

**Report on Converting the Maudrey J. Sommer School
in Tanana, Alaska to a Propane-Fueled Cogeneration
System that will provide Electricity and Waste Heat**

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Introduction

The Alaska Natural Gas Development Authority (ANGDA) funded the Yukon-Kuskokwim Propane Demonstration Project (YKPDP) last October. The City of Tanana (City) is administering the project. Bartz Englishhoe and Associates (BE&A) is providing project management and producing an implementation report¹, which will analyze the logistics, infrastructure and economics of converting Tanana public facilities, businesses and homes to propane. Enterprise Engineering, Incorporated (EEI) is developing proto-typical design requirements for a propane storage and distribution facility.

Background

The *Alaska Natural Gas Study*² (1997) found that unless a rural community is located within a few miles of a natural gas resource such as a nearby natural gas field or adjacent natural gas transportation system, it "is unlikely natural gas will be a competitive alternative with existing energy [diesel] sources."

ANGDA is a public corporation that was created by the citizens of Alaska in 2002 to bring North Slope natural gas to Alaska citizens. Since its creation ANGDA has funded many studies, which includes the 2005 *Feasibility Study of Propane Distribution throughout Coastal Alaska*.³ The study determined the feasibility and economics of distributing propane to coastal villages for electrical power generation and domestic heating. Significant findings of the report include:

- Portability – Propane can be stored, easily transported, used virtually anywhere and is not dependent on a fixed infrastructure or grid.
- Clean Burning – Propane is less harmful to the environment because it burns cleanly without smoke or residential particulate matter and with relatively low pollutant and greenhouse emissions.
- Reliability – Propane burning power generation equipment is more reliable and requires less maintenance than diesel generators. Existing diesel power generation equipment could be used for reliable backup electrical production.
- Convertibility – The availability of low-cost propane will enable remote communities to initially convert to cooking and heating devices and progress later to more sophisticated equipment such as power generation equipment.

The report indicates propane is less expensive than electricity for water and space heating. Specifically, the report stated "On a BTU basis, the cost of propane delivered by dedicated barges to coastal communities would be less than the current (2000) cost of diesel or fuel oil. It was suggested the use of expanded propane will lower the demand for electricity and result in a subsequent reduction in the cost of importing diesel fuel to a community.

The 2005 report indicates communities will be required to comply with new Environmental Protection Agency (EPA) low-sulfur emission regulatory changes by

2007⁴ and propane is considered an alternative clean-burning fuel that produces significantly less pollutants than combustion of diesel fuel. The State of Alaska has stated that tribes and rural Alaskan communities will face many challenges transitioning to clean diesel and the cost of diesel may become even more expensive due to EPA rules requiring the use of ultra low sulfur diesel (ULSD) fuel for clean air. The ULSD regulations may require distributors to modify barges and villages to add tanks to current tank farms. The Alaska Department of Environmental Conservation commissioned a study to analyze the impacts of ULSD on 151 Alaska communities. The study's findings and conclusions should be available in the next couple of months.

The idea of Interior Alaska villages receiving propane manufactured at a small fractionation facility located near the Yukon River was discussed in the report. The YKPDP is addressing the extraction of propane from the future natural gas line at the Yukon River.

The ANGDA and the City believe that using propane is the best way to alleviate the hardship of escalating diesel costs⁵ in rural Alaska, which negatively affect village economies. The ANGDA supports using propane as an alternative fuel to help provide relief from the expense of barging and storing fuel oil, diesel and gasoline in expensive to build and maintain tank farms. The YKPDP is a village-level project that will address the direct energy services that propane can provide villages along Alaska river systems.

YKPDP

Villages will not be able to directly acquire natural gas from the future large-diameter pipeline since it is not economically⁶ feasible to construct a small gauge spur-line from the mainline to communities along the Yukon River. Barging propane to villages processed from the future gas pipeline appears to be the only opportunity where villages can take advantage of the economic⁷ potential⁸ of using in-state natural gas. Tanana is currently working on acquiring bulk propane from North Slope producers and from the retail market⁹.

Tanana is dealing with all aspects of converting a village to use a river based propane distribution system. The village's participation in the YKPDP will provide guidance for other villages who may wish to convert to propane and reduce dependence on diesel, which costs residents from \$4.85 to \$8.00 per gallon in rural communities. There will be no "drop a new technology on a village" scenario since the sustainability of using propane will have been tested and refined by Tanana.

The YKPDP will delineate the costs and logistics of barging, storing and distributing propane within Tanana. This project will determine the feasibility of:

- using high efficiency propane-powered cogeneration systems for public facilities;
- converting existing and purchasing propane appliances and heating systems;
- establishing a central storage area for distribution of propane to a grid system;
- developing underground conduit lines for delivery of propane to residents, and

- converting heavy equipment and vehicles to propane.

From the very beginning of the YKPDP the Tanana City School District (TCSD) showed interested in converting to a propane cogeneration system that provides combined heat and power (CHP). State education officials have already shown interest in supporting the cogeneration electrical and heat upgrades to the Maudrey J. Sommer School because high energy costs divert funding from delivering comprehensive education to rural students.

YKPDP Project Priorities

A public hearing was held in Tanana on January 9, 2008. Participants debated which propane conversion projects would best benefit Tanana. Converting the school was selected as the **Number 1** YKPDP priority. People concluded that acquiring a grant to convert the school to propane would require detailed work and would most directly benefit other future conversion projects. The school would require mechanical and electrical engineering, regulatory compliance, infrastructure upgrades, system evaluation and monitoring. The school conversion project would establish the basis from which other facilities, homes and business could adapt propane technology. People concluded that the school project would receive the most community, grantor and funding agency support because money saved through lowering electrical and heating costs would go to educating students. Additionally, the project has the potential to save other rural school districts money.

Participants talked about cogeneration CHP systems that would produce electricity for the school and provide an option for excess power to be sold back to Tanana Power. The *Energy Policy Act of 2005* requires public utility commissions to consider net metering¹⁰. Net meters allow power to go both ways; 1.) from the electrical grid into a home/facility with a cogeneration unit and 2.) from the home/facility cogeneration unit to the grid. The Regulatory Commission of Alaska (RCA) oversees state regulations (attached) that encourage cogeneration and small power production. The RCA regulations delineate how cogeneration owners can sell electric power back to an electric utility. Tanana Power's latest tariff sheet shows the RCA proposed *Non-Firm Purchased Power Rate* for the utility is \$0.2107/Kwh.

Cogeneration Technology

CHP technology has historically been limited to larger facilities because of perceived cost constraints. New advances in small micro-cogeneration technology are creating options for home, business owners and small facilities. CHP units offer an alternative to purchasing electricity from local suppliers. Cogeneration helps ensure electric reliability, reduces energy costs and protects the environment. The increased energy efficiency of propane CHP systems yields significantly reduced emissions of pollutants¹¹, long maintenance intervals and low noise levels when compared to diesel systems. CHP technology has the ability to operate multiple systems in parallel. New micro CHP units provide small installation space and have low engineering costs.

CHP systems produce electricity and heat simultaneously, addressing both thermal and power needs for home and facilities. Propane CHP systems¹² operate at around 90% (electrical and thermal) efficiency. The electricity can be used for any electrical devices and the waste heat produced can be used for hot water and space heating. CHP technology eliminates transmission and distribution losses associated with purchasing electricity from a central grid. CHP systems are extremely efficient when compared to the 30% to 40% efficiency of electricity provided by a diesel fueled central power station. The use of CHP systems will boost year-round propane sales, which should lower the cost of propane.

Energy Saving Laws

To address new CHP technology many states have created new energy-saving laws¹³, easing of electric power regulations¹⁴ and procedures for reducing carbon dioxide emissions. Using CHP technology supports Alaska's¹⁵ ambitions to reduce America's dependence on foreign oil, promote alternative energy sources, encourage energy efficiency and diversification of the electric power industry.

Alaska Testing of Propane CHP Technology

The Propane Education and Research Council¹⁶ (PERC) has funded many propane demonstration and technical review projects. PERC is working with the National Park Service on using propane technology in the Kenai Fjords National Park, Exit Glacier¹⁷ and Denali Visitors Center. Larry Osgood, Consulting Solutions, LLC, is providing project coordination for PERC on the park propane projects. Precision Power, LLC, of Palmer, Alaska and the University of Alaska-Fairbanks will be testing CHP cogeneration technology this year for Underwriters Laboratories (UL) certification for use in Alaska. Precision Power is the UL nationally recognized testing laboratory for Alaska. The City has been in contact with PERC and plans on submitting a request for project funding.

Current Cogeneration Technology

The school has numerous options available for converting to propane cogeneration. The cogeneration technologies for the following manufactures were reviewed.

Yanmar Energy Systems: Yanmar developed its CP micro cogeneration systems in 1998 and comes in 5 kW, 9.9 kW and 25 kW propane units. Variations of these units can also use biogas fuel (methane fermentation gas) derived from animal and plant based organic matter (leftover food, animal manure, drainage sludge, etc.). Up to eight CP units can be managed from one controller. Currently, CP units are being used by businesses such as health spas, hot bath facilities, hospitals, super markets and welfare facilities. The CP5VB model measures 44 x 23 x 61 inches in size. The 5 kW has low operating noise (51dB) and long maintenance intervals (10,000 hours). A PERC fact sheet on Yanmar systems is attached.

Marathon Engine Systems: In 2002, Marathon developed propane micro-cogenerators for the U.S. and world markets. A 5 kW engine is the heart of the cogeneration production line. The Marathon ecopower Micro-CHP production line has long life

(40,000 hours), low maintenance (4,000 hour service interval) and total efficiency greater than 90% (fuel to recovered energy). The ecopower Micro-CHP has been available for the past five years in Europe, where 1,400 systems have been installed. PERC assisted Marathon with U.S. certification for sales in North America. A PERC fact sheet on Marathon is attached.

Solar Energy: The Dachs micro CHP unit uses natural gas, propane, fuel oil or bio diesel to fuel an internal combustion engine. The Dachs has a continuous output of 5.5 kW electricity/12.5 kW heating and achieves approximately 90% overall efficiency. An additional external exhaust heat exchanger can add 2.5 kW of thermal energy, raising the efficiency up to approximately 98%. Dachs has operated successfully across Europe for many years. Dachs and its partner network have installed over 13,000 units. The system can be configured to meet varying heat and power demands of different building types from a stand alone unit to full systems working in conjunction with other sources of heat and power. A Dachs pamphlet is attached.

Tecogen, Incorporated: Tecogen is located Waltham, Massachusetts and produces CHP systems that use engine-driven commercial cogeneration systems suitable hospitals, nursing homes and schools. Tecogen equipment has heat recovery capability, provides remote monitoring and has engine low-emissions that meet all current environmental standards. Tecogen has installed over 1,800 units in the U.S. and is supported through an established network of engineering, sales, and service support. A San Francisco co-op style residential high-rise uses a Tecogen CM-60 module, which produces 60 kW of electricity along with 444,000 BTU/hour of hot water. A brochure on the Tecogen CM-60 is attached.

Capstone: Capstone produces MicroTurbines in 30 kW, 60 kW, 65 kW and 200kW systems. The military, food processing, governmental and manufacturing facilities uses Capstone units. Capstone advertises the MicroTurbines as producing low NO_x and CO₂ emissions, remote monitoring and lost-cost installation. The brochure for the C65 MicroTurbine is attached.

Climate Energy, LCC: Climate Energy, in partnership with Honda and ECR International, has developed a micro-CHP system designed to replace conventional warm air furnaces. Honda generator technology is used in more than 50,000 homes in Japan. The Climate Energy Propane Warm Air Micro-CHP system uses Honda's propane internal combustion engine to generate electricity. The unit can operate at an energy efficiency of 90% and is expected to yield a 30 percent reduction in carbon dioxide emissions when compared to conventional heating appliances and grid-supplied electricity. PERC is working with Climate Energy and a fact sheet is attached. The micro-CHP system provides high-quality electrical output.

Cogeneration Technology for the School

The school might want to install more than one type of CHP system for testing purposes. This would allow the school to analyze and monitor which type of system works best. CHP units should take advantage of current technology and adopt accessories such as:

- battery banks that are charged by the CHP system
- photovoltaic panels (solar cells) connected to the CHP system
- solid oxide fuel cells¹⁸ that use propane as the fuel for the reformer
- hybrid power generation systems that include a generator, batteries, inverters, switchgear, solar panel array and a wind generator
- thermal storage tanks that store energy and extends heat loss
- internet-connected control systems
- technologies such as platinum long-life spark plugs and extended air filters

The school has a mixed assortment of boilers, furnaces, heat exchangers and a hot water boiler. The maintenance supervisor and a mechanical engineer will need to work together to detail how CHP technology can be integrated into the current heating and electrical systems. CHP technology would work in the school, generator building, and Vocational Education Building or in a system interconnecting the structures.

The school (24,695 sq. ft.), Vocational Education Building (5,000 sq. ft.) and Generation Building (500 sq. ft.) can all benefit from CHP technology. Adding CHP units would alleviate furnace, boiler and heat exchange overload during December, January and February when temperature can average -45°F¹⁹.

It is recommended that the school district work with Precision Power since the company has years of experience working in rural Alaska and on electrical generation systems. The company has facilities in Anchorage, Deadhorse, Kenai and Prudhoe Bay, Alaska. Additionally, the school should work with Larry Osgood, Consulting Solutions since he probably has more knowledge on propane CHP systems than any individual in the nation. He is considered the leading expert on propane and has worked on over a 100 propane related projects. Mr. Osgood has worked with the University of Alaska-Fairbanks, State of Alaska and Precision Power and has been a presenter at Alaska Rural Energy Conferences.

Current Heating System

The school currently has three (3) separate boiler rooms. Two are inside the school and one is located in an adjacent generator building. There is also an unused forced air furnace located in the vocational building, which acquires heat from the generator building. There is not enough heat to have classes in the vocational building unless the forced air furnace is in operation. The boiler room in front of the school is referred to as the River Front Boiler Room. The boiler room located in the center of the school is referred to as the Inner Boiler Room. James R. Edwards, III, Maintenance Superintendent, has indicated to the best of his knowledge that the school in the past used waste heat from the Tanana Power plant. The plant down-sized because the local hospital closed and there was not enough waste heat available for the school. The school still has the waste heat exchanger in place that was used by the Tanana Power waste heat system. The exchanger is located in the gym and shares a common wall with the River Front Boiler Room. The entire heating system was upgraded in 2007. Following are descriptions of the school's heating systems.

Maudrey J. Sommer School River Front Boiler Room

Burnham Hydronics Boilers (two) with the Following Specifications		
Boiler number: PF-504	Serial number: #7563411	Gross output: 620 MBH
Steam: 1938 sq. ft.	Steam: 465.1 MBH	Water: 539.1 MBH
Firing rate for light oil: 5.45 g.p.h.	Firing rate for gas: 763 MBH	
Minimum relief value capacity: 620 MBH or lbs/hour		
APV Equipment, Inc. Heat Exchanger		
Model: SR650-T	Serial number: #15556	Item: HX-5
Minimum relief value capacity: 620 MBH or lbs/hour		
Ajax Boiler, Inc. Hot Water Generator		
Model: HG-3604-C-4860-S-M	Serial number: #4456	Year built: 2007
Installed: December 2007	Shell: 125 psi@390°F	Tubes: 155 psi@390°F
Minimum DMT: 0 F @ 125psi	Capacity: 275 gallons	Tubes: 539.1 MBH

The river front boiler room is used to heat the lower half of the school which includes the gym, kitchen and lower hallway. The boiler room has two air handlers on the hot water system.

Maudrey J. Sommer School Inner Boiler Room

Burnham Hydronics Low Pressure Boilers (two) with the Following Specifications		
Model: V905A	Serial number: #64997290	Gross output: 646 MBH
Steam: 2021 sq. ft.	Steam: 485 MBH	Water: 562 MBH
Firing rate for light oil: 5.6 g.p.h.	Firing rate for gas: 808 MBH	
Installed: December 2007	Manufactured: July 2007	

The inner boiler room supplies heat to all base board heat throughout the upper section of the school. The system has two air handlers. Both boiler rooms are connected to each other by a heat trace that goes through the gym. The heat trace is located next to the old waste heat lines, which connect to the gym from outside the north side of the building.

Maudrey J. Sommer School Generator Building

Burnham Hydronics Low Pressure Boiler with the Following Specifications		
Model: FV8SWC-GBWN2S	Serial #: 64975798	Water: 543-170 MBH
Firing rate for light oil #2: 1.35-1.65 g.p.h.	D.O.E. HTG Cap: 164-196 MBH	
Manufactured: March 2007	Installed: December 2007	

The generator boiler room heats the generator building and provides some heat to the vocational building. A heat trace flows from the generator building to the vocational building.

Vocational Education Building

Hasting Forced Air Furnace with the Following Specifications		
Model: CF-40-C02	Serial number: #47497	Manufactured: April 1994
BTU rating per hour: Max input 500,000, Outputs: 4000,000 – Min Input 250,000		
Firing rate for light oil #2: 3.6 g.p.h.	Operation pressure 250	BTU: 140,000
Hasting Burner		
Model: R6. 9-0-05/N523044	Firing rate for light oil #2: 3.5 - 9.0 g.p.h.	

The school district has an Operational and Maintenance Plan through Southeast Regional Resource Center (SERRC) in Juneau, Alaska. SERRC provides direct student services, school and district support services throughout Alaska. Photographs of the boilers, furnace and heat exchangers are attached.

School Operation and Maintenance Program

The school's maintenance program with SERRC is a computerized preventive maintenance work order and scheduling program. The maintenance management program tracks the timing and costs associated with planned and completed maintenance activities. The school is able to produce preventative and corrective work orders via the internet. The SERRC computer system allows the school to schedule maintenance for the following systems:

- Electrical
- Mechanical
- Fire protection
- Fuel system
- Structural
- Interior building
- Exterior building
- Roofing

SERRC is working with the school on an energy management program and energy reduction plan. The program focused on ways to; 1.) control and reduce consumption of heating fuel and 2.) reduce consumption of electricity. Preventative measures include annual servicing of boilers, pumps and controls and includes on-site training for maintenance staff. SERRC assists the school in renewal and replacement schedules for electrical, mechanical and structural systems. Additional preventative maintenance training was provided in 2006 by a consultant hired by the City and a previous employee. This training included trouble shooting heating systems and boilers. Attached is a table that shows maintenance hours by month and work type from July 2006 to June 2007.

The SERRC prepared the TCSD "FY 09" *Capital Improvement Plan* (CIP), which states the District's energy management plan is extremely hard to quantify and analyze because of extreme factors preventing the school from accurately measuring and controlling energy use. The village's sub-arctic winter weather, prevailing winds, large window surfaces and air leaks determine how much fuel is used. The CIP states the uncontrollable factors contributing to fuel consumption and the escalating cost of heating oil make it impossible to accurately quantify any fuel saving that can be attributed to preventative or corrective maintenance. Unpredictable fuel consumption (2006-2007) caused all but 1,000 gallons out of 22,500 gallon of fuel to be used. Integrating a CHP system into the heating system would prevent the school from running out of fuel.

Power usage is easier to quantify and compare. The total kilowatt hours consumed in FY2004 was 102,467 Kwh. Consumption climbed to 123,840 Kwh in FY2005 or 14.1 Kwh per hour. The main school used 17,280 Kwh during November 2007. The first 10,000 Kwh were billed at \$0.4665 per Kwh. The next 7,280 Kwh were billed at \$0.4485 per Kwh. Additionally, a fuel charge of \$3,022 was added to the November billing.

The CIP lists capital improvements of \$5,443,687 for the Maudrey J. Sommer School and \$507,768 for the school gym. The capital project cost for heating, ventilating and electrical systems is \$2,292,131, as show below:

System	Year Installed	Remaining Life Span	Total System Costs
HVAC Distribution	1959	-10	\$371,538
HVAC Equipment	1959	-20	840,926
HVAC Controls	1959	-30	158,179
Electrical Sev./Gen.	1959	-10	149,719
Electrical Distribution	1959	0	179,883
Electrical Lighting	1959	15	411,267
Special Electrical	1959	-35	180,619
Total HVAC and Electrical Capital Improvements			\$2,292,131

The FY 2007-2008 budget allocation for the school is \$1,091,811. The Operation and Plant Maintenance budget is 309,630 or 28% of the total budget. Utility and energy costs represent 55% of this budget category. The Operation and Plant Maintenance budget will probably keep increasing because the school is a wood-framed structure on wooden pilings that was built in 1959. The original school has had three additions in 1963, 1972 and 1974. The gym was part of the 1974 expansion. According to a 1985 Conditions Survey, the school had a major renovation in 1980. None of the additions or renovations were constructed to meet today's building standards. The addition of cost effective and energy efficient CHP systems conform with the district's energy management plan of being proactive in replacing systems that will provide better energy efficiency for the school. The school district will need to work with SEERC to incorporate a CHP system(s) into the maintenance program.

Potential CHP Systems

The school district has three potential options for using propane-powered CHP systems in school facilities. The district could incorporate all three options at once or elect to install one or two of the systems. Below is an analysis of each scenario:

1. School Maudrey J. Sommer School: Two Yanmar 9.9 kW micro-CHP systems could be installed in the inner boiler room. The systems would provide 19.8 kW of electricity and 33.6 kW of heat (114,600 BTU/hr).

2. Vocational Education Building: The Marathon ecopower would fit the needs for this building. The ecopower provides 2.2 - 4.7 kW's of power. Excess power would be forwarded to the school's electrical system. The unit would use a heating loop and buffer tank for heat storage. The thermal power (167° F) produced is between 20,473 and 42,652 BTU's. Excess heat could be channeled to the school gym. The approximate efficiency is 92%.
3. Generator Building: The old diesel generator could be replaced by a CHP system by Capstone's C65 or C65-ICHP MicroTurbine systems. The units provide 65Kw of power and 408,000 BTU/hr (120kW) with a copper core. There are several other companies that supply similar models.

Propane Information

Propane is part of the liquefied petroleum gas (LPG or LP) family, a term widely used to describe light hydrocarbons called natural gas liquids (NGL). Propane is found mixed with natural gas and petroleum deposits. Propane is not produced for its own sake, but is a by-product of natural gas processing and petroleum refining. Basically, propane is manufactured during the refining of crude oil or extracted from oil or gas streams as they emerge from the ground. Around 55% of the propane used in the United States is extracted from raw natural gas. The remaining 45% is extracted from petroleum. The United States uses more propane gas than any other country in the world and LPG supplies 3% to 4% of our total energy needs. Nearly 90% percent of the propane used in this country is produced in the United States. Propane is a \$30 billion a year industry in the United States and more than 15 billion gallons of propane are used annually.

Propane Facts

Propane (C₃H₈) is an energy rich gas. One gallon of liquid propane weights 4.24 lbs compared to a gallon of water that weighs 8.33 lbs, which means propane is lighter than water. The solubility of propane in water is 0.1 to 1.0 %. Propane will not sink in water. The freezing point of propane is -310°F and boiling point is -44°F, which is cold enough to freeze skin (and tissue underneath) to the point of severe damage. One cubic foot of gas propane weighs 0.1162 lbs. and one cubic foot of air weighs .07655. Propane is heavier than air and will sink to the lowest space available.

The British thermal unit (BTU or Btu) is a unit of energy used in the United States and relates to the heat value or quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit. It takes about 143 BTU or .0016 gallons of propane, to melt one pound of ice (at 32°F). Propane produces 91,600 BTU's per gallon. Number 1 heating oil that is used in rural Alaska produces 134,000 BTU's. The octane level for propane is 100-125, compared to 97 for regular gasoline. The ignition temperature in air is 920°F to 1,120°F. Propane is 270 times more compact in its liquid state than it is in gas form. Propane is colorless and odorless. Ethyl mercaptan (an odorant) is added to serve as a warning agent for escaping gas.

Benefits of Propane

Propane is one of the lightest, simplest hydrocarbons in existence and as a result is one of the cleanest burning of all fossil fuels. Propane is all fuel and doesn't require additives such as some grades of gasoline. Propane leaves no lead, varnish, or carbon deposits that cause the premature wearing of pistons, rings, valves, and spark plugs. This means that engines stay clean, free of carbon and sludge. Propane-powered engines require less maintenance and have an extended engine life. Many states offer fuel tax incentives to encourage the use of clean fuels, thus further reducing operating costs.

Propane is a "green" energy product and is listed as a clean alternative fuel in the *1990 Clean Air Act* and *National Energy Policy Act of 1992*. Propane exhaust creates 60%-70% less smog-producing hydrocarbons²⁰ than gasoline. Compared to gasoline, propane yields 12% less carbon dioxide, about 20% less nitrous oxide and as much as 60% less carbon monoxide²¹. Propane cuts emissions of toxins and carcinogens like benzene by up to 96% when compared to gasoline.²² Propane gas is not harmful to soil and water and the placement of propane tanks either above or below ground is not regulated by the Environmental Protection Agency.

Propane Storage

Propane is stored and transported in its compressed liquid form. Propane is sold as a pressurized liquid in refillable steel containers of various sizes. All containers are built and transported according to highly regulated safety standards. Propane tanks are around 20 times more puncture proof than conventional gasoline tanks. In order to allow for thermal expansion, propane bottles are filled to between 80% and 85% of their capacity.

Propane becomes a liquid at 140 psi (room temperature) and any container with a mix of liquid and gaseous propane will be pressurized to 140 psi, regardless of the ratio of liquid to gas. This is similar to having ice in a glass of water. If there is a mix of ice and water, the water will be exactly at its freezing point regardless of the ratio of ice to water. The temperature can only drop below freezing if all the water freezes or above freezing if all the ice melts. Simply stated, propane is always a liquid until it is used. Even at -40°F propane vaporizes; that is why it can even be used at low freezing temperatures. Liquid propane instantly vaporizes into a gas when it is released from its tank to fuel propane gas appliances and equipment. When propane vapor is drawn from a tank some of the liquid in the tank instantly vaporizes to replace the vapor that was removed.

Propane Safety

Propane has a remarkable safety record due in large part to stringent regulations developed by the propane industry and the National Fire Protection Association. Propane can not be ingested like gasoline or diesel because it is released as a vapor from a pressured container. Propane has a narrow range of flammability when compared with other petroleum products. In order to ignite, the propane/air mix must contain from 2.2% to 9.6% propane vapor. If the mixture contains less than 2.2% gas it is too lean to burn. If it contains more than 9.6 percent it is too rich to

burn. Propane won't ignite when combined with air unless the source of ignition reaches at least 920°F. In contrast, gasoline will ignite when the source of ignition reaches only 430°F to 500°F.

When used properly, propane is safe. Although high concentrations could displace enough oxygen to cause suffocation, the real danger of propane is the fire hazard. Although there is practically no chance of causing a propane tank to explode, there is still a fire hazard and it is important to keep open flame, sparks, and cigarettes away from storage tanks when filling a tank. Adequate ventilation should always be provided when working with propane indoors.

Conclusions

The YKPDP implementation report is due December 31, 2008, but a preliminary report will be available in August. The report can be used by Tanana and other villages as the basis from which to convert to propane. Extracting propane from the future gas line at the Yukon River Bridge will provide river villages a ready source of inexpensive propane when compared to propane that is now produced by the Tesoro refinery in Nikiski or shipped from Canada. Propane now must be shipped by railroad, truck or barged before it arrives in villages. The Yukon River propane will be good bargain, especially when reduced state taxes on in-state use of natural gas is considered.

CHP technology will reduce school energy costs. Propane will continue to become cheaper, especially when ordered in bulk. Cogeneration is a technology the school needs to embrace.

¹ The YKPDP implementation report is due December 31, 2008.

² *Alaska Natural Gas Study* was prepared for Alaska Department of Community and Regional Affairs, Division of Energy by Mark Foster, MAFA, Anchorage, Alaska, in collaboration with Advanced Resources International, Inc., Arlington, Virginia.

³ *The Feasibility Study of Propane Distribution throughout Coastal Alaska was prepared for ANGDA by PND, Incorporated.*

⁴ EPA proposed rules for fuel sulfur levels in rural Alaska on October 13, 2005. DEC recommendations were incorporated into the proposed ruling, including the request to accelerate marine sources to the 2010 deadline.

⁵ During the 2004 Alaska Federation of Natives Convention Alaska Governor Frank Murkowski (1992-1996) indicated the high price of fuel has put an "almost insurmountable burden on small communities and their residents". The Governor spoke about the state's "efforts to lower the cost of energy for our state and focus on making our state and villages energy self-sufficient by 2010." A plan to help even the most financially-strapped villages to "better manage their own winter fuel programs" was discussed.

⁶ There are not enough potential utility, institutional, business and residential natural gas users in Yukon River villages to make a spur-line economical because numerous villages have less than 100 residents. For example, Beaver, Alaska had a population of 84.

⁷ The Alaska Legislature succeeded in passing a revised Petroleum Profits Tax (PPT), which contained an amendment that gives preferential production tax rates for Alaska-produced gas used in-state. The 5% tax provision for in-state natural gas sales will be consistent across the state. Basically, North Slope natural gas processed for in-state use will be taxed at 5% and not 25%.

⁸ The future cost of purchasing natural gas to process into propane at a delivery point near the Yukon River will be based on an in-state rate. ConocoPhillips (which owns a portion of the natural gas on the

North Slope) has indicated the company would cooperate with local distribution companies and set up an in-state rate so the customer would only have to pay to move the gas to their respective in-state location and not the full price that Lower 48 distributors will be paying. The *Peninsula Clarion* reported that ConocoPhillips North Slope gas development manager Wendy King, stated that "(The customer) should only pay to move gas to Fairbanks," King said. "Not to the Alberta-British Columbia border."

- ⁹ The City of Tanana and BE&A has been working with BP and Conoco Phillips, Fairbanks Gas Company, Flint Hills North Pole Refinery and AmeriGas. AmeriGas is the nation's largest marketer of propane and propane equipment and operating in nearly 50 states. The City hopes to establish a distribution system and acquire enough propane in large quantities to reduce the price of propane from current levels.
- ¹⁰ Net metering measures the difference between the electricity you buy from your utility and the electricity you produce using your own generating equipment. Your electric meter keeps track of this "net" difference as you both generate electricity and take electricity from the electric grid. Net metering policies generally require that sales to the grid to not exceed purchases from the grid.
- ¹¹ Diesel power plants require state operating permit because of because of air contaminants and waste oil. Tanana has a Class III municipal landfill and can not accept waste oil. Tanana Power has an incinerator that burns waste oil.
- ¹² The Kauai Marriott Resort and Beach Club installed a CHP system because of Hawaii has the highest utility rates nationwide (they forgot rural Alaska). The resort formed a partnership with the Propane Education and Research Council (PERC), Gas Technology Institute, Gas Company of Hawaii and the U.S. Department of Energy to design and test and the CHP system. It is believed the resort will save \$706,000 per year. The onsite propane CHP system is expected to use about 860,000 gallons of propane a year and meet all of the domestic water and pool heating needs for the one-million square foot facility at 70 to 80 percent energy efficiency. The system will provide 50 percent of the hotel's base power on a 24-hour basis.
- ¹³ On September 14, 2007, Governor Sarah Palin established a sub-cabinet to prepare a climate change strategy. The Climate Change Sub-cabinet will consolidate the state's knowledge about global warming in Alaska, recommend measures and establish policies to prepare communities to address the expected effects of global warming. The Governor believes that state has tremendous alternative energy potential. The Climate Change Sub-Cabinet will be looking at ways to develop, support and expand renewable energy resource programs and to promote aggressive development of renewable energy sources such as geothermal, wind, hydroelectric, tidal, and in-stream energy. The Department of Natural Resources has a program to find renewable energy resources around the State. The Alaska Department of Environmental Conservation has formed workgroups other state agencies in addition to started working with communities, federal agencies, the legislative Climate Impact Assessment Commission and the Congressional Delegation.
- ¹⁴ The RCA is considering adopting new standards under the Public Utilities Regulatory Policies Act of 1978 as amended by the Energy Policy Act of 2005. The standard in the federal law include fuel source diversification, fossil fuel generation efficiency, time-based metering and interconnection. Access to at: <https://rca.alaska.gov/RCAWeb/Dockets/DocketDetails.aspx?id=488a99ec-2008-43ccb466-fd3abeffac93>
- ¹⁵ Governor Sarah Palin has announced that she plans on using state earnings to establish a \$250 million "Renewable Energy Fund" for alternative projects, like hydro, wind, geothermal, and biomass.
- ¹⁶ The U.S. Congress passed the Propane Education and Research Act in 1996 and PERC was established. PERC receives funding from an assessment on each gallon of odorized propane. Through PERC, the propane industry has committed itself to multi-year, multi-million dollar effort to improve consumer and employee safety, fund research and development of new and more efficient propane technology. PERC is expected to collect approximately \$45.1 million in 2007 to fund programs and projects. PERC website is at: <http://www.propanecouncil.org/>

¹⁷ Exit Glacier uses a 5kW continuous duty rated propane generator and shows that a 5 kW generator can provide reliable power with peak loads well in excess of 5 kW due to the battery configuration of the generator package.

¹⁸ Fuel cells use electrochemical process discovered more than 150 years ago and supplied electric power for spacecraft in the 1960's. Fuel cells are now being used for more down-to-earth applications such as on-site power for the military, banks, police stations, and office buildings.

¹⁹ The average December, January and February of - 45°F was documented within a September 20, 2007 letter to the State of Alaska Board of Education and Early Development.

²⁰ Southwest Research Institute

²¹ World LP Gas Association

²² Southwest Research Institute.