Pipeline report: Gas plant totals one-third of project cost

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About one-third of the Alaska gas pipeline project cost has little to do with physically burying steel pipe along hundreds of miles of the northern continent.

Instead, this major piece of the overall project would center on a 120-acre patch at the Prudhoe Bay oil field that would house a massive complex of structures known as the gas treatment plant.

The plant's cost has been estimated at $12 billion, compared with a total project cost of $32 billion to $41 billion. It would be the most expensive complex of buildings ever assembled in Alaska.

The plant would purify the natural gas produced from the North Slope fields, then chill and compress the gas to get it ready for injection into the pipeline.

Everything about the gas treatment plant, including its price tag, is oversized.

It would be one of the world's largest gas treatment/processing plants, much larger than the major liquefied natural gas and gas-to-liquids plants built recently or planned around the globe.

The North Slope would see its biggest sealifts in years – probably three of them over three years to deliver some 270,000 tons of mega-modules.

An estimated workforce of 3,000 people would assemble the modules into the plant. They would build, essentially, four parallel factories that would simultaneously process the gas.

The plant would deliver about 4.5 billion cubic feet of gas every day to the pipeline, enough gas to supply 20 million U.S. homes with all the gas they need for heating and cooling.

Why is such a gargantuan treatment plant needed to begin with?

The answer rests mainly on two factors: the huge flow of gas that would be treated, and the amount of treatment that gas would need.

MAKING THE GAS 'PIPELINE QUALITY'

The natural gas most familiar to residents of Southcentral Alaska residents is special.

The Cook Inlet gas burned to heat their homes and businesses, or to electrify their flat-screen TVs and smartphone battery rechargers, is almost pure methane as it rises out of the ground. Methane is the dry gas that furnaces burn. The Southcentral gas comes mostly from two

formations in the vast Cook Inlet oil and gas basin – the Beluga and Sterling formations – and this gas needs little cleansing before it's ready for use.

On the other hand, gas from Prudhoe Bay, the North Slope's biggest field by far, is acidic. Roughly 12 percent of the flow arriving at the gas treatment plant would be carbon dioxide, or CO_2, and only about 81 percent would be methane. CO_2 essentially has little value when it comes to heating your home, but it does have a value in oil and gas production, as we will see.

The vast North American pipeline network is choosy about the gas it handles. Different gas fields and different pipeline companies all feed into the network, and for the system to hum, every molecule of gas must be nearly identical in chemistry to every other molecule. Like a picky kid who plucks pepperoni from the school-lunch pizza before gobbling it down, the gas pipeline network refuses to ingest gas that has more than a trace of impurities.

A key role of the North Slope gas treatment plant would be to create so-called "pipeline-quality" gas by reducing the CO_2 content from around 12 percent to about 1.5 to 2 percent of the gas.

The plant also would extract a smattering of other corrosive impurities, particularly hydrogen sulfide.

People in the industry sometimes use the term "sweetening" to describe this cleansing of gas to make it pipeline ready.

A THIRD DEGREE OF GAS PROCESSING

Prudhoe Bay operators already send their natural gas through two phases of processing.

The gas is a byproduct of their production of the more valuable crude oil. Gas and water surge up wells with the oil. This mixture is treated initially at one of six plants called gathering centers or flow stations. These plants collectively handle about 8 billion cubic feet of gas each day. The plants separate out the gas, dehydrate it, compress it and push it on to a gigantic plant called the Central Gas Facility, or CGF.

Step two occurs at the CGF. Just as produced natural gas typically contains methane, carbon dioxide and hydrogen sulfide, it typically harbors some valuable natural gas liquids. The CGF extracts the heavier liquids such as butane.

Unlike the methane, Prudhoe Bay oil producers turn much of the heavy liquids into cash right away, blending them with crude oil to flow down the trans-Alaska oil pipeline and on to refineries. However, they pipe some liquids and other components of the gas to another plant to become a product called miscible (mixable) gas, which they shoot back into the oil reservoir at Prudhoe Bay or into the big Kuparuk River field to the west. Miscible gas helps harder-to-produce oil flow more freely to wells.

Beside the gas-liquids extraction, about 680 million cubic feet a day of the gas the CGF handles is burned to run the oil fields or sold to North Slope utilities, the state estimates. But most of the gas is injected back underground at a neighboring plant, pressurizing the field to boost oil production and saving the gas for the day when a pipeline can carry it off the North Slope.

The proposed $12 billion gas treatment plant would add a third phase to this chain of gas processing.

Plans are to locate the plant near the CGF. It would receive 5.3 billion to 5.8 billion cubic feet a day of gas from the CGF. Up to 1 billion cubic feet a day of this stream would never make it to the large-diameter pipeline:

- The plant would extract 600 to 700 million cubic feet of carbon dioxide, hydrogen sulfide and other contaminants. The extracted CO_2 and other impurities would be piped away for injection back into the oil reservoir. CO_2 also is a miscible gas, and plans are to use it to scrub more oil from Prudhoe Bay.

- The plant operations would consume 200 to 300 million cubic feet daily – about the same amount of gas Southcentral Alaska consumers and utilities now consume.

(These numbers are in ranges because the two consortia pursuing a gas pipeline project estimate different numbers for the treatment plant. The consortia are the Alaska Pipeline Project formed by TransCanada and ExxonMobil, and Denali – The Alaska Gas Pipeline formed by BP and ConocoPhillips.)

APP estimates it would cost about $300 million annually to run the gas treatment plant.

Why not modify the existing Central Gas Facility to extract the CO_2? After all, that plant already is there. It already processes 8 billion cubic feet of gas a day. Why not add CO_2 removal to its list of chores?

One reason is that the main plant and its core machinery would be about 35 years old if the pipeline started up about a decade from now.

At least as important are two other factors. First, converting the CGF would bring a new regulator to the CGF, possibly complicating how it is operated. The Federal Energy Regulatory Commission has no jurisdiction over the CGF and Prudhoe Bay today. But by law it would oversee the gas treatment plant.

Second, as currently conceived, the ownerships of Prudhoe Bay and the proposed gas treatment plant would differ; the owners' interests could conflict, and negotiating a meeting of the minds would be cumbersome and lengthy.

CLEAN, CHILL, COMPRESS

The proposed gas treatment plant would occupy a 120-acre site near the CGF, a footprint about the size of 90 football fields. A construction camp and staging yard would occupy another 35 acres or so, according to Denali's preliminary design.

Besides removing CO_2 and other impurities, the plant would chill and compress the gas to prepare it for the main pipeline.

Gas would enter the plant at a temperature of 45 to 80 degrees – too warm for a pipe buried in permafrost. This gas would exit the plant at a temperature of 30 degrees or lower.

Gas coming into the plant also must be super-pressurized to begin its 1,700-mile journey through the main pipeline. Compression propels gas through pipelines.

Gas would enter the treatment plant pressurized at 600 pounds per square inch, or psi. It would exit the plant bound for the main pipeline at 2,500 psi. Over a dozen compressor stations would be strung along the pipeline to Alberta like rest stops on a freeway to keep the gas properly pressured as it pulses through the trunk line. Some of the compressor stations, particularly those in Alaska, would keep the gas cold during its journey.

The cleansing, chilling and compressing would occur inside four identical factories, called trains, at the gas treatment plant site. Think of how airline ticket counter agents check in, take baggage and issue boarding passes for multiple passengers simultaneously before sending them all over to the TSA line. The gas treatment plant would work similarly.

The volume of gas needing treatment, the remote location and the time-is-money maxim combine to dictate this four-train design.

The plant must be big enough to handle over 5 billion cubic feet of gas daily. Its physical bulk would dwarf the nearby CGF. Globally, the biggest natural gas processing plants recently built or planned typically have been designed for 2 bcf to 3 bcf per day. The average size of Lower 48 processing plants is a bit over 100 million cubic feet a day.

So by definition, the components of the plant would be big. But the plant modules cannot be so big and heavy that vessels delivering them to Prudhoe Bay via sealifts draw too deep a draft to maneuver into the dock.

And the modules can't be so small that delivering them would take more than three sealifts – one each for three years. Deliveries can occur reliably only during a short late-summer window when the sealift armada can navigate an ice-free Beaufort. Building, delivering and assembling the gas treatment plant would involve the choreography of a major military assault. One missed sealift and the whole pipeline project could be delayed a year, costing developers untold millions.

Given these constraints, developers could not build one train to process all 5 bcf of daily gas flow, but four smaller trains could do the job. Building multiple trains is standard for the world's giant gas processing plants.

Denali's preliminary design for its four-train gas treatment plant envisions 95 modules totaling 270,000 tons in weight. These include 18 CO_2-removal modules, eight compression modules, three chilling modules, a power plant, utilities and other buildings.

Delivering these modules via sealifts would require dredging the channels leading from deeper water to the Prudhoe Bay delivery terminal called West Dock – a two-dock causeway jutting into the Beaufort Sea.

Today, one dock there has a government-permitted approach depth of 9 feet; the other has 6.5 feet. But it's been a long time since Prudhoe Bay has seen a sealift like those envisioned for the gas treatment plant. A deeper channel would be needed. Scooping and disposing of the dredged sediments would add millions to the overall gas treatment plant costs.