

National Aeronautics and Space Administration (NASA)

2018 Sustainability Report and Implementation Plan

Executive Summary

NASA's sustainability policy is to execute the mission without compromising the planet's resources so that future generations can meet their needs. In the risk management culture of NASA, that means we endeavor to implement proactive measures to reduce NASA's exposure to environmental, institutional, programmatic, and operational risks. In doing so, we continuously improve the resilience of NASA's space and ground asset operations and performance. NASA will continue to integrate sustainability principles into existing policies and procedures to foster awareness, approaches, and actions for a more sustainable world. For example, the Agency's energy management program reduces risk to NASA's mission by minimizing potential energy insecurity while also increasing the cost-effectiveness of our scarce resources. Since 1995, NASA has reduced facility energy consumption by 28.2%, resulting in a cost avoidance of more than \$46.2 million in our fiscal year (FY) 2017 energy bill. Although this is impressive, and a great reflection of the hard work and dedication of our personnel, more remains to be done to maintain NASA's focus on cost-effective stewardship of our resources.

NASA remains committed to integrating sustainability practices into its operations in order to maintain a cost-effective agency dedicated to accomplishing its core missions. Current sustainability integration activities under way at NASA include the following:

- Technical capabilities assessments align and streamline required assets to fit NASA's mission and strategic goals;
- Master Plans and Capital Investment Plans inform construction and demolition investments to reduce life-cycle costs and ensure stewardship of the infrastructure required to support missions and capabilities;
- Building designs address different kinds of risks: operational and mission risks, such as direct mission risks (schedule, cost, technical); safety, security and health; legal requirements; and climate risks (short term, long term, and extreme events);
- Center plans and strategies incorporate technologies and best practices that enable them to identify and execute the most cost-effective energy initiatives, thus improving our energy security and reducing total life-cycle costs in support of our missions;
- A 10-year Strategic Energy Investment Plan supports NASA's mission by targeting resources to improve efficiency and effectiveness while achieving annual energy goals; and
- A land management policy incorporates flooding risks into facility renovation and construction investment evaluations.

Strategic Priorities for FY 2018-2020

NASA is committed to pursuing continuous improvement in its operations to achieve efficiencies wherever possible, save resources, and maintain cost-effectiveness that keeps ahead of inflation and rising energy unit costs. Three initiatives in particular highlight NASA's continuing commitment to responsibly stewarding public resources:

Energy Efficiency Projects – NASA's Strategic Energy Investment Plan (SEIP) prioritizes energy efficiency projects that decrease facility costs and improve reliability; the SEIP also provides guidance on implementing both appropriated and financed projects. In particular, the plan promotes bundling energy conservation measures into efficiency projects. Projects include heating, ventilation, and air conditioning

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(HVAC) efficiency improvements, other mechanical system upgrades, chilled water and steam piping insulation replacement, lighting retrofits, energy management control system upgrades, and various other energy efficiency improvements. In addition, retro-commissioning efforts are underway to ensure top building performance and to identify new opportunities for improvement.

Sustainable, High-Efficiency Buildings – NASA continues to reduce the footprint of its portfolio of built assets through strategic demolition and consolidation efforts. The design of new or remodeled buildings minimizes long-term infrastructure energy, water, and maintenance costs. In FY 2018, NASA expects to add four new high performance facilities (with a total area of nearly 190,000 gross square feet (GSF)), thereby increasing the inventory of sustainable facilities to more than 3.2 million GSF. These buildings are the Wallops Flight Facility (WFF) Island Fire Station, the WFF Mission Operations Control Center, the Langley Research Center Katherine G. Johnson Computational Research Facility, and the Johnson Space Center Human Health and Performance Laboratory.

Renewable Energy Projects – The SEIP also identifies and prioritizes Centers’ renewable energy and storage projects with a strong emphasis on improving the energy resiliency and security of critical mission elements and reducing life-cycle energy expenditures. New renewable energy initiatives include additional solar photovoltaic systems.

In all of these initiatives, NASA managers weigh several factors to maximize cost-effectiveness, including life-cycle costs, payback periods, and the value of long-term resiliency and security to avoid disruptions to mission activities. Furthermore, NASA’s persistent pursuit of Energy Savings Performance Contracts and Utility Energy Service Contracts yields impressive life-cycle savings with reduced upfront investment costs for the Agency.

Implementation Summary

1. Facility Management:

FACILITY ENERGY EFFICIENCY

Status FY 2017: Reduced energy intensity (Btu/GSF) by 40% compared to 2003
 Reduced energy intensity by 19% compared to 2015

<i>Implementation Status</i>	<i>Operational Context</i>	<i>Priority Strategies & Planned Actions</i>
NASA successfully achieved the FY 2017 goal for energy intensity through energy conservation measures and on-site renewable energy projects. NASA Centers reduce energy consumption through all available methods,	NASA is facing increasing challenges in reducing energy consumption. NASA excludes many mission-dependent facilities from the energy intensity metric per guidance (e.g., Mission Control Center at Johnson Space Center and Spacecraft Systems Development and	NASA will continue to invest in life-cycle cost-effective energy efficiency projects using all available funding streams, including appropriated funds,

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<p>including energy efficiency and renewable energy project implementation; operations and maintenance best practices; sustainable building design, construction, and renovation; and employee training, outreach and awareness.</p> <ul style="list-style-type: none"> - NASA’s first Combined Heat and Power (CHP) plant began full-time operations in spring 2018 at Johnson Space Center. This project saves source energy and increases site-delivered energy. 	<p>Integration Facility at Goddard Space Flight Center); however, mixed use buildings are harder to classify. Without sub-metering in these buildings, we cannot estimate how energy intensity is impacted by mission activity that should be excluded. Projects with the highest rate of return on investment (e.g., light-emitting diode [LED] lighting upgrades or HVAC upgrades) have been completed at many Centers. Remaining potential conservation measures have longer paybacks and/or are located in highly specialized facilities. Thus, optimizing energy efficiency and reducing utility costs will be increasingly difficult.</p>	<p>financing, and Enhanced Use Lease Agreements. Investments are guided by the Agency SEIP.</p> <p>In addition, assessments for CHP implementation at other Centers are ongoing. Systems like CHP increase energy efficiency, reduce greenhouse gas (GHG) emissions, and improve energy security.</p>
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EFFICIENCY MEASURES, INVESTMENT, AND PERFORMANCE CONTRACTING

ESPC and UESC investment / number of projects FY 2017: \$0.0M / 0

<i>Implementation Status</i>	<i>Operational Context</i>	<i>Priority Strategies & Planned Actions</i>
<p>As planned, NASA awarded \$0.0M investment value in ESPCs and UESCs in FY 2017. From start of FY 2018 through end of July 2018, NASA awarded nearly \$23.4M investment value in ESPCs and UESCs; this already surpassed by nearly \$17.5M our pledge to award \$5.9M in FY 2018. This success is due to a data center ESPC awarded at Jet Propulsion Laboratory in Feb 2018, estimated to annually avoid 12.6 billion Btus of energy and \$2.7M in energy and related expenditures.</p> <ul style="list-style-type: none"> - Glenn Research Center completed implementing FY 2016 ESPC that includes nine energy and water conservation measures. Conducting measurement and verification (M&V) to assess performance against annual avoidance estimates. - Johnson Space Center began operating the Combined Heat and Power plant constructed under FY 2015 ESPC. Conducting final commissioning and M&V to assess performance against annual avoidance estimates. 	<p>In addition to conventional energy conservation measures, projects began implementing more challenging and complex measures with longer development cycles such as combined heat and power and data centers.</p>	<p>NASA will implement and monitor energy performance contracts awarded in FY 2015, 2016, and 2018. NASA will continue to develop potential ESPC and UESC projects that support the mission at various Centers. However, at this time, NASA does not plan to award any performance contracts in FY19.</p>

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RENEWABLE ENERGY

Status FY 2017:

13.0% of total electricity consumed was from renewable sources

<i>Implementation Status</i>	<i>Operational Context</i>	<i>Priority Strategies & Planned Actions</i>
<p>NASA successfully exceeded its FY 2017 goal for 10% Renewable Electric Energy. This is result of a diverse mix of renewable sources and technologies, including on-site electricity and thermal energy generation or conversion, direct purchases, a hosted solar photovoltaic (PV) project, and renewable energy certificate purchases. On-site generation ranges from small solar parking lot lighting projects to larger geothermal heat pump systems and a 1 megawatt (MW) solar PV system, with many additional projects in progress.</p> <ul style="list-style-type: none"> - Completed installation of geothermal heat pumps at Glenn Research Center in FY 2017; expect to complete two additional solar PV systems at White Sands Test Facility and Kennedy Space Center. Will benefit from peak shaving, reduced energy costs, and increased energy security. 		<p>The Agency SEIP summarizes potential renewable energy projects (solar, wind, and storage) at each Center and provides estimates for economic viability of projects. Based on this analysis, NASA is now strategically deploying funding to construct renewable energy projects that provide the most economic and resilience benefit to the Agency. Other planned actions include continued efforts to work with local utilities and/or adjoining military installations on potential projects.</p>

WATER EFFICIENCY

Status FY 2017:

Reduced potable water intensity (gal/GSF) by 38% compared to FY 2007
Potable water intensity increased 4% compared to FY 2016

<i>Implementation Status</i>	<i>Operational Context</i>	<i>Priority Strategies & Planned Actions</i>
<p>NASA significantly exceeded its potable water intensity and industrial and landscaping water consumption reduction goals in FY 2017. Continued to implement major water infrastructure upgrades by replacing aging distribution systems, optimizing building</p>	<p>About 97% of NASA water consumption is reported as potable water. NASA continues to be challenged by fluctuations in mission tempo in meeting this goal. A significant portion of success on this metric is due to a sharp reduction in consumption after the Space Shuttle Program ended in FY 2011. Since then, NASA has</p>	<p>NASA Centers will continue to assess their water distribution systems, conduct leak detection audits, replace/repair components, as appropriate, and evaluate using or expanding the</p>

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<p>HVAC systems, installing meters, re-configuring fire protection systems, retrofitting bathroom fixtures, and reducing use of landscaping water systems.</p> <ul style="list-style-type: none"> - Multiple Centers repaired and reconfigured fire protection systems to reduce flushing requirements. - Several Centers continued replacing water-intensive landscaping with drought-tolerant native plants. 	<p>continued to reduce water use; however, a recent increase in Space Launch System Program activity may hinder progress.</p> <p>Many Centers still report problems associated with dated water distribution systems. Continued degradation increases risk of major leaks and potential disruption of mission activities. Repair and rehabilitation requires significant construction because typically large sections must be replaced.</p>	<p>use of water-efficient landscaping to reduce water use. Centers will also continue to assess whether it is appropriate to deploy additional water closed-loop, capture, recharge, and/or reclamation systems. For industrial water uses, NASA will continue to evaluate the need for additional metering.</p>
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HIGH PERFORMANCE SUSTAINABLE BUILDINGS

Status FY 2017:

14% of buildings met Guiding Principles

21% of GSF met Guiding Principles

<i>Implementation Status</i>	<i>Operational Context</i>	<i>Priority Strategies & Planned Actions</i>
<p>Three newly constructed high performance sustainable buildings totaling 165,000 square feet (sf) were completed in FY 2017. The three buildings—Johnson Space Center Health Clinic, Goddard Space Flight Center Flight Projects Building, and Marshall Space Flight Center Office Building—met the Guiding Principles for Sustainable Federal Buildings. In addition, two of the three facilities (GSFC Flight Projects Building and the JSC Health Clinic) received Leadership in Energy and Environmental Design (LEED) Gold ratings in FY 2017 and the MSFC Office Building earned a LEED certified rating.</p>	<p>Meeting the goals for sustainable facilities is dependent upon building commissioning requirements, construction schedules, the demolition program reducing NASA footprint, and verification of meeting the Guiding Principles. These issues greatly impact meeting the goals for FY 2018 and predicting goals for FY 2019.</p>	<p>In FY 2018, NASA Procedural Requirement 8820.2G, Facility Project Requirements, will undergo a thorough revision incorporating new project funding processes, new requirements for NASA High Performance Buildings, and other facilities project processes. In FY 2018, NASA expects to add four new high performance facilities (with a total area of about 190,000 GSF) therefore increasing inventory of sustainable facilities to more than 3.2 million GSF.</p> <p>Will update NASA’s existing <i>Sustainable Facilities Training</i> course with current high performance and sustainable facility strategies emphasizing net zero requirements for new facility projects entering design phase. Plan to schedule one course offering in 2018.</p>

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WASTE MANAGEMENT AND DIVERSION

Status FY 2017: Diverted 59.5% of non-construction solid waste
Diverted 92.6% of construction and demolition waste

<i>Implementation Status</i>	<i>Operational Context</i>	<i>Priority Strategies & Planned Actions</i>
NASA continued to use several means to support and improve solid waste diversion efforts: a) Recycling and Sustainable Acquisition (RSA) Principal Center provides technical resources and implementation support for waste prevention, recycling, and sustainable acquisition; b) a web-based collaboration tool shares RSA work and organizes program activities and initiatives on both individual and team levels; c) Environmental Management Systems focus Center attention by tracking priority aspects that are measured and evaluated on a continual basis; and d) awards programs encourage the workforce, notably the Agency’s Blue Marble Awards program and the EPA Federal Green Challenge.		NASA will continue to maintain and improve Agency websites, host a series of quarterly training opportunities for Agency participants, and maintain a tracking and reporting system for solid waste in the NASA Environmental Tracking System (NETS). During Procurement Management Reviews (PMR), NASA will complete a sample contract review for all applicable FAR clauses relating to waste management.

2. Fleet Management:

TRANSPORTATION / FLEET MANAGEMENT

Status FY 2017: Reduced consumption of petroleum fuel by 66.8% compared to FY 2005
Reduced consumption of petroleum fuel by 8.8% compared to FY 2016;
36% of total Gasoline Gallon Equivalent (GGE) fuel was alternative fuel (same percentage as FY 2016)

<i>Implementation Status</i>	<i>Operational Context</i>	<i>Priority Strategies & Planned Actions</i>
The continued execution of NASA’s Fleet Management Plan maintained the		Plan to continue Vehicle Utilization Review Board (VURB) process of reviewing and

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<p>following objectives: a) optimize use of the vehicle fleet; b) acquire and/or adjust the size and functional utility of each vehicle to match the program’s needs and/or mission’s requirement (right-sizing the vehicle fleet); and c) acquire Alternative Fuel Vehicles (AFV), Flex Fuel Vehicles (FFV), Low GHG emitting and Zero Emission vehicles during end-of-life cycle replacements.</p> <p>NASA Center Transportation Officers (CTOs) manage and control all assigned vehicles and annually evaluate NASA’s vehicle fleet for both existing vehicle assignments and new requests for transportation support. Through the actions of the CTOs, NASA’s FY 2017 Federal Automotive Statistical Tool (FAST) report reflects an overall fleet inventory growth of 3.6%, compared to FY 2016.</p>		<p>evaluating vehicle requirements for both existing and new requests. VURB reviews ensure right-sizing of the NASA fleet, allowing NASA to identify end-of-life vehicle assets and consider opportunities for optimal AFV, FFV, Low GHG and Zero Emission replacement selections.</p> <p>Information Technology (IT) investment within NASA’s Fleet Information Management Systems (FIMS) will allow improved cost and data collection for the Transportation Fleet. Development of coding enhancements will transmit cost and data information electronically from NASA to DOE’s FAST via Vehicle Level Data (VLD), therefore saving hundreds of work hours compared to manual cost and data record keeping and reporting.</p>
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3. Cross-Cutting:

SUSTAINABLE ACQUISITION / PROCUREMENT

Status FY 2017: Decreased percentage of sustainable contract actions by 1.0% compared to FY 2016

 Increased percentage in value of contracts with sustainable clauses by 1.8% compared to FY 2016

<i>Implementation Status</i>	<i>Operational Context</i>	<i>Priority Strategies & Planned Actions</i>
<p>Continued to use several avenues to support and improve sustainable acquisition efforts: a) perform Procurement Management Reviews (PMR) to evaluate sustainable acquisition within contracts and to identify root causes and potential corrective actions or support needed to improve acquisition efforts; b) Recycling and Sustainable Acquisition (RSA) Principal Center provides technical resources and implementation support to community-of-</p>		<p>Continue to use the PMRs performed at each NASA Center on a three-year review cycle. Use the lessons learned from these reviews to inform development of specific training tailored to spur continuous improvement at each Center in FY 2018. Ensure that Federal Procurement Data System</p>

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<p>practice members; and c) contracting officers examine the NASA Form 1707 Environmental /Sustainable Acquisition section completed by the intended acquisition end users; Centers have the option to perform additional pre-solicitation and pre-award reviews. NASA continued to compile data from its contractors on biobased purchases and set an FY 2018 target of \$1M in biobased purchases.</p>		<p>(FPDS) data on new awards entered by NASA contracting personnel accurately reflect actual sustainability clauses in contract awards.</p>
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ELECTRONICS STEWARDSHIP

Status FY 2017: Electronic Product Environmental Assessment Tool (EPEAT): All newly procured systems (PCs/Laptops and monitors) were, to the maximum extent practicable, EPEAT Gold with Power Management: 100% computers, laptops, and monitors had power management enabled
 End of Life: 100% of electronics were disposed through GSA Xcess, Computers for Learning (CFL), Unicorn or a Certified Recycler

<i>Implementation Status</i>	<i>Operational Context</i>	<i>Priority Strategies & Planned Actions</i>
<p>NASA ensured procurement preference for EPEAT Gold-registered products, implemented policies to enable power management, duplex printing, and other energy-efficient features, employed environmentally sound practices with respect to the disposition of electronic products, and procured Energy Star and Federal Energy Management Program (FEMP) designated electronics.</p>		<p>Implement Agency-wide enterprise contract for purchase and maintenance of desktops, laptops, network printers, multifunction devices, and other computing devices. Enterprise contract contains energy efficiency clauses. Continue to implement standardized configurations to manage and monitor energy efficiency settings. Continue to ensure efficiencies in desktop service functions, costs, and compliance with federal initiatives. Continue normal refresh cycle for the Agency Consolidated End-User Services enterprise contract for procured office automation equipment, ensuring 100% compliance with EPEAT standards. Continue to ensure all NASA Enterprise IT Support and Services contracts contain clauses on environmentally sound practices for disposition of all Agency excess or surplus equipment.</p>

GREENHOUSE GAS EMISSIONS

Status FY 2017: Reduced Scope 1 & 2 emissions by 32.1% compared to 2008

<i>Implementation Status</i>	<i>Operational Context</i>	<i>Priority Strategies & Planned Actions</i>
<p>NASA reduced Scope 1 and 2 GHG</p>		<p>NASA will advance efforts to continue reducing</p>

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<p>emissions by 32.1% through FY 2017. Scope 1 includes direct GHG emissions from sources owned by NASA; Scope 2 includes direct GHG emissions from purchased electricity, heat, or steam. Reducing purchased electricity and steam and lowering on-site fossil fuel consumption were the biggest contributors to reductions.</p>	<p>GHG emissions through life-cycle cost-effective strategies. Scope 1 and 2 efforts include investing in more efficient building equipment (boilers, generators, furnaces), replacing or renewing inefficient legacy buildings to standards that exceed required levels of efficiency, and reducing facility footprints to maximum extent practical. NASA is assessing the installation of charging stations at Centers to accommodate employees who commute to work in privately-owned electric vehicles.</p>
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Notable Projects and Highlights

Strategic Energy Investment Plan (2017)

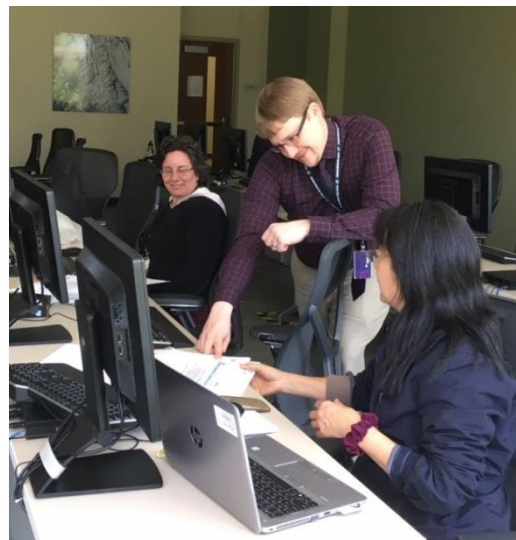
In FY 2017, NASA’s Office of Strategic Infrastructure (OSI) completed the first ever Agency-wide energy assessment, providing NASA leadership with a roadmap of energy efficiency and renewable energy projects that yields the highest return on investment and the greatest positive impact toward meeting federal energy mandates. The NASA Strategic Energy Investment Plan (SEIP) was developed in partnership with the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP), the National Renewable Energy Laboratory (NREL), and industry consultants. The SEIP effort leveraged partners’ expertise and tools, like NREL’s Renewable Energy Optimization (REopt) model and AECOM’s *Sustainable Systems Integration Methodology*™ modeling platform to identify executable measures that reduce energy consumption, optimize renewable energy production, and improve resilience.

The SEIP was developed using a bottom-up and top-down approach. At the Center level, 10-Year Energy Conservation Performance Plans and Forecasts were developed. These 10-Year Plans provided key inputs into the top-down assessment that examined NASA’s current energy baseline and identified energy strategies that offered the best energy reduction and highest cost savings for the Agency. This top-down assessment also used the REopt tool to identify, evaluate, and prioritize on-site renewable energy generation opportunities at each Center.

Results from the SEIP show the potential for significant cost avoidance and savings using a mix of NASA appropriated funding and financing to implement projects. Projections indicate that without additional energy project investments, the Agency will spend approximately \$419M more in utility, maintenance, and repair costs through FY 2035. NASA began programming projects for FY 2019 and FY 2020, including a mix of energy efficiency and renewable energy, based on the results of the assessment.

Training for U.S. Environmental Protection Agency Greenhouse Gas Reporting Requirements

The installation of a Combined Heat and Power unit at Johnson Space Center contributes significantly to energy use reduction goals for the Center and NASA. This energy efficient unit combusts natural gas and produces electricity, steam, and chilled water. This noteworthy



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achievement carries some additional complications for JSC. While the overall GHG emissions associated with energy for JSC are reduced, the *on-site* emissions are now sufficient to trigger an Environmental Protection Agency GHG reporting requirement. NASA had a two-pronged response even before the CHP unit went online – deliver training to Center employees responsible for reporting and prepare a publically available handout to describe details about the new CHP unit and its features. NASA employees from GRC and JSC received training in March 2018 (photo above).

A six-panel handout (front cover shown below) describes how the CHP plant operates, the energy savings achieved through its operation, and relevant EPA greenhouse gas reporting requirements.



New Office Building at Marshall Space Flight Center Boasts Many Sustainable Features

The Marshall Space Flight Center Office Building, over 28,000 sf, received LEED certification in FY2017. The facility employs bio-swales around the building to control storm water run-off and provides parking for low-emitting and government electric vehicle charging. The building reduced energy cost by 30.5% through an improved thermal envelope, high efficiency glazing, shading, occupancy

sensors for high efficiency LED lighting, and a variable air volume HVAC system. The building also underwent an enhanced commissioning process.

Additionally, 83% of construction debris was recycled, 24% of total building materials was manufactured using recycled materials, and 31% of building materials were manufactured within 500 miles of MSFC. The facility incorporates carbon dioxide monitoring in internal zones to ensure proper ventilation.



Low-emitting construction materials were installed and a pre-occupancy flush-out was performed. Temperature and humidity sensors were installed and commissioned permitting control of individual building zones to maintain thermal comfort within the ranges defined in ASHRAE 55-2004.