Building Monitoring System

AHFC Headquarters
Chugach Manor
Glacier View - Seward

Alaska Housing Finance Corporation

Deliverable One – Tasks 3, 7, 9, 10
Final Report
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Section 1

Introduction

BACKGROUND

The goal of this project is to demonstrate the potential for building monitoring systems to improve the energy efficiency of Alaska Housing Finance Corporation buildings. By monitoring the buildings, we intend to gather and display data that is useful to assessing the real-time operation of the systems. The data will be useful to building operators, energy auditors, and designers.

New capabilities for improving the energy efficiency of AHFC properties will be developed including training of operating personnel on the building energy systems, recommending incentives for gains in energy efficiency, the gathering of useful data on daily, weekly, monthly, and annual energy performance, and displaying the data in a manner that gives operators information and sets goals toward improvement.

The monitoring systems will also provide valuable information as a research tool. Monitoring will save the most energy when applied to systems that have complicated and prone-to-fail control systems (e.g. sidewalk snowmelt) and systems where the operator can control the level and schedule of the system (e.g. ventilation systems). We can demonstrate to other operators and designers the long-term costs of poor design calculations and assumptions.

Philosophy

A project is more successful if it is guided by a shared philosophy about the desired goals and objectives. Our philosophy is tightly coupled to our past experience with AHFC properties and operations. We take an owner’s perspective in our work for AHFC; a unique perspective that can only be developed through established relationships and successful collaboration. Our approach to this project builds on that foundation. The work is based on the following guiding philosophy:

- We will perform the work in a manner that produces results that are most beneficial to AHFC. While the following narrative represents our best attempt to define the project, we expect to adjust our efforts as we gather data and learn more about what is most useful to AHFC.
- Comprehensive data gathering is essential to making good decisions as we move through the tasks. Only after we have gathered information on the systems, energy use, and operations of each building will we make collaborative decisions on which buildings to monitor, the systems to monitor, energy policy components, and the monitoring data most useful to improving energy efficiency.
- The success of this project is closely tied to the installation of three building monitoring systems that are well-designed and user friendly. The monitoring systems will demonstrate the use of the technology to improve a building’s energy efficiency and set the standard for monitoring future AHFC facilities (lessons will be learned). Monitoring is the essential tool for measuring the success of this project.

By identifying the best monitoring opportunities, our goal is to deliver a quality monitoring system that fully demonstrates the long-term benefits of monitoring. Our goal is to monitor many different systems so we can demonstrate monitoring benefits for future projects.

BUILDING MONITORING

The following tasks are presented in this deliverable:

- Preliminary Data Collection: Preliminary research is an essential step to gaining knowledge of the buildings and their operation.
- Existing Building Monitoring Systems (Task 9): This section provides information on the monitoring potential of each system.
- Research BMS Potential (Task 5): This section describes the monitoring potential of existing building monitoring systems.
- Identify Buildings for Monitoring Systems (Task 10): This section describes the monitoring potential of each building and provides recommendations on which buildings to monitor.
- Best Practices for Building Monitoring (Task 3): This section describes the opportunities and benefits of monitoring the buildings.
- Determine Useful Data Reports (Task 6): The section describes the proposed data reports and their usefulness to AHFC.
- Internet Security and IT Issues (Task 4): This section describes the issues associated with using the AHFC IT systems to transmit the monitoring data.
- Identify Monitored Systems for Commercial Buildings (Task 7): This section describes the monitoring opportunities that are typically available in commercial buildings.
- Identify Remote Control Costs (Task 12): This section describe options and the cost of remote control of building systems.

Section 2

Preliminary Information Collection

INTRODUCTION

Information was collected on the twenty facilities and was confirmed through discussions with AHFC construction and operating personnel. This section summarizes the information on the facilities.

BUILDINGS

Anchorage AHFC Headquarters

Building: Four stories plus basement, 77,900 sqft, 200 occupants

Drawing Record: 2012 HVAC Replacement

Heating System

- Boilers: Three Weil McLain Condensing boilers, 702 MBH each
- Pumps: Primary secondary pumping, variable speed secondary pumps

Ventilation Systems

- Rooftop air handling unit with return fan, mixing box, heating coil, cooling coil, and supply fans. 50,000 cfm,

Exhaust Fans

- EF-1 Toilet Exhaust Fan: 3,000 cfm

Domestic Hot Water System

- 50 gallon electric hot water heater

Lighting Systems

- Interior:
- Exterior:

DDC Controls: DDC system controls HVAC system

BMS: DDC system capable but not configured as a BMS

Anchorage Chugach View

Building: Three story with 120 units. 96,500 square feet.

Drawing Record: 2001 Interior Renovation.

Heating System: Two identical boiler rooms installed in 2012, each as follows:

- Boilers: Two modulating gas boilers 1,290 MBH output each, modulating burners, internal boiler control, both boilers operate simultaneously.
- Pumps: Two variable speed heating pumps flow through boilers and building. Speed and lead/lag controlled by Tekmar controllers.
- Control panel (Tekmar controllers) provide OSA reset control with low limit of 138°F for DHW heating.
- HX-1: Glycol heating loop for UV-1 (two ea), finned tube, and snowmelt.
- HX-2: Glycol heating loop for UV-1 (two ea) and finned tube.

Snowmelt

- HX-1 supplies glycol heating water. 2,500 sqft
- Controls: Tekmar controller, sensor in slab, works well.

Ventilation Systems

- UV-1 Cabinet Unit Ventilator (4 total): Corridors. Disabled.
- Laundry Rooms: HRV-1 and HRV-2, 650 cfm supplying 3 rooms, operate 24/7. No knowledge of defrost operation.

Exhaust Fans

- Apartments: Toilet exhaust fans, range hood.
- Crawlspace: Panasonic EFs on humidistat
- Trash room
- Elevator equipment

Domestic Hot Water Systems: In each boiler room

- Indirect hot water heater Aerco Smartplate
- Separate storage tanks
- Hot Water Recirculation Pump

Lighting Systems

- Interior: On all the time. Not energy efficient.
- Exterior: Photocell control.

DDC Controls

- Boiler control panel
- DDC controls for HRVs; no computer interface

Anchorage Chugach Manor

Building: Three story with 120 units. 114,431 square feet.

Drawing Record: 2003 Renovation

Heating System: Two identical boiler rooms installed in 2012, each as follows:

- Boilers: Four modulating gas boilers 1,358 MBH output each, type burners, W-M boiler control panel stages boilers.
- Pumps: Primary secondary pumping arrangement.
- Boiler Pumps: Constant speed, PMP-3
    a. Heating Pumps
        1) PMP-1/1A: VFD drives. DDC system provides lead/lag and modulating control.
        2) PMP-2/2A: VFD drives. DDC system provides lead/lag and modulating control.
        3) PMP-6: Serves AHU-1/ HC-2 and HC-3
        4) PMP-8: SF-1/ HC-4
        5) PMP-9: SF-2/ HC-5
        6) Minimum flow control valve in boiler room.

Snowmelt System: HX-2 and HX-3, PMP-5; Tekmar panel with sensor in slab, south side, uses bag of ice in spring. 5,000 sqft.

Cooling System: Compressor/condenser unit with cooling coil in AHU-1

Ventilation Systems

- AHU-1 2nd and 3rd Floor Lounge: 2,940 cfm, mixed air system with cooling coil and reheat coils HC-2 and HC-3, DDC schedule not used, continuously operated.
- VF-1 Boiler Room: 3,175 CFM
- VF-2 Crawlspace: 790 cfm Humidistat control, may be several
- SF-1 W103 2,740 cfm: (Laundry Room)
- SF-2 E103 2,740 cfm (Laundry Room)

Exhaust Fans

- Public Toilets (4): Ceiling exhaust fans, 100 cfm
    a. Apartments Bathrooms: Toilet exhaust fans
    b. Apartment Kitchen: Range Hood, 200 cfm

Domestic Hot Water Systems: In each boiler room

- Two Smartplate heaters, instantaneous heaters
- Hot Water Recirculation Pump PMP-4

Lighting Systems

- Interior: On 24/7 T-8 and CFL; Common spaces meeting, lounge on all the time, some OS in storage rooms
- Exterior: Photocell controlled

DDC Control System: Pumps, Ventilation, Room Temperatures; not used for BMS or trending. Used for monitoring and control.

Anchorage – Family Investment Center

Building: Two story, 9,300 sqft

Drawing Record

- 1976 Original Mechanical
- 2012 Renovation

HVAC System: Roof mounted AHUs with gas heating unit, cooling coil and compressor/condenser

Exhaust Fans: Toilet exhaust fans

Domestic Hot Water Systems: Electric hot water heater

Lighting Systems

- Interior: T8 fluorescents
- Exterior: Photocell control

DDC Controls: DDC

BMS: Not used

Anchorage Lane Public Housing

Description: One 9-plex and two 8-plex

Heating System: New gas boilers, condensing. Single pump. Indirect hot water tank

Ventilation System: None

Exhaust Systems: Toilet exhaust and kitchen exhaust

Controls: None

Monitoring Opportunities: None.

Anchorage Taylor Public Housing

Description: One 8-plex.

Heating System: Gas boiler, not-condensing. Indirect hot water tank

Ventilation System: None

Exhaust Systems: Toilet exhaust and kitchen exhaust

Controls: None

Monitoring Opportunities: None.

Anchorage Park Public Housing

Description: One 8-plex.

Heating System: Gas boiler, not-condensing. Indirect hot water tank

Ventilation System: None

Exhaust Systems: Toilet exhaust and kitchen exhaust

Controls: None

Monitoring Opportunities: None.

Anchorage Parkview Manor

Building: Three story with 120 units.

Drawing Record: 2001 Interior/Exterior Renovation. No envelope improvements.

Heating System

- Three gas boilers installed in 2010. Equal size, modulating burners, internal boiler controls lead/lag/standby and modulation. OSA reset control. Controls work well. Regular boiler maintenance due to modulating operation. No idea if energy use changed with new boilers.
- Boiler pumps controlled by boiler. Three building pumps with Tekmar lead/lag/standby control.

Cooling: Six room air conditioners served by three compressor/condensing units. Will soon remove four with renovation to offices.

Ventilation Systems

- AHU-2: Corridor ventilating unit, 100% OSA
- Bathroom exhaust fans

Domestic Hot Water Systems: Indirect hot water tanks

Lighting Systems

- Interior: On all the time. Not energy efficient.
- Exterior: Photocell control.

BMS: None

Fairbanks – Birch Park I

Building: 51 Units,

Drawing Record

- 1992 Renovation
- 2009 Heating Plant Replacement

Heating System: Central heating plant

- Central Heating Plant
    a. Boilers: one condensing gas boiler 1,410 MBH, two non-condensing gas boilers, 1,374 MBH. Small boiler May to Fall, not known if heating supply resets downward.
    b. Pumps: Primary/Secondary Pumping
        1) Boiler Pumps: Constant speed
        2) Secondary Pumps: Variable speed

Apartment Buildings

- Tertiary Pump at each building with 3-way mixing valve.

Ventilation Systems

- HV-1 Community Building: Mixing box, heating coil, supply fan, 1,010 cfm. Thermostat control.

Exhaust Fans

- Apartments: Toilet exhaust fans and kitchen range hood exhaust fan
- Community Building: Toilet exhaust fans

Domestic Hot Water Systems

- Apartments: Gas water heater in each apartment.
- Community Building: Electric water heater.

Lighting Systems

- Interior: Community Room wall switch
- Exterior: Photocell

DDC Controls: Boiler control panel for boilers; Tekmar pump sequencer.

BMS: None

Fairbanks – Fairbank Family Investment Center

Building: Single story; 2,000 sqft

Drawing Record: None

Heating System:

- Boilers: One gas boiler, non-condensing
- Pumps: Single heating pump

Ventilation Systems

- HRV ventilation

Cooling: Office wall-mounted cooling units.

Exhaust Fans

- Toilet exhaust fan

Domestic Hot Water Systems: Indirect tank

Lighting Systems

- Interior: Manual
- Exterior: Photocell

DDC Controls: None

BMS: None

Fairbanks – Golden Ages

Building: Two story, 20 units, 14,561 sqft

Drawing Record: 1996 Renovation

Heating System:

- Boilers: Two gas, condensing boilers, 328 MBH each
- Pumps: Primary/secondary arrangement
  a. Primary: Constant speed
  b. Secondary: Variable speed

Ventilation Systems

- HRV-1: Apartment ventilation, 1400 cfm.
  a. Preheat coil (before HX) and reheat coil.
  b. Defrost: Not known
- VF-1: Boiler Room, 600 cfm
  a. Operates: Operates regularly

Exhaust Fans

- EF-1: Laundry, 120 cfm
- Range hoods 160 cfm

Domestic Hot Water System: Indirect hot water tank

Lighting Systems

- Interior: Occupancy sensors
- Exterior: Photocell control

DDC Controls: Local controls, one boiler locks out.

BMS: None.

Fairbanks – Golden Towers Senior facility

Building: Five story building, 99 units, 65,000 sqft

Drawing Record: 1997 Renovation

Heating System: Purchased hot water from Aurora Energy

- Heat: Building heat exchanger interface with district heat.
- Pumps: Primary only arrangement
  a. CP-1/2: Building heat, VFD?
  b. CP-3/4: HRV coils, VFD?

Snowmelt: Sidewalk, 200 sqft, heat exchanger and glycol loop

- Controls: Control box, sidewalk sensors

Ventilation Systems

- HRV-1 Apartments: 6,050 cfm, preheat coil, reheat coil, supply and exhaust
- HRV-2 Corridors: 3,550 cfm, preheat coil, reheat coil, supply and exhaust
- Defrost: Not being monitored.

Exhaust Fans

- EF-1 Apartment Toilets: 50 cfm
- EF-2 Common Toilet, Maintenance: 100 cfm
- EF-3 Elevator Machine: 426 cfm
- EF-4 Receiving: 645 cfm
- RH-1 Range Hood: 160 cfm

Domestic Hot Water Systems

- Instantaneous heat exchanger

Lighting Systems

- Interior: Occupancy sensors
- Exterior: Photocell

DDC Controls: Local controls

BMS: None

Fairbanks Southall Manor

Building: Five stories, 32,299 sqft, 40 units

Drawing Record: 2003 Modernization

Heating System: Purchased hot water

- Heat
    a. Building heat exchanger interface with district heat.
    b. Backup Boiler: Oil, sits cold
- Pumps:
    a. CP-1: 113 gpm, constant speed
    b. CP-3/4: HRV coils, constant speed

Ventilation Systems

- HRV-1 Corridors and Apartments: preheat coil, 2,000 cfm
- F-1 : Supply fan 1,035 cfm

Exhaust Fans

- EF-1 Toilets: 50/20 cfm
- EF-2 and EF-3 Laundry: 30 cfm
- EF-4 Elevator Mach: 70 cfm

Domestic Hot Water System

- Instantaneous heat exchanger

Lighting Systems

- Interior: Occupancy sensors
- Exterior: Photocell

DDC Controls: Local heating controls; Pump sequencer

Juneau - Cedar Park

Buildings: Seven buildings, 6 apartment buildings, one community. 55,430 sqft

Drawing Record: 1995 Original construction

Heating System: Separate heating plant in each building

- Boilers: Fuel oil boiler
- Pumps: Primary only, constant speed

Ventilation Systems

- HRV for each apartment
- HRV in Community Building: Not working

Exhaust Fans

- TEF Apartment Toilets: 80 cfm

Domestic Hot Water Systems: Each heating plant

- Indirect DHW heater

Lighting Systems

- Interior: Manual
- Exterior: Photocell

DDC Controls: Community Bldg

BMS: None

Juneau – Mt. View/Annex senior facility

Building: Four stories, 38,600 sqft

Drawing Record: 1999 Interior and Exterior Renovation

Heating System:

- Boilers: Two fuel oil boilers, 1,180 MBH
- Pumps: Primary/Secondary arrangement
    a. Primary Pumps: CP-18 and CP-19, constant speed
    b. Secondary Pumps
        1) CP-1/2: Mt. View Annex
        2) CP-3/4: Mt. View secondary
        3) CP-5/6: Mt. View Primary
        4) CP-11 HWM-1
        5) CP-12 HWM-2
        6) CP-15 Mt. View hot water

Ventilation Systems

- AHU-1 Annex 1st floor: Not working; heating coil broke
- MAU-1 Laundry: 200 cfm
- MAU-2 Annex boiler room, 800 cfm
- AHU-3 Solarium
- HRU-1 Annex 2nd thru 4th floors, 1,400 cfm
- HRU-2 Mt. View west, 1,400 cfm
- HRU-3 Mt. View east, 1,610 cfm
  All three shutdown in winter: freeze issues

Exhaust Fans

- EF-1 Apartments: Toilet exhaust fan, 70 cfm
- EF-2 Common Toilet: 200 cfm
- EF-3 Dishwasher Hood: 750 cfm
- EF-4 Kitchen hood
- EF-5 Exercise Area, 500 cfm
- EF-6 Trash shoot, 400 cfm
- EF-7 Trash 123, 375 cfm
- RH-1 Apartment range hoods, 160 cfm

Domestic Hot Water Systems: Mt. View and Annex have indirect HW heaters

Lighting Systems

- Interior: Common areas 24/7; Toilets, Laundry OS; Offices, Dining: Manual
- Exterior: Photocell

DDC Controls

- Heating Plant: DDC Boiler control panel
- HRV: Local controller

BMS: None

Bethel – Administrative Facility

Building: One story, 3,364 sqft

Drawing Record: 2011 Original Construction

Heating System:

- Boilers: One oil-fired boiler, 98 MBH
- Pumps: Primary/secondary/tertiary arrangement
    - a. Primary: CP-1, Constant speed
    - b. Secondary
        - 1) CP-2 HWG: Constant speed
        - 2) CP-3 UHs: Constant speed
        - 3) CP-4 Radiant Injection: Constant speed
    - c. Tertiary Radiant: Constant speed

Ventilation Systems

- None

Exhaust Fans

- EF-1 Toilets: 90 cfm
- EF-2 Toilets: 90 cfm
- EF-3 Mechanical Room: 300 cfm
- RH-1 Range Hoods: 190 cfm

Domestic Hot Water Systems: In each boiler room

- Indirect tank

Lighting Systems

- Interior: Manual
- Exterior: Photocell

DDC Controls: None

BMS: None

Cordova – Sunset View Senior facility

Building: Four stories, 22,377 sqft, 22 units

Drawing Record: 2004 Modernization

Heating System: Will be replaced in 2013

- Boilers: Two fuel oil boilers, 290 MBH
- Pumps: Primary/Secondary arrangement
    - a. Primary: constant speed
    - b. Secondary: Variable speed

Ventilation Systems

- HRV-1 Basement Common Area: 475 cfm

Exhaust Fans

- TEF-1 Apartment Toilets: 20 cfm
- TEF-2 Public Toilet: 75 cfm
- BF-1,2,3 Dryer Booster Fans: 120 cfm
- RH-1 Apartment Range Hoods: 160 cfm

Domestic Hot Water Systems

- Two indirect tanks

Lighting Systems

- Interior: Manual
- Exterior: Photocell

DDC Controls: None

BMS: None

Ketchikan – Schoenbar Park

Building: Five buildings, 20 units, 21,120 sqft

Drawing Record: 1995 Modernization

Heating System

- Boilers: Electric boiler
- Pumps:

Snowmelt: 100’ long sidewalk

- Controls: Tekmar control, sensor in slab

Ventilation Systems

- None

Exhaust Fans

- EF-1 Apartment Toilets: 50 cfm
- RH-1 Range Hoods: 250 cfm

Domestic Hot Water System

- Indirect tanks

Lighting Systems

- Interior: Manual
- Exterior: Photocell

DDC Controls: None

BMS: None

Ketchikan – Sea View Terrace

Building: Four stories, 49 units, 37,339 sqft

Drawing Record: 2004 Modernization

Heating System

- Boilers: Two oil-fired boilers, 634 MBH each
- Pumps: Primary Only
    a. CP-1/CP-2: Building heat, constant speed
    b. CP-3: Domestic hot water
    c. CP-4: Shop unit heater
    d. CP-6: Crawlspace unit heaters

Ventilation Systems

- AHU-1: Supplies corridors; Off in winter
- VF-1 Boiler Room: 775 cfm

Exhaust Fans

- EF-1 Trash Room: 110 cfm
- EF-2 Crawlspace: 90 cfm
- EF-4 Elevator Machine: 110 cfm
- EF-5 Generator Room: 3,000 cfm
- DF-1 Dryer Boost: 200 cfm
- DF-2 Dryer Boost: 250 cfm

Domestic Hot Water Systems: In each boiler room

- Indirect hot water tank
- CP-5: HWR Pump

Lighting Systems

- Interior: Corridor, On 24/7; Storage, Photocell; Community Room, switch
- Exterior: Photocell

DDC Controls: None

BMS: None

Seward – Glacier View Senior Housing

Building: Three story, 30 units, 27,749 sqft.

Drawing Record: 2003 Modernization

Heating System: New in 2012

- Boilers: Two low mass, oil-fired boilers, 357 MBH
- Pumps: Primary/secondary arrangement
    a. Primary: Constant speed
    b. Secondary: Variable speed

Ventilation Systems

- None

Exhaust Fans

EF-1 Apartment Toilets: 110 cfm

- EF-2 Common Kitchen Range Hood: 190 cfm
- EF-3 Dryer Boost: 110 cfm
- EF-4 Elevator Machine: 150 cfm

Domestic Hot Water Systems

- Two indirect tanks

Lighting Systems

- Interior: Manual
- Exterior: Photocell

DDC Controls: None

BMS: None

Sitka – Swan Lake Terrace Senior facility

Building: Three stories, 19 units

Drawing Record

- 2002 Renovation
- 2012 Heating Plant Replacement

Heating System

- Boilers: Two oil-fired, 135 MBH
- Pumps: Primary only, variable speed

Ventilation Systems

- SF-2 Office: 90 cfm, electric heating coil
- HRV-1 Common Spaces: 600 cfm

Exhaust Fans

- EF-3 Elevator Equip: 110 cfm

Domestic Hot Water Systems

- Two indirect tanks

Lighting Systems

- Interior: On 24/7
- Exterior: Photocell

Controls: Local controls

BMS: None

Wrangell – Etolin Heights M213

Building: Five buildings, two story, 24,042 sqft

Drawing Record

- 1999 Renovation

Heating System:

- Boilers: Electric boiler; fuel oil backup
- Pumps: Primary/Secondary/Tertiary
    a. Primary: constant speed
    b. Secondary: constant speed
    c. Tertiary: constant speed

Ventilation Systems

- None

Exhaust Fans

- Toilet exhaust fans

Domestic Hot Water Systems

- Three indirect tanks

Lighting Systems

- Interior: 24/7 on
- Exterior: Photocell

DDC Controls: DDC controls in boiler room

BMS: None

Section 3

Existing Building Monitoring Systems (Task 9)

ASSESSMENT

The preliminary information collection determined that none of the facilities have operating Building Monitoring Systems (BMS). However, two of the facilities have DDC systems that could be enhanced with BMS capabilities.

Chugach Manor

The building has a direct digital control (DDC) system for the following systems:

- Secondary Pumps
- Snowmelt Systems
- Ventilation Systems: AHU-1, SF-1, SF-2, VF-1, VF-2
- Room Temperature control

The DDC system does not provide control of all systems in the building. Notably, the heating plant is not connected to the system. However, the system offers many opportunities for visual monitoring of the building temperatures, the snowmelt system, and the ventilation systems. The system provides the operators a tool to assess the real-time operation of the systems, but it is not currently trending or monitoring the data to provide historical operating information on the systems.

AHFC Headquarters

The building has a direct digital control (DDC) system for the following systems:

- Heating plant including boiler sequencing and pumps
- Ventilation System: RTU-1, EF-1
- Rooms: VAV box operation and temperatures

The DDC system has screens for each system that provide visual monitoring of the building. Building operators can use the system to assess the real-time operation of the systems, but it is not currently trending or monitoring the data to provide historical operating information on the systems.

Section 4

Identify Buildings for Monitoring Systems (Task 10)

ASSESSMENT CRITERIA

The following criteria were considered in evaluating the building's monitoring potential:

- Energy Savings: Systems that offer a greater potential for energy savings through monitoring are desirable to demonstrate the cost and effort associated with monitoring the building.
- Variety: It is our intention to demonstrate the monitoring potential on a variety of systems. Buildings that offer the most variety are preferred.
- Complexity: More complex systems inherently can benefit the most from monitoring as a means to insure they are operating optimally. Monitoring can also provide the information in more useful formats for understanding system operation.
- Operators: The building operators are essential to the success of a monitoring system. Operators that are interested in energy efficiency and gaining knowledge on system operation increase the likelihood of monitoring success.
- Location: Buildings that are in closer proximity to the monitoring team are desirable so that the equipment can be readily installed and adjusted to ensure accurate information.

Monitoring data can be used for several benefits. The data can be used to assess the building for proper operation of the systems. The data is also useful for quantifying energy use and understanding the dynamics of how energy is used in the building. The data can also be used to promote better design through right sizing for actual loads.

When ranking the buildings for monitoring potential, these factors are applied to the assessment criteria to determine which buildings will benefit the most form monitoring.

SUMMARY TABLE

The following table summarizes our assessment of the monitoring potential of the buildings.

BUILDING MONITORING ASSESSMENT

BUILDINGS	ENERGY SYSTEMS					ASSESSMENT CRITERIA					
	Heat	HW	Cooling	Vent	Lights	Energy	Variety	Complex	Operator	Location	Rank
Anchorage Buildings											
AHFC Headquarters	Excellent	Poor	Excellent	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Chugach Manor	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Chugach View	Excellent	Good	n/a	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Family Investment Center	Excellent	Fair	Excellent	Good	n/a	Good	Good	Fair	Excellent	Excellent	Good
Lane	Excellent	Fair	n/a	n/a	n/a	Poor	Poor	Poor	Good	Excellent	Poor
Park	Fair	Fair	n/a	n/a	n/a	Poor	Poor	Poor	Good	Excellent	Poor
Parkview Manor	Excellent	Fair	n/a	Good	n/a	Excellent	Good	Good	Excellent	Excellent	Good
Taylor	Fair	Fair	n/a	n/a	n/a	Poor	Poor	Poor	Good	Excellent	Poor
Fairbanks Buildings											
Birch Park I	Excellent	Poor	n/a	Fair	Poor	Excellent	Fair	Fair	Excellent	Good	Good
Family Investment Center	Fair	Fair	Good	Excellent	Fair	Poor	Poor	Poor	Excellent	Good	Fair
Golden Ages	Excellent	Fair	n/a	Excellent	Good	Good	Good	Good	Excellent	Good	Good
Golden Towers	Fair	Excellent	n/a	Excellent	Good	Excellent	Fair	Good	Excellent	Good	Good
Southall Manor	Fair	Excellent	n/a	Excellent	Good	Excellent	Fair	Good	Excellent	Good	Good
Juneau Buildings											
Cedar Park	Good	Fair	n/a	Good	Fair	Good	Fair	Fair	Good	Excellent	Fair
Mountain View	Excellent	Fair	n/a	Poor	Fair	Excellent	Good	Excellent	Good	Excellent	Good
Other Cities											
Bethel Admin Facility	Good	Fair	n/a	n/a	n/a	Fair	Poor	Poor	Good	Poor	Fair
Cordova Sunset View	Poor	Poor	n/a	Excellent	Fair	Good	Good	Fair	Good	Fair	Poor
Ketchikan Schoenbar Park	Excellent	Fair	n/a	n/a	Fair	Good	Fair	Fair	Excellent	Fair	Fair
Ketchikan Sea View Terrace	Excellent	Fair	n/a	Poor	Fair	Good	Fair	Fair	Excellent	Fair	Good
Seward Glacier View	Excellent	Fair	n/a	n/a	Fair	Good	Fair	Good	Excellent	Excellent	Good
Sitka Swan Lake Terrace	Excellent	Fair	n/a	Excellent	Fair	Good	Good	Good	Good	Fair	Good
Wrangell Etolin Heights	Excellent	Fair	n/a	n/a	Fair	Good	Fair	Good	Excellent	Fair	Fair

Excellent	Good	Fair	Poor	n/a

ASSESSMENT

We recommend that monitoring be done on Chugach Manor, AHFC Headquarters, and Glacier View. The buildings rank high with regard to the selection criteria and will benefit from monitoring. These three buildings will provide a successful demonstration of the capabilities of building monitoring.

Chugach Manor and the Headquarters are large buildings with complex systems. They offer plenty of opportunity to demonstrate the benefits of building monitoring. Glacier View provides a fuel oil heating plant for more focused monitoring of its operating efficiency.

The monitoring potential of the three buildings is described below along with the reasons the other buildings are not recommended.

Anchorage – AHFC Headquarters

This building has excellent monitoring potential because it is a commercial building and has complex systems that can be optimized by evaluating the monitoring data. Monitoring will allow us to demonstrate the value of energy modeling on a commercial building. The monitoring potential includes:

- Boilers: The three gas boilers are sequenced and modulated to supply heating both in and above the condensing range. Monitoring will allow us to optimize the control sequence so the plant operates at optimal efficiency within the condensing range.
- Ventilation: The rooftop ventilating unit was supplied with an integral control strategy. Monitoring will allow us to assess if this control strategy is optimal for Anchorage and this building.
- VAV Terminal Units: The terminal units mix cooling air from the rooftop unit with warmer air from the ceiling plenum and also add heat from a heating coil to condition the space. Monitoring will allow us to assess if the units are operating optimally without simultaneous heating and cooling.
- VAV Terminal Units: The terminal units mix cooling air from the rooftop unit with warmer air from the ceiling plenum and also add heat from a heating coil to condition the space. Monitoring will allow us to assess if the units are operating optimally without simultaneous heating and cooling. It will also allow us to assess if the rooftop unit supply air temperature is being optimally reset.
- Lighting: The building appears to have considerable daylight potential. Monitoring of light levels will demonstrate the potential for daylight control. A lighting control panel provides control of all the lighting in each suite in the building. Currently, all the lighting is scheduled the same during normal working hours. During off-hours, the control can be overridden to turn on all the lighting in an individual suite. Off-hours lighting use can be monitored to quantify the lighting energy associated with people working off-hours.

Anchorage – Chugach Manor

This building has excellent monitoring potential because it has high energy use, a variety of systems, and it typical of AHFC multilevel housing buildings. The monitoring potential includes:

- Boilers: The four gas boilers are sequenced to supply the heating load. They are locked in low fire, even though they are capable of low-high fire. Monitoring will allow us to quantify the efficiency of this operating strategy with a strategy that allows low-high fire modulation so that a boiler can increase output to match the load rather than turn on the next boiler.

- Domestic Hot Water System: The two instantaneous hot water heaters have three pumps operating continuously at a load of 5 kW. Monitoring will allow us to track needed data on actual hot water use and determine if one the heaters and associated pump can be turned off during periods of non-peak HW loads.
- Snowmelt System: The building has two snowmelt systems that are maintaining the sidewalks at 50°F throughout the winter. The control is capable of lowering the sidewalk temperature when the surface is dry, but it is not utilized. Monitoring the heating load of the system will provide a cost of snowmelt. This will offer incentive to optimize the control or consider other snow removal methods.
- Corridor Ventilation: The building has two 100% outside air systems that supply a total of 5,500 cfm of ventilation air to the corridors. The purpose of this system is to pressurize the corridors to apartment odors do not flow outward. Monitoring the corridor pressure will demonstrate if the corridor is being over-pressurized. If so, there is incentive to modulate the fan with corridor pressure to reduce the ventilation air flow and save energy.
- Lounge Ventilation: The lounges are served by AHU-1 which supplies ventilation, heat, and cooling. The system is currently supplying 82°F air by recirculating air from the lounges. Monitoring will focus on occupancy and carbon dioxide levels to determine if the system is providing adequate ventilation and if it can be turned off during unoccupied periods.
- Lighting: The corridor lighting is operated continuously. Occupancy monitoring will provide data on the energy savings associated with providing a base level of lighting and utilizing occupancy sensors to operate corridor lighting.
- Building Electric Service: Monitoring the building electric service will provide useful data on the demand profile and opportunities to reduce demand and use. One area of value will be to assess the energy consumption of engine block heaters. The tenants can choose to plug in their cars during cold weather. A preliminary calculation indicates that this service costs $30-$50 per month per car, yet the tenants are charged $10. Monitoring will allow an assessment of the amount of energy used and costs.

Seward – Glacier View

This building has good monitoring potential because it has a fuel oil boiler plant, good location, and offers a scale more typical of AHFC housing. The monitoring potential includes:

- Boilers: The two fuel oil boilers are capable of sitting cold when not needed. Monitoring will allow us to quantify boiler operation to determine if the plant is operating optimally. The data can be used to downsize the boiler nozzles and demonstrate the efficiency gain. The scale of the heating plant lends itself to monitoring of boiler real-time and seasonal efficiency, which is valuable data that is not currently available. The monitoring will also provide data on building heating load, including distribution losses. This data will be useful to quantifying distribution losses and demonstrate the benefit of heating supply temperature reset strategy.
- Domestic Hot Water System: Two indirect hot water heaters supply domestic hot water to the building. Monitoring will allow us to track needed data on actual hot water use.
- Boiler Room Ventilation Fan: The fan cools the boiler room. Monitoring will provide data on the heating plant losses.

The value of this building to the overall monitoring project is:

- Evaluate energy savings associated with a recent boiler replacement
- The monitoring data will be beneficial to final commissioning of the heating system
- The monitoring will provide a valuable data for optimizing the heating supply reset temperature.
- The monitoring system can provide alarms to AHFC maintenance personnel if there is a problem.
- The team has a person in Seward who can give the monitoring system close attention.

Anchorage Family Investment Center

The building was recently renovated. The energy systems that offer the best monitoring potential are the rooftop AHUs with gas heating unit, cooling coil and compressor/condenser unit. However, these systems are unique and representative of AHFC housing or the majority of commercial buildings in Alaska. For this reason, this building was not selected.

Anchorage Lane, Taylor, and Park Public Housing

These are eight and nine-plex apartment buildings. The energy systems that offer the best monitoring potential are the condensing, gas boilers. The building was not selected because there is not sufficient variety and complexity to demonstrate the potential of building monitoring systems.

Anchorage Parkview Manor

The building heating and ventilating systems offer good monitoring potential. The building was not selected because Chugach Manor also has these systems plus greater complexity and variety.

Fairbanks – Birch Park I

The district heating plant with condensing and non-condensing boilers offers excellent monitoring potential. The buildings were not selected for monitoring because the other energy systems are simple and do not offer sufficient monitoring potential.

Fairbanks – Fairbank Family Investment Center

The building was not selected because it is small, with simple systems, and offers minor monitoring benefits.

Fairbanks – Golden Ages

The building offers the highest monitoring potential of the Fairbanks buildings with condensing boilers, heat recovery units, and occupancy sensor lighting controls. It was not selected because Chugach Manor offers similar potential and is closer in proximity to the project team.

Golden Towers Senior facility

The building has numerous system of high monitoring value including HRVs and snowmelt. It was not selected because it is connected to district heat and has little heating plant monitoring potential.

Fairbanks Southall Manor

The building has numerous system of high monitoring value including HRVs and snowmelt. It was not selected because it is connected to district heat and has little heating plant monitoring potential.

Juneau - Cedar Park

The building has fuel oil boilers which offer good monitoring opportunities. The buildings were not selected because they are relatively simple with minimal monitoring potential.

Juneau – Mt. View/Annex senior facility

The building has numerous energy systems that offer excellent monitoring opportunity, including fuel oil boilers. The building was not selected because the HRVs have failed and are not likely to be operational in the near future.

Bethel – Administrative Facility

The building is relatively simple and has little to offer in demonstrating monitoring capability.

Cordova – Sunset View Senior facility

The building has energy systems worthy of monitoring. It was not selected because a heating plant replacement is underway.

Ketchikan – Schoenbar Park

The buildings are heated by an electric boiler in a central plant, which offers an electric heating monitoring opportunity. The buildings were not selected because they are relatively simple and do not offer a variety of monitoring options.

Ketchikan – Sea View Terrace

The building has a wide variety of complex energy systems that are good monitoring candidates. The building was not selected because the ventilation systems are not operated in the winter and it is not located in close proximity to the monitoring team.

Sitka – Swan Lake Terrace Senior facility

The building has a wide variety of complex energy systems that are good monitoring candidates. The building was not selected because it is not located in close proximity to the monitoring team.

Wrangell – Etolin Heights M213

The buildings are heated by an electric boiler in a central plant, which offers an electric heating monitoring opportunity. The buildings were not selected because they are relatively simple and do not offer a variety of monitoring options.

Section 5

Best Practices for Building Monitoring (Task 3)

METHODOLOGY

This task combines our previous experience with data collection and monitoring with the unique characteristics of AHFC buildings and operations. We will determine the systems that will benefit most from monitoring and the data that will be most useful to operators in reducing energy consumption. We will also determine if monitoring is best performed using the existing BMS systems, standalone systems, or a combination of the two.

System Approach

The monitoring plan is based on providing a system that we feel is most beneficial to AHFC's short and long-term goals for building monitoring. We propose to provide stand-alone monitoring systems that can communicate via cellular networks to web-based servers that will compile and display the data. We may also learn that gathering data form the existing DDC systems may be beneficial to comprehensive monitoring of more complex buildings.

Heating Loads

Heating loads represent the highest energy cost in AHFC buildings. Most buildings are envelope-dominate that lose most of their heat through the envelope. For these buildings, our monitoring plan will focus on optimal operation of the heating plant.

Best practices include monitoring the following:

- Boiler lead/lag operation, runtimes and temperatures to determine if there are opportunities to reduce standby and cycling losses by reducing boiler sizes, turning off unneeded boilers, or optimizing boiler lead/lag controls.
- Boiler instantaneous efficiency to determine if they require more frequent cleaning or if they are not installed or operating in an efficient manner.
- Condensing operation to determine if the boiler is maximizing condensing operation for optimal efficiency.
- Proper zone control to preclude overheating or the opening of windows to cool spaces.

We intend to monitor three boiler plants with condensing gas boilers, non-condensing gas boilers, and non-condensing fuel oil boilers.

Ventilation Loads

Ventilation systems often supply excess ventilation air, operate with excessive reheat, or do not operate optimally. This can cause high energy loads and represents considerable opportunity for optimization. Monitoring opportunities include:

- Heat recovery ventilator (HRV) monitoring will focus on HRV runtime, effectiveness and defrost operation.
- Air handling unit (AHU) monitoring will focus on system runtimes and verifying the systems are not over-ventilating by monitoring occupancy and CO2 levels in critical spaces.

Domestic Hot Water

Domestic hot water loads can contribute greatly to energy consumption in housing units. Our monitoring plan will focus on proper operation of the hot water heater and gathering data on real-time hot water use and standby and distribution losses.

Snowmelt Systems

Snowmelt systems typically consume great amounts of energy. The monitoring plan is focused on measuring how much energy the system uses to keep pavement clear. We will also monitor if the controls are properly heating only during periods when ice and snow are present. The data can also be used to show the energy savings associated with optimizing the snowmelt controls or switching to manual control.

Lighting

For common areas such as corridors, we will monitor occupancy to determine if occupancy sensor can significantly reduce the lighting energy. We will monitor lighting in intermittently occupied spaces to determine if lights are properly turned off when the rooms are not in use. The findings may support a lighting energy policy or use of occupancy sensor control to reduce energy consumption.

Electric Demand

We will monitor the building electric service to track energy consumption and demand. The data will be useful to identifying large loads that have optimization potential. It will also be useful for quantifying energy use associated with an activity, such as engine block heaters at Chugach Manor.

For buildings that incur demand charges, demand data will show when the monthly peak occurs. We will determine the loads that contribute to the peak and monitor variable loads to determine if there is opportunity to turn them off or reduce them during periods of peak demand.

Motivation

A monitoring plan must provide incentive to operators and tenants to improve the energy performance of their buildings. While it may be necessary to incorporate motivational strategies into energy policies, a successful building monitoring plan can also provide motivation. The monitoring plan will display comparative data on energy use trends for the three buildings. The operators can gage the success of their efforts by how their energy use changes in relation to the other buildings. If future monitoring includes multiple buildings at a property, displaying energy use comparisons may be a method to motivate tenants to improve their building's comparative energy consumption, especially if some of the savings benefits them directly.

Section 6

Identify Monitored Systems for Commercial Buildings (Task 7)

A monitoring plan for a commercial building should focus on systems that use the most energy as well as systems that operate dynamically and/or have complicated control strategies. This section identifies the systems in commercial buildings that will typically benefit the most from monitoring.

Commercial buildings often have direct digital control (DDC) systems that perform control, monitoring, and alarm functions for the building systems. Most DDC systems are also capable of trending and storing data that can be transferred to a building monitoring system.

HEATING SYSTEMS

Heating accounts for the largest energy use in most Alaska buildings. The heating system must operate optimally to deliver the heat at the highest efficiency.

Boilers

The monitoring of boiler operation will provide valuable data on the real-time operation and efficiency of the heating system. The following are potential monitoring goals:

- Boiler instantaneous efficiency can determine optimal cleaning cycles, if they are operating efficiently, or if the design sizing is limiting their efficiency.
- Boiler lead/lag operation, runtimes and temperatures can determine if there are opportunities to reduce standby and cycling losses by reducing boiler or nozzle sizes, turning off unneeded boilers, or optimizing boiler lead/lag controls.
- Boiler combustion efficiency can determine if the boiler is being cleaned often enough
- Monitoring condensing operation to determine if the heating supply temperature reset control is maximizing condensing operation for optimal efficiency.

Hydronic Heating Pumps

The following are potential monitoring objectives with hydronic heating distribution systems:

- Heating supply reset schedules to determine if the optimal heating supply temperature is delivered to the building at various outdoor temperatures.
- Proper zone control to preclude overheating or the opening of windows to cool spaces.
- Data on heating water flow and temperature differential can determine if the pumps are operating at their lowest required speed to supply the heat.

Domestic Hot Water

Hot water systems can have high standby and distribution losses that are often ignored in daily operations. Monitoring data can determine the domestic hot water usage profile and the amount of standby and distribution losses.

Snowmelt Systems

Snowmelt systems typically consume great amounts of energy. If they are poorly controlled, they can consume even more energy. Monitoring data can determine the cost of snowmelt heating and opportunities for optimizing the control to minimize energy use.

VENTILATION SYSTEMS

Ventilation typically represents the largest heating load in the building. Monitoring can provide useful data on the dynamic operation of the systems and their success in maintaining adequate indoor air quality and thermal comfort.

Air Handling Units (AHU)

Air handling units operate dynamically to ventilate, cool, and sometimes heat the building. By coupling ventilation with thermal comfort, system operation can become complex and have unintended operating conditions of over-ventilating. Most designs incorporate common control strategies that have not been fully monitored for optimal operation.

The following monitoring opportunities exist:

- CO2 levels can be monitored to determine if the building is properly ventilated.
- Supply air reset temperature can be monitored along with zone level cooling requirements to determine if the reset control is optimal for the building. The data can also determine if a few critical zones are driving the supply temperature down, resulting in wasteful reheat in other zones.
- Building pressure monitoring can determine if the ventilation system is over-pressurizing the building by bringing in excess ventilation air.
- Pressure relationships within the AHU can be monitored to determine if the control is resulting is stable operational relationships between supply and return fans.
- Air flow can be monitored at each zone to determine if the AHU supply fan is optimally controlled to maintain the lowest required duct static pressure.

Heat Recovery Ventilator (HRV)

An HRV has the many of the same monitoring opportunities as an AHU. In addition, there is an opportunity to monitor the following:

- Defrost operation can be monitored to determine if the HRV is defrosting only when needed. Most defrost cycles operate according to factory default settings that are not optimized for the Alaska climate.
- The effectiveness of the heat recovery cell can be monitored to determine if the heat transfer rate is optimal.

Exhaust Systems

Many building are exhaust-dominant buildings where the ventilation requirement is determined not by indoor air quality but by a need to provide exhaust air makeup. In these cases, monitoring the exhaust system can determine if a variable exhaust system is optimal for the building and able to reduce the energy consumption required for ventilation air.

ELECTRICAL SYSTEMS

Demand Control

Demand charges can be a significant percentage of the total electric bill. Monitoring the building electric service for instantaneous energy use (demand) can determine if there are opportunities to reduce demand by determining the loads that contribute to the peak demand and if it is possible to change control and operating strategies. The utility may have Smart Utility Meters or Automated Meter Reading transmissions that can provide the data.

Lighting

For lighting systems, we will monitor lighting in intermittently occupied spaces to determine if lights are properly turned off when the rooms are not in use. The findings may support a lighting energy policy or use of occupancy sensor control to reduce energy consumption.