REVOLUTIONARY ENERGY SAVINGS

Water-cooled oil-free centrifugal chillers from Smardt Chiller Group

SMARDT

TD – 0080B
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SMARDT

INTRODUCTION AND OVERVIEW

SMARDT CHILLER GROUP - WORLD LEADER IN OIL-FREE CHILLER EFFICIENCY

The PowerPax and SMARDT companies joined forces in 2005 to merge their global operations in engineering, development, testing and certification, supply chain, technical services and customer support.

PowerPax, based in Melbourne, Australia, was founded in 2000 by a team of HVAC industry experts, to specialize in high-efficiency shell-and-tube heat exchangers and their optimization in oil-free centrifugal chillers.

SMARDT, based in Montreal, Quebec, was founded in 2005 by a team of Turbocor veterans, to produce chillers which optimized the energy efficiency potential of the Turbocor compressor technology.

The SMARDT Chiller Group now has well over 2000 operating chiller installations across the world, all delivering high reliability, outstanding part-load efficiencies, and the overall lowest cost of ownership in the market today. Achieving these goals consistently remains the Group’s core purpose, and clearly differentiates it from competitors with conventional machines.

CERTIFICATION

All SMARDT chillers are ETL listed, have lifetime electrical safety coverage, and incorporate evaporators and condensers that fully comply with ASME pressure vessel codes.

SMARDT chiller energy efficiency performance is certified according to AHRI standard 500/590 (ref: www.ahrinet.org). IPLV performance always far exceeds the minimum levels set out by ASHRAE standard 90.1, CSA 743, Eurovent, Australia’s MEPS, and other governing bodies.

STRONG LEED CONTRIBUTION

Use of SMARDT chiller technology can significantly contribute to achieving Leadership in Energy & Environmental Design (LEED™) certification for a building, be it in existing buildings, core and shell constructions, or new construction, because it can help win critical points in the Energy & Atmosphere category. Market research by the U.S. Green Building Council (USGBC) finds that the streamlined LEED process is second only to rising energy costs as a driver for stronger adoption of green building practices and the transformation of the built environment to sustainability. SMARDT is a member of the USGBC.

STRONG SUPPORT FOR THE EPA RESPONSIBLE USE VISION

The EPA’s Responsible Use vision, encourages manufacturers, system designers, and owners, to invest in products and technologies which document sustainability of the highest efficiencies, in tandem with the lowest emissions. SMARDT is a strong supporter of the vision and of the EPA.

SMARDT PRODUCT BENEFITS

SMARDT WATER COOLED CHILLER RANGE

60 TR to 900 TR

Lowest Lifetime Operating Costs

SMARDT works hard to minimize complexity in chiller design and operation, and SMARDT simplicity is reflected in low product operating costs. The thinking makes simple sense: no oil, flooded shell-and-tube evaporation, soft start, low power consumption, low maintenance costs and high reliability, with only one main moving part.

SMARDT field reliability has been outstanding, and not surprising when one considers that some 80% of all chiller problems in the field are due to failures in compressor oil return. And SMARDT chillers use no oil.

The growing fraternity of turbocor-trained engineers and technicians often suggests that total maintenance costs for oil-free chillers run at well under half the costs of traditional lubricated chillers.

Serviceability

Always important in minimizing operating costs, is ease of serviceability. Service access is swift and simple with SMARDT chillers, as is access to operating history through remote monitoring. Operating history and compressor and chiller set points are all accessible remotely by trained and authorized service personnel.

Simple BAS Integration

Integration with Modbus, Bacnet and LONworks building management systems is standard, as is connectivity with most industry-standard protocols.

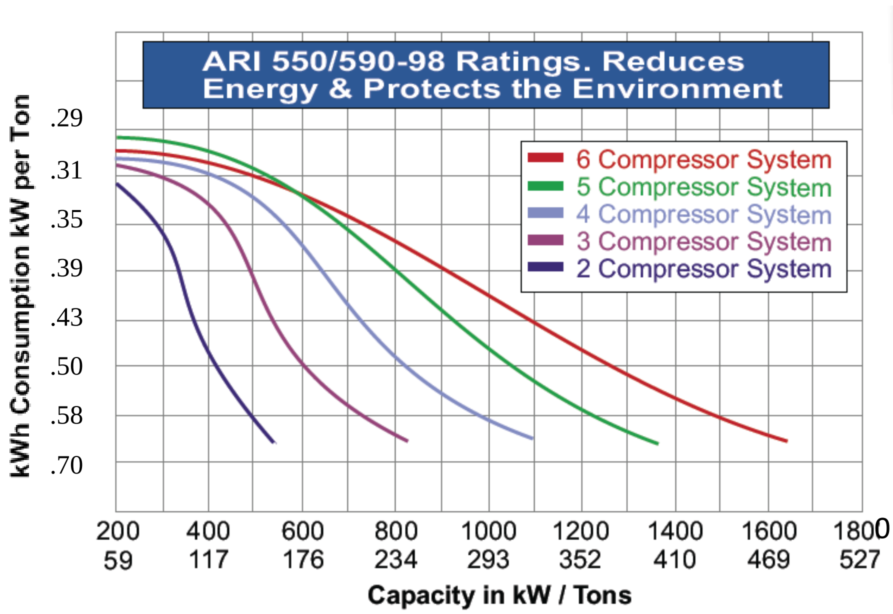
Custom Design and Problem Solving

SMARDT design engineers are always ready and willing to resolve particular equipment design challenges. For example, high-efficiency heat recovery and free-cooling applications can all be custom designed and supplied competitively, and corrosion protection and other options are also available.

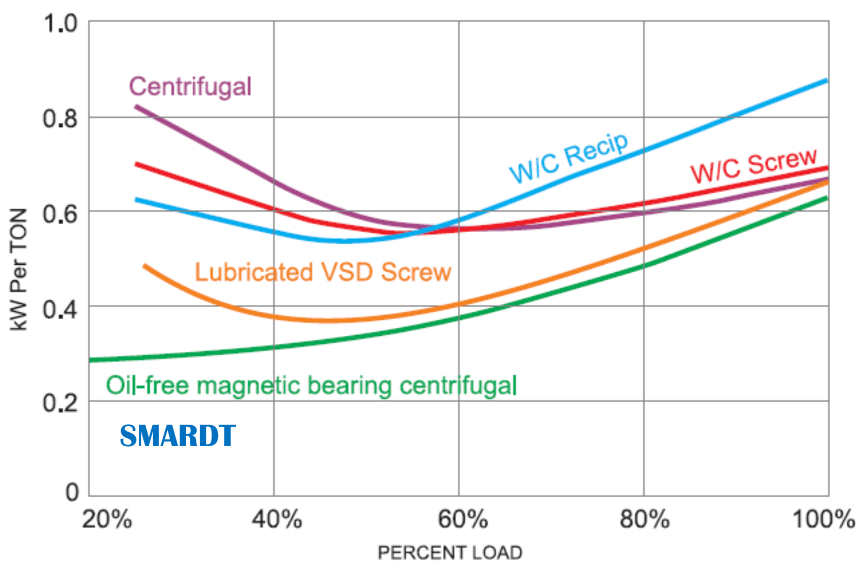
Redundancy

The use of multiple compressors allows for built-in redundancy safeguards. SMARDT's redundancy potential can offer system designers unique opportunities to eliminate multiple chillers, multiple controls, and multiple pumps, thus bringing further savings for owners.

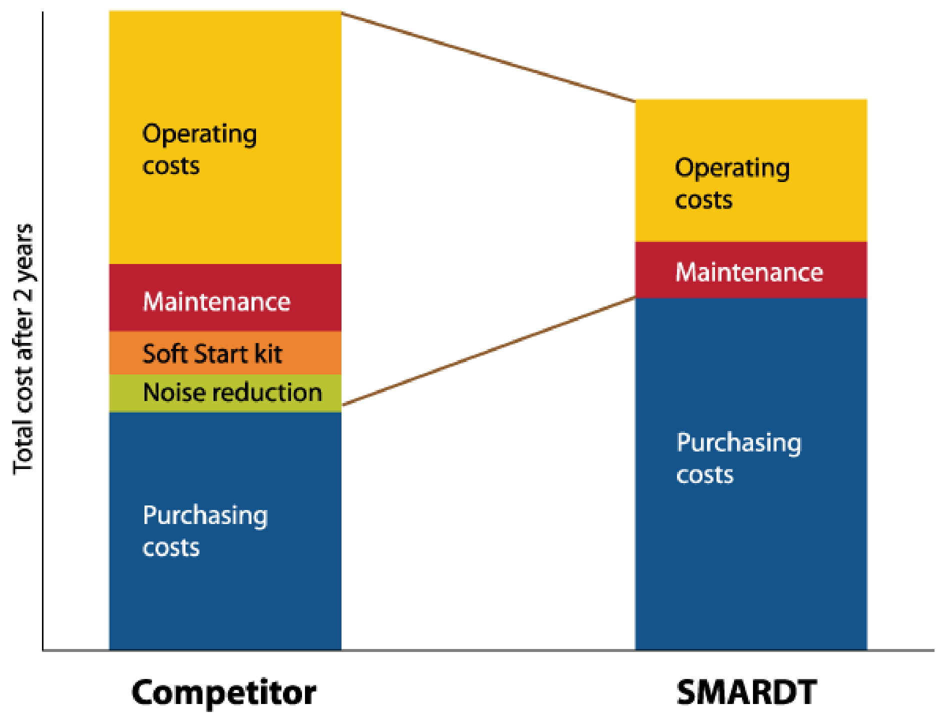
Multiple compressors also allow system designers to save on low-load or pony chillers, because with a VFD integrated into each compressor control, a chiller which uses multiple compressors can be efficiently driven right down below 10% or even 5% load.



The test data above is for a 480 TR water-cooled chiller using 2 to 6 TT300 compressors on a single pair of shell and tube vessels, and clearly shows how best-in-class energy efficiencies are routinely delivered.



CHILLER COST COMPARISON



The above diagram shows a 2 year total chiller cost comparison, for a hotel in San Diego, CA. The left-hand option is a competitor low-cost lubricated screw chiller. The right-hand option is an oil-free 300TR SMARDT water-cooled chiller.

A QUANTUM LEAP IN ENERGY EFFICIENCY

All SMARDT chillers, whether water-cooled or air-cooled, are designed to optimize the performance of the highly efficient Danfoss Turbocor oil-free centrifugal compressor. Oil-free magnetic bearing technology and variable-speed drives deliver better IPLV efficiencies than conventional oil-lubricated centrifugal, reciprocating, scroll, and screw compressors. They are also high-speed – up to 48,000 rpm, very compact, very quiet, rugged, and reliable. The Power Factor is a high .92.

Proprietary magnetic bearings replace conventional oil lubricated bearings, which eliminate high friction losses, mechanical wear, and high-maintenance oil management systems, to deliver chiller energy savings of 35 percent and more over conventional chillers, while ensuring long-term reliability. Over 75,000 magnetic bearing machines are operating in the field, mainly in high-end vacuum pumps and CNC spindles - any innovation risk having been long overcome.

Turbocor's one main moving part (rotor shaft and impellers) is levitated during rotation by a digitally-controlled magnetic bearing system. Position sensors at each magnetic bearing, provide real-time feedback to the bearing control system at 120 times each revolution, thus ensuring constantly centered rotation.

Key benefits of SMARDT chillers can be summarized as:

- Heat transfer optimization through oil-free design
- Extraordinary soft-start efficiency
- Rugged & built-in defense against power failure
- HFC-134a ozone friendly refrigerant
- Significant noise reduction
- Spectacular energy cost savings
- Improved part load efficiencies

Heat Transfer Optimization Through Oil-Free Design

The well-known ASHRAE study (research Project 361) concluded that typical lubricated chiller circuits show reductions in design heat transfer efficiency of 15-25%, as lubricant accumulates on heat transfer surfaces, denatures and blocks normal thermodynamic transfer processes. Logically, no oil in your chiller means no oil contamination over time, so design efficiency is maintained effortlessly.

Extraordinary Soft-Start Efficiency

The compressor's power electronics, further enhanced by SMARDT's chiller controllers, require only 2 amps for start-up, compared with 500-600 amps for conventional machines. This means further savings for owners, who can reduce maximum power loads and reduce backup generator size, cost and capacity.

Rugged & Built-in Defense Against Power Failure

Each compressor has a bank of capacitors for energy storage and to filter DC voltage fluctuations. In case of a power failure, the capacitors provide continuity power to the bearings to keep the shaft levitated, allowing the motor to turn into a generator and to power itself down to a stop. Extended life testing confirms the system's remarkable durability.

HFC-134a Ozone Friendly Refrigerant

R134a has no ozone depletion potential and no phase-out schedule under the Montreal Protocol; it has an A1 rating under ASHRAE standard 34 (no flame propagation, lower toxicity). Positive pressure chiller designs (compared with negative pressure designs using R123, for example) enhance sustainable performance, as neither air or moisture can leak into the chiller. No purge unit is required - a further saving. Liquid R134a refrigerant is used in SMARDT chillers to cool critical electronic and electromechanical components, to assure maximum efficiency and safe operation.

Significant Noise Reduction

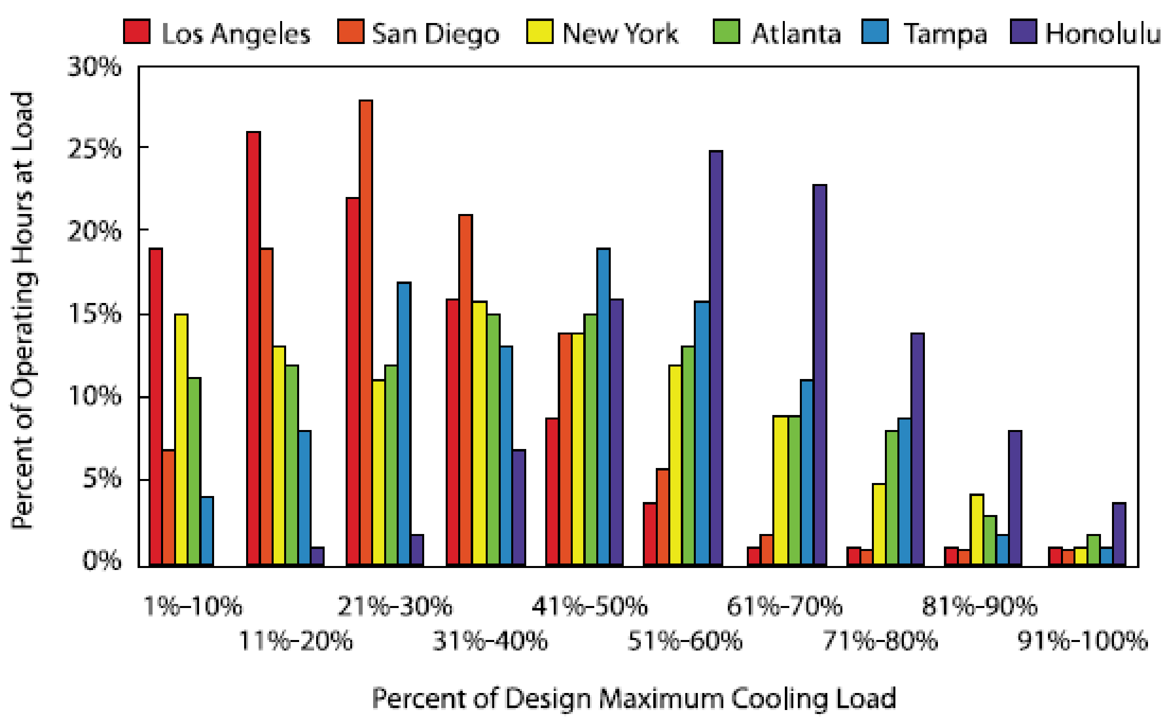
Very low sound and vibration levels are achieved, because there is no physical contact between moving metal parts, eliminating the need for expensive attenuation. Testing of SMARDT water cooled chillers, with reference to AHRI standard 575, yields readings as low as 77dBA at 1 meter.

Spectacular Energy Cost Savings

Compared with a new screw chiller, SMARDT IPLV energy efficiency is routinely more than 32% better. Compared with older lubricated reciprocating, screw, scroll, or centrifugal chillers, year round energy savings with SMARDT chillers can be a spectacular 50% and more. Under AHRI conditions, SMARDT IPLV performance can be as low as .33 kW/TR while part-load efficiency can be under .30 kW/TR.

Improved Part Load Efficiencies

The graph below (data source: AHRI 2005) shows very simply that a wide range of large US cities all demand the vast bulk of their chiller operations at part load - enabling much lower operating costs with a SMARDT oil free chiller, compared with a lubricated alternative.



PRODUCT DESCRIPTION

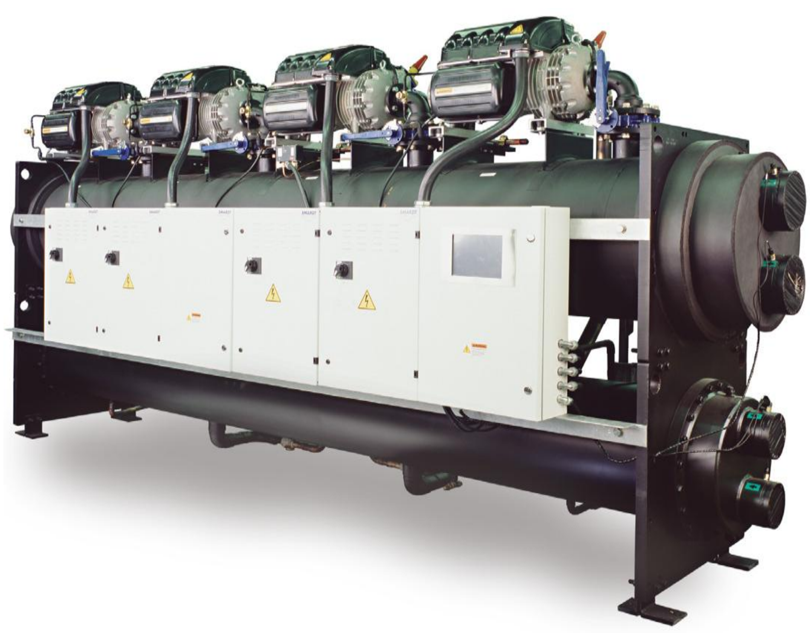
GENERAL DESCRIPTION

The SMARDT range of chillers offer the smallest footprint, the quietest operation and some of the highest operating efficiencies on the market.

SMARDT's Water-Cooled centrifugal chiller design consists of a shell and tube evaporator, shell and tube condenser, twin-turbine centrifugal compressor(s), compressor controller(s), hot gas bypass valves, refrigerant level sensors, electronic expansion valves, interconnecting refrigerant piping, and safety features such as triple freeze protection. All SMARDT chillers are designed to optimize the performance of oil-free centrifugal compressors from Danfoss Turbocor Compressors Inc.

The chiller set is a packaged unit, requiring connection to the chilled water circuit, main electrical supply, and integration with the building automation system (BAS) if applicable. The following protocols are available on SMARDT Chillers for BAS systems: LON, BACNET, BACNET/IP, N2, and MODBUS/IP, and these interfaces are usually installed inside the SMARDT main control panel.

SMARDT chillers deliver a high level of reliability, outstanding part-load efficiency, and the lowest overall cost of ownership on the market.

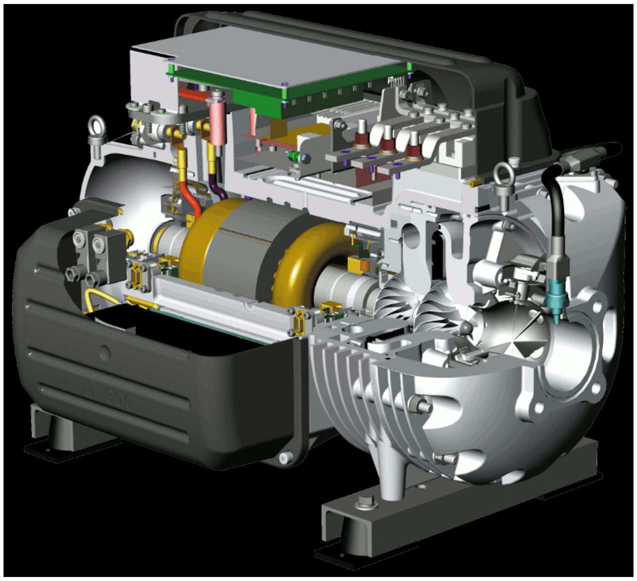


The above standard design 350 TR water-cooled chiller uses a flooded shell and tube evaporator with shell and tube condenser to achieve an approach of 1 deg. K, allowing high IPLV

COMPRESSOR TECHNOLOGY

SMARDT chillers optimize the benefits of the revolutionary Danfoss Turbocor oil-free centrifugal compressor technology. The TT300 compressor delivers 60 to 90 TR and the TT400 delivers 120 to 150 TR.

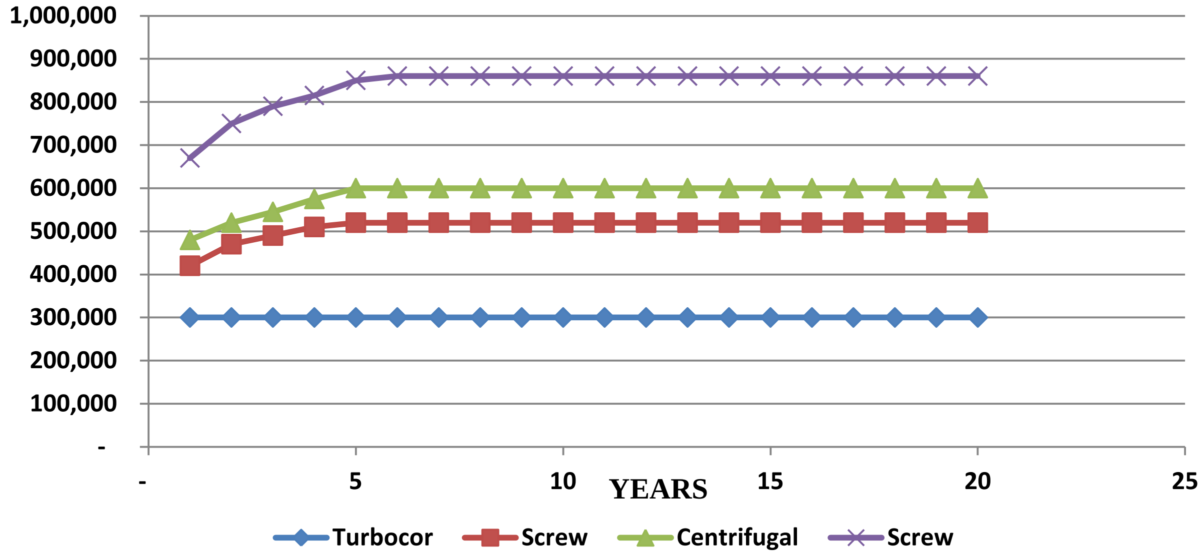
Advanced electronics mean that mechanical forces can be managed with extraordinary tolerances and achieve a very high degree of reliability.The integral 2 stage centrifugal compressor and shaft is levitated utilizing state of the art magnetic bearing technology, which positions and adjusts the assembly automatically, 120 times per revolution.



Cutaway view of the advanced oil-less magnetic bearing technology of the Danfoss Turbocor Compressor used in the SMARDT range of Chillers.

The one combined moving part in the SMARDT Chiller – the magnetically levitated 2 stage centrifugal compressor and shaft of the Turbocor Compressor.

300 kWR (85tR) flooded chiller
with 3% oil in refrigerant



As this comparative AHRI study showed, over 20% of a lubricated chiller's operating efficiency is routinely lost in its early years, as a result of oil clogging of heat transfer surfaces.

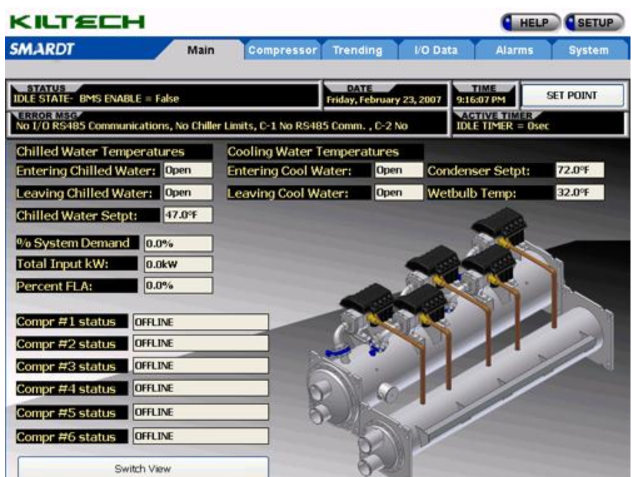
USER FRIENDLY CONTROLS

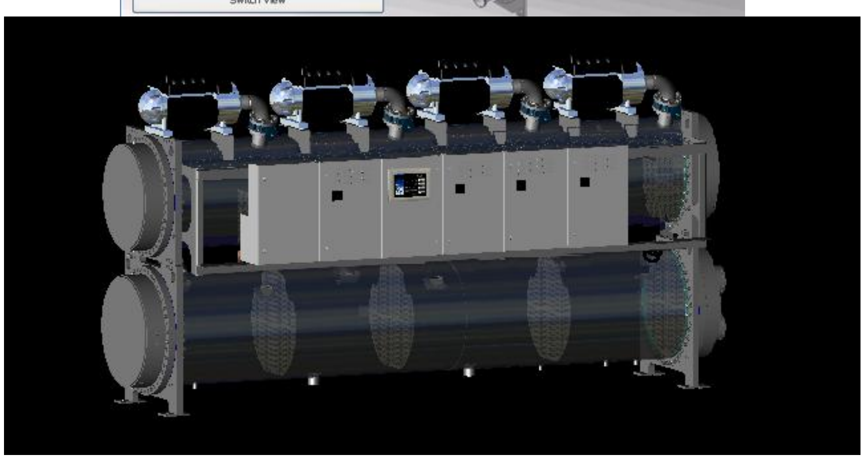
SMARDT's Kiltech controller is very user-friendly, highly intuitive, and allows optimization of both single and multiple compressor operation whilst enabling a rich array of communication options.

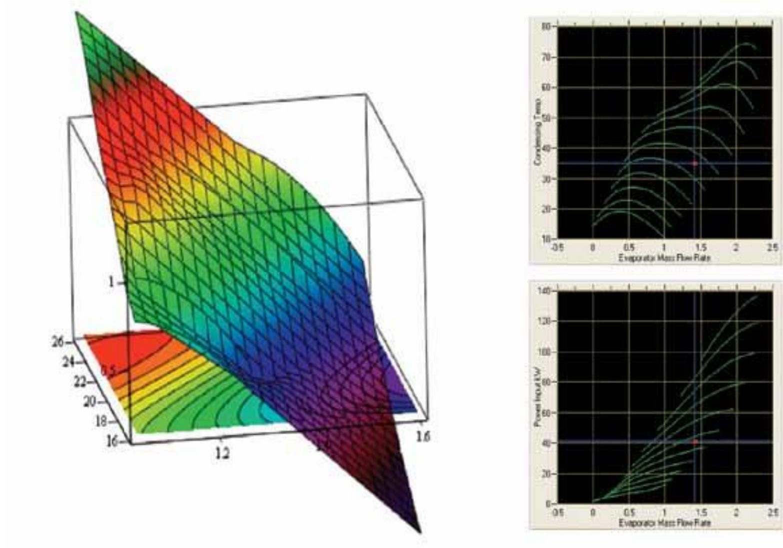
The compressor's on-board digital controller proactively manages compressor operation, while allowing external control and web-enabled monitoring of performance and reliability information.

The PowerPax microprocessor system has been used on many chiller sites, and the in-field experience gained has resulted in the generation of state-of-the-art controls software that both maximizes operating efficiencies and minimizes maintenance and operating costs.

The SMARDT Kiltech controller provides for several access levels for plant operators and for commissioning, and offers a wide variety of options for flexible operation and optimization of power consumption, thereby maximizing time spent operating at compressor sweet spots.







Condensing Temp v Evaporator Mass Flow Rate
Power Input (kW) v Evaporator Mass Flow Rate

SMARDT chiller controllers have been developed from the ground up, using primary compressor performance maps, maximizing the performance potential within these maps, then optimizing the whole of the chiller's operation to minimize energy consumption.

Remote Monitoring Application - Compressor Overview Screen Capture

The SMARDT chiller remote monitoring application brings numerous additional benefits, including superior protection of HVAC assets, early diagnostics assistance, & enhanced rapid response in the detection of alarms or faults.

WATER COOLED CHILLER – PRINCIPAL COMPONENTS

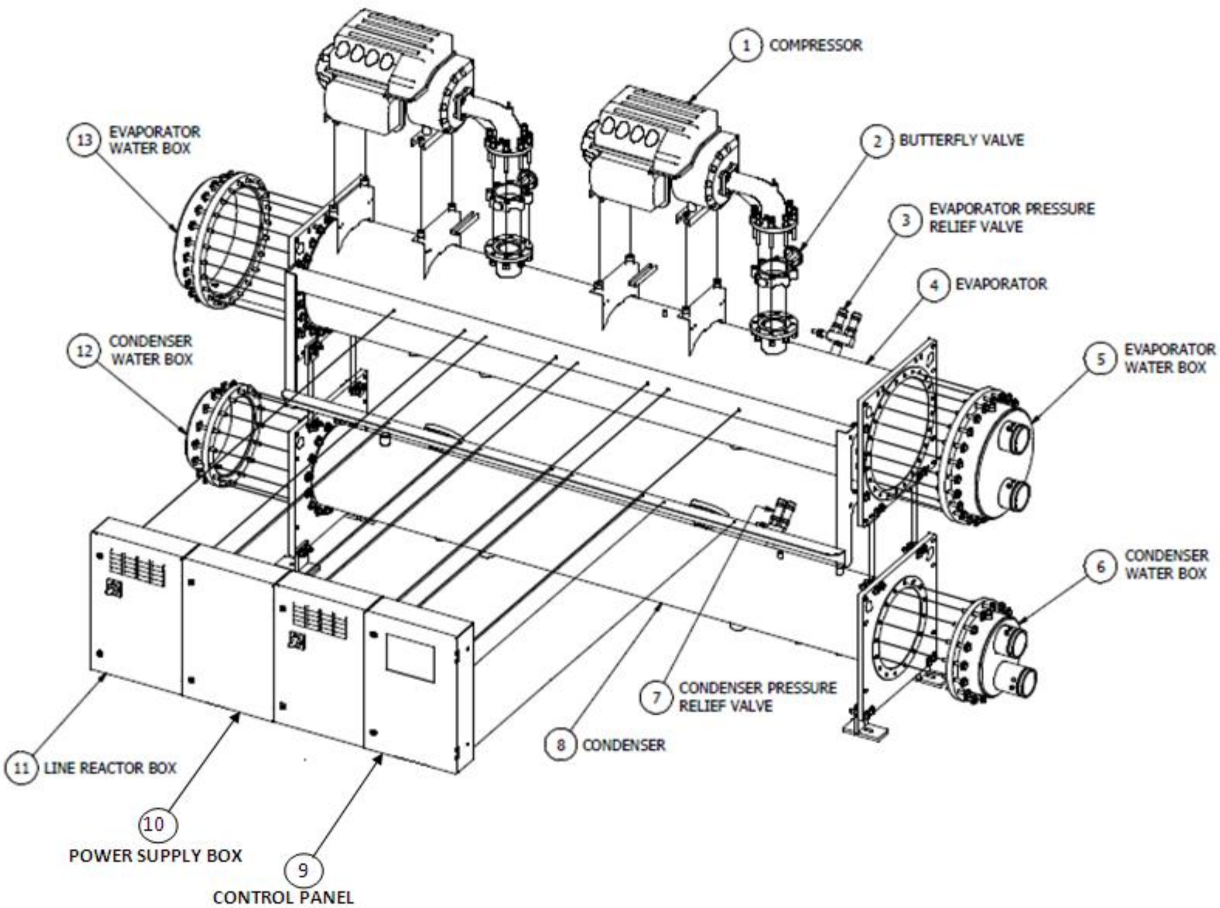


Figure 1: Exploded View - Water Cooled Chiller - Principal Components

PIPING SCHEMATIC

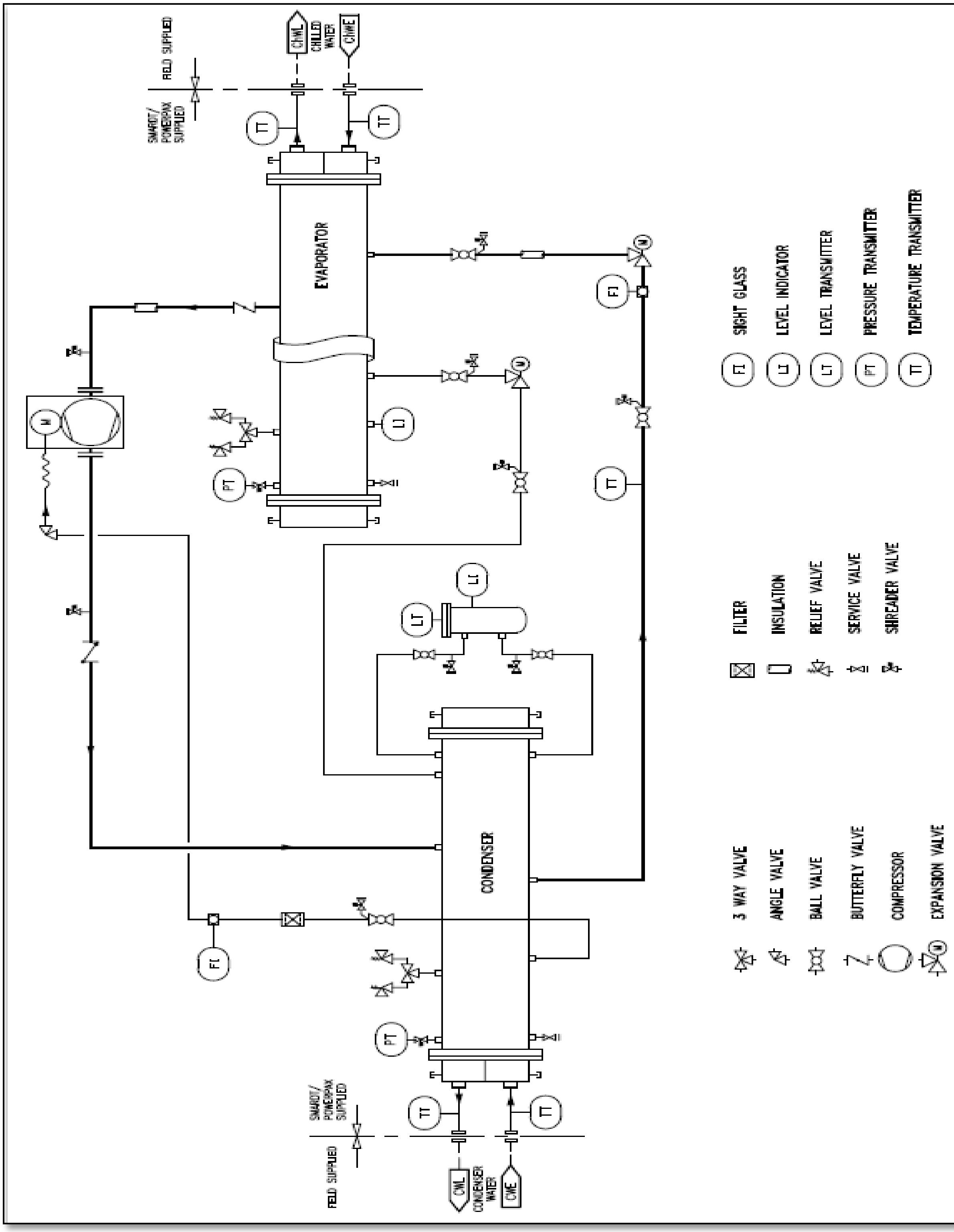


Figure 2: Piping Schematic

CHILLER NOMENCLATURE

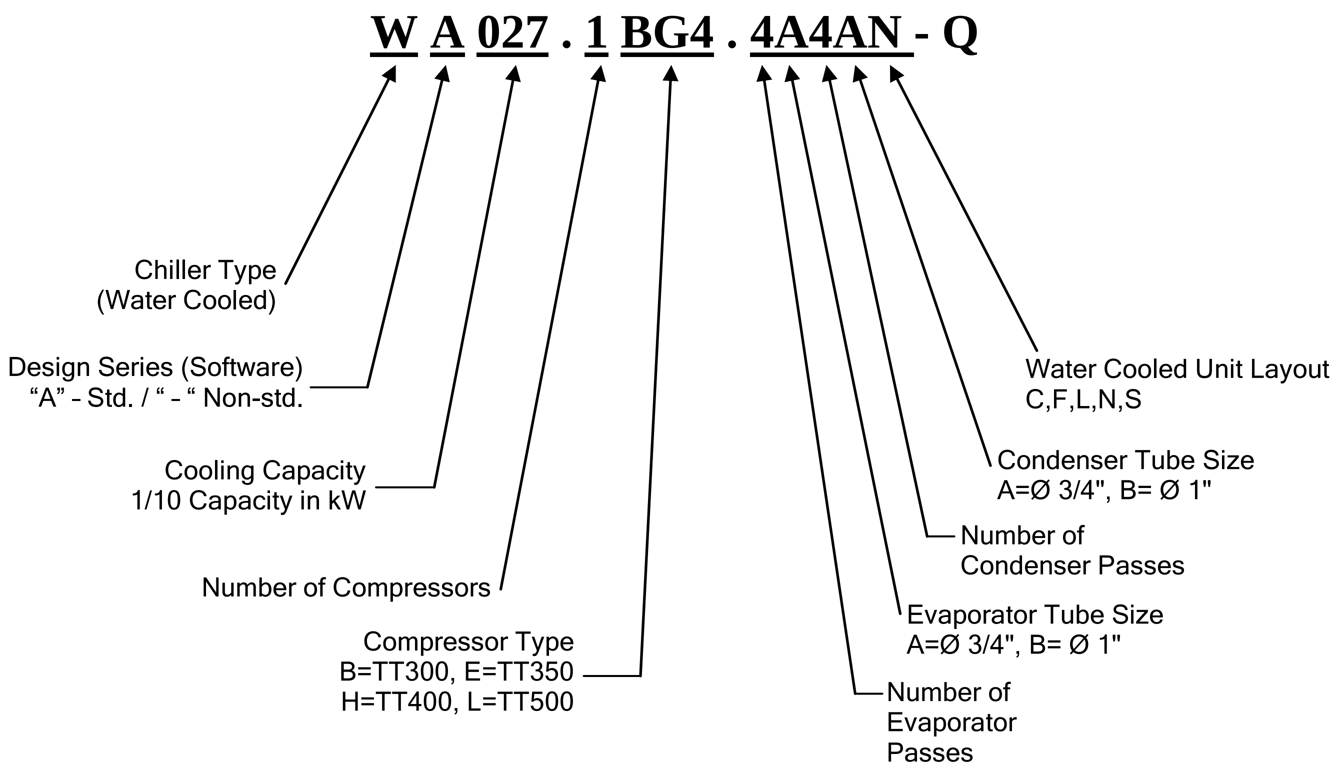
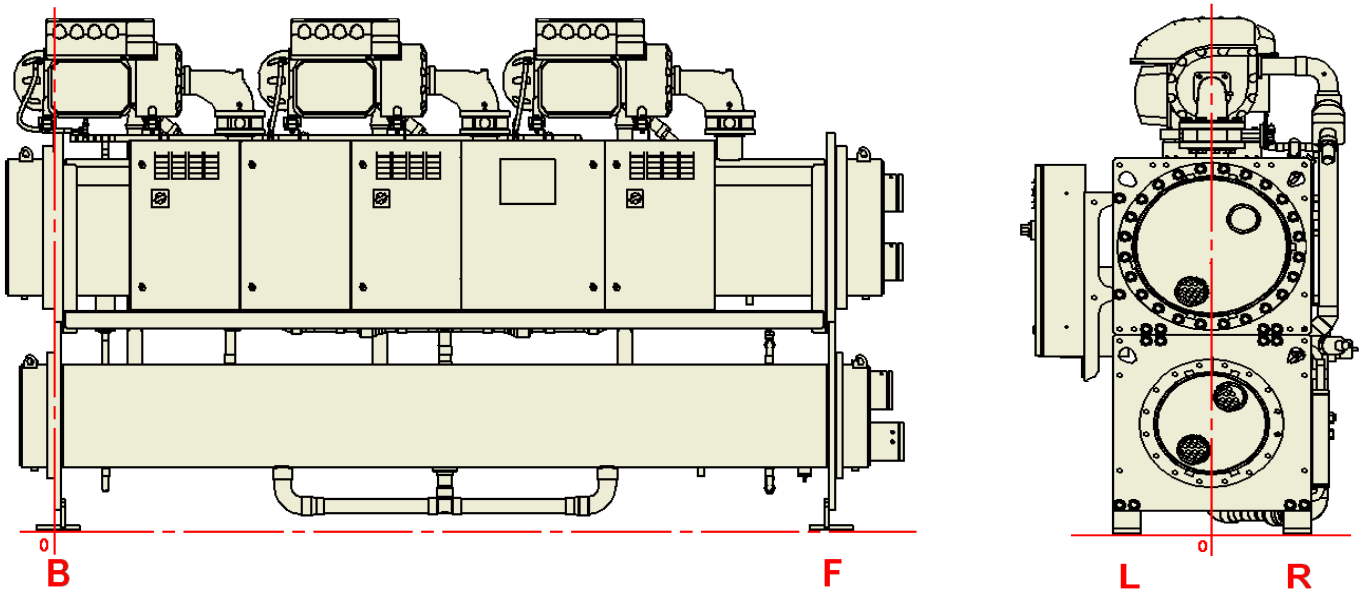


Figure 3: Chiller Nomenclature

CHILLER WEIGHTS / C OF G



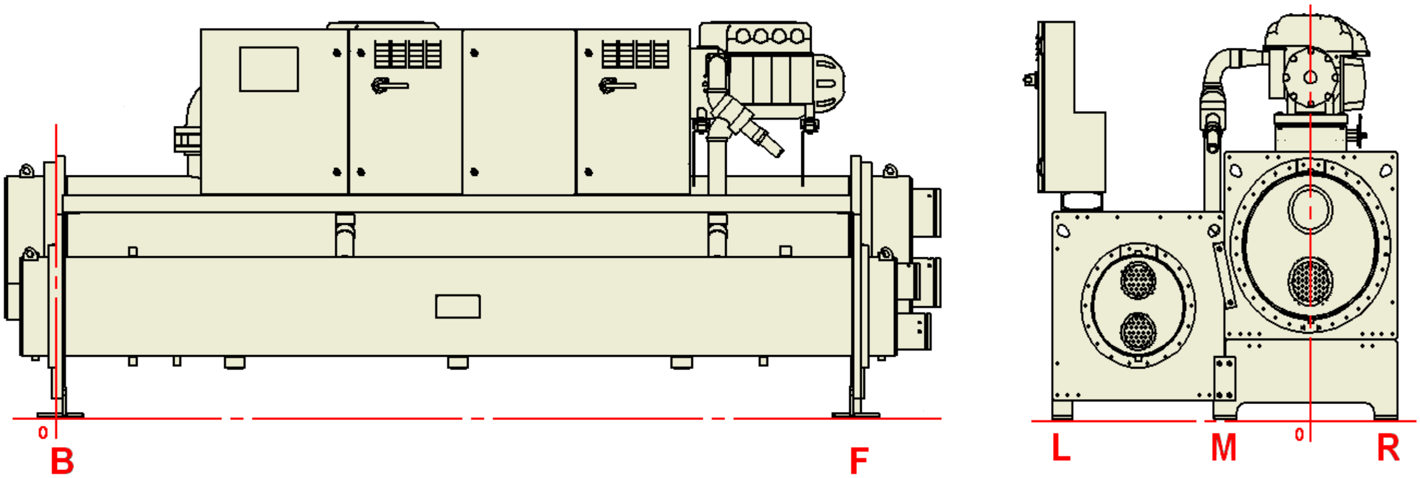
	WEIGHT kg (lbs)									CENTER OF GRAVITY mm (in.)		
	TOTAL WEIGHT		WEIGHT APPLIED TO FOOT				CONTENT WEIGHT				
Models	Empty	Operating	F-R	F-L	B-R	B-L	Refrig't	Water	Length	Width	Height
WA021.1BXX.66C	1733 (3820)	2055 (4530)	467 (1030)	517 (1139)	508 (1120)	562 (1239)	101 (223)	217 (478)	771 (30.37)	-13 (-0.51)	919 (36.18)
WA026.1BXX.44C	1656 (3650)	2005 (4420)	449 (989)	502 (1106)	498 (1098)	557 (1228)	136 (299)	212 (468)	859 (33.83)	-14 (-0.55)	900 (35.44)
WA027.1BXX.44N	1751 (3860)	2105 (4640)	568 (1031)	521 (1149)	527 (1162)	587 (1295)	130 (287)	224 (493)	937 (36.87)	-14 (-0.54)	890 (35.04)
WA030.1BXX.44C	1823 (4020)	2204 (4860)	500 (1102)	552 (1216)	549 (1210)	606 (1336)	146 (321)	238 (524)	864 (34.01)	-12.5 (-0.49)	913 (35.93)
WA030.1BXX.64C	1828 (4030)	2214 (4880)	502 (1106)	553 (1220)	549 (1211)	606 (1337)	146 (321)	238 (524)	865 (34.05)	-12.5 (-0.49)	913 (35.95)
WA031.1BXX.44N	1860 (4100)	2236 (4930)	513 (1133)	568 (1252)	548 (1208)	605 (1334)	139 (307)	235 (519)	964 (37.95)	-13 (-0.50)	914 (35.99)
WA044.2BXX.22N	2540 (5600)	3084 (6800)	656 (1454)	772 (1703)	760 (1675)	889 (1961)	241 (532)	300 (662)	1489 (58.62)	-20 (-0.77)	938 (36.92)
WA044.2BXX.32N	2540 (5600)	3084 (6800)	656 (1454)	772 (1703)	762 (1679)	892 (1966)	241 (532)	300 (662)	1487 (58.53)	-19 (-0.76)	938 (36.93)
WA044.2BXX.33N	2545 (5610)	3089 (6810)	658 (1450)	772 (1701)	763 (1683)	894 (1970)	241 (532)	300 (662)	1484 (58.44)	-19 (-0.76)	938 (36.91)
WA046.1HXX.44C	2599 (5730)	3202 (7060)	773 (1704)	847 (1867)	755 (1664)	827 (1824)	219 (483)	382 (843)	926 (36.44)	-14 (-0.54)	1334 (52.53)
WA048.1HXX.32N	2304 (5080)	2876 (6340)	662 (1460)	724 (1596)	711 (1568)	777 (1714)	271 (597)	300 (662)	1543 (60.74)	-11 (-0.42)	905 (35.64)
WA048.1HXX.33N	2309 (5090)	2876 (6340)	668 (1473)	730 (1610)	707 (1559)	773 (1704)	271 (597)	300 (662)	1555 (61.21)	-11 (-0.42)	905 (35.62)
WA050.2BXX.22N	2572 (5670)	3125 (6890)	670 (1477)	783 (1727)	770 (1697)	900 (1985)	227 (500)	327 (720)	1489 (58.64)	-19 (-0.76)	944 (37.17)

WA050.2BXX.23N	2572 (5670)	3130 (6900)	670 (1477)	799 (1726)	772 (1702)	902 (1989)	227 (500)	327 (720)	1487 (58.55)	-19 (-0.76)	944 (37.15)
WA050.2BXX.33N	2576 (5680)	3130 (6900)	670 (1476)	782 (1725)	774 (1706)	904 (1994)	227 (500)	327 (720)	1485 (58.47)	-19 (-0.76)	944 (37.16)
WA056.2BXX.44F	2998 (6610)	3633 (8010)	830 (1830)	981 (2162)	836 (1844)	988 (2178)	219 (483)	418 (921)	898 (35.36)	-25.5 (-1.00)	1103 (43.44)
WA059.2BXX.44F	3107 (6850)	3747 (8260)	859 (1894)	1011 (2229)	861 (1899)	1014 (2235)	199 (438)	438 (965)	989 (38.95)	-25 (-0.98)	1097 (43.20)
WA062.2BXX.22N	2749 (6060)	3393 (7480)	738 (1628)	831 (1833)	836 (1842)	967 (2131)	253 (558)	395 (870)	1502 (59.14)	-18 (-0.70)	920 (36.21)
WA062.2BXX.32N	2744 (6050)	3393 (7480)	735 (1621)	851 (1876)	836 (1844)	968 (2134)	253 (558)	392 (864)	1498 (58.97)	-18 (-0.70)	920 (36.21)
WA062.2BXX.33N	2749 (6060)	3393 (7480)	734 (1619)	850 (1873)	840 (1851)	971 (2141)	253 (558)	392 (864)	1494 (58.83)	-18 (-0.70)	919 (36.19)
WA062.2BXX.42N	2744 (6050)	3402 (7500)	740 (1631)	857 (1889)	836 (1843)	968 (2134)	269 (594)	387 (853)	1503 (59.16)	-18 (-0.70)	918 (36.13)
WA074.3BXX.22N	3084 (6800)	3778 (8330)	851 (1876)	997 (2199)	889 (1959)	1047 (2308)	288 (635)	406 (895)	1760 (69.28)	-20 (-0.79)	941 (37.03)
WA084.3BXX.22N	3198 (7050)	3915 (8630)	881 (1942)	1031 (2274)	923 (2035)	1081 (2383)	268 (591)	452 (997)	1761 (69.35)	-19.5 (-0.77)	932 (36.69)
WA088.2HXX.44F	3964 (8740)	4876 (10750)	1110 (2448)	1256 (2770)	1177 (2594)	1332 (2936)	276 (608)	634 (1397)	1209 (47.59)	-18.5 (-0.73)	1035 (40.75)
WA092.3BXX.22N	3656 (8060)	4445 (9800)	1013 (2233)	1166 (2570)	1055 (2325)	1214 (2676)	300 (662)	507 (1117)	1767 (69.58)	-21.5 (-0.84)	1438 (56.62)
WA092.3BXX.32N	3660 (8070)	4450 (9810)	1011 (2229)	1163 (2564)	1059 (2334)	1217 (2684)	300 (662)	506 (1116)	1763 (69.40)	-21.5 (-0.84)	1438 (56.62)
WA092.3BXX.33N	3706 (8170)	4491 (9900)	1019 (2247)	1173 (2582)	1070 (2360)	1229 (2710)	300 (662)	503 (1108)	1760 (69.30)	-21 (-0.83)	1430 (56.30)
WA092.3BXX.42N	3665 (8080)	4454 (9820)	1015 (2238)	1168 (2575)	1056 (2328)	1223 (2697)	300 (662)	507 (1117)	1768 (69.62)	-21 (-0.83)	1438 (56.61)
WA095.2HXX.22N	3642 (8030)	4504 (9930)	1039 (2291)	1149 (2534)	1099 (2423)	1216 (2680)	315 (695)	547 (1206)	1556 (61.26)	-15 (-0.59)	1374 (54.08)
WA095.2HXX.32N	3647 (8040)	4509 (9940)	1038 (2288)	1148 (2531)	1103 (2431)	1219 (2688)	315 (695)	547 (1206)	1552 (61.12)	-15 (-0.59)	1374 (54.08)
WA095.2HXX.33N	3651 (8050)	4513 (9950)	1036 (2285)	1147 (2528)	1106 (2438)	1347 (2696)	315 (694)	547 (1206)	1549 (60.99)	-15 -0.59	1373 (54.05)
WA096.2HXX.22N	3692 (8140)	4522 (9970)	1037 (2287)	1149 (2534)	1108 (2442)	1227 (2705)	289 (638)	537 (1186)	1745 (68.72)	-15.25 (-0.60)	1422 (55.99)
WA096.2HXX.32N	3674 (8100)	4513 (9950)	1038 (2288)	1151 (2537)	1101 (2427)	1221 (2691)	297 (655)	537 (1186)	1751 (68.95)	-15.5 (-0.61)	1422 (56.00)
WA105.4BXX.22N	4277 (9430)	5225 (11520)	1024 (2557)	1331 (2953)	1264 (2787)	1460 (3219)	354 (780)	592 (1304)	1909 (75.16)	-21.5 (-0.85)	1402 (55.20)
WA105.4BXX.32N	4282 (9440)	5225 (11520)	1158 (2553)	1342 (2948)	1267 (2794)	1464 (3227)	354 (780)	591 (1303)	1905 (75.00)	-21.5 (-0.85)	1402 (55.20)
WA120.4BXX.22N	4477 (9870)	5466 (12050)	1215 (2678)	1391 (3067)	1332 (2936)	1525 (3362)	362 (798)	623 (1375)	1904 (74.96)	-20.25 (-0.80)	1390 (54.73)
WA120.4BXX.24N	4350 (9490)	5470 (12060)	1217 (2682)	1393 (3070)	1334 (2941)	1527 (3367)	362 (798)	623 (1375)	1903 (74.94)	-20.25 (-0.80)	1389 (54.68)
WA125.3HXX.22N	4341 (9570)	5325 (11740)	1232 (2716)	1370 (3021)	1289 (2842)	1434 (3161)	362 (798)	623 (1375)	1949 (76.75)	-15.75 (-0.62)	1391 (54.77)
WA140.3HXX.22N	5307 (11700)	6595 (14540)	1530 (3373)	1670 (3682)	1622 (3577)	1771 (3904)	459 (1012)	828 (1825)	2183 (85.95)	-13 -0.51	1322 (52.04
WA150.5BFX.22F	5720 (12610)	7008 (15450)	1495 (3297)	1849 (4077)	1637 (3610)	2025 (4464)	459 (1012)	828 (1825)	2147 (84.52)	-31.5 (-1.24)	1087 (42.79)
WA180.6BFX.22F	6954 (15330)	8655 (19080)	2000 (4410)	2330 (5136)	1998 4405	2327 (5130)	622 (1371)	1082 (2385)	2503 (98.56)	-25 (-0.98)	1161 (45.69)

Note: Refer to job specific submittal for job specific product weights and dimensions.

Table 1 - Chiller Weights / C of G

Chiller Weights (cont'd)

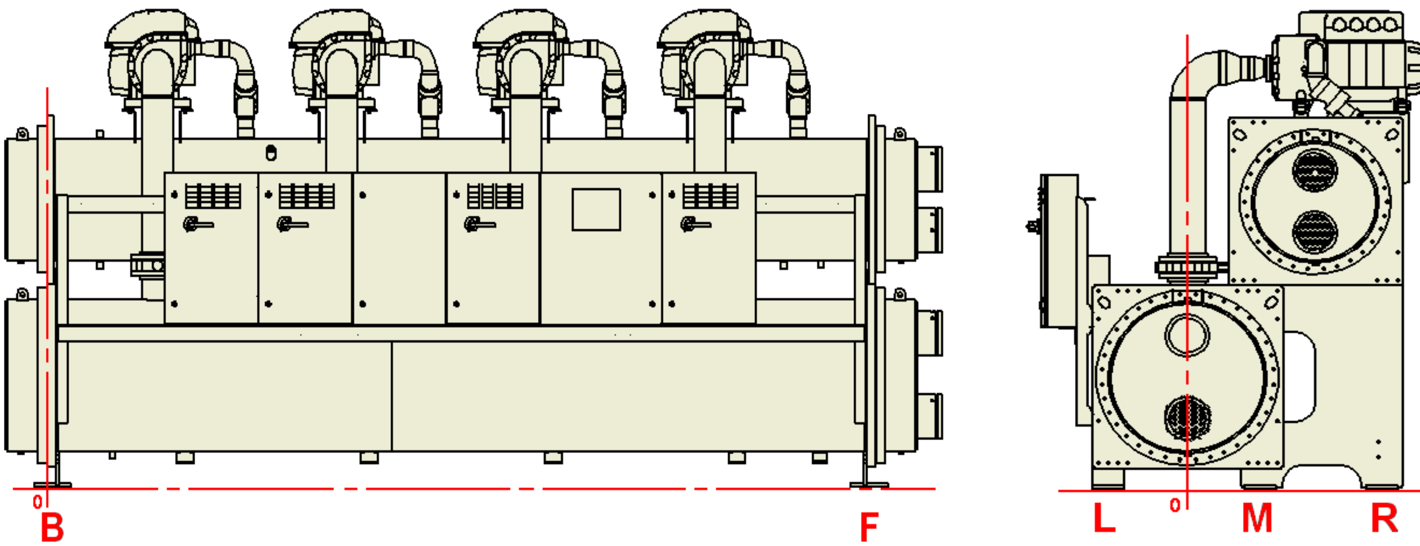


	WEIGHT kg (lbs)										CENTER OF GRAVITY mm (in.)		
	TOTAL WEIGHT		WEIGHT APPLIED TO FOOT						CONTENT WEIGHT				
Models	Empty	Oper'g	F-R	F-M	F-L	B-R	B-M	B-L	Refrig't	Water	Length	Width	Height
WA048.1HXX.32S	2422 (5340)	2994 (6600)	371 (819)	974 (2147)	201 (443)	344 (758)	924 (2037)	178 (393)	271 (597)	300 (662)	1668 (65.66)	-255 (-10.05)	628 (24.71)
WA048.1HXX.33S	2422 (5340)	2994 (6600)	371 (819)	973 (2146)	200 (442)	343 (757)	927 (2043)	180 (397)	271 (597)	300 (662)	1665 (65.56)	-256 (-10.07)	628 24.71
WA084.3BXX.22S	3316 (7310)	4023 (8870)	481 (1061)	1293 (2850)	267 (588)	435 (960)	1240 (2734)	307 (676)	256 (565)	452 (997)	1819 (71.62)	-280 (-11.01)	663 26.10
WA092.3BXX.22S	3815 (8410)	4640 (10230)	577 (1273)	1507 (3322)	265 (584)	532 (1173)	1451 (3199)	306 (674)	315 (694)	507 (1117)	1818 (71.57)	-311 (-12.23)	733 28.85
WA095.2HXX.32S	3801 (8380)	4699 (10360)	519 (1144)	1469 (3239)	293 (646)	567 (1249)	1554 (3427)	296 (653)	349 (769)	547 (1206)	1554 (61.18)	-317 (-12.49)	711 27.99
WA096.2HXX.22S	3851 (8490)	4740 (10450)	558 (1231)	1490 (3284)	249 (550)	600 (1323)	1567 (3454)	276 (609)	352 (777)	538 (1186)	1748 (68.83)	-295 (-11.63)	715 28.16
WA120.4BXX.22S	4636 (10220)	5693 (12550)	608 (1340)	1736 (3828)	377 (832)	697 (1537)	1903 (4195)	371 (819)	435 (959)	624 (1375)	1907 (75.06)	-324 (-12.75)	733 28.87
WA125.3HXX.22S	4500 (9920)	5557 (12250)	656 (1446)	1807 (3984)	355 (782)	619 (1365)	1778 (3919)	343 (756)	435 (959)	624 (1375)	2008 (79.60)	-317 (-12.48)	723 28.48
WA140.3HXX.22S	5470 (12060)	6840 (15080)	776 (1710)	2239 (4937)	472 (1041)	724 (1597)	2180 (4807)	449 (990)	543 (1197)	828 (1825)	2292 (90.25)	-333 (-13.12)	699 27.50

Note: Refer to job specific submittal for job specific product weights and dimensions.

Table 2 - Chiller Weights / C of G

Chiller Weights (cont'd)



	WEIGHT kg (lbs)										CENTER OF GRAVITY mm (in.)		
	TOTAL WEIGHT		APPLY TO FOOT						CONTENT WEIGHT				
Models	Empty	Operat'g	F-R	F-M	F-L	B-R	B-M	B-L	Refrig't	Water	Length	Width	Height
WA190.4HXX.22L	6500 (14330)	8147 (17960)	463 (1020)	2730 (6019)	839 (1849)	487 (1074)	623 (6119)	852 (1879)	622 (1371)	1023 (2256)	2225 (87.59)	266 (10.47)	1021 (40.19)
WA240.5HXX.22L	7648 (16860)	9662 (21300)	609 (1342)	3226 (7112)	960 (2117)	623 (1373)	3296 (7267)	949 (2092)	738 (1628)	1278 (2818)	2483 (97.75)	279 (11.00)	1041 (40.98)

Note: Refer to job specific submittal for job specific product weights and dimensions.

Table 3 Chiller Weights / C of G

CHILLER DIMENSIONS & CLEARANCES

STANDARD MODEL

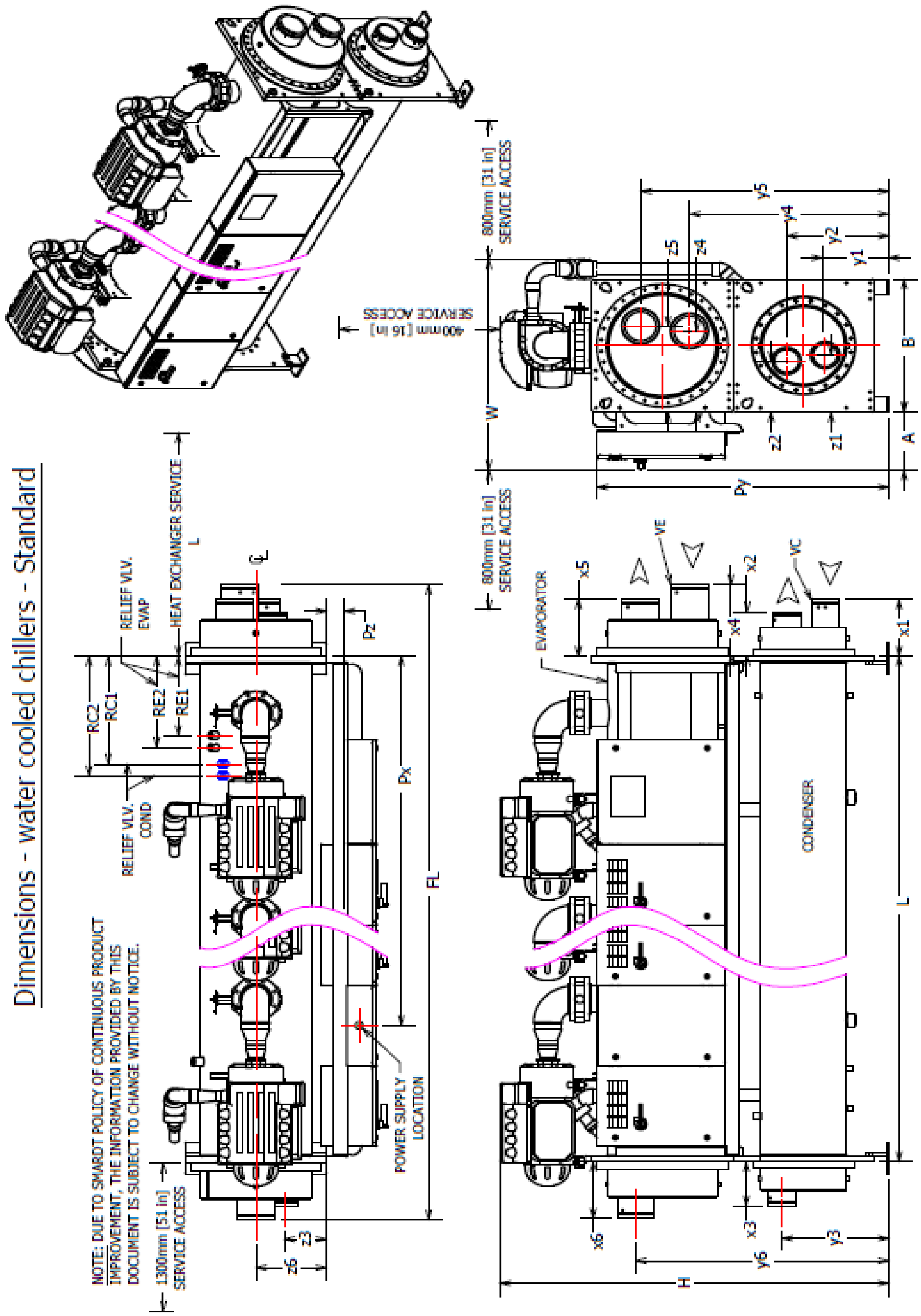


Figure 4: Chiller Dimensions & Clearances
(*Ref. Table 4)*

FATMAX MODEL

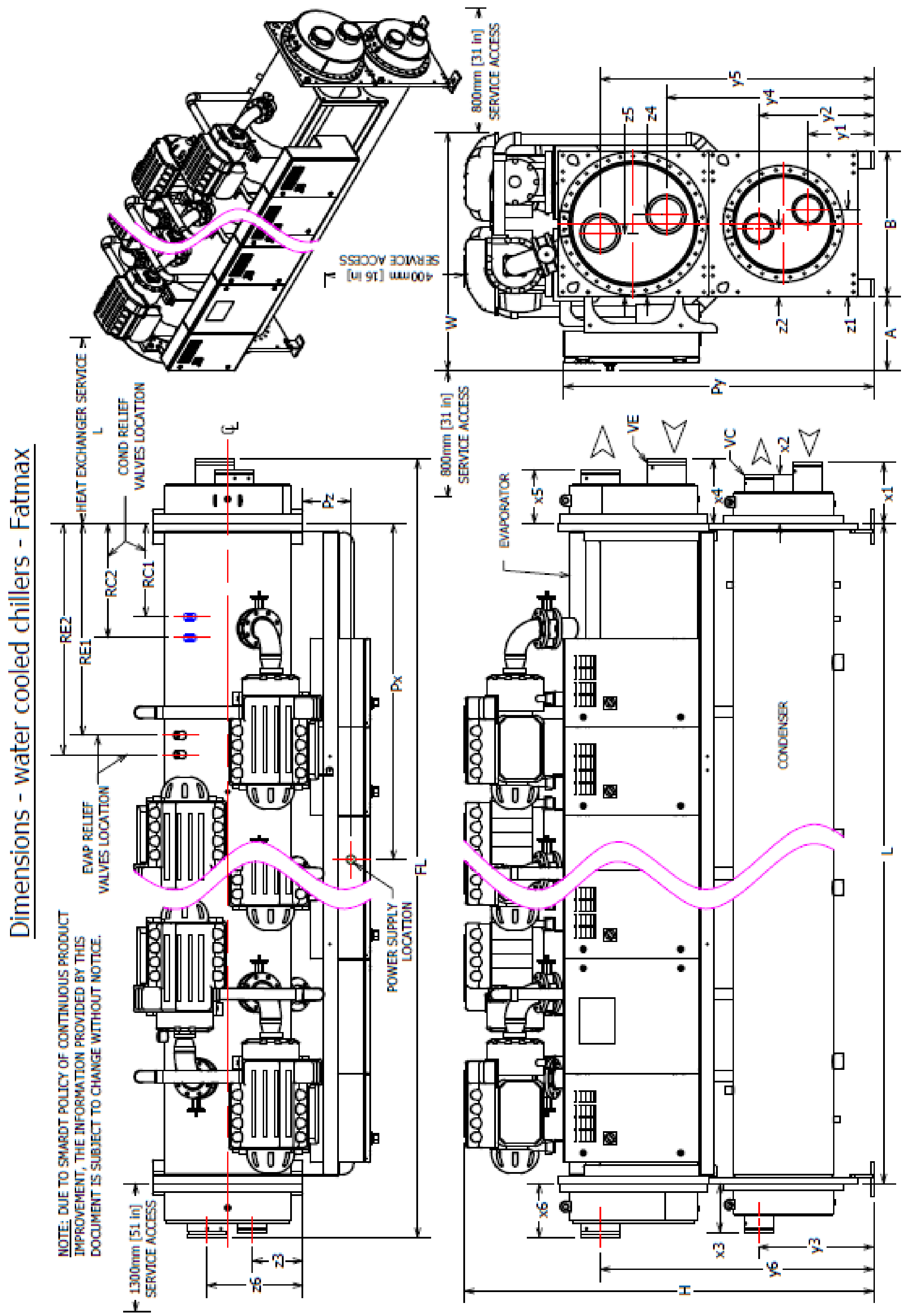


Figure 5: Chiller Dimensions & Clearances
(*Ref. Table 4)*

SIDE BY SIDE MODEL

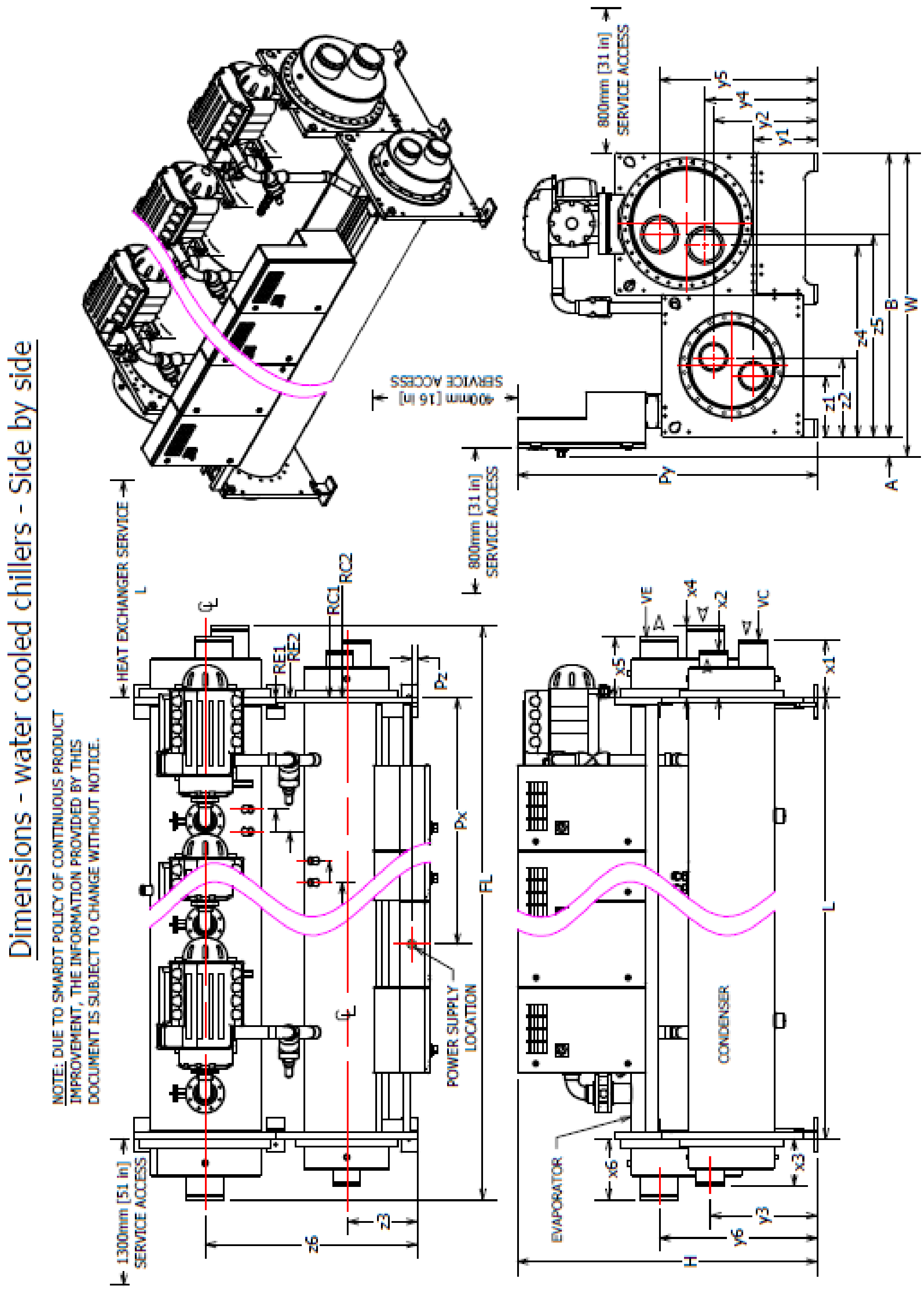


Figure 6: Chiller Dimensions & Clearances
(*Ref. Table 4)*

LOW PROFILE MODEL

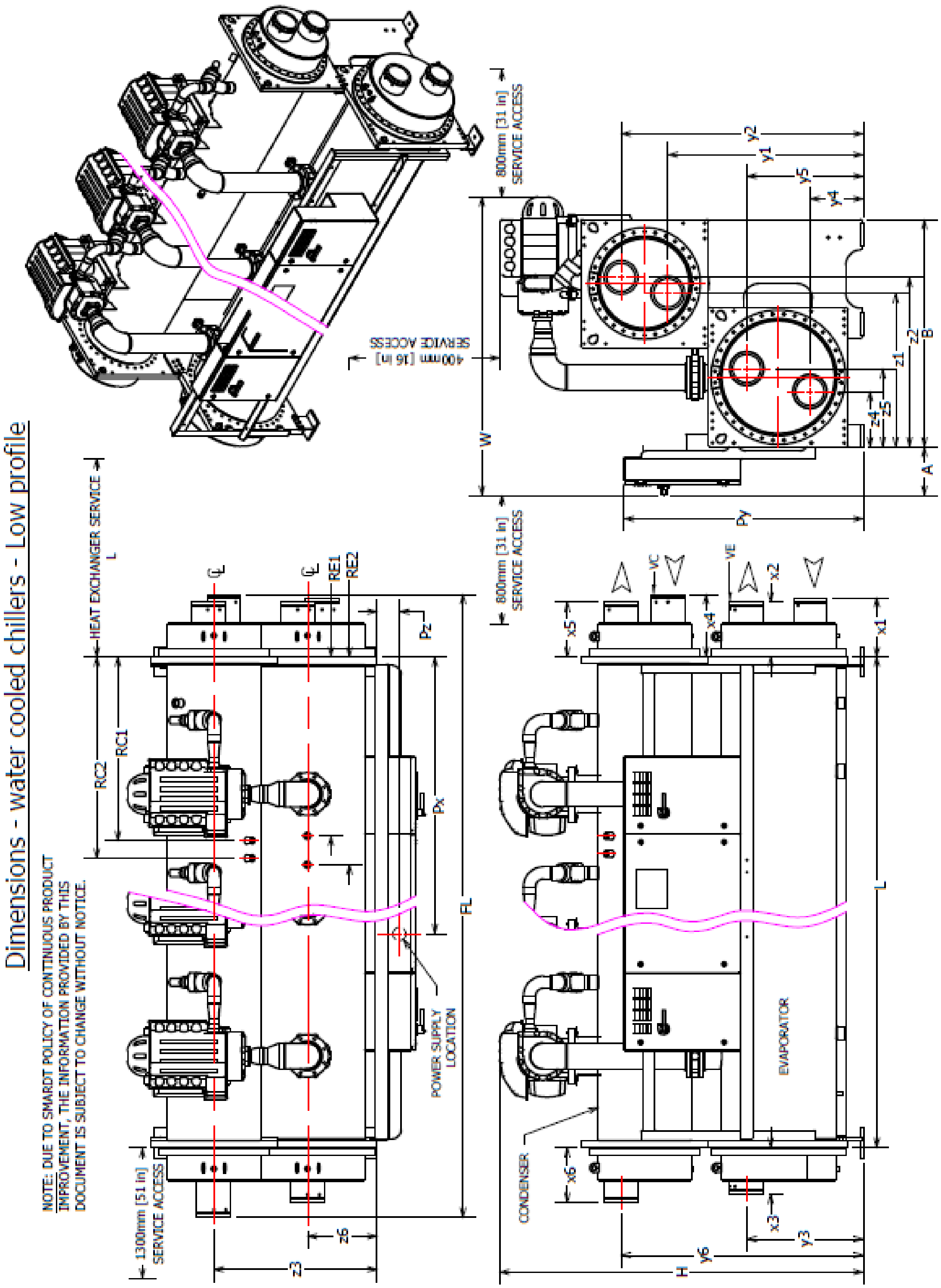


Figure 7: Chiller Dimensions & Clearances
(*Ref. Table 4)*

CHILLER DIMENSIONS BY MODEL

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	FL	W	H	L	A	B	VC	x1	y1
WA021.1BXX.66C	2062/81.2	1145/45.1	2049/80.7	1600/63	321/12.7	700/27.6	4" dia	263/10.4	331/13
WA026.1BXX.44C	2262/89.1	1145/45.1	2024/79.7	1800/70.9	321/12.7	700/27.6	4" dia	263/10.4	346/13.6
WA027.1BXX.44N	2462/96.9	1145/45.1	2024/79.7	2000/78.7	321/12.7	700/27.6	4" dia	263/10.4	346/13.6
WA030.1BXX.44C	2262/89.1	1145/45.1	2049/80.7	1800/70.9	321/12.7	700/27.6	4" dia	263/10.4	346/13.6
WA030.1BXX.64C	2262/89.1	1145/45.1	2049/80.7	1800/70.9	321/12.7	700/27.6	4" dia	263/10.4	346/13.6
WA031.1BXX.44N	2462/96.9	1145/45.1	2049/80.7	2000/78.7	321/12.7	700/27.6	4" dia	263/10.4	346/13.6
WA044.2BXX.22N	3701/145.7	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	316/12.4	335/13.2
WA044.2BXX.32N	3795/149.4	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	316/12.4	335/13.2
WA044.2BXX.33N	3754/147.8	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	263/10.4	343/13.5
WA046.1HXX.44C	2364/93.1	1332/52.5	2314/91.1	1800/70.9	369/14.5	840/33.1	5" dia	330/13	401/15.8
WA047.1HXX.44C	2559/100.7	1332/52.5	2314/91.1	2000/78.7	369/14.5	840/33.1	5" dia	330/13	401/15.8
WA048.1HXX.32N	3793/149.3	1214/47.8	2054/80.9	3200/126	343/13.5	700/27.6	5" dia	316/12.4	335/13.2
WA048.1HXX.32S	3791/149.3	1540/60.6	1637/64.5	3200/126	140/5.5	1400/55.1	5" dia	316/12.4	335/13.2
WA048.1HXX.33N	3754/147.8	1214/47.8	2054/80.9	3200/126	343/13.5	700/27.6	5" dia	263/10.4	343/13.5
WA048.1HXX.33S	3754/147.8	1540/60.6	1637/64.5	3200/126	140/5.5	1400/55.1	5" dia	263/10.4	343/13.5
WA050.2BXX.22N	3701/145.7	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	316/12.4	335/13.2
WA050.2BXX.23N	3740/147.2	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	263/10.4	343/13.5
WA050.2BXX.33N	3754/147.8	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	263/10.4	343/13.5
WA056.2BXX.44F	2638/103.9	1382/54.4	2293/90.3	1800/70.9	436/17.1	840/33.1	5" dia	330/13	401/15.8
WA059.2BXX.44F	2838/112.9	1382/54.4	2293/90.3	2000/78.7	436/17.1	840/33.1	5" dia	330/13	401/15.8
WA062.2BXX.22N	3701/145.7	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	6" dia	316/12.4	321/12.7
WA062.2BXX.32N	3701/145.7	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	6" dia	316/12.4	321/12.7
WA062.2BXX.33N	3760/148	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	6" dia	266/10.5	331/13
WA062.2BXX.42N	3715/146.3	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	6" dia	316/12.4	321/12.7
WA074.3BXX.22N	4101/161.5	1145/45.1	2049/80.7	3600/141.7	321/12.7	700/27.6	6" dia	316/12.4	321/12.7
WA084.3BXX.22N	4104/161.6	1145/45.1	2049/80.7	3600/141.7	321/12.7	700/27.6	6" dia	316/12.4	321/12.7
WA088.2HXX.44F	3040/119.7	1393/54.8	2297/90.4	2500/98.4	445/17.5	840/33.1	6" dia	310/12.2	386/15.2
WA092.3BXX.22N	4141/163	1240/48.8	2284/89.9	3600/141.7	347/13.7	840/33.1	6" dia	316/12.4	391/15.4
WA092.3BXX.22S	4141/163	1800/70.9	1777/70	3600/141.7	120/4.7	840/33.1	6" dia	316/12.4	391/15.4
WA092.3BXX.33N	4220/166.1	1241/48.8	2284/89.9	3600/141.7	347/13.7	840/33.1	6" dia	266/10.5	401/15.8
WA092.3BXX.42N	4141/163	1241/48.8	2284/89.9	3600/141.7	347/13.7	840/33.1	6" dia	316/12.4	391/15.4
WA095.2HXX.32N	3820/150.4	1332/52.5	2314/91.1	3600/141.7	369/14.5	840/33.1	6" dia	280/11	378/14.9
WA095.2HXX.32S	3820/150.4	1820/71.7	1777/70	3200/126	140/5.5	1680/66.1	6" dia	270/10.6	378/14.9
WA095.2HXX.33N	3820/150.4	1297/51.1	2314/91.1	3200/126	369/14.5	840/33.1	6" dia	280/11	391/15.4

Table 4: Chiller Dimensions By Model

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	FL	W	H	L	A	B	VC	x1	y1
WA096.2HXX.22N	4188/164.9	1335/52.5	2314/91.1	3600/141.7	369/14.5	840/33.1	6" dia	316/12.4	391/15.4
WA096.2HXX.22S	4188/164.9	1820/71.7	1777/70	3600/141.7	140/5.5	1680/66.1	6" dia	316/12.4	391/15.4
WA096.2HXX.32N	4226/166.4	1335/52.5	2314/91.1	3600/141.7	369/14.5	840/33.1	6" dia	316/12.4	391/15.4
WA105.4BXX.22N	4535/178.5	1240/48.8	2284/89.9	4000/157.5	347/13.7	840/33.1	6" dia	280/11	378/14.9
WA105.4BXX.32N	4620/181.9	1240/48.8	2284/89.9	4000/157.5	347/13.7	840/33.1	6" dia	280/11	378/14.9
WA120.4BXX.22N	4588/180.6	1241/48.8	2310/90.9	4000/157.5	347/13.7	840/33.1	6" dia	280/11	378/14.9
WA120.4BXX.22S	4588/180.6	1798/70.8	1777/70	4000/157.5	118/4.6	840/33.1	6" dia	280/11	378/14.9
WA120.4BXX.24N	4588/180.6	1241/48.8	2310/90.9	4000/157.5	347/13.7	840/33.1	6" dia	330/13	401/15.8
WA125.3HXX.22N	4588/180.6	1335/52.5	2314/91.1	4000/157.5	369/14.5	840/33.2	6" dia	280/11	378/14.9
WA125.3HXX.22N	4588/180.6	1820/71.7	1777/70	4000/157.5	140/5.5	1680/66.1	6" dia	280/11	378/14.9
WA140.3HXX.22N	5035/198.2	1335/52.5	2340/92.1	4500/177.2	369/14.5	840/33.2	6" dia	280/11	368/14.5
WA140.3HXX.22S	5035/198.2	1820/71.7	1777/70	4500/177.2	140/5.5	1680/66.1	6" dia	280/11	368/14.5
WA150.5BXX.22F	5035/198.2	1369/53.9	2293/90.3	4500/177.2	423/16.7	840/33.2	6" dia	280/11	368/14.5
WA180.5BXX.22F	5585/219.9	1434/56.5	2427/95.6	5000/196.9	423/16.7	914/36	8" dia	360/14.2	390/15.4
WA190.4HXX.22L	5085/200.2	1956/77	2384/93.9	4500/177.2	318/12.5	1491/58.7	8" dia	360/14.2	350/13.8
WA240.5HXX.22L	5585/219.9	1956/77	2409/94.8	5000/196.9	318/12.5	1491/58.7	8" dia	360/14.2	350/13.8

Table 4: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	z1	x2	y2	z2	x3	y3	z3	VE	x4
WA021.1BXX.66C	285/11.2	263/10.4	541/21.3	415/13.3	N/A	N/A	N/A	4" dia	277/10.9
WA026.1BXX.44C	282/11.1	263/10.4	526/20.7	282/11.1	N/A	N/A	N/A	4" dia	277/10.9
WA027.1BXX.44N	282/11.1	263/10.4	526/20.7	282/11.1	N/A	N/A	N/A	4" dia	277/10.9
WA030.1BXX.44C	282/11.1	263/10.4	526/20.7	282/11.1	N/A	N/A	N/A	4" dia	277/10.9
WA030.1BXX.64C	282/11.1	263/10.4	526/20.7	282/11.1	N/A	N/A	N/A	4" dia	277/10.9
WA031.1BXX.44N	282/11.1	263/10.4	526/20.7	282/11.1	N/A	N/A	N/A	4" dia	277/10.9
WA044.2BXX.22N	350/13.8	263/10.4	537/21.2	350/13.8	N/A	N/A	N/A	5" dia	277/10.9
WA044.2BXX.32N	350/13.8	263/10.4	537/21.2	350/13.8	N/A	N/A	N/A	5" dia	280/11
WA044.2BXX.33N	350/13.8	N/A	N/A	N/A	263/10.4	529/20.8	350/13.8	5" dia	280/11
WA046.1HXX.44C	325/12.8	277/10.9	621/24.4	343/13.5	N/A	N/A	N/A	5" dia	311/12.2
WA047.1HXX.44C	325/12.8	277/10.9	621/24.4	343/13.5	N/A	N/A	N/A	5" dia	311/12.2
WA048.1HXX.32N	350/13.8	263/10.4	537/21.2	350/13.8	N/A	N/A	N/A	5" dia	277/10.9
WA048.1HXX.32S	350/13.8	263/10.4	537/21.2	350/13.8	N/A	N/A	N/A	5" dia	277/10.9
WA048.1HXX.33N	350/13.8	N/A	N/A	N/A	263/10.4	529/20.8	350/13.8	5" dia	277/10.9
WA048.1HXX.33S	350/13.8	N/A	N/A	N/A	263/10.4	529/20.8	350/13.8	5" dia	277/10.9
WA050.2BXX.22N	350/13.8	263/10.4	537/21.2	350/13.8	N/A	N/A	N/A	5" dia	277/10.9
WA050.2BXX.23N	350/13.8	N/A	N/A	N/A	263/10.4	529/20.8	350/13.8	5" dia	277/10.9
WA050.2BXX.33N	350/13.8	N/A	N/A	N/A	263/10.4	529/20.8	350/13.8	5" dia	277/10.9
WA056.2BXX.44F	325/12.8	277/10.9	621/24.4	343/13.5	N/A	N/A	N/A	5" dia	311/12.2
WA059.2BXX.44F	325/12.8	277/10.9	621/24.4	343/13.5	N/A	N/A	N/A	5" dia	311/12.2
WA062.2BXX.22N	350/13.8	266/10.5	551/21.7	350/13.8	N/A	N/A	N/A	6" dia	280/11
WA062.2BXX.32N	350/13.8	266/10.5	551/21.7	350/13.8	N/A	N/A	N/A	6" dia	280/11
WA062.2BXX.33N	350/13.8	N/A	N/A	N/A	266/10.5	541/21.3	350/13.8	6" dia	280/11
WA062.2BXX.42N	350/13.8	266/10.5	551/21.7	350/13.8	N/A	N/A	N/A	6" dia	330/13
WA074.3BXX.22N	350/13.8	266/10.5	551/21.7	350/13.8	N/A	N/A	N/A	6" dia	280/11
WA084.3BXX.22N	350/13.8	266/10.5	551/21.7	350/13.8	N/A	N/A	N/A	6" dia	277/10.9
WA088.2HXX.44F	308/12.1	310/12.2	626/24.6	308/12.1	N/A	N/A	N/A	5" dia	311/12.2
WA092.3BXX.22N	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA092.3BXX.22S	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA092.3BXX.33N	420/16.5	N/A	N/A	N/A	266/10.5	611/24.1	420/16.5	6" dia	310/12.2
WA092.3BXX.42N	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	5" dia	307/12.1
WA095.2HXX.32N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA095.2HXX.32S	420/16.5	270/10.6	634/25	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA095.2HXX.33N	420/16.5	N/A	N/A	N/A	280/11	621/24.4	420/16.5	6" dia	310/12.2
WA096.2HXX.22N	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	8" dia	359/14.1

Table 4: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	z1	x2	y2	z2	x3	y3	z3	VE	x4
WA096.2HXX.22S	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA096.2HXX.32N	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA105.4BXX.22N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA105.4BXX.32N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA120.4BXX.22N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA120.4BXX.22S	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA120.4BXX.24N	420/16.5	277/10.9	621/24.4	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA125.3HXX.22N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA125.3HXX.22N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA140.3HXX.22N	420/16.5	280/11	644/25.4	420/16.5	N/A	N/A	N/A	8" dia	310/12.2
WA140.3HXX.22S	420/16.5	280/11	644/25.4	420/16.5	N/A	N/A	N/A	8" dia	310/12.2
WA150.5BXX.22F	420/16.5	280/11	644/25.4	420/16.5	N/A	N/A	N/A	8" dia	310/12.2
WA180.5BXX.22F	457/18	360/14.2	696/27.4	457/18	N/A	N/A	N/A	8" dia	358/14.1
WA190.4HXX.22L	457/18	360/14.2	764/30.1	457/18	N/A	N/A	N/A	8" dia	360/14.2
WA240.5HXX.22L	457/18	360/14.2	764/30.1	457/18	N/A	N/A	N/A	8" dia	360/14.2

Table 4: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	y4	z4	x5	y5	z5	x6	y6	z6	Px
WA021.1BXX.66C	958/37.7	280/11.0	277/10.9	1246/49.1	460/18.1	N/A	N/A	N/A	1168/45.6
WA026.1BXX.44C	986/38.8	427/16.8	277/10.9	1286/50.6	350/13.8	N/A	N/A	N/A	1265/49.8
WA027.1BXX.44N	986/38.8	427/16.8	277/10.9	1286/50.6	350/13.8	N/A	N/A	N/A	1368/53.9
WA030.1BXX.44C	989/38.9	440/17.3	277/10.9	1236/48.7	440/17.3	N/A	N/A	N/A	1268/49.9
WA030.1BXX.64C	958/37.7	280/11.0	277/10.9	1246/49.1	460/18.1	N/A	N/A	N/A	1268/49.9
WA031.1BXX.44N	976/38.4	270/10.6	277/10.9	1296/51	270/10.6	N/A	N/A	N/A	1368/53.9
WA044.2BXX.22N	976/38.4	350/13.8	277/10.9	1296/51	350/13.8	N/A	N/A	N/A	1855/73
WA044.2BXX.32N	974/38.3	350/13.8	N/A	N/A	N/A	280/11	1298/51.1	350/13.8	1855/73
WA044.2BXX.33N	974/38.3	350/13.8	N/A	N/A	N/A	280/11	1298/51.1	350/13.8	1855/73
WA046.1HXX.44C	1156/45.5	515/20.3	311/12.2	1486/58.5	560/22	N/A	N/A	N/A	1158/45.6
WA047.1HXX.44C	1156/45.5	515/20.3	311/12.2	1486/58.5	560/22	N/A	N/A	N/A	1258/49.5
WA048.1HXX.32N	974/38.3	350/13.8	N/A	N/A	N/A	277/10.9	1298/51.1	350/13.8	2365/93.1
WA048.1HXX.32S	533/21	1050/41.3	N/A	N/A	N/A	277/10.9	857/33.7	1050/41.3	1286/50.6
WA048.1HXX.33N	974/38.3	350/13.8	N/A	N/A	N/A	277/10.9	1298/51.1	350/13.8	2365/93.1
WA048.1HXX.33S	533/21	350/13.8	N/A	N/A	N/A	277/10.9	1298/51.1	350/13.8	1286/50.6
WA050.2BXX.22N	976/38.4	350/13.8	277/10.9	1296/51	350/13.8	N/A	N/A	N/A	1855/73
WA050.2BXX.23N	976/38.4	350/13.8	277/10.9	1296/51	350/13.8	N/A	N/A	N/A	1855/73
WA050.2BXX.33N	974/38.3	350/13.8	N/A	N/A	N/A	277/10.9	1298/51.1	350/13.8	1855/73
WA056.2BXX.44F	1142/45	305/12	311/12.2	1476/58.1	305/12	N/A	N/A	N/A	875/34.4
WA059.2BXX.44F	1142/45	305/12	311/12.2	1476/58.1	305/12	N/A	N/A	N/A	868/34.2
WA062.2BXX.22N	998/39.3	350/13.8	280/11	1274/50.2	350/13.8	N/A	N/A	N/A	1855/73
WA062.2BXX.32N	985/38.8	350/13.8	N/A	N/A	N/A	280/11	1287/50.7	350/13.8	1855/73
WA062.2BXX.33N	985/38.8	350/13.8	N/A	N/A	N/A	280/11	1287/50.7	350/13.8	1855/73
WA062.2BXX.42N	1016/40	270/10.6	280/11	1256/49.4	270/10.6	N/A	N/A	N/A	1855/73
WA074.3BXX.22N	998/39.3	350/13.8	280/11	1274/50.2	350/13.8	N/A	N/A	N/A	2463/97
WA084.3BXX.22N	998/39.3	350/13.8	277/10.9	1274/50.2	350/13.8	N/A	N/A	N/A	2469/97.2
WA088.2HXX.44F	1142/45	305/12	311/12.2	1476/58.1	305/12	N/A	N/A	N/A	1536/60.5
WA092.3BXX.22N	1193/47	420/16.5	310/12.2	1499/59	420/16.5	N/A	N/A	N/A	2487/97.9
WA092.3BXX.22S	622/24.5	1260/49.6	310/12.2	928/36.5	1260/49.6	N/A	N/A	N/A	2465/97
WA092.3BXX.33N	1181/46.5	420/16.5	N/A	N/A	N/A	310/12.2	1511/59.5	420/16.5	2487/97.9
WA092.3BXX.42N	1173/46.2	325/12.8	307/12.1	1466/57.7	300/11.8	N/A	N/A	N/A	2487/97.9
WA095.2HXX.32N	1154/45.4	420/16.5	N/A	N/A	N/A	310/12.2	1538/60.6	420/16.5	2109/83
WA095.2HXX.32S	583/23	1680/66.1	N/A	N/A	N/A	310/12.2	967/38.1	1680/66.1	1142/44.9
WA095.2HXX.33N	1154/45.4	420/16.5	N/A	N/A	N/A	310/12.2	1538/60.6	420/16.5	2109/83
WA096.2HXX.22N	1186/46.7	420/16.5	359/14.1	1506/59.3	420/16.5	N/A	N/A	N/A	2487/97.9

Table 4: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	y4	z4	x5	y5	z5	x6	y6	z6	Px
WA096.2HXX.22S	615/24.2	1260/49.6	359/14.1	935/36.8	1260/49.6	N/A	N/A	N/A	1528/60.2
WA096.2HXX.32N	1154/45.4	420/16.5	N/A	N/A	N/A	310/12.2	1538/60.6	420/16.5	2487/97.9
WA105.4BXX.22N	1193/47	420/16.5	310/12.2	1499/59	420/16.5	N/A	N/A	N/A	3130/123.2
WA105.4BXX.32N	1181/46.5	420/16.5	N/A	N/A	N/A	310/12.2	1511/59.5	420/16.5	3130/123.2
WA120.4BXX.22N	1186/46.7	420/16.5	359/14.1	1506/59.3	420/16.5	N/A	N/A	N/A	3130/123.2
WA120.4BXX.22S	615/24.2	1260/49.6	359/14.1	935/36.8	1260/49.6	N/A	N/A	N/A	2846/112.1
WA120.4BXX.24N	1186/46.7	420/16.5	359/14.1	1506/59.3	420/16.5	N/A	N/A	N/A	3130/123.2
WA125.3HXX.22N	1186/46.7	420/16.5	359/14.1	1506/59.3	420/16.5	N/A	N/A	N/A	3130/123.2
WA125.3HXX.22N	615/24.2	1260/49.6	359/14.1	935/36.8	1260/49.6	N/A	N/A	N/A	2396/94.3
WA140.3HXX.22N	1161/45.7	420/16.5	310/12.2	1531/60.3	420/16.5	N/A	N/A	N/A	1935/76.2
WA140.3HXX.22S	590/23.2	1260/49.6	310/12.2	960/37.8	1260/49.6	N/A	N/A	N/A	2396/94.3
WA150.5BXX.22F	1161/45.7	420/16.5	310/12.2	1531/60.3	420/16.5	N/A	N/A	N/A	1936/76.2
WA180.5BXX.22F	1250/49.2	457/18	358/14.1	1664/65.5	457/18	N/A	N/A	N/A	2078/81.8
WA190.4HXX.22L	1281/50.4	1071/42.2	360/14.2	1587/62.5	1071/42.2	N/A	N/A	N/A	2590/102
WA240.5HXX.22L	1274/50.2	1071/42.2	360/14.2	1594/62.8	1071/42.2	N/A	N/A	N/A	3267/128.6

Table 4: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS					
	DIMENSIONS (mm/in)					
	Py	Pz	RC1	RC2	RE1	RE2
WA021.1BXX.66C	1462/57.6	170/6.7	383/15.1	N/A	288/11.3	N/A
WA026.1BXX.44C	1462/57.6	170/6.7	438/17.2	N/A	238/9.4	N/A
WA027.1BXX.44N	1462/57.6	170/6.7	538/21.1	N/A	238/9.4	N/A
WA030.1BXX.44C	1462/57.6	170/6.7	438/17.2	N/A	338/13.3	N/A
WA030.1BXX.64C	1462/57.6	170/6.7	438/17.2	N/A	338/13.3	N/A
WA031.1BXX.44N	1462/57.6	170/6.7	438/17.2	N/A	238/9.4	N/A
WA044.2BXX.22N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA044.2BXX.32N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA044.2BXX.33N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA046.1HXX.44C	1736/68.3	195/7.7	482/19	N/A	343/13.5	N/A
WA047.1HXX.44C	1736/68.3	195/7.7	482/19	N/A	343/13.5	N/A
WA048.1HXX.32N	1462/57.6	170/6.7	1010/39.8	N/A	805/31.7	N/A
WA048.1HXX.32S	1637/64.5	33/1.3	2035/80.1	N/A	2392/94.2	N/A
WA048.1HXX.33N	1462/57.6	170/6.7	1010/39.8	N/A	805/31.7	N/A
WA048.1HXX.33S	1637/64.5	33/1.3	2035/80.1	N/A	2392/94.2	N/A
WA050.2BXX.22N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA050.2BXX.23N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA050.2BXX.33N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA056.2BXX.44F	1736/68.3	284/11.2	1407/55.4	N/A	1457/57.4	N/A
WA059.2BXX.44F	1736/68.3	284/11.2	1543/60.7	N/A	1543/60.7	N/A
WA062.2BXX.22N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA062.2BXX.32N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA062.2BXX.33N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA062.2BXX.42N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA074.3BXX.22N	1462/57.6	170/6.7	562/22.1	N/A	701/27.6	N/A
WA084.3BXX.22N	1462/57.6	170/6.7	568/22.4	N/A	701/27.6	N/A
WA088.2HXX.44F	1736/68.3	272/10.7	355/14	N/A	355/14	N/A
WA092.3BXX.22N	1736/68.3	196/7.7	562/22.1	N/A	690/27.2	N/A
WA092.3BXX.22S	1736/68.3	31/1.2	2093/82.4	N/A	2062/81.2	N/A
WA092.3BXX.33N	1736/68.3	196/7.7	562/22.1	N/A	690/27.2	N/A
WA092.3BXX.42N	1736/68.3	196/7.7	562/22.1	N/A	690/27.2	N/A
WA095.2HXX.32N	1736/68.3	196/7.7	538/21.2	N/A	343/13.4	N/A
WA095.2HXX.32S	1777/70	33/1.3	2652/104.4	N/A	2857/112.5	N/A
WA095.2HXX.33N	1736/68.3	196/7.7	538/21.2	N/A	343/13.4	N/A
WA096.2HXX.22N	1736/68.3	196/7.7	962/37.9	N/A	943/37.1	N/A

Table 4: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS					
	DIMENSIONS (mm/in)					
	Py	Pz	RC1	RC2	RE1	RE2
WA096.2HXX.22S	1777/70	33/1.3	2738/107.8	N/A	2657/104.6	N/A
WA096.2HXX.32N	1736/68.3	196/7.7	962/37.9	N/A	943/37.1	N/A
WA105.4BXX.22N	1736/68.3	196/7.7	1097/43.2	N/A	1347/53	N/A
WA105.4BXX.32N	1736/68.3	196/7.7	1097/43.2	N/A	1347/53	N/A
WA120.4BXX.22N	1736/68.3	196/7.7	1097/43.2	N/A	1147/45.2	N/A
WA120.4BXX.22S	1777/70	33/1.3	1097/43.2	N/A	793/31.2	N/A
WA120.4BXX.24N	1736/68.3	196/7.7	1097/43.2	N/A	1147/45.2	N/A
WA125.3HXX.22N	1736/68.3	196/7.7	652/25.7	N/A	643/25.3	N/A
WA125.3HXX.22N	1777/70	33/1.3	3562/140.2	N/A	3357/132.2	N/A
WA140.3HXX.22N	1736/68.3	196/7.7	588/23.1	N/A	445/17.5	250/9.8
WA140.3HXX.22S	1777/70	33/1.3	3652/143.8	N/A	3855/151.8	4155/163.6
WA150.5BXX.22F	1736/68.3	272/10.7	545/21.5	795/31.3	545/21.5	795/31.3
WA180.5BXX.22F	1884/74.2	272/10.7	1651/65	1951/76.8	1353/53.5	1651/65
WA190.4HXX.22L	1568/61.7	145/5.7	3277/129	3577/140.8	3247/127.8	3497/137.7
WA240.5HXX.22L	1568/61.7	145/5.7	3012/118.6	3812/150.1	3047/120	3897/153.4

Table 4: Chiller Dimensions By Model (cont'd)

ELECTRICAL

FIELD WIRING

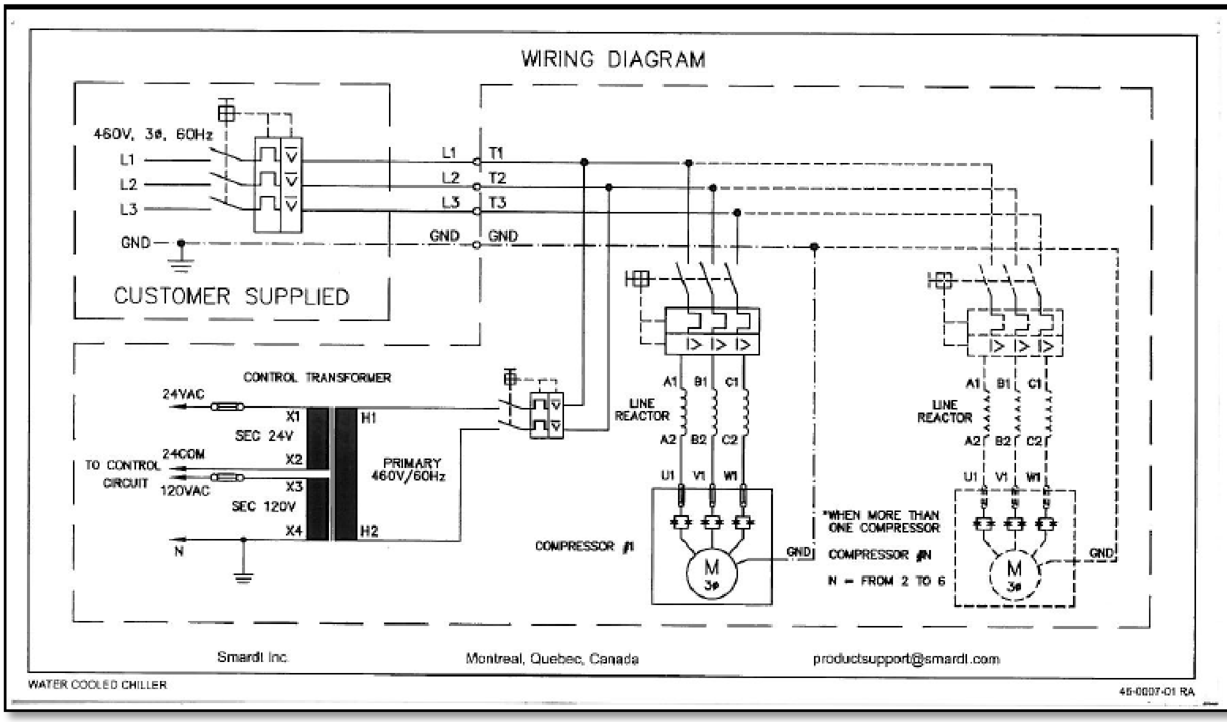


Figure 5: Field Wiring for 460V Water Cooled Chiller

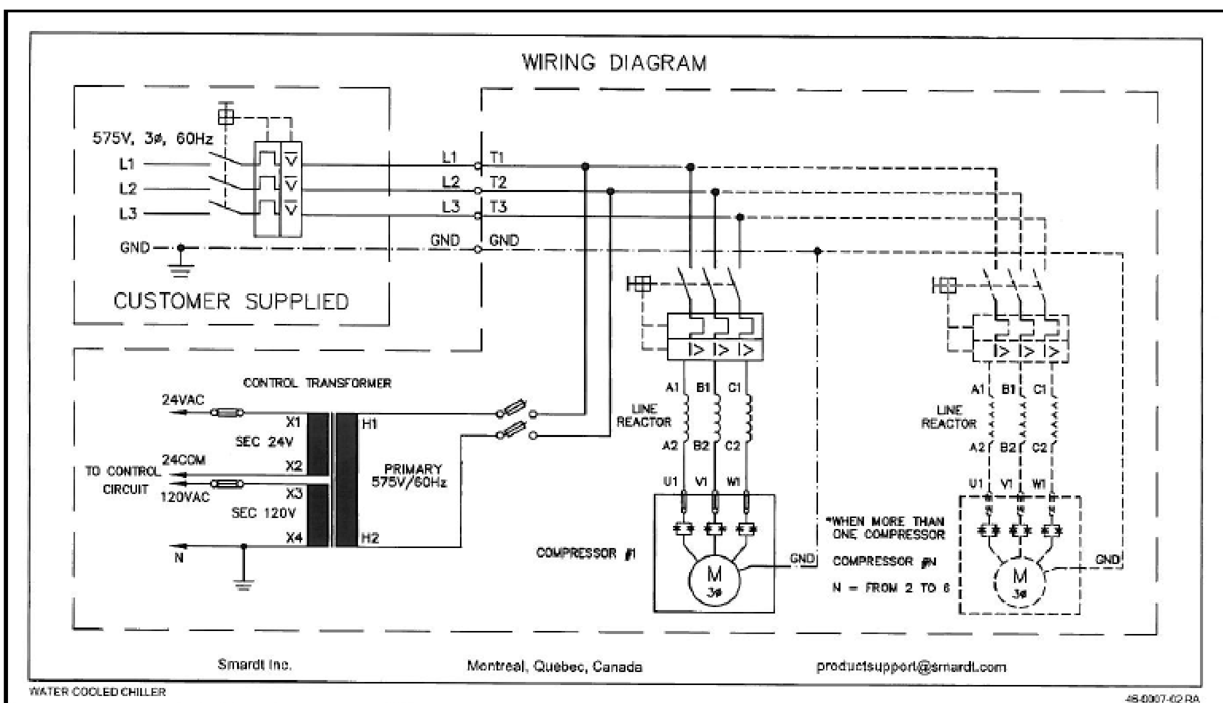


Figure 6: Field Wiring for 575V Water Cooled Chiller

ELECTRICAL RATINGS

ELECTRICAL RATING - WATERCOOLED - **TT300 460V 60Hz**							
CHILLER	COMP. - TT300		CHILLER				
	QTY	MODEL	MCA (A)	MOP (A)	MDS (A)	MFW-C	MFW-U
WA021.1BXX.XXX, WA026.1BXX.XXX, WA027.1BXX.XXX, WA030.1BXX.XXX, WA031.1BXX.XXX	1	G2	90	150	83	3	4
		G3	100	175	92	3	3
		G4	125	225	115	1	2
		G6	150	250	138	1/0	1
		G7	169	300	155	2/0	1/0
WA044.2BXX.XXX, WA050.2BXX.XXX, WA056.2BXX.XXX, WA059.2BXX.XXX, WA062.2BXX.XXX	2	G2	162	225	166	2/0	1/0
		G3	180	250	184	2/0	2/0
		G4	225	300	230	4/0	3/0
		G6	270	350	276	300	250
		G7	304	400	311	350	300
WA074.3BXX.XXX, WA084.3BXX.XXX, WA092.3BXX.XXX	3	G2	234	300	248	4/0	4/0
		G3	260	300	276	250	4/0
		G4	325	400	345	350	350
		G6	390	500	414	2 x 3/0	2 x 2/0
		G7	439	500	466	2 x 4/0	2 x 3/0
WA105.4BXX.XXX, WA120.4BXX.XXX	4	G2	306	350	331	350	300
		G3	340	400	368	400	350
		G4	425	500	460	2 x 4/0	2 x 3/0
		G6	510	600	552	2 x 250	2 x 4/0
		G7	574	700	621	2 x 300	2 x 250
WA150.5BXX.XXX	5	G2	378	450	414	500	400
		G3	420	500	460	2 x 3/0	2 x 3/0
		G4	525	600	575	2 x 250	2 x 250
		G6	630	700	690	2 x 350	2 x 300
		G7	709	800	776	2 x 500	2 x 400
WA180.6BXX.XXX	6	G2	450	500	497	2 x 4/0	2 x 3/0
		G3	500	500	552	2 x 250	2 x 4/0
		G4	625	700	690	2 x 350	2 x 300
		G6	750	800	828	2 x 500	2 x 400
		G7	844	900	932	2(2 x 300)	2(2 x 250)
MDS: MINIMUM DISCONNECT SIZE RATING							
MFW: MINIMUM FIELD WIRING SIZE - C: Canada / U: USA - BASED ON **COPPER / 90°C** (AWG / kcmil)							

Table 7: Electrical Ratings

ELECTRICAL RATING - WATERCOOLED - **TT400 460V 60Hz**							
CHILLER	**COMP. - TT400**		**CHILLER**				
	QTY	MODEL	MCA (A)	MOP (A)	MDS (A)	MFW/**90°C**	MFW/**75°C**
WA046.1HXX.XXX, WA047.1HXX.XXX, WA048.1HXX.XXX	1	G4	125	225	115	2	1
		G5	138	225	127	1	1/0
		G6	150	250	138	1	1/0
		G8	175	300	161	2/0	2/0
		G9	188	300	173	2/0	3/0
WA088.2HXX.XXX, WA095.2HXX.XXX, WA096.2HXX.XXX	2	G4	225	300	230	3/0	4/0
		G5	248	350	253	4/0	250
		G6	270	350	276	250	300
		G8	315	450	322	300	400
		G9	338	450	345	350	500
WA125.3HXX.XXX, WA140.3HXX.XXX	3	G4	325	400	345	350	400
		G5	358	450	380	400	500
		G6	390	500	414	2 x 2/0	2 x 3/0
		G8	455	500	483	2 x 4/0	2 x 4/0
		G9	488	600	518	2 x 4/0	2 x 250
WA190.4HXX.XXX	4	G4	425	500	460	2 x 3/0	2 x 4/0
		G5	468	500	506	2 x 4/0	2 x 250
		G6	510	600	552	2 x 4/0	2 x 250
		G8	595	700	644	2 x 300	2 x 350
		G9	638	700	690	2 x 300	2 x 400
WA240.5HXX.XXX	5	G4	525	600	575	2 x 250	2 x 300
		G5	578	600	633	2 x 250	2 x 350
		G6	630	700	690	2 x 300	2 x 400
		G8	735	800	805	2 x 400	2 x 500
		G9	788	800	863	2(2 x 4/0)	2(2 x 250)
WA280.6HXX.XXX	6	G4	625	700	690	2 x 300	2 x 400
		G5	688	700	759	2 x 350	2 x 500
		G6	750	800	828	2 x 400	2 x 500
		G8	875	1000	966	2(2 x 4/0)	2(2 x 250)
		G9	938	1000	1035	2(2 x 4/0)	2(2 x 250)
MDS: MINIMUM DISCONNECT SIZE RATING							
MFW: MINIMUM FIELD WIRING SIZE: BASED ON COPPER (AWG / kcmil)							

Table 8: Electrical Ratings (cont'd)

ELECTRICAL RATING - WATERCOOLED - **TT300 575V 60Hz**							
CHILLER	**COMP. - TT300**		**CHILLER**				
	QTY	MODEL	MCA (A)	MOP (A)	MDS (A)	MFW/**90°C**	MFW/**75°C**
WA021.1BXX.XXX, WA026.1BXX.XXX, WA027.1BXX.XXX, WA030.1BXX.XXX, WA031.1BXX.XXX	1	F2	80	125	74	4	4
		F3	90	150	83	3	3
		F4	100	175	92	3	3
		F5	113	200	104	2	2
		F6	125	225	115	1	1
		F7	138	225	127	1	1/0
WA044.2BXX.XXX, WA050.2BXX.XXX, WA056.2BXX.XXX, WA059.2BXX.XXX, WA062.2BXX.XXX	2	F2	144	200	147	1/0	1/0
		F3	162	225	166	2/0	2/0
		F4	180	250	184	2/0	3/0
		F5	203	250	207	3/0	4/0
		F6	225	300	230	4/0	4/0
		F7	248	350	253	250	250
WA074.3BXX.XXX, WA084.3BXX.XXX, WA092.3BXX.XXX	3	F2	208	250	221	3/0	4/0
		F3	234	300	248	4/0	250
		F4	260	300	276	250	300
		F5	293	350	311	300	350
		F6	325	400	345	350	400
		F7	358	450	380	500	500
WA105.4BXX.XXX, WA120.4BXX.XXX	4	F2	272	300	294	300	300
		F3	306	350	331	350	350
		F4	340	400	368	400	500
		F5	383	450	414	2 x 3/0	2 x 3/0
		F6	425	500	460	2 x 4/0	2 x 4/0
		F7	468	500	506	2 x 4/0	2 x 250
WA150.5BXX.XXX	5	F2	336	400	368	400	500
		F3	378	450	414	500	500
		F4	420	500	460	2 x 3/0	2 x 4/0
		F5	473	500	518	2 x 250	2 x 250
		F6	525	600	575	2 x 250	2 x 300
		F7	578	600	633	2 x 300	2 x 350
WA180.6BXX.XXX	6	F2	400	450	442	2 x 3/0	2 x 3/0
		F3	450	500	497	2 x 4/0	2 x 4/0
		F4	500	500	552	2 x 250	2 x 250
		F5	563	600	621	2 x 300	2 x 300
		F6	625	700	690	2 x 350	2 x 400
		F7	688	700	759	2 x 400	2 x 500
MDS: MINIMUM DISCONNECT SIZE RATING							
MFW: MINIMUM FIELD WIRING SIZE: BASED ON COPPER (AWG / kcmil)							

Table 9: Electrical Ratings (cont'd)

ELECTRICAL, INSTALLATION

GENERAL

All applicable codes should be adhered to. The Limited Product Warranty does not cover damaged equipment caused by wiring non-compliance, an open fuse resulting from an overload, a short, or a ground. Correct the cause of the open fuse before replacing the fuse and restarting the compressor.

Compressor motors are designed to operate satisfactorily over a range of ± 10 percent of the standard design voltage.

ELECTRICAL WIRING

All electrical wiring connecting to the unit should be made of copper.

All wiring must be installed in accordance with appropriate local and national electrical codes, and will require a circuit breaker or fuses to protect the main wiring run from the final distribution sub-board to the unit.

According to specific model and/or option selected, field wiring connections will require either one or two supply conductors in parallel.

Each SMARDT Chiller is provided with a 3 pole power distribution block or busbar system, splitting field supply main power into multiple secondary circuits.

Ground lugs are located next to field wiring terminals for equipment grounding.

Minimum required bending space at terminals and means for strain relief of supply conductors, shall be provided by installation contractor to prevent leads separating from their terminations, or subjecting them to damage from sharp edges.
All electrical wiring connecting to the unit shall only be made of copper and shall be shielded and grounded. It is assumed that supply conductors rated 75°C (167°F) will be used in determining the size of terminals.

The main power input connection for the SMARDT range of chillers is a single point termination via a main termination box (supplied as standard) on each chiller unit. All power wiring from this point on, is the responsibility of the installation contractor. From the main termination box, each compressor control box (power and controls) is pre-wired to the individual compressors.

All wiring must be installed in accordance with appropriate local and national electrical codes, and will require a circuit breaker or fuses to protect the main wiring run from the final distribution sub-board to the unit.

DESCRIPTION OF OPERATION

WATER COOLED CHILLER CYCLE

Controls – Cooling Cycle Operation:

When the SMARDT chiller control system is set to “HVAC_COOL” mode, indicating the chiller is to be used to control the leaving chilled water temperature (LCWT) to a desired value, the following description of operation is true:

EVAPORATOR DESCRIPTION

When the chiller is operated in cooling mode, the condensed liquid refrigerant exits the electronic expansion valve (4) Figure 10, and enters the bottom of the flooded evaporator, where it is evenly dispersed along the length of the evaporator by the use of a distributor plate (3). Liquid refrigerant inside the evaporator at low pressure then makes contact with the copper tubes that the building’s water runs through, exchanges heat to the refrigerant, and vaporizes it (2) at the suction pressure of the compressor (1). As a result of the lower density of the vapor and the suction of the compressor, the vaporized refrigerant gas is then drawn to the top of the evaporator through the mist eliminators (5). (Mist eliminators inhibit minute liquid particles entrained in the vaporized refrigerant, from entering the compressor). Passing through the (pre-rotation) inlet guide vanes (6), the vaporized refrigerant then enters the compressor inlet (7), where the angle of incidence of the refrigerant hitting the first stage impeller, is altered, thereby allowing a higher compression efficiency for a given compressor rotor speed.

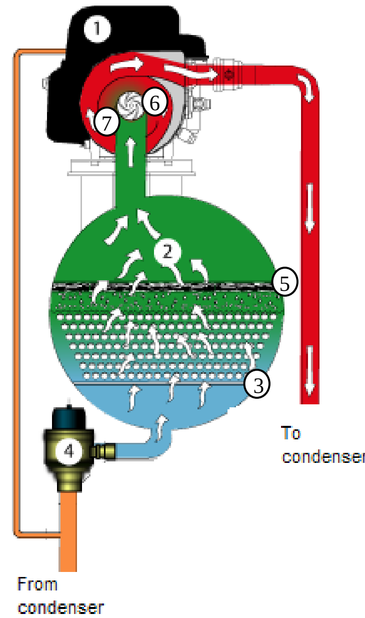


Figure 10: Evaporator Refrigerant Flow

COMPRESSOR DESCRIPTION

SMARDT oil free chillers exclusively use Turbocor variable speed magnetic bearing compressors (Figure 11) on all chillers. All of the Turbocor compressors are a two stage design, meaning the compression of the vapor refrigerant takes place through two impellers.

Figure 11: Turbocor Compressor - External View

The refrigerant enters the suction side of the compressor as a low-pressure, low-temperature, super-heated gas - ref Figure 12, (1). The refrigerant gas passes through a set of adjustable inlet guide vanes (IGV) (2) that are used to control the compressor capacity at low load conditions.

The first compression element that the gas encounters is the first-stage impeller (3), and the centrifugal force produced by the rotating impeller results in an increase in both gas velocity and pressure. The high-velocity gas discharging from the impeller is directed to the second stage impeller (4) through de-swirl vanes (5). The gas is further compressed by the second stage impeller and then discharged through a volute (6) via a vane-less diffuser (7). (A volute is a curved funnel increasing in area to the discharge port. As the area of the cross-section increases, the volute reduces the speed of the gas and increases its pressure.) From there, the high-pressure/high temperature gas exits the compressor at the discharge port (8).

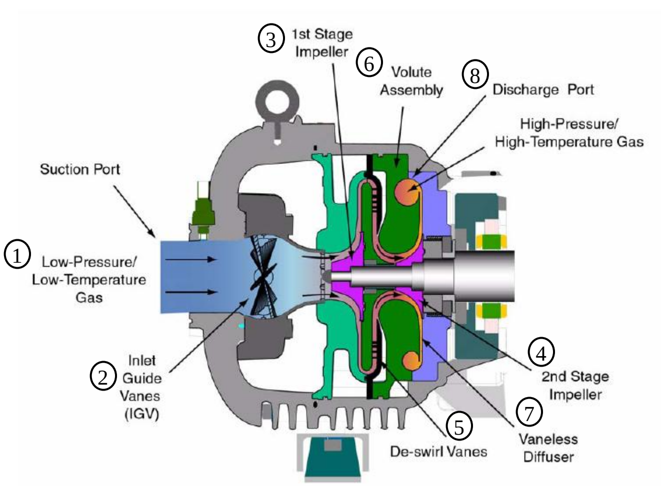


Figure 12: Turbocor Compressor Cross Section

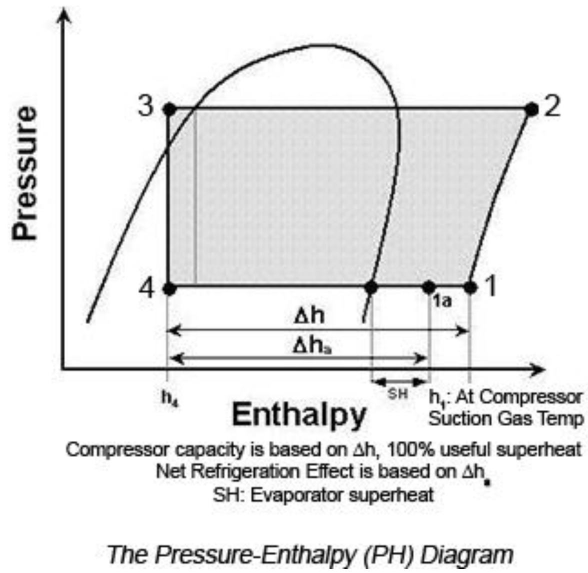


Figure 13: Pressure v Enthalpy

Capacity control on SMARDT chillers is achieved by varying the speed, inlet guide vane position, and number of operating compressors. Figure 14 provides a graphical representation of the centrifugal compressor's response to demand and operating conditions.

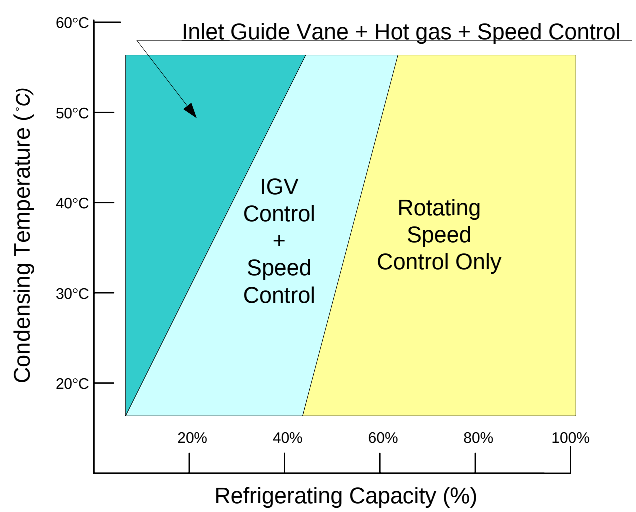


Figure 14: Graphic Representation of Capacity Control

CONDENSER DESCRIPTION

Superheated refrigerant from the compressor enters at the top of the condenser barrel where it is dispersed by a deflection plate. As the refrigerant is moving around the tubes in the condenser, heat is being constantly removed from the refrigerant and dissipated to the cooling water that is moving through the condenser tubes.

HOT GAS VALVE CONTROL

The hot gas valve provides the following functionality:

- Capacity control at low load.
- Assisted pressure ratio relief for starting new compressors.
- Head pressure relief for heat pump and air cooled chillers operating above design conditions.

Low Load Capacity Control Functionality

Hot gas control of leaving water temperature (LWT) is a last resort method of control when speed control and inlet guide vane control is no longer an option. The hot gas valve control uses the compressor's *IGV%* surge. Choke and actual rpm determine when to use the hot gas valve for capacity control.

The set point for the hot gas control is a differential temperature below the leaving temperature set point. By using a differential temperature, the hot gas control set point automatically adjusts with a change in supply temperature set point for the chiller, such that it is easy to implement alongside set point reset strategies.

As the diagram in Figure 14 shows, the hot gas valve is only used once the compressors have used up all speed and *IGV* control envelopes. If the chiller's capacity must be increased, and the hot gas valve is in the open position, the valve will close before adjustment is made for increased compressor demand.

It should be noted that the hot gas capacity control of SMARDT air cooled chillers, only takes place when the last compressor is operating. The chiller control system makes best use of compressor staging before resorting to hot gas control. Under normal air conditioning loads where the outside air temperature and the heat load applied to the chiller are closely related, it is not uncommon for the hot gas capacity control valve never to be used.

Assisted Pressure Ratio Relief

Major reasons for requiring pressure ratio relief when turning on one or more additional compressors within a refrigerant circuit where compressors are already operating, are:

- To avoid rapid rotor displacement - which is an inherent weakness of all centrifugal compressors which do not incorporate pressure ratio unloading.

  To reduce the potential of rotating component damage.

  High dynamic forces can impact traditional bearing technology significantly. With the incorporation of the revolutionary magnetic bearing design used in the Turbocor compressor on SMARDT chillers, the potential for rotating component damage is greatly reduced, in that shutdown can occur before any surface impact takes place.

- Instability, as the compressor overcomes the system pressure and begins to open the discharge check valve.

  The danger of holding ramp up conditions without flow, for an extended period of time:

  - All energy transferred to the compressor, has no outlet, and results in high internal temperatures.

– Large sudden amperage spikes on the inverter can be dangerous, due to low thermal inertia on Inert Gate By-polar Transistors (IGBT). The higher the head that must be overcome, the higher the amperage spikes.

Control Strategy

The assisted hot gas bypass start up is enabled whenever the chiller enters the “STAGE UP” mode, and the pressure ratio calculated from the highest discharge pressure and lowest suction pressure of all compressors online, is above a configured limit default pressure ratio of 2.2.

If hot gas pressure ratio assistance is required, the hot gas valve is forced open at 1% per second, until the pressure ratio is reduced below the limit at which the next compressor is start enabled. Once the new compressor has started and is running within 10% of the speed of the other compressors, the hot gas valve is closed slowly at a rate of 0.5% per second.

Return Water Control

Occasionally, instead of supplying chilled water control, SMARDT chillers are selected to provide return water temperature control in a plant. Return water temperature control allows the leaving chilled water set point to automatically float with the actual building load. Running higher leaving chilled water temperatures permits a higher chiller performance - an efficiency increase of approximately 3% per 0.5°C (1°F) increase in set point is possible (ref. Figure 15 - Power Consumption v Load graph shown below).

Selecting “HVAC_RET” mode on the chiller’s graphical touch pad interface will enable control from the return water temperature. All alarm and fault trip points are active in this mode, and extra care must be taken when selecting a return water temperature to run, to avoid driving the chiller into low suction pressure or low leaving chilled water faults. SMARDT suggests a set point of 10°C (50°F) to 15.5°C (60°F).

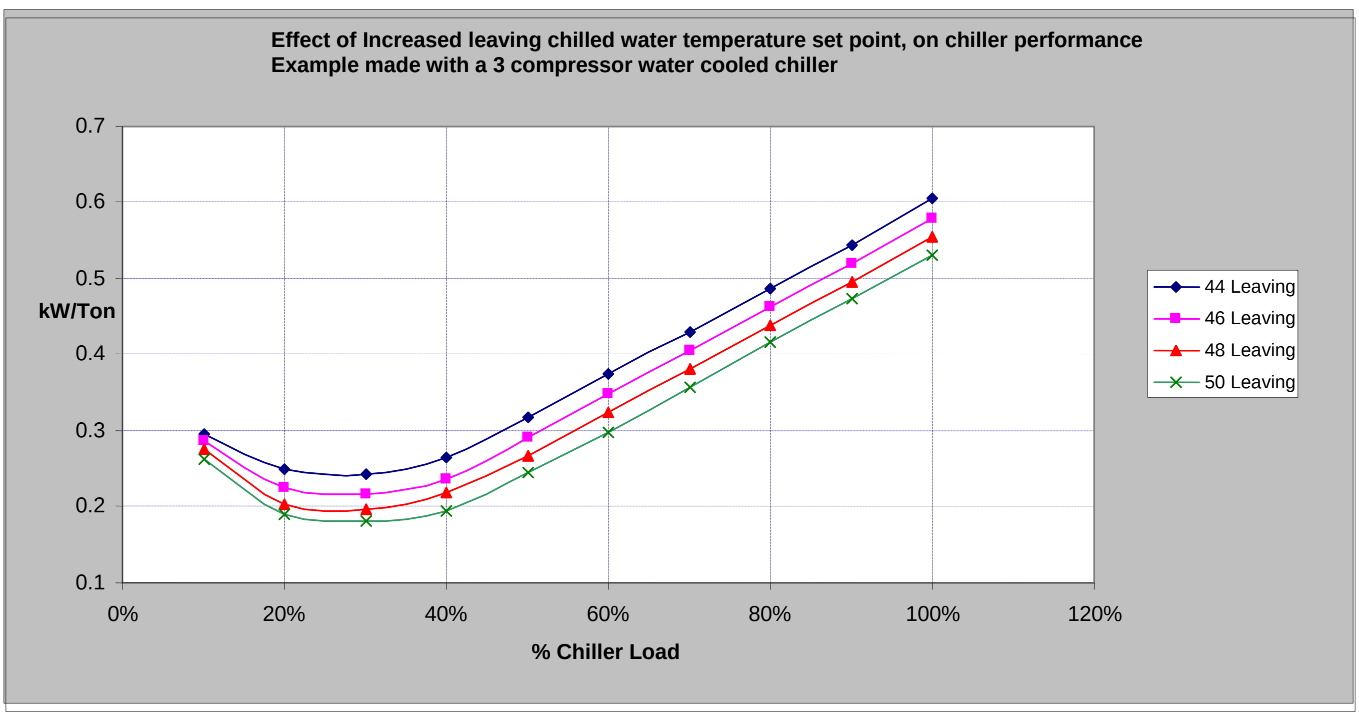


Figure 15: Power Consumption v Load

CHILLED WATER SYSTEM

EVAPORATOR WATER CIRCUITS

Chiller performance and efficiency can be adversely affected by contaminants in the water circuits, and such contaminants could impede or block the flow of water through the circuit or reduce the performance of the heat exchanger.

Strainers should be located on the inlet side of the evaporator, return water to the chiller must be connected to the lower connection of the evaporator, and all external water piping must be cleaned or flushed before being connected to the chiller set.

Water circuits should be arranged so that pumps discharge through the evaporator and are controlled as necessary, to maintain essentially constant chiller water flows through the unit at all load conditions.

To ensure the chiller's performance and longevity, air must be purged from both water boxes on the evaporator, and from the entire water circuit.

CHILLED WATER PUMPS

Make all connections prior to filling with water. Run a preliminary leak check before insulating the pipes and filling with water. SMARDT recommends consulting authorities in order to be compliant with local building codes and safety regulations.

Additional considerations, as follows, should be made when designing the piping system:

- All piping systems should include temperature and pressure measures at the evaporator. Make these connections prior to filling with water.
- Water pressure should be maintained throughout the system. Install regulating valves or comparable pressure maintenance devices.
- The piping system should be designed with a minimum number of elevation and directional changes in order to minimize system pressure drop.
- To prohibit debris from entering the pump, a strainer should be installed at the water supply line, and ahead of (before) the pump.
- Piping made to and from the chiller water connections and pressure relief valves, must be made in such a way that weight and strain is removed from the chiller connections. All chilled water piping attached to chiller connections, should be adequately insulated. Strainers with 20 mesh filters, should be installed upstream of the evaporator .
- Adequate valving should be supplied to permit draining of water from the evaporator.
- Install vibration eliminators to reduce vibration transmission to the building.
- Install air valves at the system high points and drain valves at the system low points. Additionally, shutoff valves should be installed for unit servicing.

- Protect water from freezing by insulating water piping. Ensure there is a vapor barrier on the outside of the insulation, in order to protect from pipe condensation within the insulation.

Note: If glycol or propylene is added for freeze protection, this will cause a pressure drop, which may then result in the loss of performance. Only use glycol with factory approval.

WATER VOLUME

When designing the chilled water system, consider:

- The minimum cooling load.
- The minimum plant capacity during a low load period.
- The desired cycle time for the compressor.
- If the chiller plant has a reasonable turndown, the water volume should be two to three times the chilled water gpm flow rate. If the system components do not provide the required water volume, add a storage tank.

VARIABLE WATER FLOW

A large range of SMARDT chillers are well suited to installations where the chilled water and condenser water flow rates are changed in the chiller, relative to the instantaneous building load and outdoor conditions. When applying SMARDT chillers to variable volume (variable speed) pumping applications, the designer must make sure SMARDT's design parameters are met as follows:

1. That water flow shall not be altered at a rate greater than 10% per minute.

2. That the water flow rates shall not exceed the maximum and minimum flows detailed in the chiller selection sheet.

Variable speed pumping is a design feature of the SMARDT water-cooled chiller, which reduces the water flow through the evaporator as the load decreases. This feature will function successfully if the design and minimum flow rates are not exceeded. Check individual rating sheets for maximum and minimum flow rates.

OPERATING LIMITS

- Maximum standby ambient temperature = 54°C (130°F)
- Maximum operating ambient temperature = 41°C (105°F)
- Minimum operating ambient temperature (standard) = 3°C (38°F)
- Minimum operating ambient temperature (operational low-ambient control) = -10°C (14°F)
- Leaving chilled water temperature (LCWT) = 3°C to 16°C (38°F to 60°F)
  Operating ΔT = 3K to 9K (6°F to 16°F)
- Maximum operating inlet fluid temperature = 24°C (76°F)

- Maximum startup inlet fluid temperature = 32°C (90°F)
- Maximum non-operating inlet fluid temperature = 38°C (100°F)

FLOW SWITCH

A flow switch for the chilled water system is necessary to ensure adequate water flow to the evaporator before starting the unit. Prior to starting the unit, and to ensure adequate water flow to the evaporator, it is necessary to install a flow switch for the chilled water system. A flow switch will guard against possible evaporator freezing, should water flow be interrupted. The flow switch is to be field installed in the chilled water piping and wired to the control panel by the installation contractor.

HIGH PRESSURE & LOW PRESSURE SWITCHES

The High Pressure (HP) & Low Pressure (LP) switches provide an additional safety feature, which prevents overpressure or water freezing. The cut-off pressures for the HP and LP switches are as follows:

HP: 1586 kPa (230 psig) (≈ 60°C / 140°F), reset at 1276 kPa (185 psig) (≈ 52°C / 125°F) (installed on discharge header)

LP: 179 kPa (26 psig) (≈ -1.7°C / 29°F), reset at 345 kPa (50 psig) (≈ 12.2°C / 54°F), (installed on the evaporator, except for low ambient/glycol applications, where the LP switch is not installed).

RELIEF VALVES

Ensure relief valves vent outside a building in accordance with national safety regulations and jurisdictional requirements. Concentrations of refrigerant in enclosed spaces can displace oxygen and lead to asphyxiation. Do not displace any safety devices.

RELIEF VALVE CHARACTERISTICS

The following table gives SMARDT Pressure Relief Valve parameters for the noted chiller model. Refer to SMARDT specification for other model specific values.

R134A SMARDT Chiller with Safety Master relief valves				
	EVAPORATOR		CONDENSER	
	Dual relief valves (2)		Dual relief valves (2)	
	Set pressure 1317 kPa (191 PSIG)		Set pressure 1317 kPa (191 PSIG)	
TAG	(C_r) min kg/min (lbs/min)	Outlet size (NPT)	(C_r) min kg/min (lbs/min)	Outlet size (NPT)
WA031.1BXX.44N	**14.0 (30.8)**	**25.4mm (1")**	**6.3 (13.9)**	**19mm (3/4")**

Table 10: Pressure Relief Valve Parameters

SMARDT Water Cooled chillers are supplied with dual pressure relief valves mounted on the evaporator. The valves are connected to a changeover manifold. Using a common body chamber that serves as the base for two independent relief valves, a system can remain fully operational when valves need to be serviced and replaced.

All pressure relief valves on SMARDT chillers have been sized, selected and supplied in accordance with ASHRAE 15 and the ASME unfired pressure vessel code. All discharge rates
are certified by the National Board of Boiler and Pressure Vessel Inpectors.

RELIEF VALVE APPLICATION

The ASHRAE 15 Safety Standard for Refrigeration Systems provides guidelines for sizing refrigerant relief valves and vent piping. Without attempting to provide a complete and thorough interpretation, this document provides the necessary data to properly determine piping requirements.

VENT LINE SIZING

Piping. ASHRAE 15-2004, Section 9.7.8 outlines acceptable relief piping locations and sizing. Summarized, the relief piping should vent R-134a refrigerant at least 15 feet above ground level and at least 20[1] feet from any window, ventilation opening, or building exit. The discharge piping should prevent a discharged refrigerant from being sprayed directly on personnel and prevent foreign material or debris from entering the piping. Additionally, discharge piping for a fusible plug or rupture disc shall have provisions to prevent plugging the pipe in the event of a discharge by the plug or disc.

As indicated in SMARDT Installation Instructions (Form 160.73-N1), each vent line must contain a dirt trap in the vertical section to allow collection and removal for any stack condensation or debris. The piping MUST be arranged to avoid strain on the relief valves - *SMARDT recommends the use of a flexible connector*. The vent line should be sized in accordance with ANSI/ASHRAE 15, and local codes, but should never be smaller than the relief valve outlet sizes provided in specific chiller documentation.

Common Header. ASHRAE 15 section 9.7.8.4 allows for multiple relief devices (on the same or multiple units) to be connected into a common line or header. The sizing of the common discharge header and vent piping for relief devices - expected to operate simultaneously - shall be based on the sum of their outlet areas, with due allowance for the pressure drop in all downstream sections and

back-pressure resulting from the discharge of multiple relief devices.

Maximum Length. ASHRAE 15 section 9.7.8.5 and Appendix H define the maximum length of discharge piping downstream of the pressure-relief device as:

$$L = \frac{0.2146 d^5 (P_0^2 - P_2^2)}{f C_r^2} - \frac{d \times \ln(P_0 / P_2)}{6 f}$$

[feet]Eq. (2)a

$$L = \frac{7.4381 \times 10^{-15} d^5 (P_0^2 - P_2^2)}{f C_r^2} - \frac{d \times \ln(P_0 / P_2)}{500 f}$$

[meters] Eq.(2)b

Where:

L = equivalent length of discharge piping, m (ft)
C_r = rated capacity as stamped on the device in kg/sec (lb/min)
f = moody friction factor in fully turbulent flow
d = inside diameter of pipe or tube, mm (inches)
ln = natural logarithm
P_2 = absolute pressure at the outlet of discharge piping, kPa (psia)
P_0 = allowed back pressure (absolute) at the outlet of pressure release device, kPa (psi) = (0.15 x relief valve set pressure + atmospheric pressure)

The ASHRAE 15 users manual states that when the length of the vent pipe exceeds approximately 220 diameters (L/d > 220), the first term in equation (2)a or (2)b may be used to solve for the diameter, d.

$$d = 1.36 \times \left(\frac{fLC_r^2}{P_0^2 - P_2^2} \right)^{0.2}$$ [inches] Eq. (3)a

$$d = 2521 \times \left(\frac{fLC_r^2}{P_0^2 - P_2^2} \right)^{0.2}$$ [millimeters] Eq. (3)b

An average friction factor f = 0.02, may be used when the pipe size is not known.

This section on the discharge vent line is to be used as a guide only. For a complete description of the relief valve vent line sizing, please refer to ASHRAE Standard 15 or local overriding codes.

[1]CSAB-52 requires 25' from any opening.

CONTROLS

CONTROLS WIRING

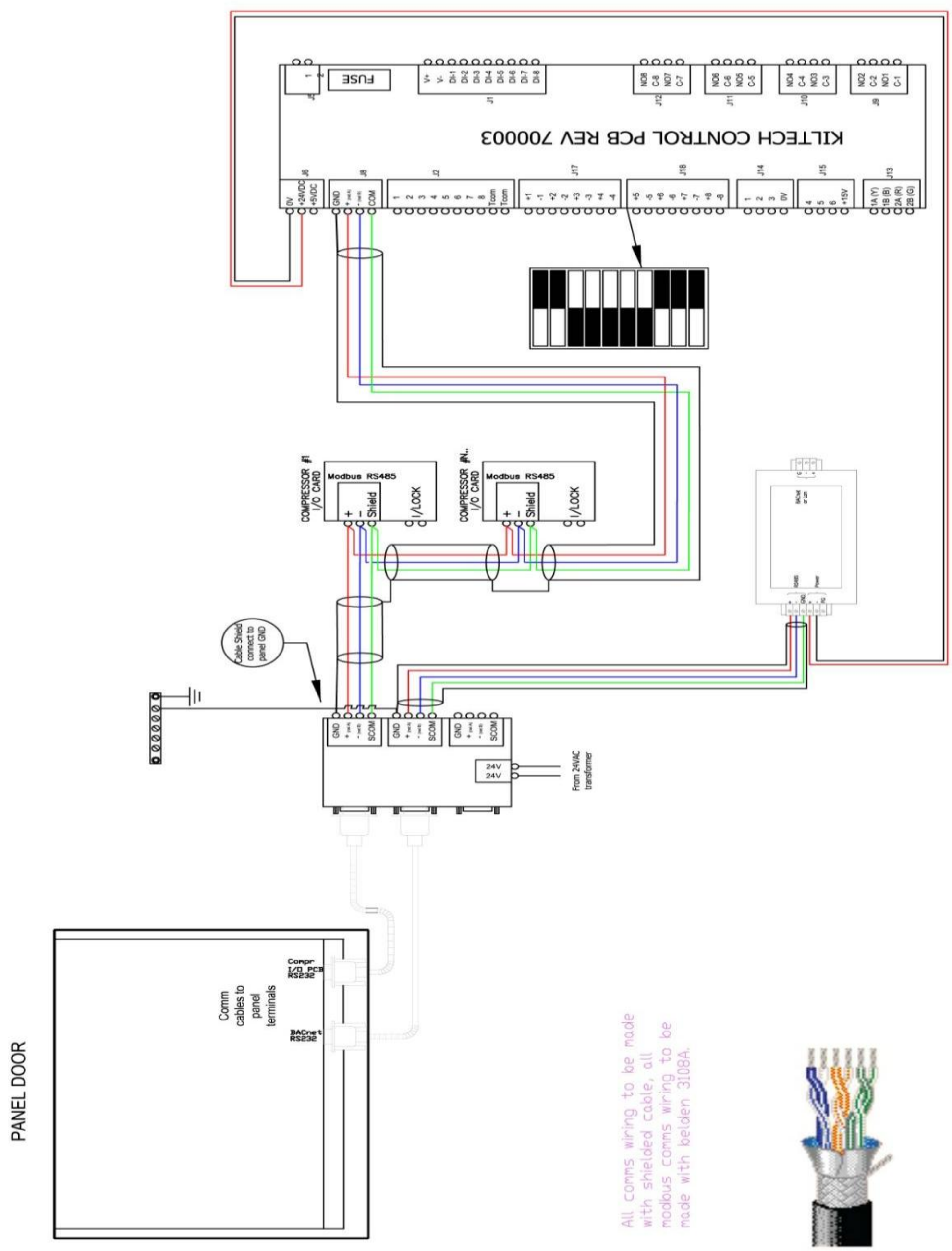


Figure 16: G3 Controls Wiring Diagram – Optical Isolated Converter – G3 Touch Panel

CONTROL PANEL WIRING

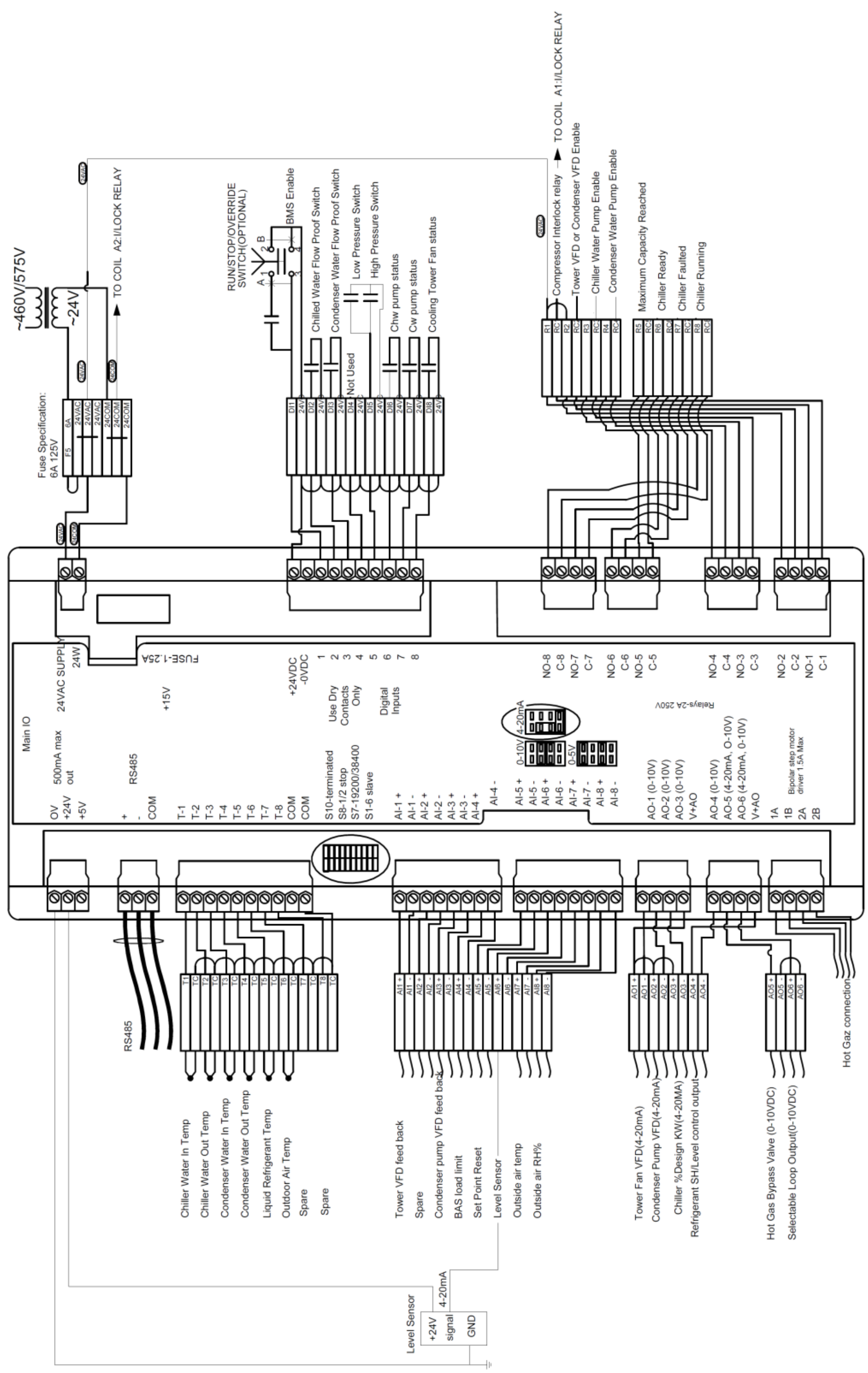


Figure 17: Control Panel Wiring Schematic – 460V/575V

Control Panel Wiring (cont'd)

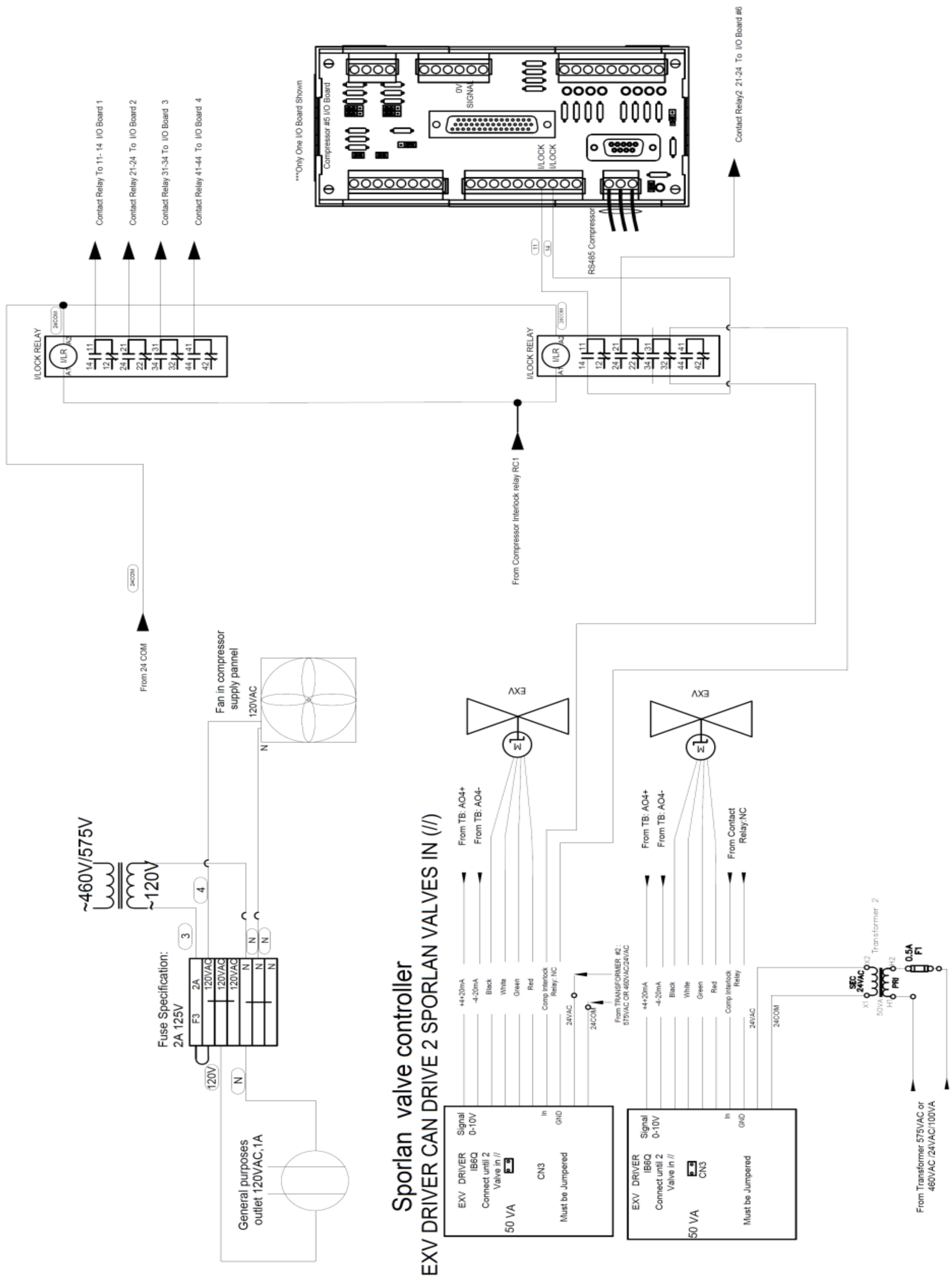


Figure 18: Control Panel Wiring Schematic (cont'd) – 460V/575V

SPECIFICATIONS – SMARDT WATER COOLED CHILLERS

GENERAL

1.1 SUMMARY

This section includes design, performance criteria, refrigerants, controls, and installation requirements for water-cooled centrifugal chillers.

1.2 REFERENCES

Compliance is with the following codes and standards:

AHRI 550/590
ANSI/ASHRAE 15
ASME Section VIII
ETL Listed
ANSI UL 1995
CSA C22.2 No. 236 (Canada)
MEPS (Australia)

1.3 SUBMITTALS

Submittals shall include the following:

A. Dimensioned plan and elevation drawings, including required service clearances and location of all field piping and electrical connections.

B. Electrical and water quality requirements during operation, standby and shutdown.

C. Control system diagram showing points for field interface and connection to external BMS systems. Drawings shall show field and factory wiring.

D. Installation and Operating Manuals.

E. Manufacturers certified performance data as per AHRI at full load and IPLV or NPLV.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Compliance with the standards in Section 1.2.

1.5 DELIVERY AND HANDLING

A. Chillers shall be delivered to the job site completely assembled (unless otherwise specified).

B. Compliance with the manufacturer's instructions for transportation and rigging.

1.6 WARRANTY and MAINTENANCE

A. The chiller manufacturer's warranty shall be for a period of one year from date of equipment start up or 18 months from the date of shipment, whichever occurs first.

B. The warranty shall include parts and labor costs for the repair or replacement of parts found to be defective in material or workmanship.

C. Maintenance of the chiller equipment while under warranty, is mandatory and shall be the responsibility of the purchaser unless supplied by the manufacturer.

Optional:

1. Extended chiller parts and labor warranty.

2. 2-5-year compressor parts and labor.

3. 2-5 year chiller parts and labor warranty.

PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Smardt Inc.

B. Approved Equal. Note approved equal does not automatically imply the alternate product matches this specification, functionality or delivered quality.

2.2 PRODUCT DESCRIPTION

A. Provide and install as shown on the plans, a factory assembled water-cooled packaged chiller.

B. Each unit shall include one or more Turbocor magnetic bearing and variable-speed centrifugal compressors. Integrated variable frequency drive shall operate with inlet guide vanes. Chillers shall operate with HCF-134a refrigerant - not subject to phase-out by the Montreal Protocol and the U.S. EPA Phase-out schedule.

C. The evaporator, condenser, and expansion valve shall be configured to operate as a single refrigerant circuit unless otherwise specified. The chiller unit compressors shall be designed for mechanical and electrical isolation to facilitate service and removal.

2.3 DESIGN REQUIREMENTS

A. Unit shall consist of one or more magnetic bearing oil-free centrifugal compressors with integrated variable frequency drive, refrigerant flooded evaporator, water cooled condenser, and operating controls with equipment protection.

B. Performance: Refer to schedule for specific operating conditions. When utilizing Turbocor model TT300 compressors (85 nominal tons), the chiller shall be capable of stable operation down to 20 tons, model TT350 compressors, stable operation down to 35 tons, TT400 compressors (145 nominal tons), stable operation down to 40 tons, and model TT500 compressors, stable operation down to 60 tons. All ratings are measured at standard AHRI entering condenser water temperatures and without utilizing hot gas bypass.

C. Acoustics: Sound pressure for the unit shall not exceed the following specified levels, and be less than 81 dBA measured at 1 meter (3.28 feet) and shall represent the highest levels recorded at all load points. Sound data shall be measured according to AHRI Standard 575-87.

Global	63	125	250	500	1k	2k	4k	8k

D. Chiller shall be equipped for single-point power connection.

E. The evaporator shall be designed to allow the flow rate to be reduced to 1 gpm per ton without entering laminar flow, in order to allow for variable chilled water flow and to facilitate chilled water pump energy savings. The chiller shall be able to operate in a stable manner at this condition for at least 8 hours continuously, and independent of condenser water flow rate or condenser water temperature relief.

F. The condenser shall be designed to allow the flow rate to be reduced to 1.5 gpm per ton without entering laminar flow, in order to allow for variable condenser water flow and to facilitate condenser water pump energy savings. The chiller shall be able to operate in a stable manner at this condition for at least 8 hours continuously, and independent of chiller water flow rate or condenser water temperature relief.

G. Minimum entering condenser water temperature shall be -11.1 °C (12°F) above leaving chilled water temperature. The chiller shall be able to operate in these conditions for at least 8 hours continuously in order to provide condenser water relief and allow compressor energy savings. The chiller shall be able to vary the condenser water temperature to the minimum condition, independently of condenser water flow rate and chilled water flow rate.

H. Each compressor shall be electrically and mechanically isolated so that if a compressor fails or needs service, it can be serviced or removed from the chiller without disabling the other compressors or the chiller. The chiller shall be able to operate with the remaining compressors with one or more compressors removed.

I. The chiller shall be provided with at least the number of compressors shown on the schedule. For chillers larger than 395 tons, at least 3 compressors shall be utilized to provide both redundancy and the ability of the chiller to turn down to low capacity. Manufacturers bidding chillers with a lesser number of compressors than shown on the schedule or provided in this section, shall provide (2) chillers at half the scheduled capacity and flow rates. It will be the manufacturer's responsibility to coordinate space and piping requirements with the contractor.

Optional:

1. Multiple point power connection, single point is standard.

2. Low profile designs with staggered evaporator and condenser, based on capacity.

2.4 CHILLER COMPONENTS

A. Compressors:

1. Compressors shall be of semi-hermetic centrifugal design and operate oil-free with two-stages of compression, magnetic bearings, movable inlet guide vanes and integrated variable frequency drive system.

2. Automatically positioned and controlled inlet guide vanes shall operate with compressor speed controls.

3. The compressor shall be capable of coming to a controlled stop in the event of a power failure. The unit shall be capable of initializing an automatic restart in the case of a power failure.

4. Each compressor shall have integrated microprocessor control capable of capacity and safety control.

5. Each compressor shall be installed with individual suction, discharge and motor cooling refrigerant line isolation valves. Chillers without discharge line isolation valves that rely on non-return valves in the discharge line for compressor removal, shall not be accepted.

6. Each compressor shall have an individual disconnect switch. The compressor shall have mechanical and electrical isolation to allow the chiller to operate when a compressor is removed from the machine, on chillers that are provided with more than one compressor.

Optional:

1. EMI filters installed for each compressor.

2. Vibration isolation pads.

B. Evaporator:

1. The evaporator shall be shell-and-tube type and have separate shells. Heat exchangers shall be designed, constructed, tested and stamped in accordance with the requirements of ASME Code, Section VIII Code Case 1518-5. They shall have a copper wall thickness of 0.64 mm (0.025 in.). In the evaporator, refrigerant shall be in the shell and water inside the tubes. The water sides shall be designed for a minimum of 1000 kPa (145 psig) or as specified. The water connections for the evaporator and condenser shall be either grooved suitable for Victaulic couplings or flanged. Vents and drains shall be provided. The refrigerant side of each vessel shall bear the ASME Code stamp, code case section VII. Vessels shall pass a test pressure of 1.1 times the working pressure but be not less than 689 kPa (100 psig). Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor suction ports. The evaporator water connections shall also be equipped with interchangeable right or left-hand connections.

2. The evaporator shall be provided with spring loaded reseating-type pressure relief valves according to ASHRAE-15. Rupture disks are not acceptable.

3. To ensure effective liquid droplet removal, prevent liquid damage to compressors, and equalize suction pressure across evaporators with multiple compressors, a perforated plate designed for vapor disengagement shall be installed inside the evaporator above the tubing.

4. Tubes shall be individually replaceable and have internally and externally enhanced surfaces designed for refrigeration duty. Tubes shall have smooth full tube wall landings at the tube-sheet ends and at intermediate tube supports. Tubes shall be mechanically roller expanded into steel tube sheets containing a minimum of three concentric grooves.

5. Minimum evaporator exiting water temperature shall be 3.3°C (38°F), unless otherwise specified.

6. Factory-mounted and wired thermal dispersion water flow switches shall be provided on the evaporator in order to prevent unit operation with no water.

Optional:

1. Available in 0.71 mm (0.028 in) and 0.89 mm (0.035 in) wall thicknesses.

2. Wall available in 90-10 cupro-nickel.

3. Marine water boxes.

4. Epoxy-coating of inside surfaces of water boxes and tube sheets.

5. Water side vessel design for of 2068 kPa (300 psi) operation.

6. Single insulation, (1 ½ inch), on evaporator, water boxes, suction piping, and compressor end-bell.

7. Lower leaving chilled fluid temperatures to 3.9°C (25°F).

C. Condenser:

1. Condenser shall be shell-and-tube type and have separate shells. Heat exchangers shall be designed, constructed, tested and stamped in accordance with the requirements of the ASME Code, Section VIII Code Case 1518-5. They shall have a copper wall of 0.64 mm (0.025 in.) wall. In the condenser, refrigerant shall be in the shell and water inside the tubes. The water sides shall be designed for a minimum of 1000 kPa (145 psig) or as specified. The water connections for the evaporator and condenser shall be grooved suitable for Victaulic couplings or flanged. Vents and drains shall be provided. The refrigerant side of each vessel shall bear the ASME Code stamp, code case section VII. Vessels shall pass a test pressure of 1.1 times the working pressure but not be less than 689 kPa (100 psig). Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor suction ports. The condenser water connections shall also be equipped interchangeable right or left-hand connections.

2. The condenser shall be provided with dual relief 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. Rupture disks are not acceptable.

3. Tubes shall be individually replaceable and have internally and externally enhanced surfaces designed for refrigeration duty. Tubes shall have smooth full tube wall landings at the tube-sheet ends and at intermediate tube supports. Tubes shall be mechanically roller expanded into steel tube sheets containing a minimum of three concentric grooves.

4. Minimum entering condenser water temperature shall be -11.1°C (12°F) above leaving chilled water temperature.

5. Factory-mounted and wired thermal dispersion water flow switches shall be provided on the condenser in order to prevent unit operation without water.

Optional:

1. Available in 0.71 mm (0.028 in.) and 0.89 mm (0.035 in.) wall thicknesses.

2. Wall available in 90-10 cupro-nickel.

3. Marine water boxes.

4. Epoxy-coating of inside surfaces of water boxes and tube sheets.

5. Water side vessel design for of 2068 kPa (300 psi) operation.

6. Increased condenser water temperature for heat recovery to 51.7°C (125°F).

D. Liquid level controls

1. Control of refrigerant flow shall utilize a single or multiple 6,000 step electronic expansion valve (EXV), to operate within the full range from full load to the lowest loading capacity for the chiller. Fixed orifice metering devices or float controls using hot gas bypass are not acceptable. The EXV liquid line shall have a sight glass with moisture indicator and temperature sensor connected to the control system for validation of sub-cooling.

2. Condenser shall be provided with a capacitive type liquid level transducer with a resolution of not less than 1024 discrete steps. The transducer shall be wired to the chiller control system. Condenser liquid level measurement shall be used in electronic expansion valve control algorithm, with a minimum level set point to ensure adequate liquid seal is maintained in the condenser, in order to provide compressor motor cooling during operation. Condenser liquid level shall be clearly displayed on a graphical operator interface in a minimum of two screens. Chillers without direct level measurement are prohibited due to possible over heating damage that may occur in compressors when liquid seal is lost.

Optional:

1. Load balancing valves shall be provided for capacity control and additional temperature stability.

2. The chiller shall be equipped with a backup valve to channel discharge gas from the outlet of the compressor to the evaporator, in order for the ramp up during a high pressure ratio application.

E. Prime Mover:

1. A permanent-magnet, synchronous hermetically sealed motor of sufficient size shall be provided to effectively meet compressor horsepower requirements. The motor shall include soft-start capabilities with an in-rush current of no more than 2 amps (TT300 models) and 4 amps (TT400 models). The motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase.

2. Compressor motor and chiller unit shall include variable-frequency speed controls to match cooling load demand to compressor speed and inlet guide vane position.

3. Each compressor shall be equipped with an AC line reactor and individual disconnect.

F. Chiller Controls

The controller fitted to the oil-free centrifugal chiller package shall be an embedded real-time microprocessor device that utilizes control software written specifically for chiller applications. User operation shall be accomplished using a panel mounted color touch-screen interface. The status of the compressors and all system parameters including compressor alarms and temperature trends shall be viewable.

Controller features must include the following:

1. Selectable control mode - leaving chilled water, entering chilled water or suction pressure control.

2. 10.4-inch, 12.1-inch or 15-inch, 65,000 colors touch panel operator interface, operating windows XP embedded.

3. Chiller documentation shall be viewable via touch panel in pdf format.

4. Operator interface shall be capable of connecting directly to compressors via serial communication protocol, and displaying compressor information using Turbocor compressor monitoring / commissioning software.

5. The chiller control panel shall contain a minimum of three processors, all control functionality shall be carried out on a dedicated real time processor, and data shall be served to a remote graphical user interface via an open Ethernet protocol. Proprietary protocols between any pc based or micro based processor are strictly prohibited.

6. Chiller controls shall be native BacNet capable via MSTP or IP. Addition of gateway devices or additional processors or pluggable pcbs to achieve BacNet communications to the BAS, are strictly prohibited.

7. Complete configuration of native BAS communications via Modbus RTU, Modbus TCP/IP, BacNet MSTP and BacNet IP shall be made via standard chiller controller graphical user interface. Chiller controls that utilize external software configuration tools to configure these protocols are explicitly prohibited.

8. Chiller control shall be capable of controlling up to eight Turbocor compressors on up to eight individual refrigerant circuits serving the same chilled water stream.

9. Chiller control panel user interface shall be capable of remote control via an internet connection, without the use of any third party gateway device or additional hardware or software.

10. Chiller control shall be capable of operating in headless mode (no touch panel connected) and utilize a standard windows XP or higher computer to display user interface via Ethernet connection.

11. Real time chiller control processor shall be capable of e-mailing a predefined list of recipients, should a fault occur. E-mail shall include details of fault, possible reason for fault, attachment of a monthly data log of 195 or more compressor and chiller variables at a minimum of 30 second intervals, and indication of fault severity.

12. Ability to place all outputs in a manual state (hand, off, auto) via graphical user interface.

13. Alarm screen shall be capable of filtering faults into specific categories such as compressor, chiller and system faults in order to provide rapid diagnosis, and separation of failure modes.

14. Variable speed cooling tower control.

15. Tower bypass valve control.

16. Optional variable speed condenser water pumping control.

17. Optional ability to turn on/off duty standby chilled water pumps.

18. Optional ability to turn on/off duty standby condenser water pumps.

19. Optional ability to operate chiller isolation valves for both evaporator and condenser.

20. Multiple compressor staging algorithm shall operate at the optimized power curves of each compressor simultaneously, and shall reset automatically every second during operation. Compressor staging methods that operate using simple incremental percent of demand shall not be accepted.

21. Continuous data logging for operational trending and bin analysis shall be exportable to “CSV” format. (12 months of data stored).

22. Embedded Web and FTP servers to enable remote encrypted control, log download, software version upload, and operational monitoring.

23. Built-in stepper motor controls for EXVs.

24. Controls lockup protection.

25. Ramp rate control - Peak energy demand limiting algorithms.

26. Three levels of alarm safety for minimum chiller down time.

27. Chiller control software shall employ an active fault avoidance algorithm to reduce chiller capacity and / or power level in the case of the chiller approaching within 10% of any trip limit value such as suction pressure, discharge pressure, chiller amp limit, leaving chilled water temperature limit, etc...

28. Store up to 32,000 alarm and fault events stored with date / time stamp.

29. Real time data trending viewable via touch panel.

30. Chiller load profile charts viewable via Touch panel.

31. Chiller control graphical user interface shall be capable of displaying data in SI or I-P units without affecting control or BAS protocol units.

32. Controls shall identify within 60 seconds, a compressor that is not starting or ramping-up properly. Upon this identification, the compressor shall be disabled, the remaining compressors shall be operated in an optimized manner, and an alarm shall be sent to alert the operator.

Optional:

1. BMS interface module for the interface with BacNET MSTP, BacNET IP or LonTalk FT10.

<u>Data on Main Display Screen shall include:</u>

a) Entering and leaving chilled water temperatures.

b) Entering and leaving condenser water temperatures.

c) Current operating state of chiller.

d) Active timers.

e) Chiller enable status.

f) Chiller water flow proof status.

g) Condenser water flow proof status.

h) Indication of compressor readiness.

i) Indication of clearance to run.

j) Chiller set point.

k) Total chiller kW.

l) Total chiller current input.

m) Three pages of data trends with zoom functionality.

n) Graphical dial indicators that clearly indicate safe and unsafe operating values.

o) Graphical representation of evaporator and condenser showing gas movement when chiller is running.

p) Current alarms (announce and manual reset provision).

q) Compressor actual rpm, maximum rpm, minimum rpm.

r) Compressor alarm description & fault description.

s) Compressor percentage motor demand.

t) Compressor safety interlock status.

u) Compressor modbus communication health status.

v) Compressor suction and discharge pressures.

w) Compressor suction and discharge temperatures.

x) Compressor internal cooling system temperatures and status.

y) Compressor motor kW and amps.

z) Compressor pressure ratio.

G. Sequence of operation.

Heat Recovery Mode:

The leaving chilled set point shall be between 5.6°C-12.8°C (42°F-55°F) in heating loop control which shall control the saturated discharge temperature in 2 stages:

1. The leaving water condenser temperature shall be accomplished by varying the flow rate in the heat recovery. The control shall be made by the on-site controls (BAS).

2. Cooling shall be available to the chiller from the cooling tower condenser circuit and controlled from the chiller control analogue output. The set point for this loop will seek to operate the chiller at a fixed condensing pressure.

3. In heating mode, the heating loop shall be active.

Cooling Mode:

The head pressure control from AO#6 shall be ignored and standard condenser/ cooling tower control shall be adopted.

1. The tower loop shall be active in cooling mode.

Notes:
1. Flow rate change through evaporator and condenser shall not exceed 2% per minute.

2. Leaving condenser water shall not exceed 105°F.

3. Switching from cooling to heating mode shall require a chiller shutdown.

4. Condenser water flow switches shall be installed in both condenser loops.

<u>EXECUTION</u>

3.1 INSTALLATION

A. Install per manufacturer’s IOM documentation, shop drawings, and submittal documents.

B. Align chiller on foundations or mounting rails as specified on drawings.

C. Arrange piping to enable dismantling and permit head removal for tube cleaning.

D. Coordinate electrical installation with electrical contractor.

E. Coordinate controls and BMS interface with controls contractor.

F. Provide all material required for a fully operational and functional chiller.

3.2 START-UP

A. Units shall be field charged with HFC-134a refrigerant.

B. Factory Start-Up Services: Provide factory supervised start-up on-site for a minimum of two working days and ensure proper operation of the equipment. During the period of start-up, the factory authorized technician shall instruct the owner's representative in proper care and operation of the equipment.

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