DCLC Series 50Hz

Water Cooled Centrifugal Chillers

Cooling Capacity: 300 to 1500 TR (1055 to 5274 kW)

Products that perform...By people who care

1.0 GENERAL

For most of the 20th Century, DB has been providing innovative solutions for the heating, air conditioning and refrigeration needs of its customers. Today's global company has a proud heritage that began over a 100 years' ago.

In the 1960s, DB introduced a revolutionary compressor technology for air conditioning and refrigeration applications – the twin helical screw compressor. Highly efficient, durable and very reliable, DB's experience of more than 50 years in the application of twin screw compressors in the HVAC industry is unrivalled.

Customers demand high efficiency products with exceptional value and DB's new range of

DCLC centrifugal chillers satisfy modern market requirements with outstanding energy efficiency and proven technology, designed specifically for environmentally safe refrigerants. This combination ensures the most cost-effective, reliable solution for comfort cooling and process cooling applications.

DB continues to deliver performance with reliability packaged in the most energy efficient way with the introduction of the DCLC range of centrifugal water chillers.

The major advantages of the DCLC:
- High reliability
- Simple operation and maintenance
- Low sound levels
- Simplified structure and compact size
- High efficiency at a competitive market price
- Designed to use environmentally friendly R134a refrigerant.

The DCLC range of chillers is ideal for offices, hospitals, hotels and retail stores as well as industrial applications. The chiller offers a full range of Evaporator/Condenser/Compressor combinations, permitting precise matching of the machine capacity to system requirements. With such a wide range of available combinations, DCLC units can be configured to provide lowest first cost, lowest operating cost or choice of several criteria important for a particular application. The centrifugal chiller selection software is certified in accordance with the latest AHRI standard 550/ 590.

DB Sales Engineers are available to assist in selecting the optimum machine needed to satisfy the particular project requirements.

The DCLC centrifugal chiller from DB offers superior value and application flexibility, a wide range of options and accessories and the peace of mind that more than 100 years of industry experience is behind this product can be ideally configured to suit your project.

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NOMENCLATURE

DCLC 1000 B

DCLC - Dunham-Bush Centrifugal Water Chiller
DCLCR - Dunham-Bush Heat recovery Centrifugal Chiller
DCLCV - Dunham-Bush VFD Centrifugal Chiller

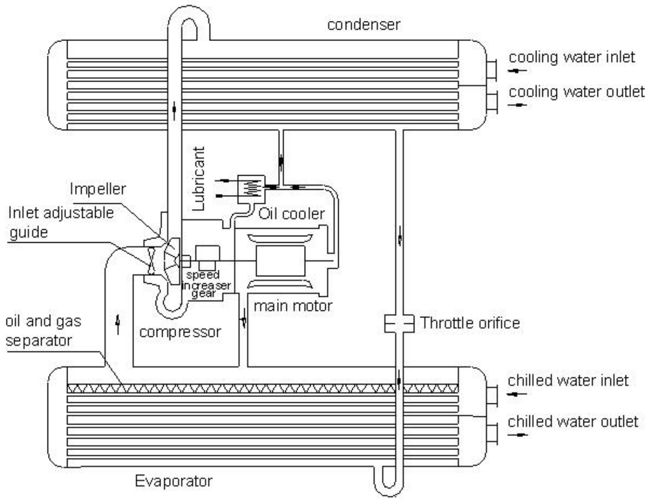
Nominal Cooling Capacity TR

Design Level : B

2.0 WORKING PRINCIPLE AND STRUCTURE

2.1 REFRIGERATION CYCLE

Single-stage compression circulating diagram



The compressor on a centrifugal chiller utilizes the Vapour Compression cycle in the much the same way as any positive displacement compressor. The Vapour compression cycle uses a medium such as refrigerant to absorb heat at one part of the cycle and reject that heat at a different part of the cycle. The centrifugal compressor is a dynamic machine which raises the pressure and temperature of the circulating refrigerant by imparting velocity or dynamic energy through an electric motor driven impeller discharging into a volute or diffuser plate to convert this velocity energy to pressure energy. As with all vapour compression systems, there are four major components: compressor, condenser, expansion device and evaporator. The evaporator absorbs heat from its surrounding and the condenser rejects the heat collected plus any system losses to its surroundings. The cycle will continue to operate all the time the compressor is operating and a system load exists.

The following is the principle in details:

Compressor: The refrigerant vapour enters the compressor in a low pressure, low temperature but superheated state. The compression process increases the pressure and the temperature and the now high pressure, high temperature superheated gas is discharged into a condenser, a heat exchanger where due to its high temperature the refrigerant can be condensed using cooling tower water or ambient air.

Condenser: The high pressure hot vapour is condensed into a high pressure hot liquid, or saturated liquid as its pressure corresponds to its condensing temperature. This now high pressure liquid refrigerant discharges from the bottom of the condenser and is passed through an expansion valve or some other restrictive device.

Expansion valve: The downstream side of this expansion device is exposed to the low pressure part of the system which causes the refrigerant to expand rapidly as it passes through the device, as it expands; adiabatic cooling of the gas/liquid mixture occurs to the point where it is then colder than the water (or other liquid to be cooled) in the evaporator.

Evaporator: This is a second heat exchanger where the medium ultimately to be cooled by this process, the ‘chilled water’, is circulated on one side and the cold refrigerant mixture is circulated through the other side where it absorbs heat, thereby cooling down the chilled water. Cooling the chilled water is the fundamental purpose of the equipment. The refrigerant then continues to circulate in the system and after going through the compression process again the heat absorbed will be rejected by the condenser to the tower water or ambient air.

The cooling capacity of a system is directly proportional to refrigerant gas flow through the compressor. An adjustable guide vane regulating device can be installed at the inlet of centrifugal compressors to control the suction flow of compressor, matching the system cooling capacity to that of the building cooling load in a regulated and step less manner across a defined range.

Maximum outside temperature — for transport and storage of the DCLC units the minimum and maximum allowable temperatures are -20°C and +50°C.

Unit (Standard type) operating temp range:

			Min.	Max.
Evaporator	Inlet water temp.	°C	8	25
	Outlet water temp.	°C	4	15
Condenser	Inlet water temp.	°C	15.6	34
	Outlet water temp.	°C	22	41

2.0 WORKING PRINCIPLE AND STRUCTURE

2.2 CHILLER SELECTION SAMPLE

Sample Specification（300TR-1500TR, 400V-3P-50Hz,star delta start）																			
Model	Chiller					Chiller current		Evaporator			Condenser			Dimension			Weight		
	Cooling capacity		Power input	COP	IPLV	Rated current	Locked-rotor current	Chilled water flow volume	Chilled water pressure drop	Water pipe in/outlet dia.	Cooling water flow volume	Cooling water pressure drop	Water pipe in/outlet dia.	Length	Width	Height	Running weight	Shipping weight	R134a injection
	kW	TR	kW	kWo/kWi	kWo/kWi	A	A	l/s	kPa	mm	l/s	kPa	mm	mm	mm	mm	kg	kg	kg
DCLC300	1055	300	179	5.91	5.76	297	691	46	72	DN200	54	58	DN200	4994	1994	2250	11375	9539	666
DCLC350	1231	350	201	6.11	6.08	334	779	53	70	DN200	63	57	DN200	4994	1994	2250	11375	9539	666
DCLC400	1406	400	222	6.34	6.78	369	861	61	68	DN200	72	73	DN200	4994	1994	2250	11068	9395	617
DCLC450	1582	450	261	6.06	6.34	434	1011	68	66	DN200	81	71	DN200	4423	1994	2250	10480	8972	521
DCLC500	1758	500	288	6.11	6.35	481	1120	76	75	DN200	89	66	DN200	4994	1994	2250	11167	9457	617
DCLC550	1934	550	318	6.08	6.55	530	1235	83	61	DN200	98	47	DN200	4994	1994	2250	10962	9331	617
DCLC600	2110	600	343	6.15	6.60	571	1330	91	79	DN250	106	71	DN200	4994	1994	2250	11068	9395	617
DCLC650	2285	650	370	6.18	6.24	615	1432	99	77	DN250	115	62	DN200	4994	1994	2250	11295	9507	648
DCLC700	2461	700	394	6.25	6.48	658	1533	106	79	DN250	124	71	DN200	4994	1994	2250	11375	9539	666
DCLC750	2637	750	427	6.18	6.35	715	1665	114	72	DN250	133	72	DN250	4959	2096	2270	12120	10154	693
DCLC800	2813	800	454	6.20	6.38	760	1771	121	81	DN250	142	73	DN250	4959	2096	2270	12321	10261	712
DCLC850	2989	850	469	6.37	6.59	786	1831	129	67	DN300	150	52	DN300	5065	2426	3010	18757	16139	907
DCLC900	3164	900	502	6.31	6.48	842	1962	136	74	DN300	159	57	DN300	5065	2426	3010	18757	16139	907
DCLC1000	3516	1000	565	6.23	6.01	949	2211	152	90	DN300	176	69	DN300	5675	2426	2903	20427	17267	1103
DCLC1100	3868	1100	613	6.31	6.17	1029	2397	167	87	DN300	194	82	DN300	5675	2426	2903	20589	17312	1157
DCLC1200	4219	1200	679	6.21	6.39	1139	2655	182	78	DN350	212	73	DN350	5675	2426	2903	20589	17312	1157
DCLC1300	4571	1300	718	6.37	6.59	1210	2818	197	102	DN350	229	95	DN350	5737	2712	2965	23214	19675	1156
DCLC1400	4922	1400	773	6.37	6.66	1300	3029	212	101	DN350	246	94	DN350	5737	2712	2965	26520	22765	1215
DCLC1500	5274	1500	825	6.40	6.61	1387	3231	227	101	DN350	264	93	DN350	5737	2712	2965	23832	19948	1270

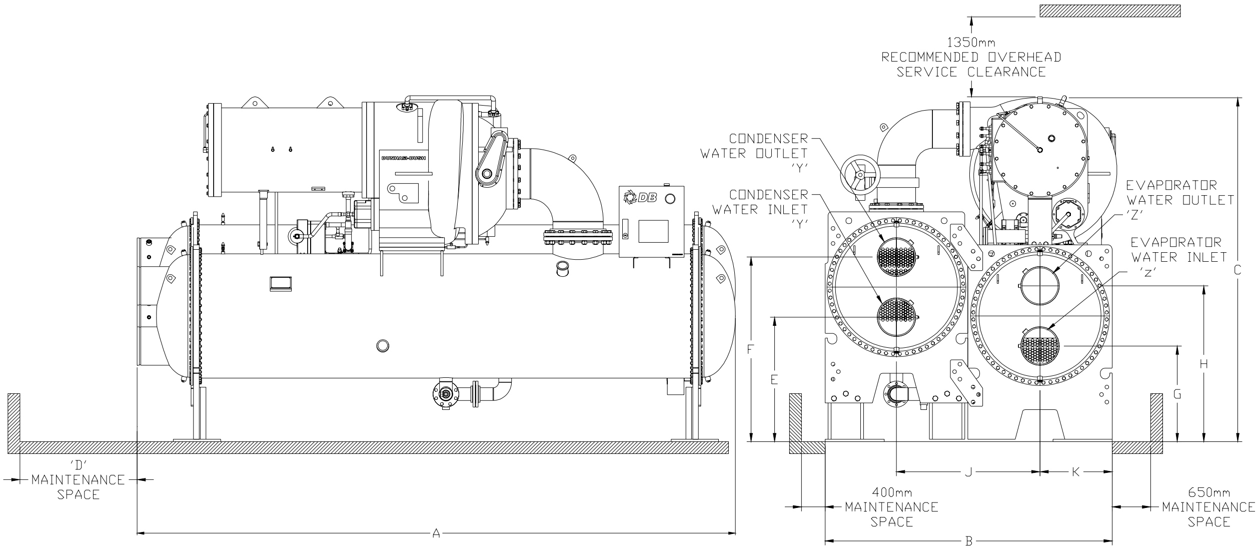
Notes:

1. Nominal Cooling capacities are based on following conditions:
   Chilled water inlet/outlet temperature 12.2/6.6°C; Condenser water inlet/outlet temperature 29.4/35°C;
   The rated current data as listed for DCLC chiller models 300-1500 is based on 400V/3P/50Hz power supply.
   60Hz performance data is available upon request.
2. For DCLC chiller models 300-1000, low-voltage 400V is standard and recommended (high voltage optional); for DCLC models 1100-1500, High Voltage 3kV/6kV/10kV is recommended (low voltage optional);
3. The design fouling factor for evaporator and condenser are 0.0176 and 0.044 m^2/kW, respectively for alternative fouling factors please contact DB
4. The design working pressure of the water (tube) side for both evaporator and condenser is 10 bar, higher pressure designs are available upon request.
5. The Sample Specification above is for reference only. According to a variety of main parts combination, the same cooling capacity can have many different models.

Contact local DB office to choose the appropriate chiller for the User's practical requirements. Due to possible product improvement, we reserve the right to make changes in design and construction at any time without notice.

2.0 WORKING PRINCIPLE AND STRUCTURE

2.3 DCLC CHILLER DIMENSIONS



Model	A	B	C	D	E	F	G	H	J	K	Y	Z
DCLC300	4994	1994	2250	4300	637	1067	483	853	997	489	DN200	DN200
DCLC350	4994	1994	2250	4300	637	1067	483	853	997	489	DN200	DN200
DCLC400	4994	1994	2250	4300	637	1067	483	853	997	489	DN200	DN200
DCLC450	4423	1994	2250	3800	637	1067	483	853	997	489	DN200	DN200
DCLC500	4994	1994	2250	4300	637	1067	483	853	997	489	DN200	DN200
DCLC550	4994	1994	2250	4300	637	1067	483	853	997	489	DN200	DN200
DCLC600	4994	1994	2250	4300	637	1067	483	853	997	489	DN200	DN250
DCLC650	4994	1994	2250	4300	637	1067	483	853	997	489	DN200	DN250
DCLC700	4994	1994	2250	4300	637	1067	483	853	997	489	DN200	DN250
DCLC750	4959	2096	2270	4300	689	1119	490	920	1048	521	DN250	DN250
DCLC800	4959	2096	2270	4300	689	1119	490	920	1048	521	DN250	DN250
DCLC850	5065	2426	3010	4300	969	1519	786	1336	1213	610	DN300	DN300
DCLC900	5065	2426	3010	4300	969	1519	786	1336	1213	610	DN300	DN300
DCLC1000	5675	2426	2903	4900	969	1519	786	1336	1213	610	DN300	DN300
DCLC1100	5675	2426	2903	4900	969	1519	786	1336	1213	610	DN300	DN300
DCLC1200	5675	2426	2903	4900	969	1519	786	1336	1213	610	DN350	DN350
DCLC1300	5737	2712	2965	4900	885	1485	695	1295	1356	678	DN350	DN350
DCLC1400	5737	2712	2965	4900	885	1485	695	1295	1356	678	DN350	DN350
DCLC1500	5737	2712	2965	4900	885	1485	695	1295	1356	678	DN350	DN350

Notes:

1. The above dimensions are based on standard water side design pressure of 10 bar, and Victaulic connections. Dimension A is for unit configurations with two pass evaporator and condenser, left hand configuration when viewed from compressor and electrical box side of unit.
2. Service access should be provided in accordance with American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) 15, latest edition, National Fire Protection Association (NFPA) 70, and local safety code.
3. Allow at least 1350mm overhead clearance for service rigging for the compressor.
4. Certified drawings available upon request. Drawings included in this section are for preliminary layout purposes only. Detailed certified drawings are available from the local DB sales office. Do not use for final construction drawings.
   The above dimensions are for the standard chillers, if other than standard vessel configuration is selected please consult local DB Sales office.
5. All dimensions are in mm.

3.0 SYSTEM COMPONENTS

The major components of the DCLC Chiller are:- the evaporator and condenser heat exchangers as separate vessels, Motor-Compressor, lubrication package, PLC control panel, and motor starter. All connections from pressure vessels have external threads to enable each component to be pressure tested with a threaded pipe cap during factory assembly.

a) Motor-Compressor

Close-coupled semi hermetic electric motor and compressor assembly, for compressing the refrigerant and circulating it around the system.

b) **Evaporato**r

The evaporator has the compressor mounted upon it, and it is within this heat exchanger that the temperature of the leaving chilled water is cooled and reduced to the desired temperature.

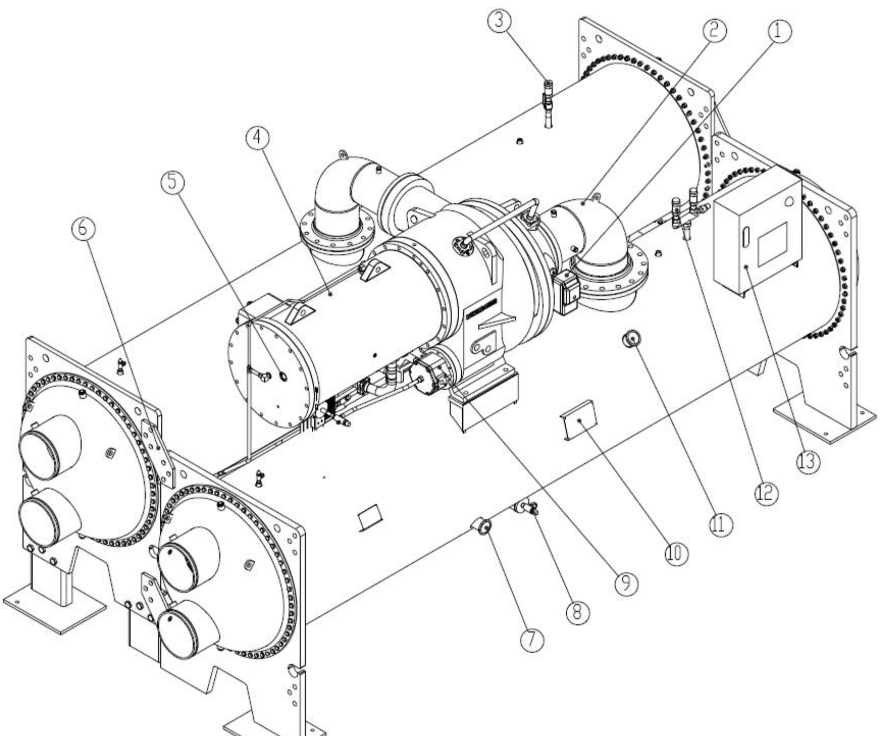
c) Condenser

The condenser water circuit requires connecting to a cooling tower or similar device in order to reject the heat removed from the 'chilled water' circuit.

d) **PLC Control Panel**

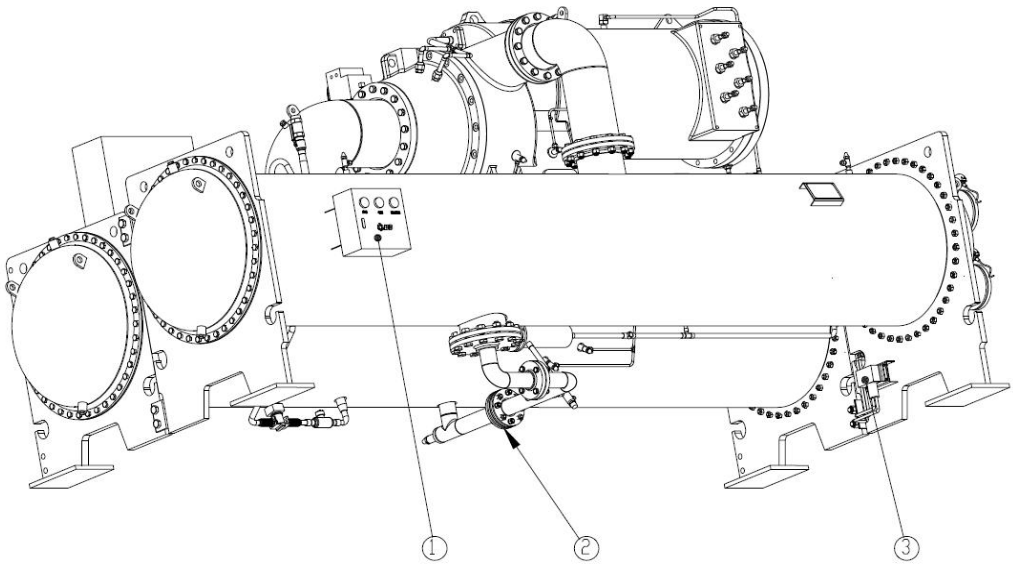
The control panel is the user interface for controlling the chiller. It regulates the chiller's capacity as required to maintain design leaving chilled water temperature. The PLC Control also monitors evaporator, condenser and lubricating system pressures and can display chiller operating condition and alarm shutdown conditions. The controller can also record the chiller operating hours and sequence the start up and stopping of the chillers.

System structure



No.	Name
1	Guide Vane actuator
2	Suction elbow
3	Safety valve PRV(condenser)
4	Motor-Compressor
5	Motor rotation sight glass
6	Heat-exchanger junction plate
7	Liquid level sight glass
8	R134a charging valve
9	Oil pump
10	Name plate
11	Evaporator sight glass
12	Safety valve PRV (evaporator)
13	PLC control panel

3.0 SYSTEM COMPONENTS



No.	Name
1	Oil pump starter
2	Orifice
3	Pressure difference water switch

Additional

- The standard design pressure for the water (tube) side of the evaporator and condenser is 10bar. 16bar and 20bar are optional.

- Providing the site selected and in particular the floor construction is suitable for the chiller and is capable of supporting the operating weight of DCLC chiller including the refrigerant charge and water content, there is no requirement to install a secondary plinth.

- All DB DCLC chillers are thoroughly run tested at the factory prior to shipment. The maximum vibration must not exceed 3mm/second, which is significantly better than other manufacturers and the industry norm. Therefore anti vibration mounts are not normally required although can be supplied as an option. The chiller can be mounted directly onto a set of rubber or similar pads.

- A noise reduction cover is available for the compressor discharge line as an option. The cover can reduce the overall sound level up to 2dB (A).

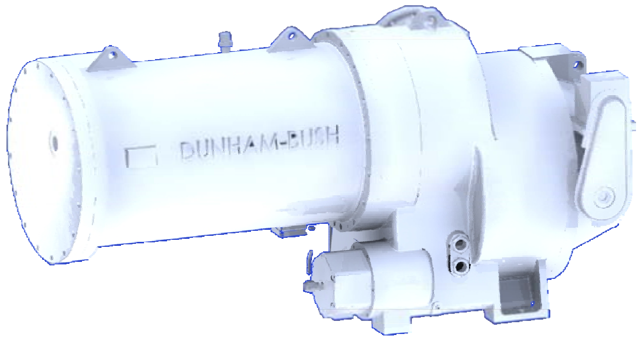
- The 6kV, 10kV high-voltage starter cabinet is optional. Where a customer wishes to supply their own starter it must comply with the DCLC ‘Technical Requirements for High-Voltage Start Motors’ for centrifugal chiller cabinets.

NOTE:
For details of options, assistance with complying with or changing specifications in favour of the DCLC chillers, please contact the local DB Sales Representative.

3.0 SYSTEM COMPONENTS

3.1 COMPRESSOR MAJOR COMPONENTS

The centrifugal compressor adopts the sealed single-stage structure. Single stage design can eliminate the additional loss in the multi-stage and provides an opportunity for maximum system efficiency. The primary advantage to multi-stage centrifugal operation in the pressure and volume ranges, characteristic of typical air conditioning systems, is the expansion of impeller head coefficients at reduced volumetric flows or cooling loads.



The DB backward inclined single stage impeller, combined with unique adjustable diffuser geometry at the impeller discharge, provides a stable operating range superior to multi-stage systems. Thus selection of DB chillers permits operation from 100% to 10% capacity without surging and at maximum efficiency, i.e. no need for hot gas bypass.

3.1.1 CHARACTERISTICS OF THE COMPONENTS

3.1.1.1 Aerodynamically contoured impellers

Impellers that use high back sweep main blades and low profile intermediate splitter blades are contoured aerodynamically to improve compressor full-load and part-load operating efficiency. For the design and aerodynamic performance calculation of the compressor impeller, some of the most advanced technologies in the world were adopted, to ensure excellent hydrodynamic performance. Especially, Ternary Toroidal Technology (3D flow) is used for the impeller, so that the impeller can run with a high efficiency within a wide flow range.

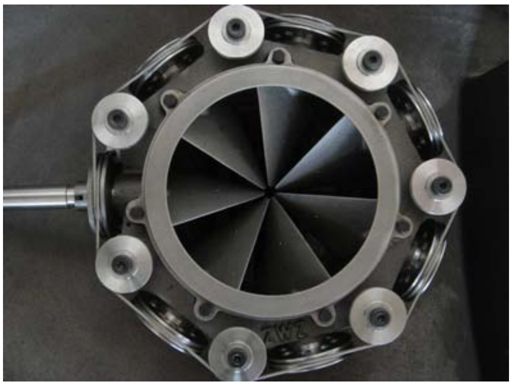
The DB designed impeller not only minimizes pressure loss at the inlet and maximizes compression efficiency, but also breaks up pure tone sound to operate at competitively low sound power levels. (<85db, according to the latest AHRI standard)

- High efficient semi-open impeller design
- The impeller is precision cast from special super high density aluminum alloy cast using the Integer mould technique, resulting in light weight and high anti-corrosion ability
- Proven at 125% over speed to ensure reliable chiller performance at all load

3.1.1.2 Adjustable inlet guide vanes

Capacity control of the chiller is achieved by adjusting the degree of opening of the inlet guide vanes, thereby adjusting the volume flow rate and angle at which the suction gas enters the compressor.

The guide vanes are connected with aircraft-quality cable and controlled by a precise electronic actuator. Chilled water temperature is maintained within ±0.3°C of the desired set point without surge or undue vibration. The vanes regulate inlet flow to provide high efficiency through a wide, stable operating range without hot gas bypass.



3.0 SYSTEM COMPONENTS

3.1.1.3 Adjustable Diffuser

The adjustable design uses a special method, increasing centrifugal compressor peak efficiency. DB can use this adjustable discharge geometry enabling the surge point of DB centrifugal compressors to be lowered.

3.1.1.4 Shaft

The shafts run on Babbitt bearings, supported on a lubricant film, as opposed to rolling element bearings, more typical in this type of compressor. This bearing configuration reduces friction losses and under normal circumstance, the DCLC shaft has, in theory, an infinite life while rolling element bearings require periodic replacement.

3.1.1.5 Durable Gear

The specially engineered, single helical gears with crowned teeth, ensure that more than one tooth is in contract at all times, providing even distribution of compressor load and quiet operation.

Gears are integrally assembled in the compressor rotor support and are oil-film lubricated. Each gear is individually mounted in its own journal with thrust bearings to isolate it from impeller and motor forces.

With the higher rotational speeds and much lighter running components compared to direct drive units, efficient hydrodynamic bearings can be used.

3.1.1.6 Casting

DCLC compressor housing and gearbox are cast together. The impeller and inlet guide vane are then installed inside it.

3.1.1.7 Guide Vane and Diffuser Actuator

The actuator is used for operating the vane and the diffuser. Here are the details:
Turning angle: 0~90°

Insulation Resistance	DC24V: 100MΩ / 250VDC AC110V/AC220V/AC400V: 100MΩ / 500VDC
Voltage-withstand Class	DC24V: 500VAC 1 Minute. AC110V/AC220V: 1500VAC 1 Minute. AC400V: 1800VAC 1 Minute
Protection Class	IP67
Installation Angle	360°. at any angle
Electric Interface	G1/2 Water – proof Cable Connector
Ambient Temperature	-30°C ~ +60°C
Optional Function	Over-torque Protection. Heater for eliminating moisture

3.0 SYSTEM COMPONENTS

3.1.1.8 Oil Heater

The oil sump is supplied with an integral heater to maintain the oil at (40°C~50°C) even when the compressor is shut down. This is to prevent oil dilution, which may causes a decrease in viscosity and hence change lubrication properties. Following an interruption in the power supply to the unit for any length of time the oil sump heaters must be energized for a minimum of 24 hours to raise the oil temperature to 40°C~50°C prior to starting the compressor.

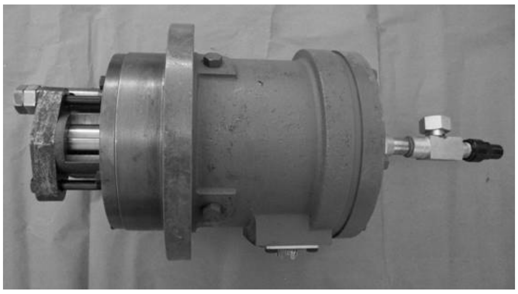
Item	Input power kW	Elec. V-PH-Hz
Oil heater control	0.1	220/1/50-60
Oil heater (≤ 800TR chiller)	0.8 (2 heaters*0.4kW)	220/1/50-60
Oil heater (＞800TR chiller)	1.0 (1 heater)	220/1/50-60

Notes:
1. The Oil sump heater starts when the temp in the oil sump is lower than the setting value.
2. Power to oil heater/controls must be on circuits that can provide continuous service when the compressor is disconnected.

3.1.1.9 Oil Pump

Gear pumps, lower pressure fluctuation and higher volumetric efficiency. The oil pump is compact and lightweight.

Item	Input power kW	Elec. V-PH-Hz	MIN/MAX motor voltage
Oil pump	1.5	400-3-50	350/420



3.1.1.10 Hermetic Motor

DCLC uses a semi hermetic motor-compressor arrangement where the motor is cooled by liquid refrigerant eliminating the need for additional ventilation equipment for motor cooling in the machine room.

This highly efficient motor cooling method results in the use of reduced frame size motors with lower starting currents, less weight and improved efficiency.

The use of semi hermetic, refrigerant cooled motors is an important factor when considering the design of the machine room and the ventilation system to be installed within it. Open frame air cooled motors may require ducting or at least a suitable ventilation system within the space to remove heat generated by the motor in order to maintain acceptable operating conditions. This will have cost implications and should be considered in the overall system design.

When evaluating the overall chiller proposal, it is important to take all the ventilation and mechanical cooling equipment, energy consumption and installation costs into consideration. Open frame air cooled motors will also have specific installation (alignment) and maintenance costs but the simplification of the required ventilation is the most significant improvement that results from using semi hermetic compressor drive motors. For detailed requirements for ventilation and safety requirement to the machine room, please refer to ASHRAE15.

3.0 SYSTEM COMPONENTS

This is the code of the DCLC motor (50Hz):

Motor Code		CB	CC	CD	CE	CF	CG	CH	CJ	CK	CL	CM	CN	CP
Input Power	KW	194	215	241	272	304	335	366	398	429	461	492	523	560
		Amps												
Voltage 400V	RLA	315	349	398	434	511	542	567	618	660	710	757	806	863
	LRYA	574	579	739	672	833	891	871	935	1172	1169	1283	1396	1216
	LRDA	1808	1820	2319	2098	2604	2783	2841	2050	3812	3807	4178	4536	3972

Motor Code		CQ	CR	CS	CT	DB	DC	DD	DE	DF	DG	DH	DJ	DK
Input Power	KW	597	634	681	738	597	634	681	738	806	856	916	966	1015
		Amps												
Voltage 400V	RLA	920	1028	1076	1181	967	1028	1076	1181	1282	1403	1484	1566	1644
	LRYA	1297	2028	1947	2226	1777	2028	1947	2226	2241	2993	3078	3246	3411
	LRDA	4234	6436	6204	7078	5636	6436	6204	7086	7128	9258	9772	10305	10827

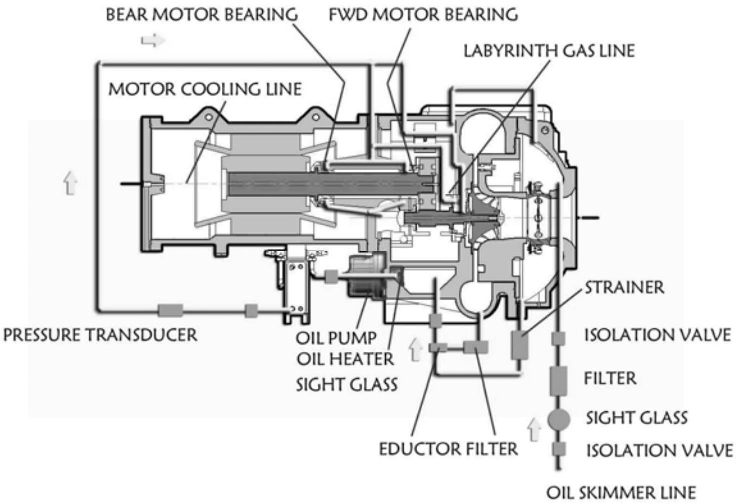
Motor Code		DB	DC	DD	DE	DF	DG	DH	DJ	DK	DL	DM	DN	DP
Input Power	KW	597	634	681	738	806	856	916	966	1015	1140	1260	1400	1560
		Amps												
Voltage 10000V	RLA	38.5	41	43	47	51	56	59	62.5	66.5	75	82	91.5	101
	LRDA	245	260	270	297	320	351	373	390	415	478	525	580	650

Notes:
1. RLA- Locked Rotor Amps. LRYA- Locked Rotor Y Amps. LRDA- Locked Rotor Delta Amps.
2. If you have any other requirements about the Power, please contract the DB Sales service.

3.1.2 OIL LUBRICATION SYSTEM

3.1.2.1 Working principle

The compressor motor assembly is internally lubricated by an oil system driven by a motor independent to that of the main compressor. The system delivers filtered oil to the compressor and motor bearings at the required temperature and pressure; the drive gears operate in a controlled lubricant mist atmosphere that efficiently cools and lubricates them.



The temperature of the lubricating oil is maintained between 35°C and 55°C, by passing it through a refrigerant cooled plate heat exchanger mounted on the compressor.

To minimize the quantity of lubricating oil entering and mixing with the refrigerant, comb (labyrinth) seals are installed at inner side of motor bearings at both ends.

The control system will not allow the compressor to start until proper oil pressure (124～172KPa), and the proper temperature is established. It also ensures the oil pump to operate after compressor shutdown to provide lubrication during coast-down.

Note:
As DB DCLC chillers are closed circuit hermetically sealed and operate at positive pressure, there is no requirement to change the lubricant or filter on a regular basis. As with any equipment of this type, an annual oil check and filter condition is recommended to evaluate the lubricant condition.

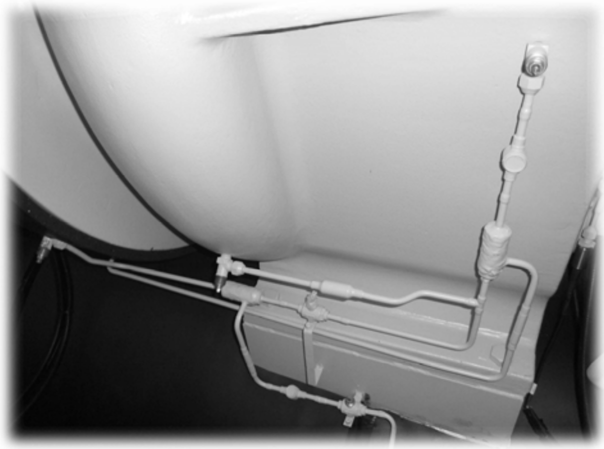
3.0 SYSTEM COMPONENTS

3.1.2.2 Characteristics of the Lubrication System Components (Check the pump in 3.1.1.9）

All bearing surfaces are pressure lubricated. Drive gears operate in a controlled lubricant mist atmosphere that efficiently cools and lubricates them.

3.1.2.2.1 Lubrication Pipeline

Lubricant from the pump is supplied to the compressor through a refrigerant-cooled, plate-type heat exchanger and single or dual 10 micron oil filters internal to the compressor. An external oil filter is also supplied, see 3.1.2.2.2



The refrigerant leaving the heat exchanger then returns to the evaporator.
The refrigerant cooling method is effective for the removal foreign matter because R134a itself has a strong self-cleaning ability

3.1.2.2.2 Replaceable oil filter

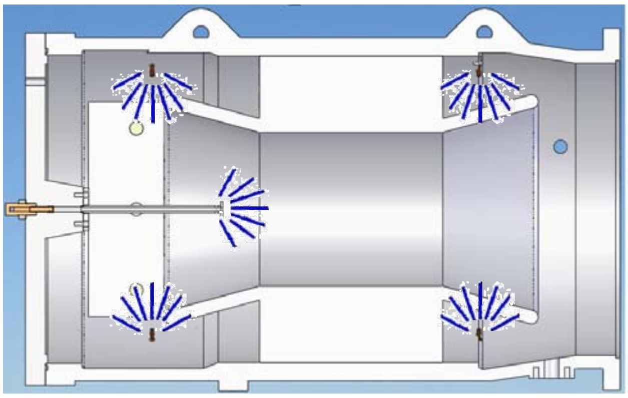
The replaceable oil filter is contained in a flanged housing providing easy and convenient access for normal inspection and maintenance of the filter.

3.1.3 MOTOR REFRIGERANT-COOLED SYSTEM

The DCLC compressor motor is cooled by an efficient refrigerant spray cooling system. Refrigerant spray cooling method is more efficient than other methods. The provision of a refrigerant cooled oil cooler eliminates the requirement for field water piping and the associated installation expenses.

3.0 SYSTEM COMPONENTS

The motor and the lubricating oil are cooled by liquid refrigerant taken from the bottom of the condenser vessel. Flow of refrigerant is maintained by the pressure difference during compressor operation. After the refrigerant passes through a control valve and filter, it is distributed by the motor cooling system.



The refrigerant flows through an orifice into the motor housing. Once past the orifice, the refrigerant is directed over the motor by a spray nozzle. The refrigerant collects in the bottom of the motor casing and is then drained back to the evaporator through the motor refrigerant drain line.

The motor is protected by the temperature sensors imbedded in the stator windings. If the temperature rises above the safety limit (110°C), the compressor will shut down automatically.

A second refrigerant line feeds the oil cooling system and is regulated by a manual valve. This valve regulates refrigerant flow into plate-type heat exchanger to control the oil temperature of the bearings.

3.1.4 EMERGENCY OIL SUPPLY

Poor lubrication can damage the bearings and reduce compressor life.

The pump provides the required supply of oil to the shaft and gears during start-up, operation, and coast down. Lubricant is made available by the oil pump running. If a power failure occurs, an emergency oil reservoir provides adequate lubrication flow under gravity, and prevents damage that could occur during the coast-down period in the event that power to the chiller is interrupted.

3.1.5 HOW TO AVOID THE SURGE

DB uses the adjustable discharge geometry to lower the surge point of centrifugal compressors.

The point at where the compressor enters a stall or surge condition generally limits compressor unloading.

At low loads, low gas velocity through a fixed discharge area results in low gas velocities and the gas can stall or surge in the impeller. When in a stall condition, the refrigerant gas is unable to enter the volute due to its low velocity and remains stalled in the impeller. In a surge condition the gas rapidly reverses direction in the impeller causing excessive vibration and heat.

The DB DCLC compressor has reduced discharge port area to maintain gas velocity and greatly reduce the tendency to stall or surge at low load conditions. A simple short diffuser and a volute design passing compressed gas directly into the condenser, maintaining the compressor efficiency.

3.2 HEAT-EXCHANGER MAJOR COMPONENTS

The evaporator and condenser can be designed, tested and stamped in accordance with **ASME** Boiler and Pressure Vessel Code or **PED** (European Code) for refrigerant side design pressure of 13 bar.

They consist of carbon steel shell with steel tube sheets welded to each end. Intermediate tube support sheets positioned along the shell axis prevent relative tube sagging. Individually replaceable externally finned 19mm nominal diameter seamless copper tubes are mechanically expanded into tube sheets.

Two or three pass water boxes rated at 1.0MPa is standard.

Grooved pipe stubs for Victaulic couplings are standard; flanged connections are optionally available.

The waterside is hydrostatically tested at 1.5 x maximum working pressure.

The condenser is equipped with Pressure Relief Valve set at 12.8 bar.

Liquid refrigerant enters the evaporator through a single calibrated fixed orifice which maintains the required pressure differential between the condenser and the evaporator.

3.0 SYSTEM COMPONENTS

3.2.1 HEAT-EXCHANGER STRUCTURE

Heat Exchanger Material Specifications

Items	Material	Standard
Shell	16MnR	ASME SA516 GR .70
Tube Sheet	16MnR	ASME SA516 GR .70
Condenser/ Evaporator Water box Cover	16MnR	ASME SA516 GR .70, SA-36, or SA-285 GRL
Condenser/ Evaporator Water box Shell	16MnR	ASME SA675 GR .60, SA-516 GR70, or SA-181 CL70
Tubes	T2	ASME SB359 (Finned Copper)
Discharge/Suction Pipe	16MnR	ASME SA106 GRB
Flanges	16MnR	ASME SA105

Design Specification (Standard type)

	Shell Side	Tube Side
Vessel Class	Class 1	
Media	R134a	Water
Design temperature °C	50	50
Design pressure Mpa	1.3	1
Maximum working pressure Mpa	1	1
Proof test in the factory Mpa	1.5 PNE.	1.25 HYD.
Pressure relief valve Mpa	1.28	

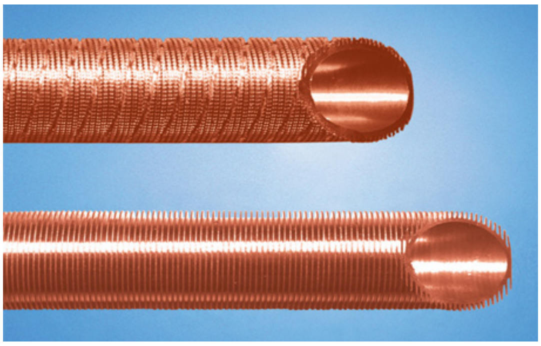
Note: all pressure should be in same units if this should be changed to 'bar'

3.2.1.1 High Performance Tubing

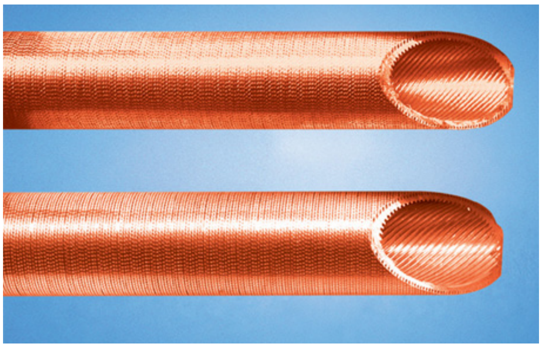
The tubing used in the heat exchangers is state-of-the-art, high-efficiency, externally and internally enhanced type to provide optimum performance by reducing the overall resistance to heat transfer. Tube O.D. in both the evaporator and condenser is 19mm, with a minimum root wall thickness is 0.635mm.

Standard tubes are manufactured from copper alloy with 'lands' or non finned sections providing a smooth internal and external surface at the position each intermediate tube support. This provides extra wall thickness and non-work hardened copper at the support location, extending the life of the heat exchangers.

Condenser tube



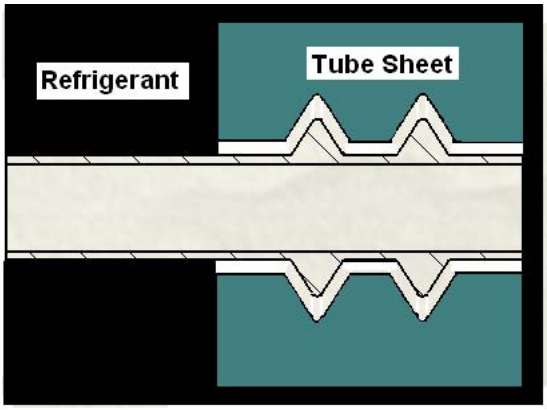
Evaporator tube



NOTE:
The evaporator and condenser tubes are copper alloy as a standard but 90/10 copper-nickel, 304 stainless steel or titanium tubes are also available for more demanding applications. These alternative tube materials can be combined with corrosion resistant tube sheets, such as Monel Clad or stainless steel. The water boxes or heads of these vessels can be supplied in steel with epoxy coating or stainless steel construction depending on the application.

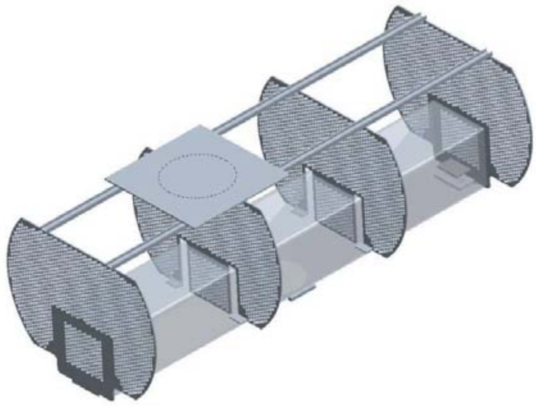
3.0 SYSTEM COMPONENTS

3.2.1.2 Heat Exchanger Construction



Double-grooved tube sheet holes — Each tube is roller expanded into the tube sheets providing a leak-proof seal, and is individually replaceable. This design minimizes the possibility of leaks between the water and refrigerant system, increasing product reliability.

The evaporator tubes are roller expanded into the center supports to prevents unwanted tube movement and reduce vibration, thereby reducing the possibility of premature tube failure.



Condenser Baffle — This baffle prevents direct impingement of high velocity refrigerant gas from the compressor onto the condenser tubes. The baffle also eliminates the related vibration and wear of the tubes and distributes the refrigerant flow evenly over the length of the vessel for improved efficiency.

Intermediate tube supports - Adequate tube support sheets are provided in all heat exchangers to prevent tube sagging and vibration, which could otherwise result in premature failure.

Subcooler — The sub-cooler, located in the bottom of the condenser, increases the overall refrigeration effect of the chiller by sub-cooling the condensed liquid refrigerant which results in a combination of increased cooling capacity and reduced compressor power consumption.

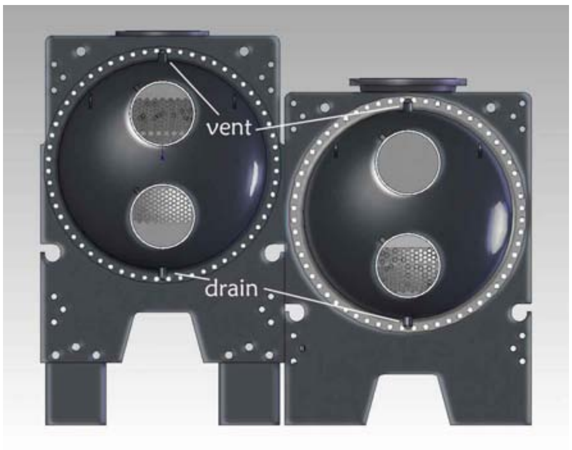
Distributor — A distributor manifold inside the evaporator provides uniform distribution of refrigerant over the entire shell length to yield optimum heat transfer.

Optional Refrigerant isolation valves — these valves enable the units entire refrigerant charge to be stored in the condenser enabling many service and maintenance activities to be completed in less time and lower costs.

3.2.1.3 Waterbox

Fabricated waterboxes are offered as the standard arrangement but the marine type water boxes are available if required in Monel clad or stainless steel configuration. Please contact the DB Sales service.

3.2.1.4 Vent and drain connections



Waterboxes are fabricated using the nozzle-in-head arrangement and are supplied with vent and drain connections on the dome head. Marine waterboxes are supplied with vent and drain connections on the waterbox shells.

Vents should be provided on the chilled water as high as possible in the system and drains should be located as low as possible to ensure ease of servicing and maintenance. Where shutoff valves are provided in the main water pipes near the unit, only minimal amount of system water will be lost when the heat exchangers are drained. This reduces the time required for drainage and saves on the cost of re-treating the system water.

3.0 SYSTEM COMPONENTS

3.2.1.5 Safety Valve

Pressure relief or safety valve connection sizes are NPT3/4 (DN18) for the DCLC evaporator and condenser. The relief setting is 12.8 bar.

All Safety Valves must be piped to the outside of the building in accordance with ANSI/ASHRAE 15-2001.

Twin pressure relief valves mounted on a changeover valve, are used on the condenser so that one PRV can be shut off and removed for testing or replacement, leaving the other in operation. Only one of the two valves is in operation at any time. Where 4 valves are shown, on some large vessels, they consist of two PRV's mounted on each of two transfer valves.

Only two PRV's of the four are active at any time.

Vent piping is sized for only one valve of the set since only one can be in operation at a time.

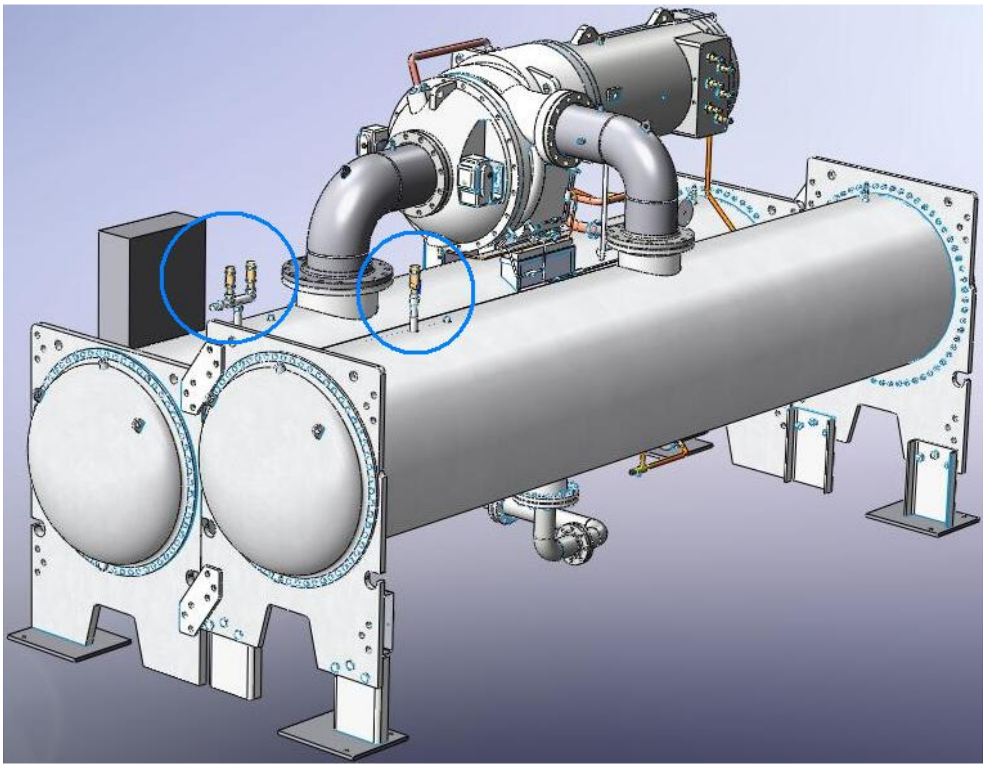
Per ASHRAE Standard 15, the pipe size cannot be less than the relief device. The discharge from more than one Safety Valve can be run into a common header, the area of which shall not be less than the sum of the areas of the connected pipes.

For further details, refer to ASHRAE Standard 15. The common header can be calculated by the formula:

$$D_{Common} = \left(D_1^2 + D_2^2 \ldots D_n^2 \right)^{0.5}$$

The above information is a guide only. Consult local codes and/or latest version of ASHRAE Standard 15 for sizing data.

The Safety Valve Locations

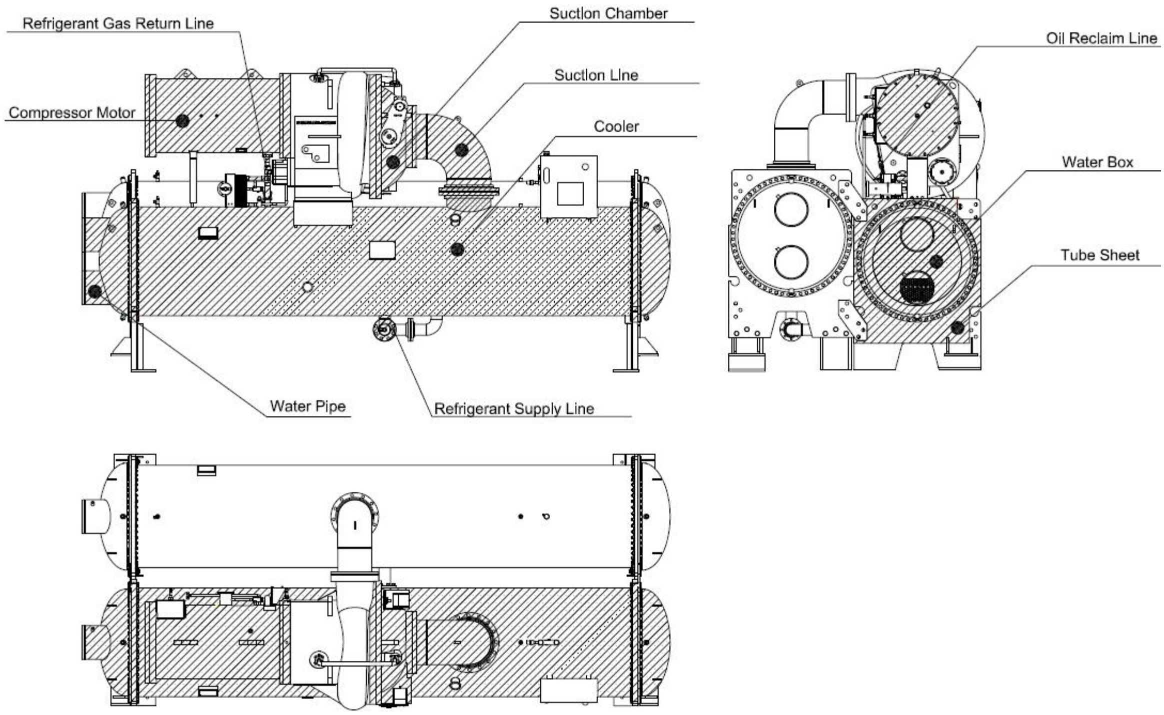


3.2.1.6 Insulation

The factory insulation for the DCLC includes the following areas:

- The evaporator shell and tube sheets;
- Suction line up to the compressor suction housing;
- Compressor motor and motor cooling return lines;
- Several small oil cooling and oil return system lines, the liquid line.

3.0 SYSTEM COMPONENTS



Insulation applied at the factory is 20mm thickness of rubber sponge and has a thermal conductivity K value of (0.0404 W)/(m².°C) [(0.28 Btu*in)/hr.f².°F].

Note:
Thermal insulation shall be fitted in a way that will not interfere with the normal operation of the unit and that will also allow removal of the water boxes to enable cleaning of the heat exchanger tubes. Access to fasteners and nameplate shall be maintained at all times.

Optional Insulation at site - As indicated in the 'Condensation' vs 'Relative Humidity' table, the factory insulation provides excellent protection against condensation under most operating conditions. If temperatures in the equipment area exceed the maximum design conditions, extra insulation is recommended. If the machine is to be field insulated, obtain the approximate areas from the 'Insulation Requirements' table. Insulation of the waterbox is made only in the field and this area is not included in Minimum Field-Installed Insulation Requirements table. When insulating the covers, allow for service access and removal of covers. To estimate water box cover areas refer to certified drawings.

3.2.1.6 Pressure differential water switch (Check other temperature/pressure transmitter in 3.3.2.3.2)

DCLC control system has an input that will accept a normally open / close on flow signal from a 'proof-of-flow' device. This 'proof-of-flow' can be provided by either a differential pressure switch or a flow switch. The customer wiring diagrams also shows that the flow / pressure differential switch be wired in series with the cooling-water (condenser-water) pump starter's auxiliary contacts. When this input does not prove flow within a fixed time during the transition from Stop to Auto modes of the chiller, or if while operating in auto mode the flow is lost, the chiller will stop from running by a non-latching device.

3.0 SYSTEM COMPONENTS

3.3 ELECTRICAL CONTROL EQUIPMENT

3.3.1 PLC MICROCOMPUTER CONTROL SOFTWARE

‘Smart logic’ control theory is used in the PLC microcomputer control system, through measurement of key parameters and the rate at which they change, the control system will anticipate operation trend and ensure the accurate stable and optimal control of the chiller.

The microcomputer in the standard chiller is complete with SIEMENS & OMRON RS485 MODBUS-RTU communications port and all hardware and software necessary to remotely monitor and control the packaged chiller up to 1500m away (hard wired) or by optional telephone modem.

This valuable enhancement to the chiller system allows the ultimate in serviceability. The microcomputer as standard is additionally equipped with history files which may be used to take logs which would be retrievable via a telephone modem. This feature provides owners of multiple buildings with a simple and inexpensive method of investigating potential problems quickly and in a highly effective manner. Printouts of operating parameters can be generated.

DB has open protocol on it’s microcomputer to allow direct interface with many Building Management Systems.

The Dunham-Bush DCLC range of centrifugal chillers uses an alphanumerical LCD customer interface providing the following:

- Adjustment of chiller operation set point
- Real time inspection and supervising of chiller operation status
- Real time failure inspection
- Historical operation data storage

Beside PC centralized monitoring method, the chillers are available with ‘group control mode’, the ‘group control’ consisting of a box mounted monitor that is able to communicate and control multiple chillers (max 254) up via twisted-pair (Industrial Ethernet TCP-IP), through which the operators can know water temperature, pressure and alarm data, etc.
Moreover, they can also set running parameters and recover alarm from remote system if required.

3.3.2 CONTROL HARDWARE

3.3.2.1 Control panel

DCLC adopt the state of art microcomputer control system with large 10.4 inch Super VGA color touchable LED display screen ,with high disturbance resistance, easy to operate and intuitive.

The screen displays parameters of chiller operation and to achieve constant monitoring. The start-stop and automatic control procedures can be adjusted, user can access the unit status and reliable start, stop, adjustable operation automatically through simply click on the button.

Addition, user can switch automatic and manual control mode easily. System has 32 items protection and malfunction used to ensure safe chiller operation, and the last 10 items of failure parameter can be recorded for investigation. If the unit operation failed, the control system can carry out an initial diagnosis, indicating the possible cause of the malfunction automatically.

3.0 SYSTEM COMPONENTS

LCD screen displays

The alphanumeric liquid crystal display utilizes easy-to-understand menu-driven software. Inexperienced operators can quickly work through these menus to obtain the information they require or to modify control parameters. More experienced operators can bypass the menu systems, if desired, and move directly to their requested control function.

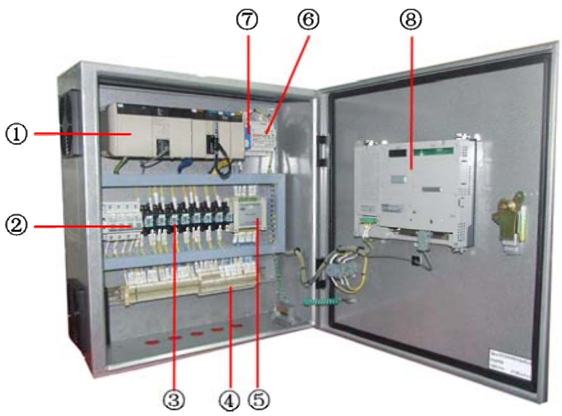
The microprocessor control on each DB centrifugal system is factory mounted, wired, and tested to ensure machine protection and efficient capacity control. In addition, the program logic ensures proper starting, stopping, and Anti-recycling of the chiller and provides a communication link to the CCS Touch I.

DB have even gone as far as installing the unit operating and maintenance manual, as well as the parts list, in the chiller's microprocessor memory, so that they are viewable on the touchable screen. And the control panel contains a USB port from which trend data and manuals can be conveniently downloaded.

3.3.2.2 Control box inside

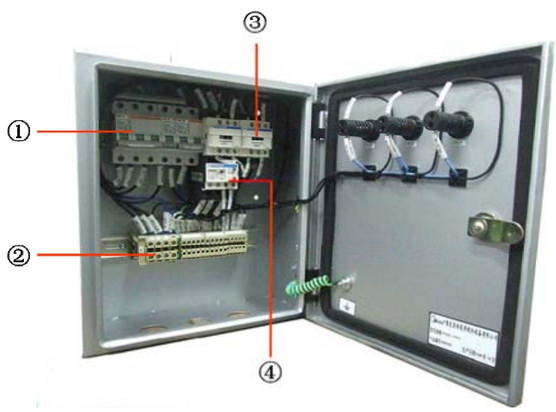
DB has incorporated the latest microprocessor technology into the CCS Touch I control system to give the clients the ultimate chiller control.

PLC Controller Panel



1. Controller
2. Air switch
3. Relay
4. Terminal
5. Multiplexer
6. Power On/Off
7. Current Transducer
8. Touchable LED display screen

Oil Pump Electrical Panel



1. Air switch
2. Terminal
3. Contactor
4. Thermal relay

3.3.2.3 System Protections

The chiller controller uses proportional integral-derivative (PID) control for all limits. This removes oscillation above and below setpoints and extends the capabilities of the chiller.

Some of the standard protection features of the chiller controller are described in this section. There are additional protection features not listed here.

High Condenser-Pressure Protection: The condenser limit controller keeps the condenser pressure under a specified maximum pressure. The chiller runs all the way up to 100 percent of the setpoint before reducing capacity using its adaptive control mode.

Starter-Contactor Failure Protection: The chiller will protect itself from a starter failure that prevents the compressor motor from disconnecting from the line, to the limits of its capabilities. The controller starts and stops the chiller through the starter. If the starter malfunctions and does not disconnect the compressor motor from the line when requested, the controller will recognize the fault and attempt to protect the chiller by operating the evaporator-and condenser-water pumps and attempting to unload the compressor.

Loss of Water-Flow Protection: DCLC control system has an input that will accept a contact closure from a proof-of-flow device. These are the pressure differential switch and the flow switch for alternative. Customer wiring diagrams also suggest that the flow switch be wired in series with the cooling-water (condenser-water) pump starter’s auxiliary contacts. When this input does not prove flow within a fixed time during the transition from Stop to Auto modes of the chiller, or if the flow is lost while the chiller is in the Auto mode of operation, the chiller will be prohibited from running by a non-latching diagnostic.

Anti-freezing Protection: Low evaporator-water temperature protection, also known as Anti-freezing protection, avoids water freezing in the evaporator by immediately shutting down the chiller and attempting to operate the chilled-water pump. This protection prevents freezing in the event of extreme errors in the evaporator- refrigerant temperature sensor.

The cutout setting should be based on the percentage of antifreeze used in the customer’s water loop. The chiller’s operation and maintenance documentation provides the necessary information for percent antifreeze and suggests leaving-water temperature cutout settings for a given chilled-water temperature set point.

Oil-Temperature Protection: Low oil temperature when the oil pump and/or compressor are running may be an indication of refrigerant diluting the oil. If the oil temperature is at or below the low oil-temperature set point, the compressor is shut down on a latching diagnostic and cannot be started. The diagnostic is reported at the user interface. The oil heater is energized in an attempt to raise the oil temperature above the low oil-temperature set point. High oil-temperature protection is used to avoid overheating the oil and the bearings.

Low Differential Oil-Pressure Protection: Oil pressure is indicative of oil flow and active oil-pump operation. A significant drop in oil pressure indicates a failure of the oil pump, oil leakage, or other blockage in the oil-circuit. During oil pump and compressor prelube mode the differential pressure should not fall below 140kPa. A shutdown diagnostic will occur within 3 seconds of the differential pressure falling below 2/3 of the low differential oil pressure cutout. When the compressor is running the shutdown diagnostic will occur when the differential pressure falls below the differential oil pressure cutout for more than (cutout x 3) seconds. This allows for a relatively high cutout to be violated longer before triggering shutdown, as compared to a low cutout.

Current Overload Protection: The control panel will monitor the current drawn by each line of the motor and shut the chiller off when the highest of the three line currents exceeds the trip curve. A manual reset diagnostic describing the failure will be displayed. The current overload protection does not prohibit the chiller from reaching its full load amperage. The chiller protects itself from damage due to current overload during starting and running modes, but is allowed to reach full-load amps.

High Motor-Winding Temperature Protection: This function monitors the motor temperature and terminates chiller operation when the temperature is excessive. The controller monitors each of the three winding-temperature sensors any time the controller is powered up. Immediately prior to start, and while running, the controller will generate a latching diagnostic if the winding temperature exceeds 110°C.

3.0 SYSTEM COMPONENTS

There are some other system protection controls which will automatically act to insure system reliability:-

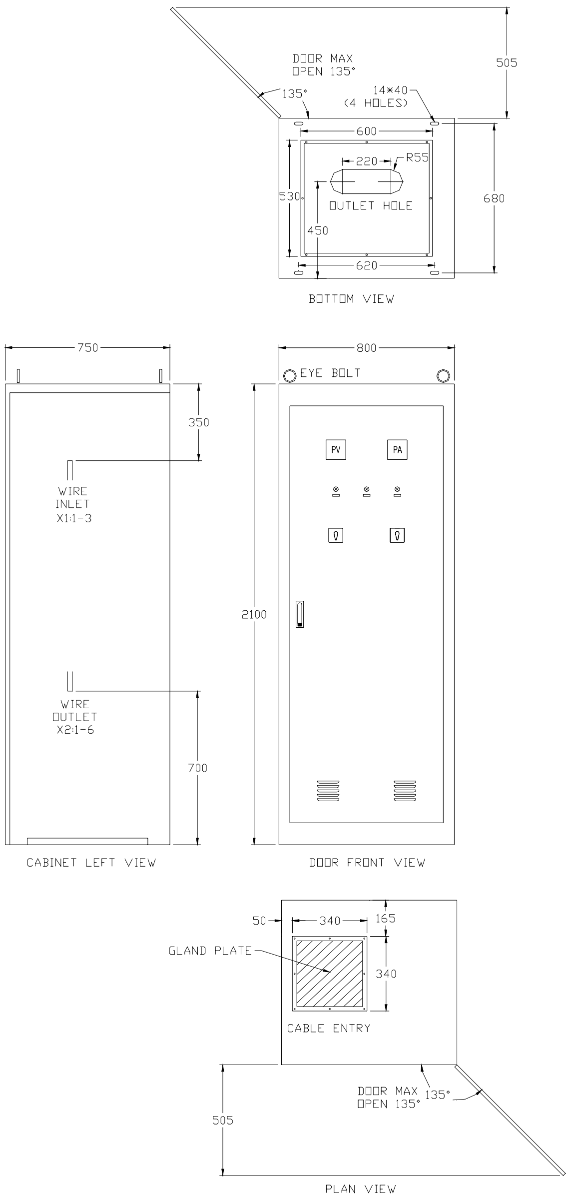
- High gear temperature
- Sensor error
- Anti-recycle
- Oil pump overload
- Oil pump starter failure (optional)
- Low pressure difference of oil
- Power loss

The microcomputer retains the latest 10 alarm conditions complete with time of failure in its alarm history. This tool aids service technicians in troubleshooting tasks enabling downtime and nuisance trip-outs to be minimized.

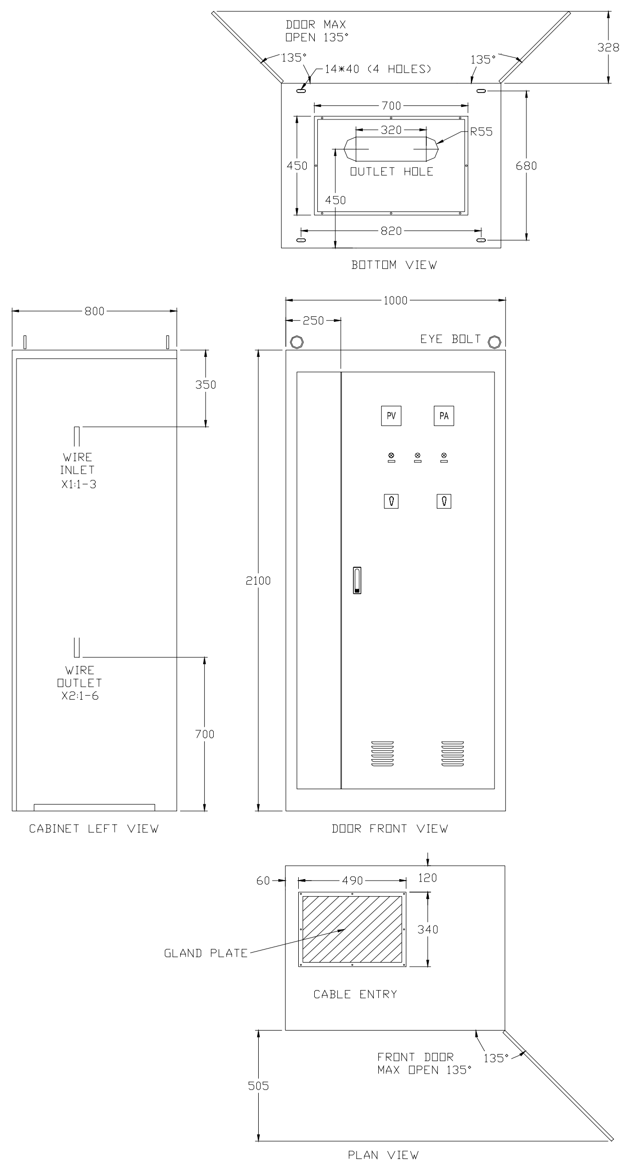
3.3.2.4 Starter Cabinet

Starter Cabinet dimensions

CABINET A



CABINET B



3.0 SYSTEM COMPONENTS

The chiller which rated power is below 400 kW (include 400 kW) use the Cabinet A;

Cabinet B is available for the chiller which rated power is 400 kW above.

Note: The starter cabinet has the power in/outlet leading brackets. The connections between the leading-out bracket and the motor terminal need be done by the user themselves.

There are many types of DB start cabinets to suit different situations. The way to choose the starter is described in the Starter catalogue. Any questions, please consult the local DB Sales Office.

Details about the motor starter

Starter type	Soft start	Close y start	Auto-transformer starter			Direct start	Reactance start	
voltage	low	low	low	low/high	low/high	-	high	high
50Hz	400	400	400	400 10000	400 10000	-	6000 10000	6000 10000
Shifter	-	close	close	close	close	-	close	close
%tap	-	-	57.7	65	80	-	65	80
The percentage of the starting current compare with the current direct start %	45	33	33	42.3	64	100	65	80

3.3.2.5 Additional remarks

3.3.2.5.1 Standard Unit Distribution Proposal

a.) Control system distribution

1	The cable in oil pump control box	VV5*2.5
2	The cable in microcomputer control box	VV3*2.5
3	The cable between the microcomputer control box and the low voltage starter cabinet	KVV10*1.5

b.) Power system distribution

No.	Incoming cable of the starter cabinet	The cable between the main motor and the starter	Model
1	2×(YJV3*120+2*70)	6×VVR120	DCLC300
2	2×(YJV3*120+2*70)	6×VVR120	DCLC350
3	2×(YJV3*120+2*70)	6×2VVR70	DCLC400
4	2×(YJV3*150+2*70)	6×2VVR70	DCLC450
5	2×(YJV3*150+2*70)	6×2VVR70	DCLC500
6	2×(YJV3*150+2*70)	6×2VVR95	DCLC550
7	2×(YJV3*185+2*95)	6×2VVR95	DCLC600
8	2×(YJV3*185+2*95)	6×2VVR95	DCLC650
9	2×(YJV3*240+2*120)	6×2VVR120	DCLC700
10	2×(YJV3*240+2*120)	6×2VVR120	DCLC750
11	3×(YJV3*185+2*95)	6×2VVR120	DCLC800
12	3×(YJV3*185+2*95)	6×2VVR150	DCLC850
13	3×(YJV3*240+2*120)	6×2VVR150	DCLC900
14	3×(YJV3*240+2*120)	6×2VVR185	DCLC1000
15	3×(YJV3*240+2*120)	6×2VVR185	DCLC1100
16	4×(YJV3*185+2*95)	6×2VVR185	DCLC1200
17	4×(YJV3*185+2*95)	6×2VVR240	DCLC1300
18	4×(YJV3*240+2*120)	6×2VVR240	DCLC1400
19	4×(YJV3*240+2*120)	6×2VVR240	DCLC1500

Notes:

1. "Incoming Cable: 3 × (YJV3*185+2*95) "means 3 cable groups parallel together, and the components of each group are 3*185 and 2*95,5 cables total.
2. "The cable between the starter and the main motor: 6 × VVR120" means there are 6 cables between the main motor and the starter. Each cable is VVR120;
3. "The cable between the main motor and the starter: 6 × 2VVR120" means there are 6 groups cables between the main motor and the starter. Each group consists of 2 VVR120 parallel.
4. The control system distribution is applicable to all centrifugal chillers;
5. The incoming Cable of the Starter cabinet is applicable to all the low voltage chillers. The cable between the main motor and the starter is applicable to the low voltage delta start and the soft starter.
6. The electrical junction box must be protected by the ground wire.

3.0 SYSTEM COMPONENTS

3.3.2.5.2 The specification of the sensor

There are 6 temperature sensors in the chiller in total:

- 1 chilled water inlet temperature sensor;
- 1 chilled water outlet temperature sensor;
- 1 cooling water inlet temperature sensor;
- 1 cooling water outlet temperature sensor;
- 1 oil sump temperature sensor;
- 1 bearing temperature sensor;

There are 4 pressure sensors in the chiller in total;

- 1 evaporation pressure sensor;
- 1 condensation pressure sensor;
- 1 oil supply pressure sensor;
- 1 oil sump pressure sensor;

The spec of the water temperature sensor:
The precision of the temperature sensor: B-level accuracy, thermal resistance ferrule: 1×PT100, 3-wire;
In-built Germany JUMO brand transducer, 24V DC power source, 4～20mA DC output;
The temperature range of the transducer: 0～50°C；
The sensor casing and threaded bolts are made of 304 stainless steel. The sensor casing can resist 20kgf/cm2 external pressure, external is water;
The length of the sensors casing is 150 mm, Φ12×1.5. The connection thread is NPT3/4. The thread between the sensor and casing is G1/2;
The sensors are with a BUZ IP65-junction box, where cooled water temperature sensor has a 50mm extension tube;
The length of all the threads meets the requirement of standard GB/T12716-1991.

The spec of the oil sump temperature sensor:
The precision of the temperature sensor: B-level accuracy, thermal resistance ferrule: 1×PT100, 3-wire;
In-built Germany JUMO brand transducer, 24V DC power source, 4～20mA DC output;
The temperature range of the transducer: 0～100°C；
The sensor casing and threaded bolts are made of 304 stainless steel. The sensor casing can resist 20kgf/cm2 external pressure, external is R134a and the mixture of refrigerant and oil;
The length of the sensors casing is 150 mm, Φ10×1.5. The connection thread is NPT1/4. The thread between the sensor and casing is NPT1/8;
The sensors are with an BUZ IP65-junction box.
The length of all the threads meets the requirement of standard GB/T12716-1991.

The spec of the bearing temperature sensor:
The precision of the temperature sensor: B-level accuracy, thermal resistance ferrule: 2×PT100;
The sensor casing and threaded bolts are made of 304 stainless steel. The sensors are completely sealed and can resist 16kgf/cm2 external pressure. External is R134a and the mixture of refrigerant and oil;
The length of all the threads meets the requirement of standard GB/T12716-1991.
The cable of the sensor is 1100mm. The cable should resist 100°C;
The connection thread is NPT1/8, the length of the sensor probe is 20mm, Φ6×1.0.

The spec of the pressure sensor:
The pressure range: 1.6MPa (relative pressure)
The working voltage: 24VDC；
The output signal: 4～20mA；
The precision of the sensor: ±0.5%；
The stability: ±0.25% FS/year；
The Load resistance: ≤supply voltage－10/0.02A [Ohm]；
The in-build chips of the transducer are GE-NOVA brand;
The working temperature: －25～85°C；
The work media: R134a and the mixture of refrigerant and oil;
The overload pressure: 2 times of the Basic quantum;
The relative humidity: 0～95%（85°C）；
The response time: ＜5ms；
The structural materials: 304L;
The membrane materials: 316L；
The process interface: Internal thread is 7/16－20UNF (with thimble), and meet the 1/4FLR thimble valve set;
The leads way: 200mm cable, with United States AMP waterproof IP65 plug.

4.0 APPENDIX

4.1 UNIT SELECTION SAMPLE

Project:	Consultant:
Location:	Date:
PERFORMANCE SUMMARY	Tag:
	Location:

AHRI CERTIFIED™ www.ahridirectory.org
Water-Cooled Chillers AHRI Standard 550/580

Centrifugal Compressor Water Cooled Condensing Unit

Model
Quantity
Manufacturer
Rating version

Physical Specifications

Compressors (Qty)
Length (mm)
Width (mm)
Height (mm)
Shipping weight (kg)
Operating weight (kg)
Oil weight (kg)
Refrigerant
Approx. refrigerant charge (kg)

Conditions of service

Percent of full load
Capacity (kW)
Unit power (kW)
Energy efficiency (COP)
IPLV (ARI) (COP)

Evaporator

Model (Qty)
Number of passes
Fluid
Fluid flow rate (l/s)
Entering fluid temp. (℃)
Leaving fluid temp. (℃)
Fouling factor (m^2·℃/kW)
Pressure drop (kPa)
Fluid freezing point (℃)

Condenser

Model (Qty)
Number of passes
Fluid
Fluid flow rate (l/s)
Entering fluid temp. (℃)
Leaving fluid temp. (℃)
Fouling factor (m^2·℃/kW)
Pressure drop (kPa)
Fluid freezing point (℃)

Electrical characteristics

Unit power supply
Motor starter mode
Motor Rated Current (Amp)
Motor Starting Current (Amp)

Notes

- Certified in accordance with the AHRI Water-Chilling Packages Using the Vapor Compression Cycle Certification Program, which is based on AHRI Standard-550/590-2003.
- Refrigerant charge may vary. Unit nameplate will show final factory charge.

IPLV (ARI) Points at Standard AHRI Rating Conditions

% Full load	kWr	Unit kWe	COP	Cond. EFT	Type

Part load points

Frequency (Hz)	63	125	250	500	1000	2000	4000	8000	Total dB(A)
Sound Pressure Level (free field) at 1.0 m									

**Sound Pressure Level (free field) ± 2 dB(A) Tolerance*

4.0 APPENDIX

4.2 STANDARD DCLC CHILLER SUPPLY SCOPE

Compressor
- Refrigerant cooling squirrel-cage motor
- Babbitt alloy shaft and bearings
- Cast iron housing
- Inlet guide vane
- Aerodynamically contoured impeller
- Adjustable diffuser
- IGV/ ADW Actuator
- Semi hermetic design
- Compressor oil sump heater(s)
- Compressor oil pump
- Emergency oil tank
- Oil level sight glasses
- Plate heat exchanger for oil cooling
- One(1) year warranty

Evaporator /condenser
- Cleanable and removable integral copper tubes
- Two water passes (Two passes default. One pass, three passes optional)
- Intermediate support sheets
- Condenser baffle
- Subcooler in condenser
- Distributor in evaporator
- Removable water headers(Nozzle in head)
- Victaulic groove water connections (Flange optional)
- Safety Valves
- Vent and drain connections
- Full pump down capacity condenser (Isolation valve optional)
- Pressure Transducer
- Evaporator slight glass
- Evaporator 20mm insulation
- Pressure differential device

Refrigerant Specialties
- Fixed orifice
- Electric valve
- One way valve
- Three ways valve
- Refrigerant charge
- Oil charge
- Injector valve
- Replaceable core oil line filter/drier

Standard Electrical Components
- Reduced inrush starter
- Mounted oil pump starter
- Mounted PLC control box

Standard Unit Components
- Single point power connection
- Under voltage/phase failure-Phase sequence relay
- Leaving chilled water temperature sensor
- Evaporator and condenser pressure sensor
- Compressor motor winding temperature protector
- Compressor oil-supply pressure sensor
- Bearings temperature sensor
- Oil sump temperature sensor
- Current transformers

Unit protection
- High condensing pressure and low evaporating pressure
- Freeze protection
- Low oil-supply pressure differential
- Motor over current
- Compressor high motor temperature
- Chilled water flow loss
- Sensor fault
- Oil pump overload
- Starter-box fault
- Compressor surge protection
- Compressor anti-recycle
- Under voltage/phase failure-Phase sequence protection
- Low oil sump temp.

Controls
- PLC controller, 640*480mm LED touchable screen with menu driven software digital read out.

Analog Readout
- Leaving chilled water temperature
- Evaporator and condenser saturation pressure
- In/out chilled water temperature
- In/out cooling water temperature
- Evaporation saturation pressure
- Condensation saturation pressure
- Percentage of the full load Amps
- Guide vane open degree
- Diffuser open degree
- Water temperature set value
- Oil sump temperature
- Oil sump pressure
- Oil pressure difference
- total chiller running time
- Elapsed compressor run time

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Digital readout
- Motor status
- Oil pump status
- Oil heater status
- Pressure difference flow device status
- Temp/press sensor status
- External stop/start command status

Set points
- System restart temperature
- System suspend temperature
- Chilled water outlet target temperature
- PID parameters
- Sampling period
- Max IGV (Inlet Guide Vane) open degree
- Surge restriction point
- System control mode
- Remote chiller shutdown
- Host closing type

Alarm history
- Identification of 10 most recent alarms

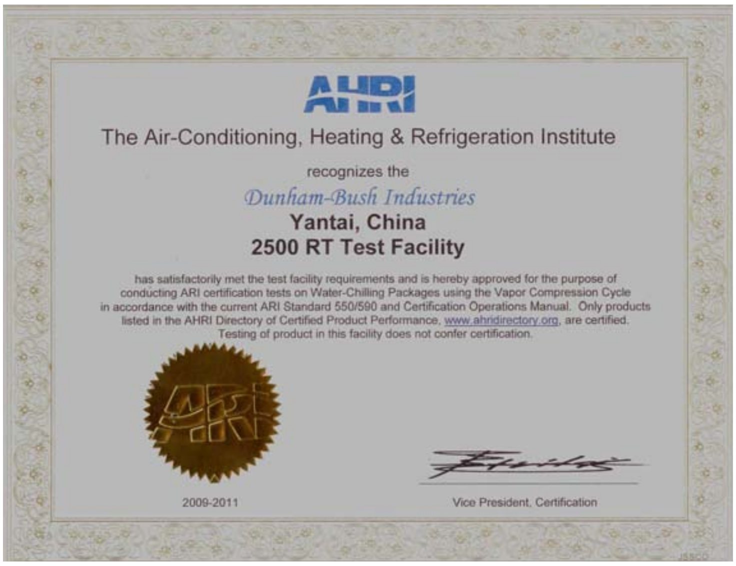
Trouble shooting Solutions
- Reasons and Solutions of Abnormal Phenomenon

Code compliance
- Rated in accordance with AHRI 550/590-2003 standard
- Rated in accordance with GB/T18430.1-2007 standard
- Rated in accordance with the AHRI Water-Chilling Packages Using the Vapor Compression Cycle Certification Program

4.3 TEST ISSUE

Factory Performance Test

All DCLC centrifugal chillers have been tested in the facilities which are approved by the AHRI. The CCS touch control system in the chiller is stored with the test facility. Due to this, the test facility can monitor all the parameters and unit operation.



AHRI

The Air-Conditioning, Heating & Refrigeration Institute

recognizes the

Dunham-Bush Industries

Yantai, China

2500 RT Test Facility

has satisfactorily met the test facility requirements and is hereby approved for the purpose of conducting ARI certification tests on Water-Chilling Packages using the Vapor Compression Cycle in accordance with the current ARI Standard 550/590 and Certification Operations Manual. Only products listed in the AHRI Directory of Certified Product Performance, www.ahridirectory.org, are certified. Testing of product in this facility does not confer certification.

2009-2011

Vice President, Certification

The Chiller Test starts from the beginning of dry and vacuum the refrigerant circuit, followed by the filling of refrigerant and lubricant and then the chiller running in a certain flow and temperature.

Vibration shall not be more than 3mm/sec, moisture level not exceeding 30ppm. The test check the operation control part and makes sure the chiller running well after the chiller be sold to our clients.

Optional Certification Testing

DB Engineer will supervise the test, analyze the exact accuracy of test results and compile this data to a simple test report. AHRI specified tests will be running at 10% ~ 100% load, the cooling capacity and power consumption certainly meet the specified value in the AHRI。

Optional Witness Test

The test will be started when the clients or their designated officers arrived at the scene. Under the supervision of DB engineers, the test results will be conducted and be organized into a simple test report. AHRI test will run at any load between 10% to 100% with each of the designated test time in 2-3 hours. Test results of cooling capacity and power consumption must be within the provisions of AHRI.

4.0 APPENDIX

Test report sample

DUNHAM-BUSH Products that perform...By people who care	CENTRIFUGAL CHILLER TEST REPORT
	Nameplate Parameter
Chiller Type	Test conditions
Chiller NO.	Voltage setting [V]
Manufacturer	Elec. Data
Refrigerant [kg]	Test date
Motor Power[kW]	Rated cooling capacity [kW]
Operator	
Work Condition	
Cooled water flow [m3/h]	Cooled water in/outlet temp [℃]
Cooling water flow [m3/h]	Cooling water in/outlet temp [℃]
specification	

No.	data	unit	1	2	3	4	5	average value
1	Average phase voltage	V						
2	Input power	kW						
3	Main side cooling capacity	kW						
4	Auxiliary side cooling capacity	kW						
5	Main and auxiliary bias	%						
6	COP	kW/kW						
7	percentage	%						
8	cooled water in/oulet pressure difference	kPa						
9	Temp of cooled water inlet	°C						
10	Temp of cooled water outlet	°C						
11	cooled water in/oulet temp difference	°C						
12	Cooled water flow	m3/h						
13	Temp of cooling water inlet	°C						
14	Temp of cooling water outlet	°C						
15	cooling water in/oulet temp difference	°C						
16	Cooling water flow	m3/h						
17	cooling water in/oulet pressure difference	kPa						
18	current	A						
19	frequency	Hz						
20	power factor	%						

4.0 APPENDIX

4.4 SAFE APPLICATION

- The temperature of the engine room should be lower than 40°C. Good ventilation and low humidity. (High humidity can cause the electrical breakdown, and accelerate the corrosion on the machine). Max humidity: 95%RH, 40°C.
- For health and safety, it is recommended that an oxygen content monitor is installed in the plantroom. The alarm will sound at the time that the oxygen content is lower than 19.5%.
- It is recommended that the client connect the Safety Valve by the steel tubing to the outside.
- All cables must be in place and marked with the identifiable labels.
- When the chiller is running, make sure of adequate drainage.
- Cooling and chilled water pipes need be supported. The condenser and evaporator cannot hold any weight load.
- The 10 muses filter is a must in the pipe system of the cooling and cooled water.
- The cooling water quality is an important part of the centrifugal unit maintenance. If the quality is poor, there will be scaling, mud sediment, corrosion as well as micro-organism reproduction etc. Scale and mud heavily affects the normal operation of the unit, will decrease the heat transfer coefficient of copper tubes and refrigerating capacity and increase the energy consumption. It also decreases the flowing area and increases the water resistance. The corrosion could lead to pipe perforation and water leakage in the unit possibly resulting in shut down of the unit for tube repair. Regular and reliable monitoring of the cooling water quality is recommended for the long term reliable operation of the unit. It is also advised that comprehensive consideration for water treatment is required by referring to water treatment for circulating cooling water treatment method or by consulting your local DB Sales and Service.
- The DCLC compressor motor rotor is about 2960 r/min in 50 Hz. To avoid the resonance damage to the piping system, it is generally advisable not to use the pump when rotation speed is about 2960 r/min. When the last compressor is shut down, the cooling water pump must be stopped at the same time. It is better for separate the oil and the refrigerant. Furthermore by shutting down the chiller and cooling water pump together this can also save energy.
- The variable speed pump can change the system water flow rate according to the changing load condition. Two suggestions would be to:-
  - Firstly, the change of the flow rate cannot more than 2% per minute. The chiller need time to analysis the load changes.
  - Secondly, the velocity of the water in the container must remain in 1.5- 3.0 m/s.
- The laminar flow which will affect the heat exchanger efficiency occurs when the flow rate is less than 1.5m/s. The pressure drop will be higher and the tube corrosion will be faster if the flow velocity is higher than 3m/s.

Only recommended flow changes in the evaporator where the chiller efficiency will not be reduced.
Although the variable speed pump used in cooling water loop, but this is usually not advisable. The purpose of the regulation is to reduce the pump power consumption. However, reduced cooling water flow will increase the condensing pressure. This also increases the energy consumption of the compressor.

DB providing the initial start-service
All DB centrifugal chillers are commissioned by DB Service technician or authorized technician to perform the initial start.
By doing this, DB can ensure that the correct unit start-up and inspection procedures, and start the unit with zero trouble.
All commissioning engineers will have debugging experience, and be qualified as technical personnel in Malaysia and the USA.

4.5 DCLC MECHANICAL SPECIFICATIONS

PART 1 - GENERAL

1.1 SUMMARY
Section includes design, performance criteria, refrigerants, controls, and installation requirements for water-cooled centrifugal chillers.

1.2 REFERENCES
Comply with the following codes and standards AHRI 550/590 NEC ANSI/ASHRAE 15 OSHA as adopted by the State ASME Section VIII

4.0 APPENDIX

1.3 SUBMITTALS

Submittals shall include the following:-

A. Dimensioned plan and elevation view drawings, including motor starter cabinet, required clearances, and location of all field piping and electrical connections.
B. Summaries of all auxiliary utility requirements such as: electricity, water, air, etc. Summary shall indicate quality and quantity of each required utility.
C. Diagram of control system indicating points for field interface and field connection. Diagram shall fully depict field and factory wiring.
D. Manufacturer's certified performance data at full load plus IPLV or NPLV.
E. Before shipment, submit a certification of satisfactory completion of factory run test signed by a company officer. The test shall be performed on an AHRI Certified test stand and conducted according to AHRI Standard 550/590.
F. Installation and Operating Manuals.

1.4 QUALITY ASSURANCE

A. Qualifications: Equipment manufacturer must be specialized in the manufacture of the products specified and have years experience with the equipment and refrigerant offered.
B. Chiller manufacturer plant shall be ISO Registered.

1.5 DELIVERY AND HANDLING

A. Chillers shall be delivered to the job site completely assembled and charged with refrigerant and oil. Or assemble the chillers at the job site by the DB service team.
B. Comply with the manufacturer's instructions for rigging and transporting units.

1.6 WARRANTY

The refrigeration equipment manufacturer's warranty shall be for a period of (one) -- or -- (two) --or-- (five) years from date of equipment start up or 18 months from shipment whichever occurs first. The warranty shall include parts and labor costs for the repair or replacement of defects in material or workmanship.

1.7 MAINTENANCE

Chiller maintenance shall be the responsibility of the owner with the following exceptions:
A. The manufacturer shall provide the first year scheduled oil and filter change if required.
B. The manufacturer shall provide first year purge unit maintenance if required.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Dunham-Bush Yantai Co., Ltd.
B. (Approved Equal)

2.2 UNIT DESCRIPTION

Provide and install as shown on the plans a factory-assembled, factory charged, and factory run tested water-cooled packaged chiller. Each unit shall be complete with a single-stage hermetic centrifugal compressor with lubrication and control system, factory mounted starter, Evaporator, condenser, refrigerant control device and other relevant components.

2.3 DESIGN REQUIREMENTS

A. **General:** Provide a complete water-cooled hermetic centrifugal compressor water-chilling package as specified herein. In general, unit shall consist of a compressor, condenser, Evaporator, lubrication system, starter and control system.
Note: Chillers shall be charged with a refrigerant such as R134a, not subject to the Montreal Protocol and the U. S. Clean Air Act.
B. **Performance:** Refer to schedule on the drawings. The chiller shall be capable of stable operation to 10~100% of full load with standard AHRI entering condensing water relief without the hot gas bypass.
C. **Acoustics**: Sound pressure levels for the complete unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chiller as required. Sound data shall be measured according to AHRI Standard 575-87. Data shall be in dB. Data shall be the highest levels recorded at all load points. Test shall be in accordance with AHRI Standard 575.

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2.4 CHILLER COMPONENTS

A. Compressor:

1. Unit shall have a single-stage hermetic centrifugal compressor. Casing design shall ensure major wearing parts, main bearings, and thrust bearings are accessible for maintenance and replacement. The lubrication system shall protect machine during coast down period resulting from the power failure.
2. The impeller shall be statically and dynamically balanced. The compressor shall be vibration tested and not exceed 4 mm/s.
3. Compressors using an unloading system that requires penetrations through the compressor housing or linkages, or both that must be lubricated and adjusted by manufacturer and provides a five years inspection agreement consisting of semi-annual inspection, lubrication, and annual change out of any compressor seals. A statement of inclusion must be accompanied by quotations.

B. Lubrication System: The compressor shall have an independent lubrication system to provide lubrication to all parts requiring oil. Provide a heater in the oil sump to maintain oil at sufficient temperature to minimize affinity of refrigerant, and a plate heat exchanger oil subcooler. Evaporators located inside the evaporator or condenser are not acceptable due to inaccessibility. A positive displacement oil pump shall be powered through the unit control transformer.

C. Refrigerant Evaporator and Condenser:

1. Evaporator and condenser shall be of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.5 times the working pressure, but not less than 100 psig. Provide intermediate tube supports at a maximum of 120mm spacing.
2. Tubes shall be enhanced for maximum heat transfer, rolled into steel tube sheets and sealed by expanded sealer. The tubes shall be individually replaceable.
3. The water sides shall be designed for a minimum of 150 psi or as specified elsewhere. Vents and drains shall be provided.
4. Evaporator minimum refrigerant temperature shall be 2°C.
5. Fixed orifice devices or float controls are acceptable. The liquid line shall have a moisture-indicating sight glass.
6. The Evaporator and condenser shall be separate shells. A single shell containing both vessel functions is not acceptable because of the possibility of internal leaks.
7. Pressure Safety Valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual Safety Valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel.
8. The evaporator, suction line and any other component or part of a component subject to condensing moisture, shall be insulated with UL recognized 20mm closed cell insulation. All joints and seams shall be carefully sealed.
9. Provide factory-mounted pressure differential flow switches on each vessel to prevent unit operation without flow.

D. Motor: Squirrel cage induction motor of the hermetic type of sufficient size to efficiently fulfill compressor power requirements. Motor shall be liquid refrigerant spray cooled with internal thermal overload protection devices embedded in the winding of each phase. Motor shall be compatible with the starting method specified hereinafter. Other cooling methods are not acceptable.

E. Motor Starter:

1. The main motor starter is to be factory mounted and fully wired to the chiller components and factory tested during the run test of the unit. The main motor starter is shipped loose for floor mounting and field wiring to the chiller package. It shall be freestanding with NEMA-1 enclosure designed for top entry and bottom exit and with front access.
2. Low Voltage (200 through 600 volts) motor controllers are to be continuous duty AC magnetic type constructed according to NEMA standards for Industrial Controls and Systems (ICS) and capable of carrying the specified current on a continuous basis. The starter shall be Solid-State Reduced Voltage or Y-Delta Closed Transition

   Solid-State Reduced Voltage - Starter shall be furnished with silicon controlled rectifiers (SCR) connected for starting and include a bypass contactor. When operating speed is reached, the bypass contactor shall be energized removing the SCRs from the circuit during normal running.

4.0 APPENDIX

Y-Delta Closed Transition - The Y contactor shall be capable of handling 33% of the delta locked rotor current and be equipped with properly sized resistors to provide a smooth transition. The resistors shall be protected with a transition resistor protector, tripping in a maximum of 2 seconds, locking out the starter, and shall be manually reset. A clearly marked transition timer shall be adjustable from 0 to 30 seconds.

3. The starter shall be coordinated with the chiller package(s) making certain all terminals are properly marked according to the chiller manufacturer's wiring diagrams.
4. The starter shall be equipped with redundant motor control relays (MCR) with coils in parallel. The relays interconnect the starters with the unit control panels and directly operate the main motor contactors. The MCRs shall constitute the only means of energizing the motor contacts.
5. There shall be electronic overloads in each phase set at 110% of the rated load amps of each motor. When it is 105% of the rated load amps, the guide vane will close in order to reduce the amps. If the current continues increasing to 110% of the rated load amps, the chiller will stop automatically. Overloads shall be manually reset and shall de-energize the main contactors when the over current occurs. The overloads shall be adjustable and selected for mid-range.

F. Chiller Controller

The chiller shall have distributed control consisting of a unit controller, a compressor controller and a 10.4 inch super VGA color touchable screen for operator interface with the control system.

The touchable screen shall have graphics clearly depicting the chiller status, operating data, including water temperatures, percent RLA, water setpoint, alarm status, etc.

The operator interface touchable screen shall have inherent trend logging capabilities, which are able to print by a printer via a USB port.

Active trend logging data shall be available for viewing in 20 minute, 2 hour or 8 hour intervals. A full year's history is downloadable via a USB port.

The following trended parameters shall be displayed:

- Evaporator saturated refrigerant pressure
- Condenser saturated refrigerant pressure
- Oil pressure
- % rated load amps
- In/out chilled water temperature
- In/out cooling water temperature
- System voltage
- Percentage of the full load Amps
- Diffuser state
- Compressor contactors state
- Oil sump temperature
- Oil sump pressure
- Oil pressure difference

Unit set points shall be viewable on screens and changeable after key-in password.

Complete unit operating and maintenance instructions shall be viewable on the touchable screen and be downloadable via an onboard USB port. Automatic corrective action to reduce unnecessary cycling shall be accomplished through pre-emptive control of low evaporator or high discharge pressure conditions to keep the unit operating through ancillary transient conditions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install according to manufacturer's requirements, shop drawings, and Contract Documents.
B. Adjust chiller alignment on concrete foundations, sole plates or subbases as called for on drawings.
C. Arrange the piping on each vessel to allow for dismantling the pipe to permit head removal and tube cleaning.
D. Coordinate electrical installation with electrical contractor.
E. Coordinate controls with control contractor.
F. Provide all materiel required to ensure a fully operational and functional chiller.

3.2 START-UP

A. Units shall be factory charged with the proper refrigerant and oil. Alternatively the unit can be charged on site.
B. Factory Start-Up Services: The manufacturer shall provide factory authorized supervision to ensure proper operation of the unit. During the period of start-up, the start-up technician shall instruct the owner's representative in proper care and operation of the unit.

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West Hartford,
CT 06110, USA

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Fax: 1-860-953 3300

Europe

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Africa

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China

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