Village of Solomon

Development of Energy Efficiency Building Standards for New Construction

Authors:

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Preface

This report documents the first part of a multi-stage process to assist the Village of Solomon (VOS) with developing an energy-efficient central tribal location within Nome. In the first part, Cold Climate Housing Research Center (CCHRC-NREL) and VOS developed Energy Efficiency Building Standards for new construction in Solomon. These building standards form tribal amendments to the International Energy Conservation Code 2018 (IECC 2018), to be followed by contractors designing and building residential and light commercial structures in areas of tribal jurisdiction. These code amendments will be followed by an analysis of the feasibility of a microgrid for VOS in Nome. This first step of the process is funded by the Department of Energy's Office of Indian Energy (DOE IE); applications for the successive stages will be submitted to their Technical Assistance Program.

Acknowledgments

We would like to acknowledge and thank the Village of Solomon for their invitation to serve as consulting partners in the development of their Energy Efficiency Standards for New Construction, furthering their mission of promoting the wellbeing of their tribal members while protecting their environment. In addition, we would like to acknowledge the collaboration and partnership with The Department of Energy's Office of Indian Energy.

List of Acronyms

AHFC	Alaska Housing Finance Corporations
AK HERS	Alaska Home Energy Rating System
ASHRAE 90.1	American Society of Heating, Refrigerating and Air-Conditioning Engineers – Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 62.2	American Society of Heating, Refrigerating and Air-Conditioning Standard 62.1-2016, Ventilation for Acceptable Indoor Air Quality
BEES	Alaska Building Energy Efficiency Standard – Alaska-Specific Amendments to IECC 2018
CCHRC-NREL	National Renewable Energy Laboratory's Cold Climate Housing Research Center
DOE IE	Department of Energy's Office of Indian Energy
IECC	International Energy Conservation Code
IRC	International Residential Code
NJUS	Nome Joint Utility System
PCE	Power Cost Equalization
SEES	Solomon Energy Efficiency Standard
VOS	Village of Solomon

Executive Summary

This report addresses building standards for the Village of Solomon (VOS), traditionally located about 35 miles east of Nome. While VOS builds housing and community buildings on a newly purchased plot of land in Nome, they decided that they first needed a set of building standards to ensure that all new construction met the needs of residents and met or exceeded energy standards that they wished to specify.

The National Renewable Energy Lab's Cold Climate Housing Research Center (CCHRC-NREL) worked with the Solomon Traditional Council and, through a series of meetings, established a list of goals that VOS wished would be met by all future construction for VOS. CCHRC-NREL then looked for options to incorporate these goals into code. There was a strong desire to pursue ambitious energy standards, even if the standard stipulated the ability to meet a goal *later* because it was currently not feasible.

The result was a document meant to be used as a standard by all designers and contractors working on new building projects for VOS. It helps these groups by requiring their attention to traditional building forms and the inclusion of regular input from Elders, a balanced ventilation and heat recovery system, and permafrost protection. CCHRC-NREL was able to assist in bridging the goals of traditional knowledge with energy-efficient technology and building practices.

VOS will now be able to require new construction projects to meet these standards and will also be able to view design submissions through the lens of this document. This project is the first step for VOS as they oversee the preservation of their community in the temporary setting of Nome.
This document will be revised as the Tribe sees fit, and shared widely with all new construction, contractors, project management but will not be enforceable until there is a Tribal Resolution adopting these Solomon Energy Efficiency Standards (SEES).

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List of Figures and Tables

Summary of Technical Assistance

This report is a result of a technical assistance request by the Village of Solomonsubmitted to The Department of Energy's Office of Indian Energy Policy and Programs in March 2022.

1.1 Technical Assistance Request and Background

The Village of Solomon (VOS) is a federally recognized tribe under the Indian Reorganization Act of 1993. Its primary purpose is to improve the lives of tribal members by designing and implementing assistance programs. Within this capacity, it is developing an affordable housing program that will mirror the Bering Straits Regional Housing Authority's lease-to-own program and has purchased land in the City of Nome to build three residential homes and one community facility. Solomon, once an important mining hub, was largely abandoned after budget cuts forced the school to shut down in 1956. Many families relocated to Nome and Anchorage. While conserving the tribal community in Nome is a short-term goal, ultimately, the tribe plans to move 35 miles east to the traditional village site. VOS is concerned with the high cost of energy in the region and the prevalence of inefficient and non-durable construction in the region. For these reasons, VOS has requested technical assistance in developing a set of standards for new construction that emphasize energy-efficient, sustainable, and innovative housing that will be suitable for their location in Nome, as well as for the traditional village site of Solomon.

1.2 Scope of Work

VOS and CCHRC-NREL held semi-regular meetings from March 2 to July 12, 2022. These meetings served primarily for attendees to develop an energy efficiency standard for new construction that integrates the values represented by the Solomon Traditional Council (STC) and defined by STC's Environmental Coordinator. After summarizing these values, attendees discussed how to integrate them with existing construction codes and standards (e.g., ASHRAE 90.1, IRC 2018, IECC 2018, AK HERS, Passivhaus). VOS and CCHRC-NREL decided that an amendment to IECC 2018, Alaska BEES, was the best code to adapt because it is most relevant for new construction in Alaska. The resulting document is an amendment to an amendment. It is intended to be referenced alongside ASHRAE 62.2 and IECC 2018 as an energy standard for new construction for VOS. Attendees using this standard were able to discuss and evaluate other projects for the property in Nome.

The VOS Traditional Council can now discuss other projects on the plot in Nome using these standards as a lens through which to evaluate each design. VOS's next step will be an application to DOE IE to analyze the feasibility of a microgrid for this location.

Process

2.1 Location Analysis

VOS acquired a plot on the eastern end of Nome to develop into a community hub (Fig. 1). Multiple grant applications for this project are pending, and if successful, construction will likely start in the spring of 2023. The site administrator is planning for gravel pads on the property and is interested in using geotextile liners to insulate the underlying permafrost.

This property will provide space for a central community building and multiple housing units. The tribe will fund construction. Upon completion of the project, occupants can take ownership of their house through a lease-to-own program. This block is part of a new subdivision in Nome located in a previously undeveloped area, so it is not yet connected to the town's water and sewer system (Figs. 1 and 2). VOS is in the process of extending utilities to the site.

2.2 Identification of Goals for Standard Development

During regular discussions meant to outline how to proceed with the new site in Nome, VOS articulated the desire to create guidelines for new construction: something less than a code but still binding to contractors or vendors working with VOS. Ideally, it would be like an energy efficiency rating on the demand side of the design process and would shape the design while still in the schematic phase. The need for this standard early in the design process is apparent in projects that meet state and federal codes but do not perform well in the region's climate. A standard specific to VOS would ensure that any contractor or vendor met certain minimums.

VOS and CCHRC-NREL held a series of work sessions dedicated to creating safe and healthy living environments. The result was the following list of goals meant to inform guidelines for an efficiency standard. Unlike most codes, these goals include energy minimums, environmental factors, and the promotion of VOS values such as sustainability, community, traditional knowledge, and affordability.

1. Incorporate traditional knowledge and feedback from Elders
2. Consider the embodied environmental impact and strive for the use of fewer materials and a minimum building envelope
3. Research the feasibility of renewable energy sources for heating
4. Set a high standard for wall thickness and envelope
5. Specify an airflow standard and a heat recovery standard
6. Incorporate solar and wind orientation principles into the design
7. Make operation and maintenance user friendly and keep costs low
8. Set a drainage inspection policy that includes snow removal
9. Include a workforce training element

With these goals identified, VOS and CCHRC-NREL looked for ways to integrate them with existing code language meant to guide designers and contractors.

Discussion of Goals and Application to Building Code

Combining energy efficiency standards with site-specific requirements (e.g., snow removal and drainage plans) and more qualitative goals such as incorporating traditional knowledge create a unique set of standards that better serve the community. While the final document is not a building code, it should improve the design submissions of contractors hired to work with VOS and leave little room for doubt about the priorities for the community.

3.1 Building Orientation

Corresponding to Goals #*1 Incorporating traditional knowledge and feedback from Elders, #6 Solar and Wind Orientation,* and #*8 Drainage and snow removal*

VOS specified early a strong desire to include local/traditional knowledge and input from Elders during regular design meetings as a standard part of the design process. This input is rarely (if ever) included in energy efficiency codes and could easily be ignored without being inserted into a set of standards. Its inclusion reduces the chance that a feature, e.g., Arctic Entry, would be included but poorly designed (e.g., dimensions, placement). Building orientation affects solar heat gain, window placement, and community snow removal planning.

3.2 Preliminary Solar Analysis

Corresponding to Goals #*3 Researching the Feasibility of Renewable Energy Sources for Heating* and #*6 Solar and Wind Orientation*

A closer look at the schematic drawings submitted to VOS for a small mobile housing unit (Fig. 3) helps to demonstrate how standardizing goals for VOS can improve the quality of design submissions. While the building is small, its roof size and lack of proper orientation limit its ability to offset its costs.

To approximate the potential for solar energy, CCHRC-NREL analyzed the solar radiation data for Nome using SAM (System Advisor Model) in a preliminary analysis. According to the estimates, 3 kW is the maximum power that can be collected from the roof of the tiny house. This figure is slightly lower than the projected energy use, though energy use data from the tribe would help with a closer approximation. Given an electricity rate of $0.36/kWh and an installed cost of $4.25/Watt, the amortization period is projected to be about 13 years.

To incentivize renewable energy, we discussed the possibility of a PPA (Power Purchase Agreement) between VOS and NJUS, the local utility, in which their PCE reimbursement (the *Power Cost Equalization* is a program that lowers the cost of electricity in rural communities and reimburses utilities for credits extended to costumers; Fig. 4) would increase by purchasing power from VOS solar systems. In exchange, NJUS would help finance the PV panels. STC informed the group that NJUS exceeds energy production capacity and is not interested in purchasing power.

This exercise showed VOS and CCHRC-NREL that it was necessary to include a provision making new construction capable of installing renewable energy systems in the future, with little-to-no modifications. VOS also wanted a pathway for new construction to be net-zero-ready. Specifying this feature in a building standard is the only way to ensure this is included in submitted design work.

3.3 Heat Source

Corresponding to Goal #*3 Researching the Feasibility of Renewable Energy Sources for Heating*

Solar PV on the walls and/or the roof was investigated as a heating source. A backup heat source would be necessary for periods of low solar radiation as electric resistance heat can be expensive when the panels are not producing energy. Battery storage would need to be included in the design; details will have to be determined in a more detailed modeling exercise.

A ceramic core heater could be an efficient method to store excess solar energy and heat the tiny house. The Chaninik Wind Group, a partnership of four villages in the Kuskokwim Bay, developed a grid system that combines wind energy with electric thermal storage. This model could potentially be downscaled to suit Nome and VOS needs, and it should be investigated further in subsequent cooperation.

A wood stove is the traditional and most affordable heating method. Tribal members usually gather driftwood as firewood. The sand content of driftwood can create problems with the catalyst in energy-efficient wood stoves, creating unhealthy gasses and releasing them into the house. In this situation, a healthy air requirement in the standard would require the installation of a direct air vent to isolate the air circulation in the woodstove from the air circulation in the living area.

3.4 Wall System and Ventilation

Corresponding to Goals #*4 Standard for Wall Thickness and Envelope* and #*5 Air Flow and Heat Recovery Standard*

Building in the sub-arctic maritime conditions of western Alaska requires a carefully designed wall system to minimize heat loss and manage moisture accumulation. In exceptionally airtight (i.e., well insulated) houses, wall systems and ventilation should be designed with each other in mind, but this is not always the case. Polyurethane spray foam insulation is commonly used as wall insulation; however, if it is closed cell foam, it will not provide enough natural air leakage to maintain healthy indoor air quality, and a ventilation system will need to be included in the design. The desire to specify a good balance of insulation and ventilation in the standard shows the commitment of VOS to healthy living environments for their residents.

3.5 Water/Wastewater Strategies

Corresponding to Goal #*7 Low Cost of Operation and Maintenance, User-Friendliness*

Determining a suitable sanitary waste system for off grid housing in Nome and Solomon was a heavily discussed topic, as many systems have unwanted side-effects such as odors and impractical or unsanitary maintenance. The criteria for the chosen system were:

- Off grid possible
- Low maintenance
- Low cost
- Clean
- Energy efficient

VOS was initially interested in incinerating toilets, but further investigation showed that energy usage is too high to be considered sustainable and affordable. The energy cost to operate the toilet in a 4-person household in Nome ranges from $630-$3,790 per year. These numbers are based on an average energy usage of 1.75 kWh per incineration cycle, six uses per day per person, and having to run the incineration cycle after each or after up to six uses. It does not account for energy use being higher in cold climates.

Consultation with Lifewater Engineering revealed that maintenance is also a considerable cost. The hot parts of the incinerating toilet are in contact with corrosive materials and must be replaced regularly. Furthermore, these parts require consistent power for each use, which does not account for the possibility of power outages. A representative from Lifewater Engineering also reported offensive odors and a risk of burns when the incineration cycle is running.

For off-grid use, as with VOS, Lifewater Engineering recommended separating and drying toilets, which do not use any water and can be located indoors. A small ventilating fan with an outdoor vent requires very little electricity (different models operate at 12V, 24V, or 110V), and users have not reported toilet odors. Solid waste can be burned in a wood stove after drying, and diluted urine can be used as fertilizer. In periods of vacancy, everything except for the urine bucket can be left to freeze.

3.6 Analysis of Existing Codes

To structure the decision of which existing building code to base the VOS standards on, CCHRC-NREL prepared a presentation of three choices: code minimum, 30% improvement over minimum, and 60% improvement over minimum.

Tier I

- **Commercial:** ASHRAE 90.1
  This code guarantees minimum construction quality and provides opportunities for financing.
    - min. insulation value: R-31.8 for wood framed walls, R-60 for roof
    - max. air leakage rate: 0.40 cfm/ft2

- **Residential:** International Residential Code (IRC) 2018
  Alaska Housing Finance Corporations (AHFC) minimum construction standards reference IBC/IRC 2018 and provide financing opportunities. Integrating the International Energy Conservation Code (IECC) 2018 would allow for grant funding.
    - min. insulation value: R-20 to R-25 for wood framed walls, R-60 for ceiling
    - min. air tightness: at most 3 air changes per hour

Tier II

- **Commercial:** 30% Improvement over ASHRAE 90.1
  Any proposed design would be energy modelled in ASHRAE 90.1 to determine its modelled design value. The design would then be adjusted to meet the requirements.

- **Residential:** AK BEES (Alaska specific amendments to IECC 2018)
  A point score from energy modelling in AkWarm (based on AK HERS guidelines) translates to a BEES star rating. The accreditation minimum is a 5-star rating, but most regional housing authorities have adopted that new housing must meet at least 5-star+ (18% reduction of energy consumption over 5-star).
    - min. insulation value: R-30 for wood framed walls, R-59 for ceiling (Climate Zone 8)
    - min. air tightness: at most 4 air changes per hour (50 Pa) (Climate Zone 8)

Tier III

- **Commercial:** 60% improvement over ASHRAE 90.1
  Any proposed design would be energy modelled in ASHRAE 90.1 to determine its modelled design value. The design would then be adjusted to meet the requirements.

- **Residential:** AK BEES 6-star rating (36% reduction of energy consumption over 5-star)
  AkWarm can credit for renewable energy systems and the potential to integrate them, net zero ready is 100 points, and net zero is around 107 points on the AkWarm scale.

In terms of design quality and energy consumption AK BEES 6-star is similar to Passivhaus standards. Passivhaus focuses on embodied environmental impact and decreased use of materials, energy usage and capital costs are not considered extensively.

VOS made it clear that the ambitious choice of Tier III would be the best way for them to meet their goals (Table 1). CCHRC-NREL's side-by-side presentation of options helped the group reevaluate and provided clarity in decision making for VOS to draft the final standard, the Solomon Energy Efficiency Standard (SEES).

Energy Efficiency Standard for New Construction

VILLAGE OF SOLOMON
ENERGY STANDARDS (SEES)

This code shall be known as the Solomon Energy Efficiency Standard (SEES) for all construction projects, community, commercial, or residential buildings. It is referred to herein as "this code." This document is a list of specific amendments to the International Energy Conservation Code 2018 (IECC 2018) specific to Solomon, Alaska. It is meant to be read in conjunction with the IECC 2018 and ASHRAE Standard 62.1-2016, Ventilation for Acceptable Indoor Air Quality. ADD TO VOS PROJECTS.

R102.1 General.

The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code. The code official shall have the authority to approve an alternative material, design, or method of construction upon application of the owner or the Traditional Council. The code official shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code for strength, effectiveness, fire resistance, durability, and safety. Where the alternative material, design or method of construction is not approved, the code official shall respond to the applicant, in writing, stating the reasons why the alternative was not approved.

R102.1.1 Above code programs.

The code official or other authority having jurisdiction shall be permitted to deem a national, state, or local energy-efficiency program to exceed the energy efficiency required by this code. Buildings approved in writing by such an energy-efficiency program shall be considered to be in compliance with this code. The requirements identified as "mandatory" in Chapter 4 shall be met. Code official is authorized or appointed by the VOS Traditional Council.

Section R103 SEES compliance documents

R103.1 General.

Technical reports and other supporting data shall be submitted with the AkWarm Energy Rating file as described in the AK HERS Guidelines or in the AHFC Minimum Construction Guidelines

Section 202 General Definitions

This document recognizes that all construction/renovations/retrofit projects are geographically located in Climate Zone 8 with approximately 12,600- 16,800 Heating Degree days annually, (IECC) and labeled the ‘Subarctic’ climate.

R303.1.1 Building thermal envelope insulation

Building thermal envelope insulation. An R-value identification mark shall be applied by the manufacturer to each piece of building thermal envelope insulation that is 12 inches (305 mm) or greater in width. Alternatively, the insulation installers shall provide a certification that indicates the type, manufacturer and R-value of insulation installed in each element of the building thermal envelope. For blown-in or sprayed insulation, the initial installed thickness, settled thickness, settled R-value, installed density, coverage area and number of bags installed shall be indicated on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered, and the R-value of the installed thickness shall be indicated on the certification. For insulated siding, the R-value shall be on a label on the product's package and shall be indicated on the certification.

The insulation installer shall sign, date, and post the certification in a conspicuous location on the job site. Exception: For roof insulation installed above the deck, the R-value shall be labeled as required by the material standards specified in Table 1508.2 of the International Building Code or Table R906.2 of the International Residential Code, as applicable.

R303.1.1.1 Blown-in or sprayed roof and ceiling insulation.

The thickness of blown-in or sprayed roof/and ceiling insulation shall be written in inches (mm) on markers that are installed at not less than one for every 300 square feet (28 m2) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers not less than 1 inch (25 mm) in height. Each marker shall face the attic access opening. The thickness and installed R-value of sprayed polyurethane foam insulation shall be indicated on the certification provided by the insulation installer.

VILLAGE OF SOLOMON SPECIFIC STANDARDS

Testing

Spray foam testing shall be in accordance with ASTM C-518.

Building Orientation

Building Orientation must adhere to north/south facing placement for optimal solar heat gain through window placements, which are required to be installed on north and south facing walls

Face of building with the majority of window area shall be oriented South.

Roof ridge line shall be oriented West-East.

Exception: In the case of demonstrated issues with wind loading, driven rain, or other climatic conditions can allow an exception to the East-West ridge line orientation. Roof slope and orientation is to be south facing for solar installation placements *Please note, any exceptions must be approved in writing prior to construction.

Arctic Entry

Arctic entry ways are required to be designed away from the east/west winds to avoid snow drifts blocking entryway door.

Net Zero Energy Ready

All new construction is required to meet the mandatory compliance of renewable energy installation for future electrical needs.

"U. S. Department of Energy Zero Energy Ready Home Program
The U.S. Department of Energy (DOE) defines a zero-energy ready home as "a high-performance home which is so energy efficient, that a renewable energy system can offset all or

most of its annual energy consumption." DOE zero energy ready homes are designed to meet high performance standards so that they live better, work better and last longer than code-built homes." https://zeroenergyproject.org/buy/zero-energy-ready-homes/

SECTION 1.

R402.2.1 Ceilings with attic spaces.

Ceilings with attic spaces requires R-38 insulation in the ceiling, installing R-60 over 100 percent of the ceiling area requiring insulation shall satisfy the requirement for R-38 wherever the full height of uncompressed R-60 insulation extends over the wall top plate at the eaves. If continuous exterior insulation is used to meet building thermal envelope criteria, a dew-point calculation must be performed to show that condensation within the building envelope assembly is adequately addressed.

R402.2.2 Ceilings without attic spaces.

Ceilings without attic spaces requires insulation R-values greater than R- 60 in the ceiling and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation R-value for such roof/ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed.

R402.2.4 Access hatches and doors.

Access doors from conditioned spaces to unconditioned spaces such as attics and crawl spaces shall be weather-stripped and sealed to prohibit air movement and insulated to a level equivalent to the insulation on the surrounding surfaces. Access that prevents damaging or compressing the insulation shall be provided to all equipment. Where loose-fill insulation is installed, a wood-framed or equivalent baffle or retainer shall be installed to prevent the loose-fill insulation from spilling into the living space when the attic access is opened. The baffle or retainer shall provide a permanent means of maintaining the installed R- value of the loose-fill insulation.

R402.2.8 Floors.

Floor framing-cavity insulation shall be installed to maintain permanent contact with the underside of the subfloor decking. Insulation installed around systems in the flooring, shall be installed per the manufacturer's instructions.

Exception: As an alternative, the floor framing-cavity insulation shall be in contact with the topside of sheathing or continuous insulation installed on the bottom side of floor framing where combined with insulation that meets or exceeds the minimum wood frame wall R- value 59.

R402.2.11 Crawl space walls.

Crawl Space Walls, as an alternative to insulating floors over crawl spaces, crawl space walls shall be insulated provided that the crawl space is not vented to the outdoors. Crawl space wall insulation shall be permanently fastened to the exterior wall surface and shall extend downward from the floor to the footer and then vertically or horizontally for not less than an additional 24 inches (610 mm). Exposed earth in unvented crawl spaces foundation shall be covered with a continuous Class 1 vapor retarder in accordance with the International Building Code or International Residential Code, as applicable. Joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up stem walls and shall be attached to the stem walls.

Crawl spaces will undergo preliminary radon specific assessment prior to design. Overall building envelope must meet the standard of R-Value 58 in order to be in compliance with the code.

R402.4.1.2 Testing.

Where required by the code official, testing shall be conducted by an approved third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the code official. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope. The building or dwelling unit shall be tested and verified as having an air leakage rate not exceeding two air changes per hour at 50 pascals. Blower door test conducted twice, pre-drywall test and the final test. The certificate of occupancy shall be contingent upon the final blower door test. The pre-drywall test allows for adjustments to the vapor barrier or air sealing of the building envelope before finish work begins.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weather-stripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, back-draft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, if were installed at the time of the test, shall be open.
4. Exterior door or interior terminations for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.
5. Heating and cooling systems, if were installed at the time of the test, shall be turned off.
6. Supply and return registers, if were installed at the time of the test, shall be fully open.

SECTION 2.

R403.1 Controls (Mandatory).

Not less than one thermostat shall be provided for each separate heating and cooling system.

Exception – Solid fuel burning devices that are not designed to be controlled with a thermostat. Example: Woodstove.

R403.1.1 Programmable Thermostat.

The thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures of not less than 55°F (13°C) to not greater than 85°F (29°C). The thermostat shall be programmed initially by the manufacturer with a heating temperature set point of not greater than 70°F (21°C) and a cooling temperature set point of not less than 78°F (26°C).

R403.3.1 Insulation (Prescriptive).

Installing supply and return ducts in other portions of the building shall be insulated to not less than R-6 for ducts 3 inches (76 mm) in diameter and not less than R-4.2 for ducts smaller than 3 inches (76 mm) in diameter.

Exception: Ducts or portions thereof located completely inside the building thermal envelope.

R403.3.5 Building cavities (Mandatory).

Stud wall cavities and the spaces between solid floor joists shall not be used as air plenums and shall comply with the following conditions:
These cavities or spaces shall not be used as a plenum for supply air.

1. These cavities or spaces shall not be part of a required fire resistance rated assembly.
2. Stud wall cavities shall not convey air from more than one floor level.
3. Stud wall cavities and joist-space plenums shall be isolated from adjacent concealed spaces by tight-fitting fire-blocking in accordance with Section R602.8.
4. Stud wall cavities in the outside walls of building envelope assemblies shall not be utilized as air plenums.

R403.3.6 Ducts buried within ceiling insulation.

Ducts are to be installed inside the continuous air barrier and building thermal envelope of the dwelling.

R403.3.7 Ducts located in conditioned space.

For ducts to be considered as inside a conditioned space, such ducts shall comply with the following: The duct system shall be located completely within the continuous air barrier and within the building thermal envelope.

R403.4 Mechanical system piping insulation (Mandatory).

Mechanical system piping capable of carrying fluids greater than 1050ºF (410ºC) or less than 550ºF (130ºC) shall be insulated to an R-Value of not less than R-3.

R403.5.1.2 Heat Trace Systems.

Heat trace systems should be installed in such a manner as to prohibit water in piping from freezing if installed. They should be installed per the manufacturer's instructions.

R403.5.1 Heated water circulation and temperature maintenance systems (Mandatory).

Automatic controls, temperature sensors, indicator lights and pumps shall be accessible. Manual controls shall be readily accessible.

R403.5.1.1 Circulation systems.

Heated water circulation systems should be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold-water supply pipe. Controls for circulating hot water system pumps shall start the pump based on the identification of a demand for hot water within the occupancy. The controls shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is no demand for hot water.

R403.5.3 Hot water pipe insulation (Prescriptive).

Insulation for hot water piping with a minimum thermal resistance, (R-value), of not less than R-3 shall be applied to the following:

1. Piping 3/4 inch (19.1 mm) and larger in nominal diameter.
2. Piping serving more than one dwelling unit.
3. Piping located inside the conditioned space.
4. Piping from the water heater to a distribution manifold.
5. Piping located under a floor slab.

6. Buried in piping.
7. Supply and return piping in recirculation systems other than demand recirculation systems.

R403.6 Mechanical ventilation (Mandatory).

The building shall be provided with ventilation that complies with the requirements of the ANSI/ASHRAE Standard 62.2-2016 [International Residential Code or International Mechanical Code,] as applicable, or with other approved means of ventilation. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

R403.3.7 Ducts located in conditioned space.

The duct system shall be located completely within the continuous air barrier and within the building thermal envelope.

R404.1 Lighting equipment.

Not less than 90 percent of the permanently installed lighting fixtures contain only high-efficacy lamps. i.e., LED's, T8's or CFL's certified Energy Star rated and labeled.
Exception: Low-voltage lighting.

ASHRAE 62.2-2016 – Section 6 – Other Requirements

6.6 Ventilation Opening Area

Ventilation air through an exterior door or operable window shall not be considered as part of a mechanical ventilation system design and shall not be included in a calculation showing compliance with the required minimum ventilation rate. The intake shall be placed so that entering air is not obstructed by snow, plantings, or other material, and shall be located at least 18 inches above an adjacent finished grade.

6.8 Air Inlets

A ventilation system's supply and exhaust vents on the exterior of a building may be separated less than 10 feet if they are separated a minimum of 6 feet horizontally. They may be separated less than this if they are part of a system engineered to prevent entrainment of the exhaust air. Care should be taken to locate an intake vent where it can be easily cleaned at regular intervals.

ASHRAE 62.2-2016 – Section 7 – Air-moving Equipment

7.1 Selection and Installation

A ventilation appliance shall be located in a place that is accessible and convenient to access for annual or more frequent maintenance (changing of filters, oiling, cleaning, etc.)

ASHRAE 62.2-2016 – Informative Appendix C (not part of standard)

C2.0 Distribution and Circulation of Supply Air.

A ventilation system should be designed and installed to uniformly mix and circulate supply air throughout the occupiable space. Supply air should be introduced into a room in a manner that does not create human discomfort and is not potentially damaging to the building. There should be always adequate air circulation into and out of a room.

This is the end of the amendments to ANSI/ASHRAE Standard 62.2-2016.
Numbering resumes according to the IECC 2018:

C402.6 Moisture Control (Mandatory)

The building design shall incorporate both interior and exterior moisture control strategies to prevent the accumulation of moisture within insulated assemblies. Exterior moisture control shall comply with the IBC. Should insulated assemblies become wet, or start out wet, the design strategy shall allow the assembly to dry to either the exterior or the interior. Materials shall be allowed to dry prior to enclosure.

C402.6 Interior Moisture Control

Methods to control moisture accumulation within insulated assemblies from the building interior shall address both vapor diffusion and air leakage. Vapor diffusion shall be controlled by the installation of a class I or II vapor retarder on the warm-in-winter side of the insulation. The vapor retarder shall be continuous, and seams shall be lapped 6 inches minimum. Penetrations and seams shall be sealed with approved tape or sealant to control air leakage. Where duct work is located in dropped ceilings adjacent to attics and exterior walls, the vapor retarder continuity shall be maintained above the dropped ceiling.

Exceptions:

1. *A vapor retarder is not required in construction were moisture or its freezing will not damage materials.*
2. *A vapor retarder is not required on basement and crawlspace walls designed to dry to the interior.*
3. *A vapor retarder is not required at cantilevered floor assemblies where the floor decking consists of nominal ¾ inch OSB or other approved material having a perm rating of less than one. Joints shall be sealed in an approved manner. Joint sealing is not required where the deck is covered with concrete or a gypsum-based floor topping.*
4. *The rim joist does not require a vapor retarder when insulated to a minimum value of R-21 with spray foam having a minimum density of 2 pounds per cubic foot.*
5. *A class 3 vapor retarder may be used on walls insulated to a minimum value of R-21 with spray foam having a minimum density of 2 pounds per cubic foot.*
6. *Up to one-third of the total installed insulation R-value may be installed on the warm side of the vapor retarder.*
7. *Factory manufactured insulated panels consisting of a metal skin encapsulating and bonded to a foam plastic core do not require a vapor retarder.*

C403.3.1 Equipment sizing (Mandatory)

Hot water/heating backup stove will be considered utilizing AkWarm for demand heat loads plus 30%. Or the smallest scaled unit to meet the heating demands. DHW will be sized up to twice the home designed occupancy.

C407.5 Calculation software tools

Calculation procedures used to comply with this section shall be software tools capable of calculating the annual energy consumption of all building elements that differ between the standard reference design and the proposed design and shall include the following capabilities:

1. Building operation for a full calendar year (8,760 hours).

2. Climate data for a full calendar year (8,760 hours) and shall reflect approved coincident hourly data for temperature, solar radiation, humidity, and wind speed for the building location.
3. Ten or more thermal zones.
4. Thermal mass effects.
5. Hourly variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads.
6. Part-load performance curves for mechanical equipment.
7. Capacity and efficiency correction curves for mechanical heating and cooling equipment.
8. Printed code official inspection checklist listing each of the proposed design component characteristics, determined by the analysis to provide compliance, along with their respective performance ratings including, but not limited to, R-value, U-factor, SHGC, HSPF, AFUE, SEER, EF.

References

Alaska Housing Building Energy Efficiency Standard (BEES)

ANSI/ASHRAE Standard 62.1-2019 -- Ventilation for Acceptable Indoor Air Quality

International Energy Conservation Code (IECC 2018)

International Residential Code (IRC 2018)

Appendix A. Figures and Tables

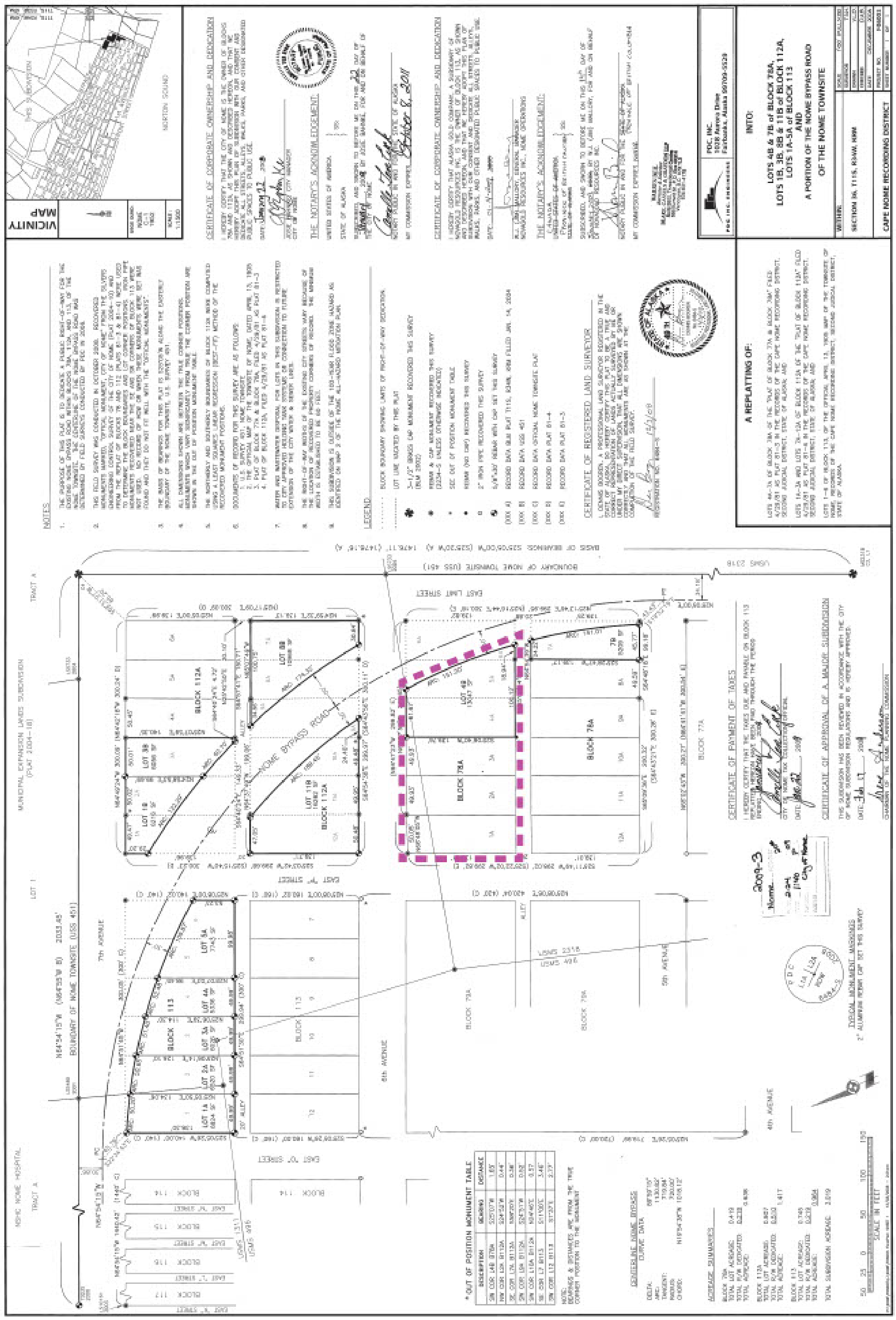

Figure 1: Plat of VOS Lot in Nome

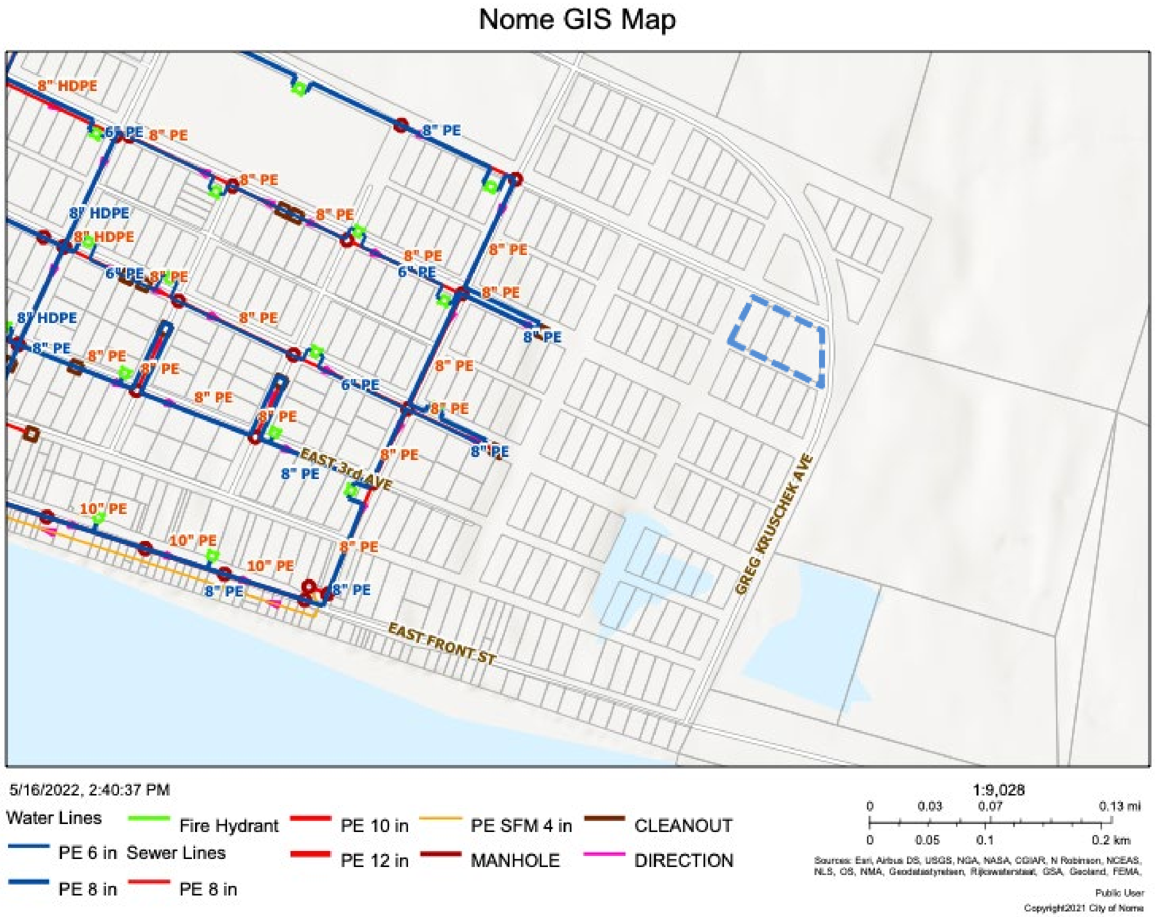

Figure 2: Existing Water and Sewer Lines in Nome

Figure 3: Mobile Housing Unit floor plans

Nome PCE

Utility: NOME JOINT UTILITY SYSTEM

Reporting Period: 07/01/20..06/30/21

Community Population	3690
Last Reported Month	June
No. of Monthly Payments Made	12
Residential Customers	1,755
Community Facility Customers	82
Other Customers (Non-PCE)	371
Fiscal Year PCE Payments	**$635,112**

PCE Statistical Data			
PCE Eligible kWh - Residential Customers	5,594,043	Average Annual PCE Payment per Eligible Customer	$346
PCE Eligible kWh - Community Facility Customers	2,149,064	Average PCE Payment per Eligible kWh	$0.08
Total PCE Eligible kWh	*7,743,107*	Last Reported Residential Rate Charged (based on 500 kWh)	$0.36
Average Monthly PCE Eligible kWh per Residential Customer	266	Last Reported PCE Level (per kWh)	$0.07
Average Monthly PCE Eligible kWh per Community Facility Customer	2,184	Effective Residential Rate (per kWh)	$0.28
Average Monthly PCE Eligible Community Facility kWh per Person	49	PCE Eligible kWh vs Total kWh Sold	26.7%

Additional Statistical Data Reported by Community*

Generated and Purchased kWh		Generation Costs	
Diesel kWh Generated	29,358,967	Fuel Used (Gallons)	1,889,487
Non-Diesel kWh Generated	2,202,841	Fuel Cost	$3,825,885
Purchased kWh	0	Average Price of Fuel	$2.02
Total Purchased & Generated	*31,561,808*	Fuel Cost per kWh sold	$0.13
		Annual Non-Fuel Expenses	$5,979,279
		Non-Fuel Expense per kWh Sold	$0.21
		Total Expense per kWh Sold	$0.34

Consumed and Sold kWh		Efficiency and Line Loss	
Residential kWh Sold	8,692,272	Consumed vs Generated (kWh Sold vs Generated-Purchased)	91.9%
Community Facility kWh Sold	2,239,538	Line Loss (%)	3.8%
Other kWh Sold (Non-PCE)	18,071,561	Fuel Efficiency (kWh per Gallon of Diesel)	15.54
Total kWh Sold	*29,003,371*	PH Consumption as % of Generation	4.3%
Powerhouse (PH) Consumption kWh	1,361,034		
Total kWh Sold & PH Consumption	*30,364,405*		

Comments

**The data contained in this report is primarily based on information submitted by the utility with their monthly PCE reports. Changes to the reported data and/or significant anomalies have been noted in the comments.*

Figure 4: Nome Power Cost Equalization Statistics

	SEES	**AK BEES**
Air leakage rate	Not exceeding **two** air changes per hour at 50 pascals	Not exceeding **four** air changes per hour at 50 pascals
Windows placements are to be south/north facing egress	U-factor 0.18	0.042
Exterior walls	R-Value 59	R-30
Floors	R-value 60	R-38
Attic/ceiling	R-value 60	R-59
Arctic Entry	Required, oriented away from the east/west winds	Not addressed
Building orientation	Roof slope south facing	Not addressed
Backup heat source	Building must have alternative off-grid backup heat source. Efficient wood stove is preferred.	Not addressed

Table 1: Summary of Key Values for Solomon Energy Efficiency Standards (SEES) vs Alaska Housing Building Energy Efficiency Standard (BEES)