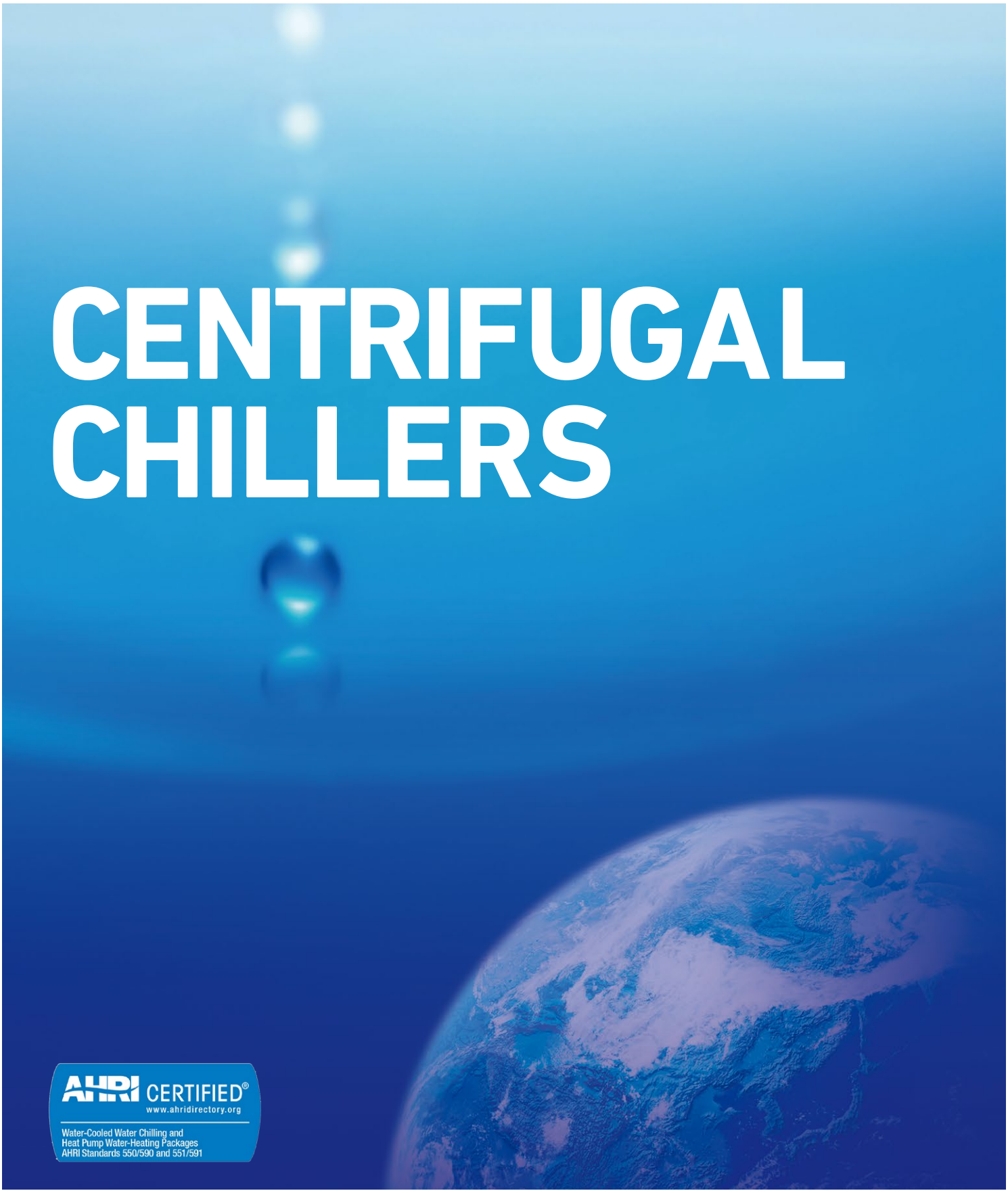
CENTRIFUGAL CHILLERS



AHRI CERTIFIED®
www.ahridirectory.org
Water-Cooled Water Chilling and Heat Pump Water-Heating Packages AHRI Standards 550/590 and 551/591

MOVE THE WORLD FORWARD

MITSUBISHI HEAVY INDUSTRIES GROUP

MITSUBISHI HEAVY INDUSTRIES

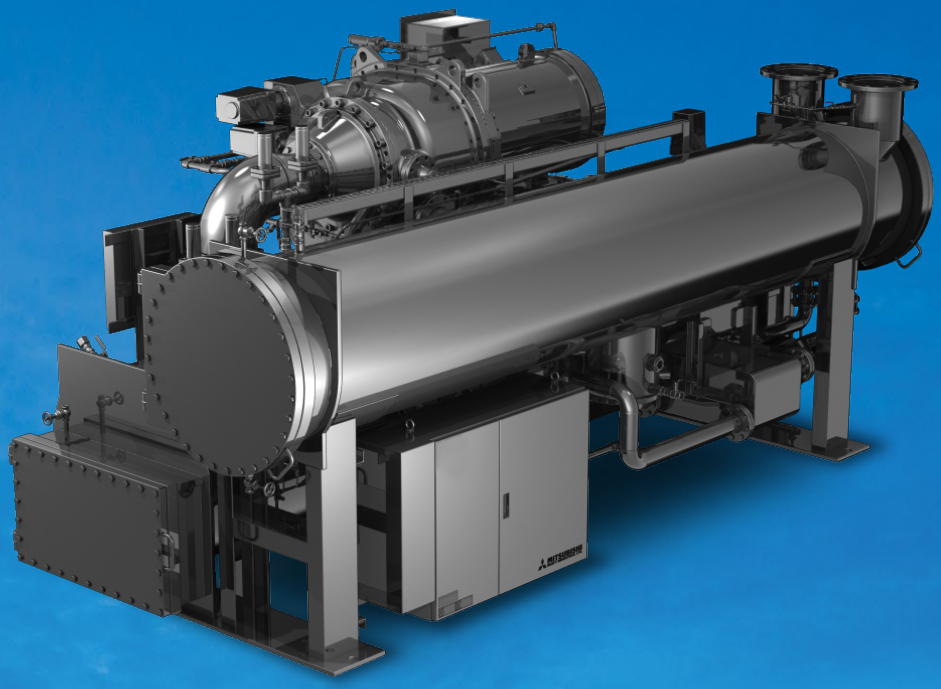
Centrifugal
Chillers

We wave a flag for environment protection by energy saving

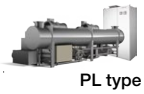
“Mitsubishi Heavy Industries Centrifugal Chiller” is the best answer for giving due consideration to environment.

Being required for contemporary office buildings, huge shopping malls or factories,
it is an environmental protection effort.
Key issue is air-conditioning system, and most important factor is efficiency of chillers used in the system.
Our Centrifugal Chiller put drastic energy saving in the place.
Putting in high efficient chillers are not only contributing to environment conservation of
the reduction of CO_2 emissions etc., but also resolve the business challenge of saving operation cost etc.

This is the proposal from Mitsubishi Heavy Industries Thermal Systems, Ltd.



Product line with Low GWP Refrigerant

Use	Drive	Series	Refrigerant	Capacity (RT) ＊3
				100 200 300 400 500 600 700 800 900 1000
Air-Conditioning	Variable (Built-in Inverter)	ETI-Z 	HFO-1233zd(E)	150-700 RT
	Constant	GART-ZE  PL type	HFO-1234ze(E)	300-5000 RT
		JHT-Y  PL type	HFO-1234yf	300-5400 RT
	Variable	GART-ZEI  PL type	HFO-1234ze(E)	300-5000 RT
		JHT-Y.I  PL type	HFO-1234yf	300-5400 RT
Low Temperature	Constant	GART-ZE 	HFO-1234ze(E)	260-3100 RT
		JHT-Y 	HFO-1234yf	280-3400 RT
	Variable	GART-ZE.I 	HFO-1234ze(E)	260-3100 RT
		JHT-Y.I 	HFO-1234yf	280-3400 RT
Heat Recovery ＊1	Constant	GART-ZE.HR 	HFO-1234ze(E)	330-2300 RT
		JHT-Y.HR 	HFO-1234yf	340-2000 RT
	Variable	GART-ZE.I.HR 	HFO-1234ze(E)	330-2300 RT
		JHT-Y.I. HR 	HFO-1234yf	340-2000 RT

Use	Drive	Series	Refrigerant	Capacity (kW) ＊3
				1000 2000 3000
Heat Pump ＊2	Constant	GART-ZE.HP 	HFO-1234ze(E)	1200-7000 kW
		JHT-Y.HP 	HFO-1234yf	1300-6000 kW
	Variable	GART-ZE.I.HP 	HFO-1234ze(E)	1200-7000 kW
		JHT-Y.I.HP 	HFO-1234yf	1300-6000 kW

＊1 Heat Recovery : Simultaneous Operation
＊2 Heat Pump : Switching Operation
＊3 Capacity range should be changed subject to temperature condition of chilled water, brine or hot water.
＊4 Control range should be changed subject to temperature condition of brine or hot water.

	Temperature			Load		Flow Rate			
	Chilled Water Leaving Lower Limit	Cooling Water Entering Lower Limited	Hot Water Leaving Higher Limit	Control Range in a Continuous Operation		Chilled Water/Cooling Water Control Range		Chilled Water Control Range	
				Standard	Option	Standard	Option	Standard	Option
	4°C	12°C		100%-10%	100%-approx. 0%	100%	Variable Flow Rate 100%-50%	100%	Excess Flow Rate 100%-150%
2500 5000 GART-ZE PL Dual Compressor	3°C			100%-20%	100%-10%				
2700 5400 JHT-Y.PL	3°C			100%-20%	100%-10%				
2500 5000 GART-ZE I.PL Dual Compressor	3°C			100%-10%	100%-approx. 0%				
2700 5400 JHT-Y.I.PL	3°C			100%-10%	100%-approx. 0%				
1550 3100 GART-ZE PL Dual Compressor	Minus 5°C			100%-30%	100%-10% ＊4				
1700 3400 JHT-Y.PL	Minus 5°C			100%-30%	100%-10% ＊4				
1550 3100 GART-ZE I.PL Dual Compressor	Minus 5°C			100%-30%	100%-10% ＊4				
1700 3400 JHT-Y.I.PL	Minus 5°C			100%-30%	100%-10% ＊4				
2300	3°C		50°C	100%-30%	100%-10% ＊4				
2000	3°C		50°C	100%-30%	100%-10% ＊4				
2300	3°C		50°C	100%-30%	100%-10% ＊4				
2000	3°C		50°C	100%-30%	100%-10% ＊4				

	Temperature			Load		Flow Rate			
	Chilled Water Leaving Lower Limit	Cooling Water Entering Lower Limited	Hot Water Leaving Higher Limit	Control Range in a Continuous Operation		Chilled Water/Cooling Water Control Range		Chilled Water Control Range	
				Standard	Option	Standard	Option	Standard	Option
7000	3°C	12°C	50°C	100%-30%	100%-10% ＊4	100%	Variable Flow Rate 100%-50%	100%	Excess Flow Rate 100%-150%
6000	3°C		50°C	100%-30%	100%-10% ＊4				
7000	3°C		50°C	100%-30%	100%-10% ＊4				
6000	3°C		50°C	100%-30%	100%-10% ＊4				

Product line

Use	Drive	Series		Capacity (RT) ＊3
Air-Conditioning	Variable (Built-in Inverter)	ETI		150-700 RT
	Constant	GART-P		500-2700 RT
		GART-R		420-1800 RT
		GART	 PL type	400-6000 RT
	Variable	GART-PI		500-2700 RT
		GART-RI		420-1800 RT
		GART-I	 PL type	400-6000 RT
Low Temperature	Constant	GART-P		530-630 RT 850-900 RT 1540-1710 RT
		GART		400-3000 RT
	Variable	GART-PI		530-630 RT 850-900 RT 1540-1710 RT
		GART-I		400-3000 RT
Heat Recovery ＊1	Constant	GART-R.HR / GART-P.HR		520-540 RT (R.HR) 720-820 RT (P.HR) 1000-1120 RT (P.HR) 1440-1620 RT (P.HR) 2000-2250 RT (P.HR)
		GART-HR		400-2300 RT
	Variable	GART-RI.HR / GART-PI.HR		520-540 RT (RI.HR) 720-820 RT (PI.HR) 1000-1120 RT (PI.HR) 1440-1620 RT (PI.HR) 2000-2250 RT (PI.HR)
		GART-I.HR		400-2300 RT

Use	Drive	Series		Capacity (kW) ＊3
Heat Pump ＊2	Constant	GART-P.HP		2100-8800 kW
		GART-R.HP		1400-6300 kW
		GART-HP		1700-9750 kW
	Variable	GART-P.I.HP		2100-8800 kW
		GART-R.I.HP		1400-6300 kW
		GART-I.HP		1700-9750 kW

＊1 Heat Recovery : Simultaneous Operation
＊2 Heat Pump : Switching Operation
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Temperature			Load		Flow Rate			
Chilled Water Leaving Lower Limit	Cooling Water Entering Lower Limited	Hot Water Leaving Higher Limit	Control Range in a Continuous Operation		Chilled Water/Cooling Water Control Range		Chilled Water Control Range	
			Standard	Option	Standard	Option	Standard	Option
4°C	12°C		100%-10%	100%-approx. 0%	100%	Variable Flow Rate 100%-50%	100%	Excess Flow Rate 100%-150%
4°C			100%-20%	-				
3°C			100%-20%	100%-10%				
4°C			100%-10%	-				
3°C			100%-10%	100%-approx. 0%				
Minus 5°C			100%-30%	-				
			100%-30%	100%-10% ＊4				
			100%-30%	-				
			100%-30%	100%-10% ＊4				
4°C		45°C	100%-30%	-				
3°C		50°C	100%-30%	100%-10% ＊4				
4°C		45°C	100%-30%	-				
3°C		50°C	100%-30%	100%-10% ＊4				

Temperature			Load		Flow Rate			
Chilled Water Leaving Lower Limit	Cooling Water Entering Lower Limited	Hot Water Leaving Higher Limit	Control Range in a Continuous Operation		Chilled Water/Cooling Water Control Range		Chilled Water Control Range	
			Standard	Option	Standard	Option	Standard	Option
4°C	12°C	45°C	100%-30%	-	100%	Variable Flow Rate 100%-50%	100%	Excess Flow Rate 100%-150%
3°C		50°C	100%-30%	100%-10% ＊4				
4°C		45°C	100%-30%	-				
3°C		50°C	100%-30%	100%-10% ＊4				

Mitsubishi Heavy Industries (MHI) Group

MHI Group Outline

Mitsubishi Heavy Industries Group is one of the world's leading industrial firms. Since 1884, we have channeled big thinking into solutions that move the world forward – advancing the lives of everyone who shares our planet. We deliver innovative and integrated solutions across a wide range of industries, covering land, sea, sky and even space.

Energy

- Gas & steam power systems
- Nuclear power systems
- Compressors
- Aero engines
- Marine machinery, etc.


Gas turbines


Aero engines

Plants & Infrastructure

- Commercial ships
- Engineering
- Environmental systems
- Metals machinery
- Machinery systems, etc.


Waste-to-energy


Transportation

Logistics, Thermal & Drive Systems

- Material handling systems
- Engines
- Turbochargers
- HVAC systems
- Automotive air conditioners, etc


Centrifugal chiller


Forklift

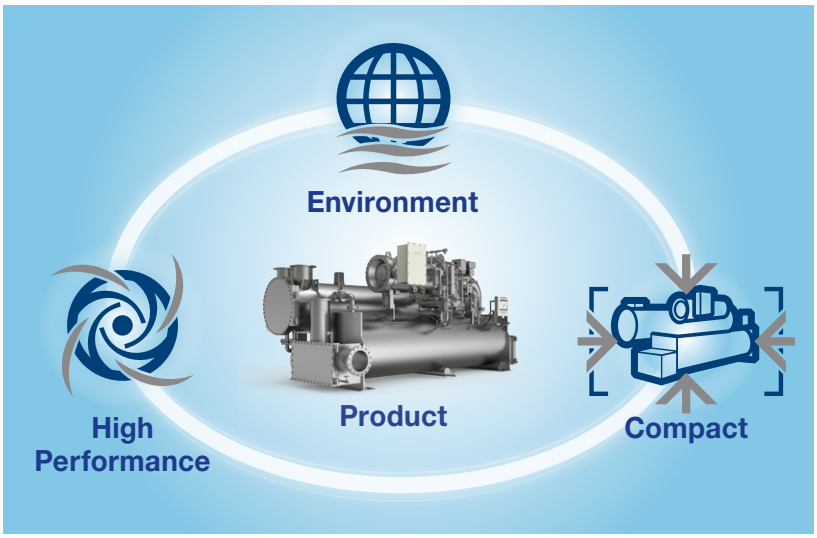
Aircraft, Defense & Space

- Commercial aviation
- Defense aircraft
- Missile systems
- Naval ships
- Special vehicles (tanks)
- Maritime systems (torpedoes)
- Space systems, etc.


Aerospace

Product Development Concept of Our Centrifugal Chillers

Our strength company comes from the extensiveness of our business fields and the synergy created between them. With the addition of Mitsubishi Heavy Industries advanced integrated technologies, we are aiming to realize optimized thermal solutions adapted to the diverse needs of our customers.



Environment

Mitsubishi Heavy Industries Thermal Systems is the first Japanese manufacturer to have developed centrifugal chillers that use low-GWP refrigerants. We are committed to developing products that contribute to the realization of a carbon neutral world.

High Performance

We aim for High Performance operation at both rated and partial loads by improving and optimizing the key technologies related to the refrigeration cycle, compressors, heat exchangers, and control systems.

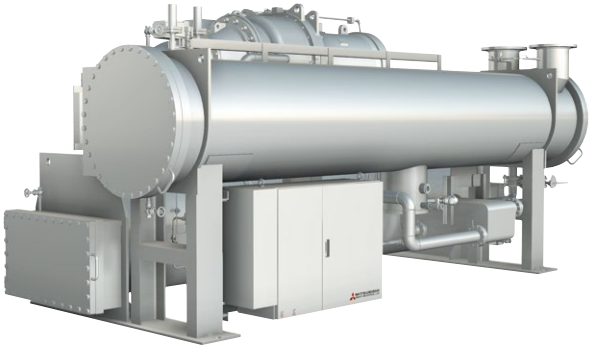
Compact

The compressors and heat exchangers are designed to be compact, with equipment arranged to fully utilize vertical space. This design facilitates easier delivery and installation while also meeting replacement needs.

Features of GART series & GART-I series

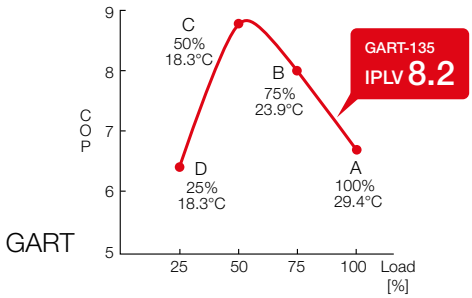
High Efficiency

- Newly shaped compressor impellers
- Improved evaporators and condensers
- Adoption of a new two-stage-compression/ one-stage-expansion/economizer/ sub-cooler cycle enhanced tracking of load fluctuations



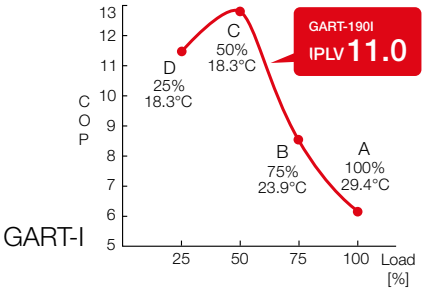
Constant speed drive **GART**

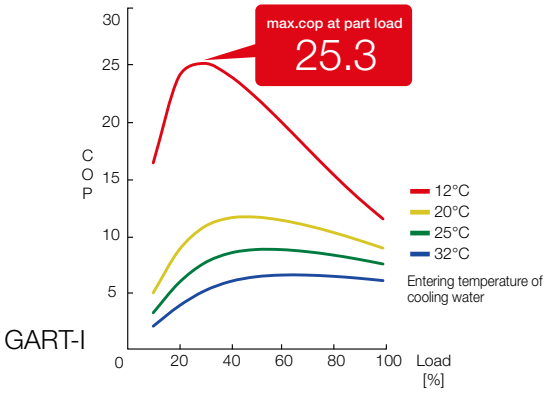
COP	IPLV
[AHRI Standard 550/590(I-P)]	[AHRI Standard 550/590(I-P)]
7.0 GART-135,190,270	**8.2** GART-135



Variable speed drive **GART-I**

Max.COPat part load	IPLV
	[AHRI Standard 550/590(I-P)]
25.3 GART-190	**11.0** GART-190





IPLV

IPLV is the formula developed by AHRI to measure the efficiency of chillers under an actual annual operating conditions. IPLV is calculated when the unit is operating at 25%, 50%, 75% and 100% of capacity and at different cooling water temperature.
[AHRI Standard 550/590(I-P)]

IPLV: Integrated Part Load Value
AHRI: Air-Conditioning, Heating and Refrigeration Institute

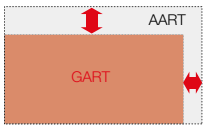
IPLV = 0.01A + 0.42B + 0.45C + 0.12D
A = COP at 100% load (29.4°C*) B = COP at 75% load (23.9°C*)
C = COP at 50% load (18.3°C*) D = COP at 25% load (18.3°C*)
Leaving temperature of chilled water: 6.7°C
*: Entering temperature of cooling water

Compact

- Chiller components are arranged in a way to use vertical space optimally
- Compressors, evaporators and condensers have been reduced in size
- Plate type heat exchanger has been introduced in the economizer

Dimensions

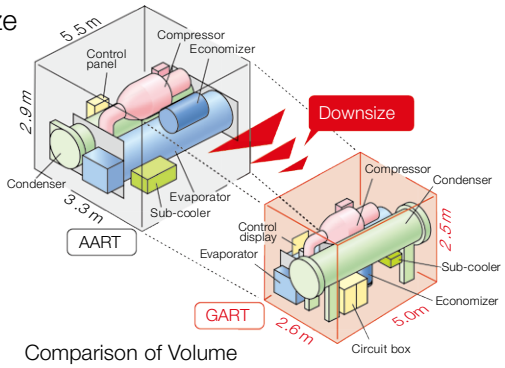
approx. **30**% reduction
〈compared to previous model : AART 1000RT〉



Comparison of Dimensions

Volume

approx. **40**% reduction
〈compared to previous model : AART 1000RT〉



Comparison of Volume

Control panel

More visible, More usable, More diverse

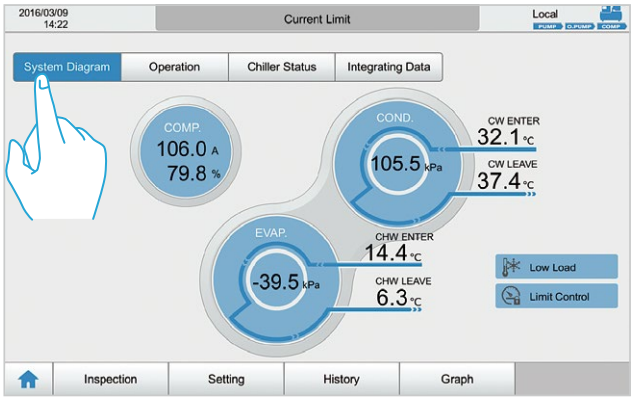
Liquid Crystal Display (LCD) with automatic lighting-up function.
Light up by human detection sensor without touching panel

For environmental standards
Use of lead-free substrate, compatible with RoHS.

Separate off control display and circuit box layout of control display is free (GART / GART-I)

More Accessible

Intutive touch panel
You can access various information and configure the setting just by touching the LCD screen.



System Diagram Screen

More Visible

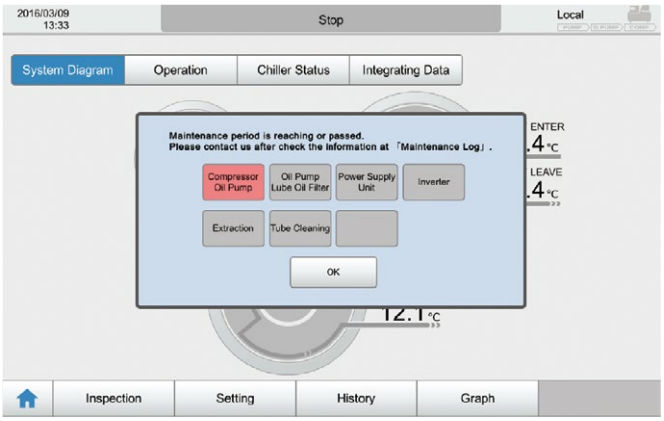
12.1-inch wide screen
More visible and easier to operate compared with the pervious 10.4-inch screen.

More Convinient

Information
- In the case of failure, solution method (help screen) is displayed to support speedy solution.
- Automatically notify a maintenance time and others.

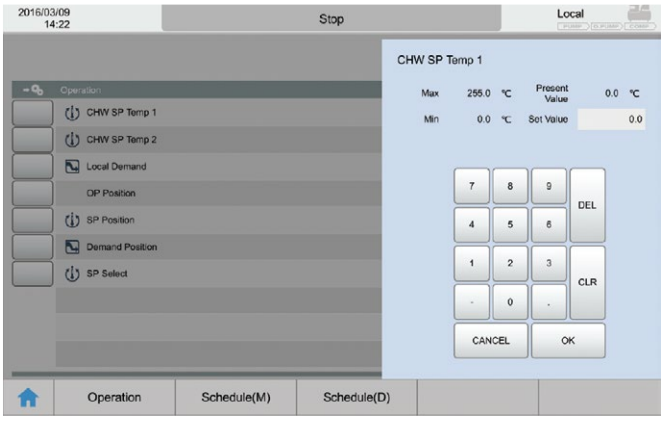
Operation Data Screen

Can display up to a maximum of 18 pieces of data at one time.



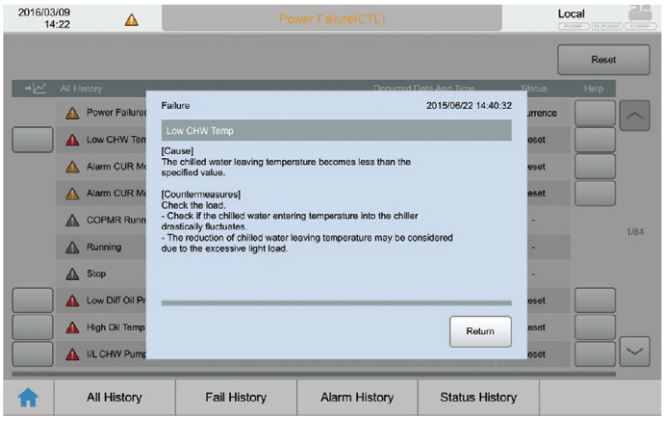
Maintenance Information Data Screen

Notifies chiller maintenance period with pop-up when it approaches.



Temperature Control Screen

Can set chilled water leaving temperature and temperature at demand control.



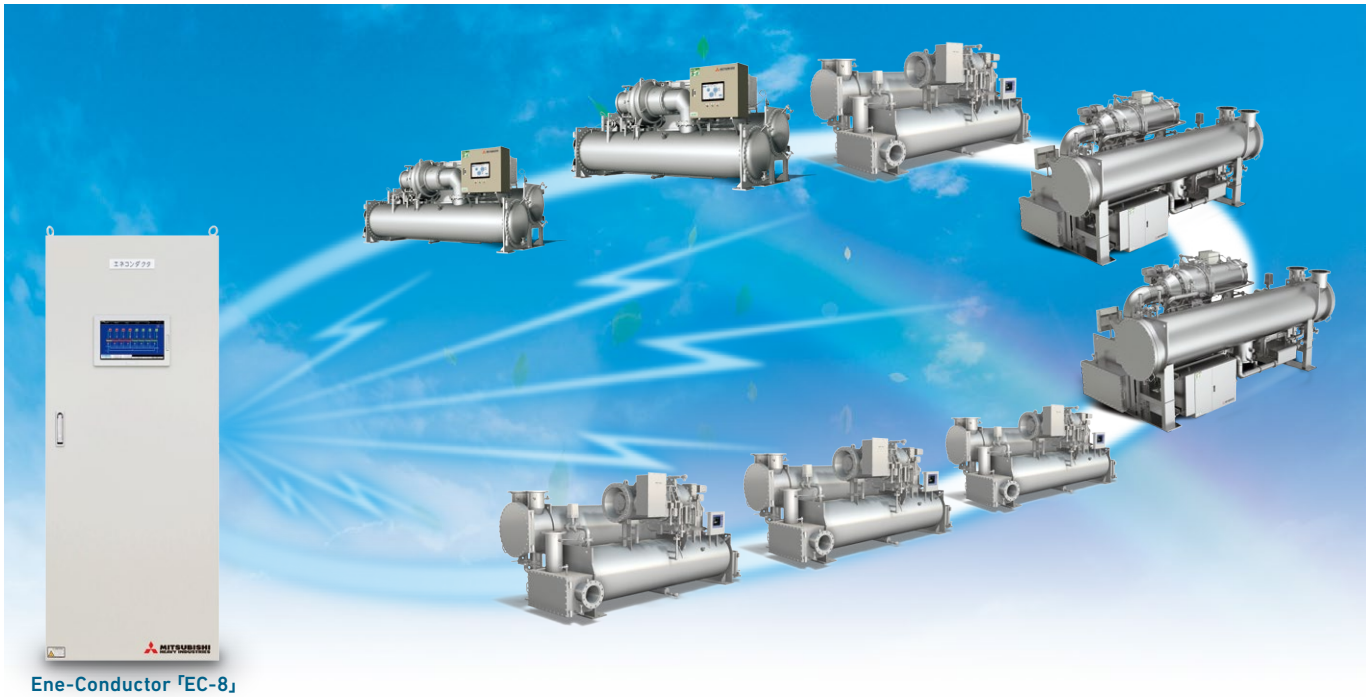
Failure Help Screen

Displays help information on failure recovery.

Heat source control system “Ene-Conductor”

Significant Energy Reduction by total control of heat system - optimization from individual equipment to whole system -

Being required for contemporary office buildings, large shopping malls or factories, it is an environmental protection effort and saving energy but the key issue is the heat source system. Energy-saving had to introduce high efficiency equipment some years ago. However it has to consider energy saving on heat source system levels rather than individual equipment.



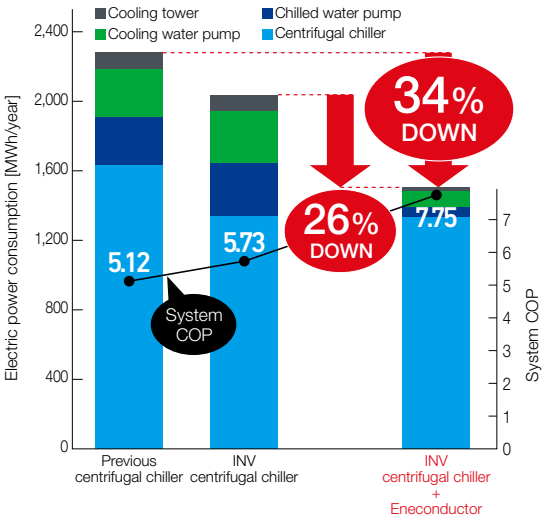
Ene-Conductor「EC-8」

Improvement of system COP by optimal control which gets the best performance out of centrifugal chiller

Various energy-saving control functions

Remote monitoring

Estimation Example



Estimation condition : chiller 700 RT x 3units,Building air conditioner use
* Auxiliary equipment : controlled by inverter

Electric power consumption in whole system — **34% DOWN**

- Improvement in COP of centrifugal chiller
- Chilled water variable flow control
- Cooling water variable flow control

Easy to use for an automatic optimization of the whole system

Application

Mitsubishi Heavy Industries centrifugal chiller presents more power to your production etc.

Semiconductor Industry

Supply chilled water for manufacturing imaging device like digital camera, LCD and semiconductors.

Automotive Industry

Supply chilled water to the drying oven of painting facility and other manufacturing process.
Air conditioning system for the facility requires high cooling load and constant long annual operating hours.

Clean Room

Special control like temperature, humidity, air purification, air flow and air pressure of the room for the semiconductor factories etc.

Hotel / Office

Constant temperature and humidity control for making comfortable atmosphere at luxury hotels, and office.

Data Center

Requirement in air-conditioning system for data center is reliability, stable supply of chilled water and energy saving.
Supply stable chilled water with high efficiency and continuously.

Food Industry

Prevent breeding various germs by cooling rapidly with nearly zero degree chilled water during process of sterilization of the mineral water manufacturing facility.
Also apply to cool down the water during process.
Supply stable water temperature of 10 to 30°C chilled water for cooling down manufacturing machinery.

Chemical Industry

Chilled water supply for dehumidifying the air at deaerate pre-processing phase during the manufacturing process of oxygen and nitrogen.

Sports Facility

Constant temperature and humidity control for making comfortable atmosphere at gymnasium and training facility.
Ice making refrigerating machine at ice skating rink.

District Cooling

District heating and cooling systems (D.H.C) are made up of one or several local plants that produce chilled water and steam for cooling and heating a certain area and hot-water supply, and a network of supply pipes that deliver
these around the clock to a number of buildings.
Centrifugal chiller is the core equipment of D.H.C system.

Shopping Mall

High efficiency is important in large shopping mall.
High efficiency centrifugal chiller and ice thermal storage system using centrifugal chiller are used,
because share of air-conditioning energy consumption is high for requiring annual cooling and constant long operation hours.
The air-conditioning load largely depends on fluctuation of visitors number.
The problem is solved by variable speed drive chiller.

Energy saving example

Sony Device Technology (Thailand) Co., Ltd.

Saving for power consumption and reduction of CO_2 emission are achieved by installation of VSD centrifugal chiller and optimal by Ene-Conductor.

Facilities

Case Study

Lower temperature side (supply chilled water : 7˚C)

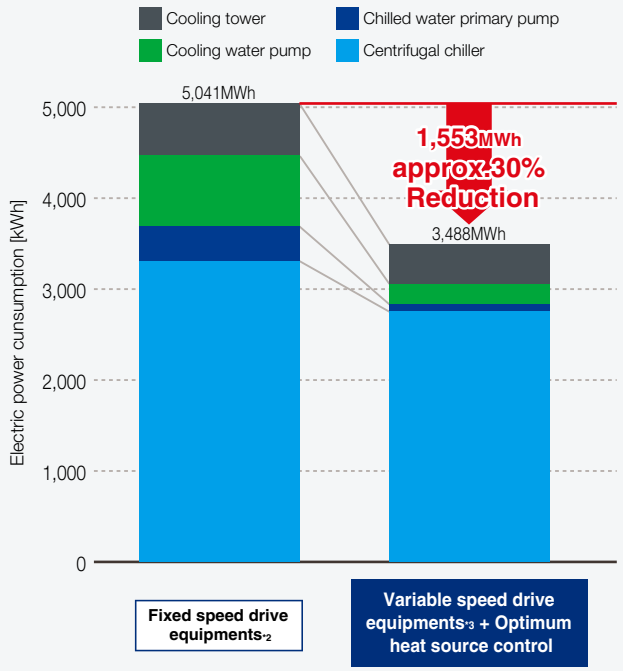
•ETI-50 500 RT × 4 units •Ene-Conductor EC-6 1 unit

Higher temperature side (supply chilled water : 14˚C)

•ETI-50 500 RT × 2 units •Ene-Conductor EC-6 1 unit

Effect (lower temperature side) actual data 2018

Annual Power Consumption *1



Annual Running Cost *4

THB 22.6M (JPY 85,880,000) — Fixed speed drive equipments-2

THB 15.6M (JPY 59,280,000) — Variable speed drive equipments-3 + Optimum heat source control

THB 6.95M (JPY 26,600,000)

approx.30% Reduction

Annual CO_2 Emission *5

2,384.6ton — Fixed speed drive equipments-2

1,649.8ton — Variable speed drive equipments-3 + Optimum heat source control

734.8ton

approx.30% Reduction

*1 Power cunsumption [kW] = Rated power cunsumtion × $\left(\frac{\text{Frequency indication value}}{\text{Rated frequency}}\right)^3$

*2 Centrifugal chiller, Chilled water pump and Cooling water pump : Fixed speed drive
Fixed speed drive centrifugal chiller : GART-50R (500 RT) × 4 units
Fixed speed centrifugal chillers are simulated values using actual load data.

*3 Centrifugal chiller, Chilled water pump and Cooling water pump : Variable speed drive
Variable speed drive centrifugal chiller : ETI-50 (500 RT) × 4 units

*4 Electricity price : calculated using JPY17/kWh and THB3.8/JPY

*5 CO_2 emission factor : calcurated using 0.473kg-CO_2/kWh

Experience

More than 50 years of experience in air-conditioning and DHC system are reflected to improve performance and reliability of products.

MARINA BAY NEW DOWNTOWN

The first district cooling plant in Marina South New Downtown, Singapore, located in One Ruffles Quay（ORQ）development, has been in operation since May 2006. This plant has high-efficiency chillers with thermal storage systems. Supplies will be extended to the integrated resort, Marina Bay Financial Centre and other new commercial buildings in the Marina Bay area as they are completed over the next few years. The two plants will be interconnected via a chilled water network in the new downtown.

- 853 RT Centrifugal chiller × 1 units
- 2,844 RT Centrifugal chiller × 11 units
- 2,000 RT Centrifugal chiller × 2 units
- 3,697 RT Centrifugal chiller × 2 units
- 5,400 RT Centrifugal chiller × 2 units

（Singapore）

KUALA LUMPUR CITY CENTER

Kuala Lumpur City Centre（KLCC）area, a prime landmark in Kuala Lumpur, Malaysia's capital city is Kuala Lumpur' s main business district, perhaps best known for the PETRONAS Twin Towers: the 452-meter high, 88-storey skyscrapers completed in1997. The area is also home to the Suria KLCC shopping complex, the Aquaria KLCC oceanarium, a park and a philharmonic hall, and as a result it is always crowded with both business persons and visitors. We have received an order for 13 large-size centrifugal chillers, with a total cooling capacity of 36,400 RT.Delivery of the chillers is slated for completion in September 2014.

- 2,800 RT Centrifugal chiller × 13 units

（Malaysia）

AMARI WATERGATE BANGKOK

Amari Watergate Bangkok is a luxury 5 star hotel located in centre of Bangkok.
New Energy and Industrial Technology Development Organization（NEDO）carried out energy saving model project utilizing Japanese energy conservation technologies.
Our centrifugal chillers were adopted as air conditioning system and achieved significant energy reduction.

- 460 RT Centrifugal chiller × 2 units

（Thailand）

MADINA HAJJ PROJECT

Medina is one of Islam's two holiest cities. By enabling air conditioning of large spaces where vast numbers of pilgrims gather, Our centrifugal chillers will help provide the city's many visitors and residents with a more comfortable environment.
The 80 units will deliver a combined cooling capacity of approximately 200,000 RT, The district cooling plant will also supply chilled water to an area of 1.6 million square meters（m^2）.

- Centrifugal chiller × 80 units（variable speed drive）Total 200,000 RT

（Saudi Arabia）

<Note> DHC: District Heating and Cooling HVAC: Heating, Ventilation and Air Conditioning

RAFFLES CITY CHONGQING

Raffles City Chongqing, the new landmark of Chongqing with a total construction area of over 1.12 million sqm, comprises 8 super tower buildings, including high-end residential, shopping malls, office buildings, and international five-star hotel and service apartments. Our centrifugal chillers are adopted by contractors to create clean and comfortable environment by making rational use of regional energy effectively.

- 2,500 RT Centrifugal chiller × 4 units (GART-250P)
- 840 RT Centrifugal chiller × 4 units (GART-80P)

(China)

CHINA GUANGZHOU INTERNATIONAL CONVENTION AND EXHIBITION CENTER

Our centrifugal chillers are installed in one of the most famous and elegant exhibition center in the world, which plays a very important role in the Chinese trade market.
Hermetic motor used in 10 kV / 50 Hz* power source.
(except for 380 RT below)
*Hermetic motor used in 11 kV / 50 Hz available.

- 380 RT Centrifugal chiller × 1 unit
- 1,000 RT Centrifugal chiller × 2 units
- 2,000 RT Centrifugal chiller × 8 units

(China)

ASAHI BREWERIES, LTD. IBARAKI BREWERY

Factories of Asahi Breweries make several efforts while protecting important global environment and walking with nature.
As one of effort to reduce CO_2 emission, Ibaraki Brewery installed a high efficiency Our Centrifugal Chiller, variable speed drive ETI-Z adopting Low GWP refrigerant. Our Centrifugal Chillers support energy saving of the factory and to prevent global warming.
*GWP=Global Warming Potential

- 480 RT Centrifugal chiller (Variable speed drive) × 1 unit (ETI-Z50)

(Japan)

MINATO MIRAI 21

Our 10 Centrifugal Chillers are installed in MM21 DHC Plant where "Land Mark Tower" and "Queens Square" are located.

- 2,650 RT Centrifugal chiller × 2 unit
- 4,000 RT Centrifugal chiller × 1 unit
- 4,400 RT Centrifugal chiller × 1 unit
- 5,000 RT Centrifugal chiller × 1 unit
- 5,400 RT Centrifugal chiller × 2 units
- 5,400 RT Centrifugal chiller × 4 units (variable speed drive)

(Japan)

Centrifugal Chillers

Mitsubishi Heavy Industries Thermal Systems, Ltd.
(Wholly-owned subsidiary of MITSUBISHI HEAVY INDUSTRIES, LTD.)

2-3, Marunouchi 3-chome, Chiyoda-ku, Tokyo, 100-8332, Japan
https://www.mhi-mth.co.jp/en/

Our factories are ISO9001 and ISO14001 certified.

Certified ISO 9001

Certificate number: JQA-0709

Certified ISO 14001

MTHSS007, 2503 (1.0) R13

VEGETABLE OIL INK

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