



Product Data

16DE Double Effect, Hermetic Absorption Liquid Chiller

150 to 500 Nominal Tons (528 to 1758 kW)



16DE033

Carrier's 16DE double effect, hermetic absorption liquid chiller provide an alternative means of efficient, cost effective water chilling. By utilizing high-pressure steam, 16DE chillers avoid high-cost electricity and qualify for utility rebates and incentives as a steam 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 steam 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 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 10 model sizes, spanning a capacity range of 150 to 500 tons, make the 16DE double effect, 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.

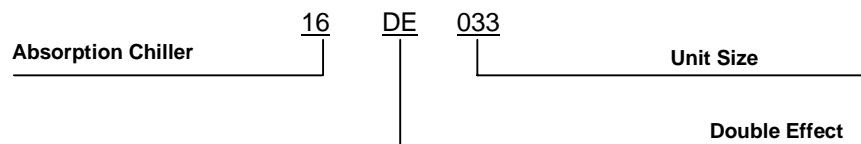
Combined use of absorption and electric-driven chillers – Utilizing both absorption and electric chillers in a central plant offers the flexibility to base load one chiller, while using the other to handle peak load requirements. Hybrid chiller systems have proven to be an

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
015-050	X	

The 16DE015-050 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 with ANSI (American National Standards Institute) raised face (RF) flanges.

Microprocessor control features/benefits

Direct Digital Product Integrated Control (PIC) – Carrier's PIC provides unmatched flexibility and functionality. Each unit integrates directly with Carrier Comfort Network (CCN), providing a system solution to controls applications. PIC is pre-programmed to meet precise control requirements.

PID (Proportional/Integral/Derivative) control algorithms – PID algorithms provide tight chilled water control to optimize chiller operation.

International Chiller Visual Controller (ICVC) – The ICVC has a wide display screen, which can be configured to display in English or Metric units, provides unparalleled ease of operation. A 16-line by 40-character backlit, liquid crystal display (LCD) features 4 menu-specific softkeys. A default display offers a one-glance review of key chiller operation data, simplifying the interaction between machine and user. Also all text strings for display and all alarm messages are provided in several languages.

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 pull-down of water loop temperature and prevents a rapid increase in steam consumption.

Variable Frequency Drive (VFD) – PIC 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.

Features/Benefits (cont)



Low maintenance

Standard features allow simple maintenance procedures – Every 16DE machine has numerous standard design features that provide for convenient and simple maintenance. Hinged water box cover on the absorber, and condenser facilitate tube and water box inspection. A flange type refractory door on the high-temperature generator simplifies inspection and cleaning of the combustion chamber and fire tubes. In addition, epoxy coating of the water boxes 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 overload switches are embedded in the stator to protect against high winding temperatures. The pumps are field serviceable. Inspection is recommended after 5 years or 20,000 hours of operation, whichever comes first. Pump isolation valves are included on 16DE machines to make field service easy, if required.

VIEW OF TYPICAL HERMETIC PUMP/MOTOR ASSEMBLIES





Reliable operation

16DE PIC control system features automatic microprocessor control center continuously monitors machine operation, ensuring precise control – Each Carrier 16DE absorption chiller includes a factory mounted and wired microprocessor 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 codes including UL (Underwriters' Laboratories), CE, and KS where appropriate and include a microprocessor CPU (central processing unit) board, 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 microprocessor control center initiates 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.

16DE 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 cupro-nickel). 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 UL-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. A heated palladium cell is provided as a standard feature. As part of the purge system, the heated palladium cell assists in the removal of hydrogen gas from inside the 16DE. This action minimizes the need for manual evacuation of the purge storage chamber. 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 80 dbA. 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.

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.

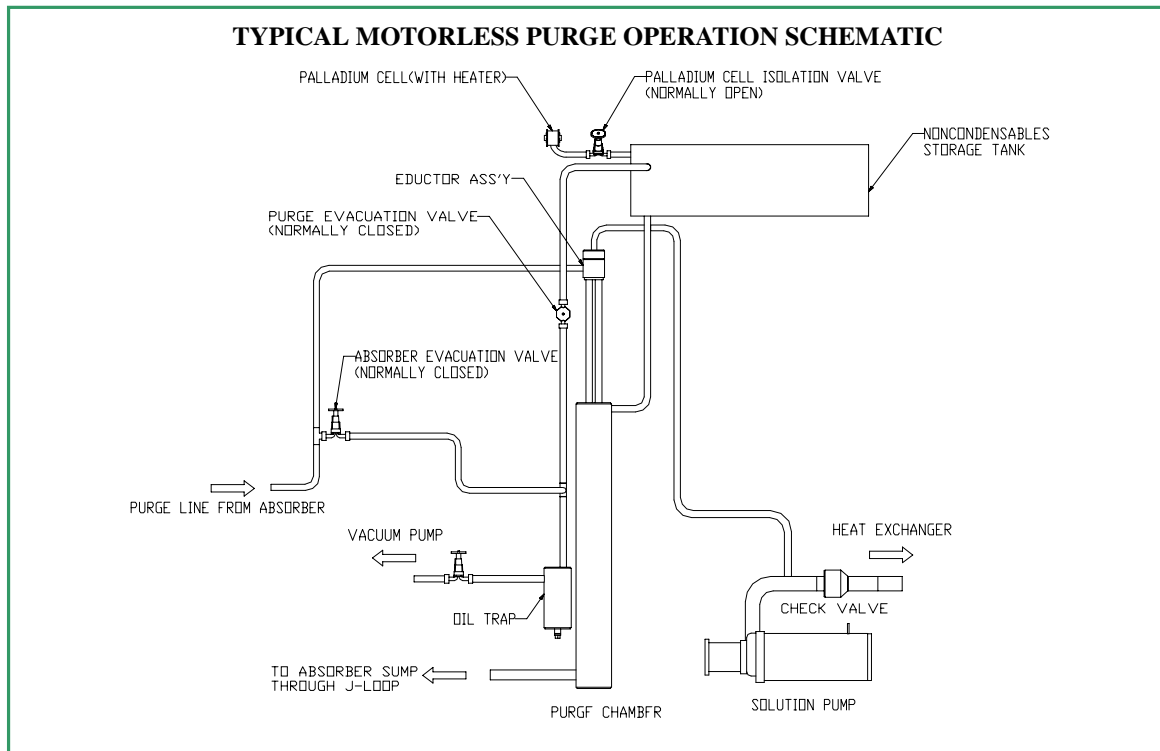
Features/Benefits (cont)



Motorless purge system operation – During operation, noncondensables 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. Typically, most of the noncondensable gas is composed of hydrogen, which is automatically dissipated to the atmosphere through a heated palladium cell.

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 59 F (15 C). 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.

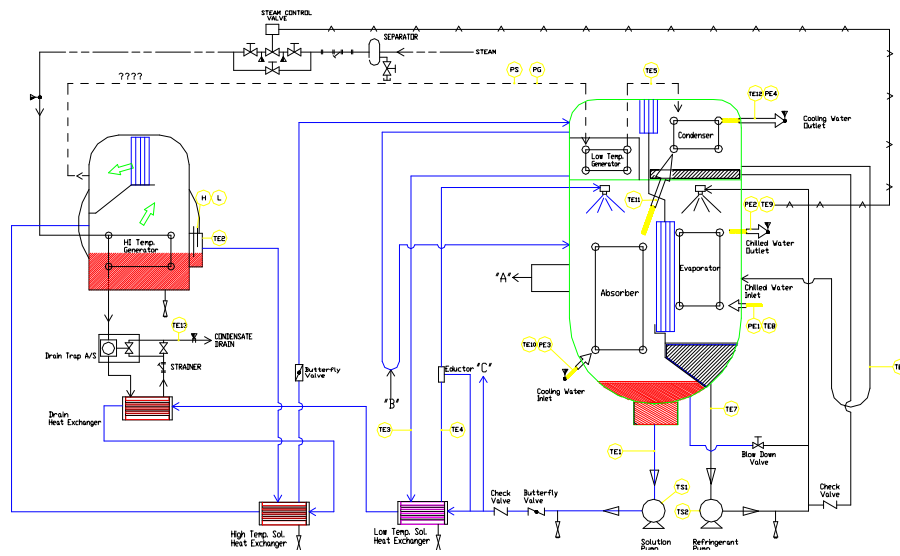
In addition, the 16DE automatic dilution cycle ensures proper concentration after unit shutdown so that the unit will not crystallize when the machine cools to ambient or machine room temperature. The dilution cycle controls operation of the pumps for a set period of time after shutdown to dilute the 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 40 F (4.4 C), 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 reconcentrated 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 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 acts as the condenser for the high-stage generator, the heat energy first

16DE ABSORPTION COOLING CYCLE



Features/Benefits (cont)



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



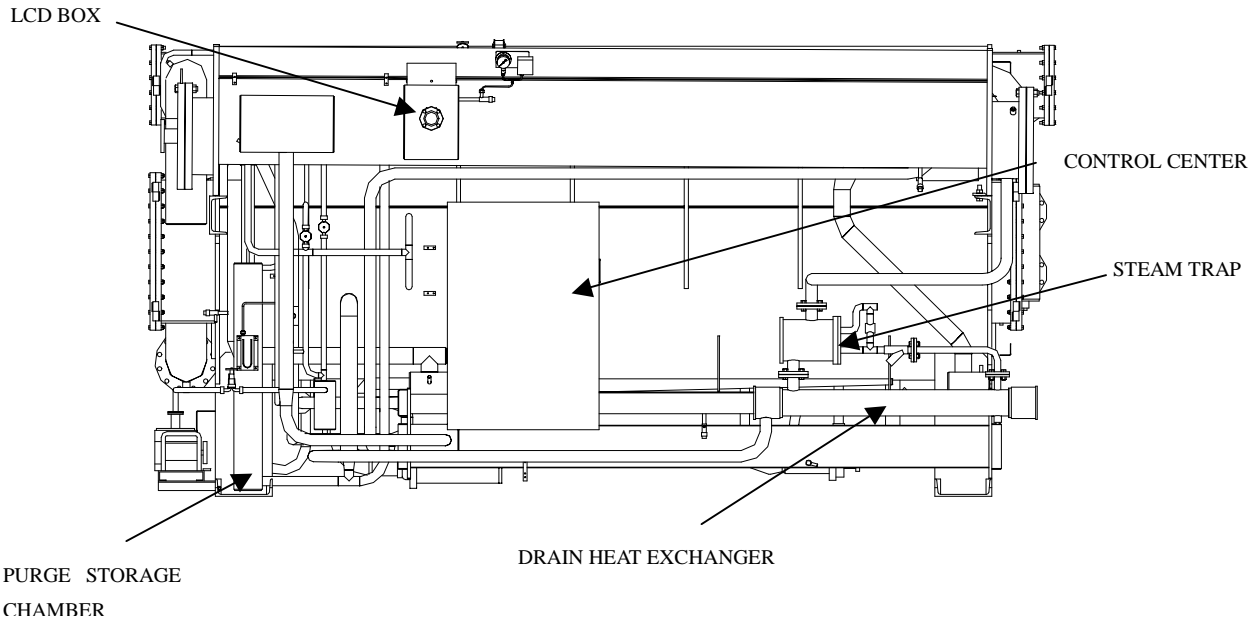
ITEM	OPTION*	ACCESSORY+
250 psig (1724 kPa)/300 psig (2068 kPa) Waterboxes	X	
Special Tubing	X	
Unit Voltage (208, 230, 400, 460, or 575-3-60/50)	X	
Pneumatic Steam Valve		X
Isolation Package		X
Condenser Water Flow Switch	X	

FM - LEGEND
 - Factory Mutual
IRI - Industrial Risk Insurers

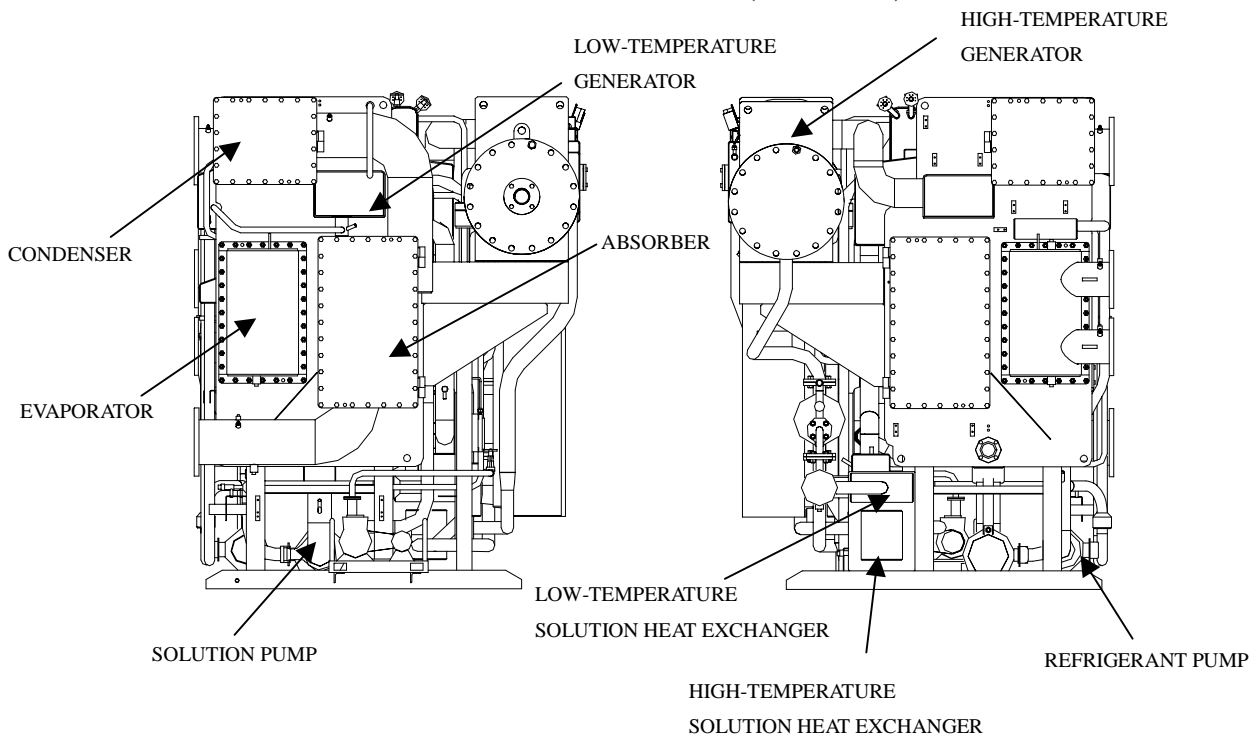
*Factory installed.
 +Field installed.

Machine components

16DE MACHINE ASSEMBLY (FRONT VIEW)



16DE MACHINE ASSEMBLY (SIDE VIEW)



ENGLISH

Unit 16DE	015	018	021	024	028	033
NOMINAL COOLING CAPACITY (ton)	150	180	021	024	280	330
RIGGING WEIGHT* (lb)						
Absorber/Evaporator/G2/Condenser	8,554	8,840	10,194	10,869	12,948	13,457
G1	2,599	2,959	3,197	3,655	4,019	4,548
Total	11,153	11,799	13,391	14,524	16,967	18,005
OPERATING WEIGHT (lb)	15,137	15,950	18,587	19,910	24,352	25,681
LITHIUM BROMIDE SOLUTION CHARGE (gal)	135	147	170	170	263	269
REFRIGERANT (WATER) CHARGE (gal)	66	66	79	79	124	129
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
NOMINAL COOLING CAPACITY (ton)	360	400	450	500
RIGGING WEIGHT* (lb)				
Absorber/Evaporator/G2/Condenser	14,383	15,476	19,145	19,500
G1	5,225	5,930	7,134	7,925
Total	19,608	21,406	26,279	26,603
OPERATING WEIGHT (lb)	27,324	29,563	34,065	35,421
LITHIUM BROMIDE SOLUTION CHARGE (gal)	276	281	334	334
REFRIGERANT (WATER) CHARGE (gal)	140	140	136	136
CHILLED/HOT WATER				
Pipe Connection Size (in.)	6	6	8	8
No. Passes	2	2	2	2
COOLING WATER				
Pipe Connection Size (in.)	8	8	10	10
No. Passes				
Absorber	2	2	2	2
Condenser	1	1	1	1
STEAM				
Pipe Connection Size (in.)				
Inlet	3	3	3	3
Outlet	1	1	1	1

*standard shipping configuration is 1-piece for sizes 015-050.

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	3,985	4,115	4,954	5,123	0	0
G1	895	917	946	977	0	0
Total	4,880	5,032	5,900	6,100	7,300	7,600
OPERATING WEIGHT (kg)	6,400	6,700	8,000	8,300	10,400	10,800
LITHIUM BROMIDE SOLUTION CHARGE (kg)	830	900	1,040	1,040	1,615	1,650
REFRIGERANT (WATER) CHARGE (kg)	250	250	300	300	470	490
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

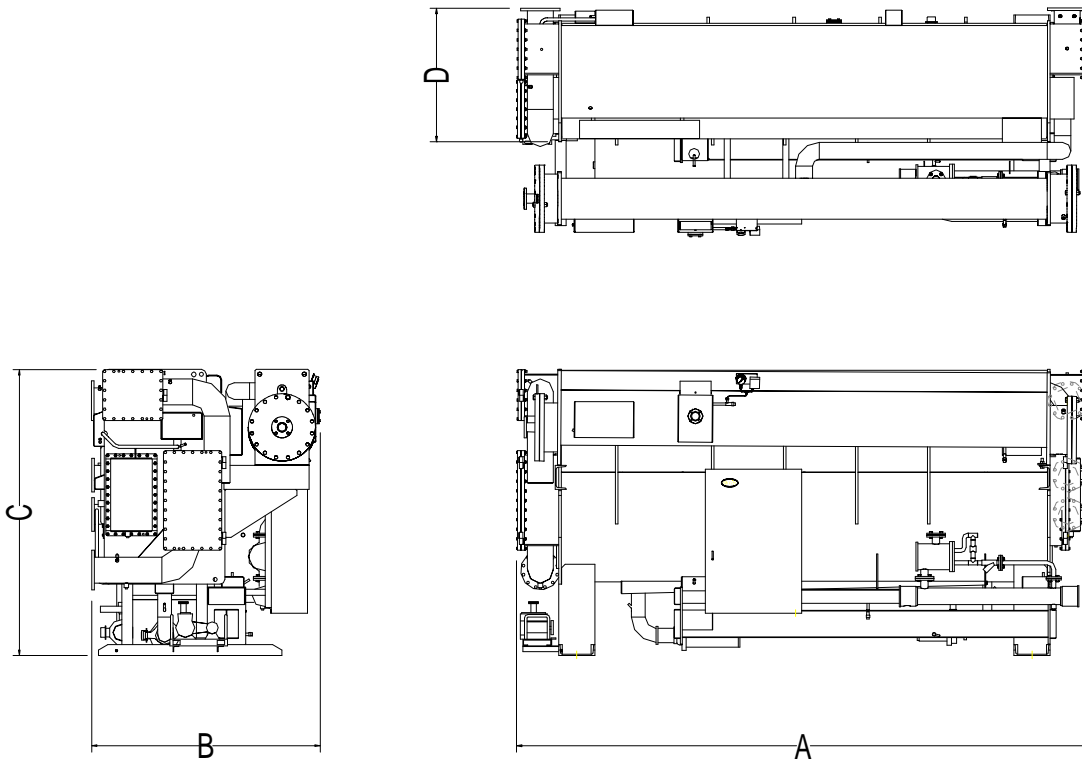
Unit 16DE	036	040	045	050
NOMINAL COOLING CAPACITY (kW)	1,266	1,407	1,583	1,758
RIGGING WEIGHT* (kg)				
Absorber/Evaporator/G2/Condenser	7,017	7,249	8,155	8,446
G1	1,500	1,554	1,658	1,705
Total	8,517	8,803	9,813	10,151
OPERATING WEIGHT (kg)	12,100	13,100	14,000	14,500
LITHIUM BROMIDE SOLUTION CHARGE (kg)	1,690	1,720	2,050	2,050
REFRIGERANT (WATER) CHARGE (kg)	530	530	515	515
CHILLED/HOT WATER				
Pipe Connection Size (mm)	150	150	200	200
No. Passes	2	2	2	2
COOLING WATER				
Pipe Connection Size (mm)	200	200	250	250
No. Passes				
Absorber	2	2	2	2
Condenser	1	1	1	1
STEAM				
Pipe Connection Size (mm)				
Inlet	80	80	80	80
Outlet	25	25	25	25

*Standard shipping configuration is 1-piece for sizes 015-050.

Dimensions



16DE SIZES 015-050



DIMENSIONS (ft-in)

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

DIMENSIONS (mm)

UNIT 16DE	015	018	021	024	028	033	036	040	045	050
Overall Length A	3,631	3,631	3,668	3,668	4,780	4,780	4,800	4,800	4,867	4,867
Overall Width B	1,556	1,556	1,700	1,700	1,903	1,903	1,980	1,980	2,079	2,079
Overall Height C	2,056	2,056	2,309	2,309	2,381	2,381	2,630	2,630	2,820	2,820
Width D*	1,209	1,209	1,328	1,328	1,413	1,413	1,456	1,456	1,614	1,614

*Standard shipping configuration is 1-piece for sizes 015-050.

Dimension "D" is width of absorber, evaporator, condenser, G2 section for 2-piece shipment. The G1 assembly is shipped separately.

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)	25.1	27.2	26.1	26.7	17.5	18.4
COOLING WATER						
Flow Rate (gpm)	600	720	840	960	1,120	1,320
Pressure Drop (ft)	21.3	24.4	17.2	19.1	26.0	27.8
STEAM (lb/hr-ton)	9.7	9.7	9.7	9.7	9.7	9.7
(lb/hr)	1,461	1,753	2,045	2,338	2,716	3,214

UNIT 16DE	036	040	045	050
COOLING CAPACITY (ton)	360	400	450	500
CHILLED WATER				
Flow Rate (gpm)	864	960	1,080	1,200
Pressure Drop (ft)	18.1	18.6	18.1	18.2
COOLING WATER				
Flow Rate (gpm)	1,440	1,600	1,800	2,000
Pressure Drop (ft)	30.4	31.9	28.1	29.0
STEAM (lb/hr-ton)	9.7	9.7	9.7	9.7
(lb/hr)	3,506	3,896	4,383	4,870

LEGEND

ARI – Air Conditioning and Refrigeration Institute

Note: Ratings are based on ARI 560, latest edition, 54/44 F (2.4 gpm/ton) chilled water; 85 F (4.0 gpm/ton) cooling water; fouling factor .00025 ft²-hr-°F/Btu for absorber and condenser, .0001 ft²-hr-°F/Btu for evaporator.

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)	75.0	81.2	77.9	79.7	52.4	54.9
COOLING WATER						
Flow Rate (L/s)	37.9	45.4	53.0	60.6	70.7	83.3
Pressure Drop (kPa)	63.6	72.9	51.3	57.0	77.8	83.0
STEAM (kg/hr-kW)	1.26	1.26	1.26	1.26	1.26	1.26
(kg/hr)	663	796	928	1,061	1,238	1,459

UNIT 16DE	036	040	045	050
COOLING CAPACITY (kW)	1,266	1,407	1,583	1,758
CHILLED WATER				
Flow Rate (L/s)	54.5	60.6	68.1	75.7
Pressure Drop (kPa)	54.2	55.7	54.1	54.5
COOLING WATER				
Flow Rate (L/s)	90.8	100.9	113.6	126.2
Pressure Drop (kPa)	90.9	95.2	83.9	86.8
STEAM (kg/hr-kW)	1.26	1.26	1.26	1.26
(kg/hr)	1,591	1,768	1,989	2,210

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; 29.4 C (.072 L/s-kW) cooling water ; fouling factor .000044 m²-hr-°C/W for absorber and condenser, .0000176 m²-hr-°C/W for evaporator.



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 10 F (5.6 C) 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:

$$\text{Steam Flow (lb/hr)} = \frac{\text{Full Load Steam (lb/hr)} \times \text{SCR}}{\% \text{ Capacity}}$$

or

$$\text{Steam Flow (lb/hr)} = \text{Full Load Steam (lb/hr-ton)} \times \text{SCR} \times \text{Part-Load Capacity (tons)}$$

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:

$$\text{IPLV} = .01A + .42B + .45C + .12D$$

Where A = COP at 100%

B = COP at 75%

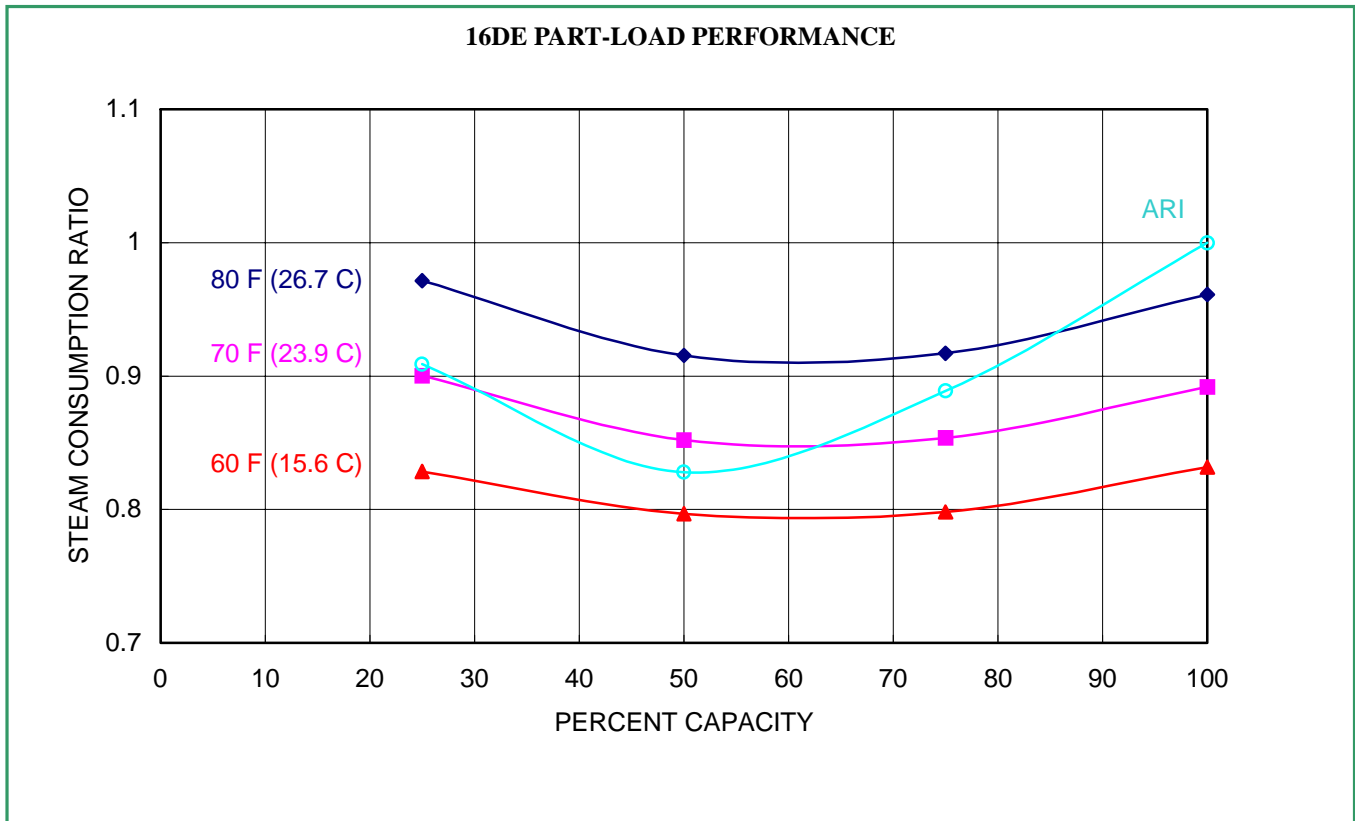
C = COP at 50%

D = COP at 25% or minimum load

NOTE: COP is the Coefficient of Performance

Therefore,

$$\text{IPLV} = .01 (1.20) + .42 (1.35) + .45 (1.45) + .12 (1.32) = 1.39$$





Application data

Vent and drain connections

All vents and drain connections are found on the waterbox covers. Connection size is 3/4-in. FPT.

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 500 tons (528 to 1758 kW) at standard ARI rating conditions.

UL listing

The burner assembly, unit control center, machine mounted controls, wiring, and the entire chiller/heater are listed together as a whole, in accordance with the requirements of UL-795, UL-726, UL-296, and UL-465, as well as other associated UL standards as applicable.

Rupture disk piping

The 16DE is equipped with a rupture disk (optional) or a fusible plug on the high-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, the current version of ANSI/ASHRAE 15 (American Society of Heating, Refrigeration, and Air Conditioning Engineers), and any local jurisdictional requirements that may apply. Piping should be adequately supported and the proper fittings should be provided to allow periodic inspection of the disk. Refer to Carrier certified drawings for exact location of the rupture disk on the chiller.

UNIT SIZE	RUPTURE DISK CONNECTION SIZE
All	3 in. 300 psig RF flange

LEGEND

RF -- Raised Face

MATERIAL SPECIFICATIONS

ITEM	MATERIAL	SPECIFICATIONS
SHELL:		
Evaporator	Steel	ASTM A283
Absorber	Steel	ASTM A283
Condenser	Steel	ASTM A283
G1	Steel	ASTM A283
G2	Steel	ASTM A283
TUBESHEET:		
Evaporator	Steel	ASTM A283
Absorber	Steel	ASTM A283
Condenser	Steel	ASTM A283
G1	Steel	ASTM A283
G2	Steel	ASTM A283
WATERBOX:		
Evaporator	Steel	ASTM A283
Absorber	Steel	ASTM A283
Condenser	Steel	ASTM A283
G1	Steel	ASTM A283
G2	Steel	ASTM A283
TUBES:		
Evaporator	Copper	ASME SB359
Absorber	Copper	ASME SB75
Condenser	Copper	ASME SB75
G1	90-10 CuNi	ASME SB111 ALLOY706
G2	Copper	ASME SB75
PIPING		
	Steel	ASTM A53

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 (FT²)

UNIT SIZE	015, 018	021, 024	028, 033	036, 040	045, 050
COLD SURFACE	67.8	75.3	94.7	100.1	117.3
HOT SURFACE	125.9	144.2	187.2	212.0	226.0

THERMAL INSULATION SURFACE AREA REQUIREMENTS – SI (m²)

UNIT SIZE	015, 018	021, 024	028, 033	036, 040	045, 050
COLD SURFACE	6.3	7.0	8.8	9.3	10.9
HOT SURFACE	11.7	13.4	17.4	19.7	21.0



STANDARD WATERBOX AND CROSSOVER PIPE CONFIGURATION

16DE UNIT	EVAPORATOR		ABSORBER		CONDENSER		CROSS-OVER PIPE
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	
015-050	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
028-050	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	110	434
018	–	–	260	1043	175	694	130	521
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	–	–

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

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	–	–

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

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	–	–

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

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	–	–

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

Controls



Control System

The Product Integrated Controls (PIC) is the control system on the machine. The PIC controls the operation of the machine by monitoring all operating conditions. The PIC can diagnose a problem and let the operator know what the problem is and what to check. It promptly positions the steam control 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 PIC can be interface with the Carrier Comfort Network (CCN). It can communicate with other PIC-equipped chiller and CCN device.

Features

Control system

- Component Test and Diagnostic Check
- Menu-Driven Keypad Interface for Status Display, Set Point Control, and System Configuration
- CCN Compatible
- Primary and Secondary Status Messages
- Individual Start/Stop Schedules for Local and CCN Operation Modes
- Recall of Up to 25 Alarm/Alert Messages with Diagnostic Help
- Advanced Crystallization Protection
- Overriding of Normal Capacity Valve Position in response to Cycle Condition and Manual Valve Control
- International Chiller Visual Controller Language Support

Safety cutouts

- Low Chilled Water Temperature Cutout
- High-Temperature Generator Solution Temperature Cutout
- High-Temperature Generator Pressure Cutout
- Low Chilled Water Flow

Protective limits

- Low Chilled and Cooling Water Flow
- Evaporator Refrigerant Temperature
- Low Chilled Water Temperature
- Weak Solution Leaving Absorber Temperature
- Strong Solution Leaving High-Temperature Generator Temperature
- High-Temperature Generator Solution Level
- Solution Pump VFD Overload/ High Temperature
- Refrigerant Pump Overload/ High Temperature
- Transducer Reference Voltage

Overrides

- Low Refrigerant Temperature
- High-Temperature Generator High Saturation Temperature
- High-Temperature Generator High Solution Temperature
- Solution Concentration Control

Control Sequence

To start: Local start-up (manual start-up) is initiated by pressing the LOCAL menu softkey which is indicated on the default local interface device (LID) screen. All pre-start safeties are checked to verify that all pre-start alerts and safeties are within limits. If one is not, an indication of the fault will be displayed and the start is aborted. The signal is sent to start the chilled water pump. If flow is not confirmed, the controls continue to monitor flows for a maximum of 5 minutes. If flow is confirmed, the controls check the chilled water temperature against the control point. If the temperature is less than or equal to control point, the controls go into a recycle mode. If the water temperature is high enough, the start-up sequence continues and starts the cooling water pump. Once the cooling water flow is verified, the cooling tower fan algorithm shall be enabled. The controls start the solution pump and warm-up routine. The refrigerant pump shall be energized 2.5 minutes after the start of warmup. The steam control valve is initially held at warmup start position at the beginning of warmup. For each additional 5 minutes of warmup, the capacity valve shall be stepped by 1/3 of the warmup travel limit until it is at the warmup travel limit for the last 5 minutes of warmup. Once the full 20 minutes of warmup is complete, the ramp loading routine shall be initiated.

Once started: The controls enter ramp loading mode to slowly open the steam control valve to prevent a rapid increase in boiler demand. Once ramp loading is completed, the controls enter the capacity control mode. Any failure that results in a safety shutdown immediately activates the dilution cycle, closes the steam control valve at its maximum rate of travel, activates the alarm light and relay, displays the fault that occurred, and updates the alarm history log.

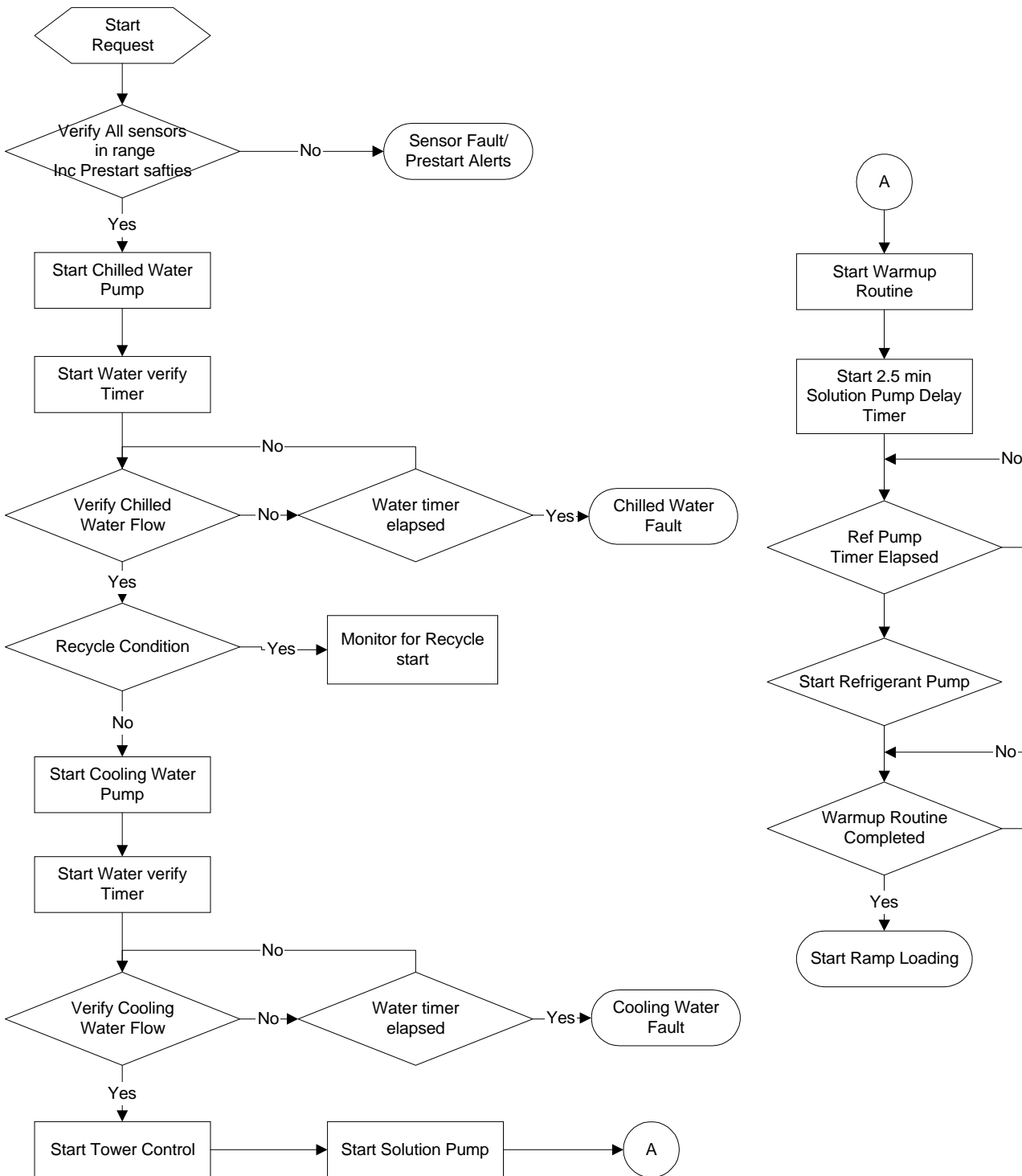
Shutdown sequence: Chiller shutdown can occur if any of the following events happen:

- The Stop button is pressed for at least one second
- A recycle shutdown is initiated
- Time schedule has gone into Unoccupied mode
- Machine protective limit has been reached and chiller is in alarm
- The start/ stop status is overridden to stop from the CCN network or the LID

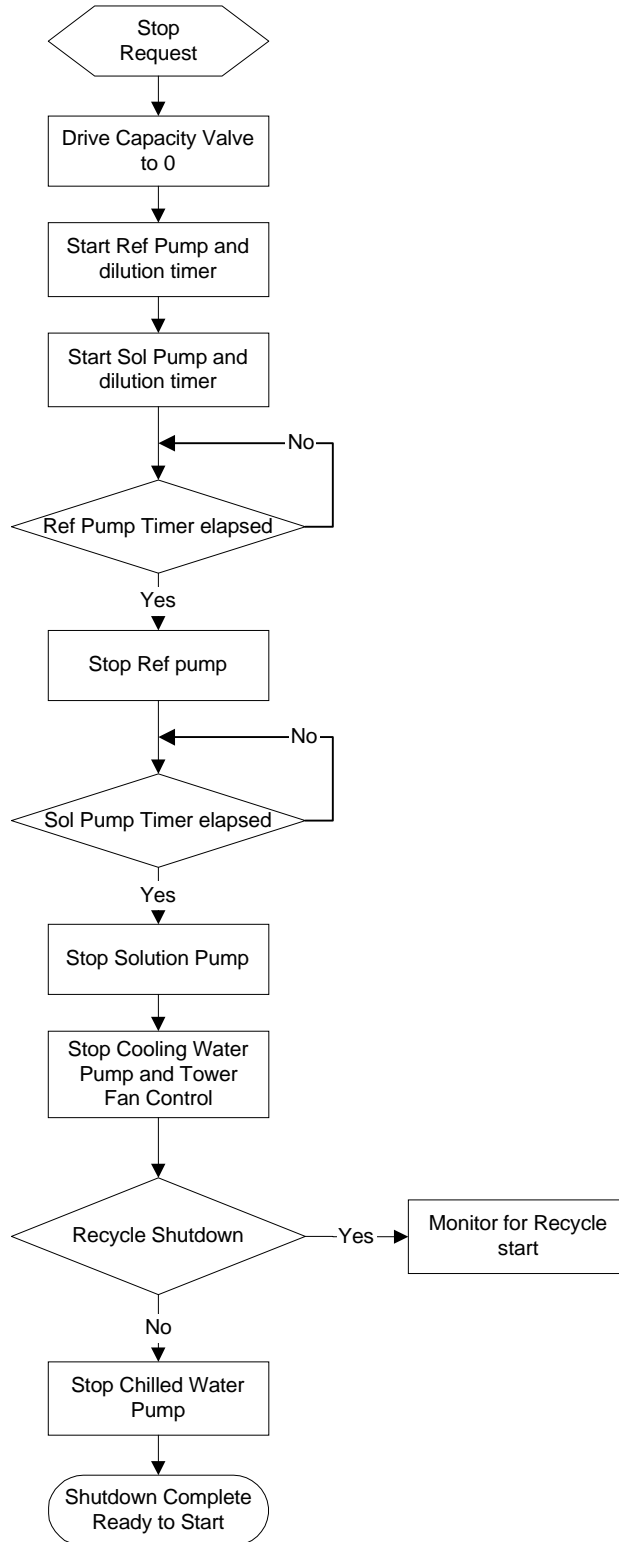
Once the controls are placed in shutdown mode, the shutdown sequence closes the steam control valve. The software initiates a 15-minute dilution cycle to lower the concentration of the solution and equalize chiller temperatures. The refrigerant pump stops 3 minutes after the start of dilution cycle. All pumps stop at the end of dilution cycle.

Restart: Restart is permitted after dilution cycle is completed and there is a need for chilled water. If the shutdown was due to a safety shutdown, the reset button must be pressed before restarting the chiller.

NORMAL START FLOW CHART



NORMAL STOP FLOW CHART



Guide specifications



Hermetic Absorption Liquid Chiller

Size Range: **150 to 500 tons (528 to 1758 kW)**

Carrier Model Numbers: **16DE**

Part 1 – General

1.01 SYSTEM DESCRIPTION

Microprocessor controlled, double-effect absorption liquid chiller utilizing hermetic refrigerant and solution pumps, lithium bromide solution as the absorbent, 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 in accordance with ANSI/ASHRAE 15 (latest edition), Safety Code for Mechanical Refrigeration or JIS B8622 (Japanese Industrial Standard), as applicable.
- C. Chiller shall be designed and constructed to meet applicable (UL) requirements and shall bear the UL label.
- 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 psig (76 kPa) 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 .0001mmHg 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 .00001 cc/sec standard air.
 2. The tubeside of the evaporator, absorber, and condenser shall be hydrostatically tested at 1.5 times rated design pressure and held for one hour.
 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. Unit shall *be* factory-charged with lithium bromide solution and performance tested before shipping. But if customer requires, unit shall *not* be factory-charged with lithium bromide solution to prevent possible internal corrosion damage from occurring should the inside of the machine be accidentally exposed to air during shipment and/or installation. Charging of lithium bromide solution shall be performed at the jobsite in accordance with the manufacturer's written instructions.
- C. One-piece units shall be shipped under vacuum on the shellside. Two-piece units shall be shipped with 5 psig (34 kPa) nitrogen pressure.
- D. Chiller shall be shipped with nameplates indicating name of manufacturer, model size, serial number, and all other pertinent machine data.

1.04 WARRANTY

Manufacturer 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. Manufacturer 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, refrigerant/ solution pumps, purge system, piping, wiring, controls, and auxiliaries. Shipment of the machine shall be in 1 piece with an option for 2-piece shipment. Initial charge of lithium bromide 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 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

Guide specifications (cont)



temperatures as low as 59 F (15 C), 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 59 F (15 C).

C. Heat Exchangers:

1. All heat exchangers shall be of shell and tube construction with shells, tubesheets, tube support sheets, and water boxes 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 150 psig (1034 kPa) working pressure. Nozzle-in-head (NIH) type water boxes shall be supplied on the evaporator while the absorber-condenser water boxes shall be either NIH or marine type, depending on model size. All water boxes shall be provided with vent and drain connections. ANSI 150 psig RF flanges shall be furnished on all water box nozzle connections.
3. The high-temperature generator shall consist of straight tubes secured to a number of baffle plate located between tubesheets. The high-temperature generator water box shall be designed for 150 psig (1034 kPa) working pressure. The steam inlet shall be provided with an ANSI 150 psig R.F. flange connection. An ASME section VIII, Division 1 U-stamp shall be provided on the high-temperature generator steam-side.
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. An ASME Section VIII, Division 1 U-stamp shall be provided when required by code. 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 tube-side with strong solution on the shell-side. 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 lithium molybdate systems, the following tube specifications shall apply to ensure long machine life and continuous operation:

Evaporator.....	copper, externally-finned
Absorber.....	copper, externally-finned
Condenser.	copper, externally-finned
Low-Temperature Generator.....	copper, externally-finned
High-Temperature Generator.....	cupronickel, prime surface

If chiller manufacturer 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. Pump/motor assemblies shall be designed for a minimum of 5 years (or 20,000 hours) normal operation between inspections. If pump/motor assemblies are furnished with less than a design of 20,000 hours between inspections, they must be provided with a bearing monitoring system to aid in diagnosing and performing on-going maintenance.

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. A palladium cell shall be provided to automatically vent hydrogen gas from the purge tank to the atmosphere to minimize the need for manual evacuation of the storage tank. Evacuation of the external storage tank shall be accomplished by the use of a unit-mounted vacuum pump to ensure that the palladium cell is not wetted with lithium bromide solution. 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 microprocessor control system with individually replaceable modular component construction. The system shall include a control center, power supply, temperature (thermistor) and pressure (transducer) sensors, and all necessary auxiliary devices required for proper operation. The chiller operation system shall have the ability to interface and communicate directly to the building control system without the use of additional field-installed hardware or software. Additional hardware will be necessary if the building control system is not a Carrier Comfort Network (CCN). The control center shall include a 16-line by 40-character liquid crystal display (LCD) screen, four function keys, stop button, and alarm light. The microprocessor 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
 - 24-character primary system status message
 - chiller operating hours
 - 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. The 4 function keys shall be software driven within the Status, Schedule, Setpoint and Service menu structures (as described below).
 - 1) Status Function
In addition to the default screen, status screen shall be accessible to view the status of every point monitored by the control center including:
 - 2) Schedule Function
The chiller controls shall be configurable for manual or automatic startup and shutdown. In automatic operation mode, the controls shall be capable of automatically starting and stopping the

chiller according to a stored user programmable occupancy schedule. The controls shall include built-in provisions for accepting a minimum of two 365-day occupancy schedules. Each schedule shall allow a minimum of 8 separate occupied and unoccupied periods, any or all of which can be scheduled by individual day for any or all days of the week, with a separate schedule for holidays. Schedules shall allow specification of daylight savings start/end and up to 18 user-defined holidays up to one year in advance (month, day, and duration in days). Display of the occupancy schedules shall be viewable on the LCD screen. Each schedule shall provide a means of configuring an occupancy timed override to permit a "one time extension" of an occupied period on the configured day. The controls shall also provide for chiller start-up and shutdown via remote contact closure from a customer supplied device, or from a building management system software command.

3) Setpoint Function

The controls shall provide the capability to view and change the leaving chilled water set point, entering chilled water set point, and demand limit set point at any time during chiller operating or shutdown periods. The controls shall allow for the specification of capacity control via either leaving chilled water or entering chilled water.

4) Service Function

The controls shall provide a password protected service function which allows authorized individuals to:

- view an alarm history file which shall contain the last 25 alarm and/or alert messages with time and date stamp. These messages shall be displayed in text form, not codes.
 - Execute a chiller controls test function for quick identification of malfunctioning components.
 - View and/ or modify chiller configuration
 - View and/ or modify
- 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

Guide specifications (cont)



- 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. Capacity control shall be by means of electronically modulating the steam control valve actuator to maintain the temperature of the leaving chilled water. Load modulation shall be from 100% to 25% of machine full load under normal ARI conditions. The steam control valve shall be precisely positioned by a PID (Proportional Integral Derivative) control algorithm to ensure precise control ($\pm .5$ F [$\pm .3$ C]) of desired chilled water temperature without hunting or overshooting the set point.
 - f. The microprocessor control system shall include a programmed sequence to ensure machine readiness prior to machine start-up. The microprocessor shall automatically activate and interlock the chilled water pump, cooling water pump, cooling tower fan upon chiller activation.
 - 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. Message will be displayed : "run capacity limited, high concentration."
 - 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. Message will be displayed: "dilution cycle shutdown, complete in *.* min."
 - 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 3 F (1.7 C) 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 an external 4 to 20 mA signal.
 - 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, complete in *.* min"
- ### 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



LCD screen, informing the operator of the shutdown cause.)

- solution pump VFD overload/high temperature
 - refrigerant pump motor overload/high temperature
 - low chilled water temperature
 - low evaporator refrigerant 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
- 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 CCM inputs test shall allow display on the LCD screen of the actual reading of each transducer and each thermistor installed on the chiller.

The CCM outputs 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 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.

4. Building Control System Interface:

The chiller control system shall have the ability to interface and communicate directly to the building control system without the use of additional field installed hardware and software. The building control system and the absorption chiller must be supplied by the same manufacturer. If different building control and chiller suppliers are chosen the chiller shall be supplied with a dataport module which shall translate the information in the chiller microprocessor to an ASCII stream of data which can be read by any manufacturer's building management control system.

G. Electrical Requirements:

1. Power supply to the unit shall be 3-ph, 60Hz with voltages of 208, 230, 460, or 575, 3-ph, 50Hz, 220V, 380V, 440V, 3-ph, 50/60Hz, 220V, 400-440V as specified on the equipment schedule. A multitap transformer shall provide 100, 110 or 200, 220 shingle-phase secondary power for the control center.
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.

Guide specifications (cont)



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 and any local jurisdictional requirements.

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 80 dbA when measured per ARI Standard 575 (latest edition).

K. Start-up:

1. Unit manufacturer 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 factory 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. Manufacturer 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 250 psig (1724 kPa) or 300 psig (2068 kPa) 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 150 psig (1034 kPa), 250 psig (1724kPa), or 300 psig (2068 kPa) 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. Unit Voltage

Unit shall be capable of operating on 3 phase, 50/60 Hz, when specified on equipment schedule.

7. 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.