DATA REALTY
SOUTH BEND, INDIANA

BY

BRIAN MEDINA

OF

ENVIRONMENTAL SYSTEMS DESIGN

CHAPTER/REGIONAL TECHNOLOGY AWARD - SHORT FORM

1. Category (Check one and indicate New or Existing, if applicable)

- ○ Commercial Buildings — ○ New or ○ Existing
- Institutional Buildings:
  - ○ Educational Facilities — ○ New or ○ Existing
  - ○ Other Institutional — ○ New or ○ Existing
- ○ Health Care Facilities — ○ New or ○ Existing
- ◉ Industrial Facilities or Processes — ◉ New or ○ Existing
- ○ Public Assembly — ○ New or ○ Existing
- ○ Residential (Single and Multi-Family)

2. Name of building or project: Data Realty - Northern Indiana

City/State: South Bend, IN

3. Project Description: Colocation Data Center

Project Study/Design Period: 10/2011 (Begin date (mm/yyyy)) to 4/2012 (End date (mm/yyyy))

Percent Occupancy at time of submission: 0%

4. Entrant (ASHRAE member with significant role in project):

a. Name: Medina (Last) Brian (First) M. (Middle)

Membership Number: 8189760

Chapter: Illinois

Region: VI

b. Address (including country): 175 W. Jackson Blvd., Suite 1400

Chicago (City) IL (State) 60604 (Zip) US (Country)

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e. Member's Role in Project: Design Engineer

f. Member's Signature:

5. Engineer of Record: Environmental Systems Design, Inc. (ESD)

By affixing my signature above, I certify that the information contained in this application is accurate to the best of my knowledge. In addition, I certify that I have discussed this entry with the owner and have received permission from the owner to submit this project to the ASHRAE Technology Awards Competition.

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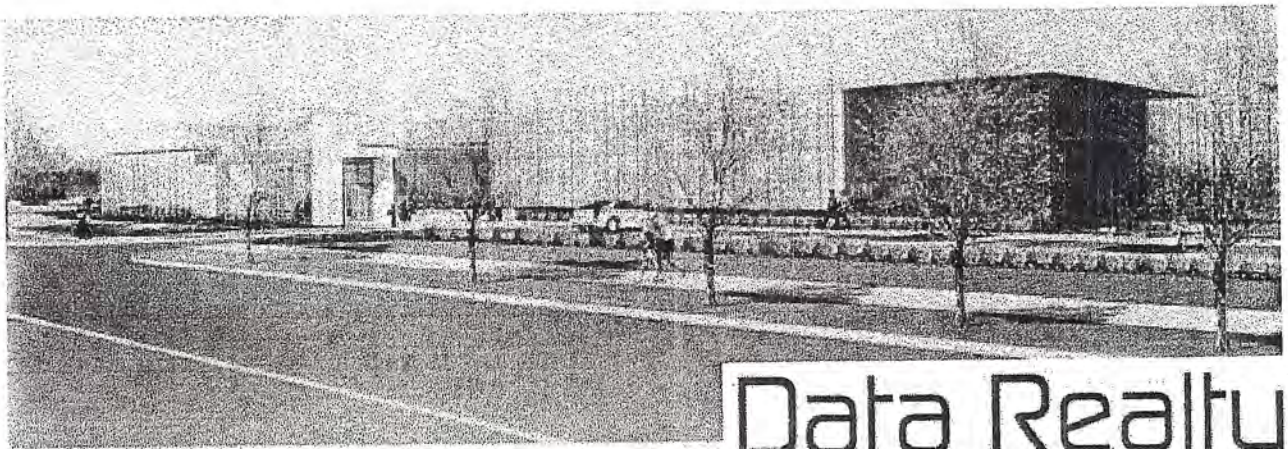
2012 TECHNOLOGY AWARDS



Data Realty®
WHERE DATA LIVES.

Data Realty Colocation Data Center
Ignition Park, South Bend, IN

Owner: Data Realty
Engineer: ESD
Architect: BSA LifeStructures

Project Overview

Data Realty is a data center service provider for middle market companies, offering colocation, cloud services, and disaster recovery solutions for organizations requiring a robust IT infrastructure. The new data center under construction in Northern Indiana is located within the 140-acre technology campus of Ignition Park. The 43,000 ft^2 facility features 18,000 ft^2 of data center white space and an adjacent 4,000 ft^2 of office area. The building's modular design requirement allows for gradual expansion and for the build-out of additional space as needed to match consumer demand. Ignition Park is ideal for data center operation as it offers abundant fiber optic infrastructure, low-cost hydroelectric power served by the St. Joseph River, and redundant power infrastructure from the Studebaker and Kankakee substations which each have a minimum of two 138 kVA feeds.

Electrical System Overview

The facility is a single story design with three nominal 5,000 ft^2 data center modules. The site is expandable to double the footprint of the data center and office space. The infrastructure for each module is designed to support a total UPS load of 750 kW, or 150 W/ft^2 load density. The total building utility service is 4.5 MW, with an additional 4.5 MW site service capacity for the future building expansion. Emergency power will be provided by four Tier 2 standby generators in an N+1 redundancy configuration. Each generator is 1,500 kW to support the total demand load connected to its output, with an integral fuel storage tank for 48 hours of generator engine operation.

Mechanical System Overview

The mechanical system features a central chilled water plant sized for 750 tons of cooling with four (4) chillers in an N+1 redundancy configuration. The chillers are furnished with two (2) magnetic bearing, oil-free compressors for increased part-load efficiency and redundancy. Each chiller is matched with a direct evaporative-cooled, closed-circuit condenser located in the adjacent equipment yard. The refrigeration system is used in conjunction with a refrigerant recirculator pump to maximize hours of free cooling in economizer mode.

When operating in evaporative mode, hot refrigerant gas is discharged from the compressor to the inlet of the condenser. Water is circulated from the condenser sump basin and sprayed over the condenser coil as ambient air is induced upward into the unit. The spray water is cooled through the evaporative process and in turn cools the coil containing the hot refrigerant gas. Condensed liquid flows back to the receiver of the refrigerant recirculator and is returned to the system. This industrial refrigeration design approach eliminates the inefficiency associated with the heat transfer in a conventional condenser water system and cooling tower. The chiller compressors also utilize an oil-free centrifugal design with magnetic bearings, to achieve greater NPLV by eliminating friction loss from oil-lubricated bearings. A VFD controls compressor speed to sustain operation at low load. This is essential to keeping the chillers online when occupancy is low and the data center floor is only partially loaded. Furthermore, regular compressor maintenance associated with oil management are eliminated, and design efficiency is retained as lubricant does not accumulate on heat-transfer surfaces and derate the equipment.

The chillers are cooling a process load, and therefore the chilled water can be produced at a temperature ~10°F warmer than a conventional plant serving a comfort-cooling load. Elevated chilled water temperatures allow for higher saturated suction temperatures, reducing compressor lift and subsequent input kW. Through the direct evaporative cooling process, lower saturated condensing temperatures can be achieved in the evaporative condenser to further drive down compressor lift.

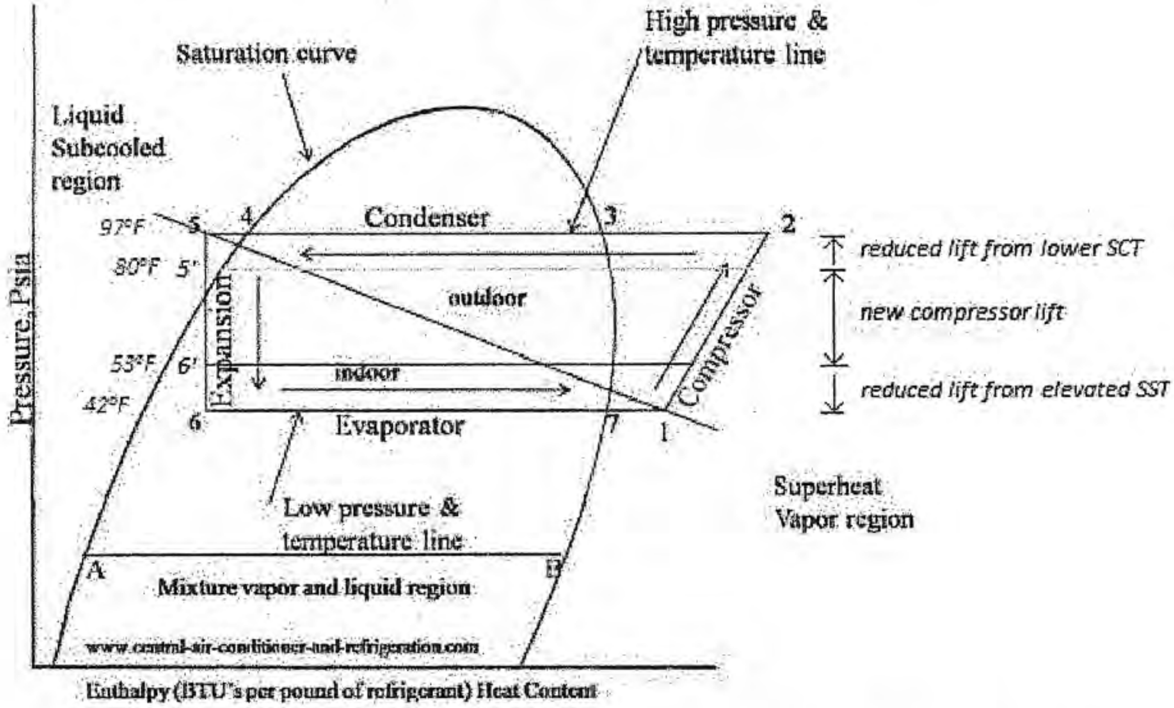


Fig. 1 – Refrigeration cycle with elevated saturated suction temperature and reduced saturated condensing temperature.

The condenser and refrigerant pump are then able to provide more hours of 100% free cooling when the OAWB temperature is 10°F below the chilled water supply setpoint of 55°F (adj.). The system also acts as an economizer and allows for partial free cooling by measuring the condensing pressure of the refrigerant. The refrigerant pump will work to overcome the pressure drop of the expansion valve, while maintaining lower saturated condensing pressures and decreasing work on the compressor. The result is reduced compressor speed, reduced power consumption, reduced heat of compression, increased efficiency, and lower input kW/ton. The chiller has an NPLV of 0.270 with a full load efficiency of 0.403 kW/Ton versus the ASHRAE 90.1-2010 baseline performance of a water-cooled centrifugal chiller having a 0.580 IPLV and full load efficiency of 0.634 kW/ton. Based on South Bend, IN, bin data, the refrigerant pump will provide almost 4,100 hours of free cooling, or 47% of the year.

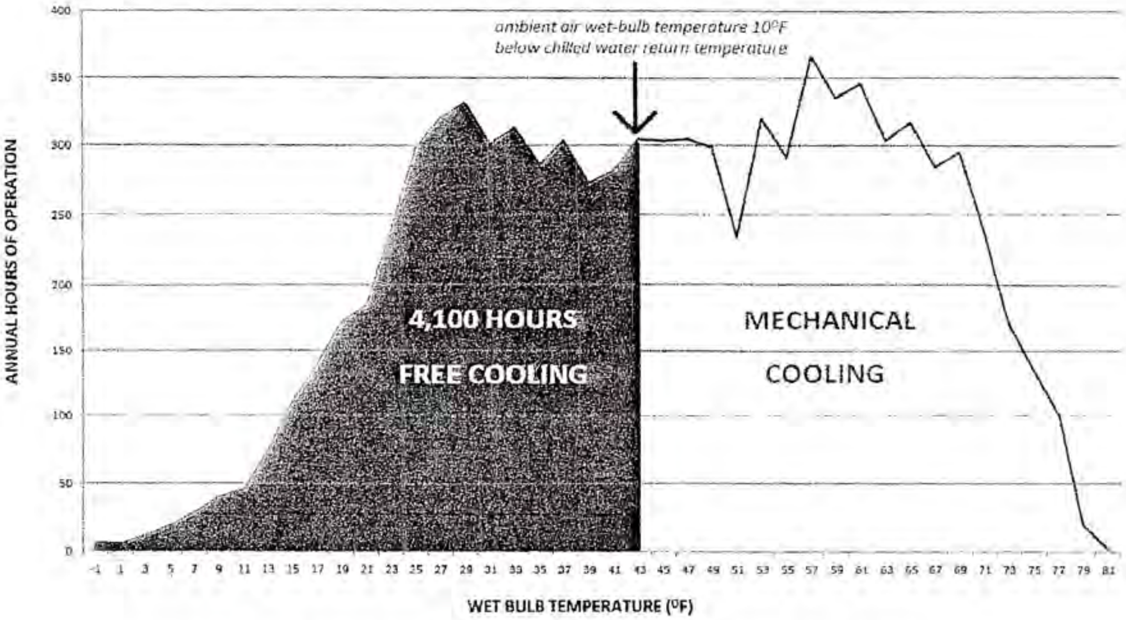


Fig. 2 – Ambient air wet-bulb temperature bin data for South Bend, IN.

The refrigerant recirculator pump is furnished with a small variable speed 2 HP motor, and the evaporative condenser has a 5 HP spray pump. The design of the refrigeration system has eliminated the need for large condenser water pumps and piping mains, in addition to ancillary components such as air separators, expansion tanks, plate and frame heat exchangers, and glycol feed systems. The refrigerant pump is controlled internally by the chiller and greatly simplifies the chiller plant operation, while reducing the connected motor load on the electrical system backed up by standby generators.

The evaporative condenser cooler will also allow for dry winter operation, to mitigate icing problems, and reduce power consumption from basin heaters and heat trace. At below freezing ambient conditions, the cooling tower basins can be drained, and the condenser can operate without the use of the spray pump. An automatic drain valve will open and empty the basin once ambient air temperature reaches 32°F, and a solenoid valve will close on the associated makeup water line. The automatic drain and fill process is controlled directly from the chillers and greatly simplifies winterizing the system and does not require any on-site maintenance staff. The ability of the condensers to run dry allowed ESD to design the mechanical and electrical infrastructure to support a long term utility water outage without the need for any onsite water storage tanks. At a design day, the redundant chiller and evaporative condenser can operate dry and meet the full critical cooling load of the data center until water service can be restored. The chillers would be demand limited to operate at the published full-load kW at normal design conditions so as to not overload the electrical substation and standby generators. Chilled water could be produced at 64°F and maintain a supply air temperature still within the acceptable ASHRAE TC 9.9 guidelines.

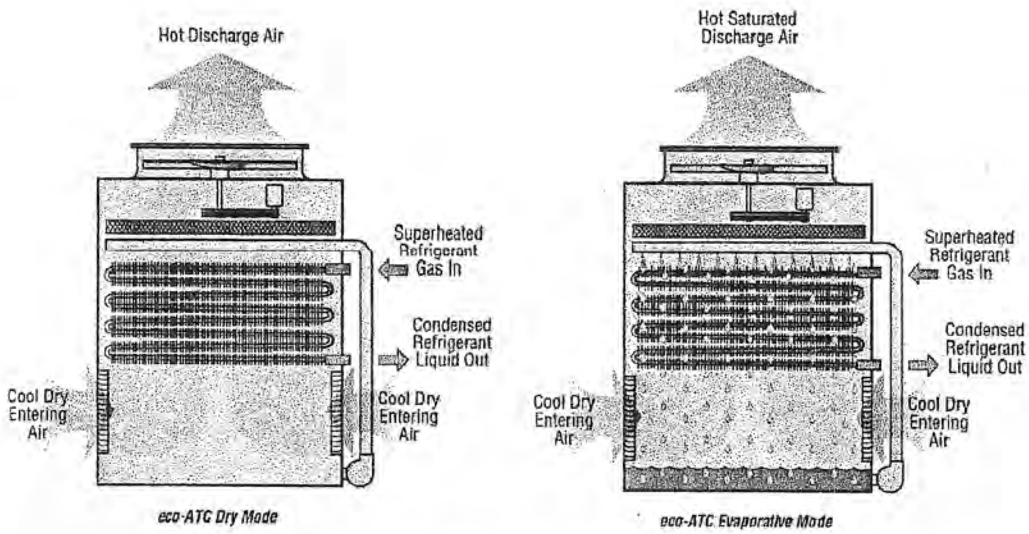


Fig. 3 – Closed-Circuit Evaporative Condenser in "evaporative" and "dry" modes.

Each chiller is matched with a dedicated pump in a variable-primary pumping arrangement with a minimum flow bypass valve. This provided energy savings over a constant volume primary-variable secondary pumping and greatly simplified the system distribution, installation, and control. The chilled water system feeds eight (8) nominal 40-ton computer room air handling (CRAH) units in a gallery adjacent to each data suite and multiple other 6-ton CRAH units serving UPS electrical rooms. The CRAH units provide redundancy for concurrent maintainability such that any CRAH may be removed for service while still meeting the critical cooling load for the respective spaces. Each unit is furnished with a pressure-independent control valve. These control valves ensure a consistent chilled water dT across the coil, even at extremely low flow rates, which can affect chilled water economizer hours and reduce pump energy usage. A 5 psi differential is required across the valve in order for the control valve to operate linearly and match the chilled water flow rate to the critical load in the space. As a result, more CRAH units can be added to the chilled water system and the existing units will not have to be rebalanced as long as the system pumps can maintain a 5 psi differential across the valves. This is also critical to maintaining data center operation as more tenants begin to populate the data center space and cooling load increases.

Each data hall module is equipped with its own packaged direct-expansion (DX), variable air volume (VAV) dedicated outdoor air rooftop air handling unit to provide ventilation air to the building for space pressurization and humidity control purposes. A VAV box provides ventilation air to the corridor and another box provides conditioned air to the data suite. On a design summer day, the RTU will provide air at a dewpoint temperature of 3°F below the chilled water supply temperature to control condensation on the CRAH unit cooling coils. Within the ductwork to the data suite are ultrasonic humidifiers to satisfy the data center environmental conditions recommended by ASHRAE TC 9.9. The humidifiers deliver deionized water adiabatically through a series of nebulizers so as to not add sensible load to the space and prevent the formation of scale. Each UPS battery room is furnished with a hydrogen gas monitor, audible horn, strobe, and dedicated exhaust fan. Upon detection of elevated gas levels, the fan will be energized to evacuate the room, and air shall be made up from the corridors. The chiller plant is equipped with an exhaust purge fan interlocked with a refrigerant detection system that will activate in the event of a leak from the chillers. Each data suite is also provided with a clean agent system that will extinguish a fire and allow for uninterrupted operation of the servers and CRAH units. A series of dampers and ductwork connects the chiller plant refrigerant exhaust fan to the data halls so that the clean agent can be purged, as well. This manual process is controlled at the operator's work station thru the building automation system.

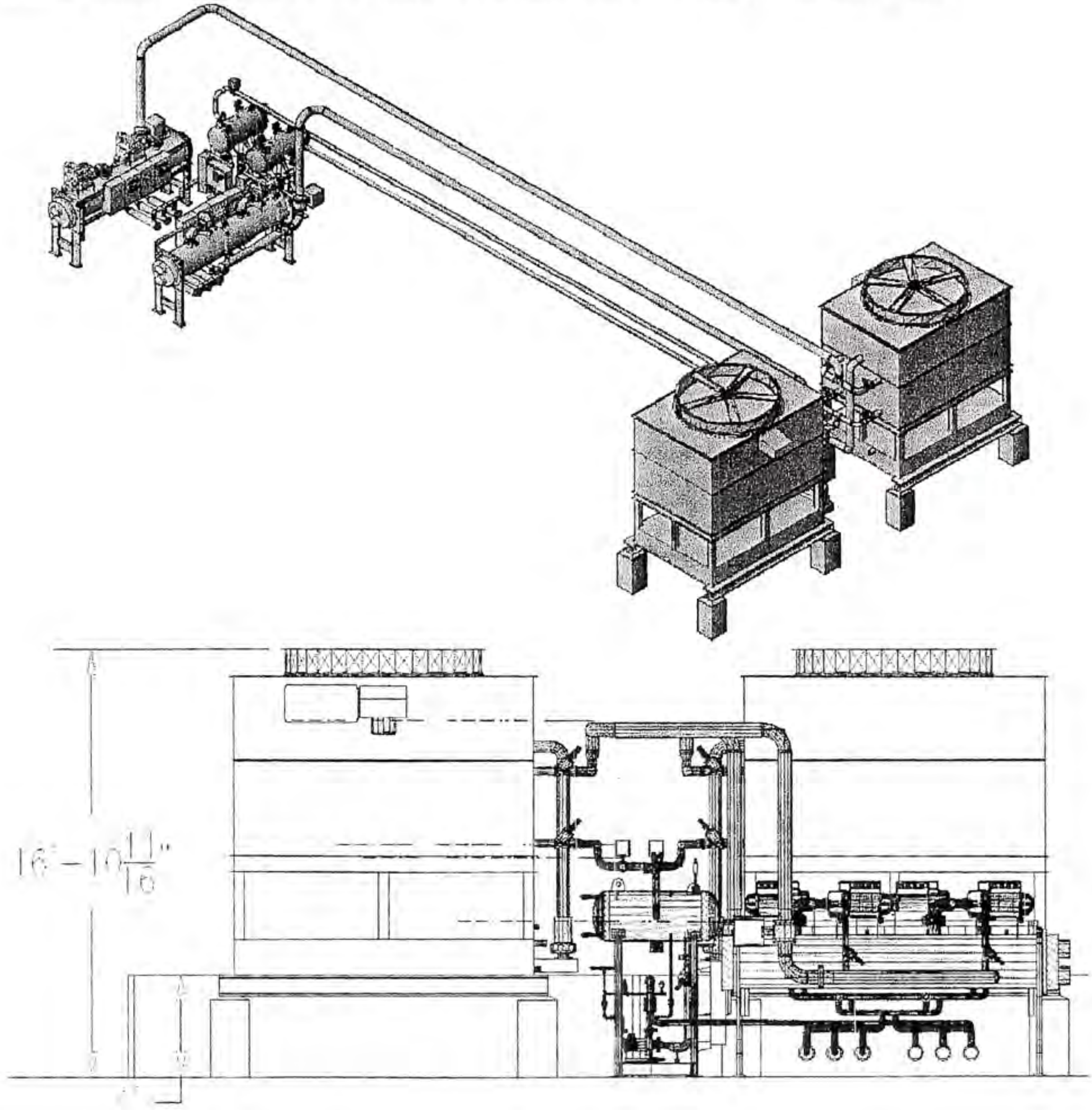


Fig. 4 – Chiller with refrigerant circulator and evaporative condenser conceptual design.