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: ARRIS

City/State: Horsham, PA

3. Project Description: HVAC upgrades

Project Study/Design Period: 01/2011 (Begin date (mm/yyyy)) to 08/2012 (implementation 2012-14) (End date (mm/yyyy))

Percent Occupancy at time of submission: 100%

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

a. Name: Doyle, Dan and Shams, Habib
(Last / First / Middle)

Membership Number: 192578 (Doyle) and 5119819 (Shams)

Chapter: Illinois

Region: VI

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Evanston (City) IL (State) 60201 (Zip) US (Country)

c. Telephone: (O) 847-328-3555 d. Email: ddoyle@grummanbutkus.com

e. Member's Role in Project: Principal-in-Charge (Doyle) and Project Manager (Shams)

f. Member's Signature: Dan Doyle

Digitally signed by Dan Doyle
DN: cn=Dan Doyle, o=Grumman/Butkus Associates, ou, email=ddoyle@grummanbutkus.com, c=US
Date: 2015.10.09 10:52:44 -05'00'

5. Engineer of Record: Dan Doyle

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.

ARRIS, Horsham, PA

The ARRIS facility in Horsham, PA, features dry labs focused on technology development, including IP, video, and broadband technology. The property is currently managed for ARRIS by JLL. The Horsham site supports the work of about 1,000 employees. In 2011, the submitting firm was contacted to develop options for energy upgrades to the site's four buildings (Buildings 1, 2, 3, and 4), totaling approximately 390,000 square feet.

The existing HVAC systems were original to the buildings, which had been constructed 14 years earlier as office space. Over time, about 40% of the property had been migrated to research, producing cooling loads far in excess of the original assumptions for cooling capacity.

The HVAC equipment ran continuously and was often inadequate to meet all cooling loads, especially on hot summer days. Several supplemental cooling units (mostly split DX) had been added in an effort to keep up with cooling demand. Annual building energy costs exceeded $5.50 per square foot (over $2 million per year). Annual compressor replacement costs were running more than $100,000. (A small amount of natural gas is used for food service and miscellaneous unit heaters, constituting about 1% of campus energy consumption.)

The engineer developed an upgrade strategy and presented several options to the client. Air-cooled, evaporative-cooled, and water-cooled options were all considered. Design and cost considerations, beyond obvious concerns about energy efficiency, included quality of new equipment; required level of redundancy; equipment locations (including potential non-roof locations); limitations on structural loading; roof modification requirements; staging and phasing needs; rigging; routing of pipes and ductwork; configuration of electrical distribution; controls compatibility; chemical treatment for new water systems (under some options); ease or difficulty of maintenance; and the nature of the labs to be served (type, criticality, layout, and potential for consolidation).

Strategies selected for more detailed analysis included basic air-cooled DX rooftop units; custom air-cooled DX rooftop units; and a chilled water system (CHW) for RTUs and labs. Projected 30-year annual and cumulative cash flows were prepared, showing the effects of phased projects that would ultimately result in HVAC replacements at all four buildings over a maximum of five years. The study included graphic representations of cost impacts for both the basic and the custom air-cooled units, alone and in combination with a possible CHW system, to make it easier for the client to make decisions based on life-cycle costing.

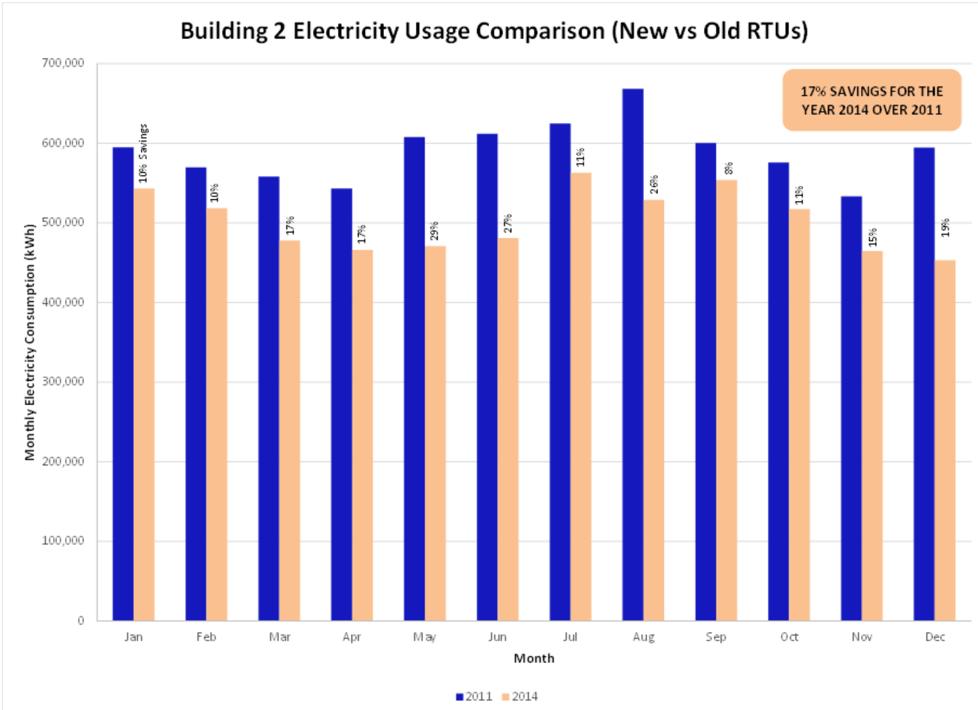
The engineer's analysis indicated that custom air-cooled DX units, though more expensive initially, would result in a much lower cumulative cost over a 30-year period (representing a cumulative advantage of more than $1.5 million). The basic air-cooled units were initially the cheaper option; however, once past the 15-year planning horizon, the custom DX option showed clear superiority. The CHW system would have provided the best cumulative cash flow over a 30-year period, but the payback period was 24 years (due to much higher initial costs) and was judged unacceptable. (The CHW system would also have presented the problem of where to locate the equipment.)

The client ultimately decided on custom air-cooled packaged DX VAV rooftop units, with supply and relief fan arrays with VFDs. The replacements also included variable speed compressors and variable speed condenser fans, with unit capacity of roughly 80 tons each (nominal). MERV 8 and MERV 14 filters were selected. Dry coolers were proposed and installed to better address current and future lab loads. All RTUs featured DDC (direct digital) controls tied into the client's existing building automation system.

Buildings 2 and 3 were upgraded between 2012 and 2014. Buildings 1 and 4 are slated for later upgrades. Each of the upgraded buildings received four RTUs, with replacements done in phases so only half of each building was affected at any given time. Buildings remained operational throughout all construction projects. In general, units were replaced over weekends, starting on Friday evenings at 7 p.m. and completing by the start of the business day on Mondays. The construction team accomplished all required ductwork and electrical connections throughout the work week, allowing the next unit to be taken out of service and replaced the following weekend.

Energy Efficiency

The chart below shows 2014 (tan) vs 2011 (blue) electricity use for Building 2 (17% savings vs the 2011 baseline). Building 3 (result not shown) experienced a 16% savings vs the baseline. Due to strategic changes by the owner, lab electricity usage at the Horsham campus increased between the time of the initial study (2011) and 2014. The capacities of the new RTUs had been selected based on demand existing at the time, and had not anticipated this change in usage pattern. Had the client chosen the less-efficient basic air-cooled DX units, the negative financial impact of this operational change, with its higher electricity demands, would have been even more profound than it was. The engineering firm’s suggestion of dry coolers to serve lab space, sized to accommodate increased lab capacity, also proved to be a useful strategy. This tactic helped decouple the lab cooling load from the base building HVAC units, allowing RTUs to be used selectively according to the load. Previously, the RTUs ran 24/7 to meet lab cooling loads. As part of a retro-commissioning initiative (scheduled for completion in Q4 2015), controls on fan-powered boxes will be corrected, which will produce further energy savings.



Indoor Air Quality

Minimum outside air control was improved. The original RTUs used a constant minimum damper position, regardless of fan speed. The new units modulate minimum outside air dampers based on fan speed. The minimum damper position curve was developed during commissioning, with assistance of the TAB contractor. New filters represented an upgrade over prior versions. The enhanced HVAC system improved both IAQ and user comfort.

Innovation

The design is notable as a state-of-the-art variable speed refrigeration system. The system responds based on actual loads, vs. a staging strategy. For a high-intensity research facility such as this, variable speed is a much more efficient way to meet the cooling demand than staging. The design provided energy savings of more than 15%, which is a challenging goal to achieve with air-cooled equipment. Extensive metering was provided to track energy use.

Operations & Maintenance

The RTUs are easily accessible for maintenance, with aluminum integrated tread plates and doors strategically placed for easy access. Filters are readily accessible. The chosen system had similarities to the old equipment, enabling the operations staff to quickly adapt to maintaining the new system. Selecting an option without a water-based cooling system also helped to simplify maintenance.

Cost Effectiveness

Detailed cost implications are confidential; however, improved energy efficiency is clearly a significant cost benefit.

Environmental Impact

The new custom rooftop units use refrigerant R410a. It is a non-ozone-depleting, long-term replacement for HCFC-22 in new residential and commercial unitary air conditioning systems. In new unitary systems optimized for its use, with either scroll or reciprocating compressors, R410a has shown in tests to have a 5% to 6% percent higher Energy Efficiency Rating (EER) than HCFC-22. R410a also has a higher capacity and pressure than HCFC-22, enabling the design of smaller, more compact air conditioning equipment. Scrap metal from the old RTUs was recycled.

CUSTOM PACKAGED ROOFTOP AIR HANDLING UNITS - BUILDING 2

CONTROL DIAGRAM

FLOW DIAGRAM IS REPRESENTATIVE OF ALL HVAC UPGRADES FOR ARRIS (COMPLETED AND PLANNED)