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Boise Air Traffic Control Tower: High Performance and Sustainable Building Guiding Principles Technical Assistance

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September 2013

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Pacific Northwest National Laboratory
Richland, Washington 99352

Executive Summary

All new commercial Federal buildings and major renovations must comply with the Guiding Principles for High-Performance and Sustainable Buildings (Guiding Principles) per Executive Orders 13423 and 13514, the implementing guidance for Guiding Principles, and the Code of Federal Regulations Part 433 (10 CFR 433), Energy Efficiency Standards for New Federal Commercial and Multi-Family High-Rise Residential Buildings. 10 CFR 433 focuses on setting energy design standards for Federal buildings. The Guiding Principles for New Construction and Major Renovations address five key areas:

- Employ Integrated Design Principles
- Optimize Energy Performance
- Protect and Conserve Water
- Enhance Indoor Environmental Quality
- Reduce Environmental Impact of Materials

The Federal Aviation Administration (FAA) regularly constructs new Air Traffic Control Towers across the country. The agency asked the Federal Energy Management Program (FEMP) for technical assistance to identify methods that would help FAA meet the Guiding Principles for this building type.

Although the Guiding Principles cover a range of sustainable building requirements, the FAA requested particular advice regarding the Guiding Principles requirements covering Energy Efficiency, Environmental Tobacco Smoke Control, and Environmental Impacts of Materials. The Guiding Principles require that agencies construct new buildings to use 30% less energy than would a building designed to perform at the minimum level set forth in model industry energy code: the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) 90.1-2007. Additionally, the Guiding Principles prohibit smoking in the building and within 25 feet of an entrance. Of further concern to the FAA, the Guiding Principles also require that Federal agencies include, in new construction project solicitations, a preference for construction materials and products that contain recycled content, biobased content, and environmentally preferable products, where those materials and products meet performance requirements and are available at a reasonable cost.

This analysis first addresses the Energy Efficiency requirement of the Guiding Principles as applied to new Air Traffic Control Tower building designs, followed by a review and recommendations addressing the Guiding Principles requirements relative to smoking and materials acquisition.

The FAA provided an existing Air Traffic Control Tower building design, the Boise Air Traffic Control Tower, on which FEMP [PNNL] analysts could base a tower design-specific review and model energy analysis. This location offered the greatest amount of available data relative to other designs, including an energy model of an early design developed with Recovery Act funds and design drawings.

The Boise Air Traffic Control Tower is comprised of three primary elements: the Tower and the Tower Cab (the windowed top of the Air Traffic Control Tower), the Base Station (office spaces), and the traffic control room with an intense computational function (in the center of the Base Station). FEMP energy analysts determined that the energy used to condition the traffic control room could be treated as

"process energy" under 10 CFR 433.2, since the mission-critical function of that part of the building meets the regulatory definition of process load; it is sufficiently related to FAA's safety mission, and cannot be designed for energy efficiency improvements without jeopardizing FAA's mission of safe conduct of aircraft. FAA maintains separate programs, outside of the design and construction program, to improve the operations of the traffic control room and its energy efficiency.

The methodology used for this analysis included the development of an ASHRAE 90.1-2007, Appendix G-compliant baseline model, and an energy efficient scenario using ASHRAE's Advanced Energy Design Guide (AEDG) for Small to Medium Office Buildings. The energy analysis resulted in almost 35% energy savings for the whole building with one-third of the energy associated with heating, cooling, and ventilation systems, one-third associated with humidification systems, and one-third associated with lighting (Table 1).

Table 1. Boise Air Traffic Control Tower Modeled Energy Savings

	Baseline (mWh)	**Proposed (mWh)**	**End-Use Savings**	**Building Savings**
Space Cool	53.94	62.73	-16.3%	-1.8%
Heat Rejection	0.21	0.00	100.0%	0.0%
Space Heat	71.61	77.42	-8.1%	-1.2%
Ventilation Fans	108.07	30.51	71.8%	15.5%
Pumps	4.98	3.94	21.0%	0.2%
Humidification	84.14	30.96	63.2%	10.6%
Hot Water	12.20	9.31	23.7%	0.6%
Lighting	109.24	55.62	49.1%	10.7%
Total Energy Consumption	**499.41**	**325.51**	**34.8%**	**34.8%**

The Energy Efficiency Measures recommended for future FAA Air Traffic Control Tower buildings include:

- Lighting: Add daylighting sensors and controls in perimeter spaces, reduce the office LPD to 0.75 W/ ft^2 using energy efficient lighting systems, and reduce the Control Tower stairwell LPD to 0.3 W/ ft^2 through the use of a bi-level fixture.

- Humidification: Include humidification systems that use a differential dry bulb air economizer. For areas where minimum humidity needs to be maintained the system would include a low humidity economizer lockout to prevent mixed-air humidity ratios below 0.0056 lb/lb.

- Hot water: Install low flow faucets to decrease hot water demand and use a condensing hot water heater with 90 percent efficiency.

- Heating, Cooling, and Ventilation: In general, increased insulation, improved fenestration (where feasible), higher efficiency heating and cooling equipment, variable flow pumps, and variable air volume fans selected for a building's specific climate zone, should offer

significant energy savings over the baseline model. The selected systems will be different based on climate zone. It is recommended the design teams refer to the AEDG for Small to Medium Office Buildings to identify appropriate alternatives for the specific location.

FAA can meet the Environmental Tobacco Smoke Control requirement by referencing FAA Order 3900.47, "Smoking Restrictions in FAA Controlled or Occupied Space," which prohibits smoking in all buildings controlled or occupied by FAA. This policy must be negotiated with each national union. Where those negotiations allow smoking, the union negotiation language should be provided as part of the Guiding Principles documentation.

FAA can meet the Reduce Environmental Impacts of Materials requirement by developing and using an FAA-wide acquisition guidance document that includes information on the relevant Federal requirements, external materials information resources, and project submittal requirements. These documents are sufficient evidence to demonstrate conformance with this Guiding Principles requirement.

Acronyms and Abbreviations

AEDG	Advanced Energy Design Guide
AFUE	Annual fuel utilization efficiency
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
Btu	British Thermal Unit
CFR	Code of Federal Regulations
CHW	Chilled Water
COP	Coefficient of performance
DOAS	Dedicated Outdoor Air System
DOE	Department of Energy
EEM	Energy efficiency measures
EER	Energy efficiency ratio
EPA	Environmental Protection Agency
eQUEST	QUick Energy Simulation Tool
F	Fahrenheit
FAA	Federal Aviation Administration
FEMP	Federal Energy Management Program
FSRIA	Farm Security and Rural Investment Act
ft^2	square feet
Guiding Principles	High-Performance and Sustainable Buildings
hr	hour
HVAC	Heating, ventilation and air conditioning
HW	Hot Water
IESNA	Illuminating Engineering Society of North America
lb	pound
LPD	Lighting Power Density
mWh	Megawatt hours
n/a	not applicable
PNNL	Pacific Northwest National Laboratory
PSZ	Packaged Single Zone
RCRA	Resource Conservation and Recovery Act
SHGC	Solar Heat Gain Coefficient
TRACON	Terminal Radar Approach Control Facility
USDA	United States Department of Agriculture
VAV	Variable Air Volume
W	Watt

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1.0 Overview

The Federal Aviation Administration (FAA) plans to build a considerable number of Air Traffic Control Towers in the near term. FAA must achieve Federal energy efficiency and sustainable design goals applicable to new construction and major renovations of Federal buildings. The Department of Energy's (DOE) Federal Energy Management Program (FEMP) provided technical assistance on design and management methods FAA can use to meet these Federal requirements.

This analysis identifies design strategies that, if employed, would enable new Control Tower facilities to meet the Guiding Principles for High-Performance and Sustainable Buildings (Guiding Principles) per Executive Orders 13423 (EO13423, 2007) and 13514 (EO13514, 2009), the implementing guidance for Guiding Principles (OMB, 2008), and the Code of Federal Regulations (CFR) Part 433, Energy Efficiency Standards for New Federal Commercial and Multi-Family High-Rise Residential Buildings (10CFR433, 2013).

The primary mechanism for identifying design strategies was through the use of energy savings analysis performed on the Air Traffic Control Tower located in Boise, Idaho. A baseline model, compliant with American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) 90.1-2007, Appendix G (ASHRAE, 2007) was developed for the purpose of this analysis, and potential energy savings were analyzed through the application in the model of several energy efficiency measures (EEMs). This document provides a summary of the energy model baseline, an EEM model, and an explanation of EEMs various to different climate zones. Finally, the study provides recommendations addressing FAA's specific questions relative to the materials acquisition and indoor environmental quality Guiding Principles requirements.

1.1 Regulatory Drivers

New Federal construction and major renovations must comply with the Guiding Principles and 10 CFR 433. The Guiding Principles are organized around five primary directives:

- Employ Integrated Design Principles
- Optimize Energy Performance
- Protect and Conserve Water
- Enhance Indoor Environmental Quality
- Reduce Environmental Impact of Materials

The majority of the analysis provided for the FAA Air Traffic Control Tower buildings focuses on methods FAA may use to conform to the Optimize Energy Performance requirement. FAA has expressed interest in receiving guidance on aspects of the Enhance Indoor Environmental Quality and Reduce Environmental Impacts of Materials principles, as well.

Within the Optimize Energy Performance principle, the energy modeling analysis focuses on how the FAA Air Traffic Control Tower buildings could meet the following:

> *Energy Efficiency. Establish a whole building performance target that takes into account the intended use, occupancy, operations, plug loads, other energy demands, and design to earn the ENERGY STAR® targets for new construction and major renovation where applicable.* ***For new construction, reduce the energy use by 30 percent compared to the baseline building performance rating per the American National Standards Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., (ASHRAE)/Illuminating Engineering Society of North America (IESNA) Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential.*** *For major renovations, reduce the energy use by 20 percent below pre-renovations 2003 baseline. Laboratory spaces may use the Labs21 Laboratory Modeling Guidelines. Use ENERGY STAR® and FEMP-designated Energy Efficient Products, where available.*

Setting ENERGY STAR® targets and the Labs21 Laboratory Modeling Guidelines are not applicable for the Air Traffic Control Tower building type. The use of ENERGY STAR® and FEMP-designated Energy Efficient Products, where available, can be incorporated into the FAA acquisition guidance documentation being developed to address the materials areas. The energy modeling analysis discussed in this report focused on those EEMs that could be included in the new building designs to reach the 30 percent better than ASHRAE 90.1-2007 Guiding Principles requirement.

Additionally Federal regulations under [EISA 2007] also address the requirement for new construction to be designed 30 percent better than ASHRAE 90.1, with the qualifier that the agency, at a minimum, must implement those energy efficiency measures that are life cycle cost effective, (10 CFR 433):

> *(2) All Federal agencies shall design new Federal buildings that are commercial and multi-family high-rise residential buildings, for which design for construction began on or after August 10, 2012, to:*
>
> *(i) Meet ASHRAE 90.1-2007, (incorporated by reference, see § 433.3); and*
>
> *(ii) If life-cycle cost-effective, achieve energy consumption levels, calculated consistent with paragraph (b) of this section, that are at least 30 percent below the levels of the ASHRAE Baseline Building 2007.*
>
> *(b)* ***Energy consumption for the purposes of calculating the 30 percent savings shall include space heating, space cooling, ventilation, service water heating, lighting and all other energy consuming systems normally specified as part of the building design except for receptacle and process loads.***
>
> *(c) If a 30 percent reduction is not life-cycle cost-effective, the design of the proposed building shall be modified so as to achieve an energy consumption level at or better than the maximum level of energy efficiency that is life-cycle cost-effective, but at a minimum complies with paragraph (a) of this section.*

Prior to the release of this document, but after the analysis was completed, an updated version of the energy efficiency performance standard was released that references ASHRAE 90.1-2010 as the baseline. This update was not incorporated into the analysis as it does not directly affect the Guiding Principles requirement.

The Federal regulation offers modeling parameters that can be used for buildings with unique, mission-critical loads, such as particularized loads that are operational in the Air Traffic Control Tower

building type. These regulatory parameters are instructive in interpreting the requirement for purposes of determining compliance with the Guiding Principles energy efficiency requirement.

The Enhance Indoor Environmental Quality Guiding Principles requirement for which FAA requested assistance relates to their union contracts allowing smoking in the buildings:

> *Environmental Tobacco Smoke Control. Implement a policy and post signage indicating that smoking is prohibited within the building and within 25 feet of all building entrances, operable windows, and building ventilation intakes during building occupancy.*

FAA's request for guidance on applying the "Reduce Environmental Impacts of Materials" requirements relates to how the agency should incorporate the solicitation language and/or guidance of building materials acquisition into design specifications sufficient to meet the relevant Guiding Principles requirement:

> *Recycled Content. Per Section 6002 of the Resource Conservation and Recovery Act (RCRA), for [Environmental Protection Agency] EPA-designated products, specify products meeting or exceeding EPA's recycled content recommendations. For other products, specify materials with recycled content when practicable. If EPA-designated products meet performance requirements and are available at a reasonable cost, a preference for purchasing them shall be included in all solicitations relevant to construction, operation, maintenance of or use in the building. EPA's recycled content product designations and recycled content recommendations are available on EPA's Comprehensive Procurement Guideline web site at <www.epa.gov/cpg>.*
>
> *Biobased Content. Per Section 9002 of the Farm Security and Rural Investment Act (FSRIA), for [United States Department of Agriculture] USDA-designated products, specify products with the highest content level per USDA's biobased content recommendations. For other products, specify biobased products made from rapidly renewable resources and certified sustainable wood products. If these designated products meet performance requirements and are available at a reasonable cost, a preference for purchasing them shall be included in all solicitations relevant to construction, operation, maintenance of or use in the building. USDA's biobased product designations and biobased content recommendations are available on USDA's BioPreferred web site at <www.usda.gov/biopreferred>.*
>
> *Environmentally Preferable Products. Use products that have a lesser or reduced effect on human health and the environment over their lifecycle when compared with competing products or services that serve the same purpose. A number of standards and ecolabels are available in the marketplace to assist specifiers in making environmentally preferable decisions. For recommendations, consult the Federal Green Construction Guide for Specifiers at <www.wbdg.org/design/greenspec.php>.*

1.2 Building Description

The building design used as the basis of the energy modeling analysis was the Boise Air Traffic Control Tower buildings. This building offered the greatest amount of existing data relative to other designs, including a previous analysis providing energy efficiency recommendations and an initial energy model (Arends & Sandusky, 2010), as well as design drawings. Based on that available data and initial

model, this analysis includes 9000 ft^2 of Tower space, and 525 ft^2 of windowed Tower Cab space with a full view of the airfield. In addition to the Tower, the building footprint includes a single-story base support building, referred to as the Base Station, which provides 11,000 ft^2 of office space. The Base Station also includes the air traffic control room, an energy intense operational space characterized by powerful computers critical to managing the Terminal Radar Approach Control (TRACON).

For the purposes of the energy modeling of the Air Traffic Control Tower, [FEMP/PNNL] analysts determined that there are limited opportunities to improve the energy efficiency of the specialized computer systems and equipment needed in the TRACON, such that those energy loads meet the definition of process loads under 10 CFR 433.2, particularly in light of the jeopardy to life safety that would result from modifications to that specialized equipment.[1] Accordingly, the process loads associated with that room were removed from the energy modeling analysis.

FAA is committed to improving the energy efficiency of the TRACON while maintaining or improving the ability of its employees and systems to maintain safe air travel. Notably, TRACON design improvements are managed separately from the building design improvements to ensure that those systems are kept fail-safe. The specialty nature of the TRACON is so significant that it comprises more than half the energy used by the combined building components of the Air Traffic Control Tower.

In consideration of all of the foregoing facts, the energy use of the TRACON was judged to meet the process load exemption under 10 CFR 433.4, which supports a correlative exemption of that process load under the Guiding Principle for energy efficiency. The energy use of the entire Air Traffic Control Tower buildings with the TRACON function was modeled and the intense computing aspects of the space were removed from the analysis throughout the remainder of the document (Table 2).

Table 2. Air Traffic Control Tower Buildings Baseline Model Energy Use

Baseline Model	Total Energy (mWh)[1]
Air Traffic Control Tower buildings with TRACON function	888.41
Air Traffic Control Tower buildings without TRACON function	499.41

[1] Megawatt hours (mWh)

Accordingly, the baseline model of the Air Traffic Control Tower buildings without the TRACON function is the modeled baseline energy use value used for the energy efficiency analysis in this report.

1.3 Energy Modeling Software

An energy model of the Air Traffic Control Tower buildings baseline energy use and an energy efficient equipment scenario were developed per the Guiding Principles Energy Efficiency and 10 CFR 433 requirements. There are many energy modeling tools available on the market. For this analysis the QUick Energy Simulation Tool (eQUEST) was used. eQUEST was selected for multiple reasons:

[1] With respect to process loads (for example, medical or industrial equipment), the Department is excluding these energy end-uses from the energy savings metric. Process loads typically involve specialized equipment for which improvements in energy efficiency may affect the functionality of the equipment or where improvements are not available at all. Some Federal buildings use most of their energy serving process loads, and application of the energy savings requirement to these buildings would likely place an undo [sic] burden on the rest of the building if the 30 percent savings is to be achieved. 72 FR 72565, 72568 (December 21, 2007).

- This analysis is based on an existing eQUEST model that was developed for a previous project, eliminating the need to duplicate aspects of the modeling that already had been substantially completed,

- eQUEST is used for hourly analysis and provides the level of detail needed to address the Guiding Principles modeling and analysis requirements, and

- eQUEST is a commonly used energy modeling tool available free on-line[1] that can be used by future modelers of FAA buildings.

The EnergyPlus modeling tool, developed by DOE, offers more detailed energy modeling and analysis than eQUEST. Although EnergyPlus is a very useful tool, especially when integrated short period analysis is needed, it typically requires a greater level of energy modeling expertise and modeling time. The detailed level of analysis provided by EnergyPlus[2] was not needed to answer the questions regarding meeting the Guiding Principles Energy Efficiency and 10 CFR 433 requirements for this project.

[1] eQUEST download available at: http://www.doe2.com/ or http://apps1.eere.energy.gov/buildings/tools_directory/software.cfm/ID=575/pagename=alpha_list

[2] EnergyPlus download available at: http://apps1.eere.energy.gov/buildings/energyplus/

2.0 Energy Efficiency Measures

eQUEST models were developed to address the Guiding Principles Energy Efficiency and 10 CFR 433 requirement of a 30% energy use reduction compared to an ASHRAE 90.1-2007 baseline for FAA Air Traffic Control Tower buildings without the TRACON function located in Boise, Idaho (Climate Zone 6). The baseline model is a minimum compliant building design. The comparison model includes energy efficiency measures identified in the ASHRAE Advanced Energy Design Guide (AEDG) for Small to Medium Office Buildings (ASHRAE, 2011) and industry best practices. In this section the energy modeling analysis is summarized by the following end uses: heating, cooling and ventilation; humidification; hot water; and lighting.

2.1 Heating, Cooling, Ventilation, and Envelope

The construction assembly has been kept consistent between the baseline and proposed model. The AEDG for Small and Medium Offices (ASHRAE, Advanced Energy Design Guide for Small to Medium Office Buildings, 2011) was used to identify the proposed energy efficiency envelope measures for Climate Zone 6 (Table 3). Insulation levels have been increased for the wall, roof and floor construction. Window properties have been modified for the Base Station, but not for the Tower Cab. Energy savings associated with the envelope changes are incorporated into the heating, cooling, and ventilation savings.

Table 3. Envelope Assembly ASHRAE 90.1-2007 Requirements and Proposed Energy Efficiency Measures

Surface	**90.1-2007 Construction Assembly**	**U Factor (Btu/ft^2 F hr)** [1] **90.1-2007 Baseline**	**U Factor (Btu/ ft^2 F hr) Proposed**
Exterior Wall	Steel Framed	R-13 + R-7.5 ci	R-13 + R-18.8 ci
Exterior Roof	Insulation Entirely Above Deck	R-20 ci	R-30 ci
Exterior Floor	Slab on Grade	R-10 for 24 in	R-20 for 48 in
Exterior Door	Metal Swinging	0.7	0.5
Vertical Fenestration (Excluding Cab)	Metal Framed	U- 0.55 SHGC[2]- 0.40	U- 0.39 SHGC- 0.38

[1] British Thermal Units per square foot degrees Fahrenheit hour (Btu/ft^2 F hr)

[2] Solar Heat Gain Coefficient (SHGC)

The baseline energy model is defined by ASHRAE 90.1-2007 Appendix G (3.1.1 Exception b) and includes: a water cooled chiller with minimum efficiency requirements and gas fired boiler for the offices and Packaged Single Zone (PSZ) systems with direct expansion cooling and gas furnaces for the Control Tower. ASHRAE requires spaces with peak thermal loads differing by over 10 Btu/hr ft^2 or with schedules that differ by over 40 equivalent full load hours per week use baseline PSZ systems type 3 or 4. The PSZ systems have constant volume fans operating almost continuously and variable air volume (VAV) fans for the chilled water system. The baseline design also includes constant speed pumps.

The energy efficient design scenario uses a high efficiency air cooled chiller with improved part load performance and a condensing gas boiler with 96 percent efficiency. VAV fans with static pressure reset

are used for the office spaces. The model also included improvements in the ductwork, such as motorized outdoor air dampers and duct sealant, which provided for fan energy savings. Table 4 provides a comparison of the baseline and energy efficiency scenario technologies.

Table 4. Baseline and Proposed Building Cooling and Heating Equipment

	Baseline	**Proposed**
Cooling Equipment		
Chiller	COP[1] 4.45	COP 5.5
PSZ TRACON	10.8 EER[2]	n/a
Heating Equipment		
Boiler	75 percent AFUE[3]	96 percent Condensing Boiler
Gas Furnace	78 percent AFUE	n/a
Pumps		
CHW[4] Primary Pump	Fixed Flow	Variable Flow Pump
CHW Secondary Pump	Variable Flow Pump	n/a
HW[5] Pump	Fixed Flow	Variable Flow Pump
Fans		
Chiller	Variable Air Volume	Variable Air Volume with static pressure reset
PSZ Systems	Constant Volume	n/a

[1] Coefficient of Performance (COP)
[2] Energy Efficiency Ratio (EER)
[3] Annual Fuel Utilization Efficiency (AFUE)
[4] Chilled water (CHW)
[5] Hot Water (HW)

Reducing the energy used for the heating, cooling, and distribution systems by 27 percent results in a 13 percent impact on the whole building energy use (Table 5).

Table 5. Heating, Ventilation, and Air Conditioning (HVAC) Energy Load

	Baseline (mWh)	**Proposed (mWh)**	**End-Use Savings**	**Building Savings**
Space Cool	53.94	62.73	-16.3%	-1.8%
Heat Rejection	0.21	0.00	100.0%	0.0%
Space Heat	71.61	77.42	-8.1%	-1.2%
Ventilation Fans	108.07	30.51	71.8%	15.5%
Pumps	4.98	3.94	21.0%	0.2%
HVAC Energy Consumption	**238.81**	**174.59**	**26.9%**	**12.9%**

2.2 Humidification

Humidification is required for the operation of the TRACON. The baseline system included electric humidifiers with a 60 percent maximum humidity limit and 30 percent minimum humidity limit. The

baseline system has an air economizer with a dry-bulb high limit shut off of 75 degrees Fahrenheit. This results in a high outdoor air intake and thus requires larger humidification system energy use.

The proposed humidification system uses a differential dry bulb air economizer. A low humidity economizer lockout to prevent mixed air humidity ratios below 0.0056 lb/lb is included, which provides economizer controls to prevent excessive humidification.

Reducing the energy used for the building and data center humidification system by 63 percent results in a nearly 11 percent impact on the whole building energy use (Table 6).

Table 6. Humidification Energy Load

	Baseline (mWh)	Proposed (mWh)	End-Use Savings	Building Savings
Humidification	84.14	30.96	63.2%	10.6%

A previous energy efficiency study recommended the use of ultrasonic humidifiers. Ultrasonic humidifiers are expected to have lower maintenance costs, but typically a higher first cost. The report described the technology in the following manner:

> "Ultrasonic humidifiers use a piezo-electric transducer to create a high-frequency mechanical oscillation in a body of water. The water tries to follow the high frequency oscillation but cannot because of its comparative weight and mass inertia. Thus, a momentary vacuum is created on the negative oscillation, causing the water to cavitate into vapor. The transducer follows with a positive oscillation that creates high pressure compression waves on the water's surface, releasing tiny droplets of water into the air. This mist is extremely fine, with droplets about 1 micron in diameter, which are quickly absorbed into the air flow." (Arends & Sandusky, 2010)

Whether either of these proposed systems are used, there is significant energy savings potential with the humidification system.

2.3 Hot Water

The ASHRAE 90.1-2007 baseline hot water system is a natural gas fired water heater with a 50 gallon storage capacity. The energy efficiency scenario included a condensing hot water heater with 90 percent efficiency and assumed a 10% decrease in hot water demand through the use of low flow faucets. By reducing the energy used for hot water systems by almost 24 percent there is less than a one percent impact on the whole building energy use (Table 7).

Table 7. Hot Water Energy Load

	Baseline (mWh)	Proposed (mWh)	End-Use Savings	Building Savings
Hot Water	12.20	9.31	23.7%	0.6%

2.4 Lighting

The primary internal loads in a building are lighting, equipment and occupancy. The equipment is not regulated by ASHRAE 90.1-2007 and the equipment energy use is not changed in the energy model. Occupancy assumptions are not altered either. Additional energy efficient lighting and daylighting sensors are supposed in the office spaces and Tower stairway. Table 8 summarizes the baseline and energy efficiency lighting scenarios by showing the Lighting Power Density (LPD) values included in the model. The model uses LPD values rather than specifying a technology solution. The AEDG offers multiple lighting options for meeting the LPD targets including (ASHRAE, 2011, pp. 140-154):

- Daylighting sensors and controls with a 30 foot candle setpoint
- T8 High Performance Lamps with lamp efficacy of 90+ nominal lumens per watt or T5 Lamps and Ballasts

The model does assume one specific technology for use in the Tower stairway: bi-level stairway lighting. A bi-level fixture has dual lighting levels so that when a space is occupied, the fixtures provide lighting at the full level, however, when the space is unoccupied these fixtures switch to stand-by mode and provide lighting at a minimum, but safe level.[1]

Table 8. Lighting Proposed Energy Efficiency Measures

	90.1-2007 Baseline LPD (W/ft^2)[1]	**Proposed Design LPD (W/ft^2)**
Offices	1.1	0.75
Control Tower Stairway	0.5	0.3

[1] Watt per square feet (W/ft^2)

Use of energy efficient lighting and daylight sensors has a multi-faceted impact of energy use by reducing lighting energy consumption, reducing cooling load, and increasing heating load. By reducing the energy used by lighting systems by 49 percent there is an almost 11 percent energy savings impact for the whole building (Table 9).

Table 9. Lighting Energy Load

	Baseline (mWh)	**Proposed (mWh)**	**End-Use Savings**	**Building Savings**
Lighting	109.24	55.62	**49.1%**	**10.7%**

2.5 Other Potential Energy Efficiency Measures

In addition to the energy efficiency measures modeled to meet the Guiding Principles and the regulatory energy efficiency requirements, the energy modeling team suggests FAA consider the following measures in future designs:

[1] More information about bi-level stairwell lighting can be found at: http://www1.eere.energy.gov/femp/technologies/eut_bilevel_stairwell.html

Control Tower Stairway: For the stairway in the tower structure, rather than unit ventilators with variable speed fans, savings may be achieved at a lower cost with fan coil units that cycle on and off to meet thermal loads. Ventilation would be met by a single dedicated outdoor air system (DOAS) that serves all floors of the tower. The DOAS would be active only when the tower was actually occupied.

Service Water Heat Recovery: Two additional options are available to offer water heating savings. Air-source water heaters can be installed inside each data equipment room that could extract heat from the air in those rooms. An alternative approach would be to use water-to-water heat pumps for water heating, with recovered heat from a chilled water return. This approach is likely to have a higher first cost.

Data Center (Process) Energy: Although the TRACON data center energy use was not included in the energy analysis and is not the responsibility of FAA facility design team, there are many proven strategies that may be useful for the broader FAA to consider. EPA's ENERGY STAR Program offers proven tips in the categories of information technology opportunities, airflow management, and HVAC adjustments.[1] The DOE Advanced Manufacturing Office has a program focused on reducing Data Center energy use in response to addressing Executive Order 13514 mandate for Federal agencies to implement green data center strategies.[2] Coordination with the TRACON data center energy efficiency team will be necessary to optimize the design of systems that can cost effectively be integrated with the building design. One example is with the data center humidification setpoints. Savings can be achieved by reducing the humidification setpoint from 30% to 20% in the data equipment areas. 20% is within the allowed range in ASHRAE standards, and is more appropriate for more rugged modern data equipment. If the humidity setpoint is lowered, the low humidity lockout for the economizer should be lowered as well, increasing the economizer effectiveness. Alternatively, a more efficient ultrasonic humidifier could be used.

2.6 Energy Efficiency Measures by Climate Zone

The design features selected for any given model building design necessarily vary by climate zone. For the purposes of this analysis, the energy modeling team used Boise, Idaho in Climate Zone 6 to derive the appropriate energy savings calculations (ASHRAE, 2011). FAA should adapt the eQUEST baseline and energy efficiency scenario models prepared for the Boise Air Traffic Control Tower buildings to accommodate differences in the building layout and to address design differences due to location of other planned towers in different climate zones.

The Lighting, Humidification, and Hot Water energy efficiency measures need not vary by location. The impact of the measures may vary across climate zones, but the measures can be effectively deployed in any climate zone. (ASHRAE, 2011, p. 28)

The AEDG for Small to Medium Office Buildings provides energy efficiency measure recommendations for eight climate zones to achieve 50% energy savings compared to an ASHRAE 90.1-2004 baseline. Note that the Guiding Principles requirements are compared to an ASHRAE 90.1-2007 baseline, so there is not a one-to-one correlation between the savings in the AEDG and Guiding Principles

[1] EPA Energy Star Data Center Energy Efficiency recommendations can be found at: http://www.energystar.gov/index.cfm?c=power_mgt.datacenter_efficiency

[2] DOE Advanced Manufacturing Office Data Center Program can be found at: http://www1.eere.energy.gov/manufacturing/datacenters/

documentation. The AEDG is a free, downloadable report from the ASHRAE webpage that could be used by the FAA design teams to select specific, proven energy efficient measures by location/climate zone. The guide provides information on integrated design (Chapters 2 and 3), design strategies by climate zone (Chapter 4), and implementation recommendations (Chapter 5). DOE has defined 8 Climate Zones in the United States, shown in Figure 1. The zones are defined by whether they have hot, mild, cold, humid, dry, and/or marine attributes.

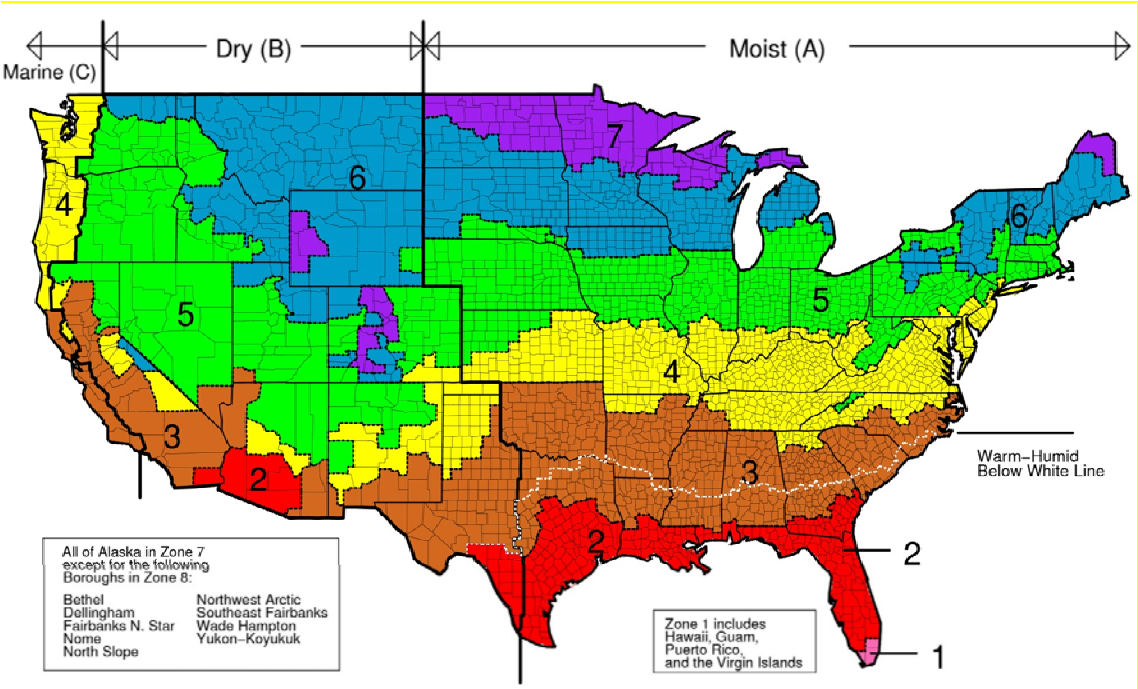

Figure 1. DOE Climate Zones (Briggs, Lucas, & Taylor, 2003)

Each of the eight climate zones has two pages of energy efficiency measure recommendations that could be considered during the design of future FAA Air Traffic Control Center buildings. The AEDG needs to be consulted for each FAA Air Traffic Control Tower design project for the selection of the most appropriate HVAC and envelope technologies for the Climate Zone. An example of the variability of the values in the AEDG for building envelope can be seen in Table 10.

Table 10. Climate Zone Specific Envelope Energy Efficiency Measures from AEDG (ASHRAE, 2011)

Climate Zone and Example City	Attic	Wall Insulation (Wood Framed)	Heated Slabs
1 – Miami	R-38.0	R-13.0	R-7.5 for 12 inches
2 – Houston/Phoenix	R-38.0	R-13.0 + R-3.8 c.i.	R-10.0 for 24 inches
3 – Atlanta/Los Angeles/Las Vegas	R-38.0	R-13.0 + R-3.8 c.i.	R-15.0 for 24 inches
4 – Baltimore/ Albuquerque/Seattle	R-49.0	R-13.0 + R-7.5 c.i.	R-20.0 for 24 inches
5 – Chicago/Denver	R-49.0	R-13.0 + R-10.0 c.i.	R-20.0 for 24 inches
6 – Minneapolis/Helena	R-49.0	R-13.0 + R-12.5 c.i.	R-20.0 for 48 inches
7 – Duluth	R-60.0	R-13.0 + R-15.0 c.i.	R-20.0 for 48 inches

Climate Zone and Example City	Attic	Wall Insulation (Wood Framed)	Heated Slabs
8 – Fairbanks	R-60.0	R-13.0 + R-18.8 c.i.	R-20.0 full slab

3.0 Indoor Environmental Quality and Materials

3.1 Environmental Tobacco Smoke Control

The Guiding Principles requirement for Environmental Tobacco Smoke Control prohibits smoking inside the building or within 25 feet of building entrances. FAA can meet this requirement by referencing FAA Order 3900.47, "Smoking Restrictions in FAA Controlled or Occupied Space," which prohibits smoking in all buildings controlled or occupied by FAA (FAA, 1990). This policy must be negotiated with each national union. Where those negotiations allow smoking in a specific building, FAA should provide the union negotiation language as part of its Guiding Principles documentation. If other standard FAA union documentation exists that addresses FAA compliance with Federal non-smoking requirements, those documents can also be used as Guiding Principles compliance documentation.

3.2 Reduce Environmental Impacts of Materials

The building materials related Guiding Principles requirements include specifying the use of recycled content materials, biobased content materials, and environmentally preferable products in construction solicitation language. Several Federal agencies have developed acquisition guidelines that assist in the process of incorporating these requirements into design and construction specifications. The acquisition guidance can be written for different audiences using varying levels of detail. Specific materials information or acquisition guidance can be incorporated directly into the design specifications of a project, or the guidance can be incorporated as direction to the construction contractor and include submittal requirements. An example of an organization's acquisition guidance, which FAA may choose to adopt or adapt, is attached in Appendix B. Generally, the acquisition guidance documentation includes:

- References to the Federal or agency-specific requirements,
- Links to DOE, EPA, and USDA websites that keep up-to-date lists of product requirements and offerings,
- Lists of specific materials or products that are minimum required purchases for that Agency or for a specific building, and/or
- Submittal or compliance documentation requirements for contractors.

Some of the most commonly referenced websites include:

- FEMP Designated Energy Efficient Products: This site provides a list of the related Federal requirements, a tool to identify the energy requirements for different product categories, model acquisition language, training, and additional resources to support compliance with energy efficient product purchases. (URL: https://www1.eere.energy.gov/femp/technologies/procuring_eeproducts.html)
- EPA Comprehensive Procurement Guidelines: This site provides useful information on recycled content product requirements and strategies for selecting the best products for the situation. (URL: http://www.epa.gov/epawaste/conserve/tools/cpg/index.htm)

- USDA Biobased Products: This site provides a list of product categories covered as biobased products and the ability to find labeled products. (URL: http://www.biopreferred.gov/Biobased_Products.aspx)

- ENERGY STAR® Products: This site provides a list of ENERGY STAR qualified products that are applicable to Federal purchasing requirements. (URL: http://www.energystar.gov/index.cfm?c=products.pr_find_es_products)

- WaterSense® Labeled Products: This site guides the user toward the products that have been through independent, third–party testing and certification to determine whether they have met EPA's specifications for water efficiency and performance. (URL: http://www.epa.gov/watersense/products/index.html)

Providing one FAA-wide acquisition guidance document that can be used for all new construction projects would offer the most consistent mechanism for implementing and documenting compliance to the Guiding Principles requirement.

4.0 Recommendations

FAA identified three Guiding Principles requirements as areas of concern for FAA Air Traffic Control Tower buildings and those compliance opportunities were evaluated as part of this study. Compared to typical office buildings, the Air Traffic Control Towers are energy intensive structures due to high process loads as well as relatively longer hours of operation. If FAA is able to incorporate the recommendations from this report into future tower designs, it is probable that the agency can meet the Guiding Principles requirements in those towers, regardless of location.

For the Guiding Principles Energy Efficiency requirement, FAA should incorporate the following energy efficiency measures into future FAA Air Traffic Control Tower buildings:

- Lighting: Add daylighting sensors and controls in perimeter spaces, reduce the office LPD to 0.75 W/ ft^2 using energy efficient lighting systems, and reduce the Control Tower stairwell LPD to 0.3 W/ ft^2 through the use of a bi-level fixture.

- Humidification: Include humidification systems that use a differential dry bulb air economizer. For areas where minimum humidity needs to be maintained the system would include a low humidity economizer lockout to prevent mixed-air humidity ratios below 0.0056 lb/lb.

- Hot water: Install low flow faucets to decrease hot water demand and use a condensing hot water heater with 90 percent efficiency.

- Heating, Cooling, and Ventilation: The selected systems will be different based on climate zone. It is recommended the design teams refer to the AEDG for Small to Medium Office Buildings (ASHRAE, 2011) to identify appropriate alternatives for the specific location. In general, increased insulation, improved fenestration (where feasible), higher efficiency heating and cooling equipment, variable flow pumps, and variable air volume fans selected for a building's specific climate zone, should offer significant energy savings over the baseline model.

If FAA includes these EEMs in the design, based on the eQUEST model developed for this project, the Air Traffic Control Towers should realize energy savings that surpass the energy performance design requirement of 30% better than ASHRAE 90.1-2007. Table 11 shows the modeled end use energy savings for the Boise Air Traffic Control Tower.

Table 11. End Use Energy Savings for Boise Air Traffic Control Tower Buildings

	Baseline (mWh)	**Proposed (mWh)**	**End-Use Savings**	**Building Savings**
Space Cool	53.94	62.73	-16.3%	-1.8%
Heat Rejection	0.21	0.00	100.0%	0.0%
Space Heat	71.61	77.42	-8.1%	-1.2%
Ventilation Fans	108.07	30.51	71.8%	15.5%
Pumps	4.98	3.94	21.0%	0.2%

	Baseline (mWh)	Proposed (mWh)	End-Use Savings	Building Savings
Humidification	84.14	30.96	63.2%	10.6%
Hot Water	12.20	9.31	23.7%	0.6%
Lighting	109.24	55.62	49.1%	10.7%
Total Energy Consumption	**499.41**	**325.51**	**34.8%**	**34.8%**

FAA already has incorporated many energy efficient design strategies Air Traffic Control Tower designs. The exclusion of the TRACON function process energy load (per 10 CFR 433 suggested modeling parameters) in the baseline model allows for the documentation of energy savings associated with the building energy use within the control of the FAA design professionals to meet the requirement. To reduce the time usually required to develop an energy model to document Guiding Principles compliance, the eQUEST energy models developed for this project are available for adaptation for future FAA Air Traffic Control Tower building designs.

FAA can meet the Environmental Tobacco Smoke Control requirement by referencing FAA Order 3900.47, "Smoking Restrictions in FAA Controlled or Occupied Space," which prohibits smoking in all buildings controlled or occupied by FAA (FAA, 1990). FAA also should reference subsequent union negotiation documentation as it applies to a specific building.

To meet the "Reduce Environmental Impacts of Materials" Guiding Principles requirement, FAA should develop an agency-wide acquisition guidance document that can be used with all design and construction projects. The acquisition guidance should include relevant Federal requirements, provide information resources, and detail project submittal requirements that can be used as part of the Guiding Principles documentation. Developing one guidance document for all projects offers consistency across projects with respect to both execution and compliance documentation.

5.0 References

10CFR433. (2013). *Energy Efficiency Standards for New Federal Commercial and Multi-Family High-Rise Residentical Buildings.* 42 U.S.C. 6831-6832, 6834-6835; 42 U.S.C. 7101 et seq. . Washington, DC: 78 FR 40945.

Arends, J., & Sandusky, W. (2010). *American Recovery and Reinvestment Act (ARRA) FEMP Technical Assistance; Federal Aviation Admistration Project 209 - Control Tower and Support Building, Boise, Idaho.* Richland: PNNL-19502. Pacific Northwest National Laboratory.

ASHRAE. (2007). *ANSI/ASHRAE/IESNA Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings.* Atlanta, GA: ASHRAE.

ASHRAE. (2011). *Advanced Energy Design Guide for Small to Medium Office Buildings.* Atlanta, Georgia: ASHRAE.

EO13423. (2007). *Strengthening Federal Environmental, Energy, and Transportation Management.* codified by 111th Congress, HR1105 §748. Washington, DC: President of the United States.

EO13514. (2009). *Federal Leadership in Environmental, Energy, and Economic Performance.* Washington, DC: President of the United States.

OMB. (2008). *High-Performance Sustainable Design Guidance.* Washington, DC: Office of Management and Budget.

Appendix A: eQUEST Modeling Results

Energy simulations developed for the annual energy savings estimates were modeled using eQUEST version 3.64. The energy model for the Boise Air Traffic Control Tower (Arends & Sandusky, 2010) was modified to create the ASHRAE 90.1-2007 baseline. The design includes a Base Station which holds the TRACON, the control tower which provides the air traffic controller occupied space (Tower Cab). This appendix documents the model assumptions for the baseline and proposed models as well as the energy modeling results.

A.1 ASHRAE 90.1-2007 Baseline Model by End-Use

The table below summarizes the monthly end-use energy consumption for heating, cooling, fans, and lights for the ASHRAE 90.1-2007 baseline model. The major end uses include equipment, lighting and heating.

Table 12. ASHRAE 90.1-2007 Baseline Model Monthly Energy Consumption by End-Use.

Electric Consumption (kWh x 1000)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0.02	0.5	3.0	5.0	9.4	14.1	11.1	7.4	3.0	0.4	0	53.9
Heat Reject	0	0	0	0.01	0.01	0.04	0.08	0.05	0.02	0	0	0	0.2
Space Heat	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Hot Water	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Vent. Fans	9.2	8.3	9.1	8.8	9.1	9.0	9.4	9.3	8.9	9.1	8.8	9.1	108.1
Pumps & Aux.	9.9	10.4	14.5	8.0	3.6	3.4	1.0	2.1	3	10.8	10.8	11.6	89.1
Area Lights	9.2	8.4	9.3	9.1	9.2	9.1	9.3	9.3	9	9.3	8.9	9.3	109.3
Total	28.3	27.0	33.4	28.9	26.9	30.9	33.9	31.8	28.4	32.1	28.9	30.1	360.6
Gas Consumption (Btu x 000,000)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	0	0	0	0	0	0	0	0	0
Heat Reject	0	0	0	0	0	0	0	0	0	0	0	0	0
Space Heat	65.8	39.0	28.2	9.1	3.8	1.4	0.2	0.9	1.9	8.1	36.4	49.7	244.4
Hot Water	3.9	3.5	3.9	3.7	3.6	3.3	3.2	3.1	3.1	3.3	3.4	3.7	41.6
Vent. Fans	0	0	0	0	0	0	0	0	0	0	0	0	0
Pumps & Aux.	0	0	0	0	0	0	0	0	0	0	0	0	0
Area Lights	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	69.7	42.6	32.1	12.8	7.4	4.7	3.4	4.0	4.9	11.4	39.7	53.4	286.0

A.2 Model Development

The schedules of operation have been developed from the original energy model for the analysis of the existing Boise ATC tower. It assumes twenty-four hours a day, seven days a week occupancy for the control tower and TRACON, due to the mission critical nature of the work. The Base Station is assumed to be occupied 5 days a week, with no occupancy over weekends. The lighting, equipment loads, heating and cooling temperature set point schedule, follow the schedule of occupancy and have been defined in the tables below.

Table 13. Occupancy and Lighting Schedules.

Start Hour	End Hour	Occupancy Fraction				Lighting Fraction			
		Control Tower		Base Station		Control Tower		Base Station	
		Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
24	1	0.603	0.603	0	0	0.620	0.620	0.2	0.2
1	2	0.603	0.603	0	0	0.620	0.620	0.2	0.2
2	3	0.636	0.636	0	0	0.655	0.655	0.2	0.2
3	4	0.807	0.807	0	0	0.834	0.834	0.2	0.2
4	5	0.870	0.870	0.0131	0	0.885	0.885	0.2	0.2
5	6	0.896	0.896	0.1659	0	0.898	0.898	0.3204	0.2
6	7	0.900	0.900	0.6384	0	0.900	0.900	0.736	0.2
7	8	0.900	0.900	0.8481	0	0.900	0.900	0.8733	0.2
8	9	0.894	0.894	0.8953	0	0.900	0.900	0.8976	0.2
9	10	0.852	0.852	0.8811	0	0.900	0.900	0.9	0.2
10	11	0.792	0.792	0.7491	0	0.900	0.900	0.9	0.2
11	12	0.771	0.771	0.5417	0	0.900	0.900	0.9	0.2
12	13	0.779	0.779	0.5606	0	0.900	0.900	0.9	0.2
13	14	0.835	0.835	0.8434	0	0.900	0.900	0.9	0.2
14	15	0.891	0.891	0.9	0	0.900	0.900	0.9	0.2
15	16	0.900	0.900	0.8717	0	0.900	0.900	0.8854	0.2
16	17	0.900	0.900	0.6704	0	0.900	0.900	0.768	0.2
17	18	0.900	0.900	0.3165	0	0.900	0.900	0.5034	0.2
18	19	0.895	0.895	0.1253	0	0.898	0.898	0.3176	0.2
19	20	0.867	0.867	0.099	0	0.883	0.883	0.2386	0.2
20	21	0.811	0.811	0.0939	0	0.845	0.845	0.2	0.2
21	22	0.664	0.664	0.0596	0	0.715	0.715	0.2	0.2
22	23	0.631	0.631	0.0091	0	0.643	0.643	0.2	0.2
23	24	0.608	0.608	0	0	0.622	0.622	0.2	0.2

Table 14. Equipment Schedules.

Start Hour	End Hour	Equipment Fraction			
		Control Tower		Base Station	
		Weekday	Weekend	Weekday	Weekend
24	1	0.6426	0.6426	0.12	0.12
1	2	0.6426	0.6426	0.12	0.12
2	3	0.6728	0.6728	0.12	0.12
3	4	0.8272	0.8272	0.12	0.12
4	5	0.8787	0.8787	0.1335	0.12
5	6	0.8971	0.8971	0.2786	0.12
6	7	0.9000	0.9000	0.6984	0.12
7	8	0.9000	0.9000	0.8632	0.12
8	9	0.8974	0.8974	0.8967	0.12
9	10	0.8803	0.8803	0.8922	0.12
10	11	0.8554	0.8554	0.8376	0.12
11	12	0.8468	0.8468	0.7518	0.12
12	13	0.8498	0.8498	0.7596	0.12
13	14	0.8730	0.8730	0.8766	0.12
14	15	0.8961	0.8961	0.9	0.12
15	16	0.9000	0.9000	0.8889	0.12
16	17	0.9000	0.9000	0.7732	0.12

Start Hour	End Hour	Equipment Fraction			
		Control Tower		Base Station	
		Weekday	Weekend	Weekday	Weekend
17	18	0.9000	0.9000	0.4365	0.12
18	19	0.8982	0.8982	0.2454	0.12
19	20	0.8871	0.8871	0.2029	0.12
20	21	0.8478	0.8478	0.164	0.12
21	22	0.7014	0.7014	0.1435	0.12
22	23	0.6566	0.6566	0.1236	0.12
23	24	0.6444	0.6444	0.12	0.12

Table 15. Heating and Cooling Temperature Setpoints

Start Hour	End Hour	Cooling Setpoint		Heating Setpoint		Cooling Setpoint		Heating Setpoint	
		Control Tower				Base Station			
		Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
24	1	76	76	70	70	80	80	60	60
1	2	76	76	70	70	80	80	60	60
2	3	76	76	70	70	80	80	60	60
3	4	76	76	70	70	80	80	60	60
4	5	76	76	70	70	80	80	60	60
5	6	76	76	70	70	80	80	60	60
6	7	76	76	70	70	74	80	70	60
7	8	76	76	70	70	74	80	70	60
8	9	76	76	70	70	74	80	70	60
9	10	76	76	70	70	74	80	70	60
10	11	76	76	70	70	74	80	70	60
11	12	76	76	70	70	74	80	70	60
12	13	76	76	70	70	74	80	70	60
13	14	76	76	70	70	74	80	70	60
14	15	76	76	70	70	74	80	70	60
15	16	76	76	70	70	74	80	70	60
16	17	76	76	70	70	74	80	70	60
17	18	76	76	70	70	80	80	60	60
18	19	76	76	70	70	80	80	60	60
19	20	76	76	70	70	80	80	60	60
20	21	76	76	70	70	80	80	60	60
21	22	76	76	70	70	80	80	60	60
22	23	76	76	70	70	80	80	60	60
23	24	76	76	70	70	80	80	60	60

Table 16. Heating and Cooling Temperature Setpoints.

Start Hour	End Hour	TRACON				Base Station				Control Tower			
		Cooling Setpoint		Heating Setpoint		Cooling Setpoint		Heating Setpoint		Cooling Setpoint		Heating Setpoint	
		WD	WED	WD	WED	WD	WED	WD	WED	WD	WED	WD	WED
24	1	75	75	70	70	80	80	60	60	80	80	67	67
1	2	75	75	70	70	80	80	60	60	80	80	67	67
2	3	75	75	70	70	80	80	60	60	80	80	67	67
3	4	75	75	70	70	80	80	60	60	80	80	67	67
4	5	75	75	70	70	80	80	60	60	80	80	67	67
5	6	75	75	70	70	80	80	60	60	80	80	67	67
6	7	75	75	70	70	75	80	70	60	80	80	67	67
7	8	75	75	70	70	75	80	70	60	80	80	67	67
8	9	75	75	70	70	75	80	70	60	80	80	67	67
9	10	75	75	70	70	75	80	70	60	80	80	67	67
10	11	75	75	70	70	75	80	70	60	80	80	67	67
11	12	75	75	70	70	75	80	70	60	80	80	67	67
12	13	75	75	70	70	75	80	70	60	80	80	67	67
13	14	75	75	70	70	75	80	70	60	80	80	67	67
14	15	75	75	70	70	75	80	70	60	80	80	67	67
15	16	75	75	70	70	75	80	70	60	80	80	67	67
16	17	75	75	70	70	75	80	70	60	80	80	67	67
17	18	75	75	70	70	80	80	60	60	80	80	67	67
18	19	75	75	70	70	80	80	60	60	80	80	67	67
19	20	75	75	70	70	80	80	60	60	80	80	67	67
20	21	75	75	70	70	80	80	60	60	80	80	67	67
21	22	75	75	70	70	80	80	60	60	80	80	67	67
22	23	75	75	70	70	80	80	60	60	80	80	67	67
23	24	75	75	70	70	80	80	60	60	80	80	67	67

Appendix B
Sample Acquisition Guidance Document

Guideline for Acquisition of Environmentally Preferable Products

Effective Date: [*as requirements are updated the guidance documentation may need to be updated*]

Contact: [*a designated expert contact within the Agency*]

1.0 Requirements

[*Federal Agency name*] is required by Executive Orders, the Resource Conservation and Recovery Act (RCRA), and Code of Federal Regulations to comply with the requirements pertaining to the acquisition of environmentally preferable products and services and energy-efficient products.

The Environmental Protection Agency's (EPA) Environmentally Preferable Purchasing Program started in 1993 after the signing of Executive Order (EO) 12873, and continues today under Executive Order 13423. The following purchasing requirements are included in EO 13423:

- Recycled-Content Products: Section 6002 of the Resource Conservation and Recovery Act (RCRA) established the Federal buy-recycled program. EPA designates recycled-content products. Recommendations primarily pertain to the levels of recycled materials that the designated products should contain.

- Biobased Products: The United States Department of Agriculture (USDA) issued a final rule establishing the framework for the Federal Biobased Products Preferential Purchasing Program under Section 9002 of the Farm Security and Rural Investment Act (FSRIA) of 2002. It is similar to the buy-recycled program managed by the U.S. EPA under RCRA, and was created in order to issue guidance for establishing affirmative procurement programs for buying Biobased products. As defined by FSRIA, "biobased products" are products determined by the U.S. Secretary of Agriculture to be commercial or industrial goods (other than food or feed) composed in whole or in significant part of biological products, forestry materials, or renewable domestic agricultural materials, including plant, animal, or marine materials.

- Energy-Efficient Products: The EPA works with the Department of Energy to qualify energy-efficient products and building practices through the ENERGY STAR® program. The Department of Energy also designates purchasing specifications for energy-efficient products through the Federal Energy Management Program (FEMP), Energy Policy Act of 2005, Section 104. The Energy Policy Act of 2005 requires federal agencies to buy ENERGY STAR® qualified products, including computer desktops, laptops and monitors. In addition, EO 13423 requires federal agencies to purchase electronic products registered with EPEAT, when a standard is available for the product. EPEAT currently registers computer desktops, laptops and monitors.

- Water-Efficient Products: Federal agencies are directed to reduce water use and improve water efficiency through several executive and legislative orders. EO 13423 directs each Federal agency beginning in FY 2008 to reduce water consumption by two percent annually through the end of

the FY 2015, or 16 percent by the end of FY 2015. The EO also directs federal sites to conduct water audits of at least 10 percent of facility square footage annually and to conduct audits at least every 10 years. Federal agencies are encouraged to purchase water efficient products and services, including WaterSense® labeled products, and use contractors who are certified through a WaterSense® labeled program, where applicable.

2.0 Recycled Content

To achieve our Environmental Stewardship Policy and meet federal requirements, [*Federal Agency name*] weighs the environmental preferability of the products and services selected in all of its purchasing decisions. Additionally, certain federally designated products must be purchased with specific environmental attributes as required by federal law and EO 13423. The current list of designated products and required attributes are listed on the EPA website (http://www.epa.gov/epawaste/conserve/tools/cpg/products/index.htm) are organized by the following eight categories:

1. Paper and Paper Products
2. Non-paper Office Products
3. Vehicular Products
4. Construction Products
5. Transportation Products
6. Park and Recreation Products
7. Landscaping Products
8. Miscellaneous Products including awards and plaques, bike racks, blasting grit, industrial drums, manual-grade strapping, mates, pallets, signage, and sorbents

3.0 Biobased Products

[*Federal Agency name*] requires the purchase of USDA Biopreferred products as designated by the ten rounds of requirements that are in place as of September 2013 (http://www.biopreferred.gov/ProposedAndFinalRegulations.aspx). Products with requirements can be found on the USDA's Biopreferred website.

4.0 Energy and Water

[*Federal Agency name*] requires the purchase of ENERGY STAR® qualified products or products conforming to the Federal Energy Management Program's (FEMP) Energy Efficient Requirements when such a designation is available, life cycle cost effective, and they meet applicable performance standards of ENERGY STAR® or FEMP designated products.

5.0 Agency Specific Purchasing Requirements

[*Specific environmentally preferable products that must be purchased or exceptions to environmentally preferable products that are specific to the Agency are included here.*]

6.0 Resources

The following websites should be used to identify products that must be purchased to meet the Federal environmentally preferable products acquisition requirements:

- FEMP Designated Energy Efficient Products: https://www1.eere.energy.gov/femp/technologies/procuring_eeproducts.html
- EPA Comprehensive Procurement Guidelines: http://www.epa.gov/epawaste/conserve/tools/cpg/index.htm
- USDA Biobased Products: http://www.biopreferred.gov/Biobased_Products.aspx
- ENERGY STAR® Products: http://www.energystar.gov/index.cfm?c=products.pr_find_es_products
- WaterSense® Labeled Products: http://www.epa.gov/watersense/products/index.html

7.0 Purchasing Records/Submittal Documentation

[*The format for this section should mimic Agency-specific construction submittal documentation and/or other purchasing documentation requirements. For environmentally preferable products the submittal should include a list of products purchased that meet the requirements and a list of products that were purchased that are within a designated category but did not meet the requirements. For the products that did not meet the requirements a reason for the purchase should be provided. Typically those reasons include: pre-defined Agency exceptions, higher cost, products were not available that met the quality expectations, and/or the environmentally preferable products were not readily available.*]

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