# 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:** Hyatt Regency Denver at Colorado Convention Center

City/State: Denver, CO

**3. Project Description:** Energy and Water Conservation Program

Project Study/Design Period: 12/2006 (Begin date (mm/yyyy)) to 09/2015 (ongoing) (End date (mm/yyyy))

Percent Occupancy at time of submission: 100%

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

a. Name: Butkus (Last) Alexander (First) S. (Middle)

Membership Number: 105624

Chapter: Illinois

Region: VI

b. Address (including country): Grumman/Butkus Associates, 820 Davis St., Suite 300

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

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

e. Member's Role in Project: Principal-in-charge

f. Member's Signature: Alexander S. Butkus

Digitally signed by Alexander S. Butkus
DN: cn=Alexander S. Butkus, o=Grumman/Butkus Associates, ou, email=abutkus@grummanbutkus.com, c=US
Date: 2015.10.08 10:21:43 -05'00'

**5. Engineer of Record:** Alexander S. Butkus

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.

## HYATT REGENCY DENVER AT COLORADO CONVENTION CENTER

The 1,100-room Hyatt Regency Denver at Colorado Convention Center is a 931,875-square-foot property initially constructed in 2005-06. The client and the submitting firm have been working together on energy and water studies and phased improvements for about nine years. These changes have resulted in major reductions in both resource usage and costs.

Facility **renovation and upgrade projects** included the following:

1. Five elevator machine rooms were converted from year around DX cooling to central plant cooling. Cooling efficiency in summer went from approximately 1.2 kW/ton to 0.65 kW/ton, and in economizer season from 1.0 kW/ton to 0.05 kW/ton.
2. The laundry steam boiler was replaced with a more efficient unit. (This project was initiated for reliability purposes but also saved energy and water.)
3. Laundry flash steam heat was recovered to preheat domestic hot water.
4. One hundred and fifty (150) fan-powered boxes were converted to VAV boxes. As much as 4 hp in motors per box were eliminated.
5. A variable kitchen hood exhaust and makeup air system was installed on all kitchen hoods.
6. The return air path for both major ballrooms was modified to maximize allowable return air, which reduced heating and cooling loads.
7. Variable speed drives were installed on condenser water pumps (225 hp total), which eliminated control valve head pressure control with VSD modulation.
8. A separate chilled water AC unit was installed for valet service, so main laundry systems can be shut down when the valet is operating without laundry.
9. Control valves were added to the plenum heating system so the system can be shut down when not needed.
10. Occupancy based lighting controls were installed in many spaces and the hotel's lighting control computer is used to control operating hours of lighting.
11. A project under construction eliminates a hot water preheat coil in a makeup air unit and uses chilled water to preheat the incoming air (50°F chilled water in winter preheats air to 45°F and contributes to the building's hydronic economizer heat rejection).
12. Lighting retrofits were pursued as follows: 250W bulbs replaced with 19W LEDs (350); 250W bulbs replaced with 70W LEDs (106); 60W bulbs replaced with 11W LEDs (2,000); 50W bulbs replaced with 7W LEDs (1,000); 32W T8s replaced with 15W T8 LEDs (1,700); and 25W T8s replaced with 10.5W T8 LEDs (600). This totals a 279 kW reduction in lighting power.

In addition, the hotel made numerous improvements to its **control strategies**:

1. Scores of pieces of mechanical equipment were added to the energy management system to allow occupancy-based control and schedules (mainly exhaust fans).
2. New control strategies were implemented for the chiller and boiler plant. This included adjustments to chiller and boiler sequencing, secondary and tertiary pump sequencing, and operating hours of the hydronic economizer.
3. The hotel reprogrammed the energy management system to allow terminal HVAC devices to be independently scheduled.
4. Air handler control sequences were modified to eliminate simultaneous heating and cooling.
5. Air handler heating valve control was changed from full open when units are off (heating plenum to 100°F plus) to modulating to maintain a mixed air temperature of 60°F.
6. Non-guest-room fan coils were changed from continuously running fans to intermittent operation for areas not occupied by people. Space examples include mechanical spaces, electrical closets, and elevator machine rooms.
7. Non-guest-room fan coil set points were standardized with an increased dead band.
8. Domestic water booster pump pressures were reset.
9. Building pressurization via mechanical systems was adjusted to reflect summer vs. winter temperatures (about 60,000 cfm less air is needed in summer, as the building stack effect diminishes).
10. Major supply fans were changed from a fixed static pressure set point to reset to a minimum of 0.6-in. w.c.

11. Secondary and tertiary hydronic loop differential pressures were reset down. Secondary differential pressures are automatically reset based on coil valve positions.
12. Minimum speeds of variable speed drives were reduced from 20 Hz to 5 Hz.
13. VAV air handler control sequences were changed to reset discharge based outside air and heating load.
14. Deicing mode was added to the cooling tower for operation during winter to maintain tower efficiency.

**Operations and maintenance strategies** were also changed:

1. Guest room thermostats are now turned off upon guest checkout.
2. All guest room shower flow rates were tested and adjusted to design where necessary.
3. All mechanical equipment operating schedules are reviewed daily by the hotel operating staff. Every six months, an outside consultant reviews the EMS for proper operation. The system vendor also provides regular maintenance.

**Energy Efficiency**

**Since changes began to be implemented in 2007, the hotel's electricity use is down 26%; gas use is down 13%; and water use is down 39%.** The following chart documents performance. Please refer to the attached additional information for further tables and charts providing a detailed analysis of performance improvements after changes were made.

| Year | Annual Electricity Consumption (kWh/yr) | Annual Natural Gas Consumption (therms/yr) | Annual Water Consumption (kgal/yr) | HDD | CDD | Guest Nights | Room Nights | Food Covers |
|---|---|---|---|---|---|---|---|---|
| 2007 | 18,018,986 | 642,435 | 45,603 | 6,040 | 966 | 450,190 | 299,442 | 423,510 |
| 2014 | 13,387,301 | 560,230 | 27,811 | 5,809 | 707 | 407,348 | 302,658 | 663,658 |

**Indoor Air Quality**

Nothing was done that compromised indoor air quality. IAQ and $CO_2$ sensors were upgraded. The significant reductions in energy use improved the regional environment.

**Innovation**

The management of the hotel insisted on a collaborative effort that involved not only management and consultants but also service technicians for chillers, control system, and VFDs, for example. Meetings were held approximately every six months with hotel management, operating staff, vendors, and contractors to brainstorm potential savings opportunities and monitor progress of projects underway.

**Operations & Maintenance**

Operating and maintenance costs were reduced in several areas. Examples of items that reduced O and M costs while saving energy include replacing bulbs with LED bulbs whose lives are as much as 25 times longer; eliminating five DX cooling units as large as 10 tons with central plant chilled water; eliminating 150 fan-powered VAV box fans; and making run-hour reductions on most equipment in the building. The drive to reduce energy costs also focused the hotel's ongoing preventive maintenance via its PM system and engaging vendors that perform boiler, chiller, and air handler maintenance.

**Cost Effectiveness**

Every project either fell into a low- or no-cost category (the traditional O and M) or met the ownership's investment criteria, which varied each year based on capital availability.

**Environmental Impact**

The project's energy use reductions have obvious positive environmental effects. Other positive effects include reduced lighting bulb waste (longer LED life), reduced boiler chemical treatment due to gas savings, reduced equipment run times resulting in reduced filter replacements and waste, five DX cooling units eliminated (less refrigerant used on-site), and water-use reductions accompanied by reduced sewer discharges and related treatment.

**Additional Information**

Using multiple linear regression to predict 2014 utility use based on 2007 energy and water use and facility data, energy and water use reductions between 2007 and 2014 were calculated.

| Utility | 2007 Actual | 2014 Actual | 2014 Predicted | 2014 Predicted - 2014 Actual | Percentage Reduction |
|---|---|---|---|---|---|
| Electricity (kWh) | 18,018,986 | 13,387,301 | 17,883,958 | 4,496,657 | 25% |
| Electrical Demand (kW) | 36,653 | 25,334 | 34,234 | 8,900 | 26% |
| Natural Gas (therms) | 642,435 | 560,230 | 780,709 | 220,479 | 28% |
| Water (kgal) | 45,603 | 27,811 | 37,667 | 9,856 | 26% |
| Btu/sf/yr | 134,915 | 109,135 | 149,259 | 40,124 | 27% |

Multiple linear regression models the relationship between two or more independent variables and an output by fitting a linear equation to the given set of data. Variables that influence energy and water use at hotels include heating degree days, cooling degree days, food covers, and occupied rooms, among others. The following tables show actual monthly energy and water use data for 2007 and 2014, and predicted energy and water use for 2014 based on 2007 consumption. The bar charts at the right provide a graphic comparison of 2007 actual usage, 2014 predicted usage, and 2014 actual usage after the improvements discussed in the submittal were made.

| Month (2007) | Actual Electricity (kWh) | Actual Electrical Demand (kW) | Actual Natural Gas (therms) | Actual Water (kgal) |
|---|---|---|---|---|
| January | 1,493,534 | 2,763 | 93,289 | 2,320 |
| February | 1,314,852 | 2,493 | 68,750 | 3,208 |
| March | 1,446,900 | 2,765 | 55,160 | 3,208 |
| April | 1,383,300 | 2,766 | 53,499 | 3,617 |
| May | 1,533,600 | 3,067 | 53,030 | 3,617 |
| June | 1,677,000 | 3,739 | 33,490 | 4,764 |
| July | 1,772,400 | 3,952 | 29,030 | 4,772 |
| August | 1,725,600 | 3,451 | 27,820 | 4,743 |
| September | 1,522,500 | 3,045 | 32,829 | 4,328 |
| October | 1,516,200 | 3,032 | 44,189 | 4,134 |
| November | 1,365,900 | 3,046 | 60,569 | 3,885 |
| December | 1,267,200 | 2,534 | 90,780 | 3,007 |

| Month (2014) | Actual Electricity (kWh) | Actual Electrical Demand (kW) | Actual Natural Gas (therms) | Actual Water (kgal) | Predicted Electricity (kWh) | Predicted Electrical Demand (kW) | Predicted Natural Gas (therms) | Predicted Water (kgal) |
|---|---|---|---|---|---|---|---|---|
| January | 1,077,291 | 2,004 | 74,570 | 1,875 | 1,411,444 | 2,546 | 88,973 | 2,107 |
| February | 1,048,701 | 1,884 | 72,140 | 1,664 | 1,378,275 | 2,501 | 85,092 | 2,526 |
| March | 1,005,882 | 2,050 | 58,670 | 2,303 | 1,496,507 | 2,884 | 74,351 | 2,345 |
| April | 1,027,500 | 2,027 | 42,760 | 2,214 | 1,431,712 | 2,608 | 63,561 | 3,318 |
| May | 1,194,374 | 2,117 | 35,730 | 2,405 | 1,444,761 | 2,696 | 49,061 | 4,109 |
| June | 1,227,175 | 2,294 | 30,120 | 3,007 | 1,600,629 | 3,272 | 38,707 | 4,071 |
| July | 1,217,439 | 2,493 | 27,880 | 3,169 | 1,730,398 | 3,641 | 38,836 | 4,150 |
| August | 1,224,084 | 2,305 | 26,760 | 2,770 | 1,614,198 | 3,233 | 37,018 | 4,420 |
| September | 1,128,985 | 2,204 | 29,630 | 2,676 | 1,559,988 | 3,062 | 47,994 | 3,736 |
| October | 1,060,231 | 2,189 | 35,590 | 2,498 | 1,493,923 | 2,806 | 73,277 | 2,378 |
| November | 1,112,343 | 1,918 | 61,390 | 1,673 | 1,379,836 | 2,480 | 88,052 | 2,338 |
| December | 1,063,296 | 1,849 | 64,990 | 1,557 | 1,342,287 | 2,504 | 95,788 | 2,168 |