PNNL-27508

Pacific Northwest
NATIONAL LABORATORY

Federal Guiding Principles for Sustainable New Construction at the 3860 Engineering and Analysis Building

May 2018

JE Pope

U.S. DEPARTMENT OF
ENERGY

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

Pacific Northwest National Laboratory
Richland, Washington 99352

Approvals

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Approved by:	Mike Moran, Sustainability Program Manager	5/7/18 Date
Approved by:	Dave Brown, Chief Engineer	5/7/18 Date
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Approved by:	GREG TURPEN Greg Turpen, Office Building Project Architect	7 MAY 2018 Date

Summary

This report details how PNNL's Engineering Analysis Building complies with each of the requirements in the Council on Environmental Quality's 2008 *Guiding Principles for Sustainable New Construction and Major Renovations.* PNNL continues to meet ongoing requirements, such as those of the Energy Independence and Security Act of 2007 (EISA) Section 432, including quadrennial evaluations, ongoing commissioning, benchmarking, and operating and maintenance requirements.

Acronyms and Abbreviations

ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
CI	continuous insulation
DOE	U.S. Department of Energy
EAB	Engineering Analysis Building
EISA	Energy Independence and Security Act (2007)
EMS	Environmental Management System
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act
EPEAT	Electronic Product Environmental Assessment Tool
F&O	Facilities and Operations
FC	foot-candles
FM	Facility Management
FMCS	facility monitoring and control system
FY	fiscal year
HPSB	High Performance and Sustainable Building
HVAC	heating, ventilation, and air conditioning
IGPP	Institutional General Plant Project
LEED	Leadership in Energy and Environmental Design
PNNL	Pacific Northwest National Laboratory
U.S.	United States
USDA	United States Department of Agriculture

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1.0 Introduction

In 2006, the United States (U.S.) Department of Energy (DOE) signed the Federal Leadership in High Performance and Sustainable Buildings (HPSBs) Memorandum of Understanding (DOE 2006), along with 21 other agencies. The Memorandum of Understanding originally committed DOE to follow the Guiding Principles for new construction and major renovations, and was revised in 2008 to include transforming existing buildings into HPSBs. The Council on Environmental Quality's 2008 *Guiding Principles for Sustainable New Construction and Major Renovations* (CEQ 2008) focus on the following five topic areas:

1. Employ Integrated Design Principles
2. Optimize Energy Performance
3. Protect and Conserve Water
4. Enhance Indoor Environmental Quality
5. Reduce Environmental Impact of Materials.

Executive Order (EO) 13693, *Planning for Federal Sustainability in the Next Decade* (EO 2007), requires that at least 15 percent, by number or total square footage, of an agency's existing federally owned buildings of more than 5,000 gross square feet comply with the revised Guiding Principles by 2025 and that the agency make annual progress toward 100 percent conformance with the Guiding Principles for its building inventory.

Pacific Northwest National Laboratory (PNNL) is exceeding the EO goal of 17 percent compliance with the Guiding Principles, and has over 60 percent of buildings compliant. The pages that follow document the Guiding Principles conformance effort for the 3860 Engineering Analysis Building (EAB) at PNNL (Figure 1). The EAB effort is part of continued progress toward a building inventory that is 100 percent compliant with the Guiding Principles.

The included documentation is intended to provide a narrative of how the EAB complies with each of the Guiding Principles requirements. These narratives draw from the many sources that are explained in the text, and rely on extensive data collection. The descriptions that follow point to each of these sources, providing the reader with specific policies, procedures, and data points.

Figure 1. Front View of the Engineering and Analysis Building

2.0 Guiding Principle Number One – Employ Integrated Design Principles

2.1 Integrated Design

2.1.1 Project Team

Requirement: *Use a collaborative, integrated planning and design process that initiates and maintains an integrated project team as described on the Whole Building Design Guide in all stages of a project's planning and delivery*.

The integrated team at PNNL is detailed on the team roster in Figure 2 and works together to meet the three requirements discussed below.

High Performance and Sustainable Buildings Guiding Principles
Building Information and Project Team Page

Building Information	Federal Real Property Building ID	3860
	Building Name	3860 Engineering Analysis Building
	Agency/Site	DOE / PNNL
	PSO	PNSO
	Department	Office of Science
	Address	860 Horn Rapids Road
	City	Richland
	State	Washington
	Zip Code	99352

		Name	Phone	Email
Project Team	HPSB Project Manager	Jason Pope	(509) 375-7545	jason.pope@pnnl.gov
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	3860 Operations Manager	Curt Nichols	(509) 371-6407	curt.nichols@pnnl.gov
	3860 Project Manager	Jeff Pittman	(509) 371-7056	jeff.pittman@pnnl.gov
	3860 Architect	Greg Turpen, (MMEC consultant)	(509) 371-7947	greg.turpen@pnnl.gov
	3860 Mechanical Engineer	Jeff Scott, (MBI consultant)	(509) 371-6168	jeffery.scott@pnnl.gov
	3860 Electrical Engineer	Brad Graf, (DEI consultant)	(509) 371-7095	bradley.graf@pnnl.gov
	3860 Civil Engineer	David Koontz, (Meier consultant)	(509) 371-7002	da.koontz@pnnl.gov
	3860 Structural Engineer	David Koontz, (DCI consultant)	(509) 371-7002	da.koontz@pnnl.gov
	3860 Commissioning Engineer	Tony Lechelt (Ecx consultitant)	(509) 371-6785	anthony.lechelt@pnnl.gov

HPSB Project Manager Signature:	Jason Pope	Date:	6/20/20017

Figure 2. PNNL Team Roster

2.1.2 Business Case

Requirement: *Use a collaborative, integrated planning and design process that integrates the use of OMB's A-11, Section 7, Exhibit 300: Capital Asset Plan and Business Case Summary.*

The *Office Building Institutional General Plant Project (IGPP) Project Definition Document,*[1] dated June 2014, discusses planning, budgeting, and acquisition of this Federal capital asset, as well as detailing the justification for construction.

The EAB provides additional office space at PNNL near the Physical Sciences Facility, a need identified in the PNNL campus strategy, and is integral to achieving DOE's cumulative campus strategy outcomes by 2023.

[1] PNNL. 2014. *Office Building Institutional General Plant Project (IGPP) Project Definition Document.* S710908-PLAN-PM-001, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

The EAB is built on Federal land and is IGPP funded, with less than $9.5M total estimated cost. The acquisition strategy for the design and construction of this facility is design/bid/build, structured with additive and deductive alternates to make sure the scope is maximized without exceeding the $9.5M threshold. Once the design was completed, construction bids were solicited from qualified contractors. Upon determination of the successful bidder, a firm fixed-price contract was entered into for construction.

2.1.3 Performance Goals

Requirement: *Use a collaborative, integrated planning and design process that establishes performance goals for siting, energy, water, materials, and indoor environmental quality, along with other comprehensive design goals, and ensure incorporation of these goals throughout the design and lifecycle of the building*.

As required by DOE, the PNNL Environmental Management System (EMS) core team develops an annual Site Sustainability Plan. PNNL's progress toward the performance goal categories listed above is captured within the PNNL *FY 2018 Site Sustainability Plan* (PNNL 2017). The EAB siting was done in accordance with the PNNL campus master plan.

Indoor environmental quality is detailed in the Facility Use Agreement, an agreement that formally captures the physical attributes of the facility and operational boundaries, among other things. This agreement is between the Facilities and Operations (F&O) Directorate and the directorate performing research in the EAB, the Energy and Environment Directorate. PNNL procedure ADM-057-PG-01, *Engineering Design Standards*,[2] contains design requirements for indoor environmental air quality and requires American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 62.1, *Ventilation for Acceptable Indoor Air Quality*, to be implemented.

2.1.4 Building Lifecycle

Requirement: *Use a collaborative, integrated planning and design process that considers all stages of the building's lifecycle, including deconstruction*.

The remainder of this report will discuss many of the feature and material considerations made during the design and construction stage of the building lifecycle.

The *Facility Management (FM) and Management and Operations Program Description* at PNNL[3] (2018) identifies the Maintenance and Repair Forecasting application as a key system implementation used during the operations stage of the building's lifecycle. The Maintenance and Repair Forecasting system supplies detailed annual forecasts of maintenance costs, staffing requirements, and deferred maintenance. Additional costs of special safety and security procedures at PNNL are part of the annual assessment.

PNNL is committed to providing a safe and healthy working environment for all staff members; protecting the general public and the environment from unacceptable environmental, safety, and health risks; and operating in a manner that protects and restores the environment.

---

[2] PNNL. 2016. *Engineering Design Standards.* ADM-057-PG-01, Pacific Northwest National Laboratory, Richland, Washington.

[3] PNNL. 2018. *Facility Management & Operations Program Description.* Pacific Northwest National Laboratory, Richland, Washington. https://hdi.pnl.gov/hdi/product/program/pd67d010.pdf.

Since 2002, we have used an International Organization for Standardization 14001 registered EMS (see Figure 3) as a tool to help us measure our environmental performance through a rigorous process of goal-setting, planning, monitoring, and reporting. The Laboratory's sustainability goals development and implementation are spearheaded by an EMS core team, which consists of representatives from key EMS programs. In 2009, we incorporated into our EMS a set of sustainability performance indicators aligned with the Global Reporting Initiative sustainability reporting framework to further improve management of our overall sustainability performance. Annually, the results of our sustainability efforts are captured in a sustainability report. Auditing conducted by an independent third party has verified that PNNL's Sustainability Program is fully integrated into the Laboratory's EMS.

Certificate of Registration

This certifies that the Environmental Management System of

Battelle - Pacific Northwest Division

Pacific Northwest National Laboratory
902 Battelle Boulevard
Mail Stop J2-25
Richland, Washington, 99354, United States

has been assessed by NSF-ISR and found to be in conformance to the following standard(s):

ISO 14001:2004

Scope of Registration:
Pacific Northwest National Laboratory, operated by Battelle for the U.S. Department of Energy: Research and development activities and associated facilities operations

Certificate Number: 6Z781-EM6
Certificate Issue Date: 10-OCT-2014
Registration Date: 20-OCT-2014
Expiration Date *: 19-OCT-2017

Carl Blazik,
Director, Technical
Operations & Business Units,
NSF-ISR, Ltd.

NSF International Strategic Registrations

Figure 3. Battelle – Pacific Northwest Division International Organization for Standardization 14001:2004 Registration

The deconstruction lifecycle phase is addressed in PNNL Administrative Procedure ADM-901.[4] This procedure defines readiness and also the process of deconstruction/decommission. The procedure sets guidelines for establishing facility activity and use limits, facility systems status, material storage control, material location requirements, waste management, facility access control and posting, facility surveillance and maintenance, and management responsibility.

2.2 Commissioning

Requirement: *Employ commissioning practices tailored to the size and complexity of the building and its system components in order to verify performance of building components and systems and help ensure that design requirements are met. This should include an experienced commissioning provider, inclusion of commissioning requirements in construction documents, a commissioning plan, verification of the installation and performance of systems to be commissioned, and a commissioning report.*

[4] De Guia AT. 2017. *Facility Transition Process*, ADM-901, Pacific Northwest National Laboratory, Richland, Washington.
https://facilities.pnl.gov/Vault/Procedures/Administrative%20Procedures/ADM-901.pdf

The procedure for commissioning at PNNL is documented in F&O Administrative Procedure ADM-CM-056, *Facility Commissioning*.[5] This Guiding Principle requirement has four components that must be satisfied, which are detailed below.

2.2.1 Commissioning Provider

An experienced commissioning provider is required. Commissioning for the EAB was provided by EcxTeam, a Fort Worth, Texas, based independent third-party building commissioning and testing, adjusting, and balancing company. Brian Sharkey was the principal engineer in charge of the overall commissioning, testing, adjusting, and balancing. Brian has a total of 25 years in the heating, ventilation, and air conditioning (HVAC) industry, is Leadership in Energy and Environmental Design (LEED) and Snell Certified, and is a National Environmental Balancing Bureau / Testing, Adjusting and Balancing Bureau Certified Professional. EcxTeam is regularly employed in the business of building commissioning and has successfully commissioned such projects as Austin Children's Museum, Fort Sam Houston Joint Base Headquarters, Laughlin Air Force Base Aircraft Maintenance Operations Complex, and Pantex Training Facility, as well as many other similar facilities.

2.2.2 Commissioning in Construction Documents

Commissioning requirements are required to be included in the construction documents. Commissioning requirements are located in Specification Section 01 91113 of the construction documents.

2.2.3 Commissioning Plan

A commissioning plan is required. EcxTeam's *Building Systems Commissioning Plan, Contract #276780-0005*, dated August 30, 2016 was received by the PNNL project team. The plan was reviewed and approved. The purpose of the commissioning process described in the plan is to provide the Owner/Operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner and operate within the performance guidelines set in the design intent.

2.2.4 Verification and Commissioning Report

Verification of the installation and performance of systems to be commissioned and a commissioning report are required. Test results verifying the installation and performance of systems commissioned are included in the commissioning report, which is approved by the PNNL Commissioning Engineer. The cover of this report is shown in Figure 4.

[5] PNNL. 2012. *F&O Administrative Procedure: Facility Commissioning.* ADM-CM-056, Pacific Northwest National Laboratory, Richland, Washington. https://facilities.pnl.gov/Vault/Procedures/Administrative%20Procedures/ADM-CM-056.pdf.

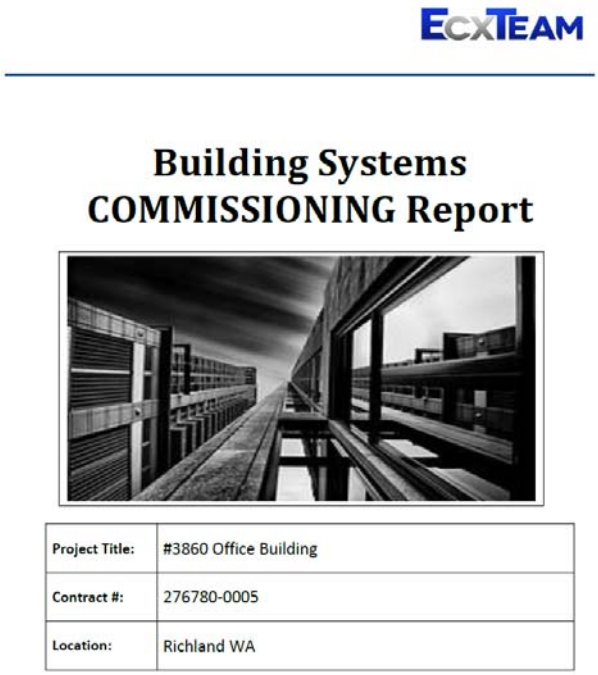


Figure 4. Commissioning Report Cover

This report contains an overview of the commissioning process and results of the commissioning program for the PNNL EAB Project. Commissioning included development of the Commissioning Plan; documenting startup and pre-functional checklists; functional testing; issues documentation, tracking, and resolution; commissioning meetings and meeting minutes; and process tracking using project communications reports. Equipment and systems commissioned included HVAC equipment, systems, and controls; lighting devices and controls; and domestic heating water systems and plumbing fixtures.

3.0 Guiding Principle Number Two – Optimize Energy Efficiency

3.1 Energy Efficiency

The energy efficiency requirement has three components.

3.1.1 Performance Target

Requirement: *Establish a whole building performance target that takes into account the intended use, occupancy, operations, plug loads, and other energy demands*.

MSI Engineers, Spokane, Washington, performed an energy study that compared the EAB against a baseline building defined in the energy code (ASHRAE 90.1), and sets the design energy performance target for the new facility. The total annual energy consumption in the model is 1,879,090 kBTU, representing an annual cost of $19,165.

3.1.2 Energy Star

Requirement: *Design to earn the ENERGY STAR targets for new construction, where applicable*.

The EAB is categorized as property type "Office" by the U.S. Environmental Protection Agency's (EPA's) Energy Star Portfolio Manager. Results from the energy study were used as an input in the Portfolio Manager Tool along with building attributes including size, use, occupant count, operating hours, and number of computers, to determine a target Energy Star score for the EAB. The building received a design score of 91, higher than the minimum target score of 75, as shown in Figure 5.

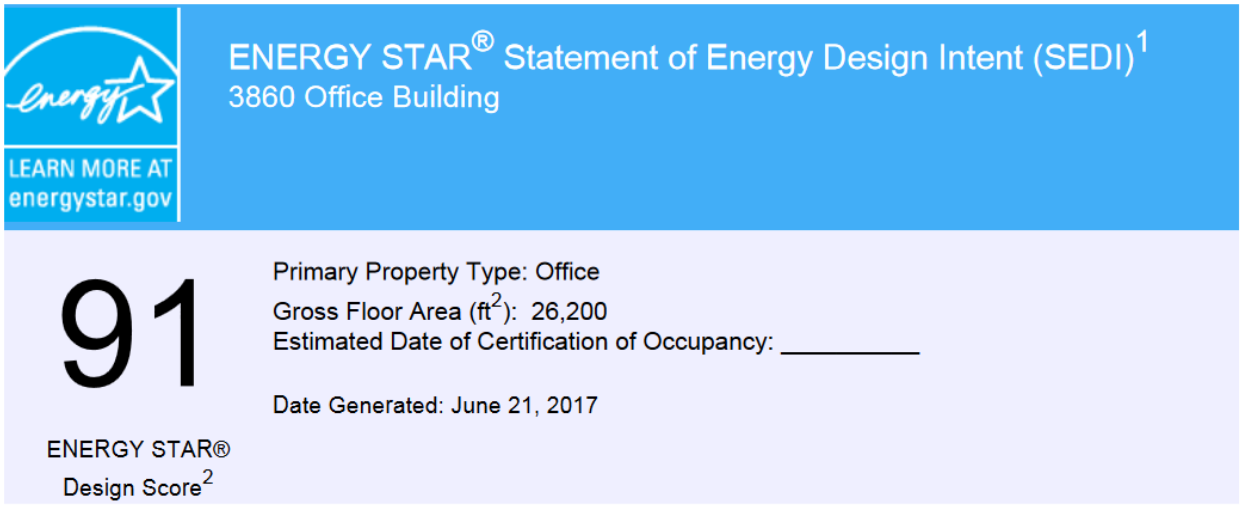


Figure 5. Energy Star Design Score

3.1.3 Energy Reduction

Requirement: *Reduce the energy use by 30 percent compared to the baseline building performance rating per the ASHRAE Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings*.

Title 10 of the Code of Federal Regulations, Part 433, mandates that federally funded facilities reduce energy consumption by 30 percent relative to the baseline standard established by ASHRAE Standard 90.1-2007, *Energy Standard for Buildings Except Low-Rise Residential Buildings*. In September, 2013, DOE updated this rule to require the use of ASHRAE Standard 90.1-2010. Compliance with the 2010 version will reduce energy consumption by approximately 18 percent relative to the 2007 version. Pursuant to this change, PNNL requires that energy consumption be reduced by an additional 12 percent using the 2010 version, to achieve the same 30 percent reduction under the previous standard.

Energy modeling was performed using Carrier Corp's Hourly Analysis Program commercial software. The model demonstrates a reduction in energy consumption of 13 percent relative to the 90.1-2010 baseline, representing a 31 percent reduction of energy compared to the 90.1-2007 baseline. The energy model and calculations were prepared by MSI Engineers, Spokane, Washington. A summary is shown in Figure 6.

Energy Cost and Consumption by Energy Type - Performance Rating Method Compliance

	Proposed Design		Baseline Design	
Energy Type	**Energy Use**	**Cost ($)**	**Energy Use**	**Cost ($)**
Electric	212,605 kWh	11,493	286,388 kWh	14,861
Natural Gas	3,125 Therm	3,034	3,304 Therm	3,209
Remote CW	49,802 tons	1,145	47,628 tons	1,095
Subtotal (Model Outputs)	**1,635,516 kBTU**	**15,673**	**1,879,135 kBTU**	**19,165**
	Energy Generated	**Renewable Energy Cost Savings ($)**		
Total On Site Renewable Energy				
	Energy Savings	**Cost Savings ($)**		
Exceptional Calculation Totals				
	Energy Use	**Cost ($)**		
Net Proposed Design Total	**1,635,516 kBTU**	**15,673**		
	Percent Savings		**Energy Use Intensity**	
	Energy	**Cost**	**Proposed Design (kBTU/ft²)**	**Baseline Design (kBTU/ft²)**
Summary Data	**13.0 %**	**18.2 %**	**73.56**	**84.94**

Figure 6. Building Energy Simulation Report

3.2 On-Site Renewable Energy

3.2.1 Solar Hot Water

Requirement*: Per the Energy Independence and Security Act (EISA) Section 523 (2007), meet at least 30 percent of the hot water demand through the installation of solar hot water heaters, when lifecycle cost effective*.

The project team considered solar hot water heaters and concluded their installation at the EAB was not lifecycle cost effective, based on *Lifecycle Costing Manual for the Federal Energy Management Program* (NIST 1995). Solar hot water heater use at PNNL was analyzed in a report titled *An Economic Analysis of Solar Water Heaters* (PNNL 2014).[6]

3.2.2 Renewable Energy Generation

Requirement: *Per EO 13423, implement renewable energy generation projects on agency property for agency use, when lifecycle cost effective*.

PNNL has implemented a photovoltaic array that fulfills this requirement. The 125-kW photovoltaic array, pictured in Figure 7 below, produced 182.8 MWh of electricity in fiscal year (FY) 2016, providing power to the Environmental Molecular Science Laboratory, including a supercomputing facility and adjacent car charging stations. Solar power generated is fully metered, and PNNL employees can access a graphic indicating real-time generation and statistics.

Figure 7. Environmental Molecular Science Laboratory Photovoltaic Array

3.3 Measurement and Verification

Requirement: *Per the Energy Policy Act of 2005 (EPAct) Section 103, install building level electricity meters in new major construction and renovation projects to track and continuously optimize performance. Per EISA Section 434, include equivalent meters for natural gas and steam, where natural gas and steam are used*.

Building-level electricity at the EAB is metered using Square D model PM870 meters installed in the service equipment in Room 111. The PM870 meters communicate to the Johnson Controls Metasys

[6] Judson C. 2014. *An Economic Analysis of Solar Water Heaters*. PNNL internal report.

facility monitoring and control system (FMCS). Data tables and trends are available to be viewed through the BuildingOS service by Lucid Design Group. BuildingOS collects metering data across the PNNL campus and makes it available in a single location using interactive displays available to all employees. A trend example for electricity consumption at the EAB is shown in Figure 8.

Natural gas is metered using a Gage model "Basic" thermal mass flow meter installed in the boiler room. Natural gas meter data is available in the same format as electrical consumption.

Aside from being a Guiding Principle requirement, metering at the EAB and all PNNL buildings is a contract deliverable requirement to DOE. Additional metering details, including our metering strategy and progress across the campus, are detailed in the *2016 PNNL Metering Plan: Intelligent Operational Strategies through Enhanced Metering Systems* (Pope 2016).

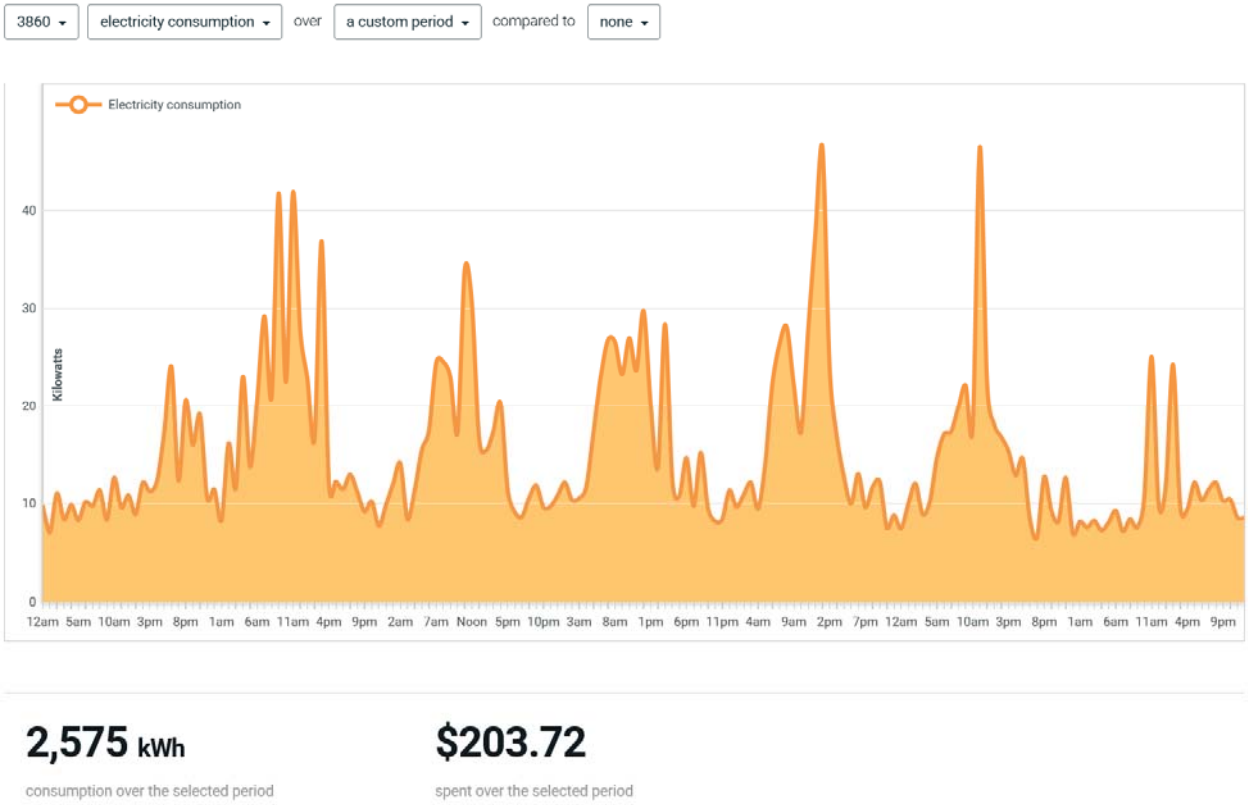


Figure 8. Electrical Meter Data Example Seen on Lucid's BuildingOS Service

3.4 Benchmarking

Requirement: *Compare actual performance data from the first year of operation with the energy design target, preferably by using ENERGY STAR® Portfolio Manager for building and space types covered by ENERGY STAR®. Verify that the building performance meets or exceeds the design target, or that actual energy use is within 10 percent of the design energy budget for all other building types. For other building and space types, use an equivalent benchmarking tool such as the Labs21 benchmarking tool for laboratory buildings*.

This Guiding Principle requires the project team to compare actual performance data from the first year of operation with the energy design target established in Section 3.1.1. The actual building performance is required to meet or exceed the energy design target. Benchmarking is being performed using Energy Star Portfolio Manager during this first year of operation. The energy target was calculated in Portfolio Manager using output data from the energy model, as shown in Figure 9. The Energy Star score calculated through March 2018 was 93, exceeding the design score of 91.

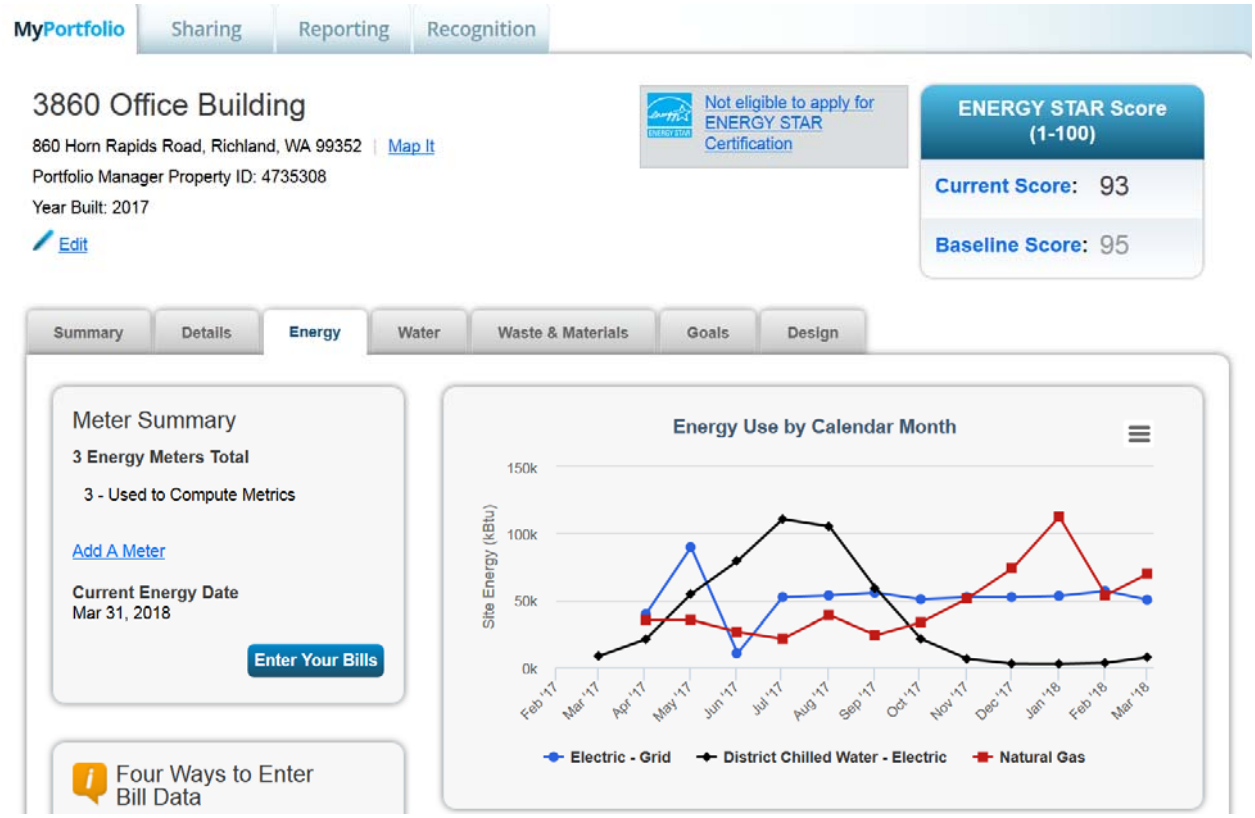


Figure 9. Energy Star Portfolio Manager Energy Trend and Score

The PNNL Energy Program performs benchmarking in each of its facilities. Monthly energy data from the energy model was input into the BuildingOS tool as "model data" and is compared with actual energy use from the advanced electrical and natural gas meters. After two months of operation, actual energy use at the EAB is below the energy target.

Monthly meetings with building management teams (known as core teams) are an important part of the benchmarking strategy at PNNL. Meetings are held in the Building Operations Control Center and are attended by the respective building manager, building engineer, FMCS specialist, and power operator, as well as the campus energy manager, sustainability engineer, and Building Operations Control Center operator. During the meeting, the core team's progress toward the energy use target from the energy summary is reviewed. Electricity and natural gas increases or reductions are presented and discussed. The sustainability engineer discusses recommended low- or no-cost energy saving strategies that can be implemented immediately, and discussion is held on additional recommendations and energy conservation measures that can be implemented over time. BuildingOS graphics assist in benchmarking facilities and are used during the monthly meetings. An example of a trend showing total energy use at the EAB compared to the energy model during the months of May and June in 2017 is shown in Figure 10.

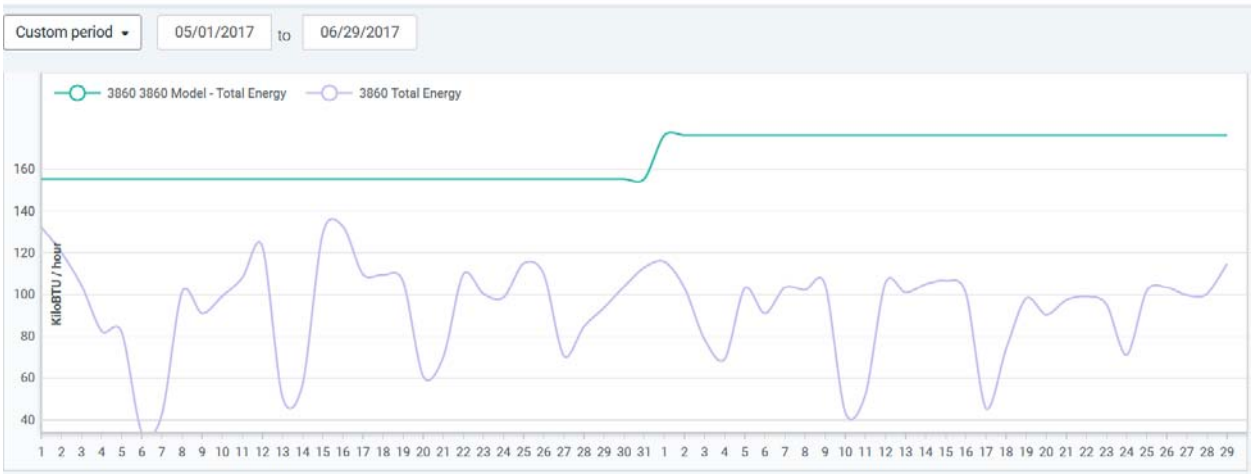


Figure 10. Total Energy Measured Compared to Model

4.0 Guiding Principle Number Three – Protect and Conserve Water

4.1 Indoor Water

4.1.1 Water Use

Requirement*: Employ strategies that in aggregate use a minimum of 20 percent less potable water than the indoor water use baseline calculated for the building, after meeting the EPAct 1992, Uniform Plumbing Codes 2006, and the International Plumbing Codes 2006 fixture performance requirements*.

Indoor water use for the EAB was calculated using the U.S. Green Building Council LEED water savings estimator, based on the actual water consumption rates for the specified plumbing fixtures and the expected number of full-time and transient occupants. The expected water use reduction is 54.2 percent compared to EPAct 1992 requirements, according to a calculation provided by MSI Engineers.

4.1.2 Water Meters

Requirement: *The installation of water meters is encouraged to allow for the management of water use during occupancy*.

An Onicon FM-1200 water meter, shown in Figure 11, was installed to measure whole-building water use and is located in Riser Room 123. This meter communicates to the PNNL FMCS using the Ethernet. Data from this meter is available on a local display and on the Lucid BuildingOS service.

Figure 11. Onicon Water Meter Local Display in Room 123

4.1.3 Rainwater Harvesting

Requirement: *The use of harvested rainwater, treated wastewater, and air conditioner condensate should also be considered and used where feasible for nonpotable use and potable use where allowed.*

The project team is required to consider the use of harvested rainwater, treated wastewater, and air conditioner condensate, where feasible, for nonpotable use and potable use where allowed. The project team considered these water conservation strategies. The average annual rainfall for the site is 6.98 inches per year, more than half of which occurs in the winter months in the form of near-freezing rain, freezing rain, or snow. A 7-inch annual precipitation rate equates to approximately 60,000 gallons of water impinging on the roof surface, the value of which (based on City of Richland cost of $0.70 per 100 ft^3) is only $56. Due to the low annual precipitation and low cost of water, harvesting rainwater is not an economically feasible strategy. Similarly, the amount of condensate generated by air conditioners, boilers, or other mechanical equipment is not sufficient to justify condensate harvesting systems.

4.2 Outdoor Water

4.2.1 Landscape and Irrigation Strategies

Requirement: *Use water-efficient landscape and irrigation strategies, such as water reuse, recycling, and the use of harvested rainwater, to reduce outdoor potable water consumption by a minimum of 50 percent over that consumed by conventional means (plant species and plant densities).*

No outdoor potable water is used at the EAB. Outdoor water for the Office Building site is delivered as irrigation water from the City of Richland. Irrigation water delivered by the City of Richland is drawn from the Columbia River and is untreated and nonpotable. Landscaping at the EAB is shown in Figure 12.

Figure 12. Water-Efficient Landscaping at the 3860 EAB

4.2.2 Irrigation Water Meter

Requirement: *The installation of water meters for locations with significant outdoor water use is encouraged*.

A McCrometer MW500 flow meter was specified to measure outdoor water, shown in Figure 13. The meter is located at the point of connection to the irrigation main, and data is transmitted to the PNNL FMCS using a FlowCom FC101 LDC electronics register with a wired transmitter, and is viewable through the Johnson Controls Metasys trend viewer.

Figure 13. Irrigation Meter Installed at 3860 EAB

4.2.3 Storm Water Runoff and Discharge Off Site

Requirement: *Employ design and construction strategies that reduce storm water runoff and discharges of polluted water offsite. Per EISA Section 438, to the maximum extent technically feasible, maintain or restore the predevelopment hydrology of the site with regard to temperature, rate, volume, and duration of flow using site planning, design, construction, and maintenance strategies.*

Storm water retention and infiltration systems have been designed and incorporated such that all storm water landing on improved hard surfaces will be collected and infiltrated on site. The roof storm water is piped to on-site underground infiltration chambers that allow for subsurface soil infiltration. Parking lots and roadways are sloped to drainage-rock swale features allowing for the containment and percolation of storm water, as shown in Figure 14.

Figure 14. Drainage Feature in 3860 Parking Lot

4.3 Process Water

Requirement: *Per the Energy Policy Act of 2005 Section 109, when potable water is used to improve a building's energy efficiency, deploy lifecycle cost effective water conservation measures*.

Cooling for this facility is provided using chilled water from the Physical Sciences Facility campus central utility plant. Separate chillers or refrigerant-based cooling systems are not used.

4.4 Water-Efficient Products

Requirement: *Specify EPA's WaterSense-labeled products or other water conserving products, where available. Choose irrigation contractors who are certified through a WaterSense-labeled program*.

All plumbing fixtures are low-flow, water conservation type, as specified in Division 22 of the construction specification and Drawing P0 001. Lavatory faucets, water closet valves, and urinal valves are electronic type and use less water than the maximum allowed under current codes. Water consumption is expected to be reduced by 54 percent from a baseline building.

Heritage Landscaping was the irrigation contractor for the EAB. At the time this project was bid, there were no WaterSense irrigation contractors in the Richland area or within the maximum 50 mile radius searchable from the EPA WaterSense website. However, water conserving strategies were incorporated in the design and implemented by the irrigation contractor.

5.0 Guiding Principle Number Four – Enhance Indoor Environmental Quality

5.1 Ventilation and Thermal Comfort

Requirement*: Meet ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy, including continuous humidity control within established ranges per climate zone, and ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality*.

Design factors were included to verify that thermal comfort requirements of ASHRAE 55 are met. HVAC systems have individual zone-level controls for heating, cooling, and dehumidification appropriate to provide occupant comfort throughout the year. Indoor design conditions set by ADM-CM-057,[7] anticipated activity levels of and types of clothing worn by building occupants, and other information required to verify the design complies with ASHRAE 55 are detailed in *Ventilation and Thermal Comfort Documentation (ASHRAE 62.1 and 55),* provided by MSI Engineers as their document number MSI#14.50, dated January 2015. Figure 15 shows the cover of that document.

Calculations were performed to make sure the HVAC design includes ventilation sufficient to meet ASHRAE 62.1 requirements. Design factors such as occupancy levels, space types/functions, supply air system effectiveness, and system type resulted in outside air flow rates that meet/exceed the minimum required by ASHRAE 62.1, as detailed in *Ventilation and Thermal Comfort Documentation (ASHRAE 62.1 and 55),* provided by MSI Engineers as their document number MSI#14.50 dated January 2015.

[7] PNNL. 2013. *F&O Administrative Procedure: Engineering Design Standards*. ADM-CM-057, Pacific Northwest National Laboratory, Richland, Washington. https://workersafety.pnl.gov/programs/fire_protection/docs/pdf_files/engineering_design_standard_ADM-CM-057-PG-01.pdf.

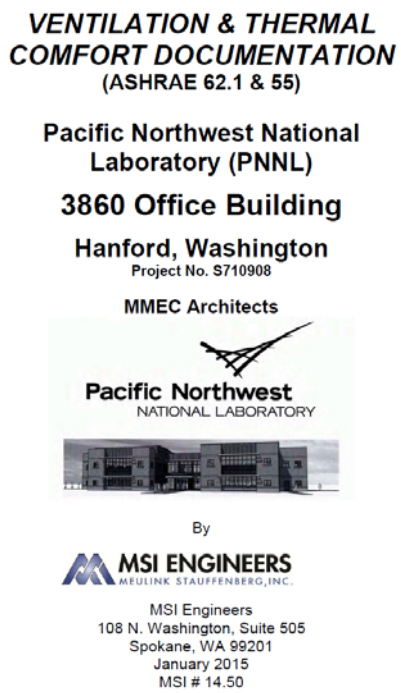


Figure 15. Ventilation and Thermal Comfort Report Cover

5.2 Moisture Control

Requirement: *Establish and implement a moisture control strategy for controlling moisture flows and condensation to prevent building damage, minimize mold contamination, and reduce health risks related to moisture*.

PNNL F&O process guide ADM-CM-057 discusses engineering design requirements across the PNNL campus. This guide details requirements for moisture control and specifics on how to address moisture infiltration into a building.

The EAB is fully insulated, with both cavity wall insulation and continuous insulation (CI). The envelope has been designed and detailed with air/water barriers that will control moisture. Fluid-applied weather barriers with self-adhered membrane flashings were applied to the exterior sheathing, under the CI system. At the concrete masonry unit (CMU) veneer wall locations, a 1″ (min) cavity space occurs between the back side of the CMU and the CI.

5.3 Daylighting

Requirement: *Achieve a minimum daylight factor of 2 percent (excluding all direct sunlight penetration) in 75 percent of all space occupied for critical visual tasks. Provide automatic dimming controls or accessible manual lighting controls, and appropriate glare control*.

The EAB meets the daylighting requirement by achieving an illuminance level of 25 FC (foot-candles) in 91.6 percent of space occupied for critical visual tasks. For the conditions, as outlined in the HPSB requirements, 25 FC typically equates to a 2 percent daylight factor. The Computer Simulation/Space by Space method was used to generate a model, detailing daylighting throughout the facility. The computer

model was generated in AGi32, and conducted per the Guidelines of the HPSB requirements. The results for each space were included in a weighted-average calculation for the entire building. Please note that two sets of criteria were provided, and the daylight study was conducted using the most widely accepted method for daylighting calculations (i.e., the daylight factor calculations have been replaced with the foot-candle metrics, and the study centers on the area of each space that exceeds 25 FC but does not exceed 500 FC, resulting in an acceptable contrast ratio of 8:1). This metric does have a linear, proportional relationship to the daylight factor calculations, as daylight factor is based on the illuminance at each point in the room in relation to the total available luminance from natural lighting, during the conditions under which the daylight study is simulated.

Dimming is achieved using a distributed, digital automatic lighting control system that combines automatic continuous daylight harvesting with manual dimming controls. The lights in each day-lit space receive a signal from a closed-loop photocell that measures the illuminance in each daylight zone. The photocell will automatically set the top end of the artificial lighting output, based on the available natural light, and this level can be manually adjusted to dim the lights in the room based on the user's preference and operational requirements. Glare control is achieved using automatic, dynamic, and fixed shade control devices and equipment.

5.4 Low-Emitting Materials

Requirement: *Specify materials and products with low pollutant emissions, including composite wood products, adhesives, sealants, interior paints and finishes, carpet systems, and furnishings.*

Materials and products with low pollutant emissions are specified in these sections of the construction specification:

- 061053 – composite wood products that contain no added urea-formaldehyde resins
- 079200 – adhesives and sealants that comply with South Coast Air Quality Management Rule #1168, as well as with volatile organic compound limits specified in the guideline
- 099113 and 099123 – exterior and interior paints and finishes that comply with the appropriate Green Seal Standard
- 096813 – carpet systems that comply with the Carpet and Rug Institute Green Label Plus Program
- 127100 – furnishings that are Greenguard Indoor Air Quality certified.

5.5 Protect Indoor Air Quality during Construction

Requirement: *Follow the recommended approach of the Sheet Metal and Air-Conditioning Contractor's National Association Indoor Air Quality Guidelines for Occupied Buildings under Construction, 2007. After construction and prior to occupancy, conduct a minimum 72-hour flush-out with maximum outdoor air consistent with achieving relative humidity no greater than 60 percent. After occupancy, continue flush-out as necessary to minimize exposure to contaminants from new building materials.*

The indoor air quality requirements were included in the construction documents, with instructions on the building flush-out procedure included in Specification Section 230900 – Instrumentation and Controls for HVAC. In addition, Section 233100 includes the requirement that the cleanliness of the duct system be maintained throughout the construction period by following the recommendations of SMACNA (Sheet Metal and Air Conditioning Contractors' National Association) Indoor Air Quality Guidelines for

Occupied Buildings under Construction, 2007, Appendix G – Duct Cleanliness for New Construction Guidelines. Prior to occupancy, a 72 hour flush-out was conducted.

5.6 Environmental Smoke Control

Requirement: *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*.

PNNL has implemented a set of "Basic Staff Practices."[8] This work control includes the basic requirements and considerations for being employed by PNNL, as well as for work activities in PNNL-operated work environments. Within the Staff Responsibilities and Limitations, Security Requirements, and Use of PNNL Facilities section lies the following requirement:

- Do not smoke inside any building or within 25 feet from building entrances, exits, windows that open, and ventilation intakes that serve a building.

This requirement is also posted at building entrances, as shown in Figure 16.

[8] PNNL. 2013. *Basic Staff Practices*. How Do I…? HDI Work Controls, Pacific Northwest National Laboratory, Richland, Washington.

Figure 16. No Smoking Sign Posted on Building Exterior

6.0 Guiding Principle Number Five – Reduce Environmental Impact of Materials

6.1 Recycled Content

Requirement: *Per Section 6002 of the Resource Conservation and Recovery Act (RCRA) (PDF), for EPA-designated products, use products meeting or exceeding EPA's recycled content recommendations for building modifications, maintenance, and cleaning. For other products, use materials with recycled content such that the sum of postconsumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost or weight) of the total value of the materials in the project. 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 website*.

Reference to recycled content of products as listed under the EPA's Comprehensive Procurement Guideline is included in the construction documents specification.

6.2 Biobased Content

Requirement: *Per Section 9002 of the Farm Security and Rural Investment Act (FSRIA), for United States Department of Agriculture (USDA)-designated products, use products with the highest content level per USDA's biobased content recommendations. For other products, use 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 should 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 website*.

Reference to biobased content of products as listed on the USDA's BioPreferred website is included in the construction documents specification.

6.3 Environmentally Preferable Product

Requirement*: 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*.

The six main categories of environmentally preferable products are recycled content products, biobased products, energy-efficient products, water-efficient products, computer products registered with the EPA's Electronic Product Environmental Assessment Tool (EPEAT), and non-ozone-depleting products. All of these six product types except computer products are discussed elsewhere in this Guiding Principle document.

PNNL strives to purchase desktop and laptop computers and monitors that are registered with EPEAT, unless there is no standard for the product.

EPEAT is managed by the Green Electronics Council of the EPA. In 2017, 96 percent of eligible acquisitions at PNNL were EPEAT-registered products.

No computers or monitors were purchased that did not qualify for an Energy Star rating or EPEAT registration. By ordering computers through the PNNL managed hardware system, purchasers are able to ensure only computers meeting the Acquisition Guideline[9] are procured.

6.4 Waste and Materials Management

Requirement: *Incorporate adequate space, equipment, and transport accommodations for recycling in the building design. During a project's planning stage, identify local recycling and salvage operations that could process site related construction and demolition materials. During construction, recycle or salvage at least 50 percent of the non-hazardous construction, demolition and land clearing materials, excluding soil, where markets or onsite recycling opportunities exist. Provide salvage, reuse and recycling services for waste generated from major renovations, where markets or onsite recycling opportunities exist*.

As listed, this Guiding Principle has two components, one in the building's design and operation, the second in the handling of construction waste.

PNNL has a genuine commitment to pollution prevention and recycling. In FY 2017, PNNL diverted approximately 60 percent of nonhazardous sanitary waste. The composting program at PNNL consists of both off-site and on-site composting. Typically, yard waste is collected in a designated yard waste container for off-site composting through the City of Richland. In FY 2017, approximately seven tons of green waste was diverted. PNNL has six plastic hot composters to support the on-site composting activities. Management of the on-site composting station is a group effort between the PNNL Pollution Prevention program, the Battelle Garden Club members, and volunteer composting leads.

PNNL's ChemAgain chemical redistribution program provides the primary means of collecting and redistributing usable chemicals. This program successfully redirected 640 containers of chemicals in FY 2017 through internal transfer or donation. PNNL also leverages its Sustainability Pays programs to promote staff-initiated opportunities in reducing chemicals and waste.

Details on waste and materials management can be found in the PNNL Solid Waste Management Policy.[10] This policy sets specific goals for waste diversion, reuse, and recycling. The policy also identifies the PNNL Pollution Prevention Program manager and Excess Material and Redeployment manager.

6.4.1 Recycling in Design and Operation

The first portion of the Guiding Principle requires the design team to incorporate adequate space, equipment, and transport accommodations for recycling in the building design. Existing contracts with recyclers already in place at PNNL were expanded to include the new Office Building. The EAB has reuse and recycling services available to all staff. PNNL transitioned from multi-stream recycling to

[9] PNNL's *General Provisions for Fixed Price Commercial Items – Supplies/Services* states, "In the performance of work under this contract, the Contractor shall provide products that comply with Federal law as follows… Energy-Efficient Products such as Energy Star certified and FEMP-designated products – http://www.energystar.gov/index.cfm?c=product_specs.pt_product_specs and https://energy.gov/eere/femp/search-energy-efficient-product."

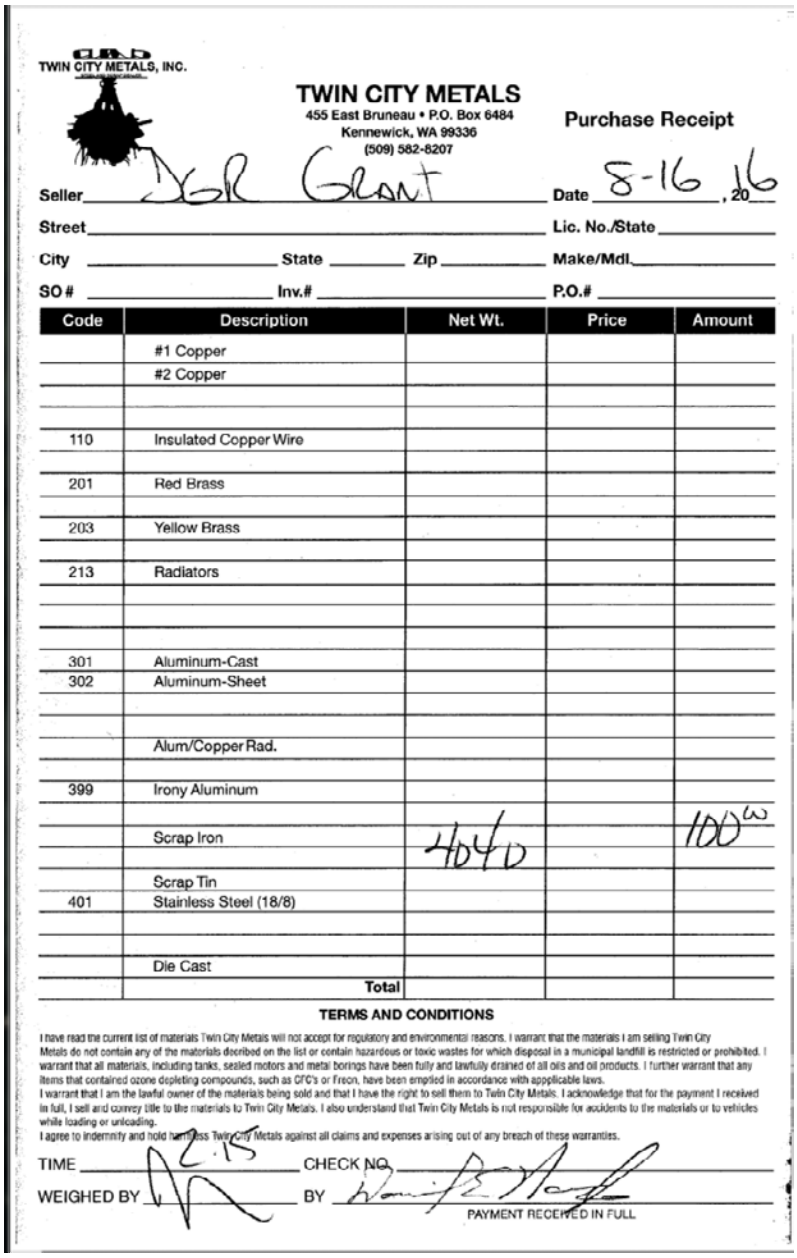
[10] PNNL. 2012. *Pacific Northwest National Laboratory Solid Waste Management Policy*. PNNL internal document.

single-stream recycling between FY 2016 and FY 2017. Kitchen areas 104 and 204 have containers to collect all recyclables such as plastic, glass, mixed paper, and tin in the same container, as shown in Figure 17. Office spaces are provided with a desk-side recycling bin. Staff can collect recyclables in their office and empty the content into the green recycling bins on an as-needed basis.

Figure 17. Single-Stream Recycling Bins in Room 104

6.4.2 Recycling in Construction

This second portion of this Guiding Principle instructs the project during construction to recycle or salvage at least 50 percent of the nonhazardous construction, demolition, and land clearing materials, excluding soil, where markets or on-site recycling opportunities exist. Construction materials recycled included cardboard, wood, metal, and concrete. A total of 58,960 pounds of non-concrete material was recycled. Including concrete, 92 percent of the nonhazardous construction, demolition, and land clearing materials were recycled. An example from recycling metal is shown in Figure 18.



TWIN CITY METALS, INC.

TWIN CITY METALS
455 East Bruneau • P.O. Box 6484
Kennewick, WA 99336
(509) 582-8207

Purchase Receipt

Seller DGR Grant Date 8-16-16

Street _____ Lic. No./State _____

City _____ State _____ Zip _____ Make/Mdl. _____

SO # _____ Inv.# _____ P.O.# _____

Code	Description	Net Wt.	Price	Amount
	#1 Copper			
	#2 Copper			
110	Insulated Copper Wire			
201	Red Brass			
203	Yellow Brass			
213	Radiators			
301	Aluminum-Cast			
302	Aluminum-Sheet			
	Alum/Copper Rad.			
399	Irony Aluminum			
	Scrap Iron	404D		100W
	Scrap Tin			
401	Stainless Steel (18/8)			
	Die Cast			
	Total			

TERMS AND CONDITIONS

I have read the current list of materials Twin City Metals will not accept for regulatory and environmental reasons. I warrant that the materials I am selling Twin City Metals do not contain any of the materials described on the list or contain hazardous or toxic wastes for which disposal in a municipal landfill is restricted or prohibited. I warrant that all materials, including tanks, sealed motors and metal borings have been fully and lawfully drained of all oils and oil products. I further warrant that any items that contained ozone depleting compounds, such as CFC's or Freon, have been emptied in accordance with applicable laws.
I warrant that I am the lawful owner of the materials being sold and that I have the right to sell them to Twin City Metals. I acknowledge that for the payment I received in full, I sell and convey title to the materials to Twin City Metals. I also understand that Twin City Metals is not responsible for accidents to the materials or to vehicles while loading or unloading.
I agree to indemnify and hold harmless Twin City Metals against all claims and expenses arising out of any breach of these warranties.

TIME 2:15 CHECK NO. _____

WEIGHED BY _____ BY _____

PAYMENT RECEIVED IN FULL

Figure 18. Example of Recycling Receipt Collected During Construction

6.5 Ozone Depleting Compounds

Requirement: *Eliminate the use of ozone depleting compounds during and after construction where alternative environmentally preferable products are available, consistent with either the Montreal Protocol and Title VI of the Clean Air Act Amendments of 1990, or equivalent overall air quality benefits that take into account lifecycle impacts*.

The EAB uses no HVAC units containing chlorofluorocarbons, hydrochlorofluorocarbon (HCFC), or hydroflourocarbon refrigerants. HCFCs are identified in the 1992 amendment to the Montreal Protocol as less damaging to the ozone layer than chlorofluorocarbons, but still containing ozone-destroying chlorine. By not using ozone depleting compounds during and after construction, this requirement is satisfied.

7.0 Conclusion

The preceding pages detail how PNNL's EAB complies with each of the requirements in the 2008 *Guiding Principles for Sustainable New Construction and Major Renovations* (CEQ 2008). PNNL continues to meet ongoing requirements, such as Energy Independence and Security Act of 2007 (EISA) Section 432 requirements, including quadrennial evaluations, ongoing commissioning, benchmarking, and operating and maintenance requirements.

At PNNL we have long recognized that excellence in scientific discovery, technological innovation, environmental stewardship, and social responsibility is foundational to delivering solutions to some of America's greatest challenges. We are committed to our sustainability culture and are proud to recognize the EAB as the newest facility at PNNL built to these *Guiding Principles* standards of sustainable building design, construction, and operating practices.

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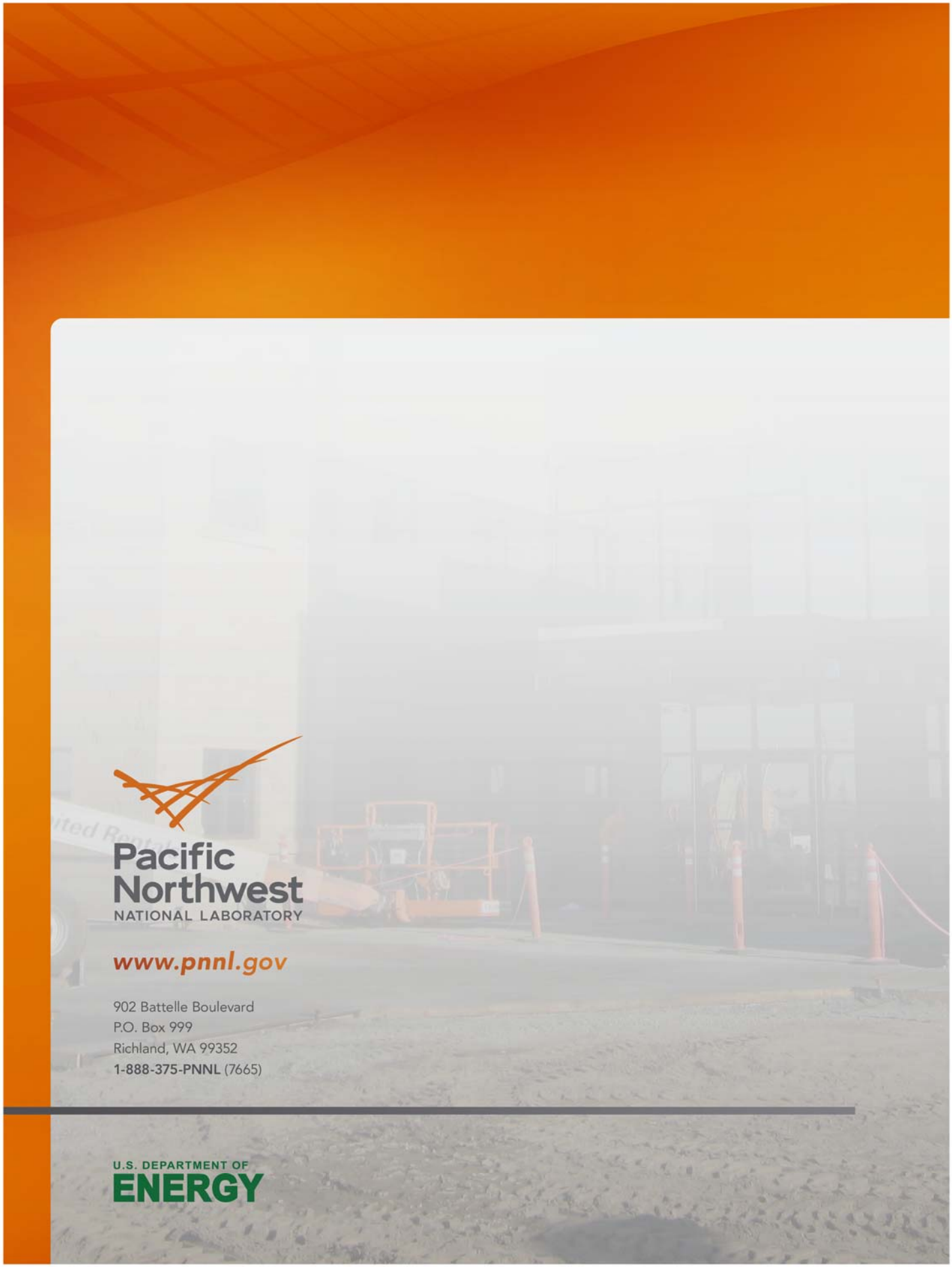

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