



**DEPARTMENT OF THE ARMY**  
ASSISTANT SECRETARY OF THE ARMY  
(INSTALLATIONS, ENERGY AND ENVIRONMENT)  
110 ARMY PENTAGON  
WASHINGTON, DC 20310-0110

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MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Energy and Water Goal Attainment Responsibility Policy for Installations

1. References. See Enclosure 1.

2. Purpose. This memorandum updates previous energy and water goal attainment responsibility policies to achieve the various federal, DoD, and Army energy, water, and renewable energy goals to advance the energy and water security of Army installations. This memorandum supersedes the previous policies (references 1 and 2).

3. Applicability.

a. This policy applies to all facilities on enduring U.S. Army Installation Management Command (IMCOM), U.S. Army Materiel Command (AMC) including Government-Owned Contractor-Operated (GOCO), Army National Guard (ARNG), and the U.S. Army Reserve (USAR) installations, sites, and facilities operated and/or maintained by federal funds, in CONUS and OCONUS (hereafter referred to as installations). All tenant facilities located on Army installations will comply with this policy. This policy does not apply to Civil Works locations, leased space located off installations, or contingency bases.

b. For the purpose of this policy, a facility is defined to be any building, installation, structure, or other property (including any applicable fixtures) owned or operated by, or constructed or manufactured for, the Army.

4. Policy.

a. All tenants using Army installation facilities will be fully engaged with the land holding commands (i.e., IMCOM, AMC, ARNG, USAR), hereinafter referred to as Commands, in supporting their efforts to reduce energy and water use and install renewable energy technologies. The Army's goal is to obtain secure access to energy and water as well as to appropriately manage our natural resources with a goal of net zero energy, water, and solid waste at installations (reference 3).

b. Commands and their installations must establish an installation energy and water master plan, which enables the installation to work constructively towards the following goals in a fiscally prudent manner. Commands will work with their installations to meet specific energy and water security and reduction goals, and renewable energy goals through management policies, behavior change, adoption of energy and water efficiency

SAIE

SUBJECT: Energy and Water Goal Attainment Responsibility Policy for Installations Update

measures, investment in renewable energy and energy security technologies, and best management practices for operations and maintenance. Third-party financing mechanisms (e.g., Energy Savings Performance Contracts (ESPCs), Utility Energy Service Contract (UESCs), Utilities Privatization) will be used when possible to minimize up-front Government financial investment while maximizing the implementation of technology and operational improvements. All new proposals will include a benefit-cost analysis or life-cycle cost analysis as appropriate in accordance with Office of Management and Budget (OMB) Circular A-94 (reference 4) and the current Army Cost Benefit Analysis Guide. A life-cycle cost analysis is required for all ESPC and UESC projects. The benefit-cost analysis is the Army's primary tool to enable resource-informed decisions. Contracts to operate Government-owned facilities will reference this policy and require the operating contractor to comply with applicable provisions of the policy to the maximum extent practicable.

(1) Installation Energy Managers. Each installation will have an Energy Manager appointed in writing and trained as required by current laws and Executive Orders (EOs) to represent the organization in all energy and water matters. Installations with up to 5 million square feet (SF) of facilities will have one full-time energy manager. For installations with over 5 million SF of facilities, the energy office shall have at least two full-time personnel to execute an effective energy and water management program (reference 5).

(2) Installation Energy and Water Master Plans. All installations will implement and maintain an installation-level energy and water master plan (reference 6). Commands will ensure that their installations develop installation-level energy and water master plans no later than 1 April 2019. These master plans will be tied to future development requirements and standards outlined in an installation's UFC 2-100-01 compliant Real Property Master Plan (reference 7).

(3) Metering. All installations will install advanced meters capable of measuring and reporting energy (electric, natural gas, steam, etc.) and water (potable and non-potable) use at 15-minute intervals and communicate that data hourly to the Army's enterprise Meter Data Management System (MDMS) (reference 8). Advanced energy meters will be installed on individual facilities and connected to MDMS to accurately capture a minimum of 60% of total installation energy use by FY2020. Operational energy uses will be metered and connected to MDMS whenever connectivity is practical. Advanced water meters will be installed on individual facilities and landscape irrigation systems and connected to MDMS to accurately capture a minimum of 60% of potable and non-potable (industrial, landscaping, and agricultural) water consumption by FY2020. The goal is to install advanced meters for all reimbursable tenant facilities and expand advanced meter reporting into an enterprise-wide meter data management system (MDMS) (reference 9). Metering efforts at the installation will be coordinated with the Army Metering Program Manager within the Office of the Assistant Chief of Staff for Installation Management (OACSIM) to prevent duplication of efforts and compliance with network security requirements.

SAIE

SUBJECT: Energy and Water Goal Attainment Responsibility Policy for Installations Update

(4) Energy Intensity. EO 13693 (reference 10) establishes an annual energy intensity reduction goal for federal buildings at 2.5% per year for FY2016 through FY2025 and a cumulative goal of 25% reduction using FY2015 as the baseline year. Installations will meet this 2.5% annual reduction goal as part of their Net Zero efforts, and Commands will meet this goal on a Command-wide basis. Both installations and Commands are strongly encouraged to exceed these minimum goals where feasible and fiscally prudent. Deep energy retrofits will be leveraged as a key tool to meet or exceed the energy reduction targets. Enclosure 2 provides suggested low cost/no cost energy measures that will assist in energy conservation efforts. Installations are strongly encouraged to execute ESPCs and/or UESCs to reduce energy consumption and increase energy efficiency when cost effective. ESPCs and UESCs are to be considered in all project development efforts. Reference 11 provides guidance regarding the objectives and requirements, roles and responsibilities, and processes for review and approval of energy projects.

(5) Electronic Stewardship. In accordance with EO 13693 Implementation Instructions Section H (reference 12) and Department of Defense Instruction (DODI) 4105.72 (reference 13), 100% of procured electronic products, including those electronic products typically used in office spaces and data centers, will be energy efficient (i.e., Energy Star®-qualified or Federal Energy Management Program (FEMP)-designated), unless an exception is provided by statute, or the products cannot be acquired (1) competitively within a reasonable performance schedule; (2) that meet reasonable performance requirements; or (3) at a reasonable price. See paragraph 1.2.b of DODI 4105.72. Commands will utilize Army's Computer Hardware Enterprise Software and Solution (CHESS) as a primary source for commercial information technology (IT) procurement of high performance electronics to achieve the electronic stewardship mandates of Section 3(l) of EO 13693 (reference 10). In accordance with reference 12, all Army organizations will establish and implement policies to enable power management, duplex printing, and other energy-efficient or environmentally-preferable features on all eligible electronic products and continue to employ environmentally-sound practices with respect to the agency's disposition of all agency excess or surplus electronics products. All Army organizations are encouraged to use active power management systems that are capable of monitoring the energy consumption and power settings of network-enabled IT equipment and applying power management protocols to optimize energy efficiency. All Army organizations will report their electronics stewardship goal performance as cited in reference 12, Section III.H to the Army Chief Information Officer (CIO/G6) and Deputy Assistant Secretary of the Army for Energy and Sustainability (DASA (E&S)) for consolidation in the Army's annual reporting for the DoD Strategic Sustainability Performance Plan (SSPP).

(6) Comprehensive Energy and Water Evaluations. In accordance with EISA Section 432 (reference 14), Commands will conduct evaluations of their facilities that account for at least 75% of their total annual facility energy use, and do so in a manner that ensures that approximately 25% of such facilities are evaluated each year, and that each facility is evaluated at least once every four years. As part of these evaluations, Commands will also identify and assess recommissioning or retro-commissioning

SAIE

SUBJECT: Energy and Water Goal Attainment Responsibility Policy for Installations Update

measures. Priority will be on the most energy and water use intensive buildings. The evaluation and reporting requirements for these facilities are addressed in reference 15 and reference 16. While installations should strive to meet this annual evaluation goal individually, Commands will meet this goal on a Command-wide basis and are encouraged to exceed this minimum goal where possible.

(7) Solar Hot Water Heating. In accordance with Energy Independence and Security Act (EISA) Section 523 (reference 14), at least 30% of hot water demand in new federal buildings and federal buildings undergoing major renovations will be met through the installation and use of solar hot water heaters, if life-cycle cost-effective. All facility designs for new construction and major renovations will evaluate the use of solar hot water heating for domestic hot water and heating needs. Installations will meet this goal at the installation/project level.

(8) Combined Heat and Power (CHP). Reference 17 outlines the Secretary of the Army's commitment to double CHP generation within two years (to 200 MW) and to triple it within four years (to 300 MW), from the 100 MW Army CHP inventory in place at the end of FY2016. On-site energy production, such as CHP, enables Army installations to enhance their resilience to continue to operate independent of the regional grid. Developing installation-based local power and thermal energy generation capability enhances installation energy resiliency by providing local sources of electrical generation and by converting waste heat to useful thermal energy. Installations will seek opportunities for CHP project development, consistent with their energy master plans, and report existing and future CHP projects as part of the Annual Energy Management Report (AEMR) submission process.

(9) Net Zero Buildings. All new construction of Army buildings greater than 5,000 gross SF that enters the planning process in FY2020 and thereafter will be designed to achieve net zero energy, and all new construction that enters the planning process in FY2030 and thereafter will be designed to achieve net zero water and waste, where feasible, in accordance with reference 10, Section 3(h)(i). Installations will meet this goal at the installation/project level in coordination with the U.S. Army Corps of Engineers (USACE), when they are the design agent.

(10) Demand Management Response. Participation in demand management programs is an efficiency measure that will be evaluated for achieving energy intensity goals in accordance with reference 10, Section 3(a)(i)(B). Installations will participate in demand management programs with utility providers or demand management aggregators if determined to be cost effective and in the best interest of the Government.

(11) Data Center Efficiency. The CIO/G6 will promote data center energy optimization, efficiency, and performance by establishing power usage effectiveness targets of between 1.2 and 1.4 for new data centers and less than 1.5 for existing data centers in accordance with reference 10, Section 3(a)(ii). By FY2018, installations in coordination with OACSIM and USACE will install and monitor building-level advanced

SAIE

SUBJECT: Energy and Water Goal Attainment Responsibility Policy for Installations Update

meters where practical at all enduring data centers to identify energy use by individual tenants and high use operations or processes.

(12) Water Intensity and Use. Army installations will achieve the following annual percentage reductions in potable water intensity and industrial, landscaping, and agriculture (ILA) water in accordance with reference 10, Section 3(f):

(a) Potable water use intensity: 2% annual reduction from a FY2007 baseline, with a cumulative 36% reduction by FY2025.

(b) ILA water: 2% annual reduction from Army's adopted FY2013 baseline (versus the reference's FY2010 baseline), with a cumulative 30% by FY2025. ILA water consumption is categorized as non-potable sources of freshwater that are consumed in ILA applications. The overall goal is to improve water use efficiency and management. Installations will strive to meet this goal individually as part of their Net Zero efforts, and Commands will meet this goal on a Command-wide basis and encouraged to exceed these minimum goals where possible. Alternative water (onsite water not supplied from freshwater sources that include rainwater harvesting, reclaimed wastewater, captured condensate, and reused process discharge water) will be used in place of potable and ILA water whenever possible to reduce demand in applications such as irrigation of golf courses, landscaping, athletic fields, and make-up water for cooling towers (reference 12, Section III.B.3). To further reduce water use in landscape irrigation, native plant species requiring no supplemental irrigation and xeriscape principles will be used in any new landscaping. Non-potable water reuse through recycling technologies (e.g., grey water technologies) will also be evaluated for implementation. Enclosure 3 provides suggested low cost/no cost water measures for water conservation.

(13) Stormwater Management. Site development or redevelopment for all projects with a footprint that exceeds 5,000 SF, will use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the pre-development hydrology of the property with regard to temperature, rate, volume, and duration of flow, in accordance with reference 14, Section 438. Documentation of the project's compliance with this requirement will be maintained in the project file, entered into the designated database, and reported via the chain of command for annual SSPP reporting. Low impact development (LID) will be integrated into real property master plans and will be included in associated DD Form 1391 program documents to ensure adequate funding of the LID structural/nonstructural best management practices (references 15 and 18).

(14) Leak Detection. Installations will identify and repair water distribution leaks in accordance with reference 5, Section 22-12. The frequency of leak detection surveys will be sufficient to cost-effectively conserve as much potable and non-potable water as possible. These surveys will also assist with quantifying the amount of water that is lost in the distribution system, which is an important element in a water balance, as described

SAIE

SUBJECT: Energy and Water Goal Attainment Responsibility Policy for Installations Update

reference 10, Section 19. For large distribution systems, permanent leak monitoring will be considered.

c. The Army is responsible for achieving renewable energy, renewable electricity, and clean energy goals (herein referred to collectively as renewable energy) in a fiscally prudent manner. The minimum contribution of renewable electricity, to the extent economically feasible and technically practicable, is not less than 7.5% beginning in FY2013 and each fiscal year thereafter (reference 19, Section 203(a)). A minimum of 25% of total building electric and thermal energy will be clean energy by FY2025 and each year thereafter (reference 10). In addition, 30% of the total building electric energy shall be renewable electric energy by FY2025 and each year thereafter (reference 10). The Army is also required to produce or procure not less than 25% of the total quantity of facility energy it consumes within its facilities during FY2025 and each fiscal year thereafter from renewable energy sources (reference 20).

(1) Renewable energy is not uniformly available or life-cycle cost-effective at all installations; thus the Army's Office of Energy Initiatives (OEI) has primary responsibility for large-scale renewable and alternative energy projects to help achieve the Army's renewable energy and security goals (references 21 and 22). The OEI has central management and implementation responsibility for all privately-financed renewable and alternative energy projects of 10 megawatts (MW) or larger.

(2) Installations will implement small-scale (<10MW) renewable energy projects when cost-effective or when there are compelling installation energy security requirements. Installations identifying renewable energy opportunities of 1MW to 10MW will consult with the OEI to determine viable project development strategies and request possible assistance from OEI. However, installations may pursue renewable energy projects less than 1MW based on economic and resource availability at the installation without prior OEI coordination. Installations will pursue all potential sources of funding for renewable energy projects. All facility designs for new construction and major renovations will evaluate the use of renewable energy. Installations are responsible for inputting all required renewable energy project data into the AEWRS, regardless of fund source or execution method (including OEI and Residential Communities Initiative (RCI) projects).

(3) Installations will consider consolidation of several smaller building-level renewable energy projects into a larger consolidated renewable energy project that can be collocated with a central energy plant or building cluster.

(4) Army Command and installations will not purchase Renewable Energy Credits (RECs) in accordance with reference 23. This prohibition includes the purchase of green power when its cost exceeds the cost of conventional energy. For renewable energy projects constructed on Army property and financed through private parties, the Army will consider the value of RECs in the project life-cycle cost analysis and retain some, if not all, RECs if it is the most economical option. When projects are privately financed and

SAIE

SUBJECT: Energy and Water Goal Attainment Responsibility Policy for Installations Update

renewable energy generation equipment is transferred to the Army, the associated RECs will also be transferred to the Army.

5. Reporting:

a. Installations will enter all energy (thermal, electric, natural gas, etc.), water (potable and non-potable, including alternative and ILA), and renewable energy information into AEWRS, as specified in reference 5. AEWRS will be maintained and administered by the Office of the Assistant Chief of Staff for Installation Management (OACSIM). Each installation will ensure timely, accurate, and complete input into AEWRS. Commands will review and certify the accuracy and completeness of their installations' AEWRS entries quarterly. The AEWRS data are vital to the Army's ability to track progress in meeting federal energy and water mandates.

b. The OACSIM will prepare the AEMR and the semi-annual OMB Scorecard, which will include the progress in achieving each of the above goals, and submit the reports to the DASA (E&S) for approval and forwarding to the Office of the Secretary of Defense (OSD). Quarterly, the OACSIM will update the Assistant Secretary of the Army for Installations, Energy and the Environment (ASA (IE&E)) on the Army's progress toward meeting federal energy and water goals.

6. This policy is effective immediately. Requests for exception to this policy will be forwarded in writing through the chain of command to the DASA (E&S) for consideration.

7. My points of contact for this policy are Mr. Paul Volkman (paul.m.volkman.civ@mail.mil or 703 697-3765), and Mr. Marc Kodack, (marc.d.kodack.civ@mail.mil or 571-256-4197).



Katherine Hammack

Enclosures

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SUBJECT: Energy and Water Goal Attainment Responsibility Policy for Installations  
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## Enclosure 1 – References

1. Memorandum, ASA(IE&E), 24 Aug 2012, Subject: Energy Goal Attainment Responsibility Policy for Installations (superseded).
2. Memorandum, ASA(IE&E), 20 Dec 2012, Subject: Water Goal Attainment Responsibility Policy for Installations (superseded).
3. Army Directive 2014-02, Net Zero Installations Policy, January 28, 2014.
4. Office of Management and Budget (OMB) Circular A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, Revised Nov 2015.
5. Army Regulation (AR) 420-1, Army Facilities Management, August 24, 2012.
6. Memorandum, ASD (EI&E), Installation Energy Plans, March 31, 2016.
7. Department of Defense Unified Facilities Criteria (UFC) 2-100-01 Installation Master Planning, 15 May 2012.
8. Army Directive 2014-10, Advanced Metering of Utilities, June 4, 2014.
9. HQDA EXORD 028-12, Program Management of the Army Central Meter Program.
10. Executive Order (EO) 13693, Planning for Federal Sustainability in the Next Decade, March 25, 2015.
11. Memorandum, ASA (IE&E), Department of the Army Guidance for Energy Related Projects and Services, dated July 19, 2010.
12. Implementing Instructions for EO 13693, Planning for Federal Sustainability in the Next Decade, The White House Council on Environmental Quality, Office of Federal Sustainability, June 10, 2015.
13. Department of Defense Instruction (DODI) 4105.72, Procurement of Sustainable Goods and Services, 7 September 2016.
14. Public Law 110-140, Energy Independence and Security Act (EISA), December 19, 2007.
15. Facility Energy Management Guidelines and Criteria for Energy and Water Evaluations in Covered Facilities (42 U.S.C. 8253 Subsection (f), *Use of Energy and Water Efficiency Measures in Federal Buildings*), Federal Energy Management Program (FEMP), November 25, 2008.

16. Department of Defense Section 432 EISA 2007 Supplemental Guidelines, May 20, 2010.

17. Memorandum, Secretary of the Army, November 1, 2016, Increasing Deployment of Combined Heat and Power (CHP).

18. Memorandum, Office of the Under Secretary of Defense, DoD Implementation of Storm Water Requirements under Section 438 of the Energy Independence and Security Act (EISA), January 19, 2010.

19. Public Law 109-58, Energy Policy Act (EPAct) of 2005, August 8, 2005.

20. 10 U.S.C. § 2911, Energy performance goals and master plan for the Department of Defense, December 31, 2011.

21. Army Directive 2014-22, Establishment of the Office of Energy Initiatives, August 2, 2014.

22. Department of Defense Instruction (DODI) 4170.11 (Installation Energy Management, Change 1), March 16, 2016.

23. Memorandum, ASA (IE&E), Department of the Army Policy for Renewable Energy Credits, May 24, 2012.

## **Enclosure 2 – Low-Cost/No-Cost Energy Measures**

The following low-cost and no-cost measures will be implemented to the maximum extent practicable at Army installations to reduce energy use. Major energy-consuming equipment are included: lighting, motors, HVAC, compressed air, domestic hot water, and plug loads; along with the building envelope. This enclosure is a compilation of information developed by Pacific Northwest National Laboratory (PNNL) for the DOE Federal Energy Management Program, and input from each of the Army's land holding Commands. Master planners will incorporate strategies to reduce energy consumption at the planning level. Strategies should leverage site selection, building orientation, and other passive approaches to reduce energy.

### **General Requirements**

- Each installation will establish an Energy and Water Steering Committee. The committee will meet quarterly to brief the Garrison Commander and Command/leadership of major tenants on energy and water program initiatives and projects.
- Each installation will appoint full-time energy managers to effectively manage their energy and water conservation efforts.
- Each installation will establish an active Building Energy Monitor (BEM) Program to push down the level of accountability to building occupants.
- Each installation will include energy conservation as a planning goal: Planners will consider reduction of demand and provision of a sustainable supply both at an individual building level and installation-wide. Planning will also include production of renewable energy, use of combined heat and power (CHP), improvement of energy security, and enhancement of energy efficiency. Installations may have opportunities to produce renewable energy through use of wind, solar, geothermal, biomass, and other sources. This reduces dependence on energy from outside sources, thereby adding to energy security.

### **Unaccompanied Personnel Housing and Family Housing**

- Reduce use of air-conditioning (A/C) systems and maximize use of fans.
- Use only A/C units in occupied room(s) where occupants have multiple A/C units.
- Turn off interior lights in all unoccupied areas, even if one intends to return immediately.
- Replace all incandescent lights with light-emitting diodes (LEDs) or other energy efficient lighting.
- Avoid using appliances (e.g., dishwashers, washers, dryers) during peak demand periods.
- Set thermostats for refrigerators at 38-40 °F and freezers at 27-29 °F.
- Wash clothes in cold or warm water, and refrain from using hot water.

## **Building Envelope**

### **Weather Stripping**

- Install or replace all weather stripping on every entry-way where a gap or light is visible.
- Caulk all joints, window frames, door jambs, and any penetrations from the outside of the building. Infiltration around windows and doors is one of the main causes of wasted energy in conditioned spaces.

### **Doors and Windows**

- Perform routine, preventative maintenance to address leaks in the building envelope (e.g., damaged or missing insulation, broken windows, poor weather stripping) before such issues require more significant capital expenditures.
- Proactively address signs of water damage (e.g., standing water due to plugged drains, wet/damp ceiling tiles due to excessive condensation) to prevent issues from compromising building envelope and/or leading to indoor air quality (IAQ) concerns.
- Doors and windows between conditioned spaces and non-conditioned spaces should not be rigged to stay open.
- Remove all door stops or other obstructions from exterior and vestibule doors to prevent them from being open portals during the heating and cooling season. Active management of doors and windows that control conditioned spaces is critical to reducing energy waste.
- Install vestibules (entry areas) at entrance doors with heavy traffic.
- Heating and cooling of vestibules should be eliminated except to prevent freezing of pipes in those areas. Thermostats for heating of vestibules should be set at no higher than 45°F and, in most cases, can be set at 40°F where the weather stripping is properly installed for entry doors. Air conditioning of vestibules should be shut off.

## **Lighting**

### **Exterior Lighting**

- Install timers/photocells to turn off all exterior lights during the day. Guardhouses, access points, gas stations, maintenance areas, and storage areas are common locations where exterior lighting is left on during daylight hours. If exterior lighting fixtures are observed “on” during daytime/sunny conditions, recalibrate the control mechanisms for these fixtures (e.g., timers, photo sensors) to ensure proper performance.
- Minimize night security and parking lighting in unoccupied spaces such as motor pools, storage areas, etc., consistent with safety and security requirements.
- Reduce or eliminate street, parking, and other security lighting, where possible, consistent with safety and security requirements. De-lamping is generally not a preferred option. Replacement of exterior lights with LED will be considered.

## Interior Lighting

- Turn off all unnecessary interior lights when not in use, especially at the end of the work day and during weekends. Install occupancy sensors in hallways and common areas. Until occupancy sensors are installed, have procedures to turn off light switches or circuit breakers. Sometimes circuit breakers are the only way to turn off lights, as is the case in many maintenance and dining facilities. Occupancy sensors in rest rooms and conference rooms can save 10-50% of lighting energy depending on area traffic.
- Rewire all indoor lighting that is on 24/7, except exit fixtures required by code, to be on either switches or motion sensors. If there is a security or safety issue, motion sensor control meets the requirement.
- Add signage for manual light switches. Light switch signage should remind staff to turn off lights when leaving a space.
- Replace all incandescent bulbs with energy-efficient LEDs, compact fluorescent lamps (CFLs) or other Energy Star-rated luminaires. LEDs and CFLs are very efficient when compared to the standard incandescent bulb. Both types of bulbs have a low wattage rating and longer operating life than incandescent bulbs. LEDs use about 1/8<sup>th</sup> to 1/10<sup>th</sup> the energy of incandescent bulbs to produce an equivalent amount of lumens.
- Maximize use of task- and day-lighting as much as possible and turn off all other lighting.
- Install occupancy sensors in hallways and common areas. Every other light in the hallways can be wired to illuminate only when triggered by the occupancy sensor.
- Replace T12s with T8 or T5 lamps with electronic ballasts or LEDs. The T8 or T5 lamps with electronic ballasts are more efficient than the standard T12 lamps with standard ballasts. In addition, the quality of lighting may be improved due to the higher Color Rendition Index (CRI) of the T5/T8s as compared to the standard T12s. To reduce maintenance costs, T8s are preferred in high ceiling applications due to the shorter life of T5s. White LEDs replacements are becoming very economical. LED products are available with effective rated lifetimes of 36,000 to 50,000 hours based on current industry accepted rating test methods, but certainly may last much longer (50,000 hours and above) before becoming too dim to be useful. They are particularly effective and last longer in most exterior applications where colder temperatures are common during the day or night.
- If installation of lighting controls, new fixtures, or retrofits in individual offices is not cost effective for a given building, consider de-lamping (i.e., removing extra lamps from light ballasts where lighting levels are excessive). These extra lamps can add to the garrison's spare equipment inventory, representing an added O&M benefit. Industrial and storage spaces currently considered over lit are prime candidates for de-lamping. Typical, expected lighting level ranges for candidate use areas, include: (1) Commercial office: 30 – 50 foot-candles (FC) and (2) Storage areas: 10 – 30 FC.
- Plan sites to provide flexibility for building orientation and configuration to optimize day-lighting. Minimize existing and planned obstructions from landscaping, structures, topography, and adjacent developments in order to preserve solar access. Buildings of any configuration with footprint elements of approximately 50

feet or less (wings, central courtyards, etc.) can allow natural light deep into the building, which, when combined with energy-efficient glazing, reduces energy consumption.

## **Exit Lighting**

- Replace all exit lighting with LED fixtures.

## **Motors**

- Replace all motors and pumps with high-efficiency Energy Star equipment every time a replacement is required. Prohibit rewinding or replacing with the same efficiency. Do not yield to the arguments that it is more convenient or less costly to rewind or replace with in-kind capability as the extra energy used by the less-efficient motors will pay the difference usually in less than three years. Energy savings are generally 3-5% per motor.
- Operate all motors and pumps with automatic controls in the auto mode and not in the manual mode that causes them to run 24/7. Very few systems require 24/7 operation, and a review of the requirement can reduce the operating hours of many pumps and motors.
- Disable systems such as hot water circulating pumps than run 24/7 in facilities where hot water is not required immediately at the faucet.
- Consider timing controls for pumps and motors during high-use or high-demand times, such as early mornings and/or late afternoons, which allows the motors or pumps to be off during non-occupied or low-use times.

## **Heating, Ventilating, and Air-Conditioning (HVAC)**

### **HVAC Equipment and Controls**

- Reduce use of A/C systems and maximize use of fans.
- Adjust programmable thermostats to 78°F plus or minus 2°F in cooling mode, and 68°F plus or minus 2 °F in heating mode.
- Consider shutting down A/C systems earlier in the afternoon and letting the system “coast” until the end of the day.
- Maximize use of natural ventilation by opening windows, when air conditioning and heating are off, and dress appropriately to maximize individual comfort.
- Set discharge-air temperatures no lower than 55°F during the cooling season, and no lower than 60°F during the heating season. If possible, implement a simple discharge-air temperature reset for all air handlers that modifies the discharge set point between 55°F and 65°F (based on return-air temperature feedback).
- Install programmable thermostats and schedule with occupied and unoccupied temperatures. They can offer effective and quick returns on investment. The increases in temperature during the cooling season and decreases in temperature during the heating season, and can result in significantly reduced energy use. The energy savings can be approximated at 1% per degree of setback for every 8 hours that a building is at a reset (non-occupied) temperature. Inspect thermostat settings

regularly and reset as necessary to ensure compliance with temperature requirements.

- Educate occupants on the use of programmable thermostats. Signage near the thermostats and other communications with the occupants should provide guidance on optimizing for both comfort and energy consumption.
- Tighten building equipment schedules through the building automation system (BAS) to match the actual building occupancy schedule. For example, barracks notoriously are scheduled for 24/7 operations. However, there are several hours during the day when the barracks are lightly occupied. During these times, schedule air-handling unit (AHU) supply fans to operate at reduced static pressures.
- Ensure setback temperatures are appropriate for each building. Unified Facilities Criteria (UFC) 3-410-01 should be used as a guideline, but specific temperatures should vary by building. Heating and cooling systems will work harder to recover when setback temperatures are inappropriate (e.g., too aggressive for building mission and/or type).
- Implement a “smart” schedule to lessen the likelihood that building occupants and/or maintenance staff will override existing HVAC equipment schedules during extreme temperature conditions. A smart schedule evaluates the outdoor temperature and automatically overrides the normal operating schedule, allowing the facilities to run 24/7 any time outdoor temperatures drop below or rise above adjustable preset values. When the outdoor temperature stabilizes within the preset value range, the schedules are then automatically re-enabled.
- Minimize existing and planned obstructions from landscaping, structures, topography, and adjacent developments to enhance natural ventilation. Narrow buildings with operable windows also allow natural ventilation to effectively flow through the interiors, which can reduce energy costs associated with air conditioning. Building footprints should be no wider than 50 feet when practical.
- Duct Static Pressure Reset: ASHRAE Standard 90.1-2010 paragraph 6.5.3.2.3 and UFC 3-410-02 section 4-4.6.2 have standardized the active resetting of duct static pressure set points based on how open the most starved terminal air damper is shown in the BAS. Buildings with modern BAS and variable air volume (VAV) systems can typically accept this high-efficiency HVAC sequence readily for substantial fan savings.
- Economizers: These air-side devices often operate poorly or not at all. Check that: linkage is not disconnected, dampers are not stuck, outside air temperature sensor is shaded, minimum outside air quantities are not excessive, high limit switchover points are based on calculated or measured ambient enthalpy conditions, mixed air temperature sensor is not skewed by stratified air, etc.
- Demand Controlled Ventilation: For areas that are regularly occupied less than the building schedule (e.g., conference spaces), adjust air handling unit (if single zone) or terminal equipment (if multiple zones) schedules or outside air quantities based on motion sensors, CO<sub>2</sub> sensors, occupant overrides, or known sub-schedules.
- Equipment Lockouts: Lockout boilers and chillers when load valves indicate no demand for some preset time. Lockout distribution pumps on a short time delay after their boilers or chillers have been locked out.

- Simultaneous Heating & Cooling: Eliminate (if possible, or at least minimize) simultaneous heating and cooling of the same space. Examples include: preheat and cooling coils of an air handler being controlled to overlapping temperature set points, VAV reheat in low-load spaces being supplied with supply air at constant design conditions, and dual duct or multi-zone decks programmed for constant temperature discharges in mild conditions.
- Oversized Equipment: Oversized pumps can be throttled at no cost or have their impellers trimmed at low cost if actual conditions are measured well below expected conditions during design. VAV boxes that don't show modulation in the BAS during average days most likely represent an excess of outside air being brought in to the spaces.
- Condensing Boilers: Often boiler distribution temperatures will be reset while primary boiler loops are not, resulting in condensing boilers not receiving low enough return water conditions to achieve condensing mode efficiencies.

## Filters

- Inspect/replace equipment filters and check fan drive belt tension every 90 days. Replace filters when dirty and adjust fan belt tension as necessary to improve equipment performance.

## Boilers and Chillers

- Determine optimum energy distribution system: Nodal energy plants, which produce hot water, chilled water and/or steam for nearby facilities, are generally more efficient than large central plants or individual building level systems. Planners should perform a life cycle cost analysis at district or installation level to determine the most efficient system.
- Reset chilled and hot water temperatures for energy-efficient operation based on ambient conditions. Between 40% and 80% load savings range from 0.5-0.75% per degree increase in temperature. Increase chilled water temperatures to maximum limits that provide output air temperatures at 78°F and relative humidity levels no greater than 60% to prevent mold problems.
- Validate chiller loading parameters with the chiller manufacturer and configure controls to sequence chiller staging to leverage the maximum efficiency within those parameters.
- Ensure refrigerants are properly charged. A low charge increases head pressure and energy consumption.
- Reduce condenser water temperature within acceptable chiller manufacturer guidelines. Each degree lower can save approximately 1.5% in energy consumption.
- Reduce chiller unit operations where there are multiple units, based on chiller manufacturer's guidelines.
- Keep boilers adjusted to manufacturers' specifications. This can reduce fuel consumption by 3-5% per boiler.



- Insulate hot water/steam piping. Many mechanical rooms are missing insulation on piping, causing significant heat loss as well as unnecessary cooling loads that can require chillers to operate when they should be off.
- Shut down hot water boilers during the cooling season. If boilers cannot be shut down, operate them at the lowest allowable temperature during the cooling season. PNNL recommends 150°F for non-condensing boilers and 100°F for condensing boilers. If possible, a simple hot water temperature reset with feedback from the outdoor-air temperature should be implemented.
- Shut down chillers during the heating season. If chillers cannot be shut down, operate them at the highest allowable temperature during the heating season. PNNL recommends 50°F set point during the heating season. During the cooling season, operate chillers no lower than 44°F.
- Perform routine, preventative maintenance to optimize HVAC equipment operation including: removing scale buildup on cooling towers, cleaning dirty filters and condenser coils, and removing debris from blocking condenser coil air flow.

## **Compressed Air Systems**

- Repair air leaks immediately. This can reduce compressed air system energy use by 30% or more.

## **Domestic Hot Water (DHW) Heaters**

- Make sure DHW set point temperatures are appropriate for the given building type.
- Add insulation blankets to water heaters and storage tanks.
- Analyze the life-cycle cost effectiveness of incorporating solar hot water and on-demand water heaters, if replacing or upgrading water heaters.

## **Plug loads**

### **Computers and Monitors**

- Turn off all computers and monitors at the end of every work day, on weekends, and on holidays, unless prohibited by local policy. Ask occupants to ensure that power management settings are enabled on all computers and monitors. It is recommended monitors be shut off after 5 minutes of inactivity and computers go into sleep mode after 20 minutes of inactivity. Computers use 250-500 kWh/year if left on continuously, depending on the age and peripherals.
- When available, use laptop computers (preferably on battery power when possible) – they consume 50% or less energy than standard computers. Purchase only Energy Star or FEMP-designated computer equipment.
- Invest in smart power strips for work stations with multiple peripherals (e.g., printer, desk light, etc.) that would be otherwise plugged into the wall. A smart power strip will automatically turn off equipment when it's not in use.

## Office Equipment

- Verify all energy-consuming equipment meets Energy Star or FEMP-designated product requirements. Purchase of equipment must meet Energy Star or FEMP designation.
- Verify scanners, copy machines, faxes, printers, and other such equipment are programmed with sleep modes to activate automatically when not in use.
- Establish procedures to turn off scanners, copy machines, printers and other such equipment at the end of every work day, on weekends, and on holidays. Set printers to duplex mode if available. If possible, do not make photocopies or print documents; conduct all business electronically. Reduce the number of printers serving a work area.

## Personal Equipment

- Eliminate and remove all extra refrigerators, microwaves, coffeepots, space heaters, and other appliances that service only one or two persons. Permit only the quantity of appliances needed for the number of personnel. Turn off or unplug all office/home appliances when not in use for extended periods of time.
- Remove non-Energy Star appliances from the workplace by requiring all appliances to bear the Energy Star label. Remove non-complying appliances from the facility so they do not simply move to another office.

## Vending Machines

- De-lamp beverage and snack vending machines whether they are inside or outside. Seek changes to the agreements with vending machine owners to avoid providing utilities without requirement to pay a utility charge. De-lamping vending machines can reduce each machine's energy consumption up to 20%, or 2.5 kWh/day/machine.
- Where de-lamping is not possible, install low wattage lighting or consider low-cost technologies (e.g., Vending Misers) that only illuminate machines when potential customers approach. It may save up to 40% of the electricity needed to run the machine.
- Replace older vending machines with Energy Star rated machines. Energy Star vending machines will be about 40% more energy efficient than the ones they replace.

## Miscellaneous

- **Analyze utility rate structure and track billing history:** To control utility costs, installations need to fully understand how the demand and energy charges are calculated and how they affect facility operating costs. Also, in order to save energy and water, it helps to understand how a building has performed in the past. Track and graph utility use for at least the previous 12 months. Commercial software programs designed to do the tracking and graphing are readily available, or develop your own with spreadsheets. At a minimum, track monthly demand, actual energy

and water use, and costs. This enables the quantification of savings due to energy and water management improvements and can help identify billing errors.

- **Work with the Utility Representative:** The utility representative can be a valuable asset in controlling energy costs. Deregulation has placed pressure on utilities to keep their customers, especially larger facilities, from thinking about switching to other suppliers or generation alternatives. This means most utilities want to do all that they can for their customers. Here are some questions to ask the utility representative: How do my rates (schedules) work? How can I get copies of them? Am I on the best possible rate (schedule)? If not, how can I get on it? What are my rate options (for both demand and consumption)? Does my demand rate include a ratchet charge? What is the demand period? Do you offer any incentives or rebates for equipment replacement? Can you help me reduce my utility costs?
- **Participate in Demand Response Programs:** Demand response programs are an integral way to reduce utility costs and manage energy usage during peak periods. These types of programs identify cost-effective procedures that reduce energy consumption and develop systematic programs of energy system efficiency improvements. Collaborating with the utility representative to enroll in a demand response program can provide financial incentives back to the installation for reducing load at peak times.
- **Building closures:** Where mission allows, shut buildings down completely on weekends. Consider implementing compressed work schedules (four 10-hour days) and/or encourage people to telework from home 2-3 days per week so some facilities can be 100% shut down every Friday/Saturday/Sunday and take advantage of temperature setbacks.
- **Operating hours:** Consider shifting missions, training, and operations from peak hours to off-peak hours where possible; for example, simulator training at night.
- **Space utilization:** Perform space utilization surveys and consolidate space as much as possible. Mothball resulting empty space and facilities.
- **Government Vehicles:** Stop idling government vehicles when unattended or waiting for more than 30 seconds. Commanders should set this as a vehicle violation with a warning and then a consequence for second and follow-on violations.

## Enclosure 3 – Low-Cost/No-Cost Water Measures

The following low-cost and no-cost measures will be implemented to the maximum extent practicable at Army installations to reduce water use. Major water-consuming equipment are included: plumbing, irrigation systems, cooling towers, steam systems, commercial kitchen equipment, and vehicle wash facilities. Information included in this document is a compilation of information developed by PNNL for the Federal Energy Management Program and the Army Reserve. Information was also gathered from the Environmental Protection Agency's WaterSense Best Management Practices<sup>1</sup>. Master planners and water resource managers will incorporate strategies to reduce water consumption at the planning level. Strategies may include the use of greywater and designing low-maintenance landscaping features.

### Plumbing

- Test system pressure to make sure it is between 20 and 80 psi. If the pressure is too low, high-efficiency devices won't work properly. If it is too high, they will consume more than their rated amount of water and increase the wear on the fixture, shortening the equipment life.

### Tank Toilets

- Ensure the water in the tank is set to the manufacturer's recommended level and is not running over the overflow tube.
- Adjust the float if the water level is too high.
- Ensure the fill valve (the mechanism that refills the tank after each flush) is working properly and not running constantly.
- Periodically test the flapper valve for leakage and repair if necessary.

### Flushometer Toilets and Urinals

- At least annually, inspect the valves and check for worn parts and long flush cycles. Long flush cycles or continuously running valves may indicate a clogged bypass orifice in the valve or improper sealing. The flush valve insert may need to be cleaned or replaced. (The flush cycle of a 1.6-gallons per flush (gpf) flushometer toilet or a 1.0-gpf urinal should not exceed 4 to 5 seconds.)
- When replacing a flush valve insert, make sure the flush rating of the replacement part matches the valve's flush volume specification. For example, a 1.6-gpf flushometer toilet should only be retrofitted with a 1.6-gpf rated flush valve insert.
- When replacing flushometer toilets and urinals, consider using piston valve technology. There are specific attributes to piston valves that have benefits compared to diaphragm valves.
- Calibrate automatic sensors to ensure they are set properly to limit double or "phantom" flushing.

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<sup>1</sup> <http://www.epa.gov/watersense/commercial/bmps.html>

## Faucets and Showers

- Establish a schedule to check for leaks in faucets and showers; establish a protocol to fix leaks immediately once they are found; and post a sign in the restrooms that will provide a mechanism for occupants to report visible leaks and other maintenance issues.
- Inspect faucets and showerheads for missing or broken aerators/flow restrictors. Aerators and flow restrictors can often be dismantled or removed causing the fixture to flow at much higher flow rates. Replace with high-efficiency models if needed and install vandal-proof fixtures that are more difficult to break or remove.
- When installing new or replacing showerheads, choose high-efficiency models with a WaterSense label, which have flow rates of no more than 2.0 gpm.
- For lavatory faucet retrofits in public restrooms, install faucets or faucet aerators or laminar flow devices that achieve 0.5 gpm flow rate, required by plumbing codes.
- For lavatory faucet retrofits in private restrooms (e.g., residential housing, barracks, hotel guest rooms, hospital rooms), install WaterSense labeled high-efficiency lavatory aerators or laminar flow devices with a maximum flow rate of 1.5 gpm.
- For kitchen faucet retrofits, install aerators or laminar flow devices and consider installing a flow rate of 1.5 gpm to maximize savings.
- Correctly adjust and maintain automatic sensors on faucets to ensure proper operation. Sensors must be calibrated to ensure water use only when washing hands and not be triggered by users passing in front of the faucet. (Note, sensors are not water conservation devices but are a “hands-free” for sanitary purposes.)
- Encourage users to take shorter showers. Place clocks or timers in or near showers to allow users to track their timing.

## Landscape Irrigation

- Installations will use water-efficient landscape strategies that achieve a minimum 50% water reduction. Native plant species and dry-scape architectural alternatives will also be considered. Irrigation will not be used except where specifically required by Army policy or during the initial plant establishment phase; areas that require irrigation will use alternative water in place of outdoor potable water.

## Scheduling

- Review the irrigation schedule to optimize the time of day and days per week for each zone.
- Verify that the irrigation schedule is appropriate for climate, soil conditions, and plant materials. In severe drought conditions, watering can generally be reduced without killing the grass.
- Change the watering schedule based upon changing weather conditions and as part of regular, periodic maintenance.
- Install a rain-delay gauge that is tied into the irrigation controller to automatically shut off the irrigation system during a rain event.

- Irrigate during non-windy and low-sun periods to decrease evaporation; early mornings are typically the least windy and coolest time of the day.
- For flat landscaped areas, water deeply and less frequently rather than lightly and often. A deep, less frequent schedule encourages deep roots resulting in more drought tolerant plants.
- Irrigate using a “cycle and soak”<sup>2</sup> schedule for steep slopes where surface runoff is likely.

### **Irrigation System Maintenance**

- Routinely check emitter components for broken heads and leaks. Common examples of damaged emitters include:
  - broken heads
  - clogged nozzles
  - nozzle seal leaks
  - sunken heads
  - tilted and misaligned heads
  - water on streets, parking lots or other non-vegetative surfaces

### **Landscape Maintenance**

- Use plant materials suitable for the particular climate conditions to reduce or eliminate outdoor water use.
- Aerate turf at the beginning of the growing season to introduce oxygen into the soil and encourage deep root growth, which allows longer time between watering cycles.
- Alternate turf mowing height between high and low levels and alternate mowing patterns that encourage deep root growth and drought tolerant turf.
- Add mulch to landscaped areas to reduce evaporation, inhibit weed growth, cool plant root zones, and reduce erosion.
- Amend the landscape soil with organic matter 4 to 6 inches deep, which will help to capture stormwater and retain moisture.
- Keep landscaped areas weed free; weeds can take up valuable water and nutrients that are needed by the landscape.

### **Cooling Towers**

- Determine the system “cycles of concentration” and determine the maximum cycles of concentration that can safely be achieved with the resulting conductivity (typically measured as microSiemens per centimeter, uS/cm). Many systems operate at two to four cycles of concentration, while six cycles or more may be possible. For

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<sup>2</sup> The “cycle and soak” method breaks up irrigation events into multiple applications of short duration. This gives adequate time for the landscape to absorb the irrigation water. If the installed irrigation controller is not capable of such programming, replace it with advanced control technology.

example, increasing cycles from three to six reduces cooling tower make-up water by 20% and cooling tower blowdown by 50%.<sup>3</sup>

- Routinely check the ratio of conductivity of blowdown and make-up water and maintain the optimized cycles of concentration; or install a conductivity controller to automatically control blowdown. A conductivity controller can continuously measure the conductivity of the cooling tower water and discharge water only when the conductivity set point is exceeded.
- Obtain the services of a water treatment vendor to help manage the cooling towers cycles of concentration. Develop the contract to prioritize water efficiency, which should be based on optimizing the cycles of concentration. Treatment programs should include routine checks of cooling system chemistry accompanied by regular service reports that provide information on the system's performance.
- Implement a comprehensive air handler coil maintenance program. As coils become dirty or fouled, there is increased load on the chilled water system to maintain conditioned air set points temperatures. Increased load on the chilled water system not only has an associated increase in electrical consumption, it also increases the load on the evaporative cooling process, which uses more water.
- Install flow meters on make-up and blowdown lines. Check the ratio of make-up flow to blowdown flow. Then check the ratio of conductivity of blowdown water and the make-up water. These ratios should match the target cycles of concentration. If both ratios are not approximately the same, check the tower for leaks or other unauthorized draw-off. If the target cycles of concentration are not maintained, check system components including conductivity controller, make-up water fill valve, and the blowdown valve.

## **Steam Boiler Systems**

- Develop and implement a routine inspection and maintenance program to check steam traps and steam lines for leaks. Repair leaks and replace faulty steam traps as soon as possible.
- Develop and implement a boiler re-tuning program to be completed a minimum of once per operating year.
- Provide proper insulation on steam and condensate return piping, as well as, on the central storage tank.
- Obtain the services of a water treatment specialist to prevent system scale and corrosion and to optimize cycles of concentration. Treatment programs should include routine checks of boiler water chemistry.
- Develop and implement routine inspections and maintenance programs on condensate pumps. Check for leaks regularly.

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<sup>3</sup> The actual number of cycles a system can carry depend on the make-up water quality and cooling tower water treatment regimen. Depending on the make-up water, treatment programs may include corrosion and scaling inhibitors along with biological fouling inhibitors.

- Regularly inspect both the water side and fire side of the boiler. If needed, clean the tube surfaces to ensure optimal heat transfer thereby maximizing system energy efficiency.
- Employ an expansion flash tank to temper boiler blowdown rather than using cold water mixing.
- Install meters on boiler system make-up lines.
- Install meters on make-up lines to recirculating closed water loop heating systems so leaks can be accounted for.
- Consider summer shutdown, especially for those systems primarily used for space comfort heating.

## **Commercial Kitchen Equipment**

- Establish a user-friendly method to report leaks and fix them immediately. Require cleaning or custodial crews to report problems.
- Check equipment water temperatures and flow rates to ensure each is within manufacturer recommendations. For maximum water savings, the water flow rate should be near the minimum recommended by the manufacturer.
- Test system pressure to make sure it is between 20 and 80 psi. High-efficiency devices won't work properly if the pressure is too low. If the pressure is too high, they will consume more than their rated amount of water.
- Dishwashers:
  - Only run dishwashers when they are full. Fill each rack to its maximum capacity.
  - Immediately replace any damaged dishwasher racks.
  - Ensure final rinse pressure is within manufacture recommendations, typically 20 ± 5 psi. If the pressure is too low, the dishes may not be rinsed and sanitized properly. If it is too high, they will require more than their rated amount of water.
- Combination ovens:
  - Use “combi-mode” sparingly because this mode consumes water and significantly increases energy usage.
  - Keep oven doors closed during operation.
  - Maximize the amount of food being cooked for each cycle.
- Steam cookers:
  - Use batch production as opposed to staged loading of food pans (i.e., do not continuously open the door to load and unload food pans).
  - Fill the steamer to capacity instead of cooking a partial load.
  - Keep the doors closed during operation.
- Pre-rinse spray valves:
  - Check for leaks and loose hose connections
  - Pre-soak dishes to reduce pre-rinse time
  - Replace plugged or poorly performing valves with new efficient models with a FEMP-designated pre-rinse spray valve, which designates pre-rinse spray valves



that have flow rates of 1.25 gpm or less and meet ASTM F2323-03, Standard Test Method for Performance of Pre-Rinse Spray Valves.

- Garbage disposals:
  - Eliminate or minimize the use of garbage disposals by using strainers or traps that employ a mesh screen to collect food waste.
  - Shut water off when not in use.
  - Do not run a faucet at the same time the disposal is operating. The additional water flow is not necessary for the disposal process.

## **Vehicle Wash Facilities**

- For pressure washers, inspect the sprayer, connecting hoses, and water storage system for leaks and/or broken or missing components; repair immediately.
- Make sure the main shut-off valve is functioning correctly and replace if needed.
- Check flow rates to ensure they are within manufacturer's recommendations.
- If there is no pressure washer, ensure spray nozzles are attached to hoses; make sure open hoses are not being used to wash vehicles.
- For facilities that use detergents, use high-quality detergents to shorten the duration required to clean each vehicle.
- Routinely verify system pressure is within manufacturer's specifications. Minimize pump head pressure or install a pressure-reducing valve to maintain system pressure based on manufacturer's recommendations.
- Assign a staff member to be responsible for checking equipment and repairing leaks.
- Encourage users to wash with brushes/rags rather than water pressure to remove large debris from vehicles.

## **Additional References**

- FEMP O&M: [http://www1.eere.energy.gov/femp/program/operations\\_maintenance.html](http://www1.eere.energy.gov/femp/program/operations_maintenance.html)
- O&M Best Practices Guide: [http://www.eere.energy.gov/femp/pdfs/omguide\\_complete.pdf](http://www.eere.energy.gov/femp/pdfs/omguide_complete.pdf)
- FEMP Water Efficiency Best Management Practices: <http://energy.gov/eere/femp/best-management-practices-water-efficiency>
- DOE/EERE FEMP: <http://www.eere.energy.gov/femp>