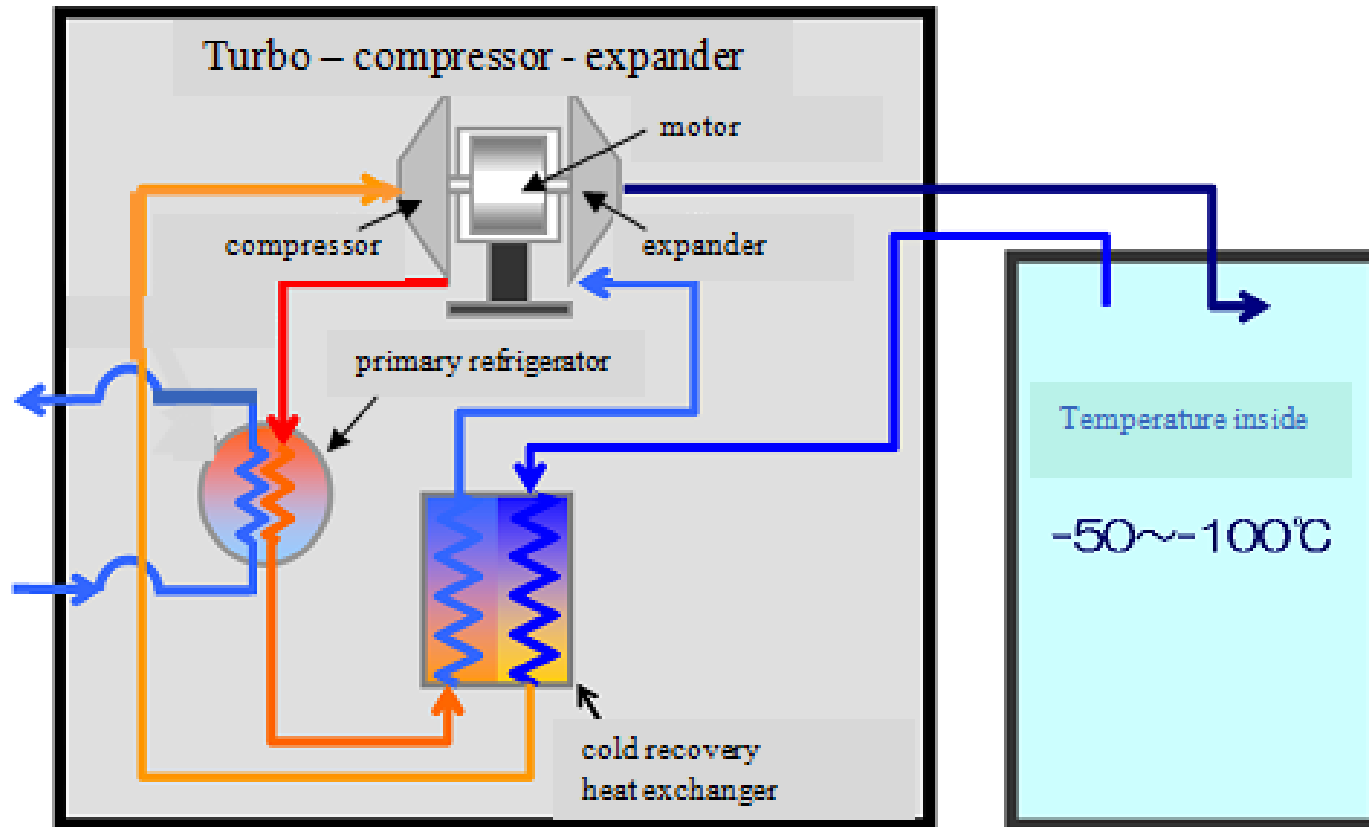
PROCESS CYCLE :  
 Adiabatic compression ->  
 Heat dissipation  
 &  
 Adiabatic expansion ->  
 Heat absorption  
 conducted in GAS phase.



with constant pressure  
 change,  
 without condensation or  
 evaporation

simple system, equipment:  
 COMPRESSOR +  
 HEAT EXCHANGERS +  
 EXPANDER

## INTRODUCTION 'PASCAL AIR'



Air - refrigeration system "Pascal Air"

Low temperature system

## OUTER VIEW AIR REFRIGERATION SYSTEM



Size:  
W3100  
L4600  
H3100  
mm

TRANSPORTABLE



## STANDARD SPECIFICATIONS

REFRIGERANT	AIR	
REFRIGERATION CAPACITY	30	kW
COMPRESSOR POWER	60	kW
TEMPERATURE (refrigerator blow-out)	-60 / -80	°C
MWP	0.2	MPa

Open cycle directly using the air with MWP of 0.2 Mpa.  
HP safety regulation n.a.

Air ducts can easily be extended or re-routed when facility re-arrangement is needed.

Refrigerant filling &/recovery n.a.

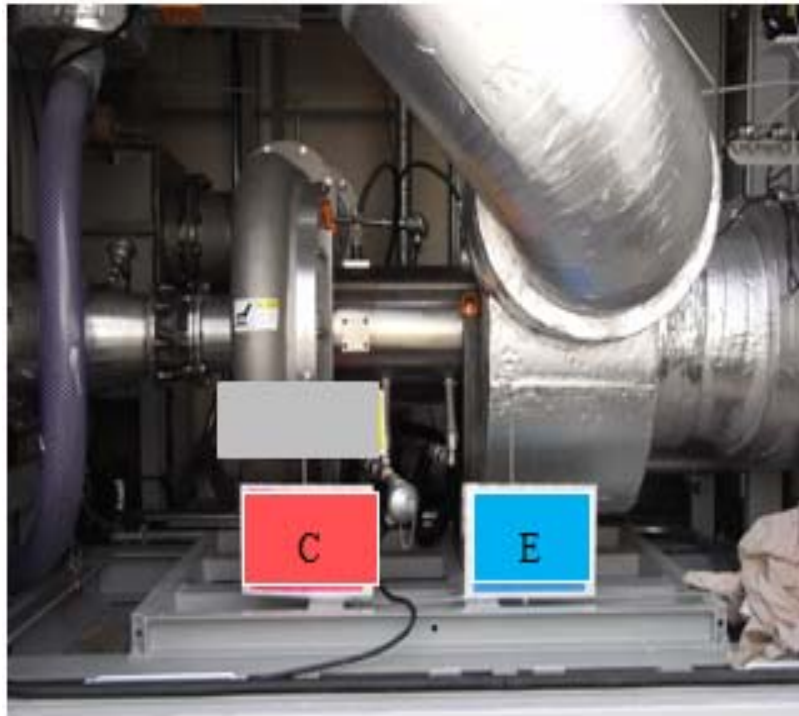
Large-scale construction n.a.

Operating costs reduced.

Maintenance reduced.

## STANDARD SPECIFICATIONS

Appearance of turbo-type expander-integrated compressor



Compressor : turbotype

Expander : adiabatic expansion  
generates 1/3rd of power  
needed for compression

Motor : built-in in center  
in coaxial structure

**FIELD CASE**

Plant :  
Yaizu City, Shizuoka Prefecture, Japan  
Tuna & bonito fish storage  
Nominal capacity 1795tons -50° C

System circulates ultra low temperature air as refrigerant (-80° C)

Installation date	December 2008	Unit
refrigerator temperature	-60	°C
total capacity	150	kW
nr of machines per room	3	
nr of rooms	2	

## INSTALLATION OF PASCAL AIR

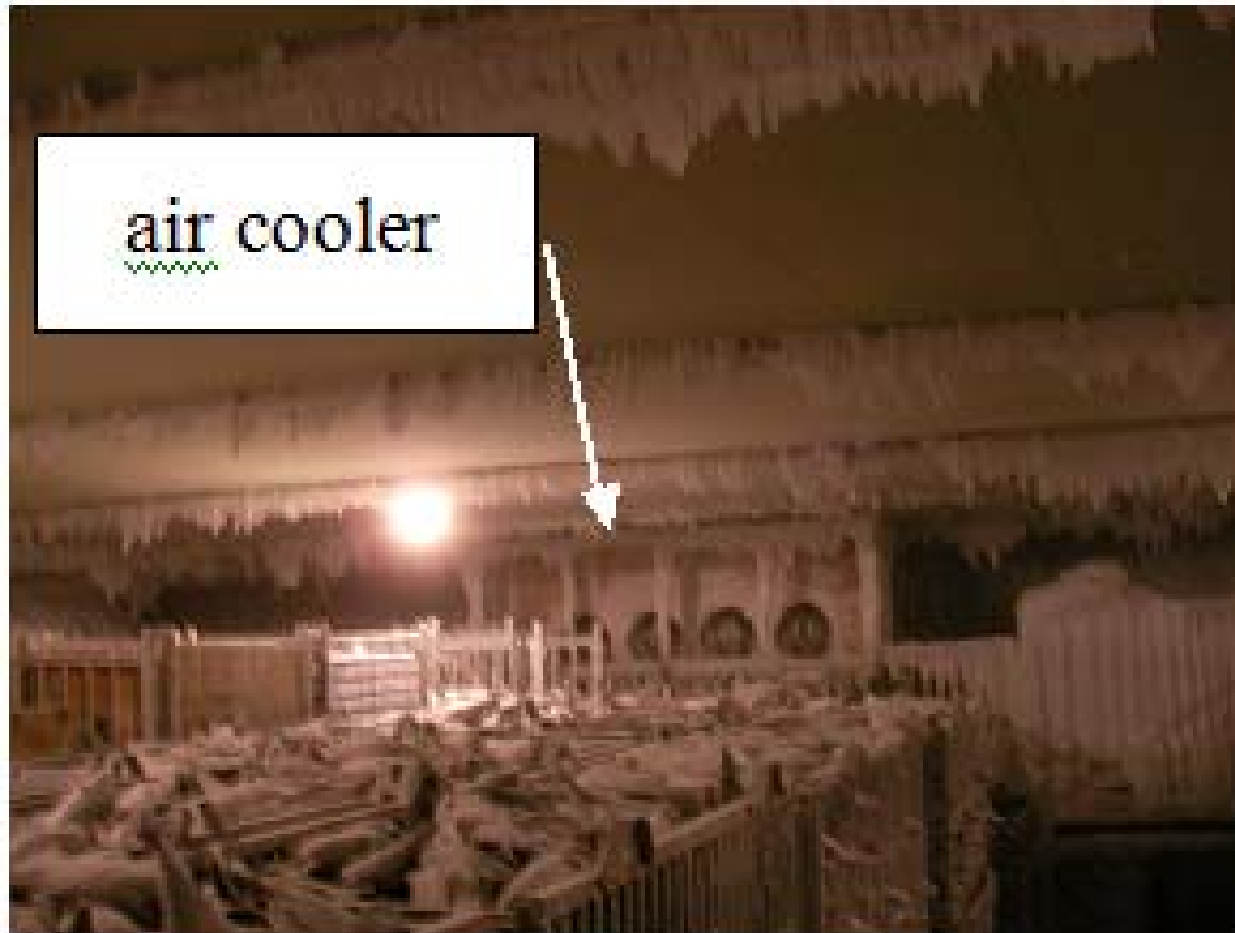


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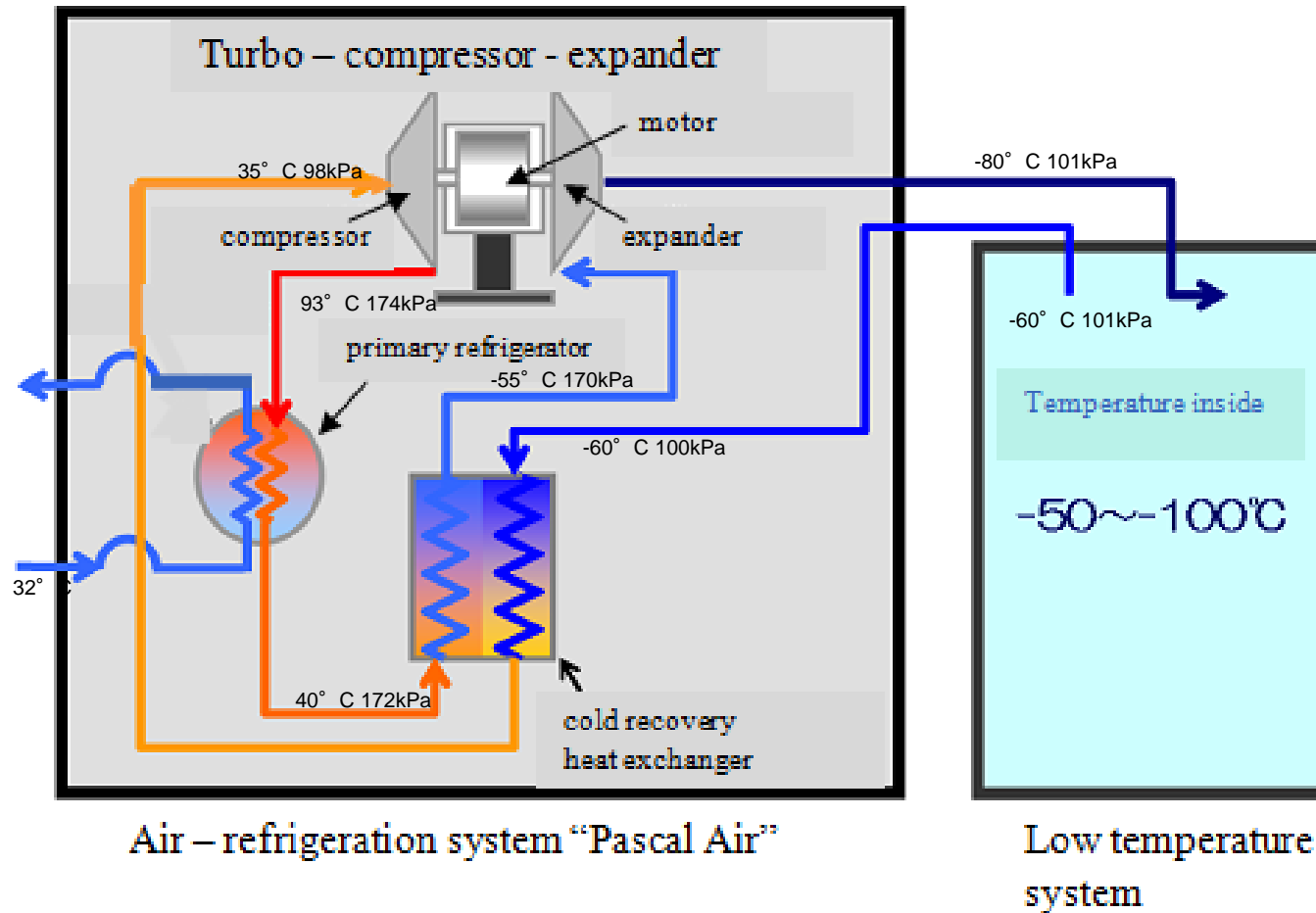
## CONVENTIONAL ULTRA-LOW TEMPERATURE REFRIGERATOR



## 'PASCAL -AIR' ULTRA-LOW TEMPERATURE REFRIGERATOR



## PLANT FLOW DIAGRAM





## PLANT OPERATING CONDITIONS

	nr 1	6667	hours
operating	nr 2	5996	hours
hours per	nr 3	6069	hours
8/4/2011	nr 4	6597	hours
	nr 5	6173	hours
	nr 6	7410	hours
performance data per unit			
	suction pressure ( 35°C)	0,98	bara
	discharge pressure (93°C)	1,74	bara
	rotation speed (invertor)	12.000 - 18.000	rpm
	capacity	30	kW
	power consumption	72	kW
	air outlet temperature	-80	°C
	refrigerator air temperature	-60	°C
	gain expander	40	kW

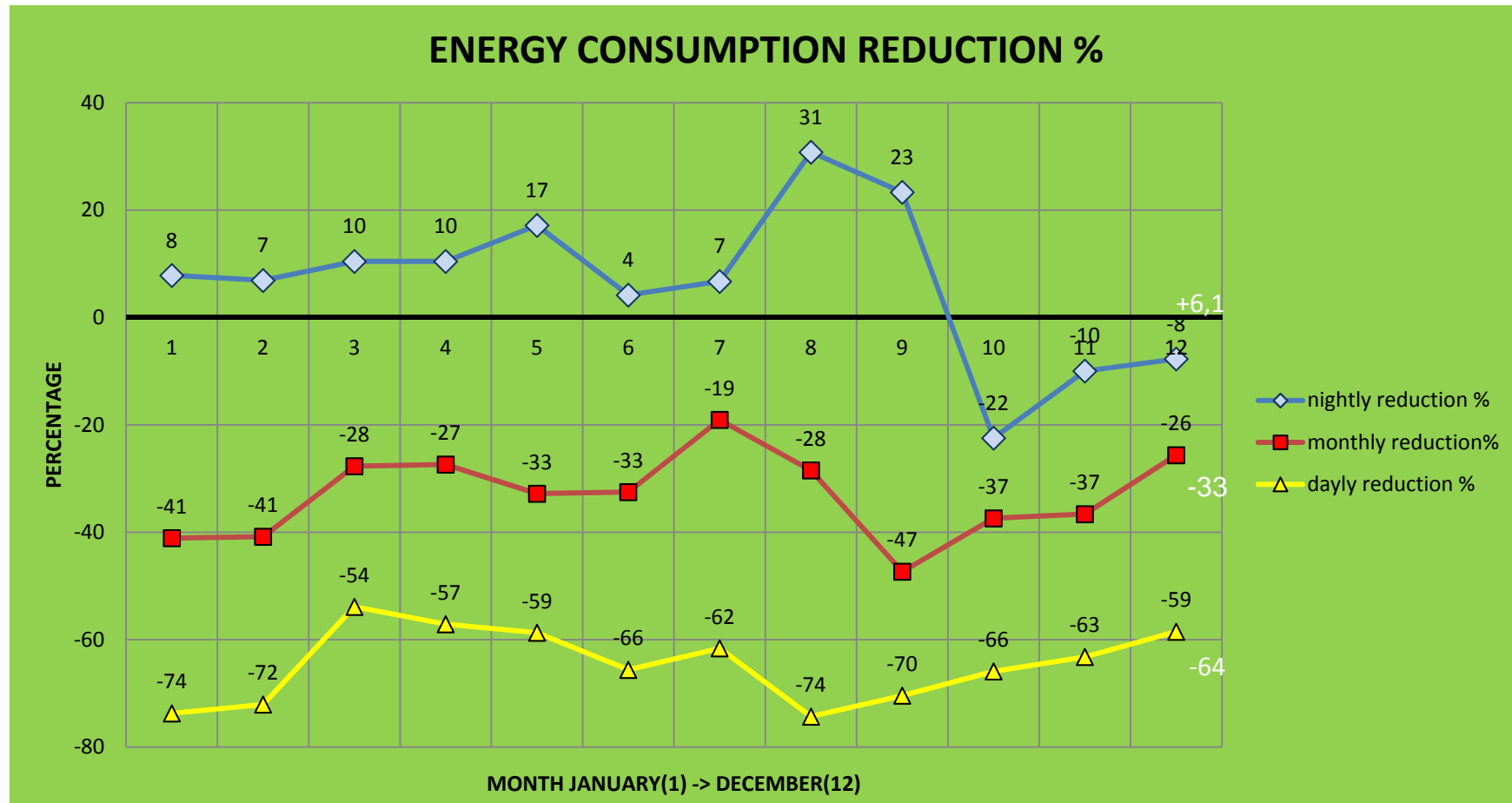
# PLANT ENERGY CONSUMPTION



TOTAL YEARLY POWER CONSUMPTION (kWh)					
R23/R22 CASCADE SYSTEM			PASCAL AIR SYSTEM		
OPERATING REGIME			OPERATING REGIME		
DAY	NIGHT	TOTAL	DAY	NIGHT	TOTAL
1880000	1490000	3370000	674000	1581000	2255000
			REDUCTION		
			-64,1	6,1	-33,1



## ENERGY SAVINGS



**20° C temperature difference :  
Blow-in air <> Low temperature system**

**Reduces the air circulation to 1/10th  
compared to conventional cooling(2-3° C)**

**Result :  
Cooled products are not dried out  
Quality is preserved  
Load on workers is reduced**

**COPwise 'PASCAL AIR'  
advantage<>conventional system**

**application-field : ultra low t° <-50° C  
'blanc area for conventional systems'  
Apart category <> conventional systems!**

**Product developed by use of research  
results with NEDO in 2003-2005**

(New Energy & Industrial Development Organisation)

**TO-DAY APPROX. 10 UNITS OPERATIONAL**

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**“PASCAL AIR” MARKETS**

<b>MARKETS</b>	<b>APPLICATION</b>
INDUSTRIAL REFRIGERATION	Fish (tuna & bonito freezing) Freeze drying Ice cream
MARINE/FISH INDUSTRY	Food
PHARMACEUTICAL/ MEDICAL	Medical producing process Storage blood samples Organ cooling reacting process
FINE CHEMICAL	Manufacturing process for electronic material
PETROCHEMICAL	Process gas cooling Condensation Distillation Extraction
SEMICONDUCTOR	Condensation process of detergent
WASTE DISPOSAL	Recycling Crushing Rubber and plastics

THANKS FOR YOUR  
ATTENTION!

Presented by Jan Boone, MAYEKAWA

# MARKET AVAILABILITY

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**MAYEKAWA**

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# MAYEKAWA MYCOM

**WORLDWIDE**  
 • 33 countries / 119 offices  
 • 8 production plants



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