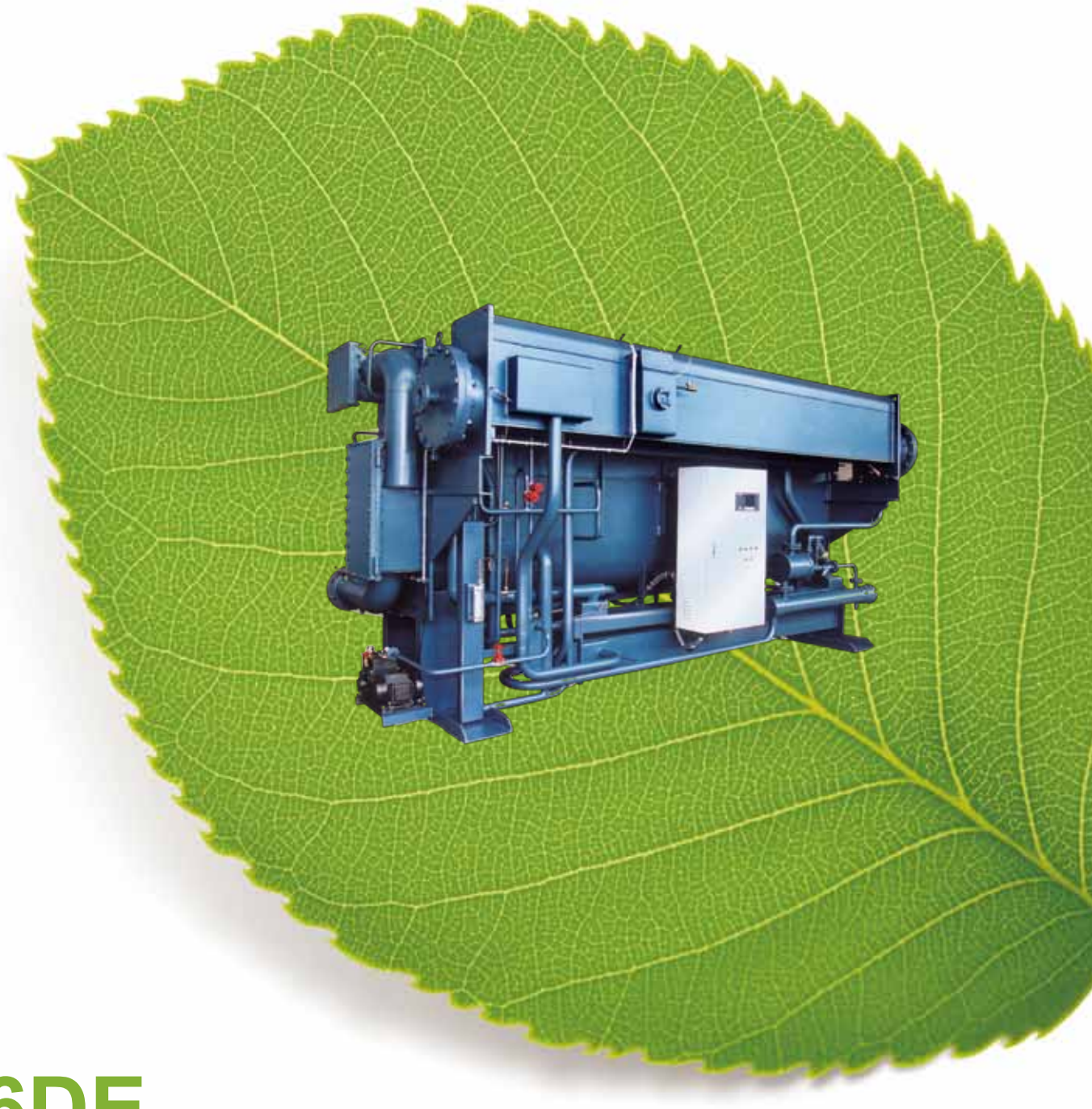
Carrier

turn to the experts



16DE

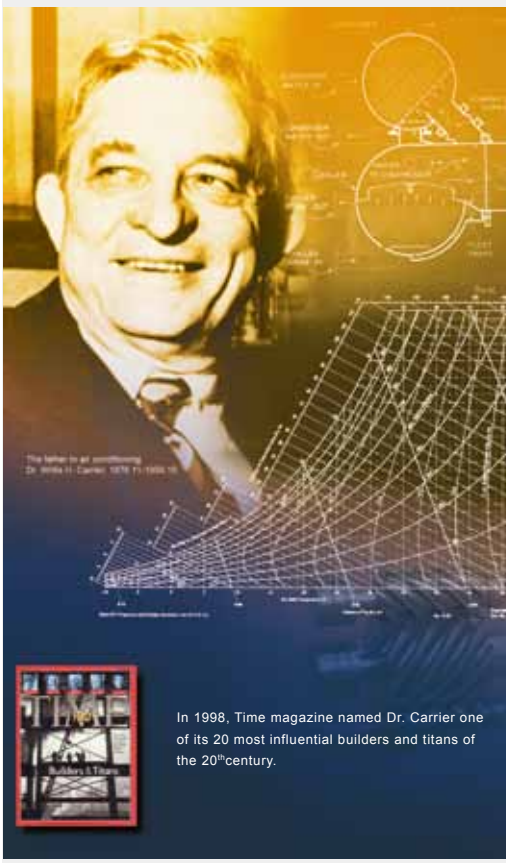
Double Effect, Hermetic Absorption Liquid Chiller

Cooling Capacity: 150 to 660 Nominal Tons (528 to 2321kW)

Carrier China

Carrier Corporation is a subsidiary of the United Technologies Corp. (UTC), which ranks the 150th in Fortune Top 500 in 2011 and has its operations in aerospace and building systems industries all over the world. From the time the founder Dr. Carrier invented the first system of modern air conditioning in 1902, Carrier has been the world leader in the air conditioning industry with its products and system solutions supplied to numerous famous buildings, and up to now, the network of distribution cover more than 170 countries all over the world. In 2011, Carrier ranked top in the HVAC industry field with its sales revenue of US $12 billion.

In China, there are 6 Carrier factories which have more than 2500 employees. As the world-class factory, Carrier has a number of technically advanced production lines, manufacturing commercial and residential chillers, compressors and air-side products. A wide range of products are able to meet diversified requirements of different customers. The global R&D center located in Shanghai has the capability of developing several major projects in the same time, with many advanced technical patents awarded to support Carrier stay most competitive in terms of technology advantage in the HVAC industry.



In 1998, Time magazine named Dr. Carrier one of its 20 most influential builders and titans of the 20th century.

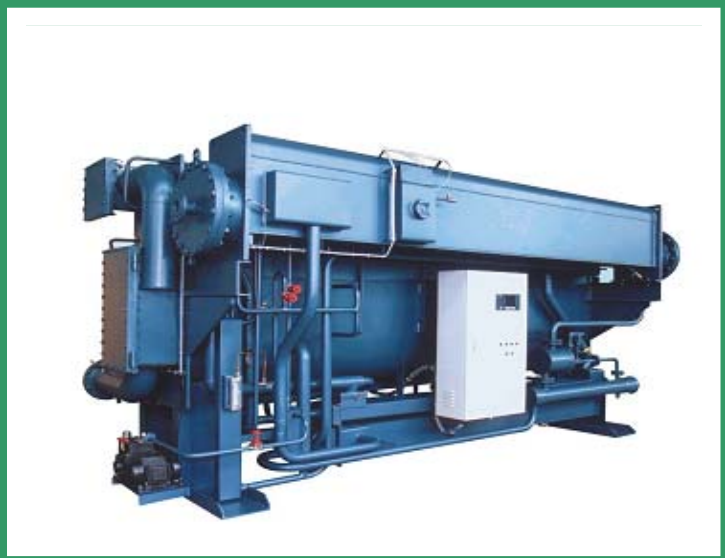
Carrier

Product Data

16DE
Double Effect, Hermetic Absorption Liquid Chiller

150 to 660 Nominal Tons (528 to 2321kW)

16DE SERIES



Carrier's 16DE double effect, hermetic absorption liquid chiller provides an alternative means of efficient, cost effective water chilling. By utilizing high-pressure steam, 16DE chillers avoid high-cost electricity and quality for utility rebates and incentives as a gas cooling product.

- no CFCs; environmentally friendly
- two-stage high efficiency design reduces energy costs
- quiet, vibration-free operation
- few moving parts equates to high reliability

Features/Benefits

High-pressure steam-fired absorption reduces energy costs, providing economical water chilling and/or process cooling.

Cost-effective cooling Alternative-energy chiller – The 16DE offers an alternative to chillers driven by increasingly expensive electrical energy. The use of steam-powered absorption not only eliminates demand charges and high cost electrical usage, but also allows the owner to take advantage of gas cooling rebates and incentive programs offered by many utility companies. The 16DE is therefore economical to own and operate compared to other types of chillers.

Double-effect absorption cycle increases efficiency – The 16DE design incorporates a high-temperature generator and a low-temperature generator (double effect) that provide 2 stages of solution re-concentration. As a result of this double-effect cycle, the 16DE has lower operating costs than

Features/Benefits (cont)

single-effect machines. The 16DE chiller offers typical full load steam rates of less than 10 lb/hr-ton at standard ARI (Air Conditioning and Refrigeration Institute) operating conditions.

Superior part-load performance – The 16DE's standard concentration control system allows stable, part-load operation at cooling water temperatures as low as 59 F (15 C) without the need for a cooling tower bypass. For maximum efficiency, a variable frequency drive pump automatically maintains optimum solution flow to the high- and low-stage generators at all operating conditions. This will result in improved part-load efficiency and eliminate the need for manual setup adjustments of the solution flow.

High-efficiency condensate drain heat exchanger saves energy – Every 16DE incorporates a condensate drain heat exchanger which reduces steam consumption, resulting in further energy savings. Valuable energy (in the form of heat) in the condensate leaving the generator is transferred to the weak lithium bromide solution as it is pumped to the generator. This reduces the amount of energy required to operate the chiller at both full and part-load.

Application versatility Ideal for new or retrofit applications – From comfort cooling to providing chilled water for process applications, the 16DE double-effect absorption chiller offers versatility for almost any job where high-pressure steam is available as the heat source. The 12 model sizes, spanning a capacity range of 150 to 660 tons, make the 16DE double-effected, absorption chiller the ideal choice for comfort cooling and/or light industrial applications.

Carrier's computerized performance ratings assist in the selection of the correct size machine to meet exact job requirements. Dependable operation, as well as low sound and vibration levels, ensures occupant comfort, even when the machine is installed on upper floors.

Combined use of absorption and electric-driven chillers – Utilizing both absorption and electric chillers in a central plant offers the flexibility to base load one chiller, while using the other to handle peak load requirements. Hybrid chiller systems have proven to be an economical solution for many comfort cooling installations. In many geographical areas, operating the electric chiller as the base loaded machine, while using the absorption chiller during peak load conditions, reduces or avoids electric demand charges. Depending on utility rate structures, the 16DE absorption chiller used in conjunction with an electric-driven chiller may be the most efficient and cost-effective combination available.

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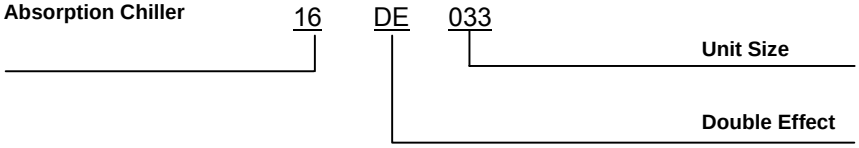
Model number nomenclature



Features/Benefits (cont)

Location and installation

Ease of installation – All 16DE units are completely fabricated, assembled, and wired in the factory as single-piece units. Standard shipping configuration is 1 piece. Refer to the 16DE Standard Shipping Configuration table below.

16DE STANDARD SHIPPING CONFIGURATION

UNIT SIZE	1-PIECE ASSEMBLY	2-PIECE ASSEMBLY
015-066	X	

The 16DE015-066 machines are shipped completely assembled as a standard feature Job-site reassembly and alignment of machines shipped in multiple sections is simplified by preerecting the machine in the factory and by incorporating weld-type assembly flanges on all interconnecting piping.

Flanged water box nozzles – To simplify chiller installation and field piping, all water box nozzles on the evaporator, absorber, and condenser are factory-supplied GB raised face (RF) flanges. ANSI raised face (RF) flanges are optional.

Low maintenance

Standard features allow simple maintenance procedures – Every 16DE machine has numerous standard design features that are provided for convenient and simple maintenance. Hinged waterbox cover on the absorber, and condenser facilitate tube and waterbox inspection. In addition, epoxy coating of the waterboxes and covers, standard on all machines, protects against corrosion and extends machine life. All moving parts are easily accessible for inspection or replacement, as required.

Factory-trained service organization – Carrier's extensive service organization offers trained and experienced service technicians in every major city. In addition to routine maintenance and repair services, Carrier also offers a wide array of preventative maintenance, full maintenance, and/or extended service contracts that can be custom tailored to any level of service.

Leak-proof hermetic pumps/motors cut maintenance costs – Carrier's proven solution and refrigerant pumps/motors are leak-proof, completely self-contained, and hermetically sealed. The hermetic design eliminates the need for a separate, complicated, and possibly leak-prone seal water system while providing leak tightness and longer machine life. Specially designed bearings absorb both radial and axial thrusts to ensure correct fit at all times. There is no possibility of external contamination since the fluid being pumped lubricates and cools the pump and motor assemblies. In addition, both the rotor and the stator are separated by a stainless steel liner that protects the windings from the fluid being pumped. As an additional safety feature, thermal over-load switches are embedded in the stator to protect against high winding temperatures. The pumps are field serviceable.

VIEW OF TYPICAL HERMETIC PUMP/MOTOR ASSEMBLIES

Reliable operation

PD5 control center continuously monitors machine operation, ensuring precise control – Each Carrier 16DE absorption chiller includes a factory mounted and wired PD5 control center that is functionally tested prior to shipment. Continuous monitoring and control of machine operation are performed automatically. A multi-language display on the front of the control center identifies operational status and fault indication. All control center components and the assembly will meet local code of GB where appropriate and include a main board, a NRCP2 board, tow Aux. boards, molded case circuit breaker, pump contactors, ambient compensated 3-phase pump overload protection, multi-tap control power transformer, and all other necessary safeties and controls.

As part of the start-up sequence, the chiller PD5 control center initiate a self-diagnostic system check to verify that all sensors are in range. Other standard features include a remote start/stop switch and a key-locked control center door that protects against unauthorized access.

PD5 control features/benefits

Chilled water reset – Reset can be accomplished manually or automatically from the building management system. Chilled water reset saves energy when warmer chilled water can be used.

Ramp loading – Ramp loading ensures a smooth

Features/Benefits (cont)

pulldown of water loop temperature and prevents a rapid increase in steam consumption.

Variable Frequency Drive (VFD) – PD5 provides VFD for solution pump control.

Advanced crystallization protection – Protects against crystallization by automatically sensing impending abnormalities in the absorption operating cycle and taking a series of actions to either self-correct and/or limit the chiller from approaching the cycle crystallization line.

Absorption cycle state points – Absorption cycle status points provide the operator with precise and dynamic cycle operating conditions at any time during chiller operation. They save time by eliminating the cumbersome task of taking solution samples and calculating state points and assist in both chiller operation and diagnostics.

Refrigerant low temperature override – The capacity control valve position is inhibited to prevent freeze-up and ensure continuous chiller operation.

Extensive service menu – Unauthorized access to the service menu can be password-protected. Built-in, enhanced, diagnostic capabilities assist in troubleshooting and recommend proper corrective action for pre-set alarms, resulting in more up time.

Alarm history – The last 25 alarms and/or alerts are retained in memory with date and time stamps. Alarm histories reduce troubleshooting time and cost.

In order to prevent the incorrect power wiring in the site to make the pump and burner fan reversal, the Power Phase Sequence Protector is added in the control panel. Only when the connection of the power phase sequence protector is correct, the chiller can start up.

16DE PD5 CONTROL CENTER

Superior corrosion protection – Absorption chillers must be protected from the possibility of internal corrosion that is always present when lithium bromide solution is in contact with internal machine surfaces. The Carrier 16DE absorption chiller incorporates a highly effective corrosion inhibitor to provide an extra margin of protection against internal corrosion. Other inhibitors may require the use of exotic tube materials in certain heat exchangers since they are less effective and require frequent maintenance and analysis. The superior corrosion protection of the Carrier inhibitor allows for the use of standard copper tubes throughout the machine (except for the high-stage generator tubes and the high temperature solution heat exchanger tubes that are made of 90-10 cupronickel). This results in long machine life and dependable operation.

Rugged machine construction – Every Carrier 16DE chiller offers numerous standard features designed to provide reliable, trouble-free operation. The machine is fabricated to meet stringent manufacturing and design requirements and is Carrier-listed to ensure product safety and machine integrity. Non-clogging, corrosion proof spray nozzles protect the 16DE from corrosion and blockage for continuous, reliable operation. Horizontally-positioned, 90-10 cupronickel tubes in the high temperature generator with steam on the inside and lithium bromide on the outside to allow the tube bundle to expand and adjust freely when subjected to rapid temperature changes. The above standard features are evidence of Carrier's commitment to building a double effect chiller able to withstand the most rigorous comfort cooling or light industrial applications.

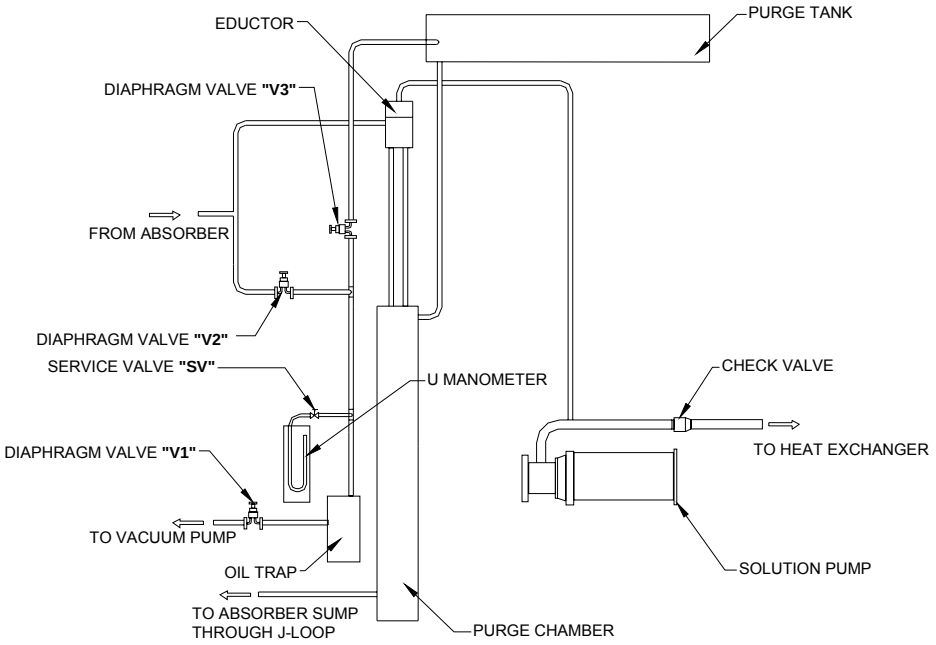
Condensate drain heat exchanger is factory installed – This energy-saving feature, consisting of a shell-and-tube heat exchanger and a float/trap assembly, is completely factory mounted and piped. There is no need for an additional trap in the condensate piping, thus reducing job site piping costs.

Single-point box electrical connection – Installation costs are further reduced by eliminating field wiring between machine components. On units shipped as a single assembly, all unit-mounted electrical items are factory-wired to the chiller microprocessor control center. Only a single-point electrical connection to the machine from the building's electrical service is required. A multi-tap transformer, mounted in the chiller control center, provides secondary, single-phase power for the 16DE controls.

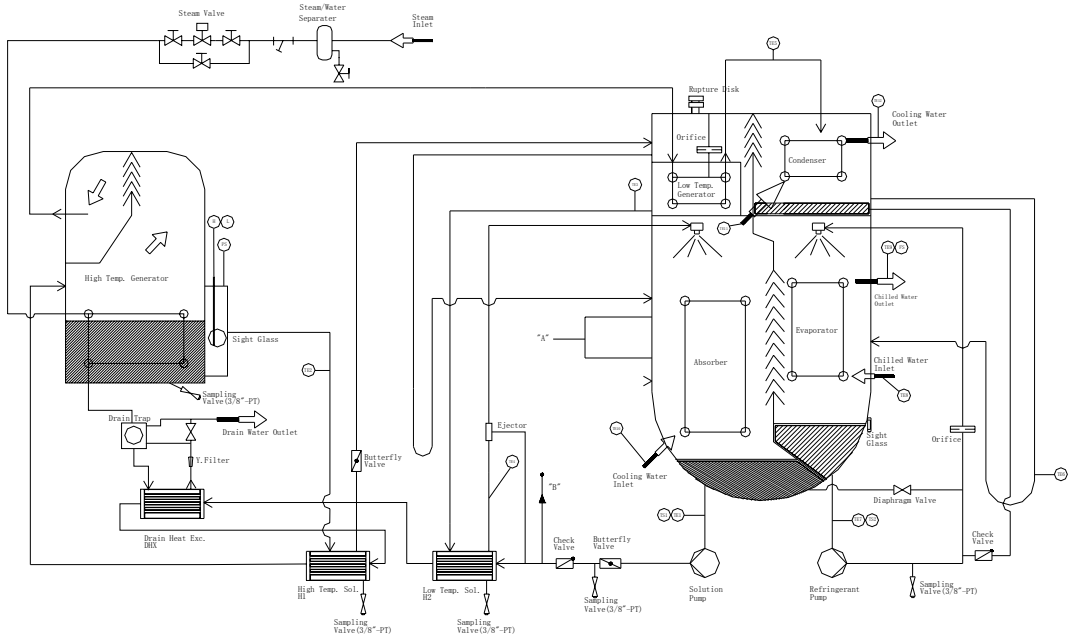
Low noise and vibration allows location flexibility – Low sound and vibration levels are characteristic of absorption chillers, primarily due to the fact that the only rotating parts are the refrigerant and solution pumps. The overall sound level of a Carrier 16DE is typically 80dbA. This allows the machines to be installed near occupied spaces or in areas with strict sound requirements. Low vibration levels also make it possible to install the chiller on upper floors without special consideration for vibration dampening systems.

Features/Benefits (cont)

TYPICAL MOTORLESS PURGE OPERATION SCHEMATIC



16DE ABSORPTION COOLING CYCLE



Features/Benefits (cont)

Automatic, motorless purge system extends machine life and ensures optimum efficiency and performance – The purge system of an absorption chiller is critical to ensuring efficient operation and long machine life. Even when machines are vacuum tight or properly inhibited, all absorption chillers generate hydrogen and other noncondensable gases in small quantities. Since these gases are present in sufficient volume to interfere with proper machine operation, they must be removed to protect the unit from internal corrosion, lithium bromide solution crystallization, and/or a reduction in chiller capacity. Carrier's motorless purge system protects 16DE machines from these potential hazards by working continuously during machine operation.

Motorless purge system operation – During operation, non-condensables tend to accumulate in the absorber section, which operates at the lowest internal pressure. A slip-stream of lithium bromide solution from the solution pump discharge flows through an eductor, creating a suction that draws noncondensables from the absorber. The noncondensables are then entrained by the solution flowing through the eductor. The eductor discharges the solution and noncondensables into a separator in a purge chamber, where the noncondensables are separated from the solution. The noncondensables flow to a storage tank, while the solution returns to the absorber sump. As noncondensables accumulate in the external storage tank, they are isolated from the chiller and cannot reenter the machine (even during shutdown). These gases must periodically be exhausted (as required) from the storage tank by a simple procedure performed while the machine is running. Evacuation is performed by a unit-mounted vacuum pump that is connected to the purge evacuation valve. Evacuation through the vacuum pump is necessary because the palladium cell will be damaged if wetted by the lithium bromide solution. Therefore, pressurizing the purge tank above atmospheric pressure with lithium bromide solution is not permitted. The unit-mounted vacuum pump can also be used during chiller maintenance or service to remove noncondensables directly from the machine.

Anti-crystallization controls maintain proper solution concentration – The 16DE automatically limits solution concentration in several ways to avoid both crystallization and overdilution to provide dependable, trouble-free operation. Crystallization of the lithium bromide solution depends on the combination of temperature and concentration. Carrier's concentration control system automatically monitors the refrigerant water level in the evaporator in conjunction with the solution temperature returning to the absorber. Because concentration varies with the amount of water in the lithium bromide solution, a rising evaporator level indicates less water in the solution and thus a higher solution concentration. When the refrigerant in the evaporator rises to a weir level, water is transferred from the evaporator to the absorber thus preventing overconcentration to ensure continuous, reliable operation even at cooling water temperature as low as 59F (15C). Overdilution (and possible refrigerant pump cavitation) shall be controlled by transferring an additional amount of refrigerant from the condenser to the evaporator.

The 16DE also incorporates a simple, passive method of control to correct any crystallization that would typically start to occur on the shell-side of the low temperature solution heat exchanger under abnormal conditions. As the hot solution begins to back up in the generator, as a result of any shell-side blockage, it rises above the overflow pipe and returns directly to the absorber. It is subsequently pumped through the tube-side (heating the shell-side) to restore proper operation.

In addition, the 16DE automatic dilution cycle ensures proper concentration after unit shutdown so that the unit will not crystallize when the machine cools to ambient or machine room temperature. The dilution cycle controls operation of the pumps for a set period of time after shutdown to dilute the solution to prevent an overconcentration condition.

16DE double effect absorption cooling cycle – The 16DE double effect absorption chiller consists of an evaporator, absorber, condenser, high- and low-stage generators, solution heat exchangers, steam condensate drain heat exchanger, refrigerant/solution pumps, purge, controls and auxiliaries. Water is used as the refrigerant in vessels maintained under low absolute pressure (vacuum). In the cooling mode, the chiller operates on the principle that under vacuum, water boils at a low temperature. In this case water boils at approximately 40F (4.4C), thereby cooling the chilled water circulating through the evaporator tubes. A refrigerant pump is used to circulate the refrigerant water over the evaporator tubes to improve heat transfer.

To make the cooling process continuous, the refrigerant vapor must be removed as it is produced. To accomplish this, a lithium bromide solution (which has a high affinity for water) is used to absorb the water vapor. As this process continues, the lithium bromide becomes diluted, reducing its absorption capacity. A solution pump then transfers this weak (diluted) solution to the generators where it is recon-centrated in 2 stages to boil off the previously absorbed water. A variable frequency drive pump automatically maintains optimum solution flow to the generators at all operating conditions for maximum efficiency. The diluted solution is pumped to the high-stage generator where it is heated and reconcentrated to a medium concentration solution by the heat from high pressure steam. The medium concentration solution from the high-stage generator flows to the low-stage generator where it is heated and reconcentrated to a

Features/Benefits (cont)

strong solution by the high temperature water vapor released from the solution in the high-stage generator. Since the low-stage generator acts as the condenser for the high-stage generator, the heat energy first applied in the high-stage generator is used again in the low-stage generator thus reducing the heat input by approximately 45% as compared to an absorption chiller with a single stage of reconcentration. The water vapor released in the shell-side of the low-stage generator, in addition to the now condensed water vapor from the tube-side of the low-stage generator, enters the condenser to be cooled and returned to a liquid state. The refrigerant water then returns to the evaporator to begin a new cycle. To remove heat from the machine, relatively cool water from a cooling tower or other source is first circulated through the tubes of the absorber to remove the heat of vaporization. The water is then circulated through the tubes of the condenser.

The strong (reconcentrated) solution from the low-stage generator flows back to the absorber to begin a new cycle. For efficiency reasons, the medium concentration solution from the high-stage generator is passed through the high-temperature solution heat exchanger to pre-heat the weak solution, while pre-cooling the medium concentration solution. The strong solution from the low-stage generator is passed through the low-temperature solution heat exchanger to preheat/precool the solution before being returned to the absorber. The efficiency is further improved by use of a condensate drain heat exchanger which transfers additional heat from the steam condensate to the weak solution.

Options and accessories

IEM	OPTION*	ACCESSORY+
300 psig (2068 kPa) Waterboxes	X	
Special Tubing	X	
Unit Voltage (400, 460-3-60/50)	X	
Isolation Package		X
Condenser Water Flow Switch	X	

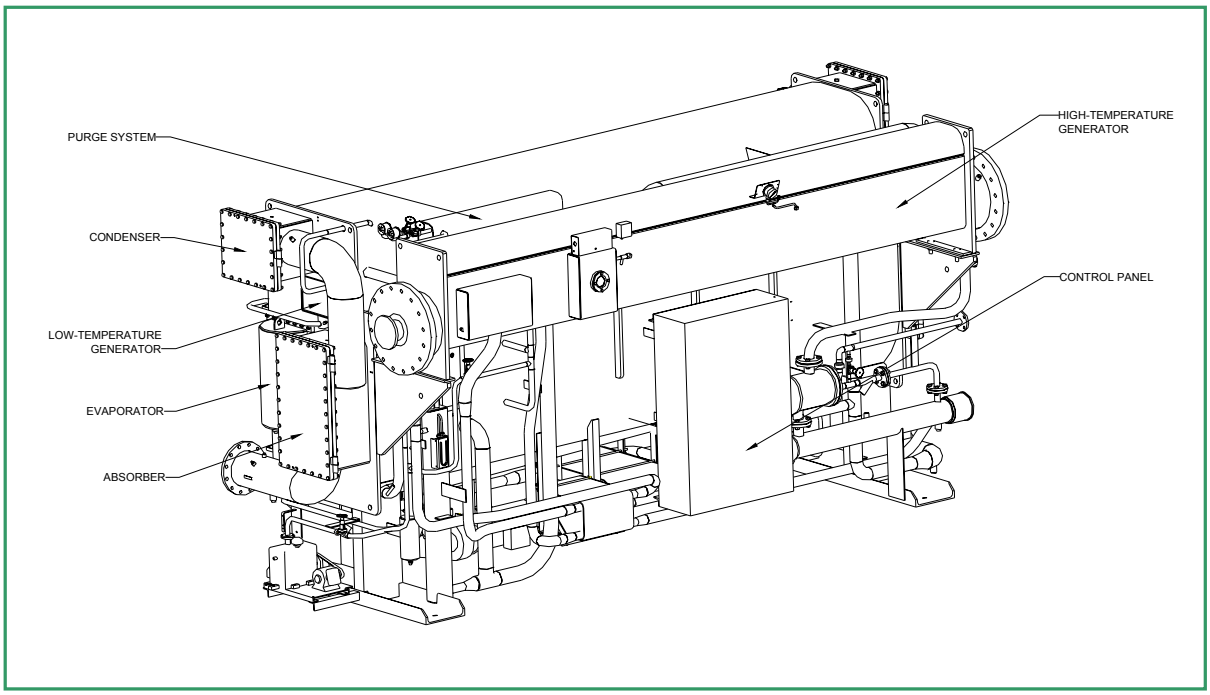
LEGEND

*Factory installed.
+Field installed.

For more information, contact Carrier or your local representative with your special application requirements.

Machine components

TYPICAL 16DE



Physical data

ENGLISH

Unit 16DE	015	018	021	024	028	033
NOMINAL COOLING CAPACITY (ton)	150	180	210	240	280	330
RIGGING WEIGHT* (lb)						
Absorber/Evaporator/G2/Condenser	8,737	9,033	10,695	11,023	13,595	14,130
G1	2,022	2,057	2,357	2,403	3,225	3,574
Total	10,758	11,089	13,051	13,426	16,821	17,703
OPERATING WEIGHT (lb)	14,154	14,749	17,703	18,232	24,394	24,780
CHILLED/HOT WATER						
Pipe Connection Size (in.)	4	4	5	5	6	6
No. Passes	3	3	3	3	2	2
COOLING WATER						
Pipe Connection Size (in.)	5	5	6	6	8	8
No. Passes						
Absorber	2	2	2	2	2	2
Condenser	1	1	1	1	1	1
STEAM						
Pipe Connection Size (in.)						
Inlet	2	2	2.5	2.5	2.5	2.5
Outlet	1	1	1	1	1	1

Unit 16DE	036	040	045	050	060	066
NOMINAL COOLING CAPACITY (ton)	360	400	450	500	600	660
RIGGING WEIGHT* (lb)						
Absorber/Evaporator/G2/Condenser	15,204	15,752	17,857	18,497	30,357	32,408
G1 (Includes Burner)	3,580	3,660	3,770	3,880	3,968	4,034
Total	18,783	19,412	21,627	22,377	34,326	36,442
OPERATING WEIGHT (lb)	27,822	28,704	30,886	31,901	49,615	53,351
CHILLED/HOT WATER						
Pipe Connection Size (in.)	6	6	8	8	8	8
No. Passes	2	2	2	2	2	2
COOLING WATER						
Pipe Connection Size (in.)	8	8	10	10	12	12
No. Passes						
Absorber	2	2	2	2	2	2
Condenser	1	1	1	1	1	1
STEAM						
Pipe Connection Size (in.)						
Inlet	3	3	3	3	4	4
Outlet	1	1	1	1	2	2

G1 – High-Temperature Generator

G2 – Low-Temperature Generator

*standard shipping configuration is 1-piece for sizes 015-066.

Physical data (cont)

SI

Unit 16DE	015	018	021	024	028	033
NOMINAL COOLING CAPACITY (kW)	528	633	739	844	985	1,161
RIGGING WEIGHT* (kg)						
Absorber/Evaporator/G2/Condenser	3,963	4,097	4,851	5,000	6,167	6,409
G1	917	933	1,069	1,090	1,463	1,621
Total	4,880	5,030	5,920	6,090	7,630	8,030
OPERATING WEIGHT (kg)	6,420	6,690	8,030	8,270	11,065	11,240
CHILLED/HOT WATER						
Pipe Connection Size (mm)	100	100	125	125	150	150
No. Passes	3	3	3	3	2	2
COOLING WATER						
Pipe Connection Size (mm)	125	125	150	150	200	200
No. Passes						
Absorber	2	2	2	2	2	2
Condenser	1	1	1	1	1	1
STEAM						
Pipe Connection Size (mm)						
Inlet	50	50	65	65	65	65
Outlet	25	25	25	25	25	25

Unit 16DE	036	040	045	050	060	066
NOMINAL COOLING CAPACITY (kW)	1,266	1,407	1,583	1,759	2,110	2,321
RIGGING WEIGHT* (kg)						
Absorber/Evaporator/G2/Condenser	6,896	7,145	8,100	8,390	13,770	14,700
G1	1,624	1,660	1,710	1,760	1,800	1,830
Total	8,520	8,805	9,810	10,150	15,570	16,530
OPERATING WEIGHT (kg)	12,620	13,020	14,010	14,470	22,505	24,200
CHILLED/HOT WATER						
Pipe Connection Size (mm)	150	150	200	200	200	200
No. Passes	2	2	2	2	2	2
COOLING WATER						
Pipe Connection Size (mm)	200	200	250	250	300	300
No. Passes						
Absorber	2	2	2	2	2	2
Condenser	1	1	1	1	1	1
STEAM						
Pipe Connection Size (mm)						
Inlet	80	80	80	80	100	100
Outlet	25	25	25	25	25	25

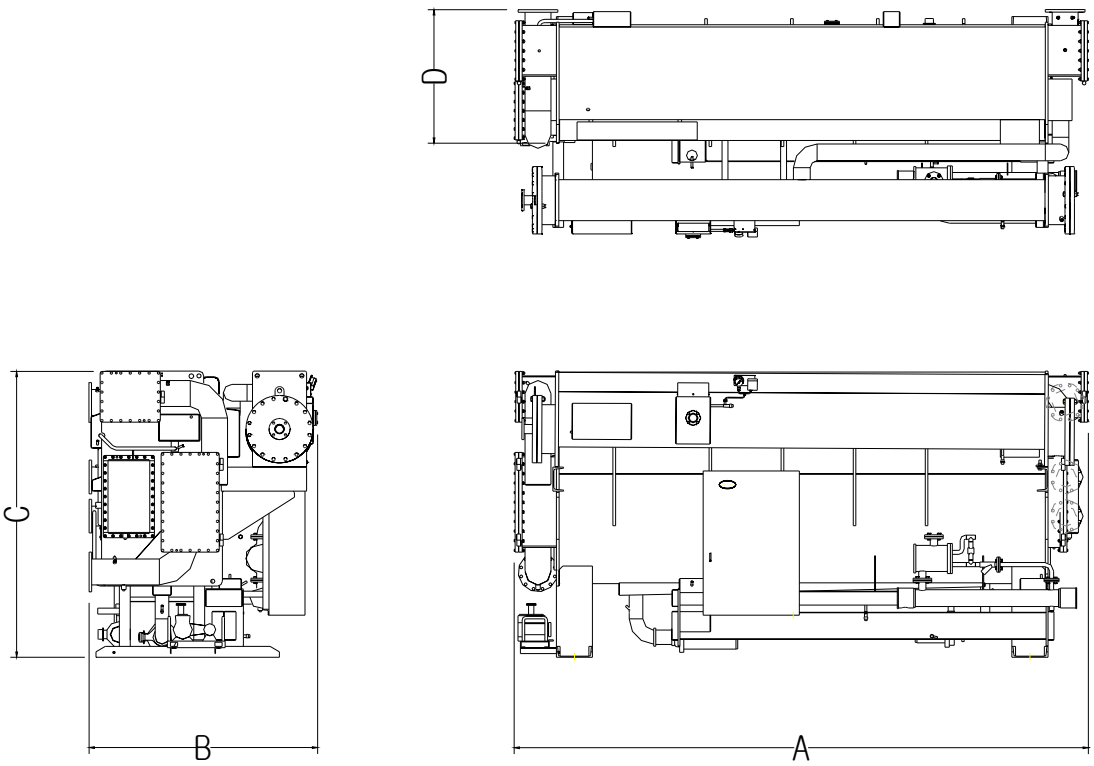
G1 – High-Temperature Generator

G2 – Low-Temperature Generator

*Standard shipping configuration is 1-piece for sizes 015-066.

Dimensions

16DE SIZES 015-066



DIMENSIONS (ft-in)

UNIT 16DE	015	018	021	024	028	033	036	040	045	050	060	066
Overall Length A	11-11	11-11	12-0	12-0	15-8	15-8	15-9	15-9	16-0	15-9	18-6	20-2
Overall Width B	5-1	5-1	5-7	5-7	6-2	6-2	6-6	6-6	6-10	6-10	7-10	7-10
Overall Height C	6-9	6-9	7-7	7-7	7-10	710	8-8	8-8	9-3	9-3	10-2	10-2
Width D*	4-0	4-0	4-4	4-4	4-8	4-8	4-9	4-9	5-4	5-4	5-4	5-4

DIMENSIONS (mm)

UNIT 16DE	015	018	021	024	028	033	036	040	045	050	060	066
Overall Length A	3,631	3,631	3,668	3,668	4,774	4,774	4,800	4,800	4,867	4,867	5,640	6,142
Overall Width B	1,556	1,556	1,714	1,714	1,866	1,866	1,980	1,980	2,079	2,079	2,386	2,386
Overall Height C	2,056	2,056	2,309	2,309	2,381	2,381	2,630	2,630	2,820	2,820	3,102	3,102
Width D*	1,209	1,209	1,328	1,328	1,413	1,413	1,456	1,456	1,614	1,614	1,623	1,623

*Standard shipping configuration is 1-piece for sizes 015-066.

NOTES:
1. All dimensions in mm are accurate and take into account absorber-condenser crossover piping.
2. For routine maintenance, allow 3 ft (1 m) clearance on all sides and 6 in. (150 mm) above chiller.
3. For service access, allow clearance as follows:
   a. For tube removal, allow space equal to “A” dimension (length) at either end of the chiller.
   b. To open waterbox cover, allow clearance space equal to half of “D” dimension (width) on the waterbox end of the chiller.

Performance data

ENGLISH

UNIT 16DE	015	018	021	024	028	033
COOLING CAPACITY (ton)	150	180	210	240	280	330
CHILLED WATER						
Flow Rate (gpm)	360	432	504	576	672	792
Pressure Drop (ft)	26.3	29.5	24.4	25.0	16.4	17.2
COOLING WATER						
Flow Rate (gpm)	600	720	840	960	1,120	1,320
Pressure Drop (ft)	22.3	25.9	18.1	20.3	26.0	27.8
STEAM (lb/hr-ton)	9.32	9.32	9.32	9.32	9.32	9.32
(lb/hr)	1,398	1,678	1,957	2,237	2,610	3,076

UNIT 16DE	036	040	045	050	060	066
COOLING CAPACITY (ton)	360	400	450	500	600	660
CHILLED WATER						
Flow Rate (gpm)	864	960	1,080	1,200	1,440	1,584
Pressure Drop (ft)	17.2	17.5	16.9	17.1	19.4	25.1
COOLING WATER						
Flow Rate (gpm)	1,440	1,600	1,800	2,000	2,400	2,640
Pressure Drop (ft)	30.8	32.0	28.2	29.2	24.5	31.5
STEAM (lb/hr-ton)	9.32	9.32	9.32	9.32	9.32	9.32
(lb/hr)	3,356	3,728	4,194	4,661	5,593	6,152

LEGEND
ARI – Air Conditioning and Refrigeration Institute
Note: Ratings are based on ARI 560, latest edition
54/44F (2.4gpm/ton) chilled water, fouling factor .0001 ft^2-hr-^oF/Btu for evaporator;
85F (4.0gpm/ton) cooling water, fouling factor .00025 ft^2-hr-^oF/Btu for absorber and condenser.

SI

UNIT 16DE	015	018	021	024	028	033
COOLING CAPACITY (kW)	528	633	739	844	985	1,161
CHILLED WATER						
Flow Rate (L/s)	22.7	27.3	31.8	36.3	42.4	50.0
Pressure Drop (kPa)	78.7	88.1	72.9	74.6	49.1	51.4
COOLING WATER						
Flow Rate (L/s)	37.9	45.4	53.0	60.6	70.7	83.3
Pressure Drop (kPa)	66.6	77.3	54.0	60.6	77.7	83.0
STEAM (kg/hr-kW)	1.20	1.20	1.20	1.20	1.20	1.20
(kg/hr)	634	761	888	1,015	1,184	1,395

UNIT 16DE	036	040	045	050	060	066
COOLING CAPACITY (kW)	1,266	1,407	1,583	1,759	2,110	2,321
CHILLED WATER						
Flow Rate (L/s)	54.5	60.6	68.1	75.7	90.9	99.9
Pressure Drop (kPa)	51.5	52.4	50.7	51.0	58.1	75.1
COOLING WATER						
Flow Rate (L/s)	90.9	100.9	113.6	126.2	151.4	166.6
Pressure Drop (kPa)	91.9	95.8	84.2	87.2	73.3	94.1
STEAM (kg/hr-kW)	1.20	1.20	1.20	1.20	1.20	1.20
(kg/hr)	1,522	1,691	1,903	2,114	2,537	2,790

LEGEND
ARI – Air Conditioning and Refrigeration Institute
Note: Ratings are based on ARI 560, latest edition
12.2/6.7 C (.043 L/s-kW) chilled water, fouling factor .0000176 m^2-hr-^oC/W for evaporator;
29.4 C (.072 L/s-kW) cooling water, fouling factor .000044 m^2-hr-^oC/W for absorber and condenser.

Performance data (cont)

Part-load performance

To determine part-load performance, refer to the 16DE Part-Load Performance curve shown below. This curve depicts Steam Consumption Ratio (SCR) versus Percent Capacity at several cooling water temperatures and in accordance with the ARI load line which is based on a 10F (5.6C) reduction in cooling water temperature for every 25% reduction in load.

Steam requirements at part-load can be calculated with one of the following equations:

Steam Flow (lb/hr) = Full Load Steam (lb/hr) x SCR x % Capacity

or

Steam Flow (lb/hr) = Full Load Steam (lb/hr-ton) x SCR x Part-Load Capacity (tons)

As shown on the part-load performance curve, the continuous operating range for the 16DE is approximately 25 to 100% of full load when operated on steam, based on minimum fire requirements of the burner. Below 25% the burner will cycle on and off to meet the required load and water temperature.

ARI 560, latest version, defines Integrated Part Load Value (IPLV) as a measure of part-load efficiency representing the weighted average of overall chiller performance calculated by the following equation:

IPLV = .01A + .42B + .45C + .12D

Where A = COP at 100%
B = COP at 75%
C = COP at 50%
D = COP at 25% or minimum load

NOTE: COP is the Coefficient of Performance

Therefore,

IPLV = .01 (1.08) + .42 (1.18) + .45 (1.25) + .12 (1.18)
= 1.21

Application data

Vent and drain connections

All vents and drain connections are found on the waterbox covers. Connection size is 3/4-in. NPT.
Provide high points of the machine piping system with vents and the low points with drains. If shutoff valves are provided in the main water pipes near the unit, a minimum amount of the system water is lost when the heat exchangers are drained.
It is recommended that pressure gages be provided at points of entering and leaving water to measure pressure drop through the heat exchanger. Gages may be installed as shown in the table below. Pressure gages installed at the vent and drain connections do not include nozzle pressure losses.
Use a reliable manometer to measure pressure differential when determining water flow. Regular gages are insensitive and do not provide accurate measurement of flow conditions.

NUMBER OF PASSES	GAGE LOCATION
1, 3	One gage in each waterbox
2, 4	Two gages in waterbox with nozzles

Range of application

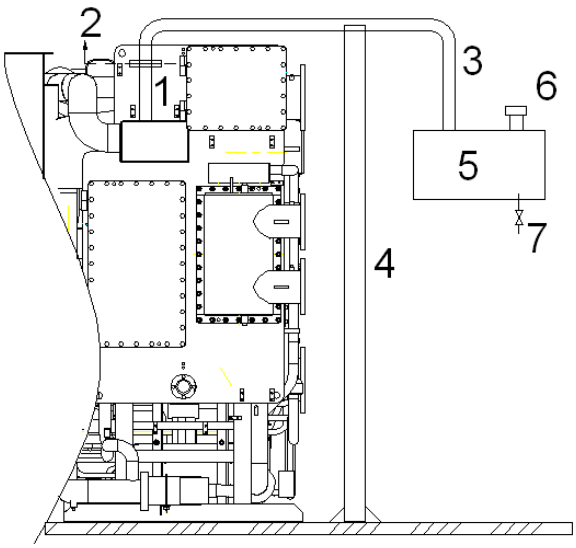
The 16DE absorption chiller is designed for standard water chilling applications of 150 to 660 tons (528 to2321 kW) at standard ARI rating conditions.

Rupture disk piping

The 16DE is equipped with a rupture disk on the low-temperature generator. It is recommended that piping from these devices be routed to appropriate areas away from the machine in accordance with Carrier's written installation instructions，and any local jurisdictional requirements that may apply. One side of Rupture disk's connective tube is connected with protected recipient and another side is leaded to safe place such as atmosphere or where there is no person. Piping should be adequately supported and the proper fittings should be provided to allow periodic inspection of the disk.

UNIT SIZE	RUPTURE DISK CONNECTION SIZE
All	2 in. RF flange

LEGEND
RF – Raised Face



1-Rupture Disk 2-Field Supply 3-Discharge Pipe
4-Piping Support 5-Tank (Above 1 cubic meter (35 cubic feet))
6-Vent Pipe 7-Drain

Application data (cont)

MATERIAL SPECIFICATIONS

ITEM	MATERIAL	SPECIFICATIONS
SHELL:		
Evaporator	Steel/Q235B	Equivalent to ASTM A283
Absorber	Steel/Q235B	Equivalent to ASTM A283
Condenser	Steel/Q235B	Equivalent to ASTM A283
G1	Steel/Q235B	Equivalent to ASTM A283
G2	Steel/Q235B	Equivalent to ASTM A283
TUBESHEET:		
Evaporator	Steel/Q235B	Equivalent to ASTM A283
Absorber	Steel/Q235B	Equivalent to ASTM A283
Condenser	Steel/Q235B	Equivalent to ASTM A283
G1	Steel/20R	Equivalent to ASTM A283
G2	Steel/Q235B	Equivalent to ASTM A283
WATERBOX:		
Evaporator	Steel/Q235B	Equivalent to ASTM A283
Absorber	Steel/Q235B	Equivalent to ASTM A283
Condenser	Steel/Q235B	Equivalent to ASTM A283
G1	Steel/20R	Equivalent to ASTM A283
G2	Steel/Q235B	Equivalent to ASTM A283
TUBES:		
Evaporator	Copper/C1220-1/2H	Equivalent to ASME SB359
Absorber	Copper/C1220-1/2H	Equivalent to ASME SB359
Condenser	Copper/C1220-1/2H	Equivalent to ASME SB359
G1	90-10 CuNi/ C7060T-OL	
G2	Copper/ C1220T-OL	
PIPING	Steel	20#

LEGEND
ASME -- American Society of Mechanical Engineers
ASTM -- American Society for Testing and Materials
G1 -- High-Temperature Generator
G2 -- Low-Temperature Generator

Thermal insulation

Application of cold/hot surface thermal insulation should be done after final installation at jobsite and machine leak integrity has been verified. Refer to Carrier certified drawings for material specifications and recommended chiller insulation requirements.

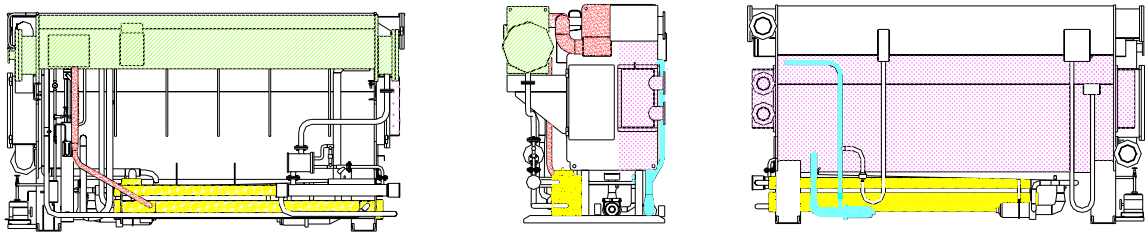
THERMAL INSULATION SURFACE AREA REQUIREMENTS – ENGLISH (FT^2)

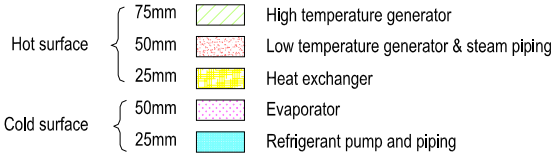
16DE UNIT	THICKNESS	015/018	021/024	028/033	036/040	045/050	060/066
HOT SURFACE	75mm	80.7	91.5	120.6	134.5	145.3	199.1
	50mm	52.7	62.4	79.7	91.5	101.2	151.8/160.4
	25mm	59.2	65.7	80.7	88.3	102.3	108.7/117.3
COLD SURFACE	50mm	61.4	70.0	90.4	105.5	106.6	159.3/174.4
	25mm	6.5	7.5	10.8	11.8	12.9	14.0

THERMAL INSULATION SURFACE AREA REQUIREMENTS – SI (m^2)

16DE UNIT	THICKNESS	015/018	021/024	028/033	036/040	045/050	060/066
HOT SURFACE	75mm	7.5	8.5	11.2	12.5	13.5	18.5
	50mm	4.9	5.8	7.4	8.5	9.4	14.1/14.9
	25mm	5.5	6.1	7.5	8.2	9.5	10.1/10.9
COLD SURFACE	50mm	5.7	6.5	8.4	9.8	9.9	14.8/16.2
	25mm	0.6	0.7	1.0	1.1	1.2	1.3

Application data (cont)





Cold surface: Non-flammable material, polyethylene rubber or equivalent. Thermal conductivity of material is 0.03 Kcal/m.h.℃ below.
Hot surface: Glass wool/Rock wool or equivalent.

STANDARD WATERBOX AND CROSSOVER PIPE CONFIGURATION

16DE UNIT	EVAPORATOR		ABSORBER		CONDENSER		CROSS-OVER PIPE
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	
015- 066	N	N	M	M	M	M	Included

LEGEND
M -- Marine Waterbox
N -- Nozzle-In-Head Waterbox

HEAT EXCHANGER STANDARD PASS AND NOZZLE ARRANGEMENT

16DE UNIT	EVAPORATOR		ABSORBER		CONDENSER	
	Pass	Inlet	Pass	Inlet	Pass	Inlet
015-024	3	L or R	2	L	1	L
028-066	2	L or R	2	L	1	L

LEGEND
L -- Left End Inlet
R -- Right End Inlet

HEAT EXCHANGER MINIMUM/MAXIMUM FLOW RATES* -- ENGLISH (gpm)

16DE SIZE	EVAPORATOR							
	1-Pass		2-Pass		3-Pass		4-Pass	
	Min	Max	Min	Max	Min	Max	Min	Max
015	–	–	218	868	145	578	114	453
018	–	–	260	1043	175	694	136	529
021	–	–	316	1264	211	844	159	632
024	–	–	348	1393	232	929	175	697
028	619	2472	310	1242	207	827	–	–
033	722	2888	362	1447	161	965	–	–
036	779	3132	390	1553	260	1043	–	–
040	861	3463	432	1731	287	1154	–	–
045	969	3894	486	1946	333	1298	–	–
050	1075	4326	538	2162	359	1440	–	–
060	1290	5160	645	2580	430	1720	–	–
066	1419	5676	709	2838	473	1892	–	–

16DE SIZE	ABSORBER-CONDENSER			
	2-Pass/1-Pass		3-Pass/1-Pass	
	Min	Max	Min	Max
015	362	1169	–	–
018	409	1401	–	–
021	536	2073	–	–
024	611	2373	–	–
028	576	2044	–	–
033	674	2387	–	–
036	666	2631	–	–
040	746	2931	–	–
045	830	3301	–	–
050	922	3660	–	–
060	1106	4426	–	–
066	1217	4869	–	–

*Flow rates based on standard tubes. Minimum flow based on tube velocity of 3 ft/sec; maximum flow based on 12 ft/sec.

Application data (cont)

HEAT EXCHANGER MINIMUM/MAXIMUM FLOW RATES* -- SI (L/s)

16DE SIZE	EVAPORATOR							
	1-Pass		2-Pass		3-Pass		4-Pass	
	Min	Max	Min	Max	Min	Max	Min	Max
015	–	–	14	54	9	36	7	27
018	–	–	17	65	11	43	9	32
021	–	–	20	79	14	53	10	39
024	–	–	22	87	15	59	11	44
028	39	156	20	78	13	52	–	–
033	46	182	23	91	10	60	–	–
036	50	197	25	98	17	65	–	–
040	55	218	28	109	19	72	–	–
045	62	245	31	122	21	81	–	–
050	68	272	34	136	23	90	–	–
060	82	327	41	164	27	109	–	–
066	90	360	45	180	30	120	–	–

16DE SIZE	ABSORBER-CONDENSER			
	2-Pass/1-Pass		3-Pass/1-Pass	
	Min	Max	Min	Max
015	23	73	–	–
018	26	88	–	–
021	34	130	–	–
024	38	149	–	–
028	37	129	–	–
033	43	150	–	–
036	42	166	–	–
040	47	184	–	–
045	53	208	–	–
050	59	230	–	–
060	71	284	–	–
066	78	311	–	–

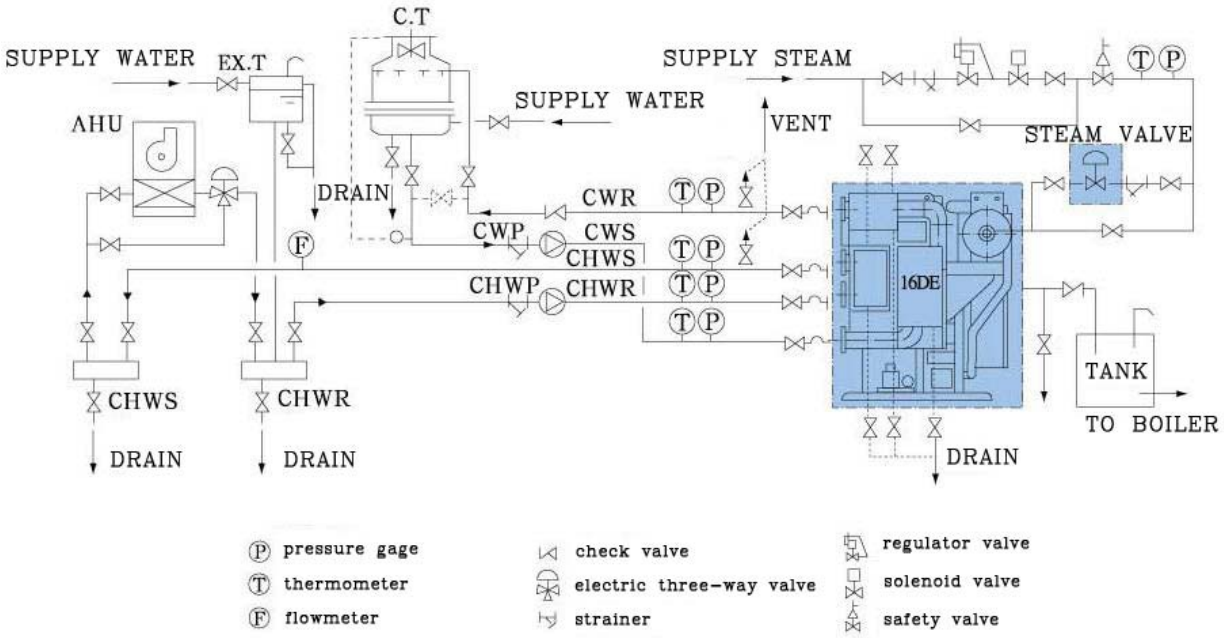
*Flow rates based on standard tubes. Minimum flow based on tube velocity of .9 m/sec; maximum flow based on 3.6 m/sec.

Application data (cont)

Water management

Item		Cooling water			Chilled water		tendency	
		Circulation flow		Direct flow				
		Circulate water	Supply water	Direct flow water	Circulate water ≤20C	Supply water	corrosion	scale
Basic	PH (25C)	6.5~8.2	6.0~8.0	6.8~8.0	6.0~8.0	6.8~8.0	√	√
	Conductivity (mS/m) (25C) [uS/m] (25C)	≤80 [≤800]	≤30 [≤300]	≤40 [≤400]	≤40 [≤400]	≤30 [≤300]	√	√
	Chlorin ($mgCl^-/l$)	≤200	≤50	≤50	≤50	≤50	√	
	sulfate ($mgSO_4^{2-}/l$)	≤200	≤50	≤50	≤50	≤50	√	
	Acid consumption(PH4.8) (mg $CaCO_3/l$)	≤100	≤50	≤50	≤50	≤50		√
	Rigidity ($mgCaCO_3/l$)	≤200	≤70	≤70	≤70	≤70		√
	Calcium carbonate Rigidity ($mgCaCO_3/l$)	≤150	≤50	≤50	≤50	≤50		√
	Ionic silicon dioxide ($mgSiO_2/l$)	≤50	≤30	≤30	≤30	≤30		√
Reference	Iron (mgFe/l)	≤1.0	≤0.3	≤1.0	≤1.0	≤0.3	√	√
	Copper (mgCu/l)	≤0.3	≤0.1	≤1.0	≤1.0	≤0.1	√	
	Sulfur ion (mgS^{2-}/l)	Not include					√	
	Ammoniac ion ($mgNH_4^+/l$)	≤1.0	≤0.1	≤1.0	≤1.0	≤0.1	√	
	rudimental chlorine (mgCl/l)	≤0.3	≤0.3	≤0.3	≤0.3	≤0.3	√	
	Dissociative carbonate ($mgCO_2/l$)	≤4.0	≤4.0	≤4.0	≤4.0	≤4.0	√	
	Stable degree	6.0~7.0	-	-	-	-	√	√

Typical Piping



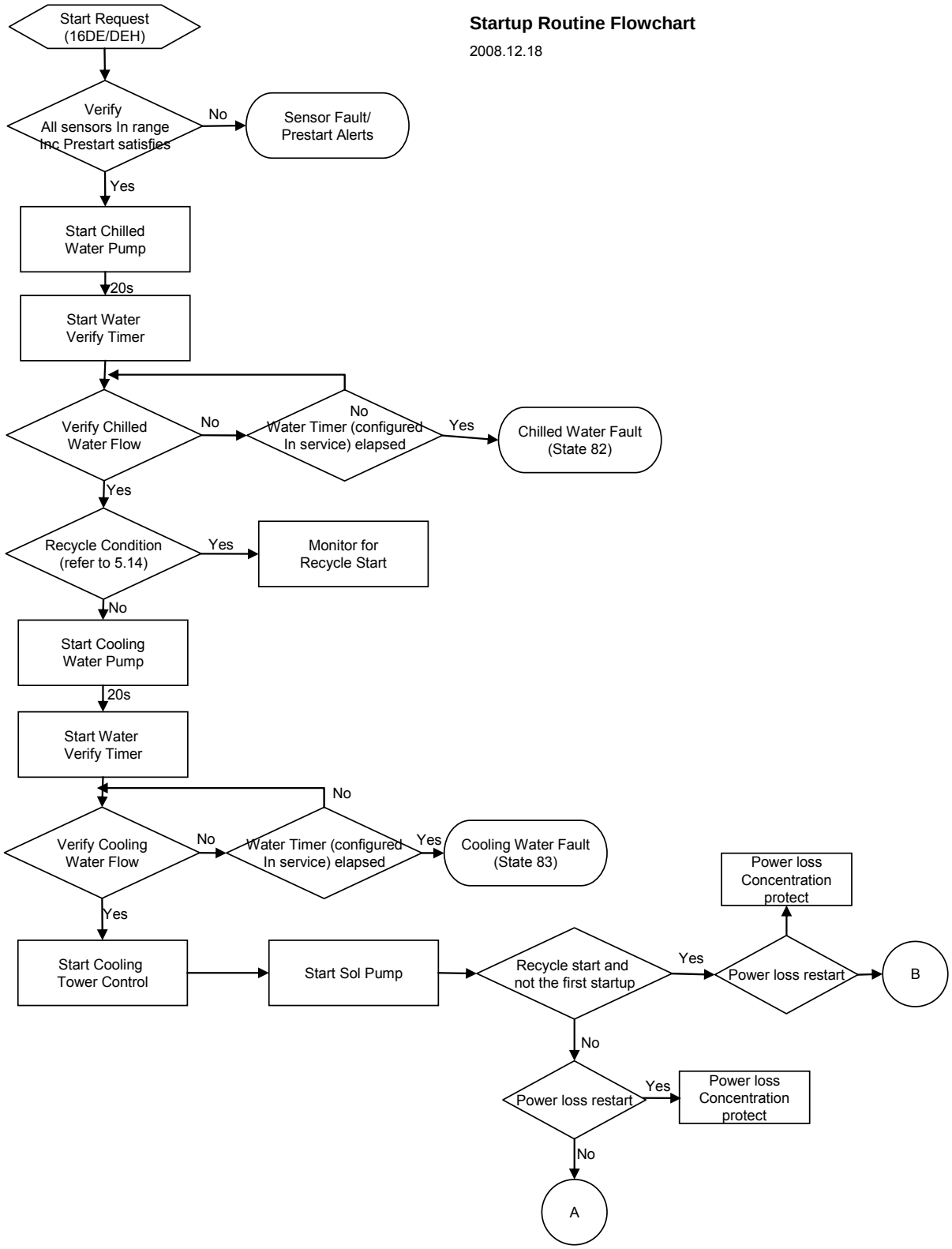
1. Equipment and parts outside the hatched area are not supplied by Carrier.
2. Make sure all connections to water box covers allow opening of covers for maintenance.
3. Installation and piping should allow sufficient access for cleaning or replacing tubes.
4. Install pipe hangers where needed and ensure that all piping is adequately supported. Make sure no weight or stress is placed on water box nozzles or flanges.
5. Water flow direction must be the same as specified in job flow diagram or water flow marking on water boxes nozzles and connections must be connected to the entering and leaving water box nozzles. For pipe connections and diameters refer to the dimensional drawings.
6. It is recommended to have separate chilled and cooling water pumps for each machine.
7. Strainers should be provided at the chilled and cooling water inlet pipe connections.
8. Install water box vent and drain piping in accordance with individual job data. Air vents (R3/4'') should be at high points in piping to eliminate water hammer and drain valves (R3/4'') should be at the bottom of outlet pipe connections. Drain pipes from the evaporator and absorber should be piped to the drain channel.
9. Location of the chilled jot water and cooling water pumps as well as the expansion tank must allow for the hydrostatic and water heads to ensure that the total pressure does not exceed the water box design working pressure.
10. A cooling tower bypass valve should be installed if the cooling water temperature might fall down 15C (59F) during chiller operation.
11. A water flow control valve should be provided at the cooling water inlet pipe connections.
12. Locate steam control valve, a minimum of 100mm from high temperature generator nozzle and install a pressure gage between steam control valve and machine.
13. Install thermometer wells and thermometers on the entering and leaving chilled water pipes, absorber entering and condenser leaving cooling water pipes. Thermometer wells should extend into the pipe a minimum of 1/3 pipe diameter. Provide a thermometer (0~100C) and pressure gauge (0~1.5MPa) at the chilled and cooling water outlet and inlet pipe connections.
14. Provide an expansion tank in the chilled water line.
15. Install pressure gage taps and pressure gages on the entering and leaving chilled/hot water pipe and cooling water pipes.
16. A flow meter can be installed on the chilled water piping for convenient operation.

Typical Piping (cont)

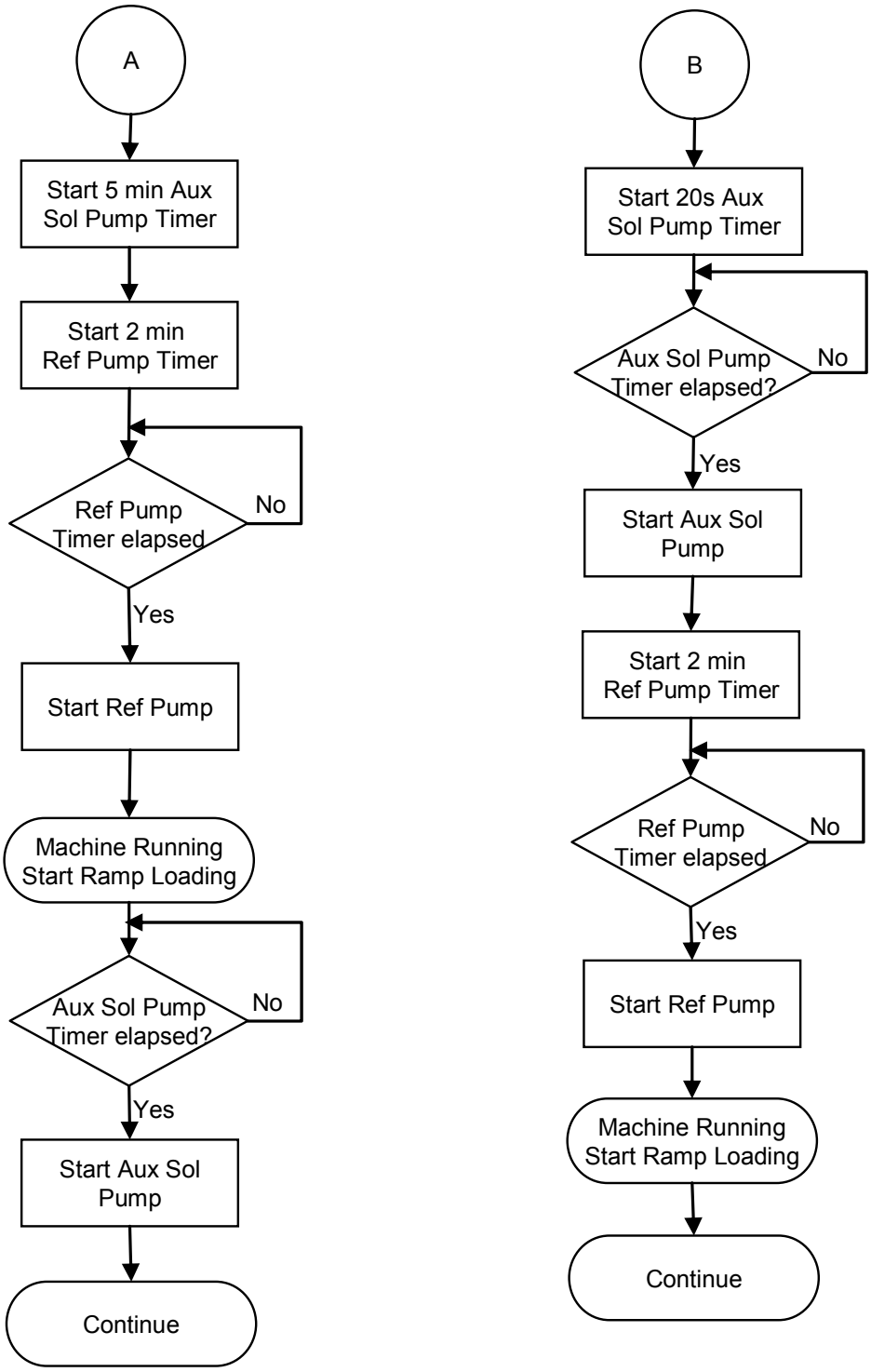
17. For water quality control refer to the water quality management and provide a blow-down valve in the water line for water quality control if necessary.
18. There should be sufficiently large clearances for easy access to the evaporator, absorber and condenser, to facilitate inspection and cleaning.
19. All external water piping with welding flanges is to be provided by the customer.

Typical control sequence

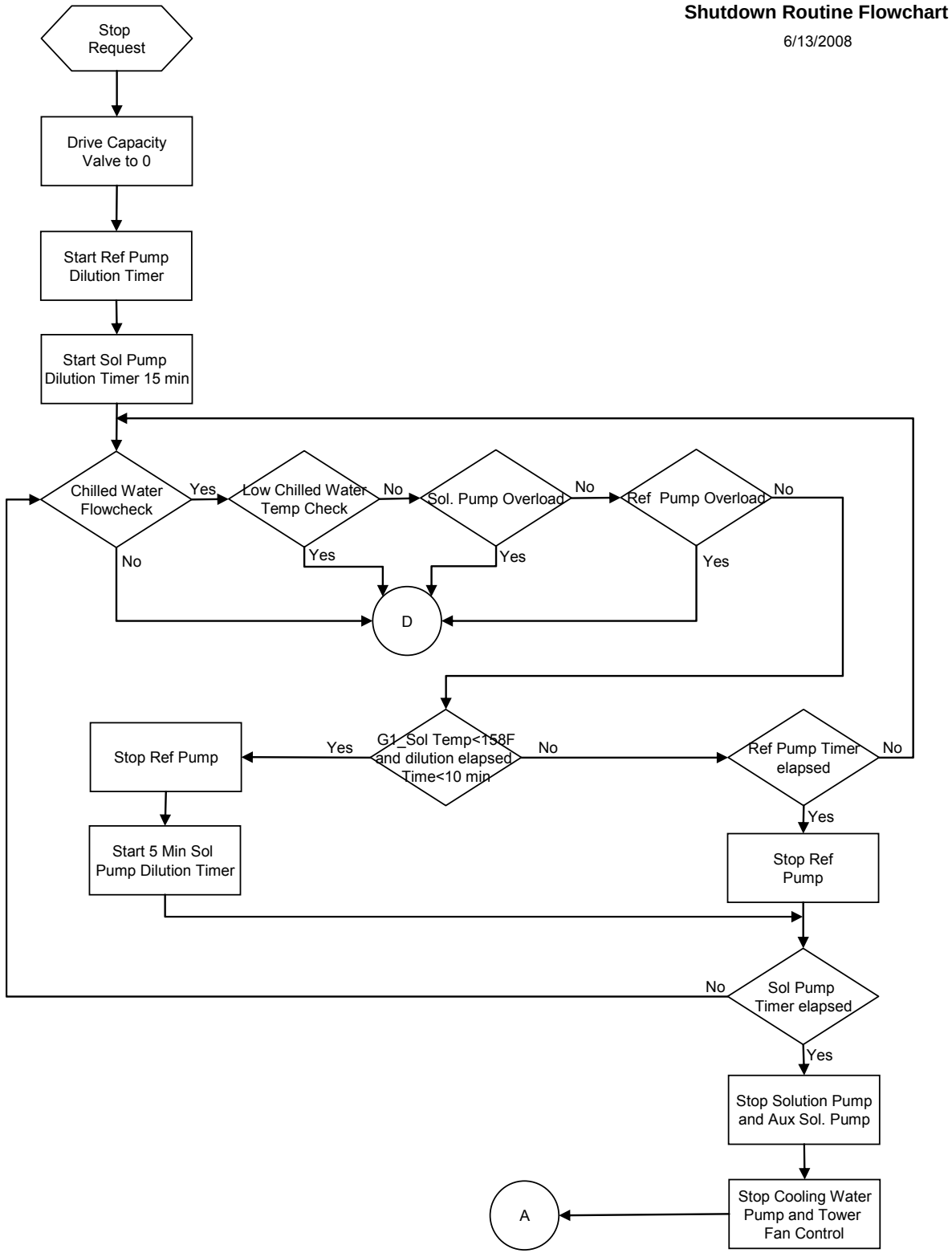
NORMAL COOLING START FLOW CHART (PART 1)



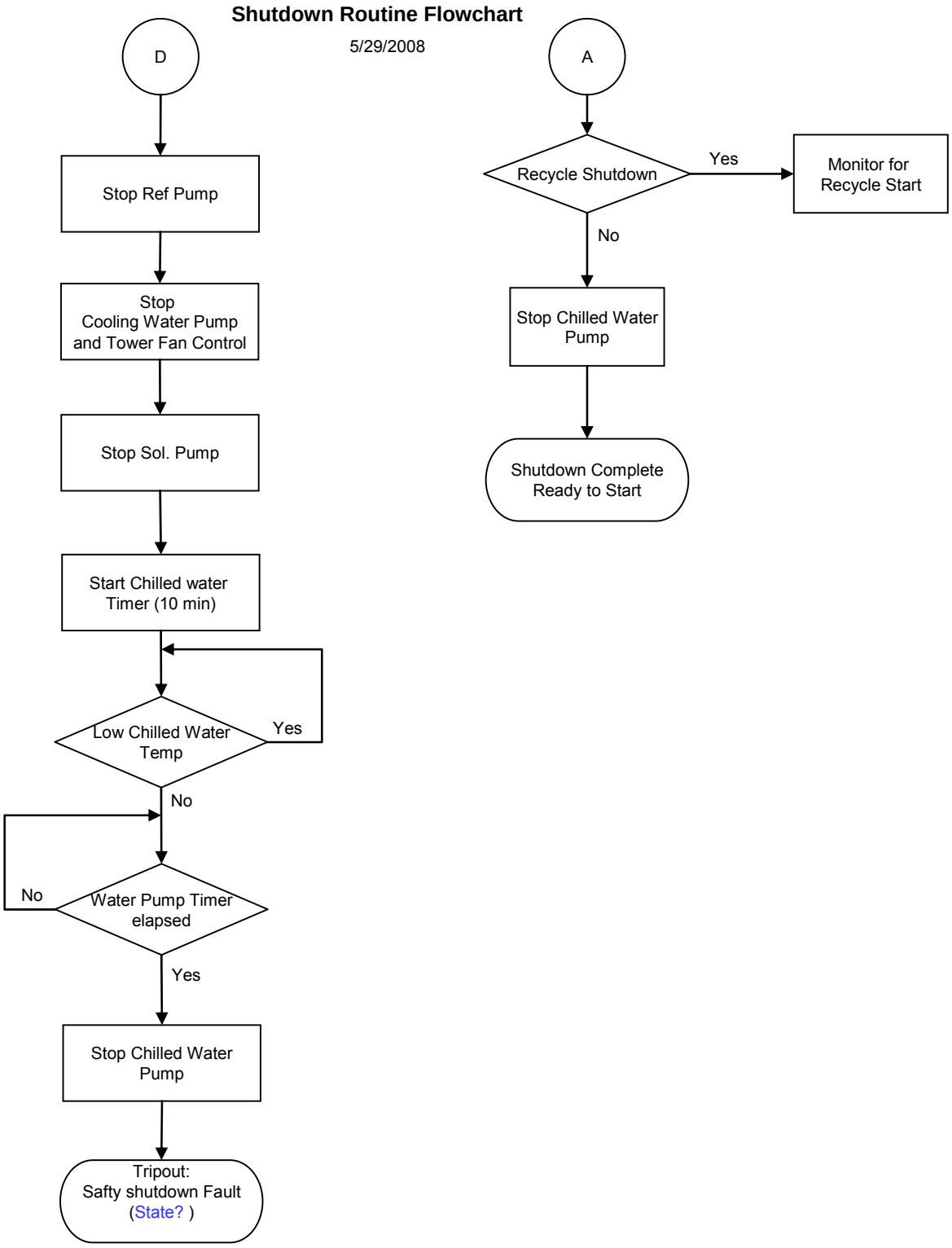
NORMAL COOLING START FLOW CHART (PART 2)



NORMAL COOLING SHUTDOWN FLOW CHART (PART 1)



NORMAL COOLING SHUTDOWN FLOW CHART (PART 2)



Guide specifications

Hermetic Absorption Liquid Chiller

Size Range: **150 to 660 tons (528 to 2321 kW)**
Carrier Model Numbers: **16DE**

Part 1 – General

1.01 SYSTEM DESCRIPTION

Electronically controlled, double-effect (two-stage) absorption liquid chiller utilizes hermetic refrigerant and solution pumps, lithium bromide solution as the absorbent, and water as the refrigerant, and water as the refrigerant. High pressure steam shall be supplied to the high-temperature generator as the heat source.

1.02 QUALITY ASSURANCE

A. Chiller performance shall be rated in accordance with ARI Standard 560 (latest edition).
B. Chiller shall be manufactured and designed in accordance with ANSI/ASHRAE 15 (latest edition), Safety Code for Mechanical Refrigeration.
C. Chiller shall be designed and constructed to meet applicable (GB) requirements.
D. Each chiller shall undergo a series of standard factory tests to ensure that the unit is leak tight, that all electrical components operate as intended, and that every aspect of the unit fabrication meets stringent quality standards in accordance with good practice and the manufacturer's quality assurance requirements.
   1. The shellside of each chiller shall be leak tested by pressurizing to 11.6psig (80kPa) with nitrogen and then checked by spraying a soap/water mixture on all welds, tube joints, and/or gasketed joints to identify any major leaks. Afterward, a mass spectrometer test shall be performed by evacuating the unit to 0.5mmHg absolute, covering the machine with a vinyl tent, and introducing helium gas under the tent. Any remaining leaks will allow the helium to be drawn into the shellside of the machine. The acceptable leak rate as measured by the mass spectrometer test shall not exceed $1*10^{-6}$ atm.cc/sec standard air.
   2. The tubeside of the evaporator, absorber, and con-denser shall be hydrostatically tested at 1.5 times rated design pressure and held for 30 minutes.
   3. The refrigerant and solution pump/motors shall undergo standard factory tests to ensure proper head flow, and motor output characteristics.
   4. All machine wiring shall undergo an insulation resistance test. The chiller/heater control center and all electrical components shall also be functionally tested to verify continuity and proper electrical operation.
   5. Final assembly inspection shall consist of verifying that all valves, controls, instrumentation, pumps, purge components, and all other machine components have been properly installed on the machine.
   6. Each unit shall then be checked for overall appearance and dimensional accuracy.
   7. Final inspection shall be performed on each unit to check that painting of the unit is as specified, nameplate data is correct, and that all accessories are furnished as required.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Unit shall be stored and handled in accordance with the manufacturer's recommendations.
B. Normally, unit shall be charge with lithium bromide solution at the jobsite in accordance with the manufacturer's written instructions. But if customer requires, unit can be factory-charged with lithium bromide solution and performance tested before shipping as special requirement.
C. Machines shall be pressurized to 4.4psig (0.03MPa) with dry nitrogen gas on the shell side.
D. Chiller shall be shipped with nameplates indicating name of manufacturer, model size, serial number, and all other pertinent machine data.

1.04 WARRANTY

Carrier shall guarantee the chiller against defects in materials or workmanship for a period of one year from date of initial operation or 18 months from date of shipment, whichever occurs first. Carrier shall provide the labor to repair or replace any part found to be defective in material or workmanship within the warranty period.

Part 2 – Products

2.01 EQUIPMENT

A. General

Absorption liquid chiller shall include evaporator, absorber, condenser, high- and low-temperature generators, solution heat exchanger, condensate drain heat exchanger, float trap, purging system, piping wiring, refrigerant/solution pumps, controls, and auxiliaries. Shipment of the machine shall be in 1 piece. Initial charge of lithium can be included with the chiller for charging at the jobsite.

B. Operating Characteristics
   1. Chiller operation shall be characteristic of a double-effect absorption cycle with series solution flow. The weak solution from the absorber shall be entering the high-temperature generator via the low- and high-temperature solution heat exchangers. A variable frequency drive pump shall automatically regulate the flow of solution to the high-temperature generator to maintain optimum flow at all operating conditions. This

Guide specifications (cont)

shall result in improved part-load efficiency and eliminate the need for manual set-up adjustments of the solution flow.

2. Unit shall be capable of continuous operation from 100 to 25% capacity, with entering cooling water temperatures as low as 59F (15C), without the need for a cooling tower bypass valve. Thermostat ON/OFF control of the cooling tower fan is recommended when cooling water temperature falls below 59F (15C).

C. Heat Exchangers

1. All heat exchangers shall be of shell and tube construction with shells, tubesheets, tube support sheets, and waterboxes fabricated of carbon steel. All heat exchangers shall incorporate straight tubes. All tubes shall be rolled into grooveless tubesheets and expanded into tube support sheets, except for the high- and low-temperature generator tubes. High and low-temperature tubes shall be rolled into grooved tubesheets and expanded into tube support sheets.
2. The evaporator, absorber, and condenser water-boxes shall be designed for 150psig (1034kPa) working pressure. Evaporator waterboxes shall be nozzle-in-head type and absorber-condenser waterboxes shall be marine type. All waterboxes shall be provided with vent and drain connections. GB RF flanges shall be furnished on all waterbox nozzle connections. ANSI (American National Standards Institute) raised face flanges are available.
3. The high-temperature generator shall consist of straight tubes secured to a number of baffle plate located between tubesheets. The high-temperature generator waterbox shall be designed for 150psig (1034kPa) working pressure. The steam inlet shall be provided with an GB RF flange connection.
4. A steam condensate drain heat exchanger shall be factory mounted and piped on the machine to reduce steam rate by pre-heating the weak solution while cooling the condensate for easier condensate return handling. The steam condensate outlet connection shall be located above grade, in proximity to the bottom of the generator overflow chamber, thereby permitting a greater allowable pressure drop to be considered in the design of the condensate return system piping before flashing occurs.
5. A high-temperature and low-temperature solution heat exchanger shall be an integral part of the machine to increase efficiency by pre-heating weak solution on the tubeside with strong solution on the shellside. Tube material for the high-temperature heat exchanger shall be cupronickel, and tube material for the low-temperature heat exchanger shall be copper.
6. Spray heads for the evaporator and absorber shall be of a non-clogging design, specifically designed for the intended duty, and shall be fabricated of a corrosion-proof material to ensure continuous, high-efficiency operation.
7. Heat exchanger tube material and minimum wall thickness shall be contingent on the type of corrosion inhibitor used in the machine. For molybdate systems, the following tube specifications shall apply to ensure long machine life and continuous operation:

Evaporator……..……..copper, externally-finned
Absorber…….……..…...copper, corrugated
Condenser. ……..……copper, corrugated
G2……..copper, externally-finned
G1……...cupronickel,externally-finned

If chiller Carrier requires the use of tube materials other than as listed above, due to the use of a less effective inhibitor, the chiller manufacturer shall guarantee performance of the machine for its design life and shall replace tubes and/or tube bundles as necessary during this period at no additional cost to the owner.

D. Pump/Motors

Refrigerant and solution pump/motors shall be self-contained, leakproof, hermetic type, with isolation valves, and internal seal water system to minimize air leakage into the machine. Lubrication and cooling shall be accomplished by the fluid being pumped; auxiliary water piping for cooling and lubrication shall not be acceptable.

E. Purge System

An automatic, motorless purge system shall be furnished to provide a continuous purging action whenever the chiller is in operation to assure long machine life and efficient performance. Noncondensables shall be removed from the absorber by a liquid eductor, which shall use flow from the solution pump to create a suction. Noncondensables shall be stored external to the unit and shall be prevented from diffusing back into the machine when the unit is not operating. The vacuum pump shall be factory mounted on the chiller and wired to the control center by the chiller manufacturer.

F. Controls, Safeties and Diagnostics

1. Controls
   a. The 16DE series chiller shall be provided with a factory installed and wired PD5 control system with individually replaceable modular component construction. The PD5 controls system matches the cooling capacity of the

Guide specifications (cont)

machine to the cooling load while providing state-of-the-art machine protection. The system controls cooling capacity within the set point plus the dead band by sensing the leaving chilled water and regulating the steam valve. The PD5 controls the operation of the machine by monitoring all operating conditions. The PD5 can diagnose a problem and let the operator know what the problem is and what to check. It promptly positions the steam valve to maintain leaving chilled water temperature. It can interface with auxiliary equipment such as pumps and cooling tower fans. It continually checks all safeties to prevent any unsafe operating condition. The PD5 can be interface with the Carrier Comfort Network (CCN). It can communicate with other PIC-equipped chiller and CCN device. The system shall include a PD5-BASE board, two PD-AUX boards and an NRCP-BASE board, power supply, temperature (thermistor) sensors, and all necessary auxiliary devices required for proper operation. All boards communicate via an internal LEN bus. The PD5-BASE boards continuously manage the information received from the various pressure and temperature probes, and incorporates the program that controls the unit. The user interface is a touch screen. It is connected to the main basic board and gives access to a full array of control parameters. The PD5 shall be configurable to display either English or SI metric units.

b. The default standard display screen shall simultaneously indicate the following minimum information:
   - date and time of day
   - primary system status message
   - entering chilled water temperature
   - leaving chilled water temperature
   - evaporator refrigerant temperature
   - entering absorber water temperature
   - leaving absorber water temperature
   - leaving condenser water temperature
   - strong solution temperature leaving high-temperature generator
   - weak solution temperature leaving absorber
   - output signal to steam control valve
   - The default screen shall be displayed if there is no manual activity at the control console for 15 minutes

c. PD5 Operation Button.

DESCRIPTION OF THE MAIN NAVIGATION AND OPERATION BUTTONS	
	Returns to the previous screen
	Displays the default screen (“Group Display” screen)
	Displays the main screen
	Displays the next screen
	Displays the previous screen
	Accepts the current action
	Rejects the current action
	Cancels the current action
	Removes the data in the value modification dialog box
	Adds a point to one of the “Group Display” screens
	Removes a point from one of the “Group Display” screens
	Reduces/increases the value
	Displays the previous/following item
	Displays the previous/following page
	Forces a point
	Cancels the forcing of a point
	Displays the value modification dialog box for a point
	Alarm indication light
	Start/stop control button

d. Network Window Function:
   Each Chiller LID (Local Interface Device) shall be capable of viewing multiple point values and statuses from other connected on a common network, including controller

maintenance data. The operator shall be able to alter the remote controller's set points or time schedule and to force point values or statuses that are operator forcible. The LID shall also have access to the alarm history file of all like controllers connected on the network.

e. PD5 System Functions
   - Capacity Control:
     The PD5 controls the chiller capacity by modulating the capacity valve in response to chilled water temperature changes away from the CONTROL POINT. The CONTROL POINT may be changed by a CCN network device, or is determined by the PD5 adding any active chilled water reset to the ECW (Entering Chilled Water) SET POINT or LCW (Leaving Chilled Water) SET POINT
   - Entering Chilled Water Control (Optional):
     The PD5 uses ENTERING CHILLED WATER temperature to modulate the vanes instead of LEAVING CHILLED WATER temperature.
   - Chiller Timer:
     The PD5 maintains 2 runtime clocks, known as SOLUTION PUMP ONTIME AND SERVICE ONTIME. SOLUTION PUMP ONTIME indicates the total lifetime. The SERVICE ONTIME is a resettable timer that can be used to indicate the hours since the last service visit or any other reason.
   - Occupancy Schedule:
     This schedule determines when the chiller is either occupied or unoccupied. The chiller will shut down when the schedule goes to UNOCCUPIED. These schedules can be set up to the follow the building schedule or to be 100% OCCUPIED if the operator wishes. The schedules also can be bypassed by forcing the Start/Stop commend on the PD5 Status screen to start. The schedules also can be overridden to keep the unit in an OCCUPIED mode for up to 4 hours, on a one-time basis.

f. The PD5 control system shall include a programmed sequence to ensure machine readiness prior to machine start-up. The PD5 shall automatically activate and interlock the chilled water pump, cooling water pump, cooling tower fan upon chiller activation. The PD5 monitors all safety control inputs and if required shuts down the chiller or VFD speed stops solution pump to protect the chiller from possible damage from any of the critical conditions. The PD5 screen displays primary and secondary massage if the controller starts safety controls to stop, the alarm relay operates and alarm indicator is brink. The alarm is saved in the PD5 alarm table to correct the problems.

g. Upon request to start the chiller, the control system shall start the chilled water pump and verify chilled water flow. The controller shall then compare the entering or leaving chilled water temperature with the chilled water set point. If the chilled water temperature is less than the chilled water set point, the control system shall enter the recycle mode until a cooling load has been established. Once a cooling load has been established the control system shall start the cooling water pump and verify flow, before starting tower fan, solution pump and refrigerant pump. Once the refrigerant pump is started the control system shall then initiate a programmed warm-up cycle. Once the full 20 minutes of warm-up cycle is completed, the ramp loading routine shall be initiated.

h. The control system shall automatically sense impending abnormalities in the absorption operating cycle and take one or all of the following actions to either self-correct and/or limit the machine from approaching cycle crystallization line:
   - inhibit steam control valve position until concentration drops below preset threshold.
   - drive steam control valve to closed position until concentration drops below preset threshold
   - initiate non-recycle shutdown of the chiller if safety shutdown threshold exceeded.

i. A user-configurable ramp loading rate, effective during the chilled water temperature pulldown period, shall control the rate of steam control valve opening to limit start-up steam demand. The controls shall allow configuration of the ramp loading rate in degrees per minute of chilled water temperature pulldown. During the ramp loading period, a message shall be displayed informing the

operator that the chiller is operating in ramp loading mode.

j. The control system shall automatically cycle the machine to minimize energy usage whenever the leaving chilled water temperature is 3F (1.7C) below the desired chilled water set point. The chilled water pump shall remain on, and when the leaving chilled water temperature rises above the set point by a user-configured amount, the chiller shall automatically restart. During the shutdown period, a message shall be displayed informing the operator a recycle is pending.

k. The control center shall allow reset of the chilled water temperature set point based on any one of the following criteria:
   - Chilled water reset based on a remote temperature (such as outdoor air).
   - Chilled water reset based on water temperature rise across the evaporator.

   When reset is active, a message shall be displayed indicating the type of reset in effect.

l. The control center shall limit the opening of the steam control valve to 65% (user-configurable) open at startup until the warm-up period has been completed and ramp loading is enabled.

m. When the stop button is pressed, or remote contacts open the control center shall immediately drive the steam control valve to the closed position and initiate the normal shutdown sequence including dilution cycle. The display shall indicate: “dilution cycle shutdown”

2. Safeties:

a. Unit shall automatically shutdown when any of the following conditions occur: (Each of these protective limits shall require manual reset and cause an alarm message to be displayed on the screen, informing the operator of the shutdown cause.)
   - solution pump VFD overload/high temperature
   - high motor winding temperature – ref/sol pump
   - high motor amperage – ref/sol pump
   - low chilled water temperature
   - high-temperature generator high solution temperature
   - high-temperature generator high pressure
   - high-temperature generator high solution level
   - high-temperature generator low solution level
   - loss of evaporator water flow
   - loss of cooling water flow (optional)

b. The control system shall detect conditions which approach protective limits and take self-corrective action prior to an alarm occurring. The system shall automatically reduce chiller capacity when any of following parameters are outside their normal operating range:
   - low evaporator refrigerant temperature
   - high-temperature generator high saturation temperature
   - high-temperature generator high solution temperature
   - high solution concentration

   During the capacity override period, a pre-alarm (alert) message shall be displayed informing the operator which condition is causing the capacity override. Once the condition is again within acceptable limits, the override condition shall terminate and the chiller shall revert to normal chilled water control. If during either condition the protective limit is reached, the chiller shall shutdown, an alarm shall be generated, and a text message shall be displayed informing the operator which condition caused the shutdown and alarm.

3. Diagnostics and Service:

a. The control system shall execute a series of pre-start checks whenever a start command is received to determine if pressures, temperatures, and timers are within prestart limits, thereby allowing start-up to proceed. If any of the limits are exceeded a text alert message will be displayed informing the operator of the cause of the pre-start alert.

b. The control system shall provide a manual test which permits selection and test of individual control components and inputs. The screen will show the actual reading of each transducer and each thermistor installed on the chiller.
   The test shall automatically energize the refrigerant pump, solution pump, tower fan relay, alarm relay, chilled water and cooling water pumps and chiller run relay, and the control system shall confirm water flows have been established and require operator confirmation prior to proceeding to the next test.
   A capacity valve actuator test shall allow

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the operator to test the steam control valve position by manually increasing, decreasing or holding in response to the key pressed. Upon completion of the steam control valve test the control valve shall revert to the closed position.
A variable frequency drive test shall allow the operator to check the VFD speed value by manually increasing, decreasing or holding in response to the key pressed. Upon completion of the VFD test the VFD speed shall revert to 0.0%.

c. All sensors shall have quick disconnects to allow replacement of the sensor without replacement of the entire sensor wire.

G. Electrical Requirements
1. Power supply to the unit shall be 3ph/50Hz/400V and 3ph/60Hz/460V. If need, Carrier also can meet customer's requirement.
2. Contractor shall supply and install the electrical power line and all auxiliary electrical protection devices per local code requirements and as indicated necessary by the chiller manufacturer.
3. Contractor shall supply and install electrical wiring and devices required to interface the chiller controls with the building control system, if applicable.

H. Piping Requirements
1. Piping and instrumentation for the chilled water, cooling water, steam, and condensate piping shall be supplied and installed by the contractor/owner.
2. Chilled water flow switch shall be factory supplied and factory installed in the evaporator water nozzle. Cooling water flow switch shall be field installed or factory installed if customer requires and supplied by either the chiller manufacturer or the contractor/owner.
3. Piping from the rupture disk shall be provided and installed by the contractor/owner and piped in accordance with the chiller manufacturer's written instructions.

I. Thermal Insulation
Insulation of cold or hot surfaces shall be field supplied and field installed on the machine. Chiller manufacturer shall specify the recommended material and surface area to be insulated.

J. Sound Level
The overall sound pressure level of the chiller shall not exceed 80dbA when measured per Standard ARI Standard 575 (latest edition).

K. Start-up
1. Carrier shall provide a factory-trained service representative, employed by the chiller manufacturer, to perform and/or supervise chiller pressure test (when required), charge chiller with refrigerant (water) and lithium bromide solution, place unit into operation, and calibrate all controls in accordance with the manufacturer's written start-up, operating, and maintenance instructions.
2. After unit start-up has been performed, the same Carrier representative shall be available for a period of instruction (not to exceed 4 hours) to instruct the owner's personnel in the proper start-up, operation, and maintenance procedures.
3. Carrier shall provide the following literature:
   a. Installation, Operation and Maintenance Instructions
   b. Field Wiring Diagrams

L. Options and Accessories
1. High-Pressure Waterboxes:
Waterboxes rated for 250psig (1724kPa) or 300psig (2068kPa) working pressure shall be furnished when specified on the equipment schedule
2. Special Tubing:
Tubing of non-standard materials and/or wall thickness shall be provided when specified on the equipment schedule.
3. Shipping Configuration:
Chiller shall ship in either 1 or 2 pieces, as specified on the equipment schedule.
4. Cooling Water Flow Switch:
A cooling water flow switch, rated for either 150psig (1034kPa), or 300psig (2068kPa) shall be field installed or factory installed if customer requires and supplied by either the chiller manufacturer or the contractor/owner.
5. Steam Valve (electric or pneumatic)
A steam valve shall be provided when specified on the equipment schedule.
6. Isolation Package:
A vibration isolation package consisting of machine soleplates and neoprene isolation pads shall be furnished for field installation when specified on the equipment schedule.

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Carrier improves the world around us; Carrier improves people's lives; our products and services improve building performance; our culture of improvement will not allow us to rest when it comes to the environment.

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