IMPROVING ENERGY EFFICIENCY IN STATE-FUNDED FACILITIES THROUGH THE DEVELOPMENT AND USE OF A SIMPLIFIED ENERGY AUDIT PROCEDURE

by

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B.S., Kansas State University, 2011

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Civil Engineering
College of Engineering

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2012

Approved by:

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Abstract

Over the past few years, state governments and entities have become concerned with energy consumption and efficiency at their facilities. The Department of Energy has become increasingly involved in energy code enforcement, and has established initiatives to help states monitor and improve energy consumption. In order to reduce energy consumption and increase building efficiency, facilities must be compared to a baseline building and changes made accordingly. The thesis objectives are to establish a process that all states and state-funded facilities can follow that determines the baseline, establish an energy auditing procedure, and recommend monitoring techniques. In addition, this report documents a procedure developed to make recommendations for improvements and select building and equipment upgrades based and return on investment calculations. The procedures and processes established are designed so that any employee, especially non-engineers, can accomplish changes that will improve facility energy efficiency.

In order to develop simplified energy auditing procedures for large and dispersed organizations, a literature review of prevalent energy codes and standards was conducted, as well as documents outlining energy audit procedures. An energy audit workbook outlining a simplified auditing procedure was created. Six KDOT facilities were audited using the procedure as part of the case study. The audit results were then used to determine practical economic calculations and determine viable improvements that reduce energy consumption.

As a result of this research and case study, a simplified energy audit procedure was created. This procedure was developed to include selecting a baseline of requirements, conducting an energy audit, and selecting viable improvements using economics. All of these procedures are able to be executed by any state employee, specifically those at the facilities who may not be engineers.

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Acknowledgements

I would like to thank my major professor, Dr. Kyle Riding, as well as my committee, Dr. Julia Keen and Dr. Robert Stokes. In addition, I would like to acknowledge Rebecca Gentry and David Carter for assisting with the energy audits of the KDOT facilities. I also want to acknowledge the Kansas Department of Transportation for funding and supporting the research of this report. Leif Holliday and Peter Carttar's assistance in accessing the facilities and gathering missing data was instrumental in completing the research. Accommodations and aid of the managers and staff of the six audited facilities were invaluable. Dale Borger, John Boxberger, Dean Earegood, Wayne Nelson, Gary Simmons, and Robbie Weishaar were helpful throughout the auditing procedure. Lastly, student researchers Ramesh Krishna Sreerama, Vamshi Vemula, and Sreedurga Kona collected all of the utility data, allowing for the energy audits to be conducted.

Dedication

I would like to dedicate this report to my husband, Chris. It has been with his support and encouragement that I embarked upon completing my master's degree. Chris has been my inspiration and my motivation to complete my graduate work and this thesis.

Chapter 1 - Introduction

As a result of rising utility costs and growing concern about the effects of building systems on the environment, the building industry has shifted towards more efficient design methods. Government-funded projects, specifically those funded by state governments, are slow to adopt stringent energy standards and enforce them. Many state governments are unaware what steps to take to improve efficiency. Research needs to be conducted to determine how to reduce energy consumption and energy costs in state owned and operated facilities. Research conducted for this paper aids in reducing energy use of state-funded facilities with the objective of reducing operational energy costs through implementation of building upgrades and improvements that payback in a time period equal to 20 years. This not only will help state governments budget, but will create a process for states to meet energy efficiency requirements of the Department of Energy (DOE) in the present and future.

The objectives of this thesis are to establish a process that all states and state-funded facilities can follow that determines the energy use baseline, establish an energy auditing procedure, and recommend monitoring techniques. In addition, this report documents a procedure developed to make recommendations for improvements and select building and equipment upgrades based and return on investment calculations. The procedures and processes established are designed so that any employee, especially non-engineers, can accomplish changes that will improve facility energy efficiency.

To best meet the needs of state governments and complete the objectives, many steps were completed. A literature review of prevalent energy codes and standards was conducted, as well as documents outlining energy audit procedures. This review allowed for the minimum acceptable levels of energy consumption for existing building operation to be defined and established design criteria for new facilities concentrating on minimum energy use and compliance with DOE requirements. A simplified and custom building audit procedure was then created. Using the created procedures, a case study was conducted consisting of six buildings in the state of Kansas and owned by the Kansas Department of Transportation (KDOT). The audit results and utility data of the facilities were compared and used to generate a list of areas of potential improvements. Economic analysis was conducted for the potential upgrade options and an economic payback tool was developed for future use. Changes were recommended to specific facility attributes that were most commonly problematic, and had a reasonable payback period relative to the initial investment and potential savings. The process used, as well as recommendations that resulted from each of the tasks listed, is described in the chapters that follow.

Chapter 2 focuses on selection of minimum acceptable energy consumption requirements for building design and operation level for state facilities. Requirements of the selected baseline are discussed and established in Chapter 3. Chapter 4 addresses energy audits, including the procedure. Chapter 5 establishes how to select improvements and recommendations, including calculating life-cycle cost, payback period, and carbon footprint reduction. Chapter 6 concentrates on the continual process used in order to ensure energy efficiency. The KDOT building audit case study is addressed in Chapter 7. The last chapter, Chapter 8, is the conclusion which discusses recommended changes and how to implement them. The appendices provide supporting documents and additional details related to recommendations contained in the thesis, as well as documents that can be used by facility managers to conduct their own energy audits. Appendix A provides further information on energy audits including a field guide to energy audits, the audit worksheet, and a tool guide. Appendix B contains audit data collected for the KDOT facilities assessed in this thesis. Lastly, Appendix C is comprised of example calculations performed for the life-cycle-cost analysis for all recommended KDOT facility improvements.

Chapter 2 - Selection of Minimum Acceptable Requirements for Energy Design/Operations

The first step was to research and determine the most appropriate energy standard to be used in the recommendations related to new facilities and upgrades of existing facilities. Selecting an energy standard not only establishes the minimum accepted level of construction and operation of existing facilities but serves as a basis of design for new facilities. Energy savings will become a greater priority as federal regulations, in the form of DOE Determinations, need to be met. A comparison between existing building conditions and the selected minimum level extracted from the content of an industry-accepted energy standard was a critical step in this research. This comparison identified changes that could be considered to reduce energy consumption.

Selecting an industry-accepted and -supported energy standard ensures the content is vetted, regularly used, reviewed, and updated by others; therefore, minimizing the risk of implementation and effort needed to stay current in the future. To find the best and most applicable energy standard for this comparison, two primary factors were considered. First a review of the states and their adopted energy standards was conducted. The intent of this review was to determine what was common practice and accepted among states. Certain states, such as California, are known to be much more aggressive than others on the topic of energy use, and these stringencies were taken into consideration in this comparison. The second factor considered was recommendations made by the DOE in regard to published energy standards. The following subsections will identify and discuss industry-accepted energy standards, and further explain the decision-making process in selecting an energy standard used as the minimally accepted construction and operational level for KDOT buildings.

Defining Energy Codes

Energy codes and standards set minimum requirements for energy-efficient design and construction (Department of Energy, 2012). Energy codes outline uniform requirements for new buildings as well as additions and renovations (Department of Energy, 2012). The implementation of energy codes is beneficial to help reduce energy consumption, increase cost savings, and reduce carbon dioxide emissions (Department of Energy, 2012). Many energy codes and standards are developed through member and industry consensus on the established requirements and details of the code (Department of Energy, 2012). This procedure can be very time and labor intensive for the involved parties, but the effort results in requirements that many parties support and can meet. Code adoption is not automatic in all states, as many are allowed to address energy codes as they see fit (Department of Energy, 2012).

Changes and updates in energy codes require industry members to design using new standards and techniques; implement new requirements at the jobsite; and provide staff and resources to plan, review, and inspect to ensure compliance (Department of Energy, 2012). Energy codes and standards are created and maintained by three main bodies: American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), International Code Council (ICC), and state and locally adopted codes (Department of Energy, 2012). These codes and standards serve commercial and residential sectors and address building envelope, mechanical, service water heating, lighting, and electrical power (Department of Energy, 2012).

Energy code adoption can occur at the state or local level in one of two ways: directly through legislative actions or by regulatory action through state or local agencies (Department of Energy, 2012). Overall, energy codes and standards are created to increase energy efficiency, reduce utility costs, and reduce harmful effects on the environment. It is in the best interest of state governments to adopt the most current industry-accepted energy codes and standards, and apply them to all state facilities.

Accepted Energy Codes

Using an existing energy standard as the basis for recommendations in this thesis allows for well-defined, and industry-accepted and understood requirements. The two most prominent energy efficiency codes in the United States are the International Energy Conservation Code (IECC), published and maintained by the International Code Council (ICC), and the ANSI/ASHRAE/IES Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings (ASHRAE 90.1). In addition to these two base energy codes, references are available that focus on high-performance and green/sustainable design. The ICC publishes the

International Green Construction Code (IGCC), and ASHRAE publishes Standard 189.1 Standard for the Design of High-Performance Green Buildings (ASHRAE 189.1). Neither the IGCC nor ASHRAE Standard 189.1 were considered or selected to be used as the basis of design for this paper, because they are newly introduced and very few jurisdictions have adopted them. State governments may select to reference these documents in the future in order to achieve energy savings above that achieved when implementing the IECC and ASHRAE Standard 90.1. In the event that state want to increase energy-efficiency above that of ASHRAE 90.1-2010, energy certification programs such as LEED, Green Globes, and ASHRAE Building Energy Quotient provide guidelines and ratings for facilities based on energy efficiency and sustainability. States wanting to go above the minimums established by ASHRAE Standard 90.1-2010 can use these programs to track progress and can achieve a rating that correlates to efficiency. These programs are best suited for new facilities since the stringent requirements are difficult to implement in renovations.

The DOE recognizes both the IECC and ASHRAE Standard 90.1 references as acceptable energy codes. Energy codes are adopted on a state-by-state basis, even though the DOE has established minimums that states must adhere to by established dates. Figure 2.1 depicts current state- adopted energy codes for commercial construction, as updated and provided on the DOE website as of June 1, 2012 (Department of Energy, 2011).

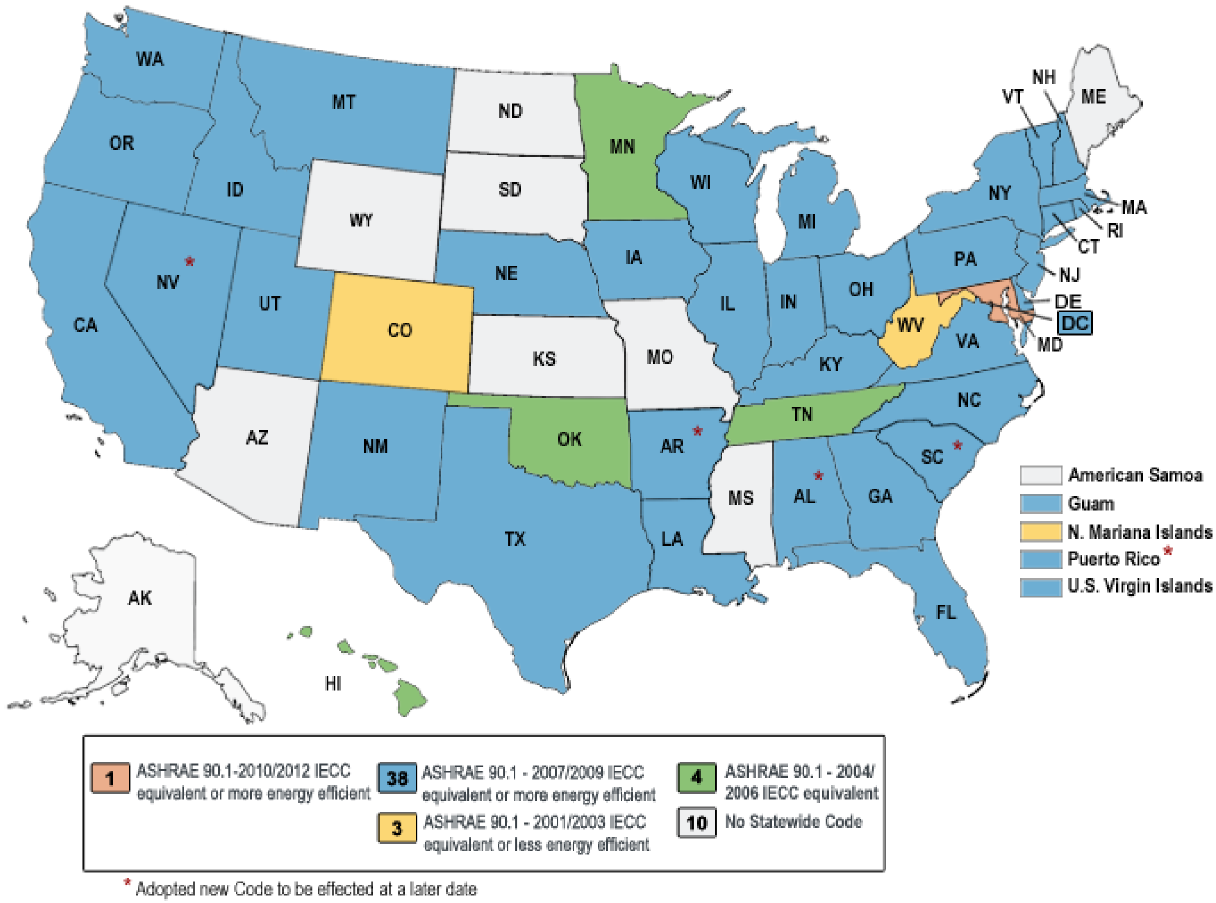

Figure 2.1 Status of Commercial Energy Code Adoption

As of June 1, 2012, three states have adopted ASHRAE Standard 90.1-2001, four states have adopted ASHRAE Standard 90.1-2004, 38 states have adopted ASHRAE Standard 90.1-2007, and one state has adopted ASHARE Standard 90.1-2010. Ten states have no adopted energy codes (Department of Energy, 2012). In addition to having a statewide commercial code, many states have additional requirements for state-funded facilities. For state-funded facilities, three states require ASHRAE Standard 90.1-2004, one state requires 30 percent better than ASHRAE Standard 90.1-2004, four states require ASHRAE Standard 90.1-2007, five states require 10 to 30 percent better than ASHRAE Standard 90.1-2007, and one state requires 10 percent better than ASHRAE Standard 90.1-2010 (Department of Energy, 2012). Twenty states require LEED certification for state-funded facilities, which features environmental requirements in addition to energy efficiency requirements that are at least 25 percent better than ASHRAE Standard 90.1-2007 (Department of Energy, 2012). Six states have created their own minimum efficiency requirements for state-funded facilities, with these requirements typically based on one of the industry-accepted energy codes (Department of Energy, 2012). Lastly, 10 states do not have any requirements for state-funded facilities (Department of Energy, 2012).

The IECC, as with most of the International Code Series, is predominantly referenced by code officials, whereas ASHRAE Standard 90.1 is more familiar to those in a design capacity. Both of the codes have similar content (building envelope, heating, cooling, ventilation, service water heating, power, and lighting), and many of the same people are involved in their development. IECC specifically states in Chapter 5 – Commercial Energy Efficiency, that compliance can be achieved with design meeting the requirements of ASHRAE Standard 90.1. ASHRAE Standard 90.1 will be used as the minimum level of acceptable construction and operation for this report, since it is the more universal and those reading this report will be acting more so as designers than code officials.

ASHRAE Standard 90.1 provides minimum requirements for the energy-efficient design of most buildings and offers, in detail, minimum energy-efficient requirements for the design and construction of new buildings and their systems, new portions of buildings and their systems, and new systems and equipment in existing buildings as well as the criteria for determining compliance with these requirements (ASHRAE, 2010). ASHRAE publishes a revised version of the standard every three years, continually increasing stringency of the requirements to reduce energy consumption and increase efficiency (ASHRAE, 2010). The most current version of ASHRAE Standard 90.1 is 2010, with a new version planned to be published in 2013. Using the 2010 version, as opposed to earlier versions, is an especially appropriate choice for this report because the DOE has issued mandates, also known as determinations, to push the building industry towards energy-efficient design and utilization. Determinations establish requirements that must be met by a stated time. On July 20, 2011, DOE issued a determination that ASHRAE Standard 90.1-2007 would achieve greater energy efficiency in buildings subject to the code than the 2004 edition, and all states had two years to adopt ASHRAE Standard 90.1-2007 or upgrade their existing commercial building codes to meet or exceed its requirements (Department of Energy, 2011). However, on October 19, 2011, DOE issued a final determination that ASHRAE Standard 90.1-2010 would achieve greater energy efficiency in buildings subject to the standard than the 2007 edition (Department of Energy, 2011). This final determination was published before the two-year deadline to file a certification for the 2007 positive determination; therefore, a state may file just one certification to address both determinations (Department of Energy, 2011). The certification must include a demonstration that provisions of the state's commercial building energy code regarding energy efficiency meet or exceed ASHRAE Standard 90.1–2010 and be filed by July 20, 2013 (Department of Energy, 2011). All states have two years to adopt ASHRAE Standard 90.1-2010, or upgrade their existing commercial building codes to meet or exceed its requirements (Department of Energy, 2011). The DOE can enforce the determinations by imposing fines, withholding funding, and setting other restrictions. Therefore, the 2010 edition of the standard should serve as the minimum construction and performance criteria for state governments.

Chapter 3 - Minimum Construction and Operational Requirements for New Facilities and Renovations

ASHRAE Standard 90.1-2010

ASHRAE Standard 90.1-2010 should be used as the design minimum for all state government facilities. The standard establishes minimum requirements for both new facilities and renovations to existing facilities. In order to improve energy efficiency in state-funded facilities, requirements defined by ASHRAE Standard 90.1-2010 should be consulted for any project and requirements of the document must be understood. ASHRAE Standard 90.1-2010 was chosen to allow for energy compliance now and in the future when the 2010 version is adopted. As energy codes continue to advance and newer editions are published, state governments should consider adopting the most current code when it is introduced to ensure future progress.

ASHRAE Standard 90.1-2010 addresses energy efficiency requirements for all aspects of buildings, from the building envelope to specific building systems. The standard is applicable to all buildings, except for low-rise residential, with sections tailored to varying building classifications (ASHRAE, 2010). A majority of state facilities, specifically those addressed in the KDOT case study described in this thesis, fall under the classification of a 'simplified building.' As defined in ASHRAE Standard 90.1-2010, a simplified building is, "two stories or fewer in height and gross floor area is less than 25,000 square feet" and meets additional system requirements as stated in each section of the standard (ASHRAE, 2010).

Renovations to existing state facilities have requirements established by the baseline of ASHRAE Standard 90.1. According to ASHRAE Standard 90.1, when an addition is added or alterations are made to the facility, the changes must comply with requirements of the standard (ASHRAE, 2010). Therefore, if any changes are made to state facilities, the changes should meet the requirements. In making changes to existing facilities, the baseline of ASHRAE Standard 90.1 must be consulted in order to ensure the changes improve the energy efficiency of the facility. To know when requirements of ASHRAE Standard 90.1-2010 are applicable, see subsection 4.2 Compliance Paths (ASHRAE, 2010).

For simplicity and clarity, this report will only address simplified buildings. For all construction that does not meet the requirements of the simplified building, ASHRAE Standard 90.1-2010 will need to be consulted in its entirety. Table 3.1 displays sections of ASHRAE Standard 90.1 that need to be consulted when designing a new simplified building, with discussion about the sections' content following the table. Minimums established in the sections of ASHRAE Standard 90.1-2010 only apply to new construction, additions, or significant renovations when adopted. For purposes of this report; however, it is suggested these minimums also be considered as the baseline for improvements to existing facilities.

Table 3.1 Applicable Sections of ASHRAE Standard 90.1-2010 for Simplified Buildings

Section Number	Section Title
5.4	Mandatory Provisions for Building Envelope
6.3	Simplified Approach Option for HVAC Systems
7.4	Mandatory Provisions for Service Water Heating
8.1.2	Low-Voltage, Dry-Type Distribution Transformers
8.4	Mandatory Provisions for Power
9.4	Mandatory Provisions for Lighting
Normative Appendix B	Climate Zones

ASHRAE Standard 90.1-2010, Section 5, addresses the building envelope (ASHRAE, 2010). For this section, it is imperative to know the type of spaces being designed and how they are thermally conditioned. Most KDOT facilities in the case study will feature two types of conditioning: nonresidential conditioned, referring to office areas; and semiheated, referring to enclosed garages (ASHRAE, 2010). Subsection 5.4 addresses requirements for insulation, as well as maximum areas allowed for fenestration and doors (ASHRAE, 2010). This section also addresses requirements to reduce air leakage, such as vapor barriers, caulking, and sealing (ASHRAE, 2010). By adhering to the conditions of Section 5, heat loss and gains can be reduced in the building (ASHRAE, 2010).

Section 6 of ASHRAE Standard 90.1-2010 focuses on the building's heating, ventilating, and air-conditioning (HVAC) system(s) (ASHRAE, 2010). The simplified approach, subsection 6.3, addresses all requirements of the HVAC system for simplified buildings typical of state facilities, specifically KDOT (ASHRAE, 2010). Subsection 6.3 states requirements, efficiencies, and criteria for types of systems utilized, as well as controls for the system (ASHRAE, 2010). This section also establishes efficiency requirements for HVAC equipment and minimum insulation requirements for ductwork (ASHRAE, 2010). Compliance with requirements in subsection 6.3 allows for design of an efficient HVAC system and controls, thereby reducing energy costs and life-cycle costs.

Service water heating is addressed in Section 7 of ASHRAE Standard 90.1-2010 (ASHRAE, 2010). Subsection 7.4 concentrates on mandatory provisions, including how to calculate hot water loads, efficiencies of equipment, and pipe insulation (ASHRAE, 2010). The section also addresses controls for the service water heating system, as well as outlet temperatures (ASHRAE, 2010). Employment of the requirements in Section 7 will produce an efficient service water heating system well suited for the needs of the facility.

Section 8 of ASHRAE Standard 90.1-2010 deals with power distribution within a facility (ASHRAE, 2010). Subsection 8.4 focuses on mandatory provisions of the power system (ASHRAE, 2010). The section discusses maximum voltage drop for feeders and branch circuits, and methods for automatic receptacle control (ASHRAE, 2010). The purpose of Section 8 is to design a power system for the facility that reduces unnecessary loads and ensures the voltage drop in the system is not too high, resulting in poor quality.

Lighting is addressed in Section 9 of ASHRAE Standard 90.1-2010 (ASHRAE, 2010). Subsection 9.4 offers mandatory provisions for lighting (ASHRAE, 2010). This section deals with lighting controls, including automatic controls, such as occupancy sensors, vacancy sensors, and time clocks (ASHRAE, 2010). Lighting power densities, the maximum wattage per square foot, are also addressed in Subsection 9.4 (ASHRAE, 2010). The building area method for calculating lighting power allowance is the simpler of the methods contained in the standard and is appropriate for most state facilities, as well as the KDOT facilities. Application of Section 9 requirements will reduce lighting loads, increase efficiency since power consumption is limited, and improve controls, therefore reducing energy consumption and lowering utility costs.

ASHRAE Standard 90.1-2010 Normative Appendix B deals with climate zones for the United States (ASHRAE, 2010). Figure 3.1 shows different climate zones for the continental United States. The climate zone is based on location and county, with specific counties listed in

ASHRAE Standard 90.1-2010 Appendix B, Table B-1 (ASHRAE, 2010). The climate zones are broken down even further into moisture categories represented by letters (ASHRAE, 2010). Climate zones are referenced throughout ASHRAE Standard 90.1-2010, with requirements varying based on which climate zone a project is located within. Requirements for the building envelope are one example of requirements varying based on climate zone (ASHRAE, 2010).

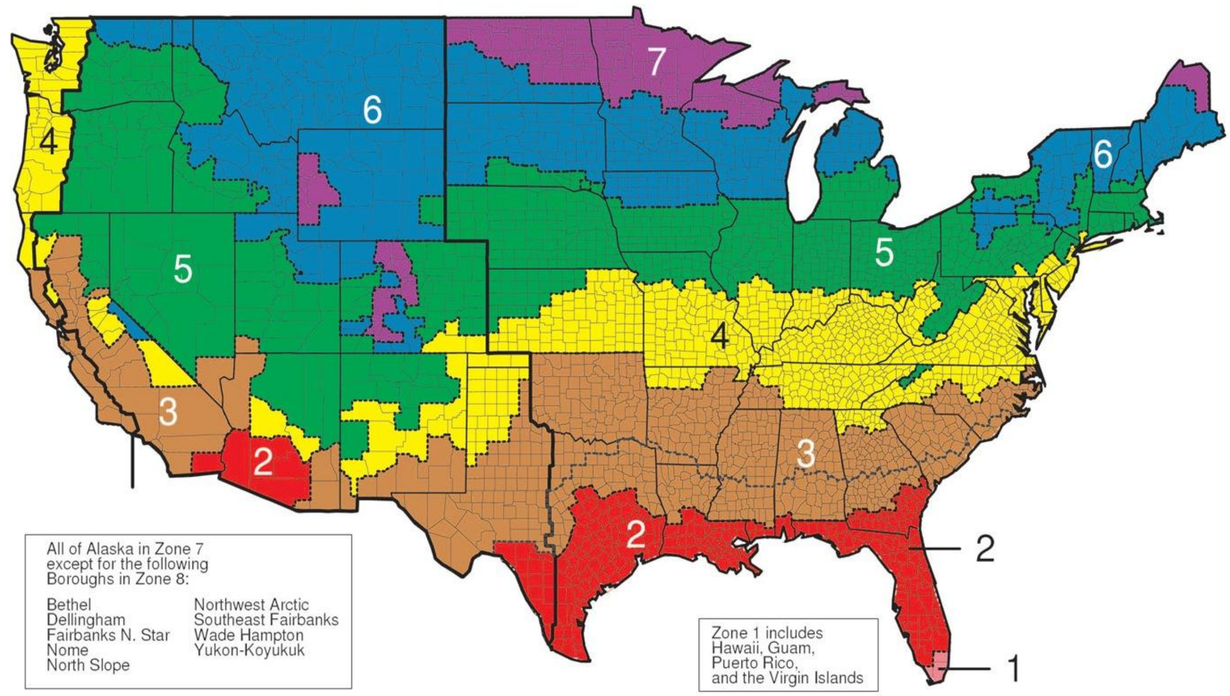

Figure 3.1 ASHRAE Climate Zones for the Continental United States

ASHRAE Standard 90.1-2010 establishes requirements for new and renovated facilities, which would also be applicable to state facilities. While a majority of state facilities will fall into the definition of a simplified building and therefore having simpler requirements, ASHRAE Standard 90.1-2010 should be consulted for all types of facilities. By adhering to ASHRAE Standard 90.1-2010 for all facilities, energy consumption will decrease and energy efficiency will increase.

It is assumed for this report that facilities will have access to ASHRAE Standard 90.1-2010. This document needs to be available to whoever will be responsible for selecting and implementing changes, whether they are at a facility level or a state level.

Energy Star Certification

Energy Star products should be used whenever possible in state-funded facilities. Specifically, equipment used in space conditioning, water conditioning, and other frequently used pieces of equipment need to be Energy Star certified.

Energy Star is a government-supported program aimed at helping the environment and saving money through energy-efficient products and practices (Energy, 2012). Products earn an Energy Star label/certification by meeting the energy efficiency requirements created by the Environmental Protection Agency, based on significant energy savings, features and performance, reasonable economic payback period, access, and measured efficiency (Energy, 2012). Many types of products are Energy Star-certified, including computers, insulation, lamps, water heaters, air conditioners, furnaces, and refrigerators.

Appliances in state-funded facilities should be Energy Star-certified whenever possible. Since it is not economically sensible to replace everything at once, Energy Star-certified products should be purchased when a replacement is needed, such as replacing a broken refrigerator with an Energy Star-certified refrigerator.

Energy Star labels have been created to help consumers make purchases. The label states the range of energy consumption for comparable products and where the specific product falls (Energy, 2012). In addition, the label will give an estimate of what the energy costs will be for the product for a year (Energy, 2012). It is also important to note that a 15 year old appliance may be Energy Star-certified, but will not be as efficient as newer models. These labels typically appear are larger products, such as water heaters and furnaces. It is in the state's best interest to purchase appliances whose labels show that are in the lower 50 percent on energy consumption since they will have lower energy consumption. If it is possible, it is best to purchase the lowest energy consumption product available. For smaller products, and Energy Star seal may be used instead of the label. For these products, such as computers and lamps, any is a viable option since they will be more efficient than a comparable product that is not Energy Star certified. To know the requirements for that particular product, consult the Energy Star website.

Chapter 4 - Energy Audits

Energy audits are an essential component for increasing energy efficiency in buildings. Primarily, energy audits serve the purpose of identifying energy use among various services within a building and depicting opportunities for energy conservation measures. The goal is to reduce energy use in areas where energy is being wasted, and in areas where a reduction will not cause disruptions to the building or occupant functions. Energy audits focus upon all systems and components within a building, including building equipment operation, building envelope, mechanical systems, lighting systems, electrical systems, and water systems.

It is imperative to have an energy audit procedure, customized for employees of state governments, to allow for consistent and determinative energy audits even when the audit conductors have little or no understanding of energy audits.

Energy Audits Procedure

Energy audits provide valuable information as to current conditions of a facility and improvements that can be made to increase efficiency. ASHRAE's "Procedures for Commercial Building Energy Audits," introduces three different levels of energy audits (ASHRAE, 2011b). In order to best suit state facilities, and the facilities of the KDOT case study, a custom audit procedure was created by combining applicable components of the three ASHRAE procedures. To best respond to current and future needs of state-funded facilities, the custom procedure allows for a great amount of details to be gathered in a simplistic manner. There are three main sections to the audit procedure: 1) pre-audit, 2) audit, and 3) post-audit. The three sections are described in detail later in this section. Energy audit documents and the step-by-step audit procedures are located in Appendix A.

Specific tasks need to be completed prior to the energy audit in order for it to be successful. The pre-audit starts two weeks prior to the audit, beginning by sending an owner survey to the facility contact person. The survey responses are needed at least two days prior to the audit. Once the survey is returned, the audit documents need to be updated by the auditor to reflect the answers on the owner survey. Prior to conducting the on-site inspection portion of the audit, it is best to fill out as much of audit spreadsheets found in Appendix A as possible, using the owner survey and, if available, building floor plans. It is important for the auditor to become familiar with the floor plans and develop a list of questions for the owner prior to the audit. These questions are different from those asked on the owner survey and are formed when discrepancies are found in the floor plans, or utility bills, or when questions arise that only the facility contact could answer. Lastly, all of the equipment needed for the audit should be assembled. The following items should be packed and readily available: flashlight, digital camera, yardstick(s), infrared camera, four-in-one device(s) (thermometer, light meter, hygrometer, and anemometer), highlighters, floor plans, clipboards, writing utensils, and blower-door testing equipment. See Appendix A, “Tool Guide”, for what each item is to be used for during the audit.

The procedure used for the most effective and informative energy audits must be consistent over time and between different facilities; therefore, a defined procedure should be adhered to. First, once at the facility, the auditor should meet with the owner, representative, or contact person and discuss the audit; ask previously developed questions and take a brief tour of the facility. With the audit worksheet in hand, the auditor should begin completing the necessary information one room at a time. The auditor should be sure to take notes and photos of everything while working through the audit. After all information has been recorded on the interior, an exterior assessment should be conducted. This should start with a walk around the structure. The auditor should take notes of any irregularities, and take digital and thermal photos of the exterior. Last, the auditor should develop exit questions for the owner, representative, or contact person. Ask about anything that was unclear or needed additional information.

After the audit, the auditor should begin the “post-audit” and compile data in the audit documents. If there are any omissions, the auditor should be sure to ask the facility point of contact for clarification or information.

Comparing Energy Audit Results to the Minimum Construction and Operational Requirements

After the energy audit has been conducted, the facility needs to be compared to the minimum construction and operational requirements by the auditor. First, the auditor should obtain all completed energy audit documents and a copy of ASHRAE Standard 90.1-2010. Then the auditor should compare each component of the facilities to the requirements established in ASHRAE Standard 90.1-2010. Reference the sections addressed in Chapter 3 of this report. While comparing, the auditor should make note of anything that is below the requirements. Once everything has been compared, including lighting, HVAC, plumbing, and building envelope, a list will have been created that notes all areas that need to be improved to meet the minimum requirements. The state can now decide if the improvements should be made to simply meet the requirements or exceed them. Chapter 5 will establish how to determine which changes to implement.

Chapter 5 - Selecting Changes and Improvements

Minimum construction and operational requirements, and energy audits are both used to determine possible changes and improvements to increase the energy efficiency of the facility in consideration. Once a list of possible changes is created, economic calculations can be used to determine which changes are economically feasible. Viable options can then be implemented to increase energy efficiency and reduce utility costs in state facilities.

Upon completion of the energy audit, the process of selecting possible improvements and changes begins. In order to determine possible changes, the facility needs to be compared to the minimum construction and operational requirements. This is done by comparing the energy audit worksheet to the requirements stated in ASHRAE Standard 90.1-2010. Some improvements will be simple, such as replacing weather stripping and installing programmable thermostats, while other improvements, such as resizing water heaters and replacing windows, are extensive. Other common changes include installing lighting controls; changing light fixtures, lamps, and ballasts; sealing building joints and penetrations; and replacing appliances such as water heaters and furnaces with Energy Star-certified products that are highly efficient.

Economic Calculations

Calculations must be done for each of the recommended changes in order to determine cost justification of improvements, and to assist determining changes to scheduling and financing. Calculating the life-cycle cost for recommendations is done using net present cost (NPC) since this value takes into account payments and savings over the life of an item. To calculate the NPC of proposed alterations, the first cost and annual maintenance cost for the life cycle is calculated using traditional economic formulas. Annual operating costs and utility costs are calculated based on average utility rates for the state facilities, and by using product energy data and energy modeling. If there is a demolition cost for an existing item, this is also included in the calculations. To assist in pricing, 2011 RS Means Cost Data manuals can be utilized to find average initial, operating, maintenance, salvage, and demolition costs. See Equation 5.1 to understand how to calculate NPC.

Equation 5.1 Net Present Cost

NPC = (Item's First Cost) + (Annual Maintenance Cost)(P|A, i, n) + (Annual Energy Cost)(P|A, i, n) + (Demolition Cost)(P|F, i, n) – Salvage Cost

Item's First Cost: Initial investment for the item.
Annual Maintenance Cost: Cost to perform annual maintenance on the item.
Annual Energy Cost: Cost to annually operate the item.
Demolition Cost: Cost to remove an item after its lifespan is over.
Salvage Cost: Worth of item after its lifespan. (Ex: Selling parts back)
(P/A, i, n) = Present cost given annual costs = A *((((1+i)^n)-1)/(i(1+i)^n))
[i = interest rate, n = number of years]
Can be calculated or found using typical economic tables
(P/F, i, n) = Present cost given future costs = F * (1+i)^n
Can be calculated or found using typical economic tables

State governments typically have an established interest rate and life cycle that is used for economic calculations. A spreadsheet can be developed specifically for the analysis of NPC and ROI for most recommendations. The spreadsheet should be created by the state and so that each cost parameter can be filled in and the NPC is calculated automatically.

The next calculation to be performed is return on investment (ROI). ROI is calculated by comparing a current item with the recommended replacement item; for example, comparing existing T12 lamps with new T5 lamps. The ROI equation can be seen in Equation 5.2. The difference in annual energy costs is divided by the difference in initial costs, to result in a percentage. The third and final calculation deals with payback period. The payback period compares two items and is the inverse of return on investment. Equation 5.3 displays the equation for calculating payback period. These are not traditional engineering economic calculations since they do not take the interest rate and time value of money into account. However, these equations serve as decision making tools, and put the economics in simple terms that anyone can understand, including employees who are not engineers.

Equation 5.2 Return On Investment

$$\text{ROI} = \frac{\Delta A}{\Delta P} = \frac{\text{Difference in Annual Energy Costs}}{\text{Difference in Initial Costs}}$$

Equation 5.3 Payback Period

$$\text{Payback Period} = \frac{\Delta P}{\Delta A} = \frac{\text{Difference in Initial Costs}}{\text{Difference in Annual Energy Costs}}$$

The process of calculating the NPC and ROI for replacing an incandescent lamp with a compact fluorescent lamp is shown in Figure 5.1 as an example. As stated before, values used in the example were found within the 2011 RS Means Cost Data manuals, and an interest rate of 6% and a life cycle of 20 years were assumed as a result of common government practices of using a low interest rate and long product life.

	Incandescent Lamp, 100W	**Compact Fluorescent, 25W**
First Cost	$ 5.82	$ 7.19
Annual Maintenance	$ 2.29	$ 2.29
Annual Energy	$ 23.36	$ 5.84
Demolition Cost	$ 5.00	$ 5.00
Net Present Cost	**$ 316.06**	**$ 116.48**

Definitions/Assumptions:

First Cost: Initial Cost of Equipment for Purchasing and Installing
Annual Maintenance Cost: Annual Costs Associated with Maintenance
Annual Energy Cost Difference: Difference between existing cost and new annual energy cost
Demolition Cost: The cost at the end of an item's life to remove it
Salvage Cost: When an item requires replacing, this is the value of the salvaged parts.
Electricity: Assumed rate of $0.07 kWh. Use regional applicable rate.

Economic Analysis Equations: (Newman, 2011)

P: Present Cost, F: Future Cost, A: Annual Cost, i: Interest Rate, n: Years
Present Cost given Future Cost: (P/F, i, n) = F * (1+i)^n
Present Cost given Annual Costs: (P/A, i, n) = A *((((1+i)^n)-1)/(i(1+i)^n))

Return on Investment

$$\text{ROI} = \frac{\Delta A}{\Delta P} = \frac{\text{(Difference in Annual Costs)}}{\text{(Difference in Initial Item Costs)}}$$

$$\text{ROI} = \frac{\Delta A}{\Delta P} = \frac{(23.36 - 5.84)}{|(5.82 - 7.19)|}$$

ROI = **1,278.83 %**

Payback Period

$$\text{Payback Period} = \frac{\Delta P}{\Delta A} = \frac{\text{(Difference in Initial Item Costs)}}{\text{(Difference in Annual Costs)}}$$

$$\text{Payback Period} = \frac{\Delta P}{\Delta A} = \frac{|(5.82 - 7.19)|}{(23.36 - 5.84)}$$

Payback Period = **0.08** Years

Figure 5.1 Calculations for Net Present Costs and Return on Investments

In order to select feasible recommendations and changes for state facilities, the NPC and ROI values must be taken into account. Once these values are calculated for the different possible improvements, they must be compared to determine the best option. To better understand what the calculated values are indicating, there are a few guidelines to follow. The lower the NPC, the lower the overall cost of the item over its life span. Next, the higher the ROI value, the sooner the cost will be recovered. The ROI value represents how long it will take to recover the cost of replacing the current system. The payback period is the inverse of the ROI and depicts how long it will take to recover the cost in terms of years. In reference to the example in Figure 5.1, the CFL is a better choice since it has the lower NPC, a high ROI, and a very low payback period.

If there are multiple options being considered, it is important to select the item with the lowest NPC as well as highest ROI. If an item does not have the best value in both calculations, then the state government must decide which aspect is more important – overall cost or recovering costs. Some items will not be economically feasible and will not need to be considered. For more examples, see Chapter 7 – Kansas Department of Transportation Case Study, Economic Calculations section.

Chapter 6 - Improving Energy Efficiency is a Continual Process

Improving the energy efficiency of state facilities is a continual process. Selecting minimum acceptable requirements for energy design/operations, conducting energy audits, and determining viable improvements and changes are three key steps in the continuous cycle of maintaining an efficient facility. State governments can implement an energy efficiency process that strives to continually improve the facilities by educating employees, maintaining an audit cycle, documenting audits and changes, and utilizing software.

State governments can benefit heavily from educating employees about energy efficiency and the process of improving efficiency. Every employee needs to understand basic energy efficiency procedures, such as turning off lights and equipment when not in use or when the facility is unoccupied. Include employees, specifically those in supervisory positions, when conducting audits to help educate them and encourage energy efficiency practices. State governments should train audit-conducting employees not only how to perform a successful audit, but how to interact with facility occupants and teach others about energy concerns and best practices.

State governments should re-evaluate minimum requirements every year and update when necessary. This process involves monitoring status of energy codes, as well as trends in industry and determinations made by the DOE. The process described in Chapter 2 should be used by states to make sure the appropriate minimum requirements are implemented. If state governments desire, more progressive minimums can be implemented. ASHRAE Standard 189.1 or LEED certification could serve as progressive minimum requirements.

Educated employees should conduct energy audits of state facilities on a routine basis. Auditing all state facilities every year is impractical; therefore, an auditing cycle should be established. The state should determine the appropriate number and location of facilities to be audited each year. Each year should consist of facilities that are representative of all facilities, taking into account locations, size, and use. Every facility should be audited at least once every five years. This cycle can determine any problems before they become detrimental and allows for comparison in energy use after changes and improvements. Utility data can help determine which facilities to audit and when. A facility with lower utility costs can be audited to determine good practices, whereas a facility with higher utility costs can be audited to determine problems and areas of improvement. The same number of facilities should be audited each year, with half being high energy consumption facilities and the other half being low energy consumption facilities. Frequent audits allow state governments to continually progress towards energy efficiency.

Documentation and use of software allow state governments to maintain a continual process of selecting minimum requirements, auditing, and improving energy efficiency. By documenting the process and any decisions made, the state can establish goals and work towards increasing efficiency and reducing utility costs. Goals can include meeting a set utility bill total, reducing energy consumption by a certain percent or in relation to the established minimum of ASHRAE Standard 90.1-2010, etc. Computer programs can be used to monitor energy consumption, establish goals and guidelines, and calculate utility savings and carbon footprints. Other computer programs can be used to monitor facilities, such as the Energy Star program. It is used to track utility use and compare multiple facilities owned by the same entity. The program can also compare facilities to similar facilities owned by others that have been submitted. Energy Star is a good program to use to help determine which facilities should be audited and when. Lastly, programs and calculators, such as those found on the Federal Energy Management Program website, can be used to calculate anything from lighting power density to carbon footprint (Federal Energy Management Program, 2012). These tools allow state governments to determine if minimums are met, and establish changes and goals.

In general, improving energy efficiency of state facilities is an ongoing process. Minimum requirements must be re-evaluated every year to ensure the state is meeting federal requirements and industry standards. Energy audits are continual, with facilities constantly being audited, and improvements and changes implemented. Employees must be educated and involved in the process. Utilization of software as well as employing a method to track and document energy use is important to implementing changes and monitoring progress towards goals.

Chapter 7 - Kansas Department of Transportation Case Study

Case Study Introduction

The Kansas Department of Transportation served as the case study for this report. KDOT has facilities located throughout the state of Kansas that serve as local offices as well as storage and maintenance facilities. As a utility-saving initiative, KDOT allowed for utility data of facilities to be collected and analyzed, and for selected facilities to be audited. From the audits, changes and improvements were recommended and economic calculations were performed to determine viable recommendations.

To begin, minimum acceptable requirements for energy consumption levels for design/operations needed to be established. Currently, Kansas has adopted the IECC 2006 as the statewide commercial code, which accepts ASHRAE Standard 90.1-2004 as an alternate compliance path; however, the state does not enforce the code, nor does it have a way to govern if the codes are not complied with (Department of Energy, 2012). Therefore, the DOE shows on the Status of Energy Codes Map that the state of Kansas has no building energy code. There are no established energy requirements for state-owned or -funded facilities in the state of Kansas (Department of Energy, 2012). As discussed in Chapter 2, ASHRAE Standard 90.1-2010 should serve as the minimum as a result of state adoption trends and requirements established by the DOE.

After selecting ASHARE Standard 90.1-2010 as the minimum acceptable energy consumption levels for energy design/operations, the next step is to audit facilities. The tailored energy audit procedure from Chapter 4 was used to audit six selected KDOT facilities. These facilities were examined to determine recommendations for improvements. From the audit results of the KDOT facilities, a list of improvements was developed that have the potential to reduce energy consumption and increase efficiency in not only these six facilities but can be applied to all 157 KDOT facilities. The following sections describe in detail the six facilities visited and the audit data collected.

Kansas Department of Transportation Facility Audits

Six KDOT facilities were audited from each KDOT district with Kansas with the purpose of providing a snapshot of building conditions. The facilities were selected based on many factors including similarities in building size and usage, age of facility, renovation timeline, complete utility usage data, and clear and readable floor plans. By choosing facilities with similar floor plans, the data collected could be compared more effectively and more substantive recommendations could be made. The buildings chosen were limited to substations because 88 substations comprise 72% of the KDOT buildings, therefore allowing the data collected and result analysis to have the greatest potential for energy-savings impact. The selected facilities are shown in Figure 7.1.

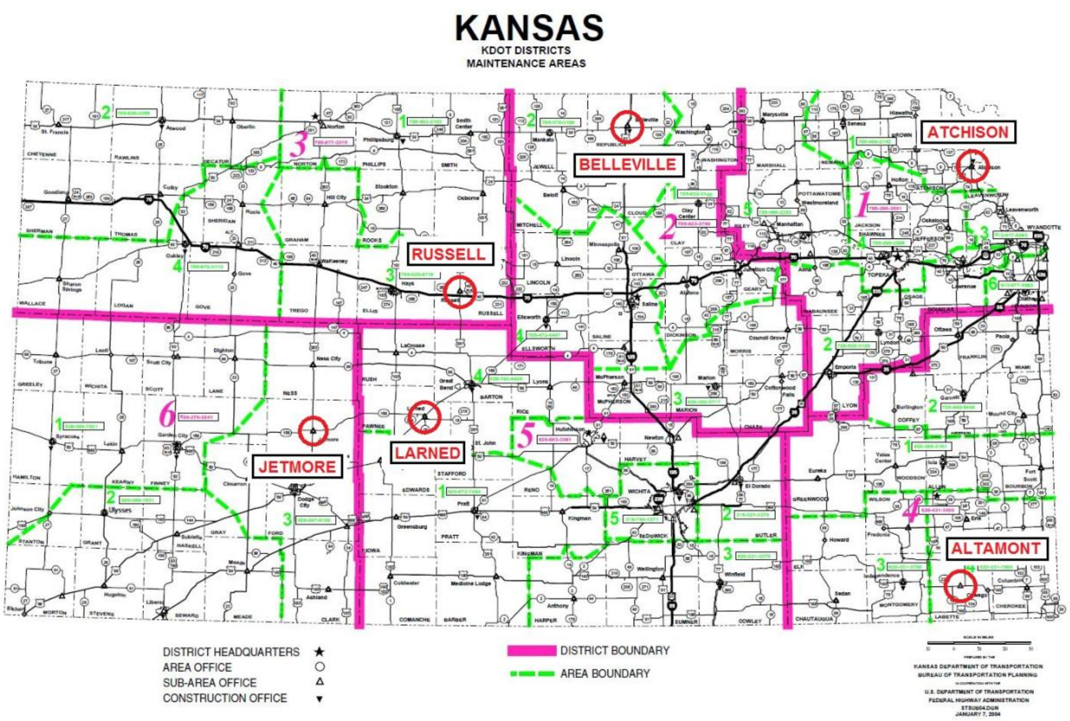

Figure 7.1 Map of Selected KDOT Facilities

Atchison, Altamont, Belleville, Jetmore, Larned, and Russell comprised the six selected KDOT facilities. A synopsis of each facility audited is provided in the following subsections.

The energy consumption is calculated and displayed per square foot of office space. The office spaces are a larger consumer of energy year round, compared to the storage areas; therefore, are concentrated on for the analysis of energy consumption.

In addition to completing the audit as outlined in Chapter 4, a blower-door test was conducted at the KDOT facilities to identify areas of infiltration and air leakage. A blower-door test is conducted by creating a building pressure of 50 Pascal (Minneapolis, 2008). A 50-Pascal pressure is roughly equivalent to the pressure generated by a 20-mph wind blowing on the building from all directions (Minneapolis). The blower-door fan creates an airflow of 50 cubic feet per minute (CFM), which is the most commonly used measure of building airtightness and gives a quick indication of the total air leakage in the building envelope (Minneapolis). The test is not included in the audit procedure since it is unlikely that state entities will have the proper equipment and trained personnel to administer the blower-door test.

Atchison

In District 1, the facility located in Atchison was audited. This facility is denoted by KDOT as District 1, Area 1, Complex 4. This facility, built in 1957, has an office area of 4,277 square feet and a storage area of 2,980 square feet. The Atchison subarea consists of two heated bays, four unheated bays, interior office space, a washbay, and exterior storage. Specifically, the facility features single-pane windows, two natural gas furnaces, a 30-gallon natural gas water heater, natural gas radiant heaters, and T12 and incandescent lamps throughout. Figures 7.2, 7.3, and 7.4 are graphs illustrating utility usage for Atchison. The blower-door test resulted in an infiltration airflow of 5592 CFM. However, the test never reached 50 Pascal and had to be run in open configuration since the door from the office area to the bays had a vent. The blower-door test was also pulling in air from the bays, which was different than any of the other facilities.

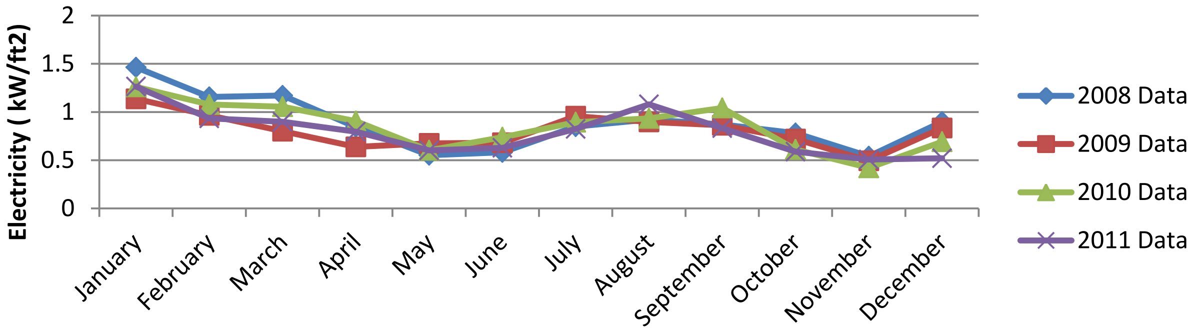

Figure 7.2 Electricity Use for Atchison

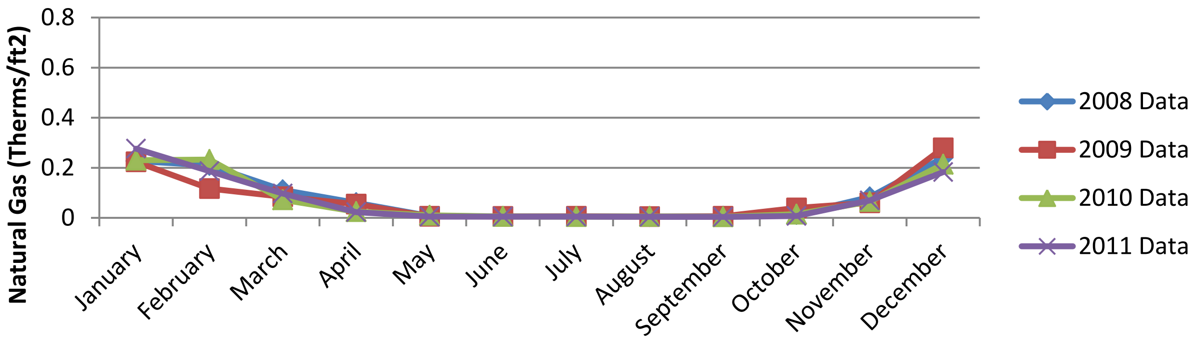

Figure 7.3 Natural Gas Use for Atchison

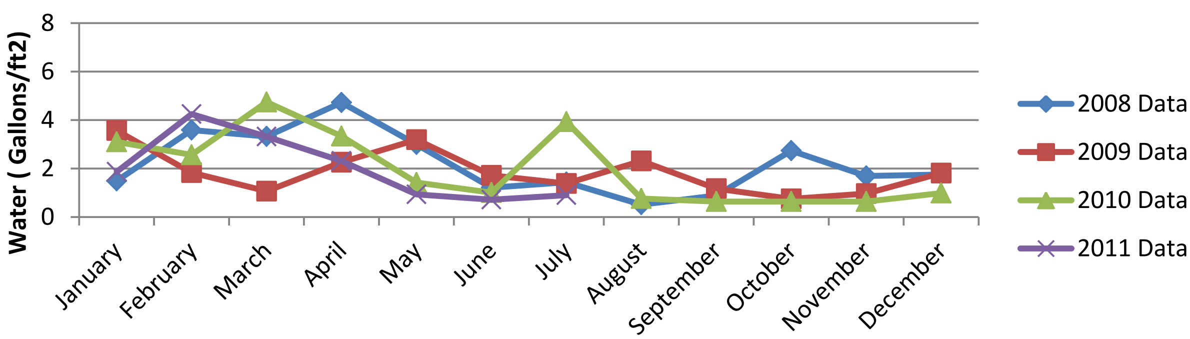

Figure 7.4 Water Use for Atchison

Belleville

The subarea in Belleville was selected as the representative for District 2. District 2, Area 2, Complex 59 denotes this facility. The building, constructed in 1963, has an office area of 4,203 square feet and a storage area of 3,027 square feet. The Belleville subarea has two heated bays, four unheated bays, interior office space, a washbay, and exterior storage. Equipment in the facility consists of double-pane windows, a natural gas furnace, an eight-gallon electric water heater, natural gas radiant heaters, and T8 and incandescent lamps throughout. The facility had all windows replaced in 2006. Graphs showing utility usage for the Belleville facility are Figures 7.5, 7.6, and 7.7. The blower-door test for Bellville resulted in an infiltration airflow of 2046 CFM.

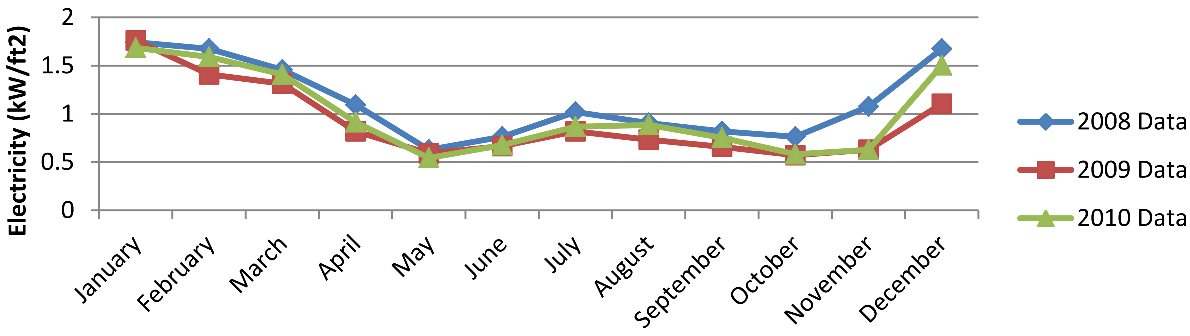

Figure 7.5 Electricity Use for Belleville

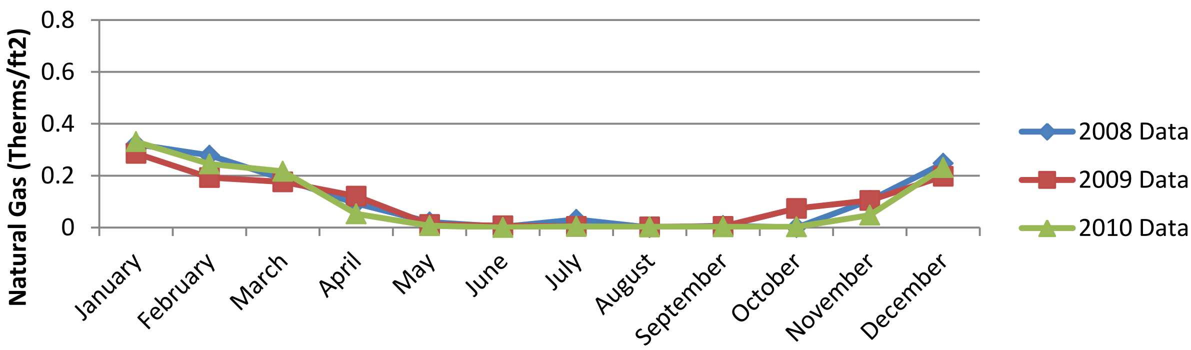

Figure 7.6 Natural Gas Use for Belleville

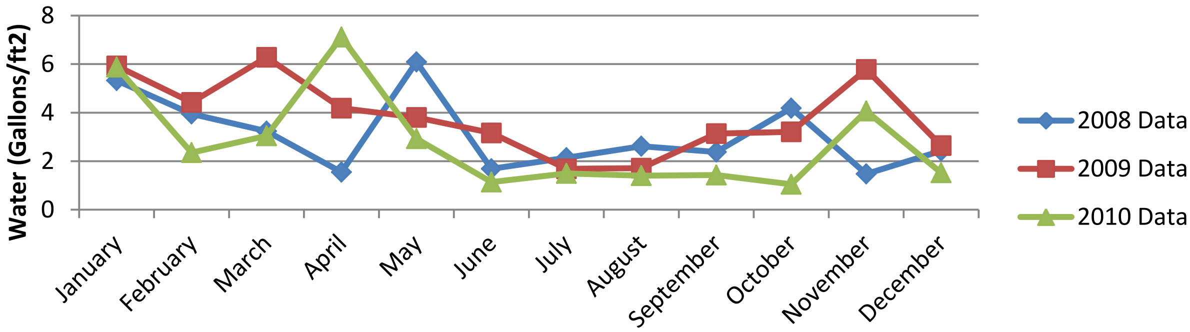

Figure 7.7 Water Use for Belleville

Russell

From District 3, the Russell subarea, District 3, Area 3, Complex 91, was selected. This facility, built in 1961, has an office area of 4,138 square feet and a storage area of 2,986 square feet. Two heated bays, four unheated bays, interior office space, a washbay, and exterior storage make up the Russell complex. Russell features double-pane windows, a natural gas furnace, a 29-gallon natural gas water heater, natural gas radiant heaters, and primarily T5HO (high-output) lamps throughout. The three figures, 7.8, 7.9, and 7.10, depict utility use for the Russell facility. The blower-door test resulted in an infiltration airflow of 2330 CFM.

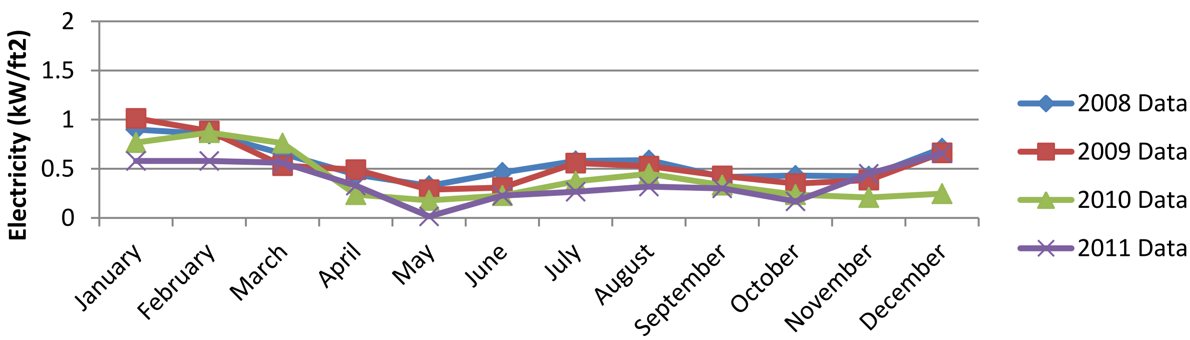

Figure 7.8 Electricity use for Russell

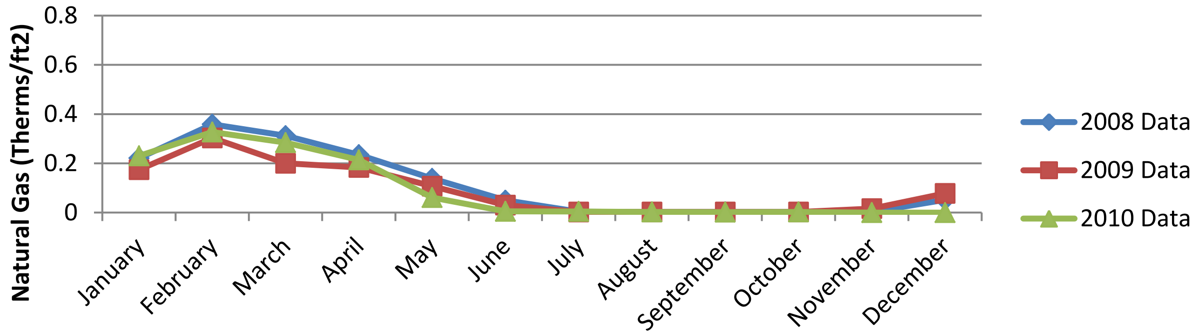

Figure 7.9 Natural Gas Use for Russell

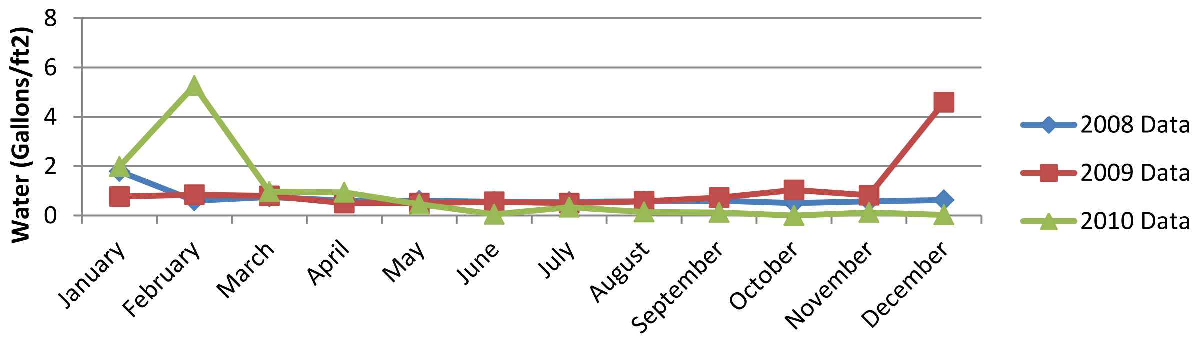

Figure 7.10 Water Use for Russell

Altamont

The Altamont subarea, District 4, Area 4, Complex 137, was audited as the District 4 facility. The facility, built in 1966 and renovated in May 2009, has an office area of 2,431 square feet and a storage area of 1,755 square feet. Four heated bays, two interior offices, a washbay, and exterior storage make up the Altamont subarea. The facility features double-pane windows, packaged through the wall air-conditioning units with electric heating coils; a six-gallon electric water heater; natural gas radiant heaters; and T8 lamps utilized throughout. Utility use is illustrated in Figures 7.11, 7.12, and 7.13. The blower-door for Altamont resulted in an infiltration airflow of 1066 CFM.

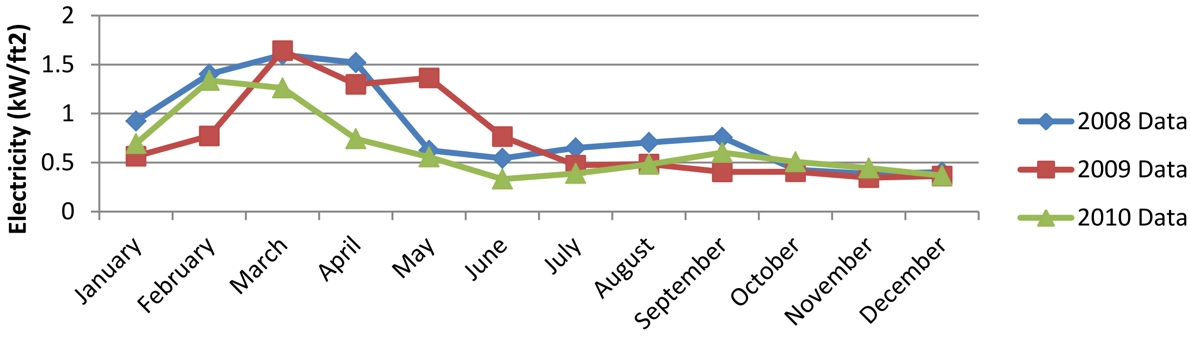

Figure 7.11 Electricity Use for Altamont

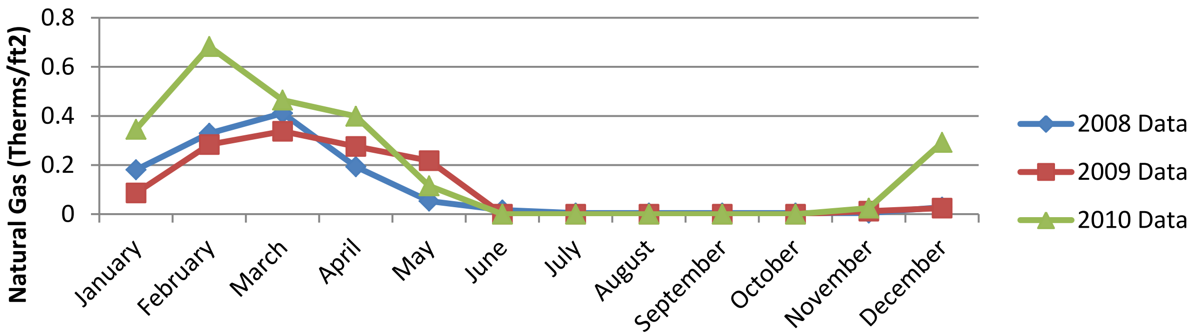

Figure 7.12 Natural Gas Use for Altamont

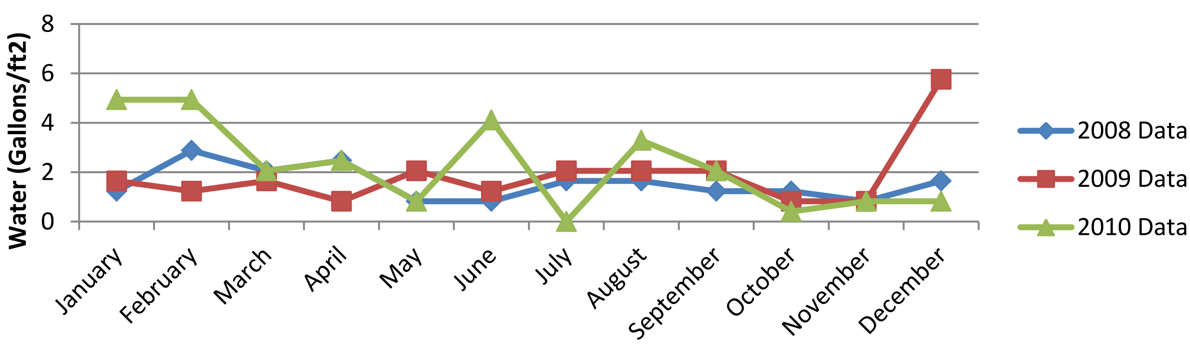

Figure 7.13 Water Use for Altamont

Larned

From District 5, the Larned subarea, District 5, Area 4, Complex 130, was selected to be audited. This facility, built in 1961, has an office area of 4,024 square feet and a storage area of 3,067 square feet. Larned subarea features two heated bays, four unheated bays, interior office space, a washbay, and exterior storage. The facility also has double-pane windows; a natural gas furnace; a 40-gallon natural gas water heater; natural gas radiant heaters; and T12, T5, and incandescent lamps. Utility use is represented in Figures 7.14, 7.15, and 7.16. The blower-door test resulted in an infiltration airflow of 1762 CFM.

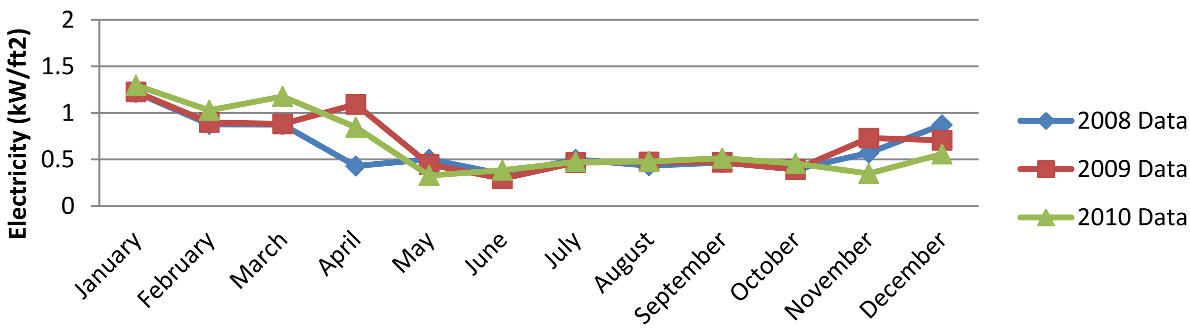

Figure 7.14 Electricity Use for Larned

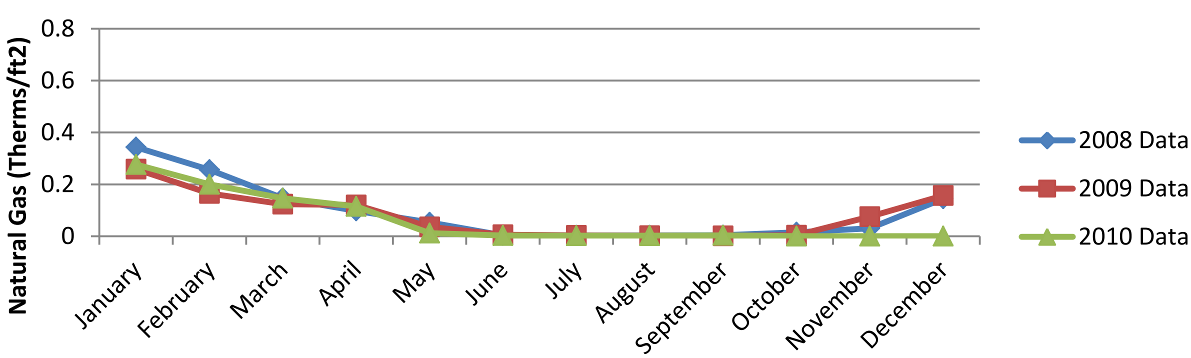

Figure 7.15 Natural Gas Use for Larned

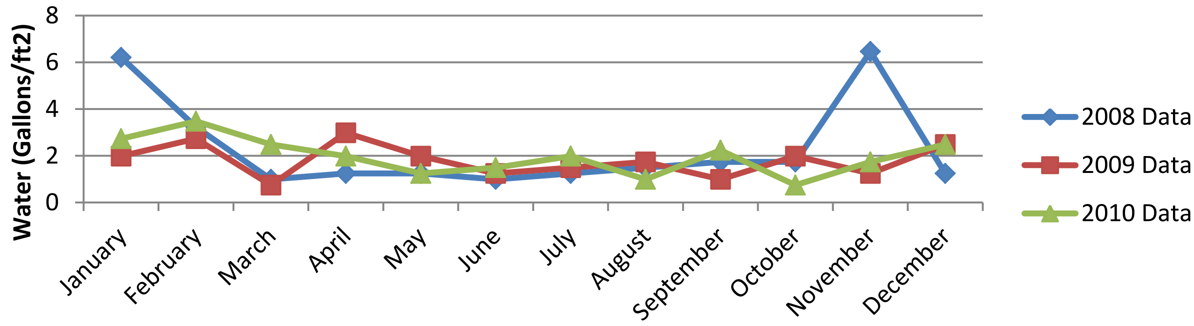

Figure 7.16 Water Use Larned

Jetmore

The Jetmore subarea, District 6, Area 3, Complex 218, was audited as a representative of District 6. The facility, built in 1967, has an office area of 2,501 square feet and a storage area of 1,998 square feet. Two heated bays, two unheated bays, interior office space, a washbay, and exterior storage make up the subarea complex. Jetmore features single-pane windows, a natural gas furnace, a 40-gallon natural gas water heater, natural gas radiant heaters, and T8 and incandescent lamps installed throughout. Graphs illustrating utility usage for Jetmore can be found in Figures 7.17, 7.18, and 7.19. The Jetmore blower-door test was inconclusive as a result of equipment problems.

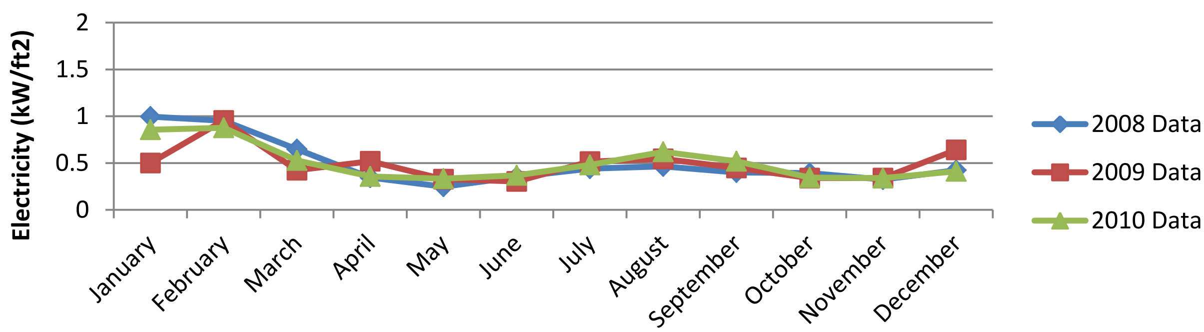

Figure 7.17 Electricity Use for Jetmore

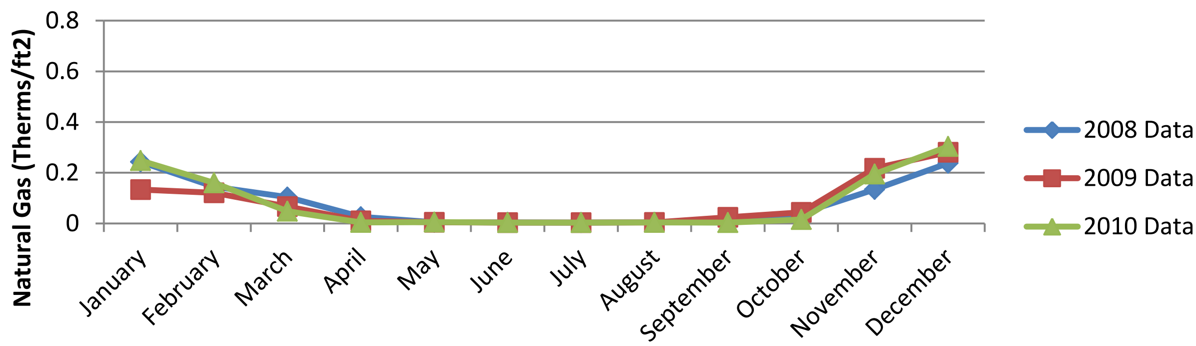

Figure 7.18 Natural Gas Use for Jetmore

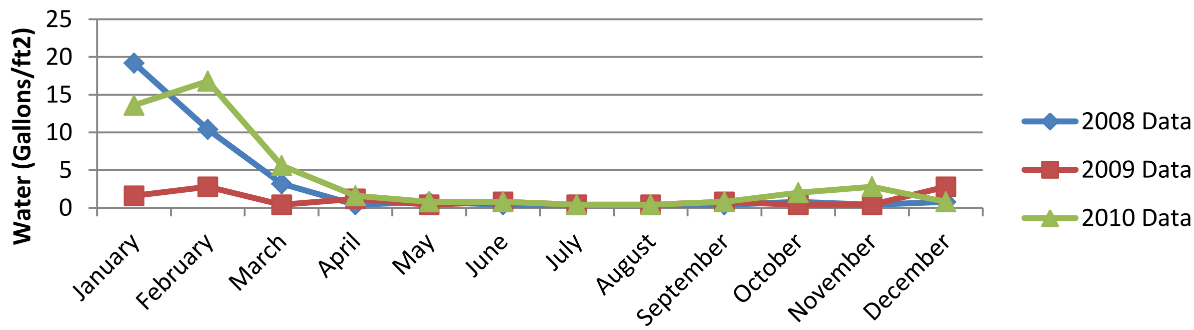

Figure 7.19 Water Use for Jetmore

As a summary of the data collected, see Table 7.1 to compare building features and systems, and Table 7.2 to compare monthly average utility consumption among the six KDOT facilities. Also, Figures 7.20, 7.21, and 7.22 display average utility usage from 2008 to 2010 for all six facilities, all on one graph to aid in comparison. Table 7.1 illustrates the variation in equipment at each facility used. The table also serves as a reference to determine possible causes of high and low energy consumption. Table 7.2 is used to see the variation in utility consumption. The table easily shows which facilities are highest and lowest. Figures 7.20-22 help display the peaks and low points in energy consumption and the diversity between the facilities. The graphs can be used to find outliers that may be affected by improvements.

Table 7.1 Summary of Facility Characteristics for All Six KDOT Facilities

	Audited KDOT Facilities					
	Atchison	Belleville	Russell	Altamont	Larned	Jetmore
Year Built	1957	1963	1961	1966	1961	1967
Office Area	4277 sf	4203 sf	4138 sf	2431 sf	4024 sf	2501 sf
Washbay/ Storage Area	2980 sf	3027 sf	2986 sf	1755 sf	3067 sf	1998 sf
Quantity of Heated and Unheated Bays	2 / 4	2 / 4	2 / 4	4 / 0	2 / 4	2 / 2
Window Panes	Single-pane	Double-pane	Double-pane	Double-pane	Double-pane	Single-pane
Heating/Cooling	(2) NG Furnaces	NG Furnace	NG Furnace	Electric PTACs	NG Furnace	NG Furnace
Water Heater	30-Gallon Natural Gas	8-Gallon Electric	29-Gallon Natural Gas	6-Gallon Electric	40-Gallon Natural Gas	40-Gallon Natural Gas
Lamps	T12, Incand.	T8, Incand.	T5HO	T8	T12, T5, Incand.	T8, Incand.

Notes: NG = Natural Gas, PTAC = Packaged Terminal Air Conditioners

Table 7.2 Monthly Average Utility Consumption (2008-2010) for All Six Selected KDOT Facilities

	Audited KDOT Facilities					
	Atchison	Belleville	Russell	Altamont	Larned	Jetmore
Electricity Average (kW/sf)	0.8479	1.0196	0.5025	0.7370	0.6512	0.4964
Natural Gas Average (Therms/sf)	0.0762	0.1005	0.1063	0.1332	0.0852	0.0794
Water Average (Gallons/sf)	2.0026	3.2351	0.8619	1.8739	2.0295	2.6767

Note: Values based on consumption per square feet of office space

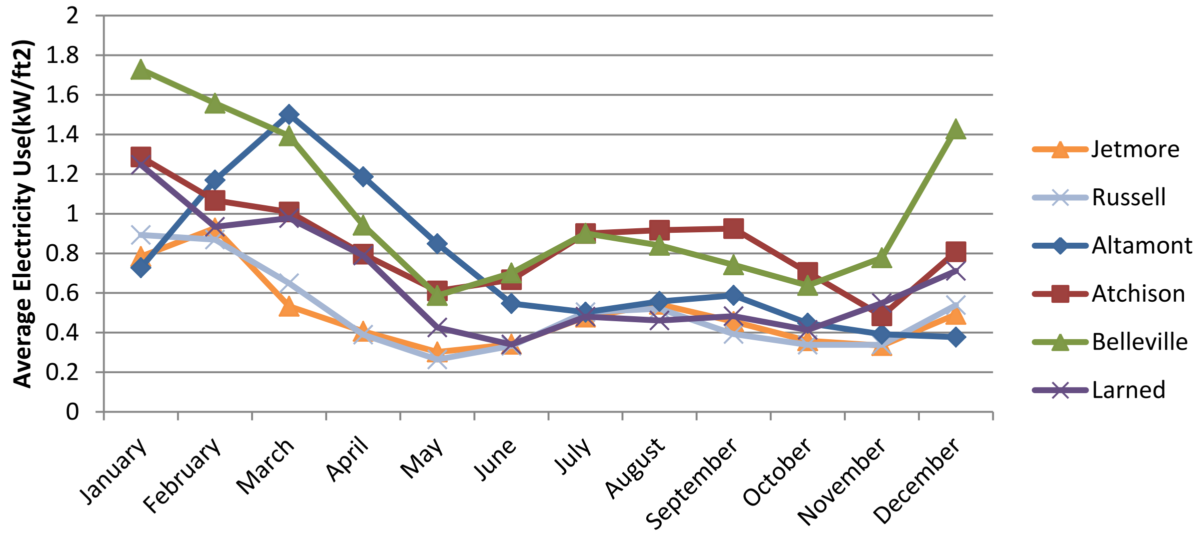

Figure 7.20 Electricity Use Comparison (2010)

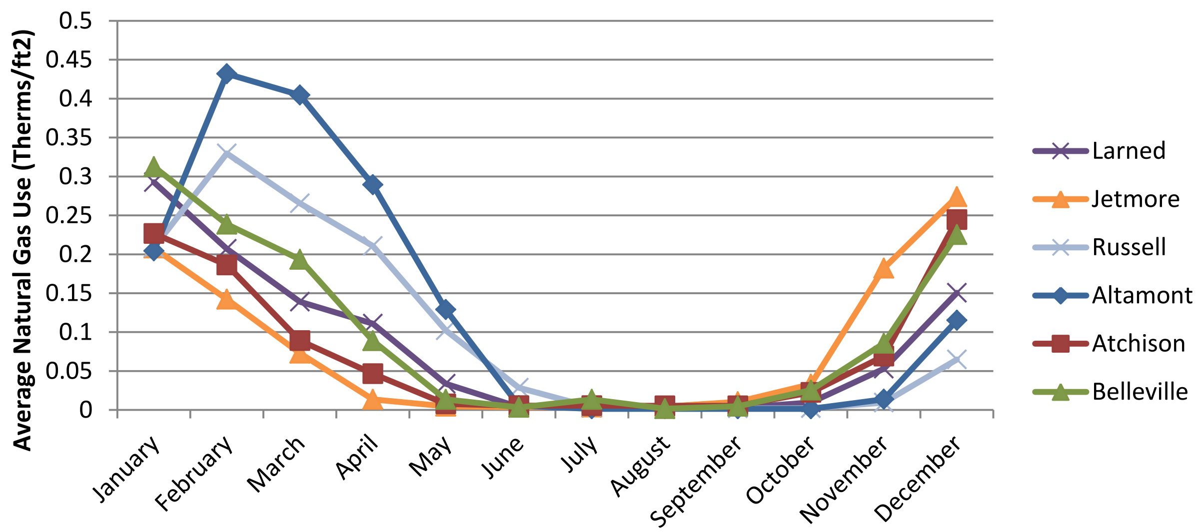

Figure 7.21 Natural Gas Use Comparison (2010)

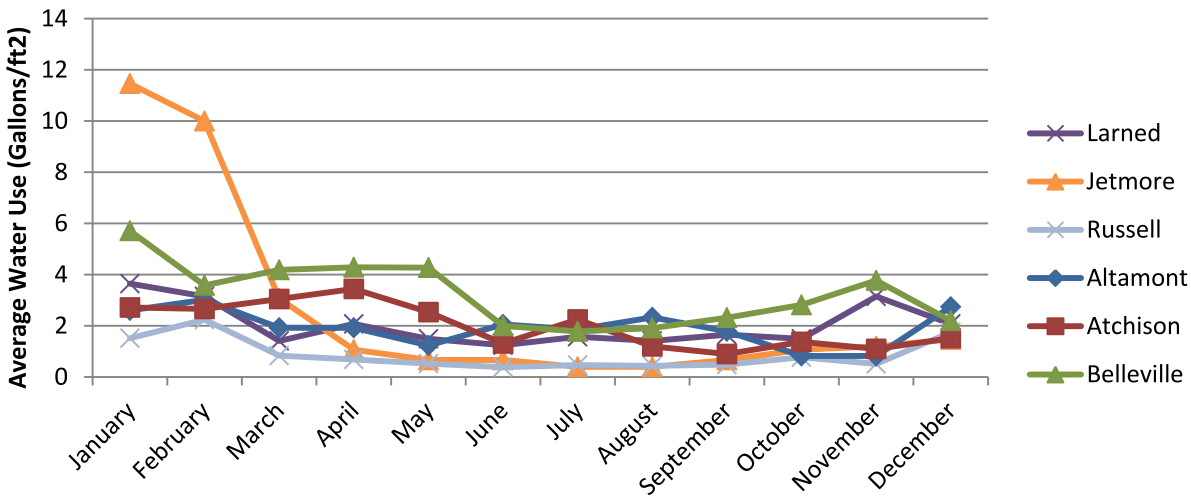

Figure 7.22 Water Use Comparison (2010)

Individual Building Summaries

Individual building summaries that follow present particular concerns for each facility, specifically those with increased energy consumption and reduced overall building efficiency as determined from the utility data. Complete audits for each facility, as well as digital photos, can be found in Appendix B.

To determine the severity of incoming air, the audit team conducted a blower-door test which depressurizes the building space to negative 50 Pascals, allowing for outside air to be drawn into the building through leaks in the building envelope. Infrared pictures, catalogued in the individual building summaries, were taken during the pressure test to indicate areas of infiltrating air. Because of the colder temperatures during the audit, the infiltrating air was colder than the inside air and can be seen as purple or blue in the thermal images.

The table following the descriptions of each individual facility, Table 7.3, Facility Summary – Measured and Recommended Values, displays actual measured values for interior lighting levels, water discharge temperatures, and room temperature settings. The table displays individual facility measured values, plus the standard values recommended by the IESNA Handbook, ASHRAE Standard 90.1-2010, and the Department of Energy. The measured values can also be found in Appendix B with the complete facility audits. For convenience, the recommended values are also displayed in Table 7.4. The following subsections are intended to document issues or specific areas that excelled for each facility.

Table 7.3 Facility Summary—Measured and Recommended Values

Interior Lighting (fc) (Office and Storage Spaces)	**Water Discharge Temperature (F)**	**Programmed Thermostat Set-Points (F)**
Recommended Values		
Office Spaces 30 – 50 fc	110°	68° HTG 78° CLG
Recommendations from: Lighting – IESNA, Water Discharge Temperatures – ASHRAE 90.1, Set-Points – DOE		

Atchison

The District 1, Atchison, subarea has many energy-inefficient components. First, the facility has single-pane windows that are drafty and ill-fitted to the building openings. Figures 7.23 through 7.32 depict problem areas within the building that allow outside air to infiltrate indoors. Infrared photos depict temperature changes with colors; purple represents the lowest temperatures and yellow represent the highest temperatures. These photos were taken in January when the outdoor air was 43ºF, during the blower-door test portion of the energy audit.

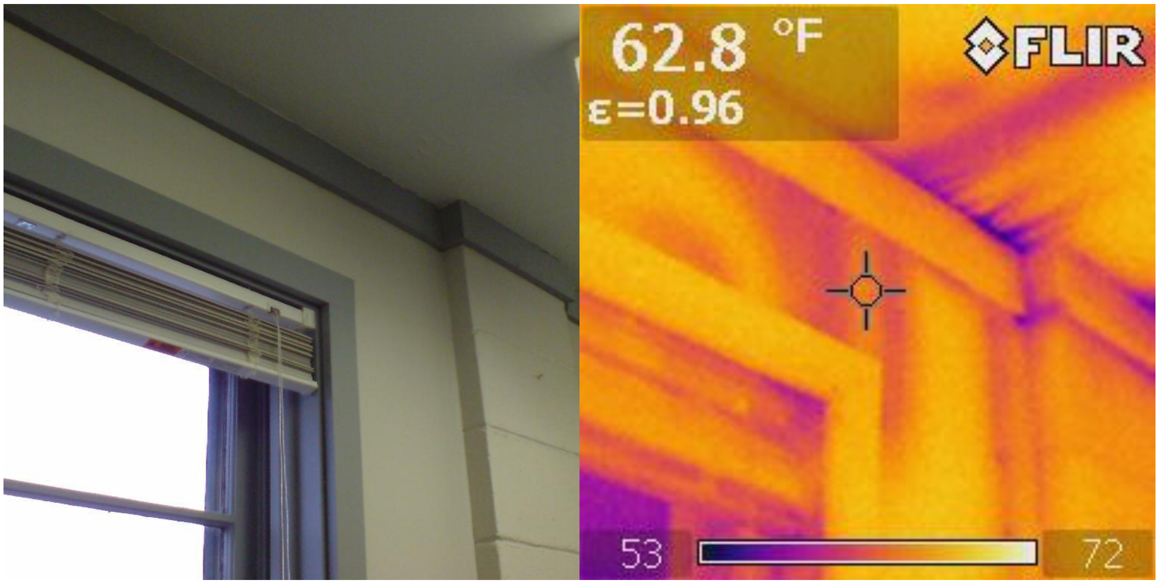

Figure 7.23 Infiltration Detection—Wall and Ceiling Seam

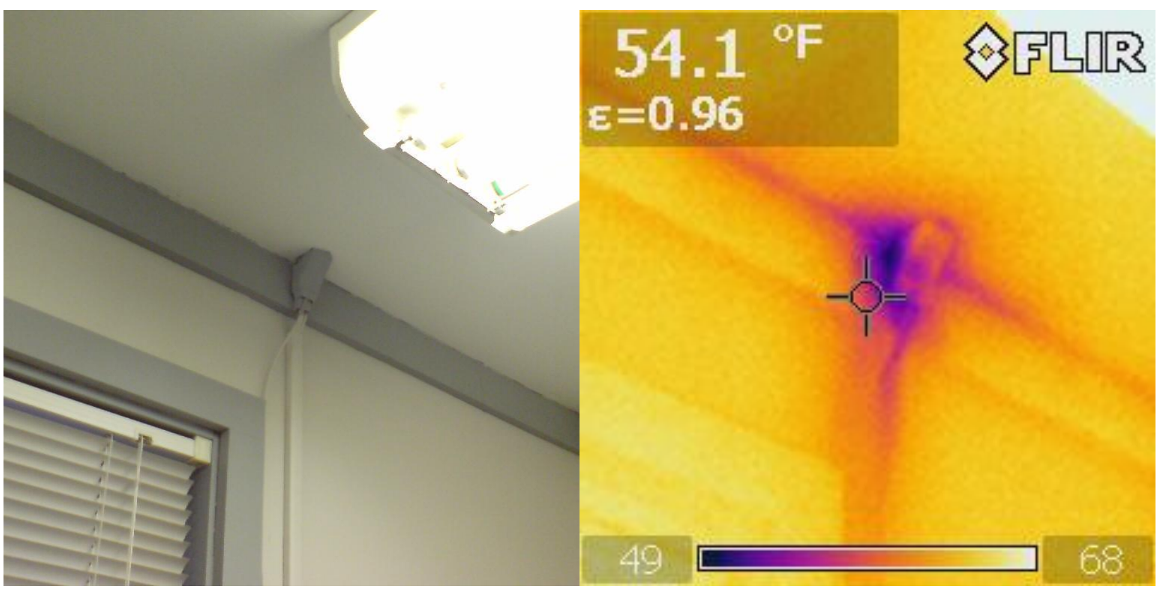

Figure 7.24 Infiltration Detection—Ceiling Penetration

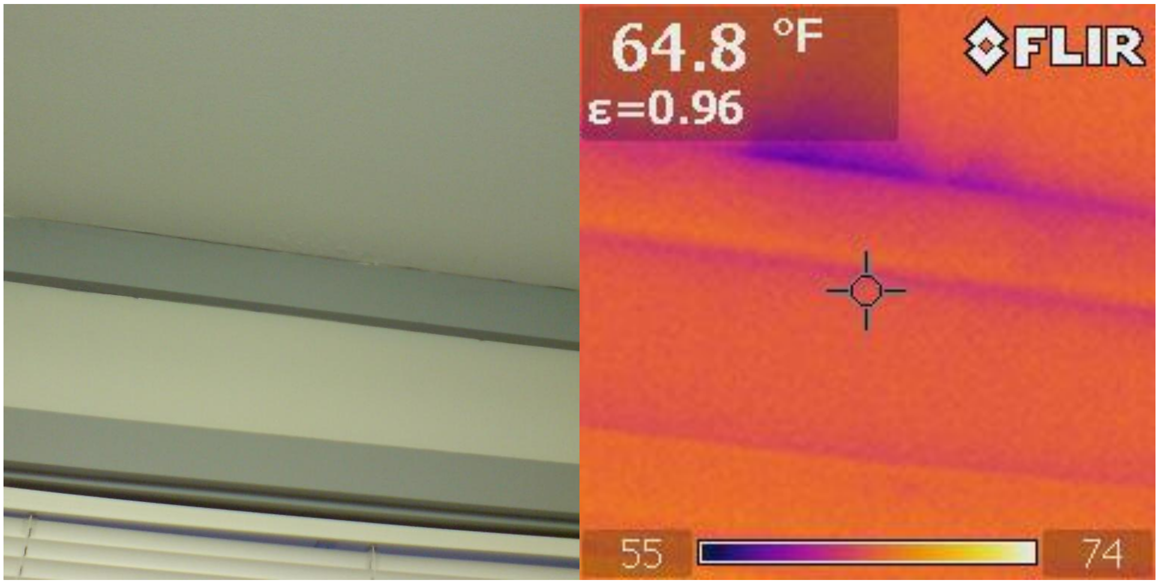

Figure 7.25 Infiltration Detection—Wall and Ceiling Seam

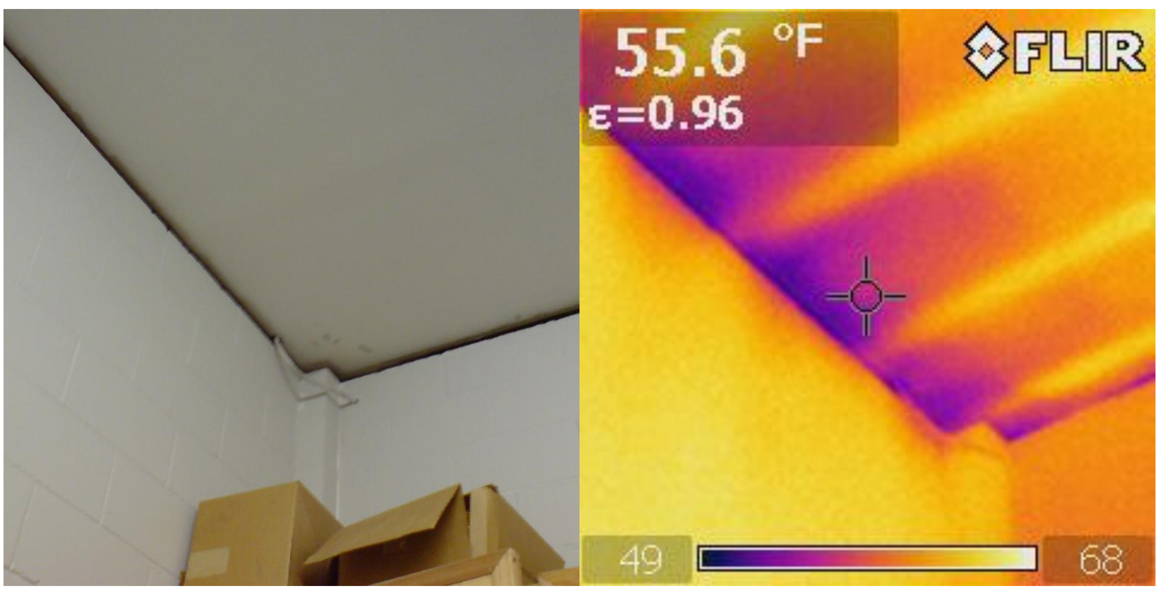

Figure 7.26 Infiltration Detection—Wall and Ceiling Seam

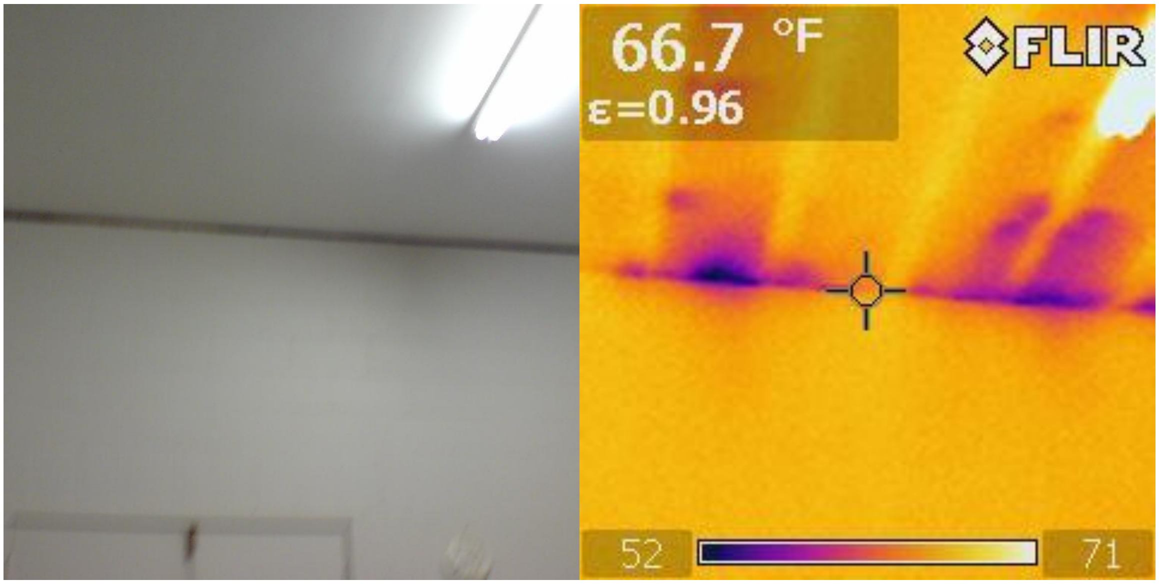

Figure 7.27 Infiltration Detection—Wall and Ceiling Seam

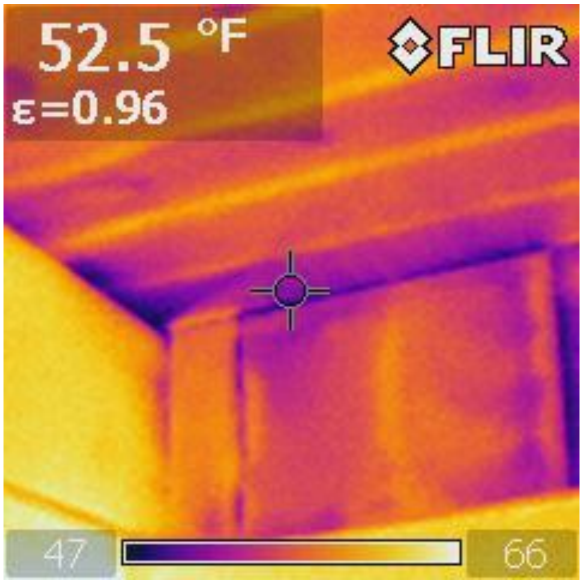

Figure 7.28 Infiltration Detection—Supply Air Diffuser

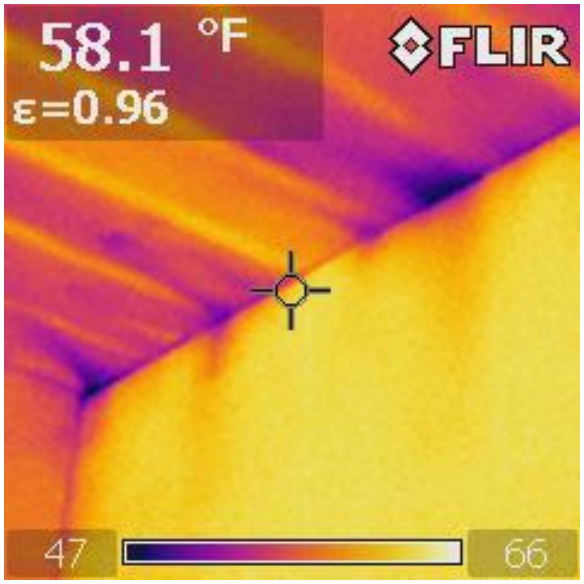

Figure 7.29 Infiltration Detection—Wall and Ceiling Seam

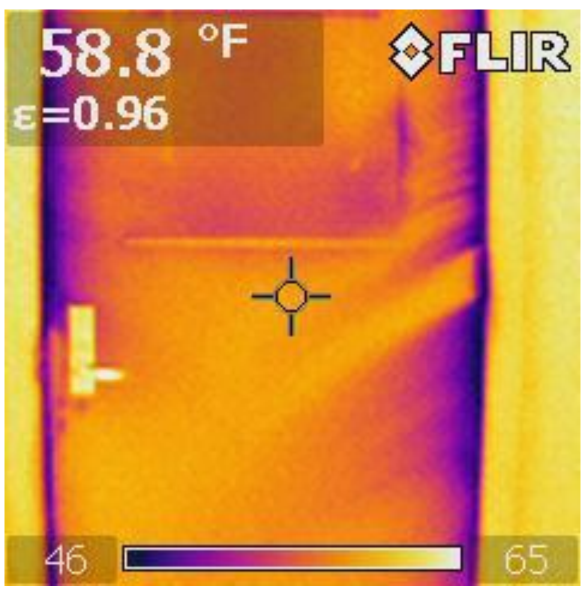

Figure 7.30 Infiltration Detection—Exterior Door

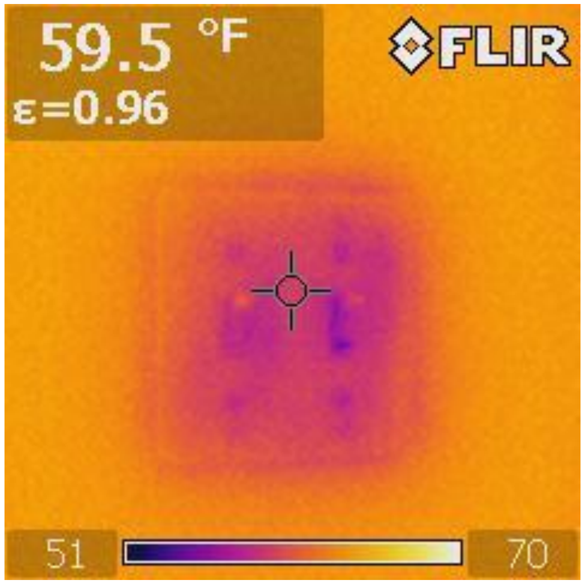

Figure 7.31 Infiltration Detection—Light Switch on Exterior Wall

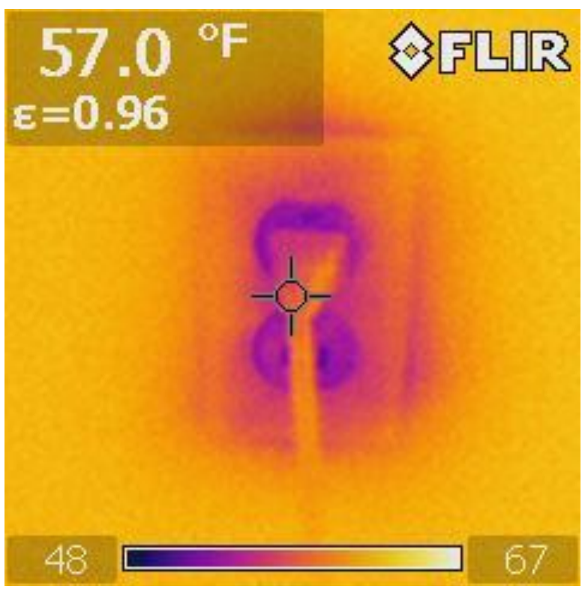

Figure 7.32 Infiltration Detection—Wall Outlet on Exterior Wall

The facility has an oversized 30-gallon water heater with a higher than necessary discharge temperature of 117 degrees Fahrenheit. Maximum discharge temperature from a lavatory in a public facility, according to ASHRAE Standard 90.1-2010, is 110 degrees Fahrenheit and storage temperature of the water should not exceed the intended use. Inefficient T12 and incandescent lamps are used in lighting fixtures throughout the facility, providing audit readings of 6.0-42.5 footcandles throughout the interior spaces. A footcandle is a unit to describe the amount of illuminance measured in a one-foot radius circle around any point. The footcandle values are within the recommended level of 30-50 footcandles (IESNA, 2011); however, the interior lighting power density (LPD) calculated in Tables C.15 and C.16 is 1.32 W/SF.

The LPD for Atchison was 1.32 W/sf and the highest of all six facilities, which contributed to the highest energy consumption among the six facilities with 0.56 kWh/SF. Controls for the furnace are simple, with a single-temperature set point thermostat and an on-off switch. Lastly, appliances are either low Energy Star certified or not certified at all.

Belleville

Belleville subarea in District 2 also has energy efficiency flaws. Similar to the Atchison subarea, exterior penetrations and joints in the facility are drafty, resulting in infiltration, seen in Figures 7.33 through 7.42. These photos were taken in January when the outdoor air was 41ºF, during the blower-door test portion of the energy audit.

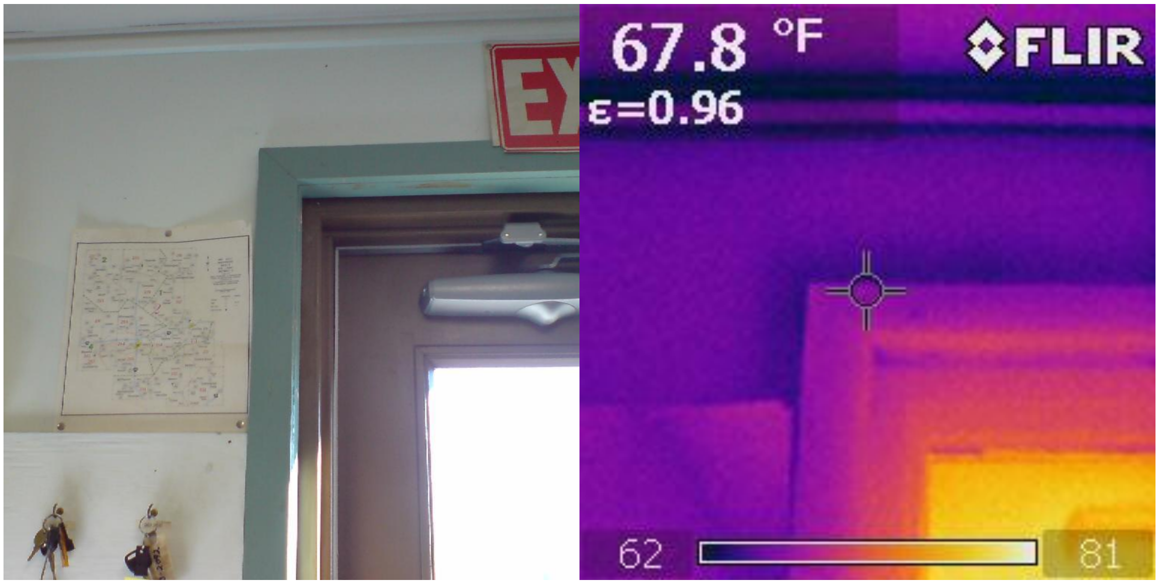

Figure 7.33 Infiltration Detection—Exterior Door

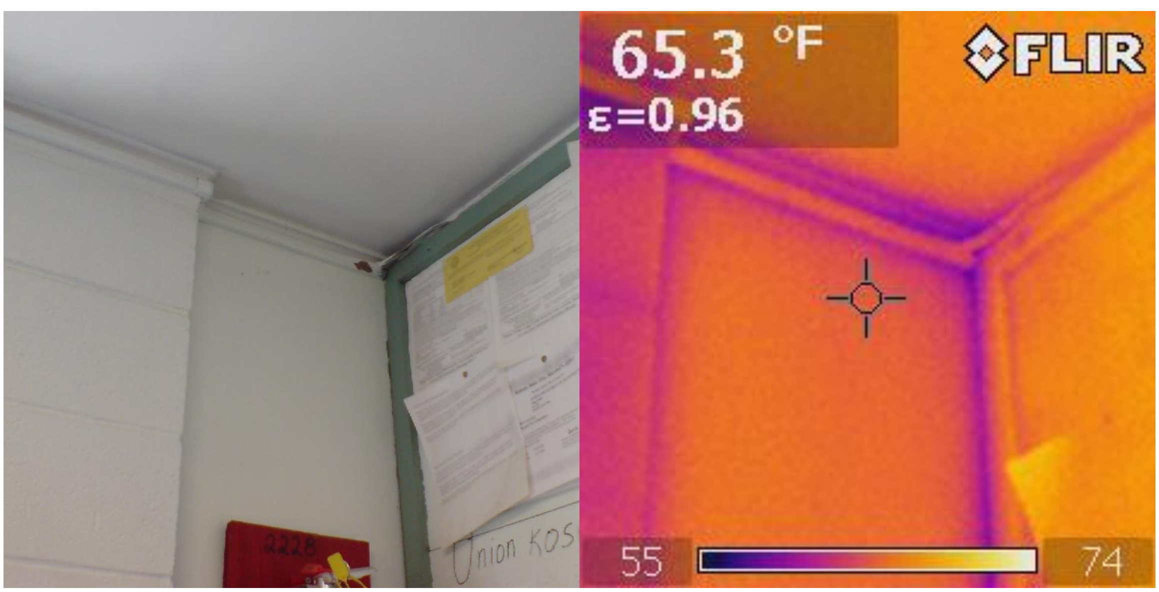

Figure 7.34 Infiltration Detection—Wall and Ceiling Seams

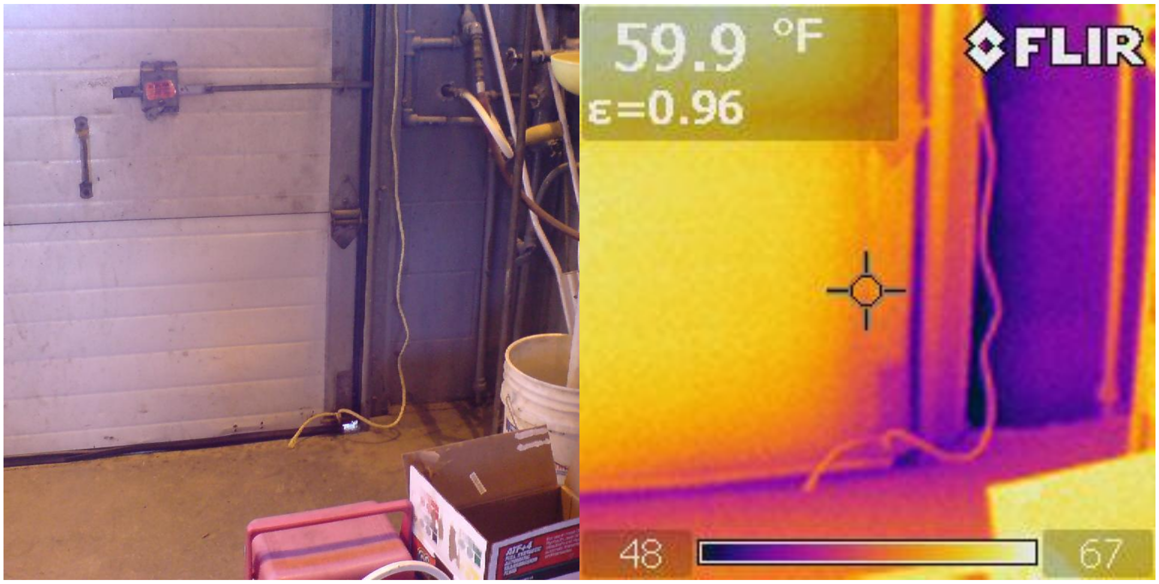

Figure 7.35 Infiltration Detection—Bay Door

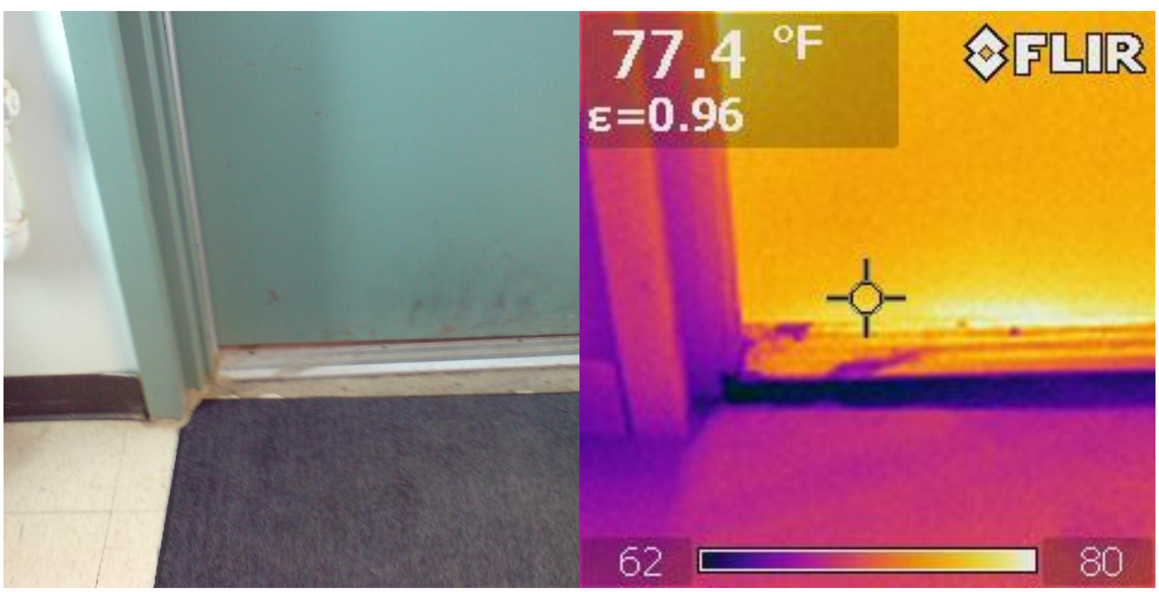

Figure 7.36 Infiltration Detection—Exterior Door

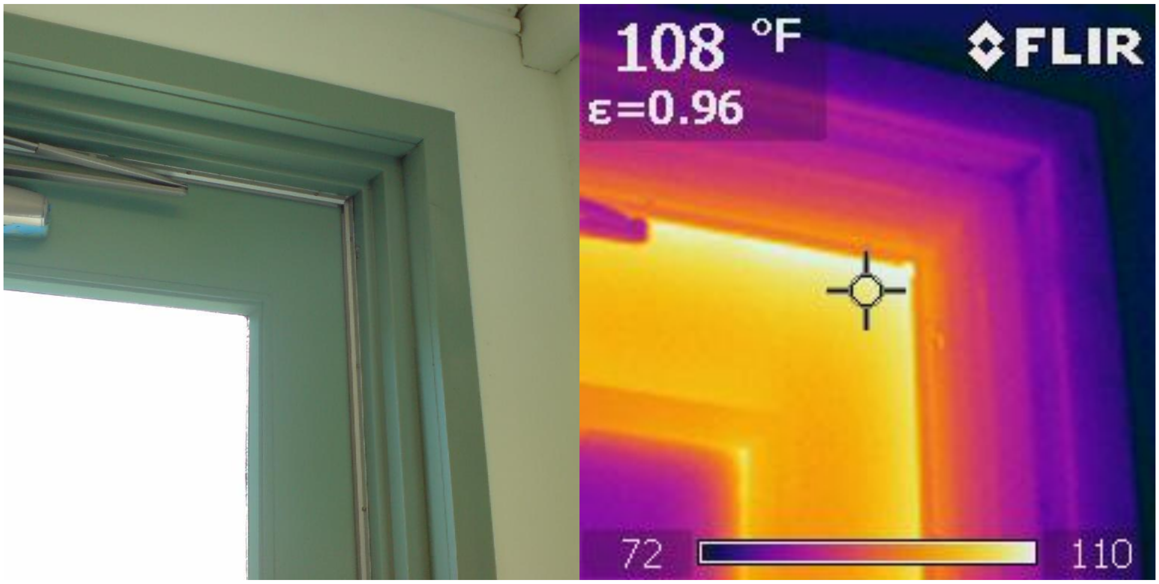

Figure 7.37 Infiltration Detection—Exterior Door

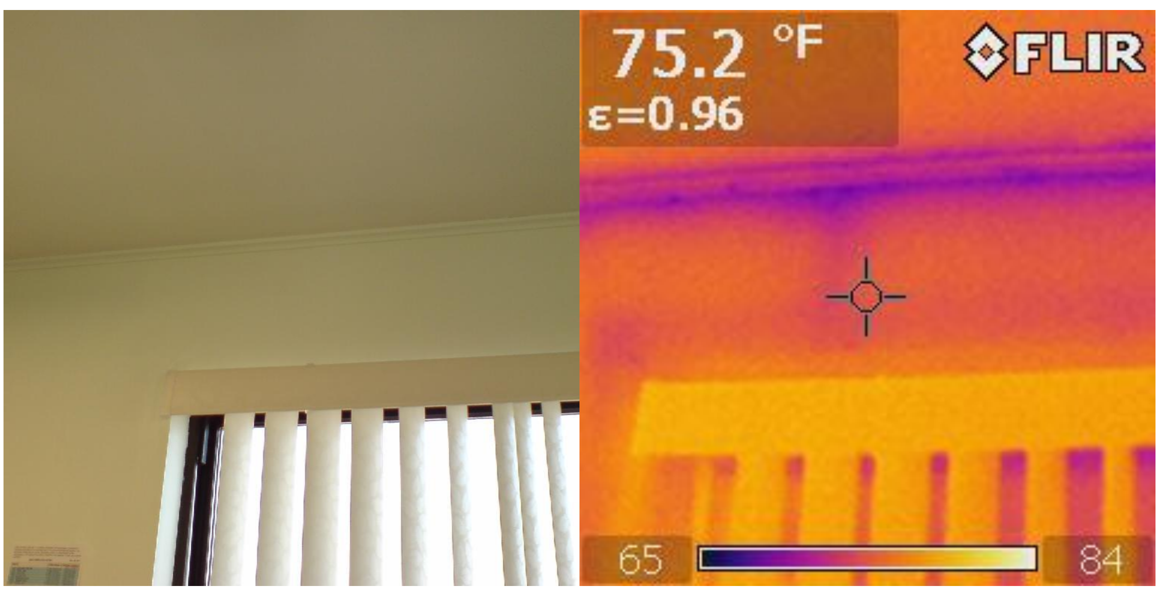

Figure 7.38 Infiltration Detection—Wall and Ceiling Seam

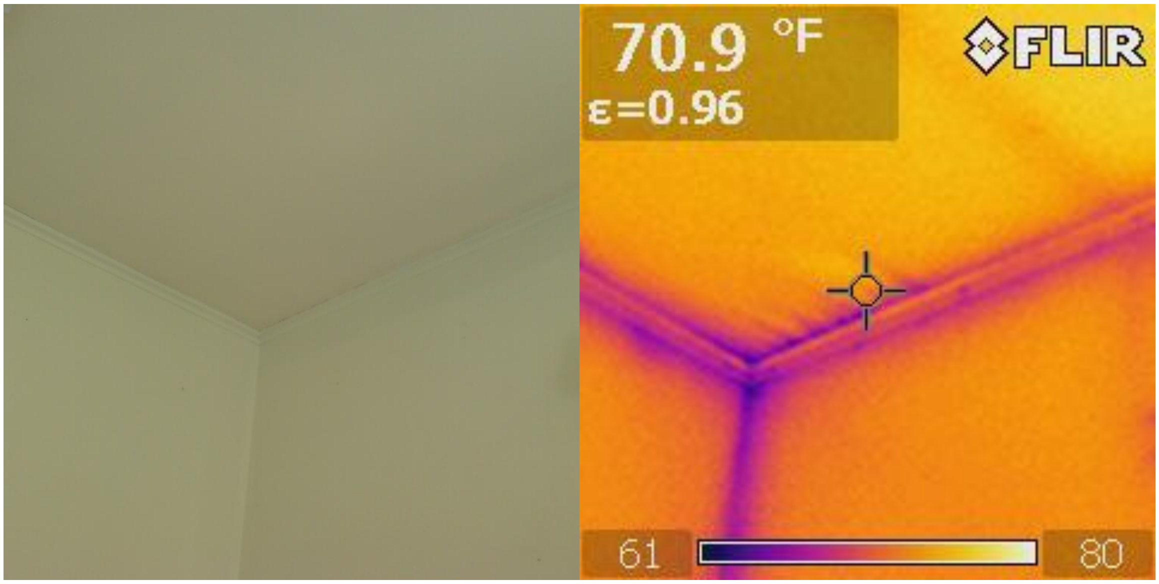

Figure 7.39 Infiltration Detection—Wall and Ceiling Seams

Figure 7.40 Infiltration Detection—Exterior Door

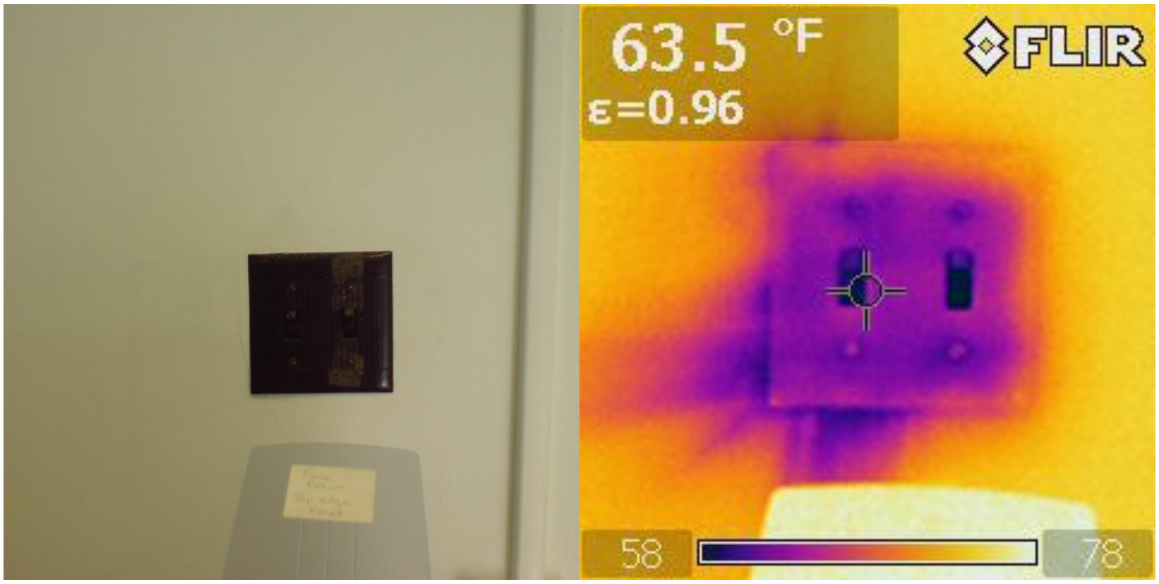

Figure 7.41 Infiltration Detection—Light Switch on Exterior Wall

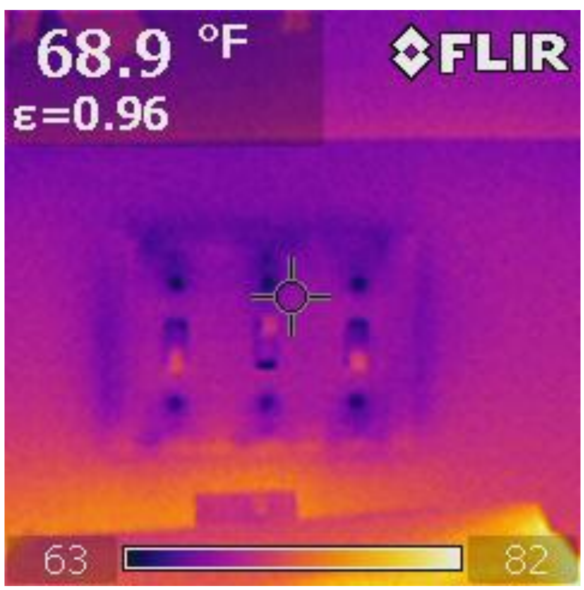

Figure 7.42 Infiltration Detection—Light Switch on Exterior Wall

While the water heater at Belleville is appropriately sized, the discharge temperature is too high at 141 degrees Fahrenheit. Lighting levels in the offices are very high at this facility, ranging from 85-111 footcandles. The high lighting level correlates to the second highest LPD, calculated in Tables C.15 and C.16, for the office space of 1.245 W/SF. Belleville has the second highest LPD, relating to the second highest energy consumer with 0.56 kWh/SF. Lastly, appliances are low efficiency and some are not Energy Star certified.

Russell

The audit of the District 3 facility, Russell, provides knowledge of the inefficient components of the subarea. Comparable to other facilities, the water heater is a 29-gallon oversized natural gas water-heater; however, water discharge temperature is appropriate at 104 degrees Fahrenheit. Controls for the furnace are rudimentary and did not allow for programming. Lamps utilized in the Russell facility are T5s, the most energy-efficient linear fluorescent option available. To support the energy efficiency, the LPD at Russell is only 0.421 W/SF and has the lowest energy consumption with 0.231 kWh/SF. The Russell facility used nearly three times less energy than the Atchison facility in September 2010, leading to the conclusion that T5 lamps are much more energy efficient than T12s when comparing similar light levels. The appliances are inefficient and lack high Energy Star certifications. Lastly, the building is poorly sealed and allows for infiltration. Figures 7.43 through 7.48 depict various leaking points in the building's envelope. These photos were taken in January when the outdoor air was 53ºF, during the blower-door test portion of the energy audit.

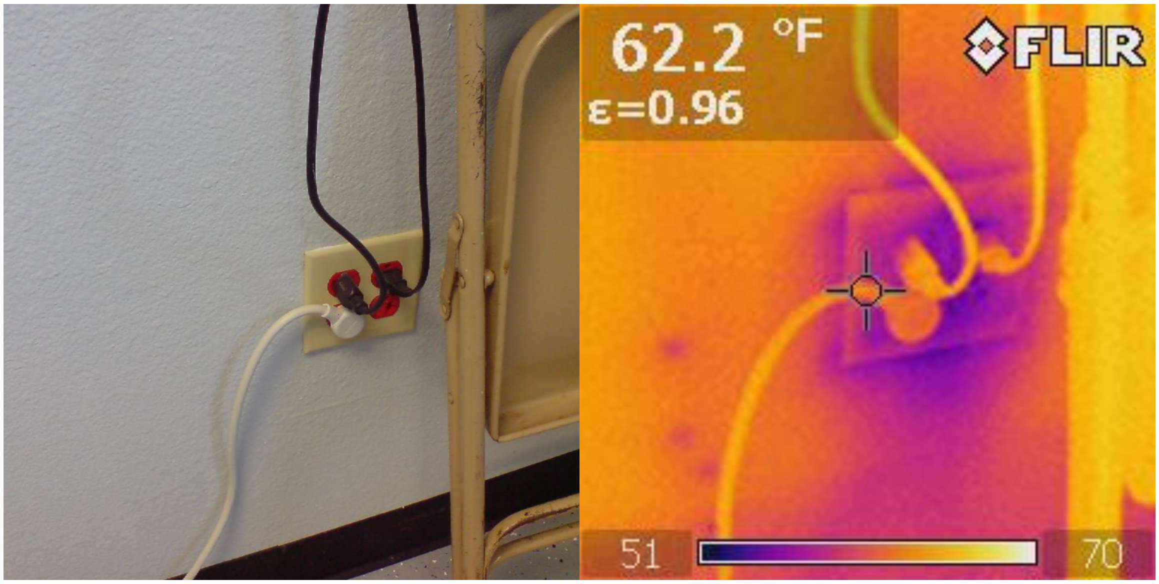

Figure 7.43 Infiltration Detection—Electrical Outlet on Exterior Wall

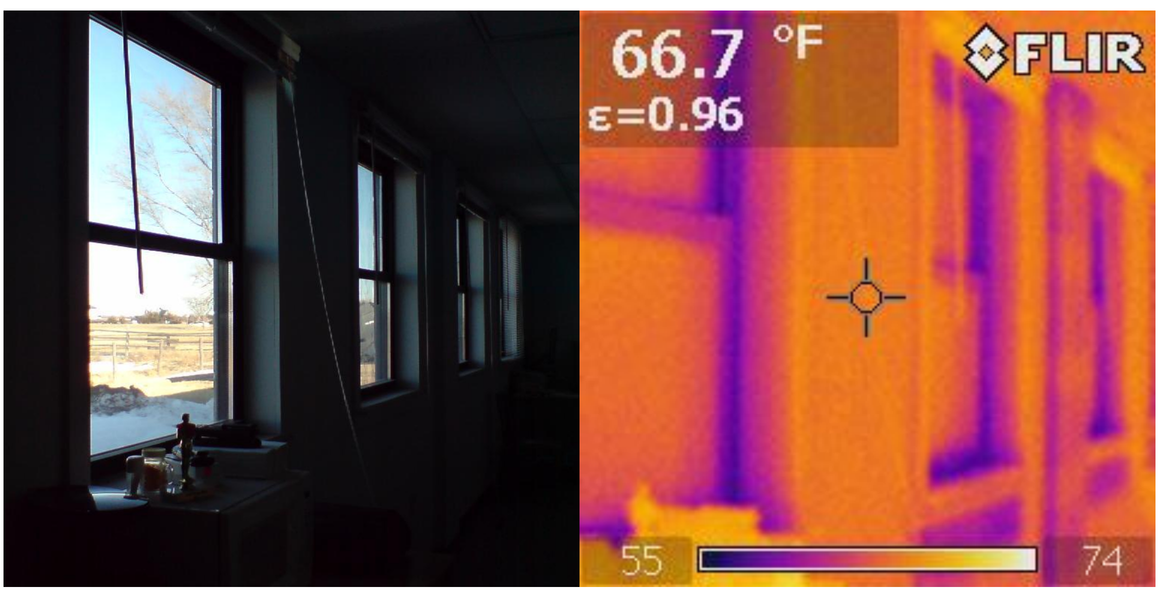

Figure 7.44 Infiltration Detection—Windows

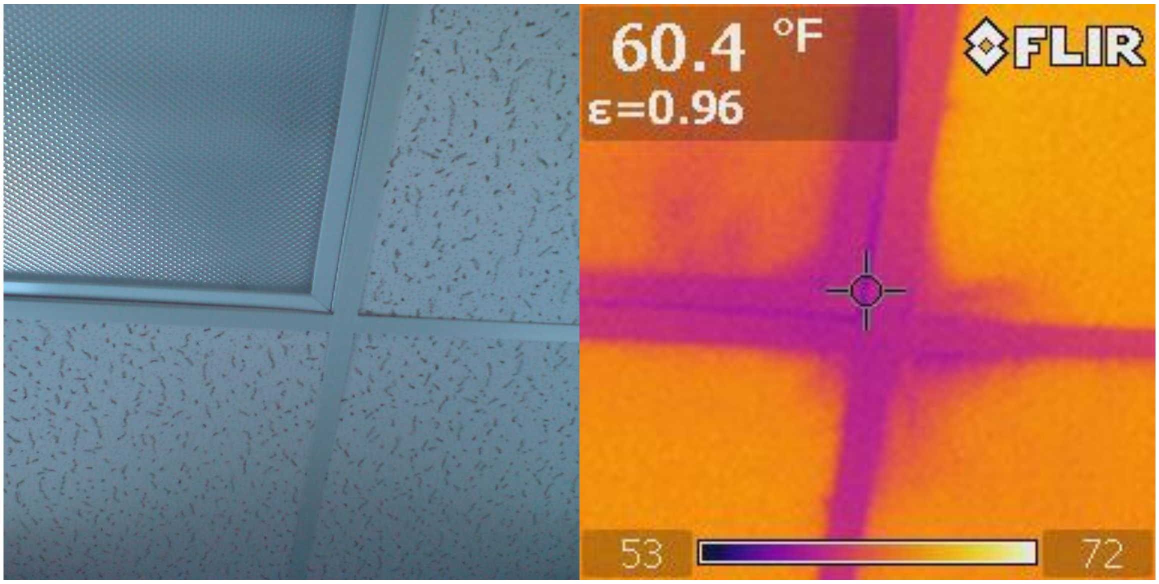

Figure 7.45 Infiltration Detection—Ceiling Grid Seams

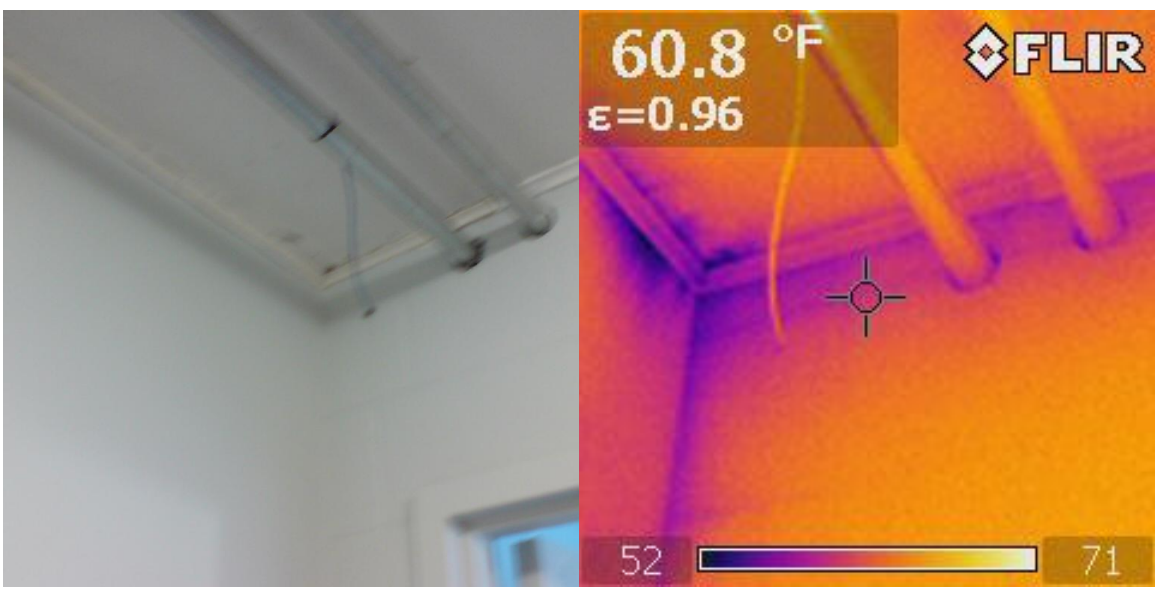

Figure 7.46 Infiltration Detection—Wall Penetrations and Seams

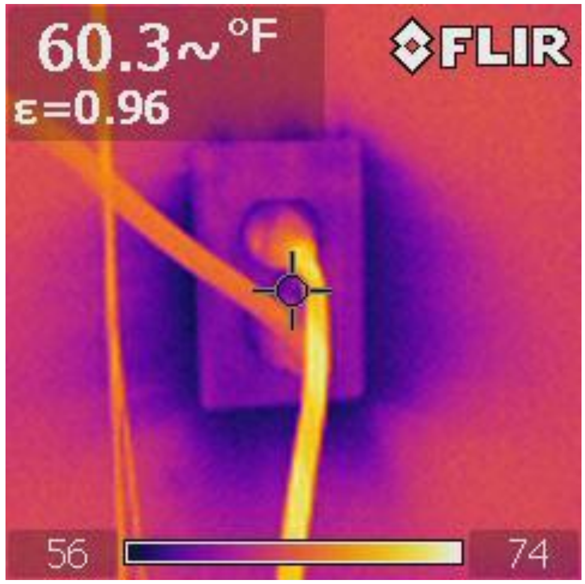

Figure 7.47 Infiltration Detection—Electrical Outlet on Exterior Wall

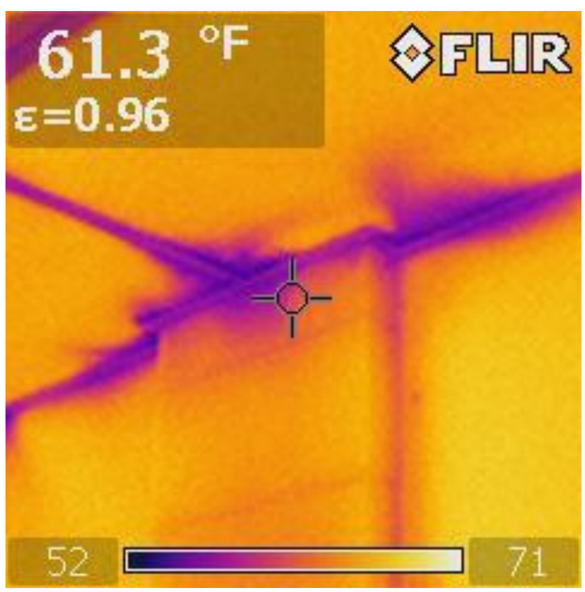

Figure 7.48 Infiltration Detection—Wall and Ceiling Seams

Altamont

The District 4 facility of Altamont was subject to issues prevalent in previous facilities and districts. First, lighting fixtures and lamps provide more than adequate, and even excessive, light levels of 42-130 footcandles. TheT8 lamps utilized are efficient; however, the high light levels negate the energy savings. While the water heater is appropriately sized at six gallons, the discharge temperature is higher than necessary at 114 degrees Fahrenheit. Since Altamont utilizes an electric water heater, energy consumption cannot be easily compared to facilities with natural gas water heaters because Altamont will draw energy for lighting and water heating throughout the year with consistency. Furthermore, infiltration is high in the facility due to exterior penetrations and building joints being poorly sealed, as can be seen in Figures 7.49 through 7.52. These photos were taken in January when the outdoor air was 44ºF, during the blower-door test portion of the energy audit. The appliances are deficient, with little or no Energy Star ratings.

Figure 7.49 Infiltration Detection—Exterior Door

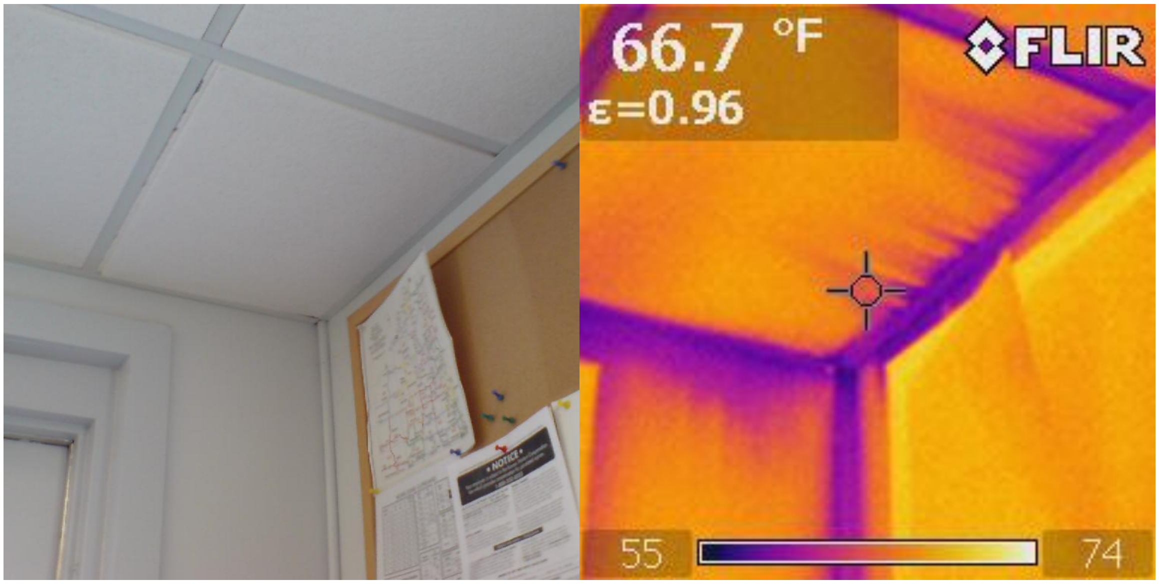

Figure 7.50 Infiltration Detection—Wall and Ceiling Grid Seams

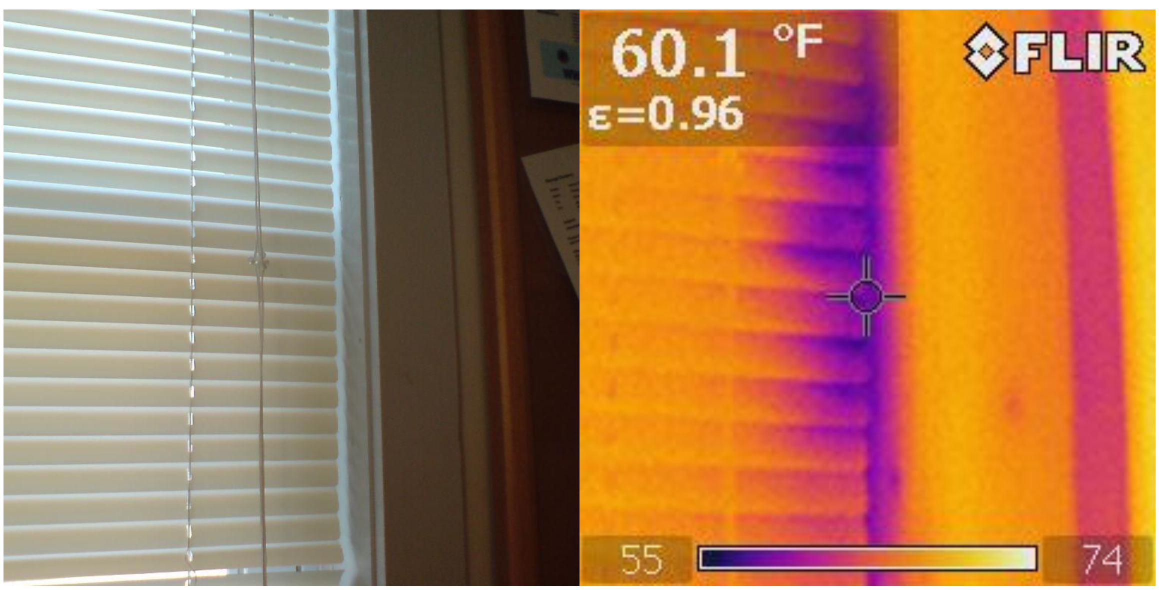

Figure 7.51 Infiltration Detection—Window

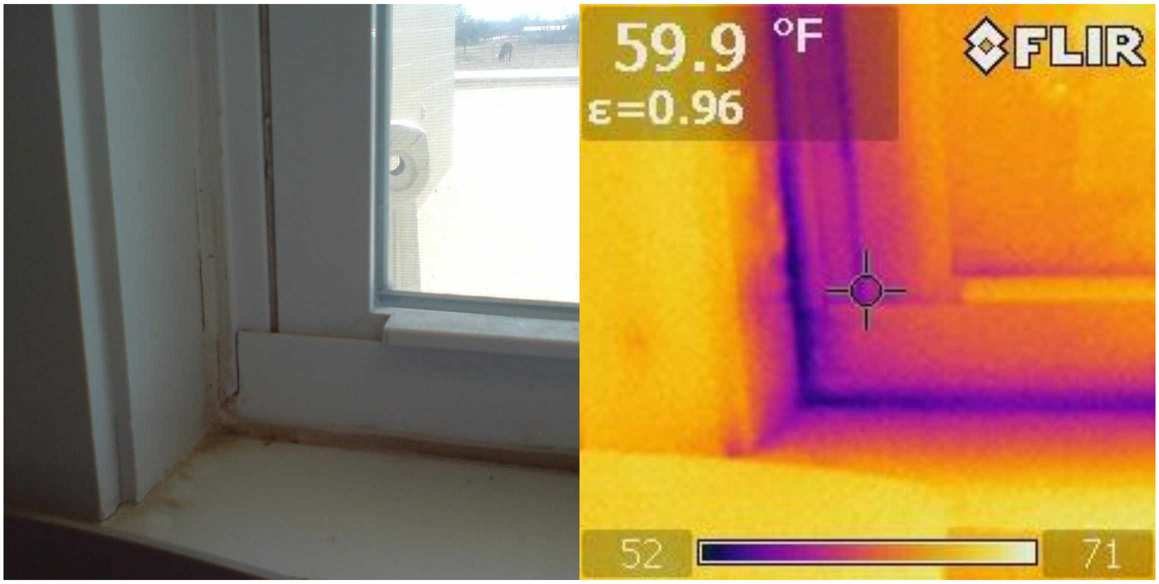

Figure 7.52 Infiltration Detection—Window

Larned

Larned, the subarea studied from District 5, exhibits energy efficiency issues that had prevailed in prior audits. Like some of the other facilities investigated, the water heater is oversized at 40-gallons. The HVAC controls are basic with no programming available. In addition, light fixtures utilize T12 and incandescent lamps, although high-efficiency T5 lamps are also used. Using both inefficient and highly efficient lamps placed Larned in the middle of LPD values and energy consumption values. LPD at the facility was 0.612 W/SF and energy consumption was 0.33 kWh/SF. Exterior penetrations and joints leak and allow for infiltration into the facility. Figures 7.54 through 7.59 illustrate areas of poor construction, leading to infiltration. These photos were taken in January when the outdoor air was 37ºF, during the blower-door test portion of the energy audit. Also, appliances lack high Energy Star ratings and are inefficient.

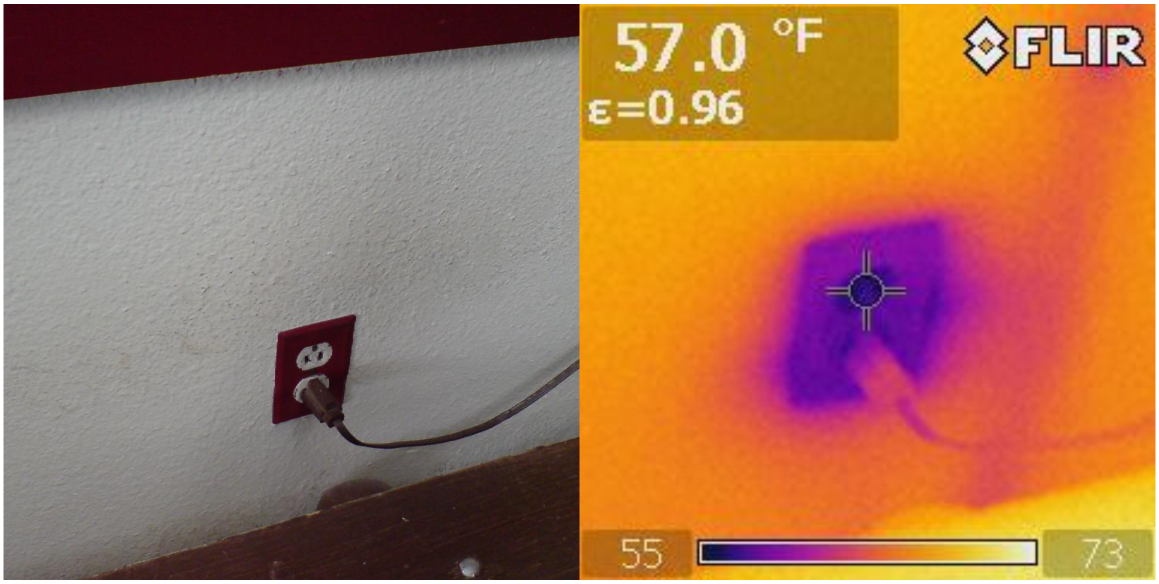

Figure 7.53 Infiltration Detection—Electrical Outlet on Exterior Wall

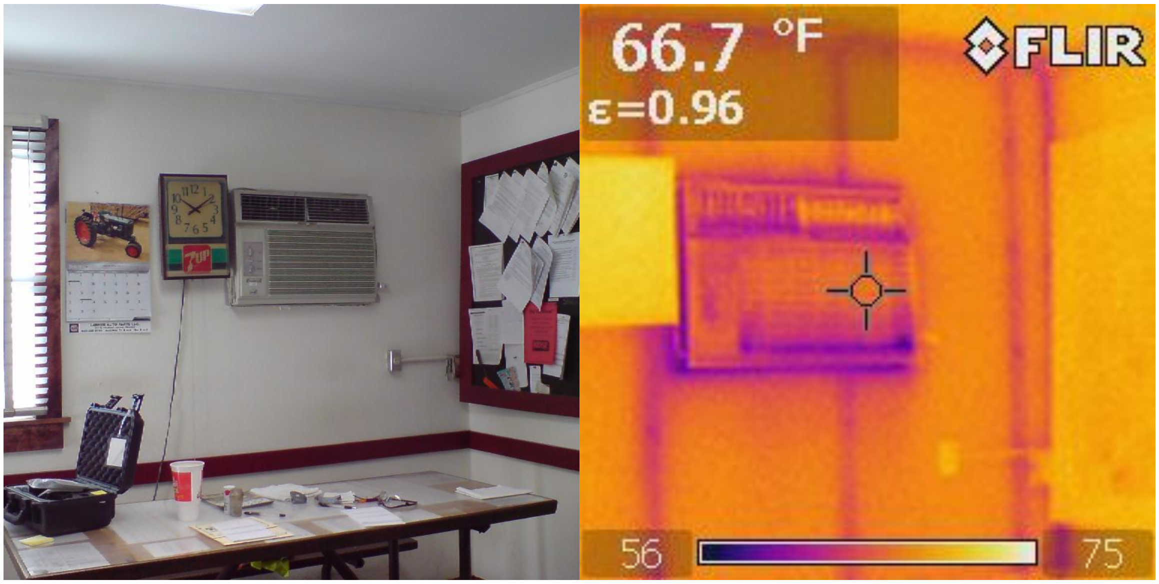

Figure 7.54 Infiltration Detection—Wall Penetration and Construction

Figure 7.55 Infiltration Detection—Bay Window

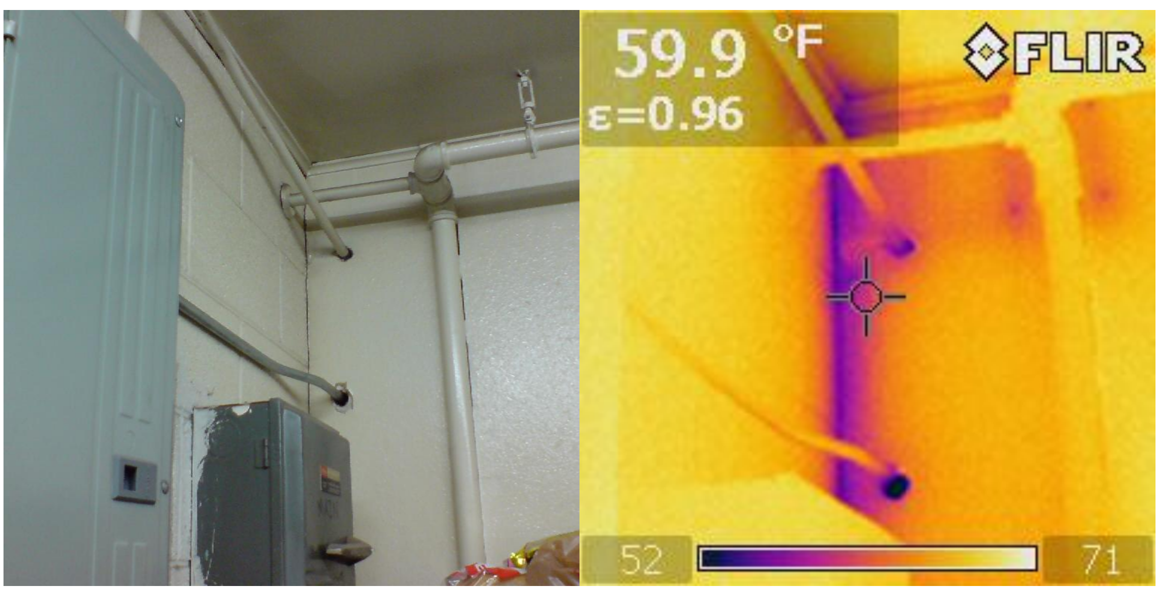

Figure 7.56 Infiltration Detection—Wall Penetrations and Seams

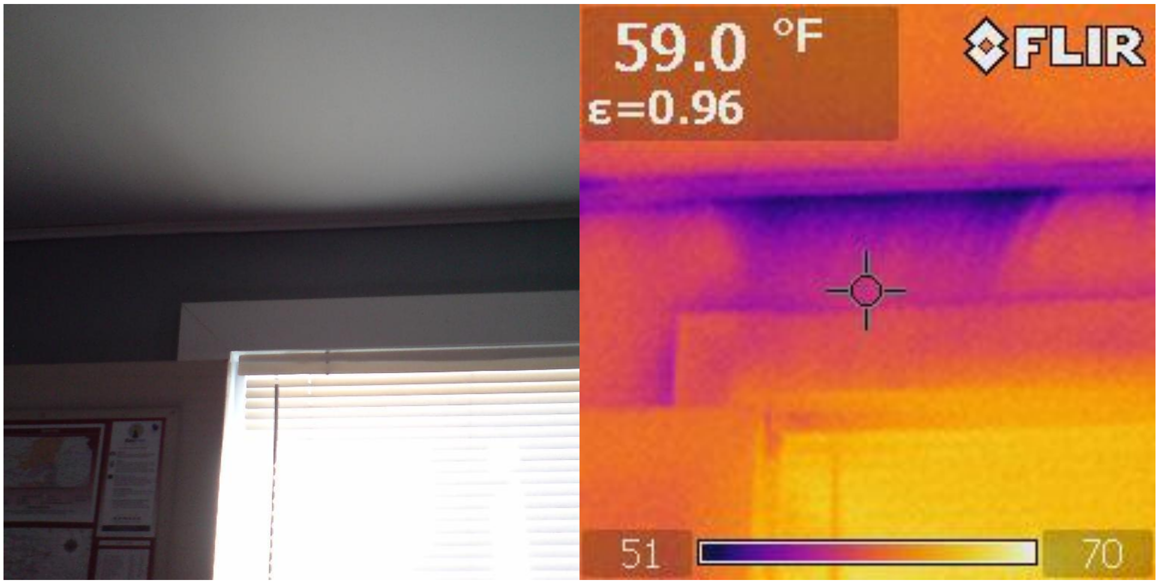

Figure 7.57 Infiltration Detection—Wall and Ceiling Seams

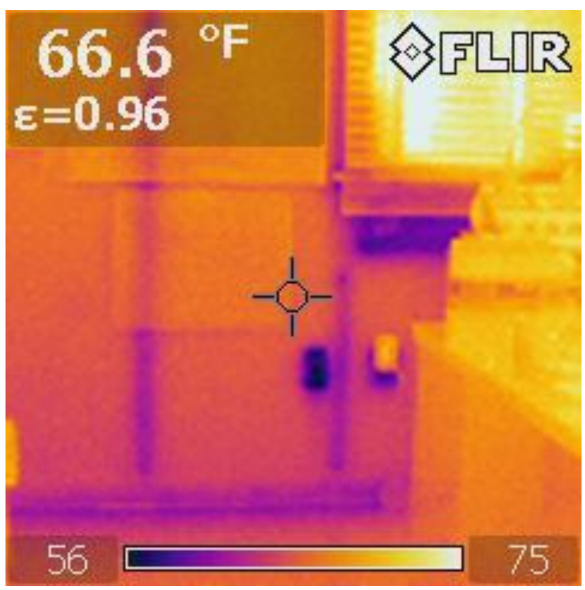

Figure 7.58 Infiltration Detection—Wall Construction

Jetmore

The District 6 facility of Jetmore exhibits similar inefficiencies. First, the windows are single-pane and allow for heat gain and loss. As seen in Figures 7.60 through 7.63, the facility also has high infiltration as a result of poorly sealed penetrations and joints. These photos were taken in January when the outdoor air was 46ºF, during the blower-door test portion of the energy audit. The water heater is oversized at 40-gallons and the discharge temperature is too high at 117 degrees Fahrenheit. Also, the HVAC controls are nonprogrammable and need to be updated. Light fixtures and lamps are primarily incandescent and inefficient, although T8s are also used. Much like Larned, the Jetmore facility combines inefficient and efficient lamps, allowing for a middle position in energy consumption. The LPD for Jetmore was 0.705 W/SF and the electric energy consumption was 0.28 kWh/SF. Moreover, the appliances are not Energy Star rated and inefficient.

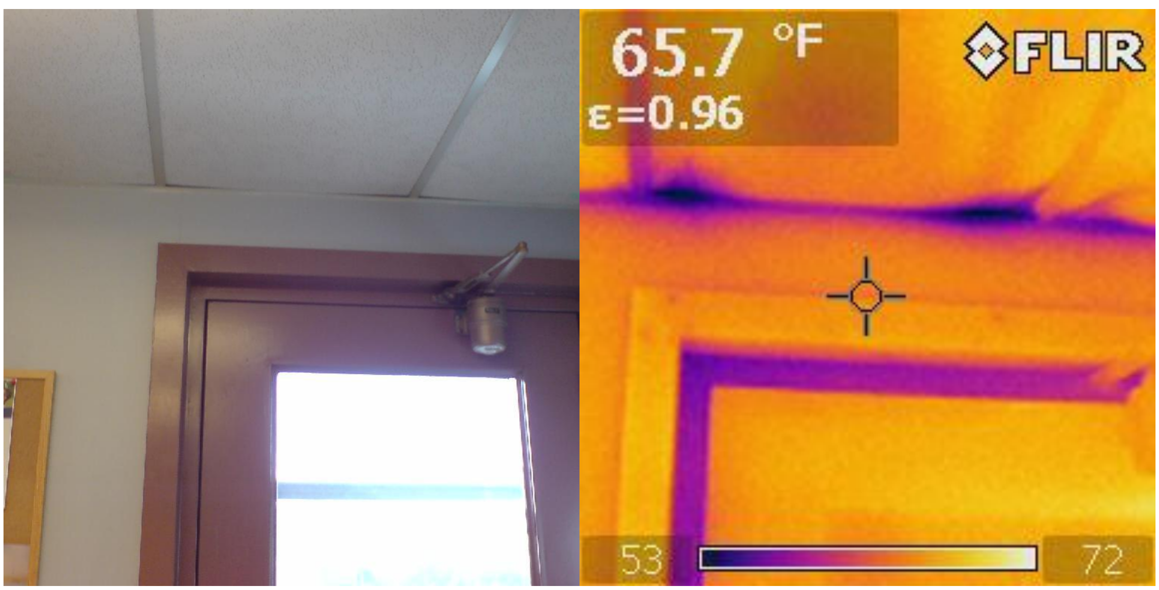

Figure 7.59 Infiltration Detection—Ceiling Seams and Exterior Door

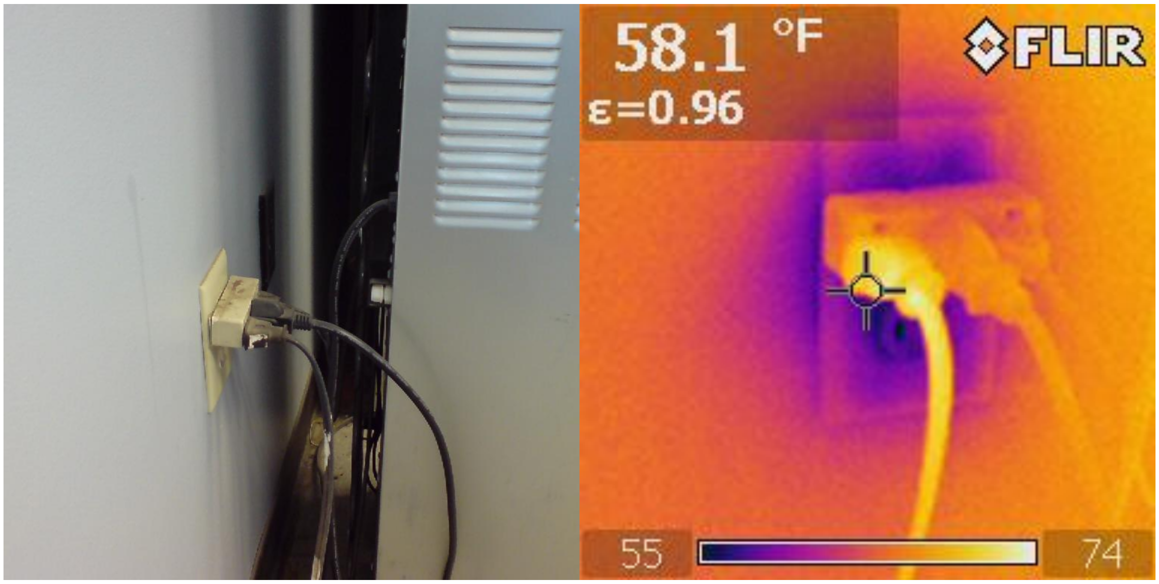

Figure 7.60 Infiltration Detection—Electrical Outlet on Exterior Wall

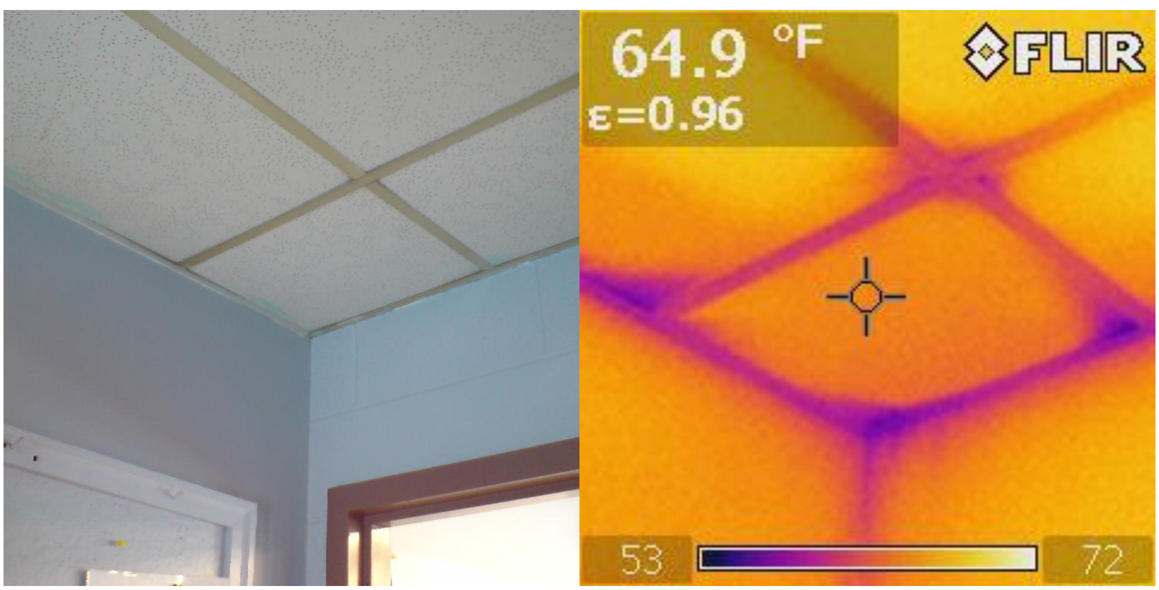

Figure 7.61 Infiltration Detection—Ceiling Grid Seams

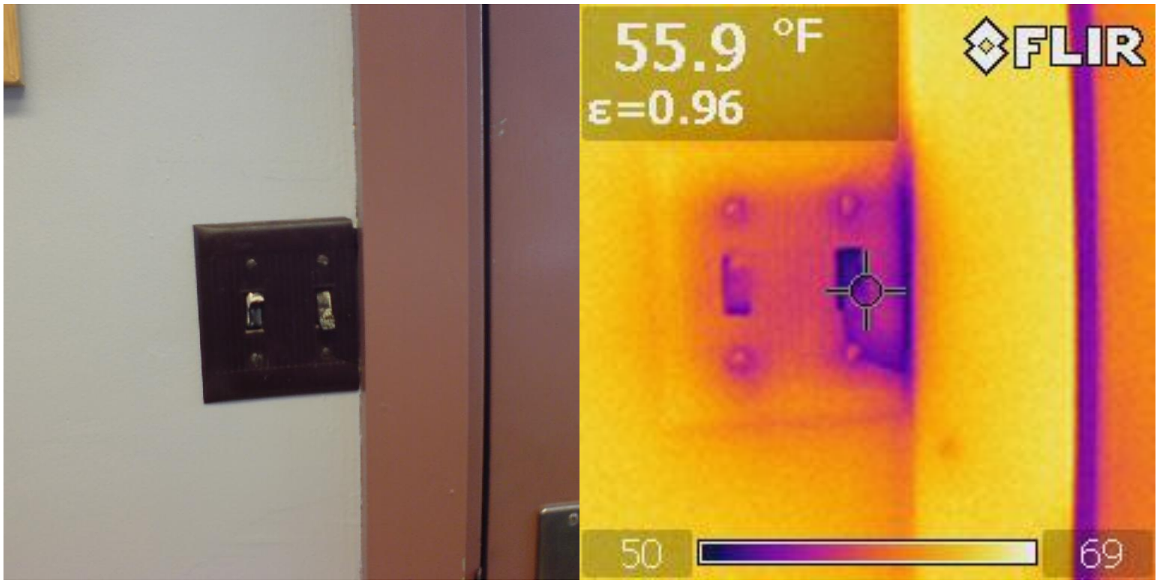

Figure 7.62 Infiltration Detection—Light Switch on Exterior Wall

Table 7.4 summarizes the six audited KDOT facilities and the information gathered on the audit worksheets, which can be found in Appendix C.

Table 7.4 Facility Summary—Measured and Recommended Values

	Interior Lighting (fc) (Office and Storage Spaces)		**LPD (W/SF)**	**Water Discharge Temperature (F)**		**Programmed Thermostat Set-Points (F)**	
Facility	Measured	Recommended	Measured	Measured	Recommended	Observed/Stated	Recommended
Atchison	6.0 - 42.5	Office Spaces 30 – 50 fc	1.322	**117.1°**	110°	**72° HTG 70° CLG**	68° HTG 78° CLG
Belleville	**11.4 – 111**		1.245	**141.5°**		**69° HTG 75° CLG**	
Russell	**8.6 – 65**		0.421	104.1°		**68° HTG 74° CLG**	
Altamont	**42 – 130**		0.211	**114.4°**		N/A, PTAC Units	
Larned	**9.6 – 128**		0.612	108.1°		**70° HTG 70° CLG**	
Jetmore	**14 – 146.8**		0.705	**117.3°**		**66° HTG 72° CLG**	
Note: Bolded values are above the recommended value and indicate an area that could be improved.							

Common Energy Consumption Issues

Each KDOT facility audited had specific issues hindering energy efficiency. Many of the facilities had similar issues that increase unnecessarily energy consumption. These included envelope / windows, hot water heaters, lighting, and low-efficiency appliances.

First is the issue of a poor building envelope, with specific attention to single-pane windows, or poorly installed windows; ill-fitting doors; and envelope joints. A leaky envelope or poor windows cannot keep outdoor air from entering the building. Therefore, the mechanical heating and cooling systems have to work harder to overcome the additional thermal load. Thus, the equipment requires more energy to maintain desired space temperatures. The thermal pictures confirmed ill-fitting windows and doors, along with poorly sealed wall and ceiling joints. Infiltration has a negative impact on the building's mechanical system, making it work harder to maintain temperatures within the space and making it nearly impossible to control moisture.

Oversized water heaters were a common problem throughout the facilities. The buildings had large water heaters when their demand was only to provide hot water to two or three sinks. By having an oversized water heater, excess water is heated and stored which results in stand-by loss of energy. For how to calculate water heater sizing and what size is recommended for KDOT facilities, see Table 7.5 in the Specific Recommendations section.

The third common occurrence was use of energy-draining lamps. One-third of the facilities utilize T12 fluorescents, and two-thirds of the facilities utilize incandescents, which draw a lot of power for a relatively low light output and are considered outdated technology. For example, a T12 can only produce 70 lumens of light per watt of energy, while today's more industry-accepted lamp, T5 fluorescent, can produce 100 lumens per watt. The Atchison and Russell facilities have similar light levels, at 6 - 42.5fc and 8.6 - 65 fc, respectively; however, lamps utilized within the buildings are T12s and incandescents in Atchison and T5s in Russell. The facilities also have similar square footage and equipment draws. Looking at September, a moderate month that most likely requires little heating or cooling needs, electricity usage between facilities easily depicts the excess energy required by T12s to provide the same lumen quantity as T5s. In September of 2010, Atchison used 1.04 kWh/SF of electricity while Russell used 0.33 kWh/SF.

Lastly, currently installed appliances are either not Energy Star certified, or are very low on the rating scale. Energy Star ratings are provided on labels affixed to equipment and appliances. Throughout the facility audits, labels were examined and ratings often fell below the median certification value. These appliances included furnaces, water heaters, refrigerators, computers, printers, etc.

Specific Recommendations for All KDOT Facilities

After auditing the six selected facilities, a list of common recommendations was developed. All of these options should be considered when renovating KDOT facilities or purchasing new equipment.

The building envelope needs to undergo many changes to reduce energy consumption and improve facility efficiency. It is recommended that all single-pane windows be replaced with double-pane windows to reduce heat gains and losses. Based on Table 5.5-4 and Table 5.5-5 in ASHRAE Standard 90.1-2010, the shading coefficient, or thermal insulating performance, for all glass should be a maximum of 0.40 for both climate zones 4A and 5A, the two climate zones represented by the state of Kansas. Maximum U-value, or the amount of heat transfer as a result of conduction, for all glass should be between 0.40 and 0.55 for climate zone 4A, and between 0.35 and 0.55 for climate zone 5A, depending on window construction; wood, steel, etc. (ASHRAE, 2010). Weather stripping, sealant, and caulk should be installed at all windows and doors to reduce infiltration to the facility. Furthermore, caulk should also be installed around building seams, walls, ceilings, and any other exterior penetrations. Insulated doors, with a maximum U-value of 0.70, per Section 5 of ASHRAE Standard 90.1-2010, should be installed between places with substantial temperature difference to reduce heat gains and losses (ASHRAE, 2010). Doors with vents should be replaced to limit infiltration between conditioned spaces and the garage bays. Locations of this occurrence would be exterior doors, or doors between semi-heated shop space and office space.

In regard to lighting, energy-efficient lamps should replace current lamps, both interior and exterior, unless T5s are already present. Incandescents should be replaced with compact fluorescents. As a guideline for linear fluorescent lamp efficiency, the following lamps are listed in order of decreasing efficiency: T5HO, T5, T8, and then T12. Linear fluorescents can also be identified by their diameter as shown in Figure 7.23. It should be noted that a lamp's ballast continuously draws power whether the lamp is on or burnt out. Therefore, if lamps are intentionally removed or left burnt out, with the intention of saving energy, replacing the fixture to house fewer lamps should instead be considered. To confirm the energy-saving capabilities of linear fluorescent lamps, lamp type, light power density (LPD) measured in watts per square foot (W/sf), and electricity use/area measured in kilowatt-hours per square foot (kWh/sf) were compared. Within Appendix C, Tables C.15 and C.16 outline calculations and numerical results for the comparison. It was found the more-efficient lamps had a lower LPD, and therefore, a lower energy use per total square foot. For example, the Russell facility primarily utilizes T5HO lamps and had a LPD of 0.459 W/sf with an electricity usage of 0.140 kWh/sf. When compared to a facility such as Atchison, which uses T12s and incandescents, the energy savings are very apparent. Atchison has a LPD of 0.981 W/SF and an electricity usage of 0.341 kWh/sf, more than double the values and energy usage of Russell. Another energy-saving measure is to avoid over-lighting a building, such as the Belleville facility. The facility had a range of light-level readings from 85-111 footcandles, when office spaces generally require 30-50 footcandles of light according to the IESNA Guidebook. By reducing light levels, occupants will still remain productive, while saving electricity usage.

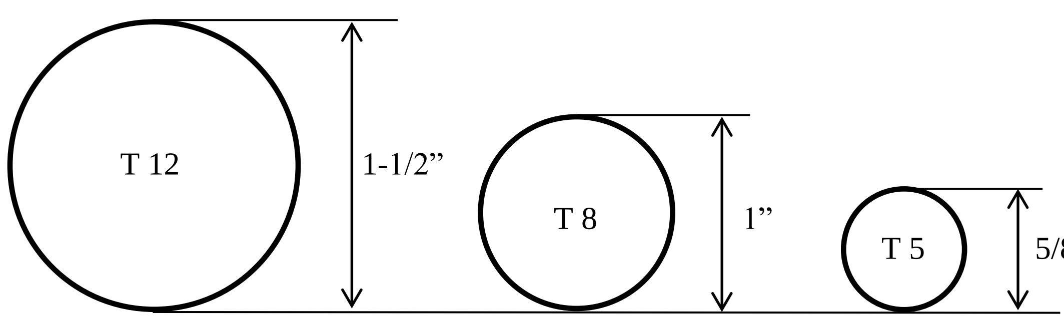

Figure 7.63 Linear Fluorescent Diameter Comparison

Lighting controls should also be upgraded. This typically occurs as light fixtures are upgraded. One option is to install occupancy sensors in the office spaces to ensure the lights are turned off when the spaces are not occupied. The second option is to install a time-clock system that will automatically turn lights on and off in the office areas at a designated times. This will ensure the lights will not be left on overnight or on the weekends. Both control options will save energy consumption; therefore, facility managers have the ability to choose either system, focusing on preference or financial feasibility. Facilities audited had photocell sensors for the exterior lighting; however, these photocells should be tested to ensure they are fully functioning and calibrated, and adequately controlling exterior light fixtures. Another aspect of lighting controls involves exhaust fans and restroom lighting. Many facilities had restroom lights directly connected to the exhaust fan, causing excess energy usage when fan operation is not desired. Unless local code requires the fan to be tied to the light switch, the two should be separated.

Programmable thermostats should be installed in all facilities, and facilities with this style of thermostat already installed need to utilize the programming function. In more than one facility the programming function was available but not used. This will allow for setbacks to reduce energy consumption when the building is unoccupied. Set points for the thermostat during occupied times need to be established for each season to be both realistic and energy efficient. The DOE suggests a winter thermostat setting of 68°F and a summer setting of 78°F, with a setback/setup of 10-15 degrees Fahrenheit in unoccupied mode in order to save around 10 percent a year on heating and cooling bills (Department of Energy, 2011). Also, all supply ductwork needs to be sealed to minimize leakage (ASHRAE, 2010).

In addition, water heaters should be sized based on a realistic daily use, using an accepted method from American Society of Plumbing Engineers (ASPE) or ASHRAE. Based on the fixtures at the KDOT facilities and based upon one public lavatory and one service sink, all water heaters need to be capable of producing eight gallons per hour (GPH) of hot water or switch to instantaneous water heaters. Instantaneous water heaters are more energy efficient because there are no stand-by losses attributed to hot water being generated and stored for long periods of time. Table 7.5 shows calculations based upon the number of lavatories and service sinks at a facility, then multiplies the total GPH of each fixture by the demand factor given in Section 50 of the ASHRAE Handbook for an office space (ASHRAE, 2011a). The total value required is the value to be used to size and select the proper water heater.

Table 7.5 Hot Water-Heater Sizing

Fixtures	Quantity		GPH/Fix	Tot GPH	Demand		GPH RQD	
Lavatories	1		6	6	0.3		1.8	
Janitor Sink	1		20	20	0.3		6	
							7.8	GPH

If changing the water heater to point of use or instantaneous, any recirculation pumps associated with the old system can be removed, allowing for additional energy savings. The water discharge temperature should be decreased to maximum of 110 degrees Fahrenheit for public-use lavatories, per ASHRAE Standard 90.1-2010, to reduce energy consumption and eliminate the risk of scalding.

Another method to ensure water-consumption savings is to install efficient, low-flow, low-water consumption plumbing fixtures. From the Energy Protection Act 2005, flow rates of public fixtures are governed to be maximum of 1.6 gallons per flush (GPF) for water closets, 0.5 gallons per minute (GPM) for lavatory faucets, and 1.0 GPF for urinals. The lower the fixture values of GPF or GPM, the more quantity of water consumed can be reduced and the savings on water utilities can be increased.

Lastly, appliances that are Energy Star certified should be installed when possible to create additional building savings. Equipment needs to be Energy Star-certified above the average rating whenever possible.

Economic Calculations

Energy audits of the six KDOT facilities highlighted many possible changes to improve energy efficiency. Recommendations include replacing windows with double-pane windows, sealing all penetrations in the building, replacing doors that divide spaces with high-temperature differentials, replacing lighting fixtures and lamps to more energy-efficient fixtures, utilizing lighting controls, installing and utilizing programmable thermostats, sealing and insulating ductwork, installing water heaters sized for actual demand, installing low-water consumption and low-flow plumbing fixtures, and investing in Energy Star-certified appliances.

By using information in Tables 7.6 through 7.11, viable recommendations can be determined. Windows should be replaced with double-pane windows, either steel or aluminum, since the NPC of either type is lower than that of single-pane windows and the payback period is low. See Tables C.6 through C.8 in Appendix C for the detailed calculations for the windows.

Table 7.6 NPC—Windows and Doors

Item	Net Present Cost
Aluminum Windows, Single-Pane	$14762.01
Steel Windows, Single-Pane	$14686.01
Wood Windows, Single-Pane	$13,599.02
Interior Metal Door	$509.95
Exterior Metal Door	$588.45

Table 7.7 NPC, ROI, and Payback Period—Double-Pane Windows

Item	Net Present Cost	Return on Investment	Payback Period
Aluminum Windows, Double-Pane	$11,533.20	Between Single-Pane and Double-Pane: 191%	Between Single-Pane and Double-Pane: 0.52 years
Steel Windows, Double-Pane	$11,414.38	Between Single- and Double-Panes: 294%	Between Single- and Double-Panes: 0.34 years
Wood Windows, Double-Pane	$9,021.96	Between Single- and Double-Panes: 784%	Between Single- and Double-Panes: 0.13 years

Thermostats should be replaced with programmable, low-voltage thermostats since those items have low NPC. The three-wire thermostat has been proven to take more accurate temperature readings and has been considered over a two-wire thermostat. Both thermostats shown in Table 7.8 are programmable and will help reduce energy consumption.

Table 7.8 NPC—Thermostats

Item	Net Present Cost
Thermostat, 24-hour, Automatic	$188.50
Thermostat, Low-Voltage, 3-Wire (More accurate thermometer)	$71.50

Linear fluorescent light fixtures need to be replaced with T5 and T8 fluorescent fixtures and lamps. Starting in July 2010, many of the ballasts associated with T12 lamps stopped being produced and T12 lamps, as of July 2012, are also being phased out of production (Green Savings Company, 2012). The ROI is under two years for both items, so facilities will recover the first costs quickly. The NPC is similar between T5 and T8 lamps and fixtures, so either is a viable option from a financial standpoint. Facilities with T12 lamps should upgrade to T5 lamps, and facilities with T8 lamps can upgrade to T5 fixtures when finances allow, reducing energy consumption even more. Due to increasing stringency of energy codes, it is recommended that facilities move toward utilization of T5 lamps and fixtures. It is important to note that lamps cannot be changed without at least changing the ballasts, and in many cases it may be more advantageous to replace the entire fixture. Ballasts deliver power to fluorescent lamps and are not interchangeable among lamp types. Therefore, either ballasts can be exchanged or a new fixture can be purchased. From cost analysis generated from material and labor prices from the RS Means Cost book, it is recommended to install a completely new fixture. Table 7.9 displays the initial cost for one fixture replacement and illustrates that facilities should replace the fixture as a whole, rather than tackle replacing ballasts.

Table 7.9 Fixture and Ballast Comparison

	Cost of Fixture Replacement	**Cost of Ballast Replacement**
Material Description and Cost	Fixture, (2) Lamps $ 52.00	2-Lamp Ballast, (2) Lamps $ 96.10
Labor Cost to Install	$ 57.50	$ 50.50
Total	$ 109.50	$ 146.60

For light fixtures that are currently using incandescent lamps, it is recommended to trade the lamps for compact fluorescents (CFL). The NPC for CFL’s is much lower than an incandescent, allowing for the conclusion that CFL’s are annually more financially wise. Also, the ROI for replacing an incandescent with a CFL is 1280%, making the upgrade a viable option and an immediate payback period with a payback period of 0.08. Ballasts do not need to be added because the CFLs have integral ballasts. Depending on financials, lamps could be replaced immediately or as the lamp fails. The CFL lamps have very comparable light output and therefore, could be replaced as an old lamp fails. However, to experience energy savings immediately, existing lamps should be replaced right away. Replacing incandescents is also necessary since they are being phased out of manufacturing, and by July 2014, all common types of incandescents will no longer be available (Sylvania, 2011).

An additional energy-saving measure would be to reduce lighting levels. If upgrading light fixtures, choose a fixture with fewer lamps to reduce energy consumption, while still maintaining adequate task lighting. IESNA recommends 30-50 footcandles within an office environment. Another method, applicable to dual-switched fixtures with multiple ballasts, would be to remove a lamp from the existing fixture, making sure to disconnect the corresponding ballast, if possible, since it continuously draws power whether a lamp is present or not.

Table 7.10 NPC, ROI, and Payback Period—Lights and Lamps

Item	Net Present Cost	Return on Investment	Payback Period
Fluorescent 4' Strip Fixture, 2-Lamp T8 (30W)	$361.08	Between T12 and T8 fixture: 9.57%	Between T12 and T8 fixture: 10.45 years
Fluorescent 4' Strip Fixture, 2-Lamp T5 (28W)	$351.17	Between T12 and T5 fixture: 10.36%	Between T12 and T5 fixture: 9.66 years
Compact Fluorescent (25W)	$116.48	Between Incandescent and CFL lamp: 1280%	Between Incandescent and CFL lamp: 0.08 years

To help seal the building and prevent outside air from entering, all exterior penetrations should be sealed. From Table 7.10, the recommended item would be latex caulk since it has the lowest NPC. The ROI and payback period cannot be calculated do to the infeasibility of determining the energy saved as a result of sealing. The three sealant options are comparable in terms of quality and durability, so any sealant is a viable option.

Table 7.11 NPC, ROI, and Payback Period—Joint Sealant

Item	Net Present Cost
Latex Caulking (1/4"x1/4")	$7.89
Latex Caulking (3/8"x3/8")	$8.08
Polyurethane Caulking (1/4"x1/4")	$7.96

Lastly, water heaters should be replaced with six-GPH instantaneous electric or natural gas water heaters. From collected data at individual KDOT facilities, subarea buildings do not have enough hot water demand to warrant a water heater of more than eight gallons. The other water heater options have a negative ROI because the annual costs are higher and offset the initial savings. The facility needs to purchase a new water heater that is the same utility as the existing one, either electric or natural gas. Table 7.11 displays NPC and ROI for suggested water heaters compared to the typically installed 30-gallon natural gas heater. Calculated values do not include additional wiring, breaker size upgrade, or other electrical components possibly required. The economic values for natural gas water heaters were unavailable so only electric water heaters were calculated. Before exchanging a current water heater for an electric option, electrical panel size and breaker space need to be considered and availability confirmed. Values in the table may not indicate a viable option; however, when considering the utility available at the facility and the sizes of water heaters available, ROI and payback period should be calculated in order to make the best selection.

Table 7.12 NPC, ROI, and Payback Period—Water Heaters

Item	Net Present Cost	Return on Investment	Payback Period
Five-Gallon Electric Water Heater	$4,887.83	Between 30-Gallon NG and Five-Gallon Electric: -4%	Between 30-Gallon NG and Five-Gallon Electric: None
10-Gallon Electric Water Heater	$7,225.36	Between 30-Gallon NG and 10-Gallon Electric: -59%	Between 30-Gallon NG and 10-Gallon Electric: None
Six-Gallon Instantaneous Electric Water Heater	$3,145.83	Between 30-Gallon NG and Six-Gallon Instant Electric: -1%	Between 30-Gallon NG and Six-Gallon Instant Electric: 20 year/Life
10-Gallon Instantaneous Electric Water Heater	$5,273.36	Between 30-Gallon NG and 10-Gallon Instant Electric: -9%	Between 30-Gallon NG and 10-Gallon Instant Electric: None

Plumbing fixtures should be changed to low-flow fixtures to conserve water and lower utility bills. While calculating the ROI and payback period, it was assumed that the building is functioning 365 days a year with all water closets receiving thirty flushes a day and every lavatory faucet running thirty minutes a day. These assumptions reflect the Department of

Energy's standard calculation rates. The water utility rate was assumed to be $4.00/1000 gallons, also in accordance to the Department of Energy's energy consumption rates. The rate could be changed to a local rate to determine the annual water usage cost. Table 6-9 displays the ROI and payback period associated with replacing a water closet and a lavatory faucet. With the ROI being large and the payback period being very small, only the lavatory faucet would be a financially beneficial investment. The water closet require too large of payback periods to justify replacing the fixtures until the end of their life.

Table 7.13 ROI and Payback Period Plumbing Fixtures

Item	NPC	ROI	Payback Period
Existing Water Closets: 1.6 GPF	$ 974.48	2.03%	49.14 Years
Replacement Water Closet: 1.28 GPF Floor-Mount	$ 1330.32		
Existing Lavatory Faucets: 1.5 GPM	$894.92	50.29%	1.99 Years
Replacement Faucet: 0.5 GPM	$ 339.84		

Case Study Conclusion

After conducting the six building energy audits, re-occurring problems were found and recommendations made. These included replacing single-pane windows with double-pane windows, sealing all penetrations in the building, replacing ill-fitting doors, replacing lighting fixtures and lamps to more energy-efficient fixtures, installing lighting controls and mechanical controls, sealing and insulating ductwork, installing practical water heaters, installing low-water consumption and low-flow plumbing fixtures, and using Energy Star-certified appliances. By implementing all of these changes and balancing the net present cost and return on investment values, energy consumption at each facility can be reduced and efficiency increased.

Assuming that all appliances are functioning properly and that there are no issues that require immediate attention, items with the highest ROI and shortest payback should be down first. Therefore, faucets, lamps and light fixtures, water heaters, and windows should all be replaced when finances are available. Everything else can be updated and replaced when it comes to the end of its life, such as furnaces.

Funding will be a main factor in determining which improvements to be made. These improvements will vary slightly per facility due to the issues found at each. For Atchison, if funding under $1,000 is available, the faucets should be replaced with low-flow faucets, a programmable thermostat should be installed, and all incandescent lamps should be replaced with CFLs. For funding under $5,000, all previously mentioned changes should be made, as well as installing a properly sized water heater. If funding is between $5,000 and $10,000, changes should include everything already stated along with all light fixtures being replaced with higher efficiency fixtures. For any funding above $10,000, either the furnace or windows should be replaced in addition to the previous changes. The decision will be based on the life remaining for each component. If the furnace is over 10 years old and the windows have been replaced in the last five years, the furnace should be replaced, or vice versa. Sealing the joints and openings of the building should occur as funding and time are available. This plan is also applicable to the Larned and Jetmore facilities. The Belleville and Altamont facilities also have similar funding plans. Funding under $1,000, low-flow faucets and a programmable thermostat should be installed, and all incandescent lamps should be replaced with CFLs. If funding is under $5,000, all light fixtures in the office area should be replaced in addition to the previous changes. For funding is between $5,000 and $10,000, any remaining light fixtures should be replaced with higher efficiency fixtures. Any funding above $10,000, should either replace the furnace or windows in addition to the previous changes. As with Atchison, the decision should be based on the life remaining for each component. When funding and time are available, the joints and openings of the building should be sealed. The last plan is dedicated to the Russell facility. For funding under $1,000, the faucets and thermostat should be replaced, and CFLs installed. In addition to those changes, the water heater should be replaced with a properly sized water heater when funding of under $5,000 is available. Any funding above $5,000 should be used to replace the furnace or windows as necessary. Similar to the other facilities, sealing of joint and openings should occur when funds and time are available.

Overall, these changes can improve the efficiency of the facilities and spend funding in the most effective manner. While changes may vary throughout the entirety of KDOT facilities, many improvements and recommendations will remain the same.

Chapter 8 - Conclusion

State governments must adapt and improve as utility costs rise and the building industry shifts towards more stringent energy codes. In order to do so, state governments must establish a continual process of evaluating and improving facilities. This report determined a minimum acceptable level of construction and operation for state-funded facilities, established an energy audit procedure, and introduced methods to determine recommendations for improvements.

In order to choose possible recommendations and improvements for state-funded facilities, a baseline, or minimum set of guidelines, needed to be selected. After examining industry-accepted energy codes and standards, the codes adopted by other states, and determinations of the DOE, ASHRAE Standard 90.1-2010 was selected to be the baseline, or minimum acceptable requirements for construction and renovation. ASHRAE Standard 90.1-2010 applies to all state-funded facilities, including both new buildings and renovations to existing buildings. ASHRAE Standard 90.1-2010 establishes requirements for all aspects of the building, specifically the building envelope, HVAC system, electrical and lighting systems, and domestic hot water system.

Once ASHRAE Standard 90.1-2010 was selected as the minimum acceptable requirements for energy, an energy audit procedure was created in order to survey and compare existing facilities to the baseline. The comparison allows for changes and improvements to be determined and recommended. The NPC and the ROI were then calculated for each recommended change in order to determine which recommendations are feasible.

The case study featured six KDOT facilities, one from each district. These facilities were audited using the procedure created. Facilities selected were the subarea buildings in Atchison, Belleville, Russell, Altamont, Larned, and Jetmore. From the data collected during the audits, changes were recommended in order to increase the efficiency of each facility. Final recommended changes included installing double-pane steel or aluminum windows, installing programmable low-voltage thermostats, upgrading to T5 lamps and fixtures, downsizing to either instantaneous water heaters or six-gallon point-of-use small-capacity storage water heaters, and caulking and sealing.

However, it is not enough to audit facilities and make improvements once; the facilities must undergo a continual process of auditing and improvements. Selecting the minimum acceptable requirements for energy design/operations, conducting energy audits, and determining viable improvements and changes are three crucial steps in the continuous cycle of maintaining an efficient facility. Status of energy codes, industry trends, and DOE determinations should be monitored and the minimum requirements/baseline should be reevaluated every year and updated when necessary. An auditing cycle should be established and every facility should be audited once every five years. Utility data can help determine which facilities to audit and when. A facility with lower utility costs can be audited to determine good practices, whereas a facility with higher utility costs can be audited to determine problems and needed areas of improvement.

Educating employees is imperative to the energy efficiency of facilities. Make sure all employees are aware of basic energy efficiency tasks, such as turning off lights and equipment when not in use. Audit-conducting employees must be taught not only how to perform an audit, but how to interact with occupants in order to obtain data as well as educate them on simple steps to increase energy efficiency.

Documentation and use of software are vital to the process of improving energy efficiency in state-funded facilities. Documenting allows for goals to be determined and worked towards, as well as knowing what has been done in the past. Software programs, such as Energy Star and even Excel spreadsheets, allow for utility data to be monitored. Certification programs, such as LEED, Green Globes, and ASHRAE Building Energy Quotient, provide guidelines and ratings for facilities based on energy efficiency and sustainability. States wanting to go above the minimums established by ASHRAE Standard 90.1-2010 can use these programs to track progress and can achieve a rating that correlates to efficiency.

In summary, state-funded facilities must employ a continual process of selecting minimum requirements, auditing facilities, implementing changes, and documenting and monitoring in order to increase energy efficiency. The steps outlined in this report can help state-funded facilities, as well as other multi-facility entities, increase energy efficiency and reduce energy consumption in the present and the future. Further research can determine the exact amount of savings as well as the benefits of using more progressive energy standards and programs, such as ASHRAE Standard 189.1 or LEED.

The research and case study for this report provide a great starting point for state governments to improve facility efficiency; however, there are limitations. The research is limited to simplified buildings and further research would be needed to implement the procedure in large facilities with advanced HVAC, plumbing, and lighting systems. The KDOT case study provided an opportunity to test the energy audit procedure and implement the cycle of increasing energy efficiency. However, the case study had limitations. The facilities audited were small and had simple HVAC, plumbing, and lighting systems. Audits were only conducted in the winter due to time and cost limitations, so an accurate model of how the building performs year round could not be created. If time and costs were not an issue, more facilities, varying in sophistication, would be audited throughout the year. It would also be beneficial to implement the recommended changes in the facilities and measured and monitor the energy savings to compare to the calculated predicted savings.

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Appendix A - Audit Procedure and Documents

Audit Procedure

Pre-Audit

1. Two weeks prior to audit, send owner survey to contact person and request to have it returned at least two days prior to the audit.
2. Update audit documents to reflect the owner survey.
3. If available, use building floor plans to fill out as much of the paperwork as possible prior to audit.
4. Become familiar with the floor plans.
5. Develop a list of questions and unknowns to ask contact person.
6. Assemble all items needed for the audit: flashlight; digital camera; yardstick(s); thermal camera; 4-in-1 device(s): thermometer, light meter, hygrometer, and anemometer; highlighters; floor plans; clipboards; and writing utensils.

Audit

1. Meet with owner/representative/contact person, discuss audit procedure, and ask questions.
2. Take a brief tour of the facility.
    a. Note major building equipment and attributes.
        i. HVAC equipment
        ii. Fans
        iii. Restrooms
        iv. Mechanical and electrical rooms
        v. Access to roof/storage areas/equipment areas
3. Start with one specific task and work through others.
4. Be sure to take notes and photos.
    a. HVAC
        i. Note: manufacturer, type of equipment

ii. Utility/fuel source

iii. Take photos of name plates, equipment, and location.

b. Room conditions

i. Note any nonoperational lamps/fixtures.

ii. Record data for each room.

1. Number of fixtures
2. Number of lamps
3. Light level at center of the room at consistent height (use yardstick as a standard)
4. Room temperature and relative humidity
5. Thermostat set point for both heating and cooling
6. Review of thermostat-programmed set points

c. Plumbing

i. Record hot and cold water discharge temperatures.

ii. Record hot water heater data and take photos.

iii. Document all pumps (i.e. recirculation pumps).

d. Walk around the structure, taking note of any irregularities.

i. Take thermal and regular photos of the exterior.

e. Check electrical rooms for time clocks used to control equipment and lights.

5. Develop exit questions for the owner/representative/contact person.

a. Ask about anything that was unclear.

b. Ask about any equipment that was not found.

c. Make sure to answer their questions, if any.

Post-Audit

1. Add all data to the audit documents.
2. Title and save all photos for documentation and later clarification.

Instructions for Audit and How To Use the Audit Workbook

There are many sections within the audit workbook. This how-to guide will walk through each section and note what information should be gathered.

1. Building Information
   a. Name of building
   b. Address of building
   c. Date and weather conditions at time of audit
   d. Introduce yourself to building manager, and take down his or her name and number.
   e. Make note of the auditing team.
   f. Next, describe the building type in general and by building function.
   g. Ask owner/operator if previous audits have been performed.
   h. Ask owner/operator if energy-saving measures are currently being implemented or if there are plans for some to be initiated.
   i. Ask owner/operator for typical occupied hours of the building.
   j. Ask owner/operator for typical thermostat set points (or get the information from the room data).
   k. Lastly, ask the owner/operator for average number of occupants.
2. Room Sheet
   a. For each room, fill out one of these sheets.
   b. Room name
   c. Room number (if available)
   d. Thermostat? If yes, what is the temperature set at?
   e. Note temperature and relative humidity in the space.
   f. Lighting
      i. First, describe the fixture with number of lamps (i.e. 2’x4’ lay-in with (2) T8 lamps).

ii. Note whether the ballast is magnetic or electronic. Either use a “ballast checker” or use the general rule that T12s usually have magnetic ballasts and T8/T5s always have electronic ballasts.

iii. Then, take the footcandle reading. Stand in the center of the room. Take the measurement with a lightmeter at 36” above the floor (common working-plane height).

iv. Lastly, note controls for the lights (occupancy sensors, manual toggles, etc.).

g. Equipment

   i. Take inventory of all equipment that requires power (i.e. exhaust fan, computer, etc.).

   ii. If there is an exhaust fan, is it tied to the light or does it have independent controls?

h. Exterior Doors

   i. Are there exterior doors in the space?

      1. Note the quantity, type (metal, wood, orientation), size, and condition.

         a. Door conditions can be defined as—

            i. Good: Door has no obvious defects and no visible gaps when shut.

            ii. Fair: Door has minor defects (dents, scratches, cracks) that do not affect operation or allow gaps.

            iii. Poor: Door has major defects (dents, scratches, cracks) that prevent proper operation and results in gaps to outside.

i. Exterior Windows

   i. Are there exterior windows in the space?

      1. Note the quantity, type (operable, number of panes, shading, orientation), size, and condition

a. Window conditions can be defined as—
   i. Good: Window has no obvious defects, no visible gaps when shut, and glazing is intact.
   ii. Fair: Window has minor defects (scratches, cracks) that do not affect operation or allow gaps; minor cracks in glazing.
   iii. Poor: Window has major defects (scratches, cracks) that prevent proper operation and results in gaps to outside; extensive cracks in glazing.

3. Building Characteristics
   a. Most information will need to be taken from a floor plan or consolidated from individual room sheets.
   b. Note the floor area of the building.
      i. What percent of the area is conditioned?
   c. Compile total door areas and conditions.
   d. Compile total glass areas and conditions.
   e. Note construction of walls and roof.
      i. If available from the plans or inspection, note the insulation.
   f. Note how the building is metered for utilities.
4. HVAC Distribution System
   a. First, note location of the equipment.
   b. There are multiple sections on this sheet in case there are multiple systems within the building, but each section requires the same information.
   c. First, system type
      i. Check-box the type of system.
      ii. Note maintenance of the items.
      iii. Record a detailed description of the system such as brand, model number, etc.; use the boxes on the right.

    iv. Then, if ductwork is used to transmit conditioned air, note the condition of the insulation and installation.
    v. Lastly, check-box the type of control scheme used with the system.

5. Domestic Hot Water
    a. First, check-box the type of fuel used to heat the water.
    b. Next, in the box to the right, describe the water heater installed.
        i. Include brand, model, gallon capacity, BTUh input, and any other information provided on the unit.
    c. Note the number of units, location of units, and if there is a recirculation loop attached to the water heater.
    d. Next, note the temperature at the heater, both entering (city water) and leaving (at heater).
    e. Hot water temperature “at point of use” is measured at the individual lavatory faucets. The temperature “at point of use” should not be more than 110 degrees Fahrenheit.
    f. If available, record the water heater’s manufacturer and installation date.
    g. Next, answer the check-box questions regarding the heater’s condition.
    h. The last item is to note if hot water is used for just the public lavatories, or for other building uses as well.
6. Water Consumption
    a. Tally the number of water-using fixtures within the building.
    b. Note the gallons/flush or gallons/minute of flow for the fixtures.
    c. Next, record hot and cold water temperatures “at point of use” in the public restrooms.
    d. Lastly, ask the owner/operator if there are any periods throughout the year when large amounts of water are used (i.e., irrigation, filling tanks, etc.).
7. Specialty Equipment

    a. Note all power-drawing equipment within the building. The simplest way to achieve this is to record the equipment on a room-by-room basis and compile the sheets after the audit is complete.

8. Lighting
    a. For interior and exterior of the building, compile the lighting utilized throughout. The simplest way to achieve this is to record lighting information on a room-by-room basis and compile the sheets after the audit is complete.
9. After the Audit
    a. After completing the audit, thank the owner/operator who assisted with the audit process, and make sure to take his or her contact information in case questions arise after you have left the audit site.
    b. Example after-audit questions:
        i. Lighting – is there a preference as to what lights should be on/off?
        ii. If the water temperature is high, is it required for a certain process?

Energy Audit On-Site Spreadsheet

Building Information			
Name of Institution, Building			Building #
			--
Address (Street or P.O. Box)			City, State, Zip
Date of Audit	Time of Audit	Weather Conditions	
Building Manager			Building Manager's Phone Number
Auditing Team			Phone
Building Type and Use			
		Building Use	% Dedicated to this Use
Building Description / Type:		☐ Office	______
		☐ Storage	______
		☐ Maintenance Garage	______
		☐ Other - Shop	______
Date of Construction:	______		
Original Architects, if known		Original Engineers, if known	
Does the Institution have an ongoing Energy Management Program? ☐ Yes ☐ No			
If yes, describe program: ______			
Any previous energy audits completed? ☐ Yes ☐ No		Dates:	
Name of Utilities: Electric, Gas, etc.			

Building Information

List of Energy Savings Programs or Efforts Currently Implemented:

No. Years Implemented

1.______________________________ __________

2.______________________________ __________

3.______________________________ __________

4.______________________________ __________

5.______________________________ __________

Conservation Measures Under Consideration Prior to this Audit.

1.______________________________

2.______________________________

3.______________________________

4.______________________________

What are the facility manager's feelings towards saving energy?

Priority of Saving Energy and Money with Utilit Low 1 2 3 4 5 6 7 8 9 10

What are the barriers to implementing energy saving strategies?

- ☐ Lack of Information
- ☐ Lack of Funds
- ☐ Lack of Support from Upper Management
- ☐ Other : ____________________

Building Information

Building Occupancy Profile

Typical Occupied Periods:

	Hours (i.e. 8am - 5pm)
Sunday	______________
Monday	______________
Tuesday	______________
Wednesday	______________
Thursday	______________
Friday	______________
Saturday	______________

Thermostat Set points:				
Daytime	Heating	________	Cooling	________
Nighttime	Heating	________	Cooling	________
Weekend	Heating	________	Cooling	________

Average Number of Occupants in Building: ________

Include a Floor Plan.

1. Look for discrepancies between plan and existing conditions.
2. Mark locations of heating and cooling units.

ROOM NAME: ____________________

ROOM NUMBER: __________

Thermostat? ☐ Yes ☐ No Setting: __________ ° F

Temperature __________ ° F
Relative Humidity __________ %

Lighting:	Ballast	Footcandles	Controls

All Lights On: __________

Equipment:

			Quantity
Exhaust Fan	☐ Yes	☐ No	
Computer	☐ Yes	☐ No	

Exterior Doors: ☐ Yes ☐ No

Standard Doors: Quantity: __________ Door Condition:
Type: __________ ☐ Good
Size: __________ ☐ Fair
☐ Poor

Shop Doors: Quantity: __________ Door Condition:
Type: __________ ☐ Good
Size: __________ ☐ Fair
☐ Poor

Exterior Windows: ☐ Yes ☐ No

Windows: Quantity: __________ Window Condition:
Type: __________ ☐ Good
Size: __________ ☐ Fair
☐ Poor

Windows: Quantity: __________ Window Condition:
Type: __________ ☐ Good
Size: __________ ☐ Fair
☐ Poor

Building Characteristics									
Gross Floor Area		________	gross sf	,	ceiling ht	________	ft		
		________	gross sf	,	ceiling ht	________	ft		
		________	gross sf	,	ceiling ht	________	ft		
							* If multiple ceiling heights		
Conditioned Floor Area		Heating Only:			________	sf			
		Cooling Only:			________	sf			
		Heating and Cooling:			________	sf			
Number of Conditioned Floors:									
		Above Grade		________					
		Below Grade		________					
Total Standard Door Area		________	sf		Glass	________	sf	Door Condition:	
					Wood	________	sf	☐ Good	
					Metal	________	sf	☐ Fair	
					Garage	________	sf	☐ Poor	
Total Shop Door Area		________	sf		Glass	________	sf	Door Condition:	
					Wood	________	sf	☐ Good	
					Metal	________	sf	☐ Fair	
					Garage	________	sf	☐ Poor	
Office Exterior Glass Area		________	sf	Single Panes		________	sf	Window Condition:	
(Note: Operable or Fixed)				Double Panes		________	sf	☐ Good	
								☐ Fair	
			North	Total Area		________	sf	☐ Poor	
				Single Panes		________	sf		
				Double Panes		________	sf		
			South	Total Area		________	sf		
				Single Panes		________	sf		
				Double Panes		________	sf		
			East	Total Area		________	sf		
				Single Panes		________	sf		
				Double Panes		________	sf		
			West	Total Area		________	sf		
				Single Panes		________	sf		
				Double Panes		________	sf		

Shop Ext Glass Area	________	sf	Single Panes	________	sf	Window Condition:
(Note: Operable or Fixed)			Double Panes	________	sf	☐ Good ☐ Fair ☐ Poor
		North	Total Area	________	sf	
			Single Panes	________	sf	
			Double Panes	________	sf	
		South	Total Area	________	sf	
			Single Panes	________	sf	
			Double Panes	________	sf	
		East	Total Area	________	sf	
			Single Panes	________	sf	
			Double Panes	________	sf	
		West	Total Area	________	sf	
			Single Panes	________	sf	
			Double Panes		sf	
Office Exterior Wall Are	________	sf	☐ Masonry ☐ Wood ☐ Concrete	☐ Stucco ☐ Other ☐ Unknown		
Shop Ext Wall Area	________	sf	☐ Masonry ☐ Wood ☐ Concrete	☐ Stucco ☐ Other ☐ Unknown		
Total Roof Area	________	sf	Condition:	☐ Good ☐ Fair ☐ Poor		

Insulation Type	Roof:	________________	If Provided on Building Plans.
	Wall:	________________	
	Floor:	________________	
Insulation Thick	Roof:	________________	
	Wall:	________________	
	Floor:	________________	

Metering:

Is this building individually metered for electricity?	☐ Yes	☐ No
Is this building individually metered for natural gas / LP?	☐ Yes	☐ No
Is this building individually metered for water?	☐ Yes	☐ No

Describe the general building condition:

HVAC DISTRIBUTION SYSTEM

Location of Unit(s)

SYSTEM 1

SYSTEM TYPE

- ☐ Single Zone (Furnace, RTU, etc.)
- ☐ Multi Zone (i.e. AHU)
- ☐ Dual Duct
- ☐ Variable Air Volume
- ☐ Single Duct Reheat
- ☐ 2-Pipe Water
- ☐ 4-Pipe Water
- ☐ Window Unit
- ☐ Packaged Air Terminal Unit
- ☐ Unit Ventilator
- ☐ Fan Coil
- ☐ Unit Heater
- ☐ Other ____________

MAINTENANCE

- ☐ Good
- ☐ Fair
- ☐ Poor

DUCTWORK

Insulation:

- ☐ Good
- ☐ Fair
- ☐ Poor

Installation:

- ☐ Good
- ☐ Fair
- ☐ Poor

CONTROLS

- ☐ Space Thermostat
- ☐ Outside Temperature Sensors
- ☐ Time Clocks
- ☐ Energy Management System
- ☐ Auto Supply Temperature Reset
- ☐ Economy Cycle
- ☐ Heat Recovery
- ☐ Other ____________

Style:

SYSTEM 2

SYSTEM TYPE		MAINTENANCE	
	☐ Single Zone	☐ Good	
	☐ Multi Zone	☐ Fair	
	☐ Dual Duct	☐ Poor	
	☐ Variable Air Volume		
	☐ Single Duct Reheat		
	☐ 2-Pipe Water		
	☐ 4-Pipe Water		
	☐ Window Unit		
	☐ Unit Ventilator		
	☐ Fan Coil		
	☐ Unit Heater		
	☐ Other ______		
	CONTROLS		
	☐ Space Thermostat		
	☐ Outside Temperature Sensors		
	☐ Time Clocks		
	☐ Energy Management System		
	☐ Auto Supply Temperature Reset		
	☐ Economy Cycle		
	☐ Heat Recovery		
	☐ Other ______		

SYSTEM 3

SYSTEM TYPE

- ☐ Single Zone
- ☐ Multi Zone
- ☐ Dual Duct
- ☐ Variable Air Volume
- ☐ Single Duct Reheat
- ☐ 2-Pipe Water
- ☐ 4-Pipe Water
- ☐ Window Unit
- ☐ Unit Ventilator
- ☐ Fan Coil
- ☐ Unit Heater
- ☐ Other ____________

MAINTENANCE

- ☐ Good
- ☐ Fair
- ☐ Poor

CONTROLS

- ☐ Space Thermostat
- ☐ Outside Temperature Sensors
- ☐ Time Clocks
- ☐ Energy Management System
- ☐ Auto Supply Temperature Reset
- ☐ Economy Cycle
- ☐ Heat Recovery
- ☐ Other ____________

DOMESTIC HOT WATER

Domestic Hot Water Heated By:

- ☐ Electricity
- ☐ Natural Gas
- ☐ Oil
- ☐ Steam
- ☐ Heat Pump
- ☐ Other ____________

Number of Units: ____________

General Location of Units: ____________

Is there a re-circulation loop? ☐ Yes ☐ No

Hot Water Temperature

At Point of Use ____________

At Heater ____________

Temperature of City Water ____________

Date of Water Heater ____________

Date of Installation ____________

Is the tank warm to the touch? ☐ Yes ☐ No

Are pipes insulated at least 3' from heater? ☐ Yes ☐ No

Any signs of leakage? ☐ Yes ☐ No

Requires maintenance? ☐ Yes ☐ No

Is the tank wrapped? ☐ Yes ☐ No

Do obstructions prevent wrapping? ☐ Yes ☐ No

Distance from Heater to Furthest Point of Use: ____________

Hot Water Uses Other than Lavatories:

WATER CONSUMPTION

Fixture Type	Quantity	Gal/Flush	Gal/Min	Low-Flow?	Aerators?
Water Closets (tank)					
Water Closets (valve)					
Urinals					
Lavatories					
Service Sinks					
Showers					
Electric Water Coolers					
Dishwashers					
Hose Bibs					

Exhaust Fans tied to Lights? ☐ Yes ☐ No

HW Temperature = °F

CW Temperature = °F

Large Water Consumption Scenarios

	Yes	No	Time Period of Water Usage	Estimated Amount
Irrigation - Sprinkler System				
Filling Water Tanks				
Other: _______________				

SPECIALTY EQUIPMENT		
Item	Yes / No	Quantity
Refrigerators		
Mini-Fridges		
Freezers		
Walk-In Refrigerators		
Walk-In Freezers		
Microwaves		
Mixers		
Ranges		
Ovens		
Dishwashers		
Hoods w/ Exhaust Fans		
Coffee Makers		
Pop Machines		
Vending Machines		
Ice Makers		
Space Heaters		
Copiers		
Fax Machines		
Scanners		
Printers		
Printer/Fax/Scan/Copy Machines		
Plotters		
Compressors		
Motors		
Presses		
Laser Cutting Machine - Independent Exhaust Fan		
Press Brake Machine		
Waterjet Cutting Machine		
CNC Lathe		
CNC Mill		
Powder Paint Curing Oven		
Misc. Manual Shop Lathes/Mills		
Welding Machines		
Test Fixtures		
Exhaust Fans (Separate from Light)		
Computers		
Projector / Screen		

Lighting

INTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

EXTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

Fixture Types:
- Incandescent
- Fluorescent
- Mercury Vapor
- High Pressure Sodium
- Low Pressure Sodium
- Metal Halide

Are lights on in unoccupied areas? ☐ Yes ☐ No

Is the exterior lighting on during the day? ☐ Yes ☐ No

How are lights operated?
- ☐ Toggle Switches
- ☐ Occupancy Switches
- ☐ Photovoltaic/Daylight Sensors
- ☐ Other ________

Owner Survey

Building Information

Name of Institution, Building	Building #
Address (Street or P.O. Box)	City, State, Zip

Building Manager	Building Manager's Phone Number

Building Description / Type: ________

Building Use — % Dedicated to this Use

☐ Office ________
☐ Storage ________
☐ Maintenance Garage ________
☐ Other ________

Date of Construction, if known:

Original Architects, if known	Original Engineers, if known

Does the Institution have an ongoing Energy Management Program? ☐ Yes ☐ No

If yes, describe program:

List of Energy Savings Programs or Efforts Currently Implemented:

No. Years Implemented

1.______________________________________ ________
2.______________________________________ ________
3.______________________________________ ________
4.______________________________________ ________
5.______________________________________ ________

Conservation Measures Under Consideration Prior to this Audit.

1.______________________________________
2.______________________________________
3.______________________________________
4.______________________________________

Any previous energy audits completed? ☐ Yes ☐ No Dates:

Name of Utility Companies: Electric, Gas, etc.

Owner Survey

Building Information

Building Occupancy Profile

Typical Occupied Periods:

	Hours (i.e. 8am - 5pm)
Sunday	______________
Monday	______________
Tuesday	______________
Wednesday	______________
Thursday	______________
Friday	______________
Saturday	______________

Thermostat Set points:				
Daytime	Heating	________	Cooling	________
Nighttime	Heating	________	Cooling	________
Weekend	Heating	________	Cooling	________

Average Number of Occupants in Building: ________

List Areas of Building Known to Need to Repair or Concern Areas

____

____

____

____

____

____

____

Large Water Consumption Scenarios

	Yes	No	Time Period of Water Usage	Estimated Amount
Irrigation				
Filling Water Tanks				
Other: ______________				

Owner Survey

Building Information

Specialty Equipment

Item	Yes / No	Quantity
Refrigerators		
Mini-Fridges		
Freezers		
Walk-In Refrigerators		
Walk-In Freezers		
Infra-red Warmer Microwaves		
Mixers		
Ranges		
Ovens		
Frying Tables		
Steam Tables		
Dishwashers		
Hoods w/ Exhaust Fans		
Coffee Makers		
Pop Machines		
Vending Machines		
Ice Makers		
Space Heaters		
Copiers		
Fax Machines		
Scanners		
Printers		
Printer/Fax/Scan/Copy Machines		
Plotters		

Lighting

Are lights on in unoccupied areas? ☐ Yes ☐ No

Is the exterior lighting on during the day? ☐ Yes ☐ No

How are lights operated?
- ☐ Toggle Switches
- ☐ Occupancy Switches
- ☐ Photovoltaic/Daylight Sensors
- ☐ Other ____________________

Tool Guide

- Flashlight: Use to examine dark spaces.

- Camera: Take photos to document current conditions and equipment.

- Yardstick: Use to make sure that all temperature and light-level readings are taken at the same height.

- Thermal Camera: Use to take photos of the building to identify any areas where heat is lost/gained through the envelope. Can also be used to determine if insulation is effective. If a thermal camera is unavailable, visually check for sealing around joints and feel for intruding air.

- Four-in-One Device(s): Use to measure light levels at working plane (typically 3' above floor,) and temperature and relative humidity in each space. Use with the probe to measure temperature of cold and hot water at plumbing fixtures. If a four-in-one device is unavailable, use a lightmeter, thermometer, and hygrometer separately to note the light level, temperature, and relative humidity.

- Highlighters: Use to highlight the plans if any discrepancies are identified and to highlight any issues on the worksheets.

- Plans: Use the plans to make sure all spaces are accounted for and are accurate according to the plans.

- Clipboards: Use clipboards to keep all sheets organized and provide a surface to write on.

- Pens and Pencils: Use to document everything and fill out the audit worksheets.

Appendix B - KDOT Audit Information

Atchison: Photos and Completed Audit

Figure B.1 Lamp

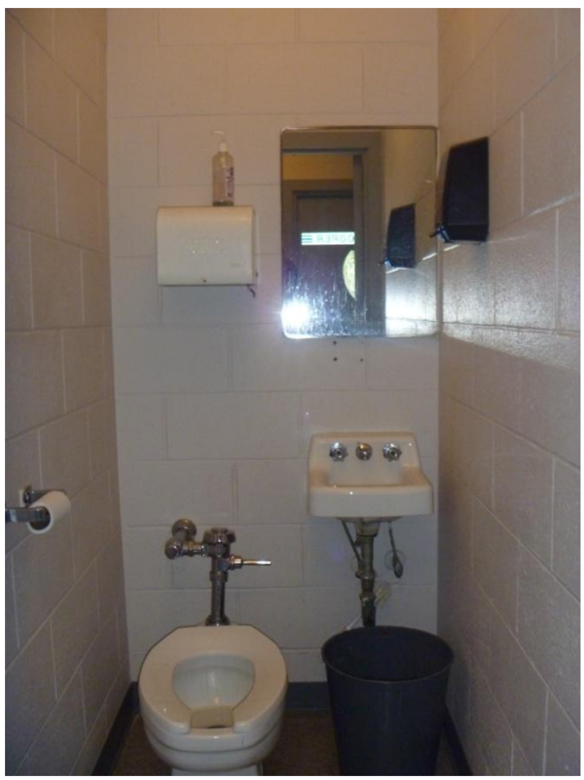

Figure B.2 Typical Plumbing Fixtures

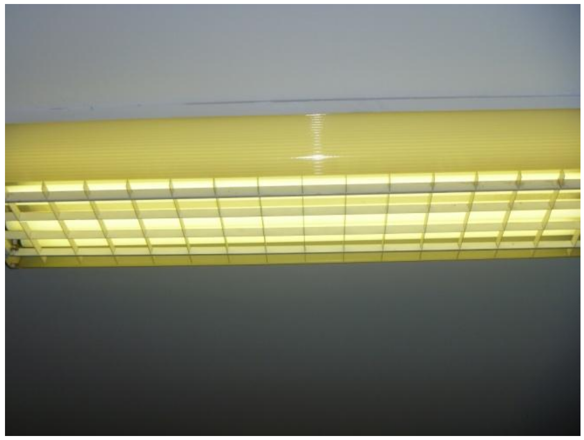

Figure B.3 Light Fixture

Figure B.4 Furnace

Figure B.5 Water Heater

Figure B.6 Unit Heater

Figure B.7 Thermostat

Figure B.8 Second Furnace


Figure B.9 Outdoor Air-Condensing Unit

Table B.1 Completed Atchison Audit

Building Information

Name of Institution, Building	Building #
Atchison KDOT Building, District 1	--
Address (Street or P.O. Box)	City, State, Zip
313 Woodlawn	Atchison, KS, 66002

Date of Audit	Time of Audit	Weather Conditions
February 3, 2012	*8:00 AM*	*43 °F, 87% RH, Heavy Rain, ESE 23 mph*

Building Manager	Building Manager's Phone Number
Robbie Weishaar, "Subarea Supervisor"	785-207-0714
Auditing Team	Phone
Rebecca Gentry, Kimberly Pierson, David Carter	

Building Type and Use

Building Description / Type:	Building Use	% Dedicated to this Use
Original Building, plus additions on either end (1968). Plus office renovations.	☑ Office	
	☑ Storage	
	☑ Maintenance Garage	
	☑ Other - Wash Bay	

Date of Construction: ____________

Original Architects, if known	Original Engineers, if known

Does the Institution have an ongoing Energy Management Program? ☐ Yes ☑ No

If yes, describe program: ____________

Any previous energy audits completed? ☐ Yes ☑ No Dates:

Name of Utilities: Electric, Gas, etc.

Atchison – Completed Audit

Building Information

List of Energy Savings Programs or Efforts Currently Implemented:

No. Years Implemented

1.____________________________ ____________
2.____________________________ ____________
3.____________________________ ____________
4.____________________________ ____________
5.____________________________ ____________

Conservation Measures Under Consideration Prior to this Audit.

1.____________________________
2.____________________________
3.____________________________
4.____________________________

What are the facility manager's feelings towards saving energy?

Priority of Saving Energy and Money with Utilit Low 1 2 3 4 5 6 7 8 9 10

What are the barriers to implementing energy saving strategies?

- ☐ Lack of Information
- ☐ Lack of Funds
- ☐ Lack of Support from Upper Management
- ☐ Other : ____________________

Building Information				
Building Occupancy Profile				
Typical Occupied Periods:				
		Hours (i.e. 8am - 5pm)		
	Sunday	8:30-4:30 (Win), 7:30-3:30 (Sum)		
	Monday	8:30-4:30 (Win), 7:30-3:30 (Sum)		
	Tuesday	8:30-4:30 (Win), 7:30-3:30 (Sum)		
	Wednesday	8:30-4:30 (Win), 7:30-3:30 (Sum)		
	Thursday	8:30-4:30 (Win), 7:30-3:30 (Sum)		
	Friday	8:30-4:30 (Win), 7:30-3:30 (Sum)		
	Saturday	8:30-4:30 (Win), 7:30-3:30 (Sum)		

Thermostat Set points:	Daytime	Heating	72	Cooling	70
	Nighttime	Heating	72	Cooling	70
	Weekend	Heating	72	Cooling	70

Average Number of Occupants in Building: 3

Include a Floor Plan.

1. Look for discrepancies between plan and existing conditions.
2. Mark locations of heating and cooling units.

Atchison – Completed Audit

ROOM NAME:	Outside			
ROOM NUMBER:				
Thermostat?	☐ Yes ☐ No	Setting:	° F	
Temperature	° F			
Relative Humidity	%			
Lighting:		Ballast	Footcandles	Controls
(12) Small MH Lights				
(4) PAR lamps				
(5) 100W Incan in Ext Stor				
			All Lights On:	
Equipment:				
		Quantity		
Exhaust Fan	☐ Yes ☑ No			
Computer	☐ Yes ☑ No			
Exterior Doors:	☐ Yes ☑ No			
Standard Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Exterior Windows:	☐ Yes ☑ No			
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	

ROOM NAME:	Washbay			
ROOM NUMBER:				
Thermostat?	☐ Yes ☐ No	Setting:	° F	
Temperature	° F			
Relative Humidity	%			
Lighting:		Ballast	Footcandles	Controls
(18) 2-lamp T12 fixture		Magnetic		Toggle
		All Lights On:	Yes	
Equipment:				
		Quantity		
Exhaust Fan	☑ Yes ☐ No	1	* Rain leaking through flue of Radiant Heater	
Computer	☐ Yes ☑ No			
Motorized Vents		2		
Hot Water Pressure Washer		1		
Exterior Doors:	☑ Yes ☐ No			
Standard Doors:	Quantity:	1	Door Condition:	
	Type:	Metal	☑ Good	
	Size:	3x7	☐ Fair ☐ Poor	
Shop Doors:	Quantity:	1	Door Condition:	
	Type:	Metal Garage	☑ Good	
	Size:	12x15	☐ Fair ☐ Poor	
Exterior Windows:	☐ Yes ☑ No			
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	

ROOM NAME:	Men's Restroom			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	69.3 ° F			
Relative Humidity	32.5 %			

Lighting:	Ballast	Footcandles	Controls
(3) 60W Incand		42.3	Toggle
	All Lights On:	No	

Equipment:		Quantity
Exhaust Fan	☐ Yes ☑ No	
Computer	☐ Yes ☑ No	
Flush Valve WC		1
Lavatory		1

Exterior Doors: ☐ Yes ☑ No

Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows: ☑ Yes ☐ No

Windows:	Quantity:	1, South	Window Condition:
	Type:	Single Pane, Wood Frame	☐ Good
	Size:	2x3	☐ Fair ☑ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

ROOM NAME:	Hallway Attached to Restrooms				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No		Setting:	° F	
Temperature	69.7	° F			
Relative Humidity	36.5	%			

Lighting:	Ballast	Footcandles	Controls
(3) 60W Incand		6.2	Toggle
	All Lights On:	No	

Equipment:		Quantity
Exhaust Fan	☐ Yes ☑ No	
Computer	☐ Yes ☑ No	
Water Cooler		1

Exterior Doors:	☑ Yes ☐ No		
Standard Doors:	Quantity: 1, South		Door Condition:
	Type: Wood, Glass Panel		☐ Good
	Size: 3x7		☑ Fair
			☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Exterior Windows:	☐ Yes ☑ No	
Windows:	Quantity:	Window Condition:
	Type:	☐ Good
	Size:	☐ Fair
		☐ Poor
Windows:	Quantity:	Window Condition:
	Type:	☐ Good
	Size:	☐ Fair
		☐ Poor

ROOM NAME: Women's Restroom

ROOM NUMBER: ______

Thermostat? ☐ Yes ☑ No Setting: ______ ° F

Temperature 69.8 ° F
Relative Humidity 37 %

Lighting:	Ballast	Footcandles	Controls
(3) 60W Incand		7.5	Toggle

All Lights On: No

Equipment:

		Quantity
Exhaust Fan	☑ Yes ☐ No	1, but no switch
Computer	☐ Yes ☑ No	
Flush Valve WC		1
Lavatory		1

Exterior Doors: ☐ Yes ☑ No

Standard Doors: Quantity: ______
Type: ______
Size: ______

Door Condition:
☐ Good
☐ Fair
☐ Poor

Shop Doors: Quantity: ______
Type: ______
Size: ______

Door Condition:
☐ Good
☐ Fair
☐ Poor

Exterior Windows: ☐ Yes ☑ No

Windows: Quantity: ______
Type: ______
Size: ______

Window Condition:
☐ Good
☐ Fair
☐ Poor

Windows: Quantity: ______
Type: ______
Size: ______

Window Condition:
☐ Good
☐ Fair
☐ Poor

ROOM NAME:	NE Office			
ROOM NUMBER:				

Thermostat?	☐ Yes ☑ No	Setting:	° F
Temperature	66 ° F		
Relative Humidity	33.8 %		

Lighting:	Ballast	Footcandles	Controls
(4) 4-lamp, T12 fixtures	Magnetic	42.5	Toggle
	All Lights On:	Yes	

Equipment:		Quantity
Exhaust Fan	☐ Yes ☑ No	
Computer	☐ Yes ☑ No	

Exterior Doors:	☑ Yes ☐ No		
Standard Doors:	Quantity:	1, East	Door Condition:
	Type:	Wood, Glass Pane	☑ Good
	Size:	3x7	☐ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows:	☑ Yes ☐ No		
Windows:	Quantity:	2, North	Window Condition:
	Type:	Single Pane, Wood Frame	☐ Good
	Size:	3x4	☐ Fair ☑ Poor
Windows:	Quantity:	1, East	Window Condition:
	Type:	Single Pane, Wood Frame	☐ Good
	Size:	3x4	☐ Fair ☑ Poor

ROOM NAME:	Main Office			
ROOM NUMBER:				
Thermostat?	☑ Yes ☐ No	Setting:	70 ° F	
Temperature	69.4 ° F			
Relative Humidity	34 %			
Lighting:		Ballast	Footcandles	Controls
(10) 4-lamp, T12 fixtures		Magnetic	40	Toggle
		All Lights On:	Yes	
Equipment:		Quantity		
Exhaust Fan	☐ Yes ☑ No			
Computer	☑ Yes ☐ No	2		
Microwave		2		
Printer		3		
Exterior Doors:	☐ Yes ☑ No			
Standard Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Exterior Windows:	☑ Yes ☐ No			
Windows:	Quantity:	4, North	Window Condition:	
	Type:	Single Pane, Wood Frame	☐ Good	
	Size:	3x4	☐ Fair	
			☑ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	

ROOM NAME:	Mechanical Room				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:		° F	
Temperature	71 ° F				
Relative Humidity	32 %				
Lighting:		Ballast		Footcandles	Controls
(1) 60W Incand				8.4	Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☐ Yes ☑ No				
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Kitchen					
ROOM NUMBER:						
Thermostat?	☐ Yes ☑ No		Setting:		° F	
Temperature	70.7	° F				
Relative Humidity	31.4	%				
Lighting:			Ballast		Footcandles	Controls
(12) 60W Incand					6	Toggle
*Only 9 on						
				All Lights On:	No	
Equipment:						
			Quantity			
Exhaust Fan	☑ Yes	☐ No	1, but no switch		Lavatory	1
Computer	☐ Yes	☑ No				
Fridge			1			
Coffee Maker			1			
Exterior Doors:	☑ Yes	☐ No				
Standard Doors:	Quantity:	1, South			Door Condition:	
	Type:	Wood, 2x3 Glass			☑ Good	
	Size:	3x7			☐ Fair	
					☐ Poor	
Shop Doors:	Quantity:				Door Condition:	
	Type:				☐ Good	
	Size:				☐ Fair	
					☐ Poor	
Exterior Windows:	☑ Yes	☐ No				
Windows:	Quantity:	1, South			Window Condition:	
	Type:	Single Pane, Wood Frame			☑ Good	
	Size:	3x4			☐ Fair	
					☐ Poor	
Windows:	Quantity:				Window Condition:	
	Type:				☐ Good	
	Size:				☐ Fair	
					☐ Poor	

ROOM NAME:	Electrical and Storage Room			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	71.6 ° F			
Relative Humidity	30.3 %			

Lighting:	Ballast	Footcandles	Controls
(6) 60W Incand		12.9	Toggle
	All Lights On:	No	

Equipment:			Quantity
Exhaust Fan	☐ Yes	☑ No	
Computer	☑ Yes	☐ No	1

Exterior Doors:	☑ Yes ☐ No		
Standard Doors:	Quantity:	1, North	Door Condition:
	Type:	Wood, 2x3 Glass	☐ Good
	Size:	3x7	☐ Fair
			☑ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME:	Break Room					
ROOM NUMBER:						
Thermostat?	☑ Yes ☐ No		Setting:	72	° F	
Temperature	68.7	° F				
Relative Humidity	30.6	%				
Lighting:			Ballast		Footcandles	Controls
(2) 8' T12 lamps			Magnetic		18.9	Toggle
				All Lights On:	Yes	
Equipment:						
			Quantity			
Exhaust Fan	☐ Yes	☑ No			* Doors leading to Bays:	
Computer	☐ Yes	☑ No			louvers covered with	
Fridge			1		torn posterboard	
Freezer			1			
Exterior Doors:	☐ Yes	☑ No				
Standard Doors:	Quantity:				Door Condition:	
	Type:				☐ Good	
	Size:				☐ Fair	
					☐ Poor	
Shop Doors:	Quantity:				Door Condition:	
	Type:				☐ Good	
	Size:				☐ Fair	
					☐ Poor	
Exterior Windows:	☑ Yes	☐ No				
Windows:	Quantity:	1, North			Window Condition:	
	Type:	Sgl Pane, with plexi glass			☐ Good	
	Size:	4x4			☐ Fair	
					☑ Poor	
Windows:	Quantity:				Window Condition:	
	Type:				☐ Good	
	Size:				☐ Fair	
					☐ Poor	

ROOM NAME:	Heated Bays				
ROOM NUMBER:					
Thermostat?	☑ Yes ☐ No		Setting: Off ° F		
Temperature	60 ° F				
Relative Humidity	32.7 %				
Lighting:		Ballast		Footcandles	Controls
(6) 8' T12 lamps		Magnetic		16.6	Toggle
* only 4 on					
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No			Water Cooler	1
Computer	☐ Yes ☑ No			Hose Bib	1
Air Compressor		1			
Grinder		2			
Exterior Doors:	☑ Yes ☐ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:	2, South		Door Condition:	
	Type:	Metal Garage		☐ Good	
	Size:	9x12		☑ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	2, North		Window Condition:	
	Type:	Single Pane, Wood Frame		☐ Good	
	Size:	3x4		☐ Fair	
				☑ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Storage Room Off Heated Bays			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	67.8 ° F			
Relative Humidity	33.3 %			
Lighting:		Ballast	Footcandles	Controls
(4) 4' T12 lamps		Magnetic	9.9	Toggle
* only 2 on				
		All Lights On:	No	
Equipment:		Quantity		
Exhaust Fan	☐ Yes ☑ No			
Computer	☐ Yes ☑ No			
Exterior Doors:	☑ Yes ☐ No			
Standard Doors:	Quantity: 1, South		Door Condition:	
	Type: Wood w/ Glass		☑ Good	
	Size: 2.5x7		☐ Fair ☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	
Exterior Windows:	☑ Yes ☐ No			
Windows:	Quantity: 1, South		Window Condition:	
	Type: Single Pane, Wood Frame		☐ Good	
	Size: 2.5x4		☐ Fair ☑ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	

ROOM NAME:	Bathroom Off Bay Storage				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:		° F	
Temperature	68.5 ° F				
Relative Humidity	32 %				
Lighting:		Ballast		Footcandles	Controls
(2) 60W Incand				13.1	Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	1, South		Window Condition:	
	Type:	Single Pane, Wood Frame		☐ Good	
	Size:	2x3		☐ Fair	
				☑ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Unheated Bays				
ROOM NUMBER:					
Thermostat?	☐ Yes ☐ No	Setting:	° F		
Temperature	° F				
Relative Humidity	%				
Lighting:		Ballast	Footcandles		Controls
(12) 8' T12 lamps			2.5		Toggle
*6 per set of bays					
		All Lights On:	No		
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		
Shop Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		
Exterior Windows:	☐ Yes ☑ No				
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		

ROOM NAME:	Patrol Open Office			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	65.3 ° F			
Relative Humidity	35 %			
Lighting:		Ballast	Footcandles	Controls
(24) 4' T12 lamp		Magnetic	33.5	Toggle
		All Lights On:	No	

Equipment:			Quantity
Exhaust Fan	☐ Yes	☑ No	
Computer	☑ Yes	☐ No	1
Printer			1
Space Heater			1

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows:	☑ Yes ☐ No		
Windows:	Quantity:	2, South	Window Condition:
	Type:	Single Pane, Wood Frame	☐ Good
	Size:	3x4	☐ Fair ☑ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

ROOM NAME:	Private Patrol Office				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:		° F	
Temperature	65.4	° F			
Relative Humidity	35	%			
Lighting:		Ballast		Footcandles	Controls
(12) 4' T12 lamps		Magnetic		38.5	Toggle
*Only 8 on					
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Exterior Doors:	☑ Yes ☐ No				
Standard Doors:	Quantity:	1, East		Door Condition:	
	Type:	Wood, Glass Panel		☐ Good ☑ Fair ☐ Poor	
	Size:	3x7			
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good ☐ Fair ☐ Poor	
	Size:				
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	2, East & South		Window Condition:	
	Type:	Single Pane, Wood Frame		☐ Good ☐ Fair ☑ Poor	
	Size:	3x4			
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good ☐ Fair ☐ Poor	
	Size:				

Building Characteristics

Gross Floor Area		gross sf	,	ceiling ht		ft	
		gross sf	,	ceiling ht		ft	* If multiple ceiling
		gross sf	,	ceiling ht		ft	heights
Conditioned Floor Area	Heating Only:				sf		
	Cooling Only:				sf		
	Heating and Cooling:				sf		
Number of Conditioned Floors:							
	Above Grade		1				
	Below Grade		0				
Total Standard Door Area	143.5	sf		Glass		sf	Door Condition:
				Wood	143.5	sf	☐ Good
				Metal		sf	☑ Fair
				Garage		sf	☑ Poor
Total Shop Door Area	396	sf		Glass		sf	Door Condition:
				Wood		sf	☑ Good
				Metal		sf	☐ Fair
				Garage	396	sf	☐ Poor
Office Exterior Glass Area	182	sf	Single Panes		182	sf	Window Condition:
(Note: Operable or Fixed)			Double Panes			sf	☐ Good
							☐ Fair
		North	Total Area		88	sf	☑ Poor
			Single Panes		88	sf	
			Double Panes			sf	
		South	Total Area		70	sf	
			Single Panes		70	sf	
			Double Panes			sf	
		East	Total Area		24	sf	
			Single Panes		24	sf	
			Double Panes			sf	
		West	Total Area			sf	
			Single Panes			sf	
			Double Panes			sf	

Shop Exterior Glass Area	24	sf	Single Panes	24	sf	Window Condition:
(Note: Operable or Fixed)			Double Panes		sf	☐ Good
						☐ Fair
		North	Total Area	24	sf	☑ Poor
			Single Panes	24	sf	
			Double Panes		sf	
		South	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	
		East	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	
		West	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	

Office Exterior Wall Area		sf	☑ Masonry ☐ Wood ☐ Concrete	☐ Stucco ☐ Other ☐ Unknown	CMU Block Walls, No Insulation
Shop Exterior Wall Area		sf	☑ Masonry ☐ Wood ☐ Concrete	☐ Stucco ☐ Other ☐ Unknown	
Total Roof Area		sf	Condition:	☐ Good ☐ Fair ☐ Poor	

Insulation Type:	Roof:		If Provided on Building Plans.
	Wall:		
	Floor:		
Insulation Thickness:	Roof:		
	Wall:		
	Floor:		

Metering:

Is this building individually metered for electricity?	☐ Yes	☑ No
Is this building individually metered for natural gas / LP?	☐ Yes	☑ No
Is this building individually metered for water?	☐ Yes	☑ No

Describe the general building condition:

HVAC DISTRIBUTION SYSTEM

Location of Unit(s)

Furnace #1

SYSTEM TYPE

- [x] Single Zone (Furnace, RTU, etc.)
- [ ] Multi Zone (i.e. AHU)
- [ ] Dual Duct
- [ ] Variable Air Volume
- [ ] Single Duct Reheat
- [ ] 2-Pipe Water
- [ ] 4-Pipe Water
- [ ] Window Unit
- [ ] Packaged Terminal Air Unit
- [ ] Unit Ventilator
- [ ] Fan Coil
- [ ] Unit Heater
- [ ] Other ______________

MAINTENANCE

- [x] Good
- [ ] Fair
- [ ] Poor

IN STORAGE CLOSET WITH WATER HEATER

DUCTWORK

Insulation:
- [ ] Good
- [ ] Fair
- [ ] Poor

Installation:
- [ ] Good
- [x] Fair
- [ ] Poor

CONTROLS

- [x] Space Thermostat
- [ ] Outside Temperature Sensors
- [ ] Time Clocks
- [ ] Energy Management System
- [ ] Auto Supply Temperature Reset
- [ ] Economy Cycle
- [ ] Heat Recovery
- [ ] Other ______________

Style:

* NOT PROGRAMMED. SET AT 72 FOR HEAT AND 70 FOR COOL

Furnace #2

SYSTEM TYPE	MAINTENANCE
☑ Single Zone	☑ Good
☐ Multi Zone	☐ Fair
☐ Dual Duct	☐ Poor
☐ Variable Air Volume	
☐ Single Duct Reheat	* Flue Thru-Roof, Lines Extending into Existing
☐ 2-Pipe Water	
☐ 4-Pipe Water	
☐ Window Unit	
☐ Unit Ventilator	
☐ Fan Coil	"CARRIER", ENERGY STAR RATED
☐ Unit Heater	
☐ Other ________	

CONTROLS	Style:
☑ Space Thermostat	* NOT PROGRAMMABLE
☐ Outside Temperature Sensors	
☐ Time Clocks	
☐ Energy Management System	
☐ Auto Supply Temperature Reset	
☐ Economy Cycle	
☐ Heat Recovery	
☐ Other ________	

Wash Bay

SYSTEM TYPE	MAINTENANCE
☐ Single Zone	☐ Good
☐ Multi Zone	☑ Fair
☐ Dual Duct	☐ Poor
☐ Variable Air Volume	
☐ Single Duct Reheat	MAJOR RAIN LEAKS THROUGH FLUE
☐ 2-Pipe Water	
☐ 4-Pipe Water	
☐ Window Unit	
☐ Unit Ventilator	
☐ Fan Coil	
☑ Unit Heater	
☐ Other ________	

CONTROLS
☑ Space Thermostat
☐ Outside Temperature Sensors
☐ Time Clocks
☐ Energy Management System
☐ Auto Supply Temperature Reset
☐ Economy Cycle
☐ Heat Recovery
☐ Other ________

DOMESTIC HOT WATER

Domestic Hot Water Heated By:

- [ ] Electricity
- [x] Natural Gas
- [ ] Oil
- [ ] Steam
- [ ] Heat Pump
- [ ] Other

"STATE SELECT", 30 GALLON CAPACITY, 33500 BTUh INPUT, 33.4 GAL/HR RECOVERY, EF=0.57

Number of Units:	1	
General Location of Units:	Storage Room	
Is there a re-circulation loop?	☐ Yes ☑ No	

Hot Water Temperature

At Point of Use	117.1	°F
At Heater		°F
Temperature of City Water	63.1	°F
Date of Water Heater	1/1/1998	
Date of Installation	3/6/2003	

Is the tank warm to the touch?	☐ Yes	☑ No	
Are pipes insulated at least 3' from heater?	☑ Yes	☐ No	
Any signs of leakage?	☐ Yes	☑ No	
Requires maintenance?	☑ Yes	☐ No	* Needs to be cleaned
Is the tank wrapped?	☐ Yes	☑ No	
Do obstructions prevent wrapping?	☑ Yes	☐ No	

Distance from Heater to Furthest Point of Use:

Hot Water Uses Other than Lavatories: No

WATER CONSUMPTION

Fixture Type	Quantity	Gal/Flush	Gal/Min	Low-Flow?	Aerators?
Water Closets (tank)	3	1.6			
Urinals	--				
Lavatories	3				
Service Sinks	1				
Showers	--				
Electric Water Coolers	2				
Dishwashers	--				
Hose Bibs	1				

Exhaust Fans tied to Lights?	☐ Yes	☑ No
HW Temperature =	117.1	°F
CW Temperature =	63.1	°F

Large Water Consumption Scenarios

	Yes	No	Time Period of Water Usage	Estimated Amount
Irrigation - Sprinkler System		x		
Filling Water Tanks				
Other: _______________				

SPECIALTY EQUIPMENT		
Item	Yes / No	Quantity
Refrigerators	Y	2
Mini-Fridges		
Freezers	Y	1
Walk-In Refrigerators		
Walk-In Freezers		
Infra-red Warmer Microwaves	Y	2
Mixers		
Ranges		
Ovens		
Dishwashers		
Hoods w/ Exhaust Fans		
Coffee Makers	Y	1
Pop Machines		
Vending Machines		
Ice Makers		
Space Heaters	Y	1
Copiers		
Fax Machines		
Scanners		
Printers	Y	4
Printer/Fax/Scan/Copy Machines		
Plotters		
Air Compressors	Y	1
Motors		
Presses		
Exhaust Fans	Y	3
Computers	Y	4
Projector / Screen		
Electric Water Coolers	Y	2
Hot Water Pressure Washer		1
Motorized Vents		2
Radiant Heater		1
Grinders		2

Lighting

INTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

EXTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

Fixture Types:

Incandescent
Fluorescent
Mercury Vapor
High Pressure Sodium
Low Pressure Sodium
Metal Halide

Are lights on in unoccupied areas? ☐ Yes ☑ No
Is the exterior lighting on during the day? ☐ Yes ☑ No

How are lights operated?
☑ Toggle Switches
☐ Occupancy Switches
☐ Photovoltaic/Daylight Sensors
☐ Other ___________

Atchison – Completed Audit

Belleville: Photos and Completed Audit

Figure B.10 Unit Heater in Garage Bays

Figure B.11 Packaged Window Air Conditioner

Figure B.12 First Thermostat

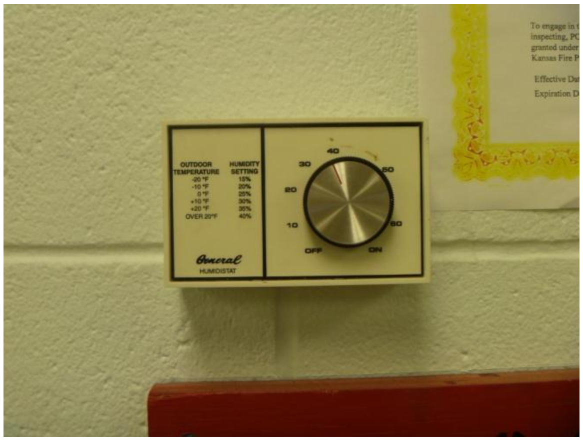

Figure B.13 Second Thermostat

Figure B.14 Third Thermostat

Figure B.15 Furnace

Figure B.16 Water Heater

Figure B.17 Outdoor Air-Condensing Unit

Table B.2 Completed Belleville Audit

Building Information			
Name of Institution, Building		Building #	
Belleville KDOT Building, District 2		--	
Address (Street or P.O. Box)		City, State, Zip	
1652 North on US-81		Belleville, KS, 66935	
Date of Audit	Time of Audit	Weather Conditions	
10-Jan-12	*10:30 AM*	*41 °F, 66% RH, WNW 5 mph*	
Building Manager		Building Manager's Phone Number	
Gary L. Simmons, "Supervisor"		(913) 527 - 2451	
Auditing Team		Phone	
Rebecca Gentry, Kimberly Pierson, David Carter			
Building Type and Use			
		Building Use	% Dedicated to this Use
Building Description / Type:		☑ Office	
Two heated and four unheated bays. Multiple office spaces. Exterior equipment storage and wash bay.		☑ Storage	______
		☑ Maintenance Garage	______
		☑ Other - Wash Bay	______
Date of Construction: ______			
Original Architects, if known		Original Engineers, if known	
Does the Institution have an ongoing Energy Management Program?		☐ Yes ☑ No	
If yes, describe program: ______			
Any previous energy audits completed? ☐ Yes ☑ No		Dates:	
Name of Utilities: Electric, Gas, etc.			

Building Information

List of Energy Savings Programs or Efforts Currently Implemented:

No. Years Implemented

1. Updated windows two years ago ______
2.______________________________ ______
3.______________________________ ______
4.______________________________ ______
5.______________________________ ______

Conservation Measures Under Consideration Prior to this Audit.

1.______________________________
2.______________________________
3.______________________________
4.______________________________

What are the facility manager's feelings towards saving energy?

Priority of Saving Energy and Money with Utilities Low 1 2 3 4 5 6 7 8 9 10

What are the barriers to implementing energy saving strategies?

- ☐ Lack of Information
- ☑ Lack of Funds
- ☐ Lack of Support from Upper Management
- ☑ Other : Lack of time to install

Building Information							
Building Occupancy Profile							
Typical Occupied Periods:							
			Hours (i.e. 8am - 5pm)				
	Sunday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Monday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Tuesday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Wednesday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Thursday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Friday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Saturday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
Thermostat Set points:		Daytime	Heating	69	Cooling	75	
		Nighttime	Heating	69	Cooling	75	
		Weekend	Heating	69	Cooling	75	
Average Number of Occupants in Bu			15				
Include a Floor Plan.							
1. Look for discrepancies between plan and existing conditions.							
2. Mark locations of heating and cooling units.							

ROOM NAME:	Washbay				
ROOM NUMBER:					
Thermostat?	☐ Yes ☐ No	Setting:	° F		
Temperature	78 ° F	*Radiant Heater Dial On/Off			
Relative Humidity	36 %				
Lighting:		Ballast	Footcandles	Controls	
(18) 2-lamp, T8 32W Strips		Elec	40.6	Toggle	
Daylighting Only			30		
(1) Ext. MH Blocks					
(2) Ext. Mini MH Blocks					
		All Lights On:	No		
Equipment:					
		Quantity			
Exhaust Fan	☑ Yes ☐ No	1	Hosebib	2	
Computer	☐ Yes ☑ No				
Power Washer		1			
Motorized Vents		2			
Exterior Doors:	☑ Yes ☐ No				
Standard Doors:	Quantity:	2, South	Door Condition:		
	Type:	Metal	☑ Good		
	Size:	3x7	☐ Fair		
			☐ Poor		
Shop Doors:	Quantity:	1, East	Door Condition:		
	Type:	Metal Garage	☑ Good		
	Size:	15x15	☐ Fair		
			☐ Poor		
Exterior Windows:	☐ Yes ☑ No				
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		

ROOM NAME:	Exterior Storage		
ROOM NUMBER:			

Thermostat?	☐ Yes ☑ No	Setting:	° F
Temperature	° F		
Relative Humidity	%		

Lighting:	Ballast	Footcandles	Controls
(14) PAR Lamps			
(2) MH Blocks			
		All Lights On:	No

Equipment:		Quantity
Exhaust Fan	☐ Yes ☑ No	
Computer	☐ Yes ☑ No	
Block Heaters		8

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

ROOM NAME: Unheated Bays (4)

ROOM NUMBER: ______

Thermostat? ☐ Yes ☑ No Setting: ______ ° F

Temperature ______ ° F

Relative Humidity ______ %

Lighting:	Ballast	Footcandles	Controls
(10) HPS Lights		45	Toggle

All Lights On: No

Equipment:

			Quantity
Exhaust Fan	☐ Yes	☑ No	
Computer	☐ Yes	☑ No	
Lab. Oven for Soil			1

Exterior Doors: ☐ Yes ☑ No

Standard Doors: Quantity: ______ Door Condition:
Type: ______ ☐ Good
Size: ______ ☐ Fair
☐ Poor

Shop Doors: Quantity: ______ Door Condition:
Type: ______ ☐ Good
Size: ______ ☐ Fair
☐ Poor

Exterior Windows: ☐ Yes ☑ No

Windows: Quantity: ______ Window Condition:
Type: ______ ☐ Good
Size: ______ ☐ Fair
☐ Poor

Windows: Quantity: ______ Window Condition:
Type: ______ ☐ Good
Size: ______ ☐ Fair
☐ Poor

ROOM NAME:	Men's Restroom				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:	° F		
Temperature	65.5 ° F				
Relative Humidity	22.3 %				
Lighting:		Ballast	Footcandles		Controls
(2) 100W Incand.			26.2		Toggle
		All Lights On:	No		
Equipment:					
		Quantity			
Exhaust Fan	☑ Yes ☐ No	1, Tied to Light			
Computer	☐ Yes ☑ No				
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		
Shop Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	1, West	Window Condition:		
	Type:	Double Pane	☑ Good		
	Size:	2x2	☐ Fair		
			☐ Poor		
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		

ROOM NAME:	Women's Restroom		
ROOM NUMBER:			

Thermostat?	☐ Yes ☑ No	Setting:	° F
Temperature	65.5 ° F		
Relative Humidity	22.3 %		

Lighting:	Ballast	Footcandles	Controls
(2) 100W Incand		26.2	Toggle
	All Lights On:	No	

Equipment:		Quantity
Exhaust Fan	☑ Yes ☐ No	1, separate from light
Computer	☐ Yes ☑ No	

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME:	West Side Office			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:		° F
Temperature	74.6 ° F			
Relative Humidity	30 %			

Lighting:	Ballast	Footcandles	Controls
(6) 4-lamp, T8 32W Strips	Elec	85	Toggle

All Lights On: Yes

Equipment:		Quantity
Exhaust Fan	☐ Yes ☑ No	
Computer	☑ Yes ☐ No	4
Printer		2
Ceiling Fans		1

Exterior Doors: ☐ Yes ☑ No

Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Exterior Windows: ☐ Yes ☑ No

Windows:	Quantity:	2, West	Window Condition:
	Type:	Double Pane	☑ Good
	Size:	3x4	☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME:	Back Office						
ROOM NUMBER:							
Thermostat?	☐ Yes	☑ No	Setting:		° F		
Temperature	76.2	° F					
Relative Humidity	28	%					
Lighting:			Ballast		Footcandles		Controls
(4) 4-lamp, T8 32W Fixtures			Elec		101		Toggle
(Only 3 On)							
				All Lights On:	Yes		
Equipment:							
			Quantity				
Exhaust Fan	☐ Yes	☑ No			Typewriter		1
Computer	☑ Yes	☐ No	3		Ceiling Fan		1
Combo Printer			1				
Fax Machine			1				
Exterior Doors:	☑ Yes	☐ No					
Standard Doors:	Quantity:	1, South			Door Condition:		
	Type:	Metal, 2x3 Glass			☑ Good		
	Size:	3x7			☐ Fair		
					☐ Poor		
Shop Doors:	Quantity:				Door Condition:		
	Type:				☐ Good		
	Size:				☐ Fair		
					☐ Poor		
Exterior Windows:	☑ Yes	☐ No					
Windows:	Quantity:	2, East & South			Window Condition:		
	Type:	Double Pane			☑ Good		
	Size:	3x4			☐ Fair		
					☐ Poor		
Windows:	Quantity:				Window Condition:		
	Type:				☐ Good		
	Size:				☐ Fair		
					☐ Poor		

ROOM NAME:	Break Room				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:	° F		
Temperature	74.1 ° F				
Relative Humidity	27.1 %				
Lighting:		Ballast	Footcandles		Controls
(4) 3-lamp 100W Fixtures		Incand	16		Toggle
		All Lights On:	No		
Equipment:					
		Quantity			
Exhaust Fan	☑ Yes ☐ No	1, with hood	Coffee Pot		1
Computer	☐ Yes ☑ No				
Microwave		1			
Mini Fridge		1			
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		
Shop Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	1, West	Window Condition:		
	Type:	Double Pane	☑ Good		
	Size:	3x4	☐ Fair		
			☐ Poor		
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		

ROOM NAME:	Open Office				
ROOM NUMBER:					
Thermostat?	☑ Yes ☐ No	Setting:	69 ° F		
Temperature	72.9 ° F				
Relative Humidity	33.3 %				
Lighting:		Ballast	Footcandles	Controls	
(10) 4-lamp, T8 32W Fixtures		Elec	86	Toggle	
		All Lights On:	Yes		
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No		Shredder	1	
Computer	☑ Yes ☐ No	6	Ceiling Fan	2	
Printer		2			
Combo Printer		1			
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		
Shop Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	4, East	Window Condition:		
	Type:	Double Pane	☑ Good		
	Size:	3x4	☐ Fair ☐ Poor		
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		

ROOM NAME:	Store Room			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	72.5 ° F			
Relative Humidity	30.3 %			
Lighting:		Ballast	Footcandles	Controls
(1) 3-lamp, 100W Fixture			20.4	Toggle
		All Lights On:	No	
Equipment:				
		Quantity		
Exhaust Fan	☐ Yes ☑ No			
Computer	☐ Yes ☑ No			
Exterior Doors:	☑ Yes ☐ No			
Standard Doors:	Quantity:	1, East	Door Condition:	
	Type:	Metal, 2x3 Glass	☑ Good	
	Size:	3x7	☐ Fair	
			☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Exterior Windows:	☐ Yes ☑ No			
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☑ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	

ROOM NAME:	Office off of Heated Bay				
ROOM NUMBER:					
Thermostat?	☑ Yes ☐ No	Setting:	58 ° F		
Temperature	68.7 ° F	Dial Space Thermostat			
Relative Humidity	29.2 %				
Lighting:		Ballast	Footcandles		Controls
(2) 4-lamp, T8 32W Fixtures		Elec	48.9		Toggle
		All Lights On:	No		
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No		PTAC		1
Computer	☑ Yes ☐ No	1			
Printer		1			
Water Cooler		1			
Exterior Doors:	☑ Yes ☐ No				
Standard Doors:	Quantity:	1, East	Door Condition:		
	Type:	Metal, 2x3 Glass	☑ Good		
	Size:	3x7	☐ Fair		
			☐ Poor		
Shop Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	1, East	Window Condition:		
	Type:	Double Pane	☑ Good		
	Size:	3x4	☐ Fair		
			☐ Poor		
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		

ROOM NAME:	Attached Restroom to Bay Office				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:	° F		
Temperature	68.9 ° F				
Relative Humidity	28.6 %				
Lighting:		Ballast		Footcandles	Controls
(2) 100W lamps				31.5	Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☐ Yes ☑ No				
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Storage Room off Heated Bays				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:		° F	
Temperature	68	° F			
Relative Humidity	27.1	%			

Lighting:	Ballast	Footcandles	Controls
(3) 2-lamp, T8 32W Fixtures	Elec	38.8	Toggle
	All Lights On:	No	

Equipment:

			Quantity		
Exhaust Fan	☐ Yes	☑ No		Computer	1
Computer	☐ Yes	☑ No		Printer	1
Air Compressor			1	Microwave	1
Mini Fridge			1	Radio Chargers	7

Exterior Doors: ☑ Yes ☐ No

Standard Doors:	Quantity:	1, West	Door Condition:	☑ Good
	Type:	Metal, 2x3 Glass		☐ Fair
	Size:	3x7		☐ Poor
Shop Doors:	Quantity:		Door Condition:	☐ Good
	Type:			☐ Fair
	Size:			☐ Poor

Exterior Windows: ☐ Yes ☑ No

Windows:	Quantity:		Window Condition:	☐ Good
	Type:			☐ Fair
	Size:			☐ Poor
Windows:	Quantity:		Window Condition:	☐ Good
	Type:			☐ Fair
	Size:			☐ Poor

ROOM NAME:	Heated Bays			
ROOM NUMBER:				

Thermostat?	☑ Yes ☐ No	Setting:	68 ° F
Temperature	68 ° F		
Relative Humidity	31 %		

Lighting:	Ballast	Footcandles	Controls
(5) HPS Fixtures		45	Toggle
	All Lights On:	No	

Equipment:

		Quantity		
Exhaust Fan	☐ Yes ☑ No		Coffee Maker	1
Computer	☐ Yes ☑ No		Grinder	1
Freezer		1	Ice Machine	1
Vending Machine		1	Hosebib	1

Exterior Doors: ☑ Yes ☐ No

Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Shop Doors:	Quantity:	2, West	Door Condition:
	Type:	Metal Garage	☑ Good
	Size:	12x15	☐ Fair ☐ Poor

Exterior Windows: ☑ Yes ☐ No

Windows:	Quantity:	2, East	Window Condition:
	Type:	Double Pane	☐ Good
	Size:	3x4	☑ Fair ☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Building Characteristics

Gross Floor Area		gross sf	,	ceiling ht		ft		
		gross sf	,	ceiling ht		ft	* If multiple ceiling	
		gross sf	,	ceiling ht		ft	heights	
Conditioned Floor Area	Heating Only:				sf			
	Cooling Only:				sf			
	Heating and Cooling:				sf			
Number of Conditioned Floors:								
	Above Grade		1					
	Below Grade		0					
Total Standard Door Area	147	sf		Glass		sf	Door Condition:	
				Wood		sf	☑ Good	
				Metal	147	sf	☐ Fair	
				Garage		sf	☐ Poor	
Total Shop Door Area	585	sf		Glass		sf	Door Condition:	
				Wood		sf	☑ Good	
				Metal		sf	☐ Fair	
				Garage	585	sf	☐ Poor	
Office Exterior Glass Area	148	sf	Single Panes			sf	Window Condition:	
(Note: Operable or Fixed)			Double Panes		148	sf	☑ Good	
							☐ Fair	
		North	Total Area			sf	☐ Poor	
			Single Panes			sf		
			Double Panes			sf		
		South	Total Area		24	sf		
			Single Panes			sf		
			Double Panes		24	sf		
		East	Total Area		72	sf		
			Single Panes			sf		
			Double Panes		72	sf		
		West	Total Area		52	sf		
			Single Panes			sf		
			Double Panes		52	sf		

Shop Exterior Glass Area	24	sf	Single Panes		sf	Window Condition:
(Note: Operable or Fixed)			Double Panes	24	sf	[ ] Good [x] Fair [ ] Poor
		North	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	
		South	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	
		East	Total Area	24	sf	
			Single Panes		sf	
			Double Panes	24	sf	
		West	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	

Office Exterior Wall Area		sf	[x] Masonry [ ] Wood [ ] Concrete	[ ] Stucco [ ] Other [ ] Unknown
Shop Exterior Wall Area		sf	[x] Masonry [ ] Wood [ ] Concrete	[ ] Stucco [ ] Other [ ] Unknown
Total Roof Area		sf	Condition:	[ ] Good [ ] Fair [ ] Poor

Insulation Type:	Roof:		If Provided on Building Plans.
	Wall:		
	Floor:		
Insulation Thickness:	Roof:		
	Wall:		
	Floor:		

Metering:

Is this building individually metered for electricity?	[ ] Yes	[x] No
Is this building individually metered for natural gas / LP?	[ ] Yes	[x] No
Is this building individually metered for water?	[ ] Yes	[x] No

Describe the general building condition:

HVAC DISTRIBUTION SYSTEM

Location of Unit(s)

Office Furnace

SYSTEM TYPE

- [x] Single Zone (Furnace, RTU, etc.)
- [ ] Multi Zone (i.e. AHU)
- [ ] Dual Duct
- [ ] Variable Air Volume
- [ ] Single Duct Reheat
- [ ] 2-Pipe Water
- [ ] 4-Pipe Water
- [ ] Window Unit
- [ ] Packaged Terminal Air Unit
- [ ] Unit Ventilator
- [ ] Fan Coil
- [ ] Unit Heater
- [ ] Other ____________

MAINTENANCE

- [x] Good
- [ ] Fair
- [ ] Poor

"Comfort-Aire", With Humidifier

DUCTWORK

Insulation:

- [ ] Good
- [ ] Fair
- [x] Poor

Installation:

- [ ] Good
- [x] Fair
- [ ] Poor

CONTROLS

- [x] Space Thermostat
- [ ] Outside Temperature Sensors
- [ ] Time Clocks
- [ ] Energy Management System
- [ ] Auto Supply Temperature Reset
- [ ] Economy Cycle
- [ ] Heat Recovery
- [ ] Other ____________

Style:
Non-programmable

Office off of Heated Bays

	SYSTEM TYPE			MAINTENANCE		
		☐ Single Zone		☐ Good		
		☐ Multi Zone		☑ Fair		
		☐ Dual Duct		☐ Poor		
		☐ Variable Air Volume				
		☐ Single Duct Reheat				
		☐ 2-Pipe Water				
		☐ 4-Pipe Water				
		☐ Window Unit				
		☐ Unit Ventilator				
		☐ Fan Coil				
		☐ Unit Heater				
		☑ Other	PTAC			
		CONTROLS		Style:		
		☐ Space Thermostat				
		☐ Outside Temperature Sensors				
		☐ Time Clocks				
		☐ Energy Management System				
		☐ Auto Supply Temperature Reset				
		☐ Economy Cycle				
		☐ Heat Recovery				
		☑ Other	Integral			

Heated Bays/ Wash Bay

	SYSTEM TYPE			MAINTENANCE		
		☐ Single Zone		☑ Good		
		☐ Multi Zone		☐ Fair		
		☐ Dual Duct		☐ Poor		
		☐ Variable Air Volume				
		☐ Single Duct Reheat		"Dayton", Natural Gas		
		☐ 2-Pipe Water				
		☐ 4-Pipe Water				
		☐ Window Unit				
		☐ Unit Ventilator				
		☐ Fan Coil				
		☑ Unit Heater				
		☑ Other	Radiant Heater, NG			
		CONTROLS				
		☑ Space Thermostat		Dial on/off.		
		☐ Outside Temperature Sensors		Dial to desired temperature.		
		☐ Time Clocks				
		☐ Energy Management System				
		☐ Auto Supply Temperature Reset				
		☐ Economy Cycle				
		☐ Heat Recovery				
		☐ Other				

DOMESTIC HOT WATER

Domestic Hot Water Heated By:

- [x] Electricity
- [ ] Natural Gas
- [ ] Oil
- [ ] Steam
- [ ] Heat Pump
- [ ] Other

"Ariston", 8 Gallon Tank, 120V/1500W

Number of Units:	1		
General Location of Units:	Closet off Main Office		
Is there a re-circulation loop?	☐ Yes ☑ No		
Hot Water Temperature			
At Point of Use	141.5	°F	
At Heater		°F	
Temperature of City Water	48.2	°F	
Date of Water Heater	1/1/2009		
Date of Installation	10/13/2009		
Is the tank warm to the touch?	☐ Yes	☑ No	
Are pipes insulated at least 3' from heater?	☑ Yes	☐ No	
Any signs of leakage?	☐ Yes	☑ No	
Requires maintenance?	☐ Yes	☑ No	
Is the tank wrapped?	☐ Yes	☑ No	
Do obstructions prevent wrapping?	☑ Yes	☐ No	
Distance from Heater to Furthest Point of Use:			
Hot Water Uses Other than Lavatories:	No		

WATER CONSUMPTION

Fixture Type	Quantity	Gal/Flush	Gal/Min	Low-Flow?	Aerators?
Water Closets (valve)	3	1.6			
Urinals	--				
Lavatories	3				
Service Sinks	--				
Showers	--				
Electric Water Coolers	2				
Dishwashers	--				
Hose Bibs	4				

Exhaust Fans tied to Lights?	☑ Yes	☑ No
HW Temperature =	141.5	°F
CW Temperature =	48.2	°F

Large Water Consumption Scenarios

	Yes	No	Time Period of Water Usage	Estimated Amount
Irrigation - Sprinkler System		x		
Filling Water Tanks				
Other: _______________				

SPECIALTY EQUIPMENT		
Item	Yes / No	Quantity
Refrigerators	N	
Mini-Fridges	Y	2
Freezers	Y	1
Walk-In Refrigerators	N	
Walk-In Freezers	N	
Infra-red Warmer Microwaves	Y	2
Mixers	N	
Ranges	N	
Ovens	N	
Dishwashers	N	
Hoods w/ Exhaust Fans	Y	1
Coffee Makers	Y	2
Pop Machines	N	
Vending Machines	Y	1
Ice Makers	Y	1
Space Heaters	N	
Copiers	N	
Fax Machines	Y	1
Scanners	N	
Printers	Y	6
Printer/Fax/Scan/Copy Machines	Y	2
Plotters	N	
Air Compressors	Y	1
Motors	N	
Presses	N	
Exhaust Fans	Y	3
Computers	Y	17
Projector / Screen	N	
Power Washer	Y	1
Motorized Vents	Y	2
Block Heaters	Y	8
Intercom System	Y	1
Laboratory Oven (for Soil Samples)	Y	1
Electric Water Coolers	Y	2
Ceiling Fans	Y	5
Typewriter	Y	1
Shredder	Y	1
PTAC	Y	1
Radio Chargers	Y	7
Grinder	Y	1

Lighting

INTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

EXTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

Fixture Types:
Incandescent
Fluorescent
Mercury Vapor
High Pressure Sodium
Low Pressure Sodium
Metal Halide

Are lights on in unoccupied areas? ☑ Yes ☑ No
Is the exterior lighting on during the day? ☐ Yes ☑ No

How are lights operated? ☑ Toggle Switches
☐ Occupancy Switches
☑ Photovoltaic/Daylight Sensors
☐ Other ___________

Russell: Photos and Completed Audit

Figure B.18 Furnace and Water Heater

Figure B.19 Plumbing Fixture

Figure B.20 Plumbing Fixtures

Figure B.21 Unit Heater in Storage Bays

Figure B.22 Outdoor Light Fixture

Figure B.23 Outdoor Air-Condensing Unit

Table B.3 Completed Russell Audit

Building Information	
Name of Institution, Building	Building #
Russell KDOT Building, District 3	--
Address (Street or P.O. Box)	City, State, Zip
225 E Witt Ave	Russell, KS, 67665

Date of Audit	Time of Audit	Weather Conditions
Wednesday, January 04, 2012	*1:33 PM*	*Sunny, 53 °F, 43% RH, WSW 13 mph*

Building Manager	Building Manager's Phone Number
John Boxberger	(785) 483 - 2362
Auditing Team	Phone
Rebecca Gentry, Kimberly Pierson, David Carter	

Building Type and Use

	Building Use	% Dedicated to this Use
Building Description / Type:	☑ Office	
Office with Space for Highway Patrol. Washbay. Two heated and four unheated bays.	☑ Storage	
	☑ Maintenance Garage	
	☑ Other - Wash Bay	

Date of Construction:

Original Architects, if known	Original Engineers, if known

Does the Institution have an ongoing Energy Management Program? ☐ Yes ☑ No

If yes, describe program:

Any previous energy audits completed? ☐ Yes ☑ No Dates:

Name of Utilities: Electric, Gas, etc.

Russell – Completed Audit

Building Information

List of Energy Savings Programs or Efforts Currently Implemented:

	No. Years Implemented
1. Replaced Windows	2
2. Replaced Furnace	1
3. Replaced Water Heater	1
4.____	
5.____	

Conservation Measures Under Consideration Prior to this Audit.

1.____
2.____
3.____
4.____

What are the facility manager's feelings towards saving energy?

Priority of Saving Energy and Money with Utilities? Low 1 2 3 4 5 6 7 8 9 10

What are the barriers to implementing energy saving strategies?

- ☐ Lack of Information
- ☐ Lack of Funds
- ☐ Lack of Support from Upper Management
- ☐ Other : ___________________________________

Russell – Completed Audit

Building Information					
Building Occupancy Profile		Summer = March to November			
Typical Occupied Periods:					
		Hours (i.e. 8am - 5pm)			
	Sunday	8:30-4:30 (Win), 7:30-3:30 (Sum)			
	Monday	8:30-4:30 (Win), 7:30-3:30 (Sum)			
	Tuesday	8:30-4:30 (Win), 7:30-3:30 (Sum)			
	Wednesday	8:30-4:30 (Win), 7:30-3:30 (Sum)			
	Thursday	8:30-4:30 (Win), 7:30-3:30 (Sum)			
	Friday	8:30-4:30 (Win), 7:30-3:30 (Sum)			
	Saturday	8:30-4:30 (Win), 7:30-3:30 (Sum)			
Thermostat Set points:	Daytime	Heating	68	Cooling	74
	Nighttime	Heating	68	Cooling	74
	Weekend	Heating	68	Cooling	74
Average Number of Occupants in Bu		9			

Include a Floor Plan.

1. Look for discrepancies between plan and existing conditions.
2. Mark locations of heating and cooling units.

ROOM NAME:	Exterior Equipment Storage				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No		Setting:		° F
Temperature		° F			
Relative Humidity		%			
Lighting:			Ballast	Footcandles	Controls
(2) Exterior HPS Lamps					
(4) Within Shed HPS Lamps					
			All Lights On:	No	
Equipment:					
			Quantity		
Exhaust Fan	☐ Yes	☑ No			
Computer	☐ Yes	☑ No			
Block Heaters			8		
Exterior Doors:	☐ Yes	☑ No			
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☐ Yes	☑ No			
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Washbay		
ROOM NUMBER:			
Thermostat?	☐ Yes ☑ No	Setting:	° F
Temperature	62.7 ° F	Radiant, Natural Gas, Heater	
Relative Humidity	37.1 %		

Lighting:	Ballast	Footcandles	Controls
(18) 2-lamp, T5HO Strips		6.6	Toggle
	All Lights On:	No	

Equipment:			Quantity
Exhaust Fan	☑ Yes	☐ No	1
Computer	☐ Yes	☑ No	
Power Washer			1

Exterior Doors:	☑ Yes ☐ No		
Standard Doors:	Quantity:	2, East	Door Condition:
	Type:	Metal	☑ Good
	Size:	3x7	☐ Fair
			☐ Poor
Shop Doors:	Quantity:	1	Door Condition:
	Type:	Metal Garage	☑ Good
	Size:	12x14	☐ Fair
			☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME:	Exterior			
ROOM NUMBER:				

Thermostat?	☐ Yes ☑ No	Setting:		° F
Temperature		° F		
Relative Humidity		%		

Lighting:	Ballast	Footcandles	Controls
(12) Block MH			Photocell
(1) MH Spotlight			
	All Lights On:	No	

Equipment:			Quantity
Exhaust Fan	☐ Yes	☑ No	
Computer	☐ Yes	☑ No	
Hosebib			1

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

ROOM NAME:	Office off of Bay			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	66.3 ° F			
Relative Humidity	29.8 %			

Lighting:	Ballast	Footcandles	Controls
(2) 2-lamp, T5HO Strips	Elec	41.3	Toggle
	All Lights On:	No	

Equipment:		Quantity
Exhaust Fan	☐ Yes ☑ No	
Computer	☑ Yes ☐ No	1
Printers		1
Space Heater/Fan		1

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows:	☑ Yes ☐ No		
Windows:	Quantity:	1, North	Window Condition:
	Type:	Double Pane	☑ Good
	Size:	3x4	☐ Fair ☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

ROOM NAME:	Unheated Bays				
ROOM NUMBER:					
Thermostat?	☐ Yes ☐ No	Setting:		° F	
Temperature		° F			
Relative Humidity		%			
Lighting:		Ballast		Footcandles	Controls
(16) 2-lamp, T5HO Strips		Elec		6	Toggles
* Lights on Normal Power, and one on Generator Back-up					
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☐ Yes ☑ No				
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Heated Bays			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	71.4 ° F	Unit Heater, Natural Gas Powered		
Relative Humidity	28.8 %			
Lighting:		Ballast	Footcandles	Controls
(9) 2-lamp, T5HO Strips		Elec	13.6	Toggles
* Lights on Normal Power, and one on Generator Back-up				
		All Lights On:	No	
Equipment:				
		Quantity		
Exhaust Fan	☐ Yes ☑ No		Service Sink	1
Computer	☐ Yes ☑ No			
Air Compressor		1		
Hosebib		1		
Exterior Doors:	☑ Yes ☐ No			
Standard Doors:	Quantity:	1, West	Door Condition:	
	Type:	Metal to Unheated Bays	☑ Good	
	Size:	3x7	☐ Fair	
			☐ Poor	
Shop Doors:	Quantity:	2, South	Door Condition:	
	Type:	Metal, 3 Windows	☐ Good	
	Size:	12x12	☑ Fair	
			☐ Poor	
Exterior Windows:	☑ Yes ☐ No			
Windows:	Quantity:	2, North	Window Condition:	
	Type:	Double Pane	☑ Good	
	Size:	3x4	☐ Fair	
			☐ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	

ROOM NAME:	Room Leading to Bays			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	74.6 ° F			
Relative Humidity	26.3 %			

Lighting:	Ballast	Footcandles	Controls
(2) 2-lamp, T5HO Strips	Elec	44.2	Toggle
	All Lights On:	No	

Equipment:		Quantity
Exhaust Fan	☐ Yes ☑ No	
Computer	☐ Yes ☑ No	
Water Cooler		1

Exterior Doors:	☑ Yes ☐ No		
Standard Doors:	Quantity:	1, South	Door Condition:
	Type:	Metal, 6"x2' Glass	☑ Good
	Size:	3x7	☐ Fair
			☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Exterior Windows:	☑ Yes ☐ No		
Windows:	Quantity:	1, South	Window Condition:
	Type:	Double Pane, Blinds	☑ Good
	Size:	3x4	☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME:	Small Additional Restroom			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	73.7 ° F			
Relative Humidity	28.7 %			
Lighting:		Ballast	Footcandles	Controls
(1) 2-lamp, T5HO Strip		Elec	36.7	Toggle
		All Lights On:	No	
Equipment:				
		Quantity		
Exhaust Fan	☑ Yes ☐ No	1, Tied to Light		
Computer	☐ Yes ☑ No			
Exterior Doors:	☐ Yes ☑ No			
Standard Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	
Exterior Windows:	☐ Yes ☑ No			
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	

ROOM NAME:	Locker Room				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:	° F		
Temperature	73.7 ° F				
Relative Humidity	26.5 %				
Lighting:		Ballast		Footcandles	Controls
(2) 2-lamp, T5HO Strips		Elec		43	Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Pop Machine		1			
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	1, South		Window Condition:	
	Type:	Double Pane, Blinds		☑ Good	
	Size:	3x4		☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Main Restroom				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:	° F		
Temperature	73.4 ° F				
Relative Humidity	27.9 %				
Lighting:		Ballast		Footcandles	Controls
(1) 2-lamp, T5HO Strip		Elec		43	Toggle
(1) Incandescent 100W					
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☑ Yes ☐ No	1, Tied to Light			
Computer	☐ Yes ☑ No				
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	1, South		Window Condition:	
	Type:	Double Pane, Blinds		☑ Good	
	Size:	3x3		☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Entry Hallway					
ROOM NUMBER:						
Thermostat?	☐ Yes ☑ No		Setting:	° F		
Temperature	73.7	° F				
Relative Humidity	27.8	%				
Lighting:			Ballast		Footcandles	Controls
(1) 2-lamp, T5HO Strip			Elec		35	Toggle
				All Lights On:	No	
Equipment:						
			Quantity			
Exhaust Fan	☐ Yes	☑ No				
Computer	☐ Yes	☑ No				
Exterior Doors:	☑ Yes	☐ No				
Standard Doors:	Quantity:	1, South			Door Condition:	
	Type:	Metal, 6"x2' Glass			☑ Good	
	Size:	3x7			☐ Fair	
					☐ Poor	
Shop Doors:	Quantity:				Door Condition:	
	Type:				☐ Good	
	Size:				☐ Fair	
					☐ Poor	
Exterior Windows:	☐ Yes	☑ No				
Windows:	Quantity:				Window Condition:	
	Type:				☐ Good	
	Size:				☐ Fair	
					☐ Poor	
Windows:	Quantity:				Window Condition:	
	Type:				☐ Good	
	Size:				☐ Fair	
					☐ Poor	

ROOM NAME:	Highway Patrol Office				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No		Setting:	° F	
Temperature	73 ° F				
Relative Humidity	28.7 %				
Lighting:		Ballast		Footcandles	Controls
Daylight				45	
(7) 2-lamp, T5HO Strips		Elec		65	Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No			Space Heater	1
Computer	☐ Yes ☑ No				
TV		1			
Microwave		1			
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair ☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair ☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	2, South		Window Condition:	
	Type:	Double Pane, Blinds		☑ Good	
	Size:	3x4		☐ Fair ☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair ☐ Poor	

ROOM NAME:	Highway Patrol Computer Room				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No		Setting:	° F	
Temperature	72.5 ° F				
Relative Humidity	30.1 %				
Lighting:		Ballast		Footcandles	Controls
(2) 2-lamp, T5HO Strips		Elec		38.4	Toggle
Daylight				25	
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☑ Yes ☐ No	1			
Printer		2			
Exterior Doors:	☑ Yes ☐ No				
Standard Doors:	Quantity:	1, East		Door Condition:	
	Type:	Metal, 6"x2' Glass		☑ Good	
	Size:	3x7		☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	2, East & South		Window Condition:	
	Type:	Double Pane, Blinds		☑ Good	
	Size:	3x4		☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Storage Room (off Break Room)			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting: ____ ° F		
Temperature	72.1 ° F			
Relative Humidity	30.2 %			
Lighting:		Ballast	Footcandles	Controls
(1) Incandescent, 100W			12.7	
		All Lights On:	No	
Equipment:				
		Quantity		
Exhaust Fan	☐ Yes ☑ No			
Computer	☐ Yes ☑ No			
Exterior Doors:	☐ Yes ☑ No			
Standard Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Exterior Windows:	☐ Yes ☑ No			
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	

ROOM NAME:	Paint Room (off Break Rm)				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:	° F		
Temperature	72.5 ° F				
Relative Humidity	32 %				
Lighting:		Ballast		Footcandles	Controls
(1) 2-lamp, T5HO Strip		Elec		22.6	Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Paint Mixer		1			
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☐ Yes ☑ No				
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Storage Room with Equipment			
ROOM NUMBER:				

Thermostat?	☐ Yes ☑ No	Setting:	° F
Temperature	° F		
Relative Humidity	%		

Lighting:	Ballast	Footcandles	Controls
(1) Incandescent, 60W		8.6	Toggle
	All Lights On:	No	

Equipment:			Quantity
Exhaust Fan	☐ Yes	☑ No	
Computer	☐ Yes	☑ No	
Furnace			
Water Heater			

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME:	Break Room				
ROOM NUMBER:					
Thermostat?	☑ Yes ☐ No	Setting:	68 ° F		
Temperature	71.7 ° F				
Relative Humidity	29 %				
Lighting:		Ballast		Footcandles	Controls
(8) 2-lamp, T5HO Strips		Elec		31.5	Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☑ Yes ☐ No	1			
Microwave		1			
Printer		1			
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	4, North		Window Condition:	
	Type:	Double Pane, Blinds		☑ Good	
	Size:	3x4		☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Supervisor Office				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:		° F	
Temperature	70.3 ° F				
Relative Humidity	30.9 %				
Lighting:		Ballast		Footcandles	Controls
(2) 2-lamp, T5HO Strips		Elec		46.1	Toggle
* One fixture has generator back-up					
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☑ Yes ☐ No	1			
Printer		1			
Exterior Doors:	☑ Yes ☐ No				
Standard Doors:	Quantity:	1, East		Door Condition:	
	Type:	Metal		☑ Good	
	Size:	3x7		☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	2, North & East		Window Condition:	
	Type:	Double Pane, Blinds		☑ Good	
	Size:	3x4		☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

Building Characteristics

Gross Floor Area		gross sf	,	ceiling ht		ft	
		gross sf	,	ceiling ht		ft	* If multiple ceiling
		gross sf	,	ceiling ht		ft	heights

Conditioned Floor Area	Heating Only:		sf
	Cooling Only:		sf
	Heating and Cooling:		sf

Number of Conditioned Floors:

	Above Grade	1
	Below Grade	0

Total Standard Door Area	105	sf	Glass		sf	Door Condition:
			Wood		sf	☑ Good
			Metal	105	sf	☐ Fair
			Garage		sf	☐ Poor
Total Shop Door Area	456	sf	Glass		sf	Door Condition:
			Wood		sf	☑ Good
			Metal		sf	☐ Fair
			Garage	456	sf	☐ Poor

Office Exterior Glass Area	165	sf	Single Panes		sf	Window Condition:
(Note: Operable or Fixed)			Double Panes	165	sf	☑ Good
						☐ Fair
		North	Total Area	72	sf	☐ Poor
			Single Panes		sf	
			Double Panes	72	sf	
		South	Total Area	69	sf	
			Single Panes		sf	
			Double Panes	69	sf	
		East	Total Area	24	sf	
			Single Panes		sf	
			Double Panes	24	sf	
		West	Total Area	0	sf	
			Single Panes		sf	
			Double Panes	0	sf	

Shop Exterior Glass Area	24	sf	Single Panes		sf	Window Condition:
(Note: Operable or Fixed)			Double Panes	24	sf	[x] Good [ ] Fair [ ] Poor
		North	Total Area	24	sf	
			Single Panes		sf	
			Double Panes	24	sf	
		South	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	
		East	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	
		West	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	

Office Exterior Wall Area		sf	[x] Masonry [ ] Wood [ ] Concrete	[ ] Stucco [ ] Other [ ] Unknown
Shop Exterior Wall Area		sf	[x] Masonry [ ] Wood [ ] Concrete	[ ] Stucco [ ] Other [ ] Unknown
Total Roof Area		sf	Condition:	[x] Good [ ] Fair [ ] Poor

Insulation Type:	Roof:		If Provided on Building Plans.
	Wall:		
	Floor:		
Insulation Thickness:	Roof:		
	Wall:		
	Floor:		

Metering:

Is this building individually metered for electricity?	[ ] Yes	[x] No
Is this building individually metered for natural gas / LP?	[ ] Yes	[x] No
Is this building individually metered for water?	[ ] Yes	[x] No

Describe the general building condition:

HVAC DISTRIBUTION SYSTEM

Location of Unit(s)

Office Furnace

SYSTEM TYPE		MAINTENANCE	
	☑ Single Zone (Furnace, RTU, etc.)	☑ Good	
	☐ Multi Zone (i.e. AHU)	☐ Fair	
	☐ Dual Duct	☐ Poor	
	☐ Variable Air Volume		
	☐ Single Duct Reheat	Energy Star. "Bryant Plus 95i". Made 10/1010	
	☐ 2-Pipe Water		
	☐ 4-Pipe Water		
	☐ Window Unit		
	☐ Packaged Terminal Air Unit		
	☐ Unit Ventilator		
	☐ Fan Coil		
	☐ Unit Heater		
	☐ Other ______		

DUCTWORK	Insulation:	☐ Good	No Insulation
		☐ Fair	
		☐ Poor	
	Installation:	☑ Good	
		☐ Fair	
		☐ Poor	

CONTROLS		Style:
	☑ Space Thermostat	Newer Thermostat.
	☐ Outside Temperature Sensors	Programming Available
	☐ Time Clocks	
	☐ Energy Management System	
	☐ Auto Supply Temperature Reset	
	☐ Economy Cycle	
	☐ Heat Recovery	
	☐ Other ______	

Heated Bays

SYSTEM TYPE		MAINTENANCE
	☐ Single Zone	☑ Good
	☐ Multi Zone	☐ Fair
	☐ Dual Duct	☐ Poor
	☐ Variable Air Volume	
	☐ Single Duct Reheat	Natural Gas.
	☐ 2-Pipe Water	
	☐ 4-Pipe Water	
	☐ Window Unit	
	☐ Unit Ventilator	
	☐ Fan Coil	
	☑ Unit Heater	
	☐ Other ______	
	CONTROLS	Style:
	☑ Space Thermostat	Non-programmable.
	☐ Outside Temperature Sensors	
	☐ Time Clocks	
	☐ Energy Management System	
	☐ Auto Supply Temperature Reset	
	☐ Economy Cycle	
	☐ Heat Recovery	
	☐ Other ______	

DOMESTIC HOT WATER

Domestic Hot Water Heated By:

- ☐ Electricity
- ☑ Natural Gas
- ☐ Oil
- ☐ Steam
- ☐ Heat Pump
- ☐ Other

"Rheem, Guardian Fury". Input = 32000BTUh, Capacity = 29 Gallon

Number of Units:	1	
General Location of Units:	Storage Room	
Is there a re-circulation loop?	☐ Yes ☑ No	
Hot Water Temperature		
At Point of Use	104.1	°F
At Heater		°F
Temperature of City Water	46.9	°F
Date of Water Heater	1/1/2010	
Date of Installation	1/27/2012	

Is the tank warm to the touch?	☐ Yes	☑ No
Are pipes insulated at least 3' from heater?	☐ Yes	☑ No
Any signs of leakage?	☐ Yes	☑ No
Requires maintenance?	☐ Yes	☑ No
Is the tank wrapped?	☐ Yes	☑ No
Do obstructions prevent wrapping?	☐ Yes	☑ No

Distance from Heater to Furthest Point of Use:

Hot Water Uses Other than Lavatories: No

WATER CONSUMPTION

Fixture Type	Quantity	Gal/Flush	Gal/Min	Low-Flow?	Aerators?
Water Closets (valve)	1	1.6			
Water Closets (tank)	1				
Urinals	--				
Lavatories	2				
Service Sinks	1				
Showers	--				
Electric Water Coolers	1				
Dishwashers	--				
Hose Bibs	2				

Exhaust Fans tied to Lights? ☐ Yes ☐ No

HW Temperature = 104.1 °F

CW Temperature = 46.9 °F

Large Water Consumption Scenarios

	Yes	No	Time Period of Water Usage	Estimated Amount
Irrigation - Sprinkler System		x		
Filling Water Tanks				
Other: _______________				

SPECIALTY EQUIPMENT		
Item	Yes / No	Quantity
Refrigerators		
Mini-Fridges		
Freezers		
Walk-In Refrigerators		
Walk-In Freezers		
Infra-red Warmer Microwaves	Y	2
Mixers		
Ranges		
Ovens		
Dishwashers		
Hoods w/ Exhaust Fans		
Coffee Makers		
Pop Machines	Y	1
Vending Machines		
Ice Makers		
Space Heaters	Y	2
Copiers		
Fax Machines		
Scanners		
Printers	Y	5
Printer/Fax/Scan/Copy Machines		
Plotters		
Compressors		
Motors		
Presses		
Powder Paint Curing Oven		
Misc. Manual Shop Lathes/Mills		
Welding Machines		
Test Fixtures		
Exhaust Fans	Y	3
Computers	Y	4
Projector / Screen		
Block Heaters	Y	8
Power Washer	Y	1
TV	Y	1
Paint Mixer	Y	1

Lighting

INTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

EXTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

Fixture Types:
Incandescent
Fluorescent
Mercury Vapor
High Pressure Sodium
Low Pressure Sodium
Metal Halide

Are lights on in unoccupied areas? ☑ Yes ☑ No
Is the exterior lighting on during the day? ☐ Yes ☑ No

How are lights operated?
☑ Toggle Switches
☐ Occupancy Switches
☑ Photovoltaic/Daylight Sensors
☐ Other ____________

Russell – Completed Audit

Altamont: Photos and Completed Audit

Figure B.24 Garage Door Motor

Figure B.25 Unit Heater in Garage Bays

Figure B.26 Water Heater

Figure B.27 Packaged Terminal Air Conditioner

Figure B.28 Plumbing Fixtures

Figure B.29 Outdoor Light Fixture

Figure B.30 Radiant Heater in Washbay

Table B.4 Completed Altamont Audit

Building Information			
Name of Institution, Building		Building #	
Altamont KDOT Building, District 4		--	
Address (Street or P.O. Box)		City, State, Zip	
211 W US 160 HWY		Altamont, KS, 67330	
Date of Audit	Time of Audit	Weather Conditions	
9-Jan-12	*11:45 AM*	*44 °F, 60% RH, NNW 6 mph*	
Building Manager		Building Manager's Phone Number	
Wayne Nelson, "Area Superintendent"		(620) 231 - 7560	
Auditing Team		Phone	
Rebecca Gentry, Kimberly Pierson, David Carter			
Building Type and Use			
		Building Use	% Dedicated to this Use
Building Description / Type:		☑ Office	
Four heated bays, two interior rooms, restroom, washbay, and exterior storage.		☐ Storage	
		☑ Maintenance Garage	
		☐ Other - Wash Bay	
Date of Construction:			
Original Architects, if known		Original Engineers, if known	
Does the Institution have an ongoing Energy Management Program?		☐ Yes	☑ No
If yes, describe program:			
Any previous energy audits completed?	☐ Yes ☑ No	Dates:	
Name of Utilities: Electric, Gas, etc.			

Altamont – Completed Audit

Building Information

List of Energy Savings Programs or Efforts Currently Implemented:

	No. Years Implemented
1.____________________________	__________
2.____________________________	__________
3.____________________________	__________
4.____________________________	__________
5.____________________________	__________

Conservation Measures Under Consideration Prior to this Audit.

1.____________________________
2.____________________________
3.____________________________
4.____________________________

What are the facility manager's feelings towards saving energy?

Priority of Saving Energy and Money with Utilit Low 1 2 3 4 5 6 7 8 9 10

What are the barriers to implementing energy saving strategies?

- ☐ Lack of Information
- ☐ Lack of Funds
- ☐ Lack of Support from Upper Management
- ☐ Other : ____________________

Building Information							
Building Occupancy Profile							
Typical Occupied Periods:							
			Hours (i.e. 8am - 5pm)				
	Sunday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Monday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Tuesday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Wednesday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Thursday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Friday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Saturday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
Thermostat Set points:		Daytime	Heating	ı, due to PT/	Cooling	n/a, due to PTAC	
		Nighttime	Heating		Cooling		
		Weekend	Heating		Cooling		
Average Number of Occupants in B			9				
Include a Floor Plan.							
1. Look for discrepancies between plan and existing conditions.							
2. Mark locations of heating and cooling units.							

ROOM NAME:	Wash Bay					
ROOM NUMBER:						
Thermostat?	☐ Yes ☑ No		Setting:	° F		
Temperature	60.5	° F		(1 Radiant Heater-Natural Gas)		
Relative Humidity	35.6	%				
Lighting:			Ballast		Footcandles	Controls
Daylight Only					30	
(18) 2-lamp, T5 Strips			Elec		37.8	
				All Lights On:	No	
Equipment:						
			Quantity			
Exhaust Fan	☑ Yes ☐ No		1			
Computer	☐ Yes ☑ No					
Power Washer			1			
Motorized Vents			2			
Exterior Doors:	☑ Yes ☐ No					
Standard Doors:	Quantity:	2, West		Door Condition:		
	Type:	Metal		☑ Good		
	Size:	3x7		☐ Fair		
				☐ Poor		
Shop Doors:	Quantity:	1, Shop		Door Condition:		
	Type:	Metal Garage		☑ Good		
	Size:	15x15		☐ Fair		
				☐ Poor		
Exterior Windows:	☐ Yes ☑ No					
Windows:	Quantity:			Window Condition:		
	Type:			☐ Good		
	Size:			☐ Fair		
				☐ Poor		
Windows:	Quantity:			Window Condition:		
	Type:			☐ Good		
	Size:			☐ Fair		
				☐ Poor		

ROOM NAME:	Exterior			
ROOM NUMBER:				

Thermostat?	☐ Yes ☐ No	Setting:		° F
Temperature		° F		
Relative Humidity		%		

Lighting:	Ballast	Footcandles	Controls
(5) Block Metal Halides			
(1) "Type 2" Near Front Door			
(1) "Type 3" Near Stnd Door of Bay			
(8) "Type 4" Eqmt Stor Light			
	All Lights On:		

Equipment:		Quantity	
Exhaust Fan	☐ Yes ☑ No		*Replace grill on PTAC
Computer	☐ Yes ☑ No		
Hose Bibs		2	

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

ROOM NAME:	Office					
ROOM NUMBER:						
Thermostat?	☐ Yes ☑ No		Setting:		° F	
Temperature	68.7	° F				
Relative Humidity	30.8	%				
Lighting:			Ballast		Footcandles	Controls
(4) 2-lamp, T8 strips			Elec		130	Toggle
				All Lights On:	No	
Equipment:						
			Quantity			
Exhaust Fan	☐ Yes ☑ No		--		Shredder	1
Computer	☑ Yes ☐ No		2		PTAC	1
Printer			2			
Fax			1			
Exterior Doors:	☑ Yes ☐ No					
Standard Doors:	Quantity:	1, South			Door Condition:	
	Type:	Metal, 2x3 film glass			☑ Good	
	Size:	3x7			☐ Fair	
					☐ Poor	
Shop Doors:	Quantity:				Door Condition:	
	Type:				☐ Good	
	Size:				☐ Fair	
					☐ Poor	
Exterior Windows:	☑ Yes ☐ No					
Windows:	Quantity:	2, West & South			Window Condition:	
	Type:	Double Pane w/ Blinds			☑ Good	
	Size:	3x4			☐ Fair	
					☐ Poor	
Windows:	Quantity:				Window Condition:	
	Type:				☐ Good	
	Size:				☐ Fair	
					☐ Poor	

ROOM NAME:	Restroom			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	65 ° F			
Relative Humidity	33.4 %			
Lighting:		Ballast	Footcandles	Controls
(1) 2-lamp, T8 strip		Elec	42	Toggle
		All Lights On:	No	
Equipment:				
		Quantity		
Exhaust Fan	☑ Yes ☐ No	1, Tied to Light		
Computer	☐ Yes ☑ No			
*Hot water spigot on wall				
Exterior Doors:	☐ Yes ☑ No			
Standard Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	
Exterior Windows:	☑ Yes ☐ No			
Windows:	Quantity:	1, West	Window Condition:	
	Type:	Double Pane	☑ Good	
	Size:	2.5x2.5	☐ Fair ☐ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	

ROOM NAME:	Restroom				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:	° F		
Temperature	65 ° F				
Relative Humidity	33.4 %				
Lighting:		Ballast	Footcandles	Controls	
(1) 2-lamp, T8 strip		Elec	42	Toggle	
		All Lights On:	No		
Equipment:					
		Quantity			
Exhaust Fan	☑ Yes ☐ No	1, Tied to Light			
Computer	☐ Yes ☑ No				
*Hot water spigot on wall					
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		
Shop Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	1, West	Window Condition:		
	Type:	Double Pane	☑ Good		
	Size:	2.5x2.5	☐ Fair		
			☐ Poor		
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		

ROOM NAME:	Four Bay Heated		
ROOM NUMBER:		* One used as break room	

Thermostat?	☐ Yes ☐ No	Setting:	° F
Temperature	62.7 ° F	* (2) NG Radiant Heaters - Dimmer	
Relative Humidity	32.5 %	* (1) NG Unit Heater - Thermo at 66F	

Lighting:	Ballast	Footcandles	Controls
(41) 2-lamp, T8 32W Strips	Elec	33.6	3 Switches
	All Lights On:	Yes	

Equipment:

		Quantity	
Exhaust Fan	☐ Yes ☑ No	Grinder (1)	TV (1)
Computer	☐ Yes ☑ No	Ice Maker (1)	VCR/DVD (1)
Air Compressor (1)		Fridge (1)	Radio Chargers (5)
Garage Motor Openers (4)		Microwave (1)	Service Sink (1)
			Hosebibs (5)

Exterior Doors: ☑ Yes ☐ No

Standard Doors:	Quantity:	2, East & West	Door Condition:
	Type:	Metal, 6"x2' glass	☑ Good
	Size:	3x7	☐ Fair
			☐ Poor
Shop Doors:	Quantity:	4, South	Door Condition:
	Type:	Metal Garage	☑ Good
	Size:	12x15	☐ Fair
			☐ Poor

Exterior Windows: ☑ Yes ☐ No

Windows:	Quantity:	4, North	Window Condition:
	Type:	Double Pane	☑ Good
	Size:	3x4	☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Building Characteristics

Gross Floor Area		gross sf	,	ceiling ht		ft	
		gross sf	,	ceiling ht		ft	* If multiple ceiling
		gross sf	,	ceiling ht		ft	heights
Conditioned Floor Area	Heating Only:				sf		
	Cooling Only:				sf		
	Heating and Cooling:				sf		
Number of Conditioned Floors:							
	Above Grade		1				
	Below Grade		0				
Total Standard Door Area	105	sf	Glass		sf		Door Condition:
			Wood		sf		☑ Good
			Metal	105	sf		☐ Fair
			Garage		sf		☐ Poor
Total Shop Door Area	945	sf	Glass		sf		Door Condition:
			Wood		sf		☑ Good
			Metal		sf		☐ Fair
			Garage	945	sf		☐ Poor
Office Exterior Glass Area	54.25	sf	Single Panes		sf		Window Condition:
(Note: Operable or Fixed)			Double Panes	54.25	sf		☑ Good
							☐ Fair
		North	Total Area	12	sf		☐ Poor
			Single Panes		sf		
			Double Panes	12	sf		
		South	Total Area	12	sf		
			Single Panes		sf		
			Double Panes	12	sf		
		East	Total Area	0	sf		
			Single Panes		sf		
			Double Panes	0	sf		
		West	Total Area	30.25	sf		
			Single Panes		sf		
			Double Panes	30.25	sf		

Building Characteristics

Gross Floor Area		gross sf ,	ceiling ht		ft	
		gross sf ,	ceiling ht		ft	* If multiple ceiling
		gross sf ,	ceiling ht		ft	heights
Conditioned Floor Area	Heating Only:				sf	
	Cooling Only:				sf	
	Heating and Cooling:				sf	
Number of Conditioned Floors:						
	Above Grade		1			
	Below Grade		0			
Total Standard Door Area	105	sf	Glass		sf	Door Condition:
			Wood		sf	☑ Good
			Metal	105	sf	☐ Fair
			Garage		sf	☐ Poor
Total Shop Door Area	945	sf	Glass		sf	Door Condition:
			Wood		sf	☑ Good
			Metal		sf	☐ Fair
			Garage	945	sf	☐ Poor
Office Exterior Glass Area	54.25	sf	Single Panes		sf	Window Condition:
(Note: Operable or Fixed)			Double Panes	54.25	sf	☑ Good
						☐ Fair
		North	Total Area	12	sf	☐ Poor
			Single Panes		sf	
			Double Panes	12	sf	
		South	Total Area	12	sf	
			Single Panes		sf	
			Double Panes	12	sf	
		East	Total Area	0	sf	
			Single Panes		sf	
			Double Panes	0	sf	
		West	Total Area	30.25	sf	
			Single Panes		sf	
			Double Panes	30.25	sf	

Shop Exterior Glass Area	48 sf		Single Panes	sf	Window Condition:
(Note: Operable or Fixed)			Double Panes	48 sf	☑ Good ☐ Fair ☐ Poor
		North	Total Area	48 sf	
			Single Panes	sf	
			Double Panes	48 sf	
		South	Total Area	sf	
			Single Panes	sf	
			Double Panes	sf	
		East	Total Area	sf	
			Single Panes	sf	
			Double Panes	sf	
		West	Total Area	sf	
			Single Panes	sf	
			Double Panes	sf	

Office Exterior Wall Area	sf	☑ Masonry ☐ Wood ☐ Concrete	☐ Stucco ☐ Other ☐ Unknown	
Shop Exterior Wall Area	sf	☑ Masonry ☐ Wood ☐ Concrete	☐ Stucco ☐ Other ☐ Unknown	
Total Roof Area	sf	Condition:	☐ Good ☐ Fair ☐ Poor	

Insulation Type:	Roof:		If Provided on Building Plans.
	Wall:		
	Floor:		
Insulation Thickness:	Roof:		
	Wall:		
	Floor:		

Metering:		
Is this building individually metered for electricity?	☐ Yes	☑ No
Is this building individually metered for natural gas / LP?	☐ Yes	☑ No
Is this building individually metered for water?	☐ Yes	☑ No

Describe the general building condition:

HVAC DISTRIBUTION SYSTEM

Location of Unit(s)

Office & Storage Room

SYSTEM TYPE

- ☐ Single Zone (Furnace, RTU, etc.)
- ☐ Multi Zone (i.e. AHU)
- ☐ Dual Duct
- ☐ Variable Air Volume
- ☐ Single Duct Reheat
- ☐ 2-Pipe Water
- ☐ 4-Pipe Water
- ☐ Window Unit
- ☑ Packaged Terminal Air Unit
- ☐ Unit Ventilator
- ☐ Fan Coil
- ☐ Unit Heater
- ☐ Other ______

MAINTENANCE

- ☑ Good
- ☐ Fair
- ☐ Poor

Two PTAC units with integral controls.

DUCTWORK

Insulation:

- ☐ Good
- ☐ Fair
- ☐ Poor

Installation:

- ☐ Good
- ☐ Fair
- ☐ Poor

CONTROLS

Style:

- ☐ Space Thermostat
- ☐ Outside Temperature Sensors
- ☐ Time Clocks
- ☐ Energy Management System
- ☐ Auto Supply Temperature Reset
- ☐ Economy Cycle
- ☐ Heat Recovery
- ☑ Other Integral Controls

Heated Bays

SYSTEM TYPE

- [ ] Single Zone
- [ ] Multi Zone
- [ ] Dual Duct
- [ ] Variable Air Volume
- [ ] Single Duct Reheat
- [ ] 2-Pipe Water
- [ ] 4-Pipe Water
- [ ] Window Unit
- [ ] Unit Ventilator
- [ ] Fan Coil
- [x] Unit Heater
- [x] Other Radiant Heaters (2)

MAINTENANCE

- [x] Good
- [ ] Fair
- [ ] Poor

Natural Gas Powered.

CONTROLS

- [x] Space Thermostat for Unit Heater
- [ ] Outside Temperature Sensors
- [ ] Time Clocks
- [ ] Energy Management System
- [ ] Auto Supply Temperature Reset
- [ ] Economy Cycle
- [ ] Heat Recovery
- [x] Other Toggle for Radiant Heaters

Wash Bay

SYSTEM TYPE

- [ ] Single Zone
- [ ] Multi Zone
- [ ] Dual Duct
- [ ] Variable Air Volume
- [ ] Single Duct Reheat
- [ ] 2-Pipe Water
- [ ] 4-Pipe Water
- [ ] Window Unit
- [ ] Unit Ventilator
- [ ] Fan Coil
- [ ] Unit Heater
- [x] Other Radiant Heater

MAINTENANCE

- [x] Good
- [ ] Fair
- [ ] Poor

Natural Gas Powered.

CONTROLS

- [ ] Space Thermostat
- [ ] Outside Temperature Sensors
- [ ] Time Clocks
- [ ] Energy Management System
- [ ] Auto Supply Temperature Reset
- [ ] Economy Cycle
- [ ] Heat Recovery
- [x] Other Toggle Switch

DOMESTIC HOT WATER

Domestic Hot Water Heated By:

- [x] Electricity
- [ ] Natural Gas
- [ ] Oil
- [ ] Steam
- [ ] Heat Pump
- [ ] Other

"Rheem",
1 Phase / 120V, 2000W, 6 Gal

Number of Units:	1		
General Location of Units:	Storage Room		
Is there a re-circulation loop?	☐ Yes ☑ No		
Hot Water Temperature			
At Point of Use	114.4	°F	
At Heater	90	°F	
Temperature of City Water	51.3	°F	
Date of Water Heater	10/1/2008		
Date of Installation			
Is the tank warm to the touch?		☐ Yes	☑ No
Are pipes insulated at least 3' from heater?		☑ Yes	☐ No
Any signs of leakage?		☐ Yes	☑ No
Requires maintenance?		☐ Yes	☑ No
Is the tank wrapped?		☐ Yes	☑ No
Do obstructions prevent wrapping?		☐ Yes	☑ No
Distance from Heater to Furthest Point of Use:			3'
Hot Water Uses Other than Lavatories:		No	

WATER CONSUMPTION

Fixture Type	Quantity	Gal/Flush	Gal/Min	Low-Flow?	Aerators?
Water Closets (tank)	1	1.6			
Urinals	--				
Lavatories	1				
Service Sinks	1				
Showers	--				
Electric Water Coolers	1				
Dishwashers	--				
Hose Bibs	8				

Exhaust Fans tied to Lights?	☑ Yes	☐ No
HW Temperature =	114.4	°F
CW Temperature =	51.3	°F

Large Water Consumption Scenarios

	Yes	No	Time Period of Water Usage	Estimated Amount
Irrigation - Sprinkler System		x		
Filling Water Tanks		x		
Other: _______________				

SPECIALTY EQUIPMENT		
Item	Yes / No	Quantity
Refrigerators	Y	1
Mini-Fridges		
Freezers		
Walk-In Refrigerators		
Walk-In Freezers		
Infra-red Warmer Microwaves	Y	1
Mixers		
Ranges		
Ovens		
Dishwashers		
Hoods w/ Exhaust Fans		
Coffee Makers		
Pop Machines		
Vending Machines		
Ice Makers	Y	1
Space Heaters		
Copiers		
Fax Machines	Y	1
Scanners		
Printers	Y	2
Printer/Fax/Scan/Copy Machines		
Plotters		
Air Compressors	Y	1
Motors		
Presses		
Exhaust Fans	Y	2
Computers	Y	2
Projector / Screen		
Shredder	Y	1
Power Washer (Wash Bay)	Y	1
Motorized Vents	Y	2
Garage Motors	Y	4
Grinder	Y	1
TV	Y	1
VCR/DVD	Y	1
Radio Chargers	Y	5
PTAC	Y	2
Water Cooler	Y	1
Water Heater	Y	1

.

Lighting

INTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

EXTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

Fixture Types:

Incandescent

Fluorescent

Mercury Vapor

High Pressure Sodium

Low Pressure Sodium

Metal Halide

Are lights on in unoccupied areas? ☐ Yes ☑ No

Is the exterior lighting on during the day? ☐ Yes ☑ No

How are lights operated?

☑ Toggle Switches

☐ Occupancy Switches

☐ Photovoltaic/Daylight Sensors

☐ Other ___________

Larned: Photos and Completed Audit

Figure B.31 Outdoor Air-Condensing Unit

Figure B.32 Outside View of Packaged Air Conditioner

Figure B.33 Inside View of Packaged Air Conditioner

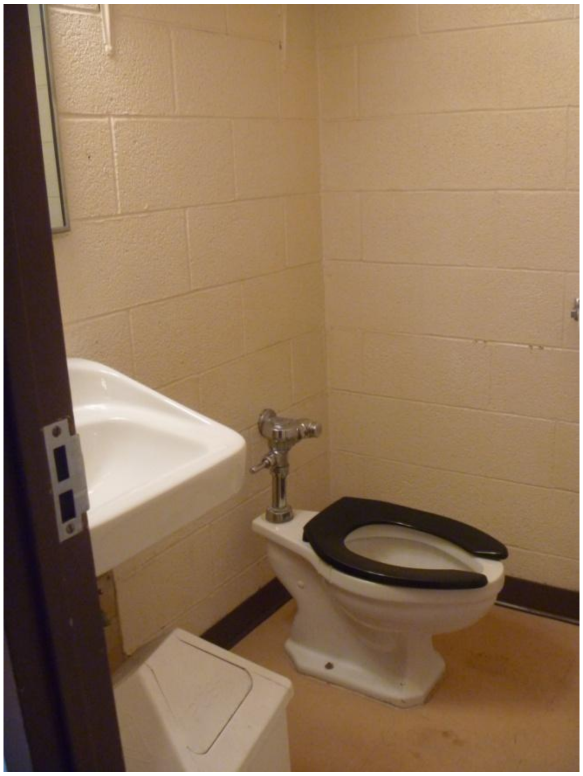

Figure B.34 Plumbing Fixtures

Figure B.35 Thermostat

Figure B.36 Unit Heater in Garage Bays

Figure B.37 Water Heater and Furnace

Table B.5 Completed Larned Audit

Building Information		
Name of Institution, Building Larned KDOT Building, District 4		Building # --
Address (Street or P.O. Box) 616 E 13th St		City, State, Zip Larned, KS, 67550
Date of Audit Wednesday, January 04, 2012	Time of Audit *10:00 AM*	Weather Conditions *Sunny, 37 °F, 70% RH, NW 10 mph*
Building Manager Dean Earegood		Building Manager's Phone Number (620) 285 - 3117
Auditing Team Rebecca Gentry, Kimberly Pierson, David Carter		Phone

Building Type and Use		
	Building Use	% Dedicated to this Use
Building Description / Type:	☑ Office	
Small Office. Six bays (two heated). Washbay, two exterior equipment storages.	☑ Storage	
	☑ Maintenance Garage	
	☑ Other - Wash Bay	
Date of Construction:		

Original Architects, if known	Original Engineers, if known
Does the Institution have an ongoing Energy Management Program?	☐ Yes ☑ No
If yes, describe program:	
Any previous energy audits completed? ☐ Yes ☑ No	Dates:
Name of Utilities: Electric, Gas, etc.	

Building Information

List of Energy Savings Programs or Efforts Currently Implemented:

	No. Years Implemented
1. Windows replaced 2 years ago. Single to Double Pane	________
2. Lights replaced 2 years ago. T12's to T5's.	________
3. Furnace replaced 2 years ago.	________
4. Water Heater installed in 2011	________
5.____	________

Conservation Measures Under Consideration Prior to this Audit.

1.____
2.____
3.____
4.____

What are the facility manager's feelings towards saving energy?

Priority of Saving Energy and Money with Utilities? Low 1 2 3 4 5 6 7 8 9 10

What are the barriers to implementing energy saving strategies?

- ☐ Lack of Information
- ☐ Lack of Funds
- ☐ Lack of Support from Upper Management
- ☐ Other : ________________________________

Larned – Completed Audit

Building Information

Building Occupancy Profile			Summer = March to November				
Typical Occupied Periods:							
			Hours (i.e. 8am - 5pm)				
	Sunday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Monday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Tuesday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Wednesday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Thursday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Friday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
	Saturday		8:30-4:30 (Win), 7:30-3:30 (Sum)				
Thermostat Set points:		Daytime	Heating	70	Cooling	70	
		Nighttime	Heating	70	Cooling	70	
		Weekend	Heating	70	Cooling	70	
Average Number of Occupants in Bu			8				

<u>Include a Floor Plan.</u>

1. Look for discrepancies between plan and existing conditions.
2. Mark locations of heating and cooling units.

ROOM NAME:	Women's Restroom				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No		Setting:	° F	
Temperature	68 ° F				
Relative Humidity	33.9 %				
Lighting:		Ballast	Footcandles		Controls
(2) 100W Incandescents			19.8		Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☑ Yes ☐ No	1, Separate from Light			
Computer	☐ Yes ☑ No				
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		
Shop Doors:	Quantity:		Door Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		
Exterior Windows:	☐ Yes ☑ No				
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair ☐ Poor		

ROOM NAME:	Men's Restroom				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:		° F	
Temperature	68.8 ° F				
Relative Humidity	30.5 %				
Lighting:		Ballast		Footcandles	Controls
(2) 100W Incandescents				10.6	Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☑ Yes ☐ No	1, Tied to Light			
Computer	☐ Yes ☑ No				
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☐ Yes ☑ No				
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Hallway			
ROOM NUMBER:				

Thermostat?	☑ Yes ☐ No	Setting:	70 ° F	
Temperature	70 ° F			
Relative Humidity	29 %			

Lighting:	Ballast	Footcandles	Controls
Incandescent Dome Light		9.6	Toggle
	All Lights On:	No	

Equipment:		Quantity
Exhaust Fan	☐ Yes ☑ No	
Computer	☐ Yes ☑ No	
Water Cooler		1

Exterior Doors:	☑ Yes ☐ No		
Standard Doors:	Quantity: 1, East		Door Condition:
	Type: Metal w/ Half Glass		☑ Good
	Size: 3x7		☐ Fair
			☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME:	Highway Patrol Room			
ROOM NUMBER:				

Thermostat?	☐ Yes ☑ No	Setting:	° F
Temperature	68.7 ° F		
Relative Humidity	30 %		

Lighting:	Ballast	Footcandles	Controls
(4) 4-lamp, T12 34W Strips	Mag	27.8	Toggle
	All Lights On:	No	

Equipment:		Quantity		
Exhaust Fan	☐ Yes ☑ No		Tv	1
Computer	☑ Yes ☐ No	2	VCR	2
Printers		2	Mini Fridge	1
Fax		1		

Exterior Doors:	☑ Yes ☐ No		
Standard Doors:	Quantity: 1, West		Door Condition:
	Type: Metal w/ Half Glass		☑ Good
	Size: 3x7		☐ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows:	☑ Yes ☐ No		
Windows:	Quantity: 2, North & West		Window Condition:
	Type: Double Pane		☑ Good
	Size: 3x4		☐ Fair ☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

ROOM NAME:	Office				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:		° F	
Temperature	69.8 ° F				
Relative Humidity	27 %				
Lighting:		Ballast		Footcandles	Controls
(4) 4-lamp, T12 40W Strips		Mag		128	Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No			Radio Chargers	6
Computer	☑ Yes ☐ No	1			
Printer		2			
Shredder		1			
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	2, South & West		Window Condition:	
	Type:	Double Pane		☑ Good	
	Size:	3x4		☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Break Room			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	71.6 ° F			
Relative Humidity	45 %			

Lighting:	Ballast	Footcandles	Controls
(2) 4-lamp, T12 Strips	Mag	96	Toggle
	All Lights On:	Yes	

Equipment:		Quantity		
Exhaust Fan	☐ Yes ☑ No		VCR/DVD	1
Computer	☑ Yes ☐ No	1	Printer	1
TV		1		
Microwave		1		

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows:	☑ Yes ☐ No		
Windows:	Quantity:	1, South	Window Condition:
	Type:	Double Pane	☑ Good
	Size:	3x4	☐ Fair ☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

ROOM NAME:	Storage Room				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No		Setting:	° F	
Temperature	65.4	° F			
Relative Humidity	28.8	%			
Lighting:			Ballast	Footcandles	Controls
(4) 2-lamp T5 Strips			Elec	74.2	Toggle
			All Lights On:	No	
Equipment:					
			Quantity		
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Fridge			1		
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	1, West		Window Condition:	
	Type:	Double Pane		☑ Good	
	Size:	3x4		☐ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Heated Bays				
ROOM NUMBER:					

Thermostat?	☐ Yes ☑ No	Setting:		° F
Temperature		° F	* Doors were open, Heater off	
Relative Humidity		%		

Lighting:	Ballast	Footcandles	Controls
(4) 4-lamp T12 Strips	Mag	--	Toggle
(5) 2-lamp, T5 Strips	Elec	--	Toggle
		59.4	
	All Lights On:	Yes	

Equipment:

		Quantity		
Exhaust Fan	☐ Yes ☑ No		Parts Washer	1
Computer	☐ Yes ☑ No			
Grinder		2		
Drill Press		1		

Exterior Doors: ☑ Yes ☐ No

Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Shop Doors:	Quantity:	2, South	Door Condition:
	Type:	Metal w/ 3 small windows	☑ Good
	Size:	12x12	☐ Fair
			☐ Poor

Exterior Windows: ☑ Yes ☐ No

Windows:	Quantity:	2, North	Window Condition:
	Type:	Double Pane	☑ Good
	Size:	3x4	☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME:	Unheated Bays			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	° F			
Relative Humidity	%			

Lighting:	Ballast	Footcandles	Controls
(8) 2-lamp, T5 Strips	Elec	14.1	Toggle
(1) Incandescent			
	All Lights On:	No	

Equipment:			Quantity
Exhaust Fan	☐ Yes	☑ No	
Computer	☐ Yes	☑ No	

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME: Wash Bay

ROOM NUMBER:

Thermostat? ☐ Yes ☑ No Setting: ____ ° F

Temperature 55 ° F

Relative Humidity 65.2 %

Lighting:	Ballast	Footcandles	Controls
(2) Exterior MH			
(18) 2-lamp, T5 Strips	Elec	10.6	Toggle

All Lights On: Yes

Equipment:

			Quantity
Exhaust Fan	☑ Yes	☐ No	1
Computer	☐ Yes	☑ No	
Radiant Heater			1
Power Washer			1

Exterior Doors: ☑ Yes ☐ No

Standard Doors: Quantity: 1, North; Type: Metal; Size: 3x7

Door Condition: ☑ Good ☐ Fair ☐ Poor

Shop Doors: Quantity: 1, East; Type: Metal Garage; Size: 12x20

Door Condition: ☑ Good ☐ Fair ☐ Poor

Exterior Windows: ☐ Yes ☑ No

Windows: Quantity: ____ Type: ____ Size: ____

Window Condition: ☐ Good ☐ Fair ☐ Poor

Windows: Quantity: ____ Type: ____ Size: ____

Window Condition: ☐ Good ☐ Fair ☐ Poor

ROOM NAME:	Equipment Storage (w/Door)			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	° F			
Relative Humidity	%			
Lighting:		Ballast	Footcandles	Controls
(3) Incandescents				Toggle
(6) Fix.2 - MH?				Toggle
		All Lights On:	No	
Equipment:		Quantity		
Exhaust Fan	☐ Yes ☑ No			
Computer	☐ Yes ☑ No			
Freezer		1		
Exterior Doors:	☐ Yes ☑ No			
Standard Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Exterior Windows:	☐ Yes ☑ No			
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	

ROOM NAME:	Equipment Storage (Open)		
ROOM NUMBER:			

Thermostat?	☐ Yes ☑ No	Setting:	° F
Temperature	° F		
Relative Humidity	%		

Lighting:	Ballast	Footcandles	Controls
(2) Fix.1 - Metal Halide			
(10) Fix.2 - MH?			
	All Lights On:	No	

Equipment:		Quantity
Exhaust Fan	☐ Yes ☑ No	
Computer	☐ Yes ☑ No	
Block Heaters		8

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME: Exterior of Office and Bays

ROOM NUMBER: ______

Thermostat? ☐ Yes ☑ No   Setting: ______ ° F

Temperature ______ ° F

Relative Humidity ______ %

Lighting:	Ballast	Footcandles	Controls
(16) Small Metal Halide			Photocell
(2) 100W Incandescent			

All Lights On: No

Equipment:

			Quantity
Exhaust Fan	☐ Yes	☑ No	
Computer	☐ Yes	☑ No	
Hosebib			1

Exterior Doors: ☐ Yes ☑ No

Standard Doors: Quantity: ______ Type: ______ Size: ______

Door Condition: ☐ Good ☐ Fair ☐ Poor

Shop Doors: Quantity: ______ Type: ______ Size: ______

Door Condition: ☐ Good ☐ Fair ☐ Poor

Exterior Windows: ☐ Yes ☑ No

Windows: Quantity: ______ Type: ______ Size: ______

Window Condition: ☐ Good ☐ Fair ☐ Poor

Windows: Quantity: ______ Type: ______ Size: ______

Window Condition: ☐ Good ☐ Fair ☐ Poor

Building Characteristics

Gross Floor Area		gross sf	,	ceiling ht		ft
		gross sf	,	ceiling ht		ft	* If multiple ceiling
		gross sf	,	ceiling ht		ft	heights

Conditioned Floor Area	Heating Only:		sf
	Cooling Only:		sf
	Heating and Cooling:		sf

Number of Conditioned Floors:

	Above Grade	1
	Below Grade	0

Total Standard Door Area	42	sf	Glass		sf	Door Condition:
			Wood		sf	☑ Good
			Metal	42	sf	☐ Fair
			Garage		sf	☐ Poor

Total Shop Door Area	548	sf	Glass		sf	Door Condition:
			Wood		sf	☑ Good
			Metal		sf	☐ Fair
			Garage	549	sf	☐ Poor

Office Exterior Glass Area	72	sf	Single Panes		sf	Window Condition:
(Note: Operable or Fixed)			Double Panes	72	sf	☑ Good
						☐ Fair
		North	Total Area	12	sf	☐ Poor
			Single Panes		sf	
			Double Panes	12	sf	
		South	Total Area	24	sf	
			Single Panes		sf	
			Double Panes	24	sf	
		East	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	
		West	Total Area	36	sf	
			Single Panes		sf	
			Double Panes	36	sf	

Shop Exterior Glass Area	24 sf		Single Panes	sf	Window Condition:
(Note: Operable or Fixed)			Double Panes	24 sf	☑ Good
					☐ Fair
		North	Total Area	24 sf	☐ Poor
			Single Panes	sf	
			Double Panes	24 sf	
		South	Total Area	sf	
			Single Panes	sf	
			Double Panes	sf	
		East	Total Area	sf	
			Single Panes	sf	
			Double Panes	sf	
		West	Total Area	sf	
			Single Panes	sf	
			Double Panes	sf	

Office Exterior Wall Area	sf	☑ Masonry	☐ Stucco	
		☐ Wood	☐ Other	
		☐ Concrete	☐ Unknown	
Shop Exterior Wall Area	sf	☑ Masonry	☐ Stucco	
		☐ Wood	☐ Other	
		☐ Concrete	☐ Unknown	
Total Roof Area	sf	Condition:	☑ Good	
			☐ Fair	
			☐ Poor	

Insulation Type:	Roof:		If Provided on Building Plans.
	Wall:		
	Floor:		
Insulation Thickness:	Roof:		
	Wall:		
	Floor:		

Metering:

Is this building individually metered for electricity?	☐ Yes	☑ No
Is this building individually metered for natural gas / LP?	☐ Yes	☑ No
Is this building individually metered for water?	☐ Yes	☑ No

Describe the general building condition:

HVAC DISTRIBUTION SYSTEM

Location of Unit(s)

Office Furnace

SYSTEM TYPE		MAINTENANCE
	☑ Single Zone (Furnace, RTU, etc.)	☑ Good
	☐ Multi Zone (i.e. AHU)	☐ Fair
	☐ Dual Duct	☐ Poor
	☐ Variable Air Volume	
	☐ Single Duct Reheat	"Comfort Maker"
	☐ 2-Pipe Water	
	☐ 4-Pipe Water	
	☐ Window Unit	
	☐ Packaged Terminal Air Unit	
	☐ Unit Ventilator	
	☐ Fan Coil	
	☐ Unit Heater	
	☐ Other ________	

DUCTWORK	Insulation:	☐ Good	No Insulation
		☐ Fair	
		☐ Poor	
	Installation:	☑ Good	* Note: All duct work is sent up from furance into ceiling. Then it is redirected and ran
		☐ Fair	
		☐ Poor	

CONTROLS		Style:
	☑ Space Thermostat	Non-programmable
	☐ Outside Temperature Sensors	
	☐ Time Clocks	
	☐ Energy Management System	
	☐ Auto Supply Temperature Reset	
	☐ Economy Cycle	
	☐ Heat Recovery	
	☐ Other ________	

Heated Bays			
	SYSTEM TYPE		MAINTENANCE
		☐ Single Zone	☑ Good
		☐ Multi Zone	☐ Fair
		☐ Dual Duct	☐ Poor
		☐ Variable Air Volume	
		☐ Single Duct Reheat	Natural Gas. Very Clean.
		☐ 2-Pipe Water	
		☐ 4-Pipe Water	
		☐ Window Unit	
		☐ Unit Ventilator	
		☐ Fan Coil	
		☑ Unit Heater	
		☐ Other ________	
		CONTROLS	Style:
		☑ Space Thermostat	Non-programmable.
		☐ Outside Temperature Sensors	
		☐ Time Clocks	
		☐ Energy Management System	
		☐ Auto Supply Temperature Reset	
		☐ Economy Cycle	
		☐ Heat Recovery	
		☐ Other ________	

DOMESTIC HOT WATER

Domestic Hot Water Heated By:

- ☐ Electricity
- ☑ Natural Gas
- ☐ Oil
- ☐ Steam
- ☐ Heat Pump
- ☐ Other

Input = 40000 BTUh, Recovery = 40.94 Gal/hr, Capacity = 40 Gal

Number of Units:	1	
General Location of Units:	Storage Room	
Is there a re-circulation loop?	☐ Yes ☑ No	
Hot Water Temperature		
At Point of Use	108.1	°F
At Heater		°F
Temperature of City Water	49.1	°F
Date of Water Heater	2/16/2011	
Date of Installation	2011	

Is the tank warm to the touch?	☐ Yes	☑ No
Are pipes insulated at least 3' from heater?	☑ Yes	☐ No
Any signs of leakage?	☐ Yes	☑ No
Requires maintenance?	☐ Yes	☑ No
Is the tank wrapped?	☐ Yes	☑ No
Do obstructions prevent wrapping?	☑ Yes	☐ No

Distance from Heater to Furthest Point of Use: 10'

Hot Water Uses Other than Lavatories: No

WATER CONSUMPTION

Fixture Type	Quantity	Gal/Flush	Gal/Min	Low-Flow?	Aerators?
Water Closets (valve)	2	1.6			
Urinals	--				
Lavatories	2				
Service Sinks	1				
Showers	--				
Electric Water Coolers	1				
Dishwashers	--				
Hose Bibs	4				

Exhaust Fans tied to Lights?	☑ Yes	☑ No	Women's separate, Men's Attached
HW Temperature =	108.1	°F	
CW Temperature =	49.1	°F	

Large Water Consumption Scenarios

	Yes	No	Time Period of Water Usage	Estimated Amount
Irrigation - Sprinkler System		x		
Filling Water Tanks				
Other: _______________				

SPECIALTY EQUIPMENT		
Item	Yes / No	Quantity
Refrigerators	Y	1
Mini-Fridges	Y	1
Freezers	Y	1
Walk-In Refrigerators	N	
Walk-In Freezers	N	
Infra-red Warmer Microwaves	Y	1
Mixers	N	
Ranges	N	
Ovens	N	
Dishwashers	N	
Hoods w/ Exhaust Fans	N	
Coffee Makers	N	
Pop Machines	N	
Vending Machines	N	
Ice Makers	N	
Space Heaters	N	
Copiers	N	
Fax Machines	Y	1
Scanners	N	
Printers	Y	3
Printer/Fax/Scan/Copy Machines	N	
Plotters	N	
Compressors	N	
Motors	N	
Presses	N	
Exhaust Fans	Y	3
Computers	Y	4
TV	Y	1
VCR	Y	3
Shredder	Y	1
Radio Chargers	Y	6
Grinder	Y	2
Drill Press	Y	1
Parts Washer	Y	1
Radiant Heater	Y	1
Pressure Washer	Y	1
Block Heaters	Y	8

Lighting

INTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

EXTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

Fixture Types:
Incandescent
Fluorescent
Mercury Vapor
High Pressure Sodium
Low Pressure Sodium
Metal Halide

Are lights on in unoccupied areas? ☐ Yes ☑ No
Is the exterior lighting on during the day? ☐ Yes ☑ No

How are lights operated?
- ☑ Toggle Switches
- ☐ Occupancy Switches
- ☑ Photovoltaic/Daylight Sensors
- ☐ Other ___________

Jetmore: Photos and Completed Audit

Figure B.38 Unit Heater in Garage Bays

Figure B.39 Water Heater

Figure B.40 Furnace

Figure B.41 Radiant Heater in Washbay

Figure B.42 Outdoor Air-Condensing Unit

Table B.6 Completed Jetmore Audit

Building Information	
Name of Institution, Building	Building #
Jetmore KDOT Building, District 6	--
Address (Street or P.O. Box)	City, State, Zip
200 South Street	Jetmore, KS, 67854

Date of Audit	Time of Audit	Weather Conditions
Tuesday, January 03, 2012	*2:23 PM*	*46 °F, 59% RH, WSW 13 mph, Sunny*

Building Manager	Building Manager's Phone Number
Dale Borger, "Sub Area Supervisor"	(620) 357 - 6335
Auditing Team	Phone
Rebecca Gentry, Kimberly Pierson, David Carter	

Building Type and Use		
	Building Use	% Dedicated to this Use
Building Description / Type:	☑ Office	
Small Office with about 6 spaces. Two heated bays and two unheated. Wash bay separate but heated. Exterior lights.	☑ Storage	
	☑ Maintenance Garage	
	☑ Other - Wash Bay	
Date of Construction:		

Original Architects, if known	Original Engineers, if known

Does the Institution have an ongoing Energy Management Program?	☐ Yes ☑ No
If yes, describe program:	
Any previous energy audits completed? ☐ Yes ☑ No	Dates:
Name of Utilities: Electric, Gas, etc.	

Building Information

List of Energy Savings Programs or Efforts Currently Implemented:

	No. Years Implemented
1. Updated windows two years ago	___________
2.______________________________	___________
3.______________________________	___________
4.______________________________	___________
5.______________________________	___________

Conservation Measures Under Consideration Prior to this Audit.

1.______________________________
2.______________________________
3.______________________________
4.______________________________

What are the facility manager's feelings towards saving energy?

Priority of Saving Energy and Money with Utilities Low 1 2 3 4 5 6 7 8 9 10

What are the barriers to implementing energy saving strategies?

- [x] Lack of Information
- [x] Lack of Funds
- [ ] Lack of Support from Upper Management
- [x] Other : It just hasn't been pushed yet.

Building Information

Building Occupancy Profile

Typical Occupied Periods:

	Hours (i.e. 8am - 5pm)
Sunday	8:30-4:30 (Win), 7:30-3:30 (Sum)
Monday	8:30-4:30 (Win), 7:30-3:30 (Sum)
Tuesday	8:30-4:30 (Win), 7:30-3:30 (Sum)
Wednesday	8:30-4:30 (Win), 7:30-3:30 (Sum)
Thursday	8:30-4:30 (Win), 7:30-3:30 (Sum)
Friday	8:30-4:30 (Win), 7:30-3:30 (Sum)
Saturday	8:30-4:30 (Win), 7:30-3:30 (Sum)

Thermostat Set points:	Daytime	Heating	66	Cooling	72
	Nighttime	Heating	66	Cooling	72
	Weekend	Heating	66	Cooling	72

Average Number of Occupants in Bu 8

Include a Floor Plan.

1. Look for discrepancies between plan and existing conditions.
2. Mark locations of heating and cooling units.

ROOM NAME:	Office 1 (NE Corner)				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No		Setting:	° F	
Temperature	65 ° F				
Relative Humidity	38.7 %				
Lighting:		Ballast		Footcandles	Controls
(2) 4-lamp, T8 Strips		Elec		125	Toggle
			All Lights On:	Yes	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☑ Yes ☐ No	1			
Radio Chargers		7			
Printer		1			
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	1, East		Window Condition:	
	Type:	Single Pane		☐ Good	
	Size:	3x4		☑ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Hallway				
ROOM NUMBER:					
Thermostat?	☑ Yes ☐ No	Setting:	66 ° F		
Temperature	66 ° F				
Relative Humidity	33.6 %				

Lighting:	Ballast	Footcandles	Controls
Dome Light, Incandescent		14	Toggle
	All Lights On:	No	

Equipment:			Quantity
Exhaust Fan	☐ Yes	☑ No	
Computer	☐ Yes	☑ No	
Water Cooler			1

Exterior Doors:	☑ Yes ☐ No		
Standard Doors:	Quantity:	1, East	Door Condition:
	Type:	Metal w/ Screen	☐ Good
	Size:	3x7	☑ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

ROOM NAME:	Men's Restroom			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	57.6 ° F			
Relative Humidity	39.7 %			
Lighting:		Ballast	Footcandles	Controls
(2) CFL's		Elec	23.7	Toggle
			All Lights On: No	
Equipment:				
		Quantity		
Exhaust Fan	☐ Yes ☑ No			
Computer	☐ Yes ☑ No			
Exterior Doors:	☐ Yes ☑ No			
Standard Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	
Exterior Windows:	☐ Yes ☑ No			
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair ☐ Poor	

ROOM NAME:	Women's Restroom			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	68.7 ° F			
Relative Humidity	57.9 %			
Lighting:		Ballast	Footcandles	Controls
(2) CFL's		Elec	27.9	Toggle
			All Lights On:	No
Equipment:				
		Quantity		
Exhaust Fan	☐ Yes ☑ No			
Computer	☐ Yes ☑ No			
Exterior Doors:	☐ Yes ☑ No			
Standard Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Exterior Windows:	☐ Yes ☑ No			
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	

ROOM NAME:	Office 2 (SE Corner)				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:		° F	
Temperature	70.3	° F			
Relative Humidity	33.3	%			
Lighting:		Ballast		Footcandles	Controls
(4) 4-lamp, T8 strips		Elec		94.2	Toggle
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Exterior Doors:	☐ Yes ☑ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	2, East & South		Window Condition:	
	Type:	Single Pane		☐ Good	
	Size:	3x4		☑ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Break Room		
ROOM NUMBER:			

Thermostat?	☐ Yes ☑ No	Setting:	° F
Temperature	72.5 ° F		
Relative Humidity	29.5 %		

Lighting:	Ballast	Footcandles	Controls
(4) 4-lamp, T8 Strips	Elec	146.8	Toggle
	All Lights On:	No	

Equipment:		Quantity		
Exhaust Fan	☐ Yes ☑ No		Water Cooler	1
Computer	☑ Yes ☐ No	1		
Microwave		2		
Fridge		1		

Exterior Doors:	☑ Yes ☐ No		
Standard Doors:	Quantity:	1, West	Door Condition:
	Type:	Metal w/ Screen	☐ Good
	Size:	3x7	☑ Fair
			☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Exterior Windows:	☑ Yes ☐ No		
Windows:	Quantity:	2, South & West	Window Condition:
	Type:	Single Pane	☐ Good
	Size:	3x4	☑ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

ROOM NAME:	Heated Bays				
ROOM NUMBER:					
Thermostat?	☑ Yes ☐ No	Setting:	64 ° F		
Temperature	75.7 ° F				
Relative Humidity	27 %				
Lighting:		Ballast		Footcandles	Controls
(4) 4-lamp, T8 strips		Elec		18	Toggle
Workbench Lamp		Elec		51.2	Toggle
(2) Incandescents					
			All Lights On:	No	
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No			Bench Grinder	1
Computer	☐ Yes ☑ No				
Air Compressor		1			
Garage Motors		2			
Exterior Doors:	☑ Yes ☐ No				
Standard Doors:	Quantity:			Door Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	
Shop Doors:	Quantity:	2, East		Door Condition:	
	Type:	Metal Garage		☑ Good	
	Size:	9x12		☐ Fair	
				☐ Poor	
Exterior Windows:	☑ Yes ☐ No				
Windows:	Quantity:	2, West		Window Condition:	
	Type:	Single Pane		☐ Good	
	Size:	3x4		☑ Fair	
				☐ Poor	
Windows:	Quantity:			Window Condition:	
	Type:			☐ Good	
	Size:			☐ Fair	
				☐ Poor	

ROOM NAME:	Storage Room			
ROOM NUMBER:				
Thermostat?	☐ Yes ☑ No	Setting:	° F	
Temperature	75 ° F			
Relative Humidity	24 %			
Lighting:		Ballast	Footcandles	Controls
(2) Large Incandescents			43	Toggle
		All Lights On:	No	
Equipment:		Quantity		
Exhaust Fan	☐ Yes ☑ No			
Computer	☐ Yes ☑ No			
Water Heater				
Furnace				
Exterior Doors:	☐ Yes ☑ No			
Standard Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Shop Doors:	Quantity:		Door Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	
Exterior Windows:	☑ Yes ☐ No			
Windows:	Quantity:	1, West	Window Condition:	
	Type:	Single Pane	☐ Good	
	Size:	3x4	☑ Fair	
			☐ Poor	
Windows:	Quantity:		Window Condition:	
	Type:		☐ Good	
	Size:		☐ Fair	
			☐ Poor	

ROOM NAME:	Unheated Bays				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:		° F	
Temperature	71.4	° F			
Relative Humidity	26.1	%			

Lighting:	Ballast	Footcandles	Controls
(4) 4-lamp, T8 Strips	Elec	63.6	Toggle
	All Lights On:	Yes	

Equipment:			Quantity
Exhaust Fan	☐ Yes	☑ No	
Computer	☐ Yes	☑ No	
Garage Motors			2

Exterior Doors:	☐ Yes ☑ No		
Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

Exterior Windows:	☐ Yes ☑ No		
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair ☐ Poor

ROOM NAME:	Wash Bay				
ROOM NUMBER:					
Thermostat?	☐ Yes ☑ No	Setting:	° F		
Temperature	65.6 ° F				
Relative Humidity	42 %				
Lighting:		Ballast	Footcandles		Controls
(18) 2-lamp, T8 Strips		Elec	9		Toggle
		All Lights On:	No		
Equipment:					
		Quantity			
Exhaust Fan	☐ Yes ☑ No				
Computer	☐ Yes ☑ No				
Hoses		6			
Exterior Doors:	☑ Yes ☐ No				
Standard Doors:	Quantity:	2, North & South	Door Condition:		
	Type:	Metal	☑ Good		
	Size:	3x7	☐ Fair		
			☐ Poor		
Shop Doors:	Quantity:	1, East	Door Condition:		
	Type:	Metal Garage	☑ Good		
	Size:	10x20	☐ Fair		
			☐ Poor		
Exterior Windows:	☐ Yes ☑ No				
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		
Windows:	Quantity:		Window Condition:		
	Type:		☐ Good		
	Size:		☐ Fair		
			☐ Poor		

ROOM NAME:	Exterior				
ROOM NUMBER:					
Thermostat?	☐ Yes ☐ No		Setting:	° F	
Temperature		° F			
Relative Humidity		%			

Lighting:	Ballast	Footcandles	Controls
Fix.1 - Metal Halides (15)			Photocell
Fix.2 - Above Washbay-MH (3)			Photocell
	All Lights On:	No	

Equipment:

	Yes	No	Quantity
Exhaust Fan	☐	☑	
Computer	☐	☑	
Hose Bib			2

Exterior Doors: ☐ Yes ☑ No

Standard Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Shop Doors:	Quantity:		Door Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Exterior Windows: ☐ Yes ☑ No

Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor
Windows:	Quantity:		Window Condition:
	Type:		☐ Good
	Size:		☐ Fair
			☐ Poor

Building Characteristics

Gross Floor Area		gross sf ,	ceiling ht		ft
		gross sf ,	ceiling ht		ft	* If multiple ceiling
		gross sf ,	ceiling ht		ft	heights

Conditioned Floor Area	Heating Only:		sf
	Cooling Only:		sf
	Heating and Cooling:		sf

Number of Conditioned Floors:

	Above Grade	1
	Below Grade	0

Total Standard Door Area	42	sf	Glass		sf	Door Condition:
			Wood		sf	☑ Good
			Metal	42	sf	☐ Fair
			Garage		sf	☐ Poor
Total Shop Door Area	458	sf	Glass		sf	Door Condition:
			Wood		sf	☑ Good
			Metal		sf	☐ Fair
			Garage	458	sf	☐ Poor

Office Exterior Glass Area	72	sf		Single Panes	72	sf	Window Condition:
(Note: Operable or Fixed)				Double Panes		sf	☐ Good
							☑ Fair
			North	Total Area		sf	☐ Poor
				Single Panes		sf	
				Double Panes		sf	
			South	Total Area	24	sf	
				Single Panes	24	sf	
				Double Panes		sf	
			East	Total Area	24	sf	
				Single Panes	24	sf	
				Double Panes	72	sf	
			West	Total Area	24	sf	
				Single Panes	24	sf	
				Double Panes		sf	

Shop Exterior Glass Area	24	sf	Single Panes	24	sf	Window Condition:
(Note: Operable or Fixed)			Double Panes		sf	[ ] Good
						[x] Fair
		North	Total Area		sf	[ ] Poor
			Single Panes		sf	
			Double Panes		sf	
		South	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	
		East	Total Area		sf	
			Single Panes		sf	
			Double Panes		sf	
		West	Total Area	24	sf	
			Single Panes	24	sf	
			Double Panes		sf	

Office Exterior Wall Area		sf	[x] Masonry	[ ] Stucco
			[ ] Wood	[ ] Other
			[ ] Concrete	[ ] Unknown
Shop Exterior Wall Area		sf	[x] Masonry	[ ] Stucco
			[ ] Wood	[ ] Other
			[ ] Concrete	[ ] Unknown
Total Roof Area		sf	Condition:	[x] Good
				[ ] Fair
				[ ] Poor

Insulation Type:	Roof:		If Provided on Building Plans.
	Wall:		
	Floor:		
Insulation Thickness:	Roof:		
	Wall:		
	Floor:		

Metering:

Is this building individually metered for electricity?	[ ] Yes	[x] No
Is this building individually metered for natural gas / LP?	[ ] Yes	[x] No
Is this building individually metered for water?	[ ] Yes	[x] No

Describe the general building condition:

HVAC DISTRIBUTION SYSTEM

Location of Unit(s)

Office Furnace

SYSTEM TYPE

- [x] Single Zone (Furnace, RTU, etc.)
- [ ] Multi Zone (i.e. AHU)
- [ ] Dual Duct
- [ ] Variable Air Volume
- [ ] Single Duct Reheat
- [ ] 2-Pipe Water
- [ ] 4-Pipe Water
- [ ] Window Unit
- [ ] Packaged Terminal Air Unit
- [ ] Unit Ventilator
- [ ] Fan Coil
- [ ] Unit Heater
- [ ] Other ________

MAINTENANCE

- [ ] Good
- [x] Fair
- [ ] Poor

"Bryant", "Payne", Natural Gas

Note: Items are stored very close to furnace.

DUCTWORK

Insulation:

- [ ] Good
- [ ] Fair
- [ ] Poor

No Insulation

Installation:

- [ ] Good
- [x] Fair
- [ ] Poor

CONTROLS

- [x] Space Thermostat
- [ ] Outside Temperature Sensors
- [ ] Time Clocks
- [ ] Energy Management System
- [ ] Auto Supply Temperature Reset
- [ ] Economy Cycle
- [ ] Heat Recovery
- [ ] Other ________

Style:
Non-programmable

Heated Bays

SYSTEM TYPE

- [ ] Single Zone
- [ ] Multi Zone
- [ ] Dual Duct
- [ ] Variable Air Volume
- [ ] Single Duct Reheat
- [ ] 2-Pipe Water
- [ ] 4-Pipe Water
- [ ] Window Unit
- [ ] Unit Ventilator
- [ ] Fan Coil
- [x] Unit Heater
- [ ] Other ______

MAINTENANCE

- [x] Good
- [ ] Fair
- [ ] Poor

Natural Gas. Very Clean.

CONTROLS

- [x] Space Thermostat
- [ ] Outside Temperature Sensors
- [ ] Time Clocks
- [ ] Energy Management System
- [ ] Auto Supply Temperature Reset
- [ ] Economy Cycle
- [ ] Heat Recovery
- [ ] Other ______

Style:
Non-programmable.

Wash Bay

SYSTEM TYPE

- [ ] Single Zone
- [ ] Multi Zone
- [ ] Dual Duct
- [ ] Variable Air Volume
- [ ] Single Duct Reheat
- [ ] 2-Pipe Water
- [ ] 4-Pipe Water
- [ ] Window Unit
- [ ] Unit Ventilator
- [ ] Fan Coil
- [x] Unit Heater
- [ ] Other ______

MAINTENANCE

- [x] Good
- [ ] Fair
- [ ] Poor

Radiant Heater. Natural Gas.

CONTROLS

- [ ] Space Thermostat
- [ ] Outside Temperature Sensors
- [ ] Time Clocks
- [ ] Energy Management System
- [ ] Auto Supply Temperature Reset
- [ ] Economy Cycle
- [ ] Heat Recovery
- [x] Other On/Off Toggle

DOMESTIC HOT WATER

Domestic Hot Water Heated By:

- [ ] Electricity
- [x] Natural Gas
- [ ] Oil
- [ ] Steam
- [ ] Heat Pump
- [ ] Other

"Reliance 606", Input = 32000BTUh, Recovery = 32.8 gal/hr, Capacity = 40 gallons

Number of Units:	1	
General Location of Units:	Storage Room	
Is there a re-circulation loop?	☐ Yes ☑ No	
Hot Water Temperature		
At Point of Use	117.3	°F
At Heater		°F
Temperature of City Water	53	°F
Date of Water Heater	1/1/1998	
Date of Installation		

Is the tank warm to the touch?	☐ Yes	☑ No
Are pipes insulated at least 3' from heater?	☑ Yes	☐ No
Any signs of leakage?	☐ Yes	☑ No
Requires maintenance?	☐ Yes	☑ No
Is the tank wrapped?	☐ Yes	☑ No
Do obstructions prevent wrapping?	☐ Yes	☑ No

Distance from Heater to Furthest Point of Use: 5'-10'

Hot Water Uses Other than Lavatories: No

WATER CONSUMPTION

Fixture Type	Quantity	Gal/Flush	Gal/Min	Low-Flow?	Aerators?
Water Closets (valve)	2	1.6			
Urinals	--				
Lavatories	2				
Service Sinks	--				
Showers	--				
Electric Water Coolers	1				
Dishwashers	--				
Hose Bibs	2				
Hoses	6				

Exhaust Fans tied to Lights?	☐ Yes	☑ No
HW Temperature =	117.3	°F
CW Temperature =	53	°F

Large Water Consumption Scenarios

	Yes	No	Time Period of Water Usage	Estimated Amount
Irrigation - Sprinkler System		x		
Filling Water Tanks	x			
Other: ______________				

SPECIALTY EQUIPMENT		
Item	Yes / No	Quantity
Refrigerators	Y	1
Mini-Fridges	N	
Freezers	N	
Walk-In Refrigerators	N	
Walk-In Freezers	N	
Infra-red Warmer Microwaves	Y	2
Mixers	N	
Ranges	N	
Ovens	N	
Dishwashers	N	
Hoods w/ Exhaust Fans	N	
Coffee Makers	N	
Pop Machines	N	
Vending Machines	N	
Ice Makers	N	
Space Heaters	N	
Copiers	N	
Fax Machines	N	
Scanners	N	
Printers	Y	1
Printer/Fax/Scan/Copy Machines	N	
Plotters	N	
Air Compressors	Y	1
Motors	N	
Presses	N	
Powder Paint Curing Oven	N	
Misc. Manual Shop Lathes/Mills	N	
Welding Machines	N	
Test Fixtures	N	
Exhaust Fans (Separate from Light)	N	
Computers	Y	2
Projector / Screen	N	
Radio Chargers	Y	7
Water Cooler	Y	2
Garage Motors	Y	4
Bench Grinders	Y	1
Radiant Heater	Y	1

Lighting

INTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

EXTERIOR

Building Area	Fixture Type	# of Fixtures	Watts per Fixture	Avg Footcandles	Ballast

Fixture Types:
Incandescent
Fluorescent
Mercury Vapor
High Pressure Sodium
Low Pressure Sodium
Metal Halide

Are lights on in unoccupied areas? ☐ Yes ☑ No
Is the exterior lighting on during the day? ☐ Yes ☑ No

How are lights operated?
- ☑ Toggle Switches
- ☐ Occupancy Switches
- ☑ Photovoltaic/Daylight Sensors
- ☐ Other ____________

Appendix C - Calculations

Table C.1 NPC and ROI Initial Costs

Item	Reference	Page #	Material		Labor	Total
Aluminum Windows, Double Pane	Gen	p.262	$ 355.00	Each	$ 77.50	$ 432.50
Aluminum Windows, Single Pane	Gen	p.262	$ 198.00	Each	$ 77.50	$ 275.50
Steel Windows, Double Pane	Gen	p.428	$ 220.00	Each	$ 81.50	$ 301.50
Steel Windows, Single Pane	Gen	p.428	$ 118.00	Each	$ 81.50	$ 199.50
Wood Windows, Double Pane	Gen	p.264	$ 276.00	Each	$ 34.50	$ 310.50
Wood Windows, Single Pane	Gen	p.264	$ 225.00	Each	$ 34.50	$ 259.50
Interior Hollow Metal Steel Door, 3'x7'	Gen	p.239	$ 345.00	Each	$ 40.50	$ 385.50
Exterior Hollow Metal Steel Door, 3'x7'	Gen	p.241	$ 415.00	Each	$ 49.00	$ 464.00
Avg 30-40 Gallon, Gas-Fired Water Heater	Plumb	p.451	$ 1,762.50	Each	$ 1,400.00	$ 3,162.50
5 Gallon Water Heater, Electric	Gen	p.472	$ 2,350.00	Each	$ 214.00	$ 2,564.00
10 Gallon Water Heater, Electric	Gen	p.472	$ 2,600.00	Each	$ 214.00	$ 2,814.00
Instananeous Water Heater, 6 Gal Electric	Plumb	p.269	$ 650.00	Each	$ 172.00	$ 822.00
Instananeous Water Heater, 10 Gal Electric	Plumb	p.269	$ 690.00	Each	$ 172.00	$ 862.00
Caulking, Latex Acrylic Based, 1/4"x1/4"	Gen	p.233	$ 0.09	LF	$ 1.15	$ 1.24
Caulking, Latex Acrylic Based, 3/8"x3/8"	Gen	p.233	$ 0.21	LF	$ 1.22	$ 1.43
Caulking, Polyurethane, 1/4"x1/4"	Gen	p.233	$ 0.16	LF	$ 1.15	$ 1.31
Fluorescent, Recessed, 2'x4', (2) 32W T8	Gen	p.550	$ 72.50	Each	$ 76.00	$ 148.50
Fluorescent, Recessed, 2'x4', (3) 32W T8	Gen	p.550	$ 76.50	Each	$ 80.50	$ 157.00
Fluorescent, Recessed, 2'x4', (4) 32W T8	--	--	--	--	--	--
Fluorescent, 4' long, T8 30W lamp	Gen	p.553	$ 8.95	Each	$ 4.45	$ 13.40
Fluorescent, 4' long, T5 28W lamp	Gen	p.554	$ 12.25	Each	$ 4.45	$ 16.70
Fluorescent, 4' long, T5 54W lamp	Gen	p.554	$ 17.75	Each	$ 4.45	$ 22.20
Fluorescent, Strip, 4' long, 2 lamp	--	--	--	--	--	--
Fluorescent, Strip, 8' long, 1 lamp	--	--	--	--	--	--
Fluorescent, Strip, 8' long, 2 lamp	--	--	--	--	--	--
25W Compact Fluorescent Lamp	Hardware	--	$ 2.74	Each	$ 4.45	$ 7.19
100W A-Lamp	Hardware	--	$ 1.37	Each	$ 4.45	$ 5.82
Thermostat, 24 hour, automatic, clock	Elec	p.80	$ 137.00	Each	$ 51.50	$ 188.50
Thermostat, Electric, Low Voltage, 2 Wire	Elec	p.80	$ 32.50	Each	$ 31.00	$ 63.50
Thermostat, Electric, Low Voltage, 3 Wire	Elec	p.80	$ 31.50	Each	$ 40.00	$ 71.50
Unit Ventilator, day/night operation, ASHRAE	Mech	p.489	$ 2,675.00	Each	$ 1,300.00	$ 3,975.00

RS Means book utilized to find values.

Table C.2 NPC and ROI Maintenance Costs

Item	Maintenance Cost					
	Material	Labor	Total	Description	Freq. (Yrs)	Total/Yr
Aluminum Windows, Double Pane	$ 1.62	$ 63.39	$ 65.01	Refinish	5	$ 13.00
Aluminum Windows, Single Pane	$ 1.62	$ 63.39	$ 65.01	Refinish	5	$ 13.00
Steel Windows, Double Pane	$ 1.62	$ 63.39	$ 65.01	Refinish	5	$ 13.00
Steel Windows, Single Pane	$ 1.62	$ 63.39	$ 65.01	Refinish	5	$ 13.00
Wood Windows, Double Pane	$ 1.62	$ 63.39	$ 65.01	Refinish	5	$ 13.00
Wood Windows, Single Pane	$ 1.62	$ 63.39	$ 65.01	Refinish	5	$ 13.00
Interior Hollow Metal Steel Door, 3'x7'	$ 11.50	$ 31.88	$ 43.38	Refinish	4	$ 10.85
Exterior Hollow Metal Steel Door, 3'x7'	$ 11.50	$ 31.88	$ 43.38	Refinish	4	$ 10.85
Average 30-40 Gallon, Gas-Fired Water Heater	--	$ 1.83	$ 1.83	Check-Up	3	$ 0.61
5 Gallon Water Heater, Electric	--	$ 1.83	$ 1.83	Check-Up	3	$ 0.61
10 Gallon Water Heater, Electric	--	$ 1.83	$ 1.83	Check-Up	3	$ 0.61
Instananeous Water Heater, 6 Gallon Electric	--	$ 1.83	$ 1.83	Check-Up	3	$ 0.61
Instananeous Water Heater, 10 Gallon Electric	--	$ 1.83	$ 1.83	Check-Up	3	$ 0.61
Caulking, Latex Acrylic Based, 1/4"x1/4"	$ 3.41	$ 8.23	$ 11.64	Re-Caulk	20	$ 0.58
Caulking, Latex Acrylic Based, 3/8"x3/8"	$ 3.41	$ 8.23	$ 11.64	Re-Caulk	20	$ 0.58
Caulking, Polyurethane, 1/4"x1/4"	$ 3.41	$ 8.23	$ 11.64	Re-Caulk	20	$ 0.58
Fluorescent, Recessed, 2'x4', (2) 32W T8	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
Fluorescent, Recessed, 2'x4', (3) 32W T8	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
Fluorescent, Recessed, 2'x4', (4) 32W T8	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
Fluorescent, 4' long, T8 30W lamp	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
Fluorescent, 4' long, T5 28W lamp	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
Fluorescent, 4' long, T5 54W lamp	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
Fluorescent, Strip, 4' long, 2 lamp	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
Fluorescent, Strip, 8' long, 1 lamp	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
Fluorescent, Strip, 8' long, 2 lamp	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
25W Compact Fluorescent Lamp	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
100W A-Lamp	$ 7.70	$ 15.22	$ 22.92	Replace	10	$ 2.29
Unit Ventilator, day/night operation, ASHRAE	$ 285.00	$ 179.90	$ 464.90	Repair	10	$ 46.49

Table C.3 NPC and ROI Annual Energy Costs

Item	Annual Energy Cost	
Window Type		
Double-glazed, Non-metal Frame	$	750.00
Double-glazed, Metal Frame with Thermal Break	$	950.00
Single-glazed, Clear Glass, Non-metal Frame	$	1,150.00
Single-glazed, Clear Glass, Metal Frame	$	1,250.00
* Software from DOE website, with energy correlating to heat loss/gain alowed by window assembly		
Electric Water Heater (35 gallon typ. Use)	$	182.00
* Calculator from DOE website		
Installed Water Heater, Gas-Fired, $0.60/therm	$	160.00
* Calculator from DOE website		

Plumbing Fixture	Annual Water Cost	
0.5 GPF Urinal	$	10.80
1.5 GPF Urinal	$	32.40
1.28 GPF Water Closet	$	27.64
1.6 GPF Water Closet	$	34.56
0.5 GPM Lavatory Faucet	$	10.80
1.5 GPM Lavatory Faucet	$	32.40
* Software from DOE website		

Table C.4 NPC and ROI Demolition Costs

Item	Demolition Cost				
	Book	Page #	Material	Labor	Total
Aluminum Windows, Double Pane	General	p. 236	--	$ 17.20	--
Aluminum Windows, Single Pane	General	p. 236	--	$ 17.20	--
Steel Windows, Double Pane	General	p. 236	--	$ 21.00	--
Steel Windows, Single Pane	General	p. 236	--	$ 21.00	--
Wood Windows, Double Pane	General	p. 236	--	$ 12.50	--
Wood Windows, Single Pane	General	p. 236	--	$ 12.50	--
Interior Hollow Metal Steel Door, 3'x7'	--	--	--	--	--
Exterior Hollow Metal Steel Door, 3'x7'	--	--	--	--	--
Average 30-40 Gallon, Gas-Fired Water Heater	General	p.453	--	$ 71.50	$ 71.50
5 Gallon Water Heater, Electric	General	p.453	--	$ 71.50	$ 71.50
10 Gallon Water Heater, Electric	General	p.453	--	$ 71.50	$ 71.50
Instananeous Water Heater, 6 Gallon Electric	General	p.453	--	$ 71.50	$ 71.50
Instananeous Water Heater, 10 Gallon Electric	General	p.453	--	$ 71.50	$ 71.50
Caulking, Latex Acrylic Based, 1/4"x1/4"	--	--	--	--	--
Caulking, Latex Acrylic Based, 3/8"x3/8"	--	--	--	--	--
Caulking, Polyurethane, 1/4"x1/4"	--	--	--	--	--
Fluorescent, Recessed, 2'x4', (2) 32W T8	General	p.525	--	$ 24.50	$ 24.50
Fluorescent, Recessed, 2'x4', (3) 32W T8	--	--	--	--	--
Fluorescent, Recessed, 2'x4', (4) 32W T8	General	p.525	--	$ 27.00	$ 27.00
Fluorescent, 4' long, T8 30W lamp	General	p.525	--	$ 15.20	$ 15.20
Fluorescent, 4' long, T5 28W lamp	General	p.525	--	$ 15.20	$ 15.20
Fluorescent, 4' long, T5 54W lamp	General	p.525	--	$ 15.20	$ 15.20
Fluorescent, Strip, 4' long, 2 lamp	General	p.525	--	$ 16.10	$ 16.10
Fluorescent, Strip, 8' long, 1 lamp	General	p.525	--	$ 19.15	$ 19.15
Fluorescent, Strip, 8' long, 2 lamp	General	p.525	--	$ 20.00	$ 20.00
25W Compact Fluorescent Lamp	--	--	--	--	--
100W A-Lamp	General	p. 525	--	$5.00	--
Thermostat, 24 hour, automatic, clock	--	--	--	--	--
Thermostat, Electric, Low Voltage, 2 Wire	--	--	--	--	--
Thermostat, Electric, Low Voltage, 3 Wire	--	--	--	--	--
Unit Ventilator, day/night operation, ASHRAE	General	p.486	--	$ 865.00	$ 865.00

Note: A -- in a cell indicate no demolition cost included.

Table C.5 NPC and ROI Example Calculation

Net Present Worth Calculation - 5 Gallon Water Heater, Electric				
Item's First Cost	$ 2,564.00	Life:	20	Yrs
		Interest Rate:	6	%
Maintenance Cost:	$ 0.61			
Annual Energy Cost:	$ 182.00			
Demo Cost:	$ 71.50			
Salvage Cost:	$ -			
NPW =	(Item's First Cost) + (Annual Maintenance Cost)(P/A,i,n) + (Annual Energy Cost)(P/A,i,n) - (Demo Cost)(P/F,i,n) + (Salvage Cost)			
				(Stokes, 2012)
NPW =	$ 4,887.83			
Definitions/Assumptions:				
First Cost - Initial Cost for Purchasing and Installing (Means)				
Annual Maintenance Cost - Annual Costs Associated with Maintenance (Means)				
Demo Cost - The cost at the end of an item's life to remove it (Means)				
Salvage Cost - The value of an item after the life span is over.				
Salvage Cost was set at zero for calculations to remain conservative.				
(P/F, i, n)=	F * (1+i)^n		(Newman, 2011)	
(P/A, i, n)=	A *((((1+i)^n)-1)/(i(1+i)^n))		(Newman, 2011)	
Electricity: $0.07 kWh / Lights on 60hrs/wk and 52wk/yr				
Natural Gas:	$0.60/therm, (1 therm = 100000 BTUh)			

Table C.6 NOC and ROI Aluminum Window Calculations

Net Present Worth Calculation - Aluminum Windows, Double Pane					
Item's First Cost	$ 432.50		Life:	20	Yrs
			Interest Rate:	6	%
Maintenance Cost:	$ 13.00				
Annual Energy Cost:	$ 950.00				
Demolition Cost:	$ 17.20				
	NPW =	$ 11,533.20			
Net Present Worth Calculation - Aluminum Windows, Single Pane					
Item's First Cost	$ 275.50		Life:	20	Yrs
			Interest Rate:	6	%
Maintenance Cost:	$ 13.00				
Annual Energy Cost:	$ 1,250.00				
	NPW =	$ 14,762.01			
Aluminum Windows, Double vs. Single Pane					
ROI =	ΔA / ΔP		Payback =	ΔP / ΔA	
ROI =	(1250.00-950.00) / |(275.50-432.50)|		Payback =	|(275.50-432.50)| / (1250.00-950.00)	
ROI =	191.08	%	Payback =	0.52	Years

Table C.7 NPC and ROI Steel Window Calculations

	Net Present Worth Calculation - Steel Windows, Double Pane					
Item's First Cost	$ 301.50		Life:	20	Yrs	
			Interest Rate:	6	%	
Maintenance Cost:	$ 13.00					
Annual Energy Cost:	$ 950.00					
Demolitian Cost:	$ 21.00					
	NPW =	$ 11,414.38				
	Net Present Worth Calculation - Steel Windows, Single Pane					
Item's First Cost	$ 199.50		Life:	20	Yrs	
			Interest Rate:	6	%	
Maintenance Cost:	$ 13.00					
Annual Energy Cost:	$ 1,250.00					
	NPW =	$ 14,686.01				
	Steel Windows, Double vs. Single Pane					
ROI =	$\frac{\Delta A}{\Delta P}$		Payback =	$\frac{\Delta P}{\Delta A}$		
ROI =	$\frac{(1250.00-950.00)}{\lvert(199.50-301.50)\rvert}$		Payback =	$\frac{\lvert(199.50-301.50)\rvert}{(1250.00-950.00)}$		
ROI =	294.12	%	Payback =	0.34	years	

Table C.8 NPC and ROI Wood Window and Metal Door Calculations

	Net Present Worth Calculation - Wood Windows, Double Pane					
Item's First Cost	$	310.50		Life:	20	Yrs
				Interest Rate:	6	%
Maintenance Cost:	$	13.00				
Annual Energy Cost:	$	750.00				
Demolition Cost:	$	12.50				
		NPW =	$ 9,021.96			
	Net Present Worth Calculation - Wood Windows, Single Pane					
Item's First Cost	$	259.50		Life:	20	Yrs
				Interest Rate:	6	%
Maintenance Cost:	$	13.00				
Annual Energy Cost:	$	1,150.00				
		NPW =	$ 13,599.02			
	Wood Windows, Double vs. Single Pane					
	ROI =	ΔA		Payback =	ΔP	
		ΔP			ΔA	
	ROI =	(1150.00-750.00)		Payback =	|(259.50-301.50)|	
		|(259.50-310.50)|			(1150.00-750.00)	
	ROI =	784.31	%	Payback =	0.13	years
	Net Present Worth Calculation - Interior Metal Door					
Item's First Cost	$	385.50		Life:	20	Yrs
				Interest Rate:	6	%
Maintenance Cost:	$	10.85				
		NPW =	$ 509.95			
	Net Present Worth Calculation - Exterior Metal Door					
Item's First Cost	$	464.00		Life:	20	Yrs
				Interest Rate:	6	%
Maintenance Cost:	$	10.85				
		NPW =	$ 588.45			

Table C.9 NPC and ROI Electric Water-Heater Calculations

	Net Present Worth Calculation - 5 Gallon Water Heater, Electric					
Item's First Cost	$ 2,564.00			Life:	20	Yrs
				Interest Rate:	6	%
Maintenance Cost:	$ 0.61					
Annual Energy Cost:	$ 182.00					
Demo Cost:	$ 71.50					
Salvage Cost:	$ -					
		NPW =	$ 4,887.83			
	Installed Water Heater: 30-40 Gallons, Avg: 34375 Btuh Input					
P =	$ 3,162.00					
A =	$ 160.00					
	Return on Investment - Water Heater - Installed vs. 5 Gallon					
ROI =	ΔA			Payback =	ΔP	
	ΔP				ΔA	
ROI =	(160.00-182.00)					
	|(3162.00-2564.00)|					
ROI =	(3.68)	%		Payback =	0	years
	Net Present Worth Calculation - 10 Gallon Water Heater, Electric					
Item's First Cost	$ 2,814.00			Life:	20	Yrs
				Interest Rate:	6	%
ıual Maintenance Cost:	$ 0.61					
Annual Energy Cost:	$ 364.00					
Demo Cost:	$ 71.50					
Salvage Cost:	$ -					
		NPW =	$ 7,225.36			
	Return on Investment - Water Heater - Installed vs. 10 Gallon					
ROI =	ΔA			Payback =	ΔP	
	ΔP				ΔA	
ROI =	(160.00-364.00)					
	|(3162.00-2814.00)|					
ROI =	(58.62)	%		Payback =	0	years

Table C.10 NPC and ROI Instantaneous Water-Heater Calculations

Net Present Worth Calculation - Instananeous Water Heater, 6 Gallon Elec					
Item's First Cost	$ 822.00		Life:	20	Yrs
			Interest Rate:	6	%
ıual Maintenance Cost:	$ 0.61				
Annual Energy Cost:	$ 182.00				
Demo Cost:	$ 71.50				
Salvage Cost:	$ -				
	NPW =	$ 3,145.83			

Return on Investment - Water Heater - Installed vs. 6 Gal Instant				
ROI =	ΔA		Payback =	ΔP
	ΔP			ΔA
ROI =	(160.00-182.00)			
	|(3162.00-822.00)|			
ROI =	(0.94)	%	Payback =	0 years

Net Present Worth Calculation - Instananeous Water Heater, 10 Gallon Elec					
Item's First Cost	$ 862.00		Life:	20	Yrs
			Interest Rate:	6	%
ıual Maintenance Cost:	$ 0.61				
Annual Energy Cost:	$ 364.00				
Demo Cost:	$ 71.50				
Salvage Cost:	$ -				
	NPW =	$ 5,273.36			

Return on Investment - Water Heater - Installed vs. 10 Gal Instant				
ROI =	ΔA		Payback =	ΔP
	ΔP			ΔA
ROI =	(160.00-364.00)			
	|(3162.00-862.00)|			
ROI =	(8.87)	%	Payback =	0 years

Table C.11 NPC and ROI Sealant and Lighting Calculations

Net Present Worth Calculation - Caulking, Latex Acrylic Based, 1/4"x1/4"				
Item's First Cost	$ 1.24	per LF	Life:	20 Yrs
			Interest Rate:	6 %
Maintenance Cost:	$ 0.58			
Annual Energy Cost:	$ -			
	NPW =	$ 7.89		

Net Present Worth Calculation - Caulking, Latex Acrylic Based, 3/8"x3/8"				
Item's First Cost	$ 1.43	per LF	Life:	20 Yrs
			Interest Rate:	6 %
Maintenance Cost:	$ 0.58			
Annual Energy Cost:	$ -			
	NPW =	$ 8.08		

Net Present Worth Calculation - Caulking, Polyurethane, 1/4"x1/4"				
Item's First Cost	$ 1.31	per LF	Life:	20 Yrs
			Interest Rate:	6 %
Maintenance Cost:	$ 0.58			
Annual Energy Cost:	$ -			
	NPW =	$ 7.96		

Net Present Worth Calculation - Fluorescent, Recessed, 2'x4', (2) 32W T8				
Item's First Cost	$ 148.50		Life:	20 Yrs
			Interest Rate:	6 %
Maintenance Cost:	$ 2.29			
Annual Energy Cost:	$ 13.98			
Demo Cost:	$ 24.50			
	NPW =	$ 413.66		

Net Present Worth Calculation - Fluorescent, Recessed, 2'x4', (3) 32W T8				
Item's First Cost	$ 157.00		Life:	20 Yrs
			Interest Rate:	6 %
Maintenance Cost:	$ 2.29			
Annual Energy Cost:	$ 20.97			
Demo Cost:	$ 27.00			
	NPW =	$ 510.34		

Table C.12 NPC and ROI Lighting Calculations

Net Present Worth Calculation - Fluorescent, 4' long, (2) T8 30W lamp fixture					
Item's First Cost	$ 109.50		Life:	20	Yrs
			Interest Rate:	6	%
Maintenance Cost:	$ 4.58				
Annual Energy Cost:	$ 13.10				
Demo Cost:	$ 15.20				
	NPW =	$ 361.08			
Return on Investment - T12 & T8					
ROI =	ΔA		Payback =	ΔP	
	ΔP			ΔA	
ROI =	(23.59-13.10)		Payback =	|(0-109.50)|	
	|(0-109.50)|			(23.59-13.10)	
ROI =	9.57	%	Payback =	10.45	years
Net Present Worth Calculation - Fluorescent, 4' long, (2) T5 28W lamp fixture					
Item's First Cost	$ 109.50		Life:	20	Yrs
			Interest Rate:	6	%
Maintenance Cost:	$ 4.58				
Annual Energy Cost:	$ 12.24				
Demo Cost:	$ 15.20				
	NPW =	$ 351.17			
Return on Investment - T12 & T5					
ROI =	ΔA		Payback =	ΔP	
	ΔP			ΔA	
ROI =	(23.59-12.24)		Payback =	|(0-109.50)|	
	|(0-109.50)|			(23.59-12.24)	
ROI =	10.36	%	Payback =	9.65	years
Net Present Worth Calculation - Fluorescent, 4' long, T12 54W lamp					
Item's First Cost	$ -		Life:	20	Yrs
			Interest Rate:	6	%
nual Maintenance Cost:	$ 4.58				
Annual Energy Cost:	$ 23.59				
Demo Cost:	$ 15.20				
	NPW =	$ 371.82			

Table C.13 NPC and ROI CFL and Incandescent Calculations

	Net Present Worth Calculation - Compact Fluorescent, 25W					
Item's First Cost	$ 7.19			Life:	20	Yrs
				Interest Rate:	6	%
Maintenance Cost:	$ 2.29					
Annual Energy Cost:	$ 5.84					
Demo Cost:	$ 5.00					
		NPW =	$ 116.48			
	Net Present Worth Calculation - Incandescent A-Lamp, 100W					
Item's First Cost	$ 5.82			Life:	20	Yrs
				Interest Rate:	6	%
Maintenance Cost:	$ 2.29					
Annual Energy Cost:	$ 23.36					
Demo Cost:	$ 5.00					
		NPW =	$ 316.06			
	Return on Investment - CFL and Incandescent					
ROI =	ΔA		Payback =	ΔP		
	ΔP			ΔA		
ROI =	(23.36 - 5.84)		Payback =	|(5.82-7.19)|		
	|(5.82 - 7.19)|			(23.36-5.84)		
ROI =	1,278.83	%	Payback =	0.08	years	

Table C.14 NPC and ROI Controls Calculations

Item's First Cost	$ 188.50	Life:	20	Yrs
		Interest Rate:	6	%
Maintenance Cost:	$ -			
Annual Utility Cost:	$ -			
NPW =	$ 188.50			

Net Present Worth Calculation - Thermostat, Electric, Low Voltage, 2 Wire

Item's First Cost	$ 63.50	Life:	20	Yrs
		Interest Rate:	6	%
Maintenance Cost:	$ -			
Annual Utility Cost:	$ -			
NPW =	$ 63.50			

Net Present Worth Calculation - Thermostat, Electric, Low Voltage, 3 Wire

Item's First Cost	$ 71.50	Life:	20	Yrs
		Interest Rate:	6	%
Maintenance Cost:	$ -			
Annual Utility Cost:	$ -			
NPW =	$ 71.50			

Net Present Worth Calculation - Clock Dial Time Switch, 24 hour, w/ enclosure

Item's First Cost	$ 173.00	Life:	20	Yrs
		Interest Rate:	6	%
Maintenance Cost:	$ -			
Annual Utility Cost:	$ -			
NPW =	$ 173.00			

Net Present Worth Calculation - Unit Ventilator, day/night operation, ASHRAE

Item's First Cost	$ 3,975.00	Life:	20	Yrs
		Interest Rate:	6	%
Maintenance Cost:	$ 46.49			
Annual Energy Cost:	$ -			
Demo Cost:	$ 865.00			
NPW =	$ 7,282.41			

Table C.15 NPC and ROI Water Closet Calculations

Item's First Cost	$ 688.00		Life:	20	Yrs
			Interest Rate:	6	%
Maintenance Cost:	$ -				
Annual Energy Cost:	$ 56.00				
			* Assuming $4.00/1000gal		
Demo Cost:	$ -				
	NPW =	$ 1,330.32			
	Net Present Worth Calculation - In-Place 1.6 Water Closet				
Item's First Cost	$ -		Life:	20	Yrs
			Interest Rate:	6	%
Maintenance Cost:	$ -				
Annual Energy Cost:	$ 70.00				
			* Assuming $4.00/1000gal		
Demo Cost:	$ 53.50				
	NPW =	$ 974.48			
Return on Investment - Replacing a Water Closet					
ROI =	ΔA		Payback =	ΔP	
	ΔP			ΔA	
ROI =	(70-56)		Payback =	|(0.00-688.00)|	
	|(0.00-688.00)|			(70-56)	
ROI =	2.03	%	Payback =	49.14	Years

Table C.16 NPC and ROI Lavatory Faucet Calculations

	Net Present Worth Calculation - 0.5 GPM Lavatory Faucet					
Item's First Cost	$ 87.50			Life:	20	Yrs
				Interest Rate:	6	%
Maintenance Cost:	$ -					
Annual Energy Cost:	$ 22.00					
			* Assuming $4.00/1000gal			
Demo Cost:	$ -					
		NPW =	$ 339.84			
	Net Present Worth Calculation - In-Place GPM Lavatory Faucet					
Item's First Cost	$ -			Life:	20	Yrs
				Interest Rate:	6	%
Maintenance Cost:	$ -					
Annual Energy Cost:	$ 66.00					
			* Assuming $4.00/1000gal			
Demo Cost:	$ 43.00					
		NPW =	$ 894.92			
	Return on Investment - Replacing a Lavatory Faucet					
	ROI =	ΔA		Payback =	ΔP	
		ΔP			ΔA	
	ROI =	(66-22)		Payback =	|(0.00-87.50)|	
		|(0.00-87.50)|			(66-22)	
	ROI =	50.29	%	Payback =	1.9886	Years

Table C.17 Light Power-Density Calculation Results

2	2	Belleville	1.25	0.56
3	3	Russell	0.42	0.23
4	3	Altamont	0.21	0.40
5	4	Larned	0.61	0.33
6	2	Jetmore	0.71	0.28

District	Area	City Office	LPD - Bays, W/SF	Energy Use/Bays SF, kWh/SF
1	1	Atchison	0.46	0.87
2	2	Belleville	0.71	0.86
3	3	Russell	0.52	0.35
4	3	Altamont	0.90	0.33
5	4	Larned	1.07	0.48
6	2	Jetmore	0.62	0.38

District	Area	City Office	LPD - Office & Bays, W/SF	Energy Usage/O&B SF, kWh/SF
1	1	Atchison	0.98	0.34
2	2	Belleville	1.06	0.34
3	3	Russell	0.46	0.14
4	3	Altamont	0.59	0.18
5	4	Larned	0.80	0.20
6	2	Jetmore	0.67	0.16

Table C.18 Light Power-Density Calculations

Interior Office Calculation					*Heated/Unheated Bay Calculation*				
Location:	**Altamont**				**Location:**	**Altamont**			
Office SF:	2431	SF			Bay SF:	2920	SF		
Lamp Type	Quantity	Wattage	Total W		Lamp Type	Quantity	Wattage	Total W	
T8, 32W	16	32	512		T8, 32W	82	32	2624	
			0.21	W/SF				0.90	W/SF
Location:	**Atchison**				**Location:**	**Atchison**			
Office SF:	4551	SF			Bay SF:	2960	SF		
Lamp Type	Quantity	Wattage	Total W		Lamp Type	Quantity	Wattage	Total W	
T12, 34W	124	34	4216		8',T12, 75W	18	75	1350	
Incan, 60W	30	60	1800						
			1.32	W/SF				0.46	W/SF
Location:	**Belleville**				**Location:**	**Belleville**			
Office SF:	4548	SF			Bay SF:	2920	SF		
Lamp Type	Quantity	Wattage	Total W		Lamp Type	Quantity	Wattage	Total W	
T5,T8, 32W	102	32	3264		HPS	15	150	2250	
Incan, 100W	24	100	2400						
			1.25	W/SF				0.77	W/SF
Location:	**Jetmore**				**Location:**	**Jetmore**			
Office SF:	2705	SF			Bay SF:	1960	SF		
Lamp Type	Quantity	Wattage	Total W		Lamp Type	Quantity	Wattage	Total W	
T8, 32W	40	32	1280		T8, 32W	32	32	1024	
Incan, 100W	5	100	500		Incan, 100W	2	100	200	
CFL, 32W	4	32	128						
			0.71	W/SF				0.62	W/SF
Location:	**Larned**				**Location:**	**Larned**			
Office SF:	4227	SF			Bay SF:	2920	SF		
Lamp Type	Quantity	Wattage	Total W		Lamp Type	Quantity	Wattage	Total W	
T12, 34W	24	34	816		T12, 34W	16	34	544	
T12, 40W	16	40	640		T5, 54W	44	54	2376	
T5, 54W	8	54	432		Incan, 100W	2	100	200	
Incan, 100W	7	100	700						
			0.61	W/SF				1.07	W/SF
Location:	**Russell**				**Location:**	**Russell**			
Office SF:	4479	SF			Bay SF:	2920	SF		
Lamp Type	Quantity	Wattage	Total W		Lamp Type	Quantity	Wattage	Total W	
T5HO, 28W	58	28	1624		T5HO, 28W	54	28	1512	
Incan, 100W	2	100	200						
Incan, 60W	1	60	60						
			0.42	W/SF				0.52	W/SF

Appendix D - Copyright

Gmail by Google

Kimberly Pierson <kdpwildcat@gmail.com>

Fwd: climate zone map

1 message

Julia Keen <jkeen@ksu.edu> Mon, Aug 27, 2012 at 10:07 AM
To: Kimberly Pierson <kdpwildcat@gmail.com>, Becky Gentry <bgentry@ksu.edu>

To be included in the report
---------- Forwarded message ----------
From: **Comstock, Steve** <comstock@ashrae.org>
Date: Mon, Aug 27, 2012 at 10:01 AM
Subject: climate zone map
To: Julia Keen <jkeen@ksu.edu>
Cc: "Michaels, Cindy" <CMichaels@ashrae.org>, "Harr, Julie" <JHarr@ashrae.org>

Hi, Julia,

Permission is granted for use of the climate zone chart from the AEDGs in the study you are preparing for I believe the State Highway Department.

The citation should read as follows: © 2003 *ASHRAE Transactions* 109(1):109–121, Briggs, et al.

If you have questions, please let me know.

Steve

W. Stephen Comstock, Publisher/Director of Publications & Education
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