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U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

American Recovery and Reinvestment Act (ARRA) FEMP Technical Assistance Federal Aviation Administration Project 209 – Control Tower and Support Building, Palm Springs, CA

J Arends
WF Sandusky

March 2010

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Pacific Northwest National Laboratory
Richland, Washington 99352

(a) Redhorse Corporation

Executive Summary

This report represents findings of a design review team that evaluated construction documents (at the 100% level) and operating specifications for a new control tower and support building that will be built in Palm Springs, California by the Federal Aviation Administration (FAA). The focus of the review was to identify measures that could be incorporated into the final design and operating specifications that would result in additional energy savings for the FAA that would not have otherwise occurred.

The process that was followed in this review was to first identify various measures that should be considered prior to finalization of the construction and operation specifications. Those measures were evaluated by the FAA and a series of recommendations were selected for further evaluation, including estimating the resulting energy savings (electric and gas), cost savings, implementation cost, and simple payback.

A total of 42 recommendations were documented and delivered to the FAA design team. Of that total, seven recommendations were selected to be incorporated into the final design document. These included both low-cost and no-cost projects that typically related to operational requirements, as well as capital projects that would result in an actual design change. Implementation of the seven measures would result in an electrical energy savings of 202,168 kWh. No savings related to natural gas were identified because the buildings will not use natural gas. Based on the present commodity rate for electricity, the annual cost savings for the site would be $29,189. The total cost for implementation is estimated to be $45,700 resulting in a simple payback of 1.6 years.

Project implementation would reduce greenhouse gas emissions to the atmosphere and create jobs for local workers. It is estimated that an emission of 145 metric tons of CO_2 to the atmosphere would be avoided by implementation of the measures and 0.5 new jobs would be created. These values would increase if other recommended measures were ultimately integrated into the final design.

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1.0 Description of ARRA Program

The Federal Energy Management Program (FEMP) facilitates the Federal Government's implementation of sound, cost-effective energy management and investment practices to enhance the nation's energy security and environmental stewardship. In fiscal year 2009, FEMP received funds specific to the American Recovery and Reinvestment Act (ARRA) of 2009 to assist in the identification, evaluation, documentation of energy efficiency and renewable energy projects at Federal sites.

These funds were allocated to expand the Department of Energy's (DOE's) laboratory and contractor support to agencies and to quickly provide technical advice and assistance to expand and accelerate project activities. FEMP requested that agencies submit projects in need of technical assistance in the following areas:

- Initial screenings or assessments of facility needs and/or feasibility of a particular technology
- Project prioritization
- Strategic energy planning and benchmarking
- Technical reviews of designs and proposals
- Energy audit training
- High-performance green building technical support
- Federal vehicle fleet technical support
- Operations and maintenance
- Detail of key lab staff to work within agencies for a limited duration (normally not more than 24 months)
- All of the above with special emphasis on particular technologies in the areas of the labs' expertise.

The Federal Aviation Administration submitted a response to a FEMP call for projects that was issued on May 1, 2009 requesting that energy audits be conducted at four FAA locations in California with the goal of identifying energy conservation measures that could be implemented in a timely manner. This project was accepted by FEMP and designated as Project 209. After project selection, it was determined the sites were being considered as part of a larger energy saving performance contracts (ESPC) project, so the scope of the project was changed and divided into two parts. The first part consisted of a technical review of the proposed construction and operating specifications for buildings to be constructed at three airport locations (Las Vegas, NV and Palm Springs and Oakland, CA. The second part requested that energy audits be performed at on-going construction activities at two other sites (Reno, NV and Boise, ID). This report represents the findings regarding review of the construction and operating specifications (100% design level) for the Palm Springs, California site. Results of the other reviews will be documented in separate reports.

1.1 Technical Assistance Activities

The Pacific Northwest National Laboratory (PNNL) contracted with the Redhorse Corporation to complete a review of construction design and operation specifications to identify additional energy efficiency measures or operating specifications that could be provided to Federal Aviation Administration (FAA) for consideration to meet final design completion timelines. Upon review of the proposed recommendations by the FAA, Redhorse Corporation developed estimates of potential energy savings impacts for those design review comments that will be incorporated in the final design documents. Table 1 summarizes the potential annual electrical energy savings associated with the accepted recommendations.

Table 1 Summary of Annual Estimated Energy Savings Recommended in Design Review for Palm Springs, CA

Review Comment Item # of 42 Identified Recommendations	Energy Saving Recommendations	Electrical Savings (kWh)
11	Heating Setpoint 70 Instead of 75°F	21,330
16	Variable Air Volume (VAV) Static Pressure Reset	30,940
21	Economizer Mode	38,450
22	Demand-controlled (CO_2) Ventilation	73,132
33	Chilled Water Reset 45 to 55°F	17,260
34,35	High Efficiency Motors	5,820
37	Occupancy Sensor Heating, Ventilation and Air Conditioning (HVAC)	36,566
	Total (Non-Interactive)	**202,168**

The design team used the Trane Trace 700 energy modeling program to model the energy use of the systems selected for the building. Recommended measures were evaluated for potential energy savings using the eQUEST model.

The eQUEST model was developed to provide a quick estimate of the energy savings potential and does not include the fine degree of detail included in the design team's Trane Trace 700 model. The inputs of the eQUEST model were adjusted until annual energy use estimates from the model matched the design team's results. The eQUEST model was developed using the schematic wizard function to develop a simple model of the building and its systems. However, some of the items were estimated using case studies, and energy estimates were extrapolated for this project. Each review item is discussed in the following sections, after the summary table. Some of the suggestions also include a discussion of the challenges associated with implementing the review item.

2.0 Background

2.1 Site Description

The site is located in the Coachella Valley desert region of southern California. This area is sheltered by the San Bernardino Mountains to the north, the Santa Rosa Mountains to the south, by the San Jacinto Mountains to the west and by the Little San Bernardino Mountains to the east.

This area was first inhabited by the Agua Caliente band of the Cahuilla Indians. A large majority of the area of the present city of Palm Springs was established as the Agua Caliente Reservation by the United States Government in 1896. The reservation land was originally composed of alternating squares of land laid across the desert in a checkerboard pattern. Thus, the Agua Caliente band is the city’s largest landowner.

The city of Palm Springs is located 37 miles east of San Bernardino, 111 miles east of Los Angeles, and 136 miles northeast of San Diego. The local landscape features a wide variety of native desert flora and fauna. The notable tree occurring in this area is the California fan palm.

2.2 Major Building Energy Uses

The major end-use of energy at the building will be lighting, space cooling, ventilation, and equipment uses (radar and communication). Minor end uses would be space heating, water heating, and pumps and motors.

2.3 Climate, Facility Type, and Operations

The climate for the site is considered hot, dry, and arid. Based on data available from the National Climatic Center, the maximum mean monthly temperature occurs in July (108.2^{0}F), with the minimum mean monthly temperature occurring in December (43.4^{0}F). The highest recorded temperature during the period from 1927 through 2001 was 123^{0}F on July 29, 1995, while the lowest reported temperature during the period of 1927 through 2001 was 19^{0}F on January 22, 1937. One of the highest night time low temperatures was recorded at the site on July 13, 1985 (105^{0}F). Based on the most recent mean data available (1971-2000), the site should experience 180 days with a maximum temperature exceeding or equal to 90^{0}F and 116 days with a maximum temperature exceeding or equal to 100^{0}F. The minimum temperature should be at 32^{0}F or below for 3 days. Annually, the site should anticipate 951 heating degree days (HDD) and 4224 cooling degree days (CDD).

Mean precipitation level for the site is 5.23 inches per year. The highest daily reported precipitation was 4.57 inches for January 23, 1943. The highest reported monthly precipitation, 8.04 inches, occurred in January 1993. The daily precipitation should be at or greater than 0.01 inches for 18 days during the year. Mean annual snow fall for the site is 0.1 inches, but the highest monthly snowfall was reported for January 1979 (1.5 inches). The highest daily snow depth is a trace.

3.0 Energy Use

No historical energy use data exists because the building has yet to be constructed.

3.1 Current Energy, Gas, and Water Use

Specific information regarding energy, gas, and water use was not obtained because the building has yet to be constructed. As noted earlier, natural gas is not available at the site. Information from the existing facility would not be appropriate for use because that building was constructed under a totally different building code.

3.2 Current Rate Structure

The FAA currently pays 13.06 cents per kWh. This value was used in calculating the baseline energy consumption and the incremental savings from the various proposed measures.

4.0 Energy Conservation Measures Identified

The design review team identified a total of 42 energy conservation measures that should be considered by the FAA building design team. This included a variety of measures, operating specifications for equipment, and potential renewable power generation sources. The FAA design team adopted seven measures to be incorporated into the final design. Some of the measures that were accepted were a combination of several recommendations. The measures included both no-cost/low-cost as well as additional capital investment projects. A summary of those measures -- estimated electrical savings, associated annual cost savings, along with implementation cost and simple payback calculation -- is provided in Table 2.

4.1 Summary of Proposed Measures

Establish Office Heating Setpoint of 70˚F instead of 75˚F: The energy model for the building, developed by the design team, has various setpoints for heating and cooling, and some do not match the setpoints stated in the summary of the Mechanical Design Data Handbook. However, if the heating set point of the building is 75°, the heating energy use will be significantly greater than if the setpoint is 70°F. An eQUEST energy model was developed, and the annual estimated energy savings is summarized in Table 2. The energy efficiency measure wizard in eQUEST was used to model the savings for the variable air volume (VAV) air handling system.

Variable Air Volume (VAV) Static Pressure Reset: Air static pressure in a VAV air handling system is normally maintained by modulating the speed of the fan. Air is distributed throughout the building by ductwork, and VAV terminal boxes control the flow of cool air delivered to the space they serve. As the space cooling load increases, the flow of cold air likewise increases to maintain the space temperature. If space cooling loads decrease, the requirements for cold air flow to cool the space also decrease.

Table 2 Energy Conservations Measures Incorporated in the Final Design Specifications

Review Comment Item #	Palm Springs FAA Control Tower and Base Buildings Energy Saving Recommendations Cost per unit	Electrical Savings (kWh)	No Natural Gas Use (therms)	Electrical Savings ($)	Total Annual Savings ($)	Cost to Implement ($)	Simple Payback (Years)
				$0.1306			
	Low Cost/No Cost Measures						
11	Heating Setpoint 70°F Instead of 75	21,330	NA	$ 2,786	$ 2,786	$ 300	0.1
16	VAV Static Pressure Reset	30,940	NA	$ 4,041	$ 4,041	$ 2,400	0.6
21	Maximize use of Economizer Mode	38,450	NA	$ 5,022	$ 5,022	$ 300	0.1
33	Chilled Water Reset 45 to 55°F	17,260	NA	$ 2,254	$ 2,254	$ 300	0.1
34,35	High Efficiency Motors (Not a Replacement)	5,820	NA	$ 760	$ 760	$ 2,400	3.2
	Capital Projects						
22	Demand-controlled (CO_2) Ventilation	73,132	NA	$ 9,551	$ 9,551	$ 25,000	2.6
37	Occupancy Sensor HVAC	36,566	NA	$ 4,776	$ 4,776	$ 15,000	3.1
	Total (Non-Interactive)	**202,168**	**NA**	**$29,189**	**$29,189**	**$ 45,700**	**1.6**

The air flow to the VAV terminal boxes is delivered at a system static pressure. The static pressure level is established by the minimum pressure required for the terminal boxes to deliver full cooling flows. During the winter, air flow requirements drop to their minimum levels, and the static pressure required at terminal boxes decreases. This reduced air flow requirement brings about an opportunity to reduce the system static pressure levels along with reducing energy usage. Static pressure reset control strategies have been in use for more than 20 years and have been proven to provide significant levels of energy savings. California Title 24 also requires static pressure reset for VAV systems.

An eQUEST energy model was developed and the estimated annual energy savings is summarized in Table 2. The energy efficiency measure wizard option to model static pressure reset is not included in the current version of eQUEST. The magnitude of energy savings was estimated by modeling the baseline VAV system as a forward curved fan system with inlet vane dampers, and the static pressure reset option was modeled as a standard VAV system with variable speed drives.

Implementation of the improved air static pressure reset control can greatly increase the energy savings. Since 1999, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1 has required that static air pressure be reset for systems with direct digital controls, "the setpoint is reset lower until one zone damper is nearly wide open." However, system design deficiencies often limit the potential energy savings. These design deficiencies create problem zones that cause the reset scheme to underperform because they frequently or constantly generate zone pressure increase requests.

Common causes are:

- Undersized VAV box because of improper selection in the design phase or unexpectedly high zone loads that are added to the space after construction;
- Cooling thermostat setpoint below design condition;
- Thermostats with heat releasing equipment under them (such as microwaves and coffee pots); and
- Air distribution design problems—high-pressure drop fittings or duct sections.

The first three items cause the zone to frequently demand maximum or near-maximum zone air flow rates. Depending on zone location relative to the fan, a constant demand for high air flow rates indirectly causes the zone to generate frequent or constant pressure requests. The fourth problem directly results in pressure requests. For example: A zone with a fire/smoke damper installed in the 6-inch (150 mm) high-pressure duct at the box inlet. Small smoke dampers have little free area so pressure drop will be high.

Ways to mitigate the impact of problem zones on static pressure reset control sequences include:

- Exclude the problem zones from the reset control sequence by literally ignoring the problem zone's pressure requests or including logic that ignores the first few pressure requests. Of course, ignoring the zone results in failure to meet zone air flow and temperature setpoints. This failure may be acceptable, however, if the zone is a problem because the temperature setpoint is too low, but it clearly can be an issue if the zone is more critical.

- Limit thermostat setpoint adjustments to a range that is close to space design temperatures. Direct digital control (DDC) systems typically have the ability to limit the range occupants can adjust setpoints from the thermostat. This limitation can prevent, for instance, cooling setpoints that are well below design conditions.
- Request that all thermostats are free of impact from appliances directly under thermostats.
- Fix duct restrictions/sizing issues. This option is clearly a better choice than ignoring the zone and letting it overheat, but the cost to make revisions may be higher that the owner is willing to invest. It is best, of course, to avoid these restrictions in the first place. For instance, the owner should avoid using flexible duct at VAV box inlets, avoid oversized inlet ducts when they extend a long way from the duct main, and avoid small fire/smoke dampers in VAV box inlet ducts.
- Add auxiliary cooling to augment the VAV zone. If the problem results from an undersized zone or unexpectedly high loads, a second cooling system, such as a split air conditioning (AC) system, can be added to supplement the VAV zone capacity. However, this solution is also expensive.

Maximize use of Economizer Mode: In office buildings, air handling systems typically recirculate return air, mix it with outside air, and then heat or cool the mixed air to the desired supply air temperature setpoint. The economizer cycle operates if there is a cooling load and the outdoor air temperatures are low enough. Extra outside air is brought in instead of running refrigeration equipment (chiller and pumps) to cool the mix of return air and minimum outdoor air.
The primary design intent of the economizer cycle is to provide free cooling anytime the outdoor temperature is below the required system supply temperature. If enthalpy control is used, the economizer cycle will also reduce the mechanical cooling load when the outdoor temperature is higher than the required supply temperature but the outdoor air enthalpy (or total heat content) is less than the enthalpy of the return air. The key is to minimize energy use with an accurate control system.

During economizer cycle operation, the outdoor air damper modulates open from the minimum position. Outside air flow varies from the minimum outside air volume to the 100% outdoor air position as the outdoor air temperature approaches the required supply air temperature. When outdoor air temperature (or enthalpy) is greater than the return air (or enthalpy), the outdoor air damper should return to the minimum setting for outside air ventilation requirements.

An eQUEST energy model was developed and the potential energy savings are summarized in Table 2. The energy efficiency measure wizard in eQUEST includes an option to model economizer control of air handling units. The dry bulb temperature option of economizer control of outside air was selected.

Often, one of the challenges of implementing economizer control is bringing in the additional outdoor air. This additional air is generally removed from the building by some sort of relief system to minimize building static pressure pressurization issues. Despite the significant energy savings that can be achieved by proper application of economizers, many economizer sections never achieve their design intent because of pressurization issues. Studies have shown that economizers are not operating properly on more than 65 percent of the air handlers because of failed controllers or damper linkages that malfunction. Thus, proper functional testing and adjustment of the economizer and mixed air section are essential to achieving design intent, efficient operation, and good indoor air quality.

Demand-controlled Ventilation (DCV) Using Carbon Dioxide (CO_2) Sensing: ASHRAE recommends a ventilation rate of 15 to 20 cubic feet per minute (cfm) per person in ASHRAE Standard 62-1999 to ensure adequate air quality in buildings. To meet the standard, many ventilation systems are designed to admit air at the maximum level whenever a building is occupied, as if every area were always at full occupancy. The result, in many cases, has been buildings that are highly over-ventilated. The development of CO_2-based DCV was driven in part by the need to satisfy ASHRAE 62 without over-ventilating.

When CO_2 sensors are used to maintain indoor air quality (IAQ), they continuously monitor the air in a conditioned space. Because people constantly exhale CO_2, the difference between the indoor CO_2 concentration and the outdoor concentration indicates the occupancy or activity level in a space and thus its ventilation requirements. An indoor/outdoor CO_2 differential of 700 parts per million (ppm) is usually assumed to indicate a ventilation rate of 15 cfm/person; a differential of 500 ppm, or a 20 cfm/person ventilation rate. The CO_2 sensor readings are monitored at the air handling system control panel, which automatically increases ventilation when the CO_2 concentration in a zone rises above a specified level.

The highest payback can be expected in high-density spaces where occupancy is variable and unpredictable (such as auditoriums, some school buildings, meeting areas, and retail establishments), in locations with high heating or cooling demand (or both), and in areas with high utility rates. Case studies show DCV offers greater savings for heating than for cooling, however. In areas where peak power demand and peak prices are an issue, DCV can be used to control loads in response to real-time prices. DCV may result in significant cost savings even with little or no energy savings in those locations. Energy savings can be as high as 10%. The potential energy cost savings for CO_2-based DCV is estimated to be between $0.05 to more than $1 per square foot annually.

A report issued by the Department of Energy (DOE 2004) identified five case studies in large office buildings with CO_2-based DCV, all of which reported energy savings that resulted in payback times between 0.4 to 2.2 years. Two of the studies were computer simulations. One of those, conducted in 1994, simulated a 10-floor office building located in Miami, Atlanta, Washington D.C., New York, and Chicago. The simulation predicted large natural gas savings for heating and smaller electricity savings, resulting in predicted payback times for the different locations between1.4 to 2.2 years.

The DOE report (2004) cited an earlier study that modeled the impact of DCV and economizer operation on energy use in four building types (office, retail, restaurant, and school) in three locations representing different climates: Atlanta; Madison, Wisconsin; and Albuquerque. For cooling, predicted savings attributed to DCV depended greatly on location. Savings were larger with DCV in Atlanta and Madison because humidity made economizer operation less beneficial. In low-humidity Albuquerque, economizer operation was much more significant than DCV in reducing cooling energy demand. In all three locations, DCV resulted in large savings in heating energy for the office building — 27% in Madison, 38% in Albuquerque, and 42% in Atlanta; from 70% in Madison to more than 80% in Atlanta and Albuquerque for the school; and more than 90% in all three locations for the retail and restaurant spaces. Similar results were obtained for 17 other U.S. locations modeled. In all locations, the office building showed the most modest savings.

The reliability of CO_2 sensors has improved in recent years, and they should be considered for use in the modern energy efficient office.

Estimated annual energy savings are summarized in Table 2. Energy savings were calculated by reducing the cooling and heating energy estimated by the baseline energy model by 20%. A conservative estimate was used because of the unknown occupancy variations for this facility compared with the above case studies.

Chilled Water Reset: The minimum chilled water temperature of the chiller is needed when the cooling load is at its maximum. The load on the chiller and its efficiency are the lowest when the chiller is fully loaded and producing its coldest chilled water (often as cold as 41°F). During periods of reduced loads, the cooling systems of the building are capable of meeting cooling requirements with chilled water as high as 54°F. Many chilled water systems are operated at a constant chilled water supply temperature even though the cooling loads vary. Therefore, energy savings can be gained by resetting the chilled water supply temperature upward as the chiller load decreases. Generally, the chiller efficiency increases by about 1.5% for each degree increase in chilled-water temperature.

An eQUEST energy model was developed and the energy savings are summarized in Table 2. The energy efficiency measure wizard option in eQUEST includes an option for chilled water temperature reset control of chillers. The chilled water reset controlled by building loads was selected.

Chilled water reset control strategies maintain the chilled water supply temperature (CHWST) at the setpoint, which ranges from 44°F to 54°F, by modulating chiller capacity. The CHWST will have a default of 44°F.

In a variable flow pumping system, the chilled water temperature will be reset upward only when the secondary pumps' speeds are at their minimum. They are reset upward only at this point because lowering pump speed with the differential pressure (DP) reset strategy competes with CHWST reset, but DP reset will save more energy than resetting the chilled water temperature up.

When the pump speed is at the minimum allowed, the CHWST reset routine is started and continues until one or more pumps are operating above their minimum speed, and then holds the CHWST setpoint at that level until the pumps return to their minimums. A differential or time delay is included to prevent excessive over response of the control logic. Likewise, the CHWST setpoint will not be reduced until all secondary pumps are at their maximum speed. This deference to the pressure reset is accomplished by starting the pressure reset downward when all coiling coil valves (CCVs) are less than 90% open and by not starting the CHWST reset upward until all CCVs are less than 80% open. When properly enabled, the CHWST reset sequence is: when all CCV's are less than 80% open, the CHWST setpoint is at its highest value of a proportional range (54°F); when three or more CCVs are 80% or more open, the CHWS setpoint is at its lowest value (44°F).

Premium Efficiency Motors: Many utilities offer incentives for improving motor efficiency, installing adjustable speed drives, or improving overall motor system efficiency. A summary of incentive programs is available on the Motor Decisions Matter web site, www.motorsmatter.org. For more information, check with the local utility, the state energy office, or regional energy efficiency group for information. Manufacturers may also offer incentives for purchasing premium efficiency motors.

Original equipment suppliers sometimes offer their products with a choice of motors. If the owner considers first-cost price alone and selects the cheapest option, it is likely that the equipment will be fitted with a motor with a lower efficiency.

An eQUEST energy model was developed, and the energy savings are summarized in Table 2. The energy efficiency measure wizard in eQUEST includes an option to model motors with three efficiencies: standard, high, and premium. The baseline was modeled with standard efficiency motors, and the option selected for this estimate was premium efficiency motors. Motors estimated by this model include the air handling unit motors and the pump motors.

Additional savings could be obtained by going to premium efficiency motors. They are generally made to higher manufacturing standards and tighter quality controls than the old standard efficiency motors they are meant to replace. Premium efficiency motors run cooler because they generate less heat, thus producing less stress on windings. This lower stress is generally taken to be an indication that the motors will last longer, and it can translate into reduced downtime and lower repair costs over the life of the motor.

Occupancy Sensor Controlled HVAC: Lighting occupancy sensors can be used to reduce the HVAC heating and cooling energy use in spaces that are not occupied. Temperatures in the unoccupied space are allowed to drift from occupied setpoints while the space is unoccupied. The state of the occupancy sensor is tapped by the building energy management system to control the heating or cooling setpoint of the space.

Energy savings can be estimated by extrapolating the savings from case studies of similar buildings. Office buildings with occupancy sensors controlling the lighting typically see savings between 38 to 48%. When the heating and cooling setpoints of the room are also controlled by the occupancy sensor, the HVAC savings will be less than the lighting energy savings because the ventilation system continues to provide minimum ventilation during the unoccupied periods. An example is an office that is unoccupied during a 2-week period while the occupant is on vacation. If this office is unoccupied during the winter, the office still needs to be kept above some minimum temperature (typically no less than 55°F). In one case study, almost 42% of the lighting and 23% of the cooling energy were saved in the private, executive office, with potential for even higher savings in applications such as conference rooms, lunch rooms, and other spaces.

Energy savings estimates included in Table 2 were calculated by reducing the cooling and heating energy from the baseline energy model by 10%. A conservative estimate was used based on the unknown occupancy variations for this facility compared with the above case studies.

4.2 Renewable Energy Measures Evaluated

Several renewable energy measures were initially recommended, but were not ultimately accepted. These included installation of a solar absorption chiller and installation of wind power generation units instead of the metal shading planned for the courtyard. The latter item was a Broad Star wind system that uses an airplane wing design concept with a reported 30% greater efficiency than typical turbine systems. These systems can be sited in turbulent environments and produce low noise pollution while operating. Because of the low rotational speed of the turbine, radar interference is eliminated.

It should be noted that the current design includes solar domestic hot water and 8,000 square feet of photovoltaic panels that will have the capability of producing over 100 kW of power at their maximum output.

5.0 Potential Green House Gas Reduction

The potential greenhouse gas emissions resulting from the energy savings was calculated based on the Environmental Protection Agency eGRID data (Pechan 2008). Based on the estimated savings of 202,168 kWh, annual non-baseload CO_2 emissions would be reduced by 145 metric tons. This calculation does not include any contribution that would be related to line losses.

6.0 Action Plan for Implementation of Energy Conservation Measures (ECMs)

The goal of providing technical assistance to agencies is to provide them sufficient information so they can make informed decisions regarding implementation of the proposed measures. This takes the form of an action plan that identifies priorities and next steps, as well as identification of funding sources for onsite activities, capital equipments purchases, and the installation and operation of the proposed measures.

6.1 Priorities and Next Steps

The FAA has indicated they will incorporate the seven measures into the final design and operating specifications. They also indicated that they may consider other recommended measures, such as additional renewable projects, but a separate funding source would have to be identified and assistance required obtaining the funding.

The design review team also recommended that operating staff at the new building become familiar with the information contained in documents listed below so the installed equipment can be properly maintained to maximize the useful life of energy related equipment.

- ✓ FEMP Retro-commissioning
  http://www1.eere.energy.gov/femp/pdf.om retrocs.pdf

- ✓ FEMP Best Practices Operations and Maintenance
  http:///www1.eere.energy.gove/femp/operations maintenance/om bpguide.html

6.2 Funding Assistance Available

The selected measures are expected to be included in the overall cost to construct and operate the service building and the control tower. Thus, funding assistance is not required for this site. However, the FAA will be encouraged to contact their utility representative from Southern California Edison regarding potential additional rebates that might be available for adding high efficiency motors to the design.

7.0 Assessment Team Members and Site Team

Mr. Jim Arends, PE, CEM, of Redhorse Corporation completed the technical review of the design and operating specification for the site. Mr. William Sandusky of PNNL was responsible for review of the technical report submitted by Redhorse and formatting of this document.

8.0 References

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APPENDIX A

eQUEST Modeling Results and Spreadsheet Calculations

Appendix A - eQUEST Modeling Results and Spreadsheet Calculations

Energy modeling developed for the annual energy savings estimates were developed in eQUEST version 3.61. The schematic design model was used to develop the building footprint and input basic building systems. Basic model inputs include: 24 hours a day operation for 7 days a week, one variable volume air handler serving the majority of the base building, with the balance of the building served by constant volume air handling systems. The control tower provides air traffic controller space on the 8^{th} floor.

Baseline eQUEST Model Results

Baseline eQUEST													
Electric Consumption (kWh x000)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	11.95	11.2	13.45	14.69	17.48	20.56	24.13	23.82	19.67	16.49	12.68	11.83	197.96
Heat Reject.	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0
Space Heat	4.08	3.29	2.71	1.56	0.99	0.33	0.13	0.1	0.24	0.91	2.69	4.54	21.58
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot Water	0.33	0.31	0.34	0.32	0.31	0.28	0.26	0.25	0.24	0.26	0.27	0.3	3.47
Vent. Fans	10.82	9.77	10.83	10.51	10.88	10.62	11	11.01	10.62	10.9	10.48	10.81	128.25
Pumps & Aux.	1.52	1.37	1.52	1.47	1.52	1.47	1.52	1.52	1.47	1.52	1.47	1.52	17.87
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Equip.	36.12	32.63	36.12	34.96	36.12	34.96	36.12	36.12	34.96	36.12	34.96	36.12	425.33
Task Lights	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.43
Area Lights	6.13	5.54	6.13	5.94	6.13	5.94	6.13	6.13	5.94	6.13	5.94	6.13	72.21
Total	71.07	64.22	71.23	69.56	73.57	74.27	79.42	79.07	73.26	72.46	68.6	71.38	868.10

Setting Office Heating Setpoint 70^0F instead of 75^0F: Model Results

eQUEST Heating Temp 70													
Electric Consumption (kWh x000)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	11.42	10.79	13.13	14.55	17.47	20.7	24.34	24.03	19.81	16.49	12.36	11.23	196.33
Heat Reject.	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0
Space Heat	0.38	0.28	0.2	0.07	0.02	0	0	0	0	0.02	0.16	0.43	1.56
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot Water	0.33	0.31	0.34	0.32	0.31	0.28	0.26	0.25	0.24	0.26	0.27	0.31	3.47
Vent. Fans	10.82	9.77	10.84	10.52	10.91	10.67	11.06	11.08	10.68	10.93	10.49	10.81	128.57
Pumps & Aux.	1.52	1.37	1.52	1.47	1.52	1.47	1.52	1.52	1.47	1.52	1.47	1.52	17.87
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Equip.	36.12	32.63	36.12	34.96	36.12	34.96	36.12	36.12	34.96	36.12	34.96	36.12	425.33
Task Lights	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.43
Area Lights	6.13	5.54	6.13	5.94	6.13	5.94	6.13	6.13	5.94	6.13	5.94	6.13	72.21
Total	66.84	60.8	68.4	67.94	72.61	74.12	79.56	79.25	73.21	71.59	65.76	66.67	846.77

Static Pressure Reset: Model Results

eQUEST Static Pressure Reset													
Electric Consumption (kWh x000)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	11.5	10.81	13	14.21	16.95	20	23.47	23.17	19.12	16	12.23	11.39	191.86
Heat Reject.	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0
Space Heat	4.16	3.36	2.78	1.61	1.03	0.35	0.14	0.11	0.26	0.95	2.76	4.63	22.11
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot Water	0.33	0.31	0.34	0.32	0.31	0.28	0.26	0.25	0.24	0.26	0.27	0.3	3.47
Vent. Fans	8.6	7.77	8.62	8.39	8.73	8.61	8.93	8.96	8.61	8.75	8.34	8.58	102.88
Pumps & Aux.	1.52	1.37	1.52	1.47	1.52	1.47	1.52	1.52	1.47	1.52	1.47	1.52	17.87
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Equip.	36.12	32.63	36.12	34.96	36.12	34.96	36.12	36.12	34.96	36.12	34.96	36.12	425.33
Task Lights	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.43
Area Lights	6.13	5.54	6.13	5.94	6.13	5.94	6.13	6.13	5.94	6.13	5.94	6.13	72.21
Total	68.48	61.89	68.63	67.02	70.91	71.71	76.71	76.38	70.71	69.85	66.07	68.79	837.16

Economizer: Model Results

eQUEST Economizer													
Electric Consumption (kWh x000)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	4.13	4.92	7.91	11.12	15.4	19.94	24.09	23.76	18.92	13.62	6.69	4.25	154.74
Heat Reject.	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0
Space Heat	5.08	4.05	3.29	1.86	1.15	0.35	0.13	0.1	0.27	1.12	3.39	5.58	26.37
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot Water	0.33	0.31	0.34	0.32	0.31	0.28	0.26	0.25	0.24	0.26	0.27	0.3	3.47
Vent. Fans	10.81	9.77	10.83	10.5	10.88	10.62	11	11.01	10.62	10.9	10.48	10.81	128.23
Pumps & Aux.	1.52	1.37	1.52	1.47	1.52	1.47	1.52	1.52	1.47	1.52	1.47	1.52	17.87
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Equip.	36.12	32.63	36.12	34.96	36.12	34.96	36.12	36.12	34.96	36.12	34.96	36.12	425.33
Task Lights	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.43
Area Lights	6.13	5.54	6.13	5.94	6.13	5.94	6.13	6.13	5.94	6.13	5.94	6.13	72.21
Total	64.25	58.69	66.27	66.29	71.63	73.67	79.38	79.01	72.54	69.79	63.3	64.84	829.65

Demand Control (CO_2) Ventilation Calculation

Baseline eQUEST Energy Model Runs	Annual Electrical Cooling Energy Use (kWh)	Demand Control Ventilation Savings	Total Annual Electrical Savings (kWh)
Heating and Cooling Energy Plus Fan and Pump Energy	365,660	20.0%	73,132

Chilled Water Reset: Model Results

eQUEST CW Reset													
Electric Consumption (kWh x000)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	10.81	10.14	12.19	13.34	15.93	18.85	22.29	21.98	17.98	15	11.5	10.69	180.7
Heat Reject.	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0
Space Heat	4.08	3.29	2.71	1.56	0.99	0.33	0.13	0.1	0.24	0.91	2.69	4.54	21.58
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot Water	0.33	0.31	0.34	0.32	0.31	0.28	0.26	0.25	0.24	0.26	0.27	0.3	3.47
Vent. Fans	10.82	9.77	10.83	10.51	10.88	10.62	11	11.01	10.62	10.9	10.48	10.81	128.25
Pumps & Aux.	1.52	1.37	1.52	1.47	1.52	1.47	1.52	1.52	1.47	1.52	1.47	1.52	17.87
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Equip.	36.12	32.63	36.12	34.96	36.12	34.96	36.12	36.12	34.96	36.12	34.96	36.12	425.33
Task Lights	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.43
Area Lights	6.13	5.54	6.13	5.94	6.13	5.94	6.13	6.13	5.94	6.13	5.94	6.13	72.21
Total	69.93	63.16	69.97	68.21	72.01	72.55	77.58	77.23	71.57	70.97	67.41	70.24	850.84

Energy Efficient Motors: Model Results

eQUEST Energy Efficient Motors													
Electric Consumption (kWh x000)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	11.88	11.14	13.37	14.61	17.4	20.47	24.03	23.71	19.58	16.41	12.61	11.76	196.97
Heat Reject.	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigeration	0	0	0	0	0	0	0	0	0	0	0	0	0
Space Heat	4.09	3.3	2.72	1.56	0.99	0.33	0.13	0.1	0.24	0.91	2.69	4.55	21.61
HP Supp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Hot Water	0.33	0.31	0.34	0.32	0.31	0.28	0.26	0.25	0.24	0.26	0.27	0.3	3.47
Vent. Fans	10.53	9.51	10.55	10.23	10.59	10.33	10.7	10.71	10.34	10.61	10.2	10.53	124.83
Pumps & Aux.	1.4	1.26	1.4	1.35	1.4	1.35	1.4	1.4	1.35	1.4	1.35	1.4	16.43
Ext. Usage	0	0	0	0	0	0	0	0	0	0	0	0	0
Misc. Equip.	36.12	32.63	36.12	34.96	36.12	34.96	36.12	36.12	34.96	36.12	34.96	36.12	425.33
Task Lights	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	1.43
Area Lights	6.13	5.54	6.13	5.94	6.13	5.94	6.13	6.13	5.94	6.13	5.94	6.13	72.21
Total	70.6	63.79	70.75	69.08	73.07	73.77	78.9	78.55	72.76	71.96	68.13	70.91	862.28

Occupancy Sensor HVAC Calculation

Baseline eQUEST Energy Model Runs	Baseline Electrical Use (kWh)	Typical Savings	Cooling Savings (kWh)
Cooling and Heating Energy Use	365,660	10.0%	36,566