



ALYESKA MONTHLY

DESIGNERS GOT IT RIGHT

Trans Alaska Pipeline System survived Century's biggest slip-fault earthquake

Everything about designing, building and operating the Trans Alaska Pipeline System is complicated. It has to carry oil from Prudhoe Bay, across 800 miles, three mountain ranges and 34 major rivers to the Valdez marine terminal, where it is loaded onto tankers and shipped to market. Designers had to account for the pressure gradients associated with pumping oil over 4,739-foot-high Atigun Pass and stresses from an ambient temperature range of 175 degrees Fahrenheit. But one of the biggest challenges was to protect the pipeline from earthquakes.

Planners knew about three major fault lines along the pipeline route, including the Denali, McGinnis Glacier and Donnelly Dome faults. They would have avoided crossing these danger zones if it had been practical. But the pipeline crosses Alaska north to south and the major fault lines extend as long as 1,300 miles east to west. Short of going through Canada, there is no alternative to crossing the faults.

Consequently, planners studied the



faults to determine the potential risks and appropriate design criteria. They concluded, for example, that the Denali Fault lay within a 1,900-foot corridor under the pipeline route and estimated that it could subject the pipeline to earthquakes up to magnitude 8.0, which could cause the ground to slip 20 feet horizontally and 5 feet vertically.

Engineers accounted for these risks by building the pipeline on top of slider beams (see Pipeline

(continued on page 3)

IN THE FIELD

Scientists compare earthquake notes

Nobody knows when or where earthquakes will occur, or what would happen if one of the three major fault lines that intercept the pipeline suddenly slips. Last November's magnitude 7.9 Denali Fault earthquake shed light on the subject by confirming some

(continued on page 2)

PRESIDENT'S MESSAGE

Alyeska's role in delivering Alaska energy

David Wight,
President and CEO

Alyeska Pipeline Service Company is doing its part to make Alaska oil more competitive in world energy markets. That's good for the companies that use the pipeline. It's also good for the state of Alaska and its residents.

We have streamlined our business and cut operating expenses by some \$100 million during the past two and a half years. These savings help reduce the cost of getting Alaska oil to market. Lower delivery costs build demand for Alaska oil and could lead to increased exploration and production. Lower oil delivery expenditures also help reduce Alaska's fiscal gap because the state pays 25 percent of the Trans-Alaska Pipeline Systems (TAPS) operating costs.

Alyeska and the rest of Alaska's oil industry constantly look for ways to improve business efficiency by adjusting for the changing business environment, taking advantage of new technologies and strict budget discipline. Our strategic reconfiguration plan is part of this effort.

Strategic reconfiguration intends to improve TAPS efficiency by updating operations to account for changing pipeline demands, improved infrastructure and

new technologies. Many of TAPS current operating procedures were established back when the pipeline carried more oil, before roads were upgraded, fiber optic links installed and remote sensing systems existed. Our strategic reconfiguration goal is to adapt to changes and take advantage of improvements to better maintain pipeline quality, safety and integrity at the same time we extend TAPS' economic life.



Everything we do to improve North Slope crude oil's competitiveness in the world energy market encourages new Alaska oil investments and boosts Alaska's economy. Oil royalties and taxes account for about 80 percent of state revenue. Each \$1 increase in the average price of Alaska oil over a year equates to between \$60 million and \$65 million in additional state revenue. And every dollar that Alyeska eliminates from the pipeline's operating cost could save the state approximately 25 cents.

Our challenge, is to keep improving pipeline operations, to ensure that it continues to deliver Alaska oil for the next 25 years.

IN THE FIELD

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predictions about the location and magnitude of earthquakes along the pipeline. It also demonstrated that key seismic designs work because the pipeline survived and didn't spill any oil.

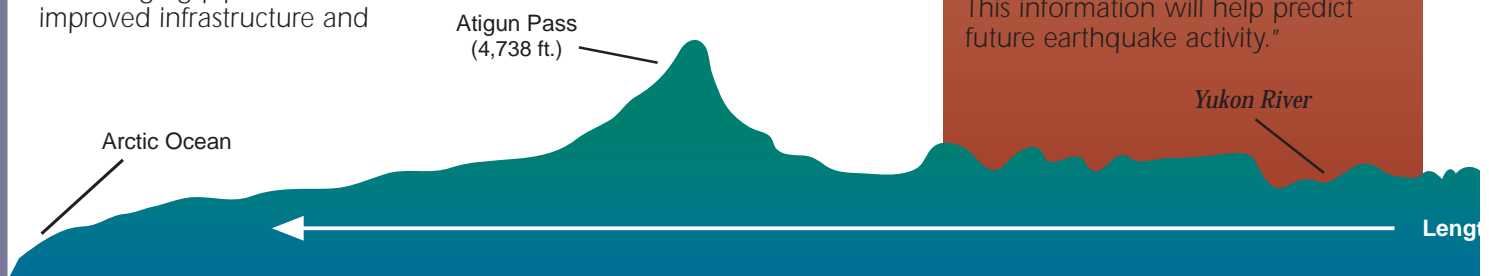
In September, officials from Alyeska, the Joint Pipeline Office and the U.S. Geological Service met to compare notes and analyze data about earthquakes, the Denali Fault and to update pipeline-engineering standards.

"The meeting was a win-win situation for everyone involved," said Jim Roddick, an Alyeska engineer.

Each group uses different seismic monitoring technologies and gathers data from different locations. Consequently, everybody has different pieces of the Denali Fault puzzle. Alyeska, for example, precisely monitors seismic activity along the pipeline, but has limited ability to locate the epicenter of earthquakes outside its monitoring area.

Integrating everybody's data creates a better picture of the Denali Fault. It also saves money by eliminating the duplication of certain research and helping scientists build upon one another's findings.

"Geological digs can be expensive," said Roddick. "Our seismic team identified a spot that produced a wealth of useful data. The USGS then accessed the site and discovered evidence of past ruptures along the Denali Fault. This information will help predict future earthquake activity."



FACE TO FACE

Jim F. Johnson

Pipeline Manager

Jim Johnson is a long-time Alaskan who has lived in Southcentral, Southeast and Interior Alaska. He joined Alyeska's staff in 1980.

Johnson is responsible for overall pipeline and pump station operations and maintenance. It's his job to know the answers to critical pipeline questions: "Is oil flowing? If not, why not? And what needs to be done to keep everything working smoothly?"

Q: Alyeska is updating the Trans-Alaskan Pipeline System (TAPS). This process, called "strategic reconfiguration," should increase operating efficiency at the same time it protects health and safety. What impact do you expect this change to have on day-to-day pipeline operations?

JJ: "The plan is still being formed, so we can't know its exact impact. But strategic reconfiguration should reduce the pipeline's overall complexity and infrastructure.

"Pump station electrification would be the single biggest change. Planners want to automate pump station functions and eliminate the need to maintain what are essentially mini-cities complete with sewer and other utility systems in the middle of the wilderness. Removing these living and work facilities would drastically reduce equipment needs at pump stations. Less equipment means reduced air emissions, decreased risk of equipment fuel or lubricant spills and fewer pieces of machinery that need to be maintained.

"Automating pump stations would reduce operating costs without degrading environmental or worker health and safety. It would eliminate support equipment that could break, leak or injure workers. And automated equipment, remote sensors, communications links, backup equipment and emergency systems provide safety margins that would ensure TAPS continued safe and reliable operation."

Q: How would strategic reconfiguration impact staffing?

JJ: "The base plan, which is still being refined, would reduce pipeline maintenance and operations staff by about half. Fewer maintenance personnel would be stationed in the field, but the existing line-wide maintenance team would be augmented to provide backup support and perform preventative maintenance. These changes should not reduce pipeline reliability.

Q: Why change successful pipeline operating procedures?

JJ: "The pipeline is 26 years old. There have been spot applications of new and improved technologies, but no system-wide equipment upgrades. Most of the equipment that actually moves oil is vintage 1977. These old systems aren't as efficient or reliable as modern systems. And it is becoming increasingly difficult to replace parts needed to maintain existing equipment. Consequently, it is getting more expensive to reliably operate the pipeline by simply maintaining the existing system. It's time to upgrade to a new system that takes advantage of technological improvements and that would work safely and efficiently for years to come.

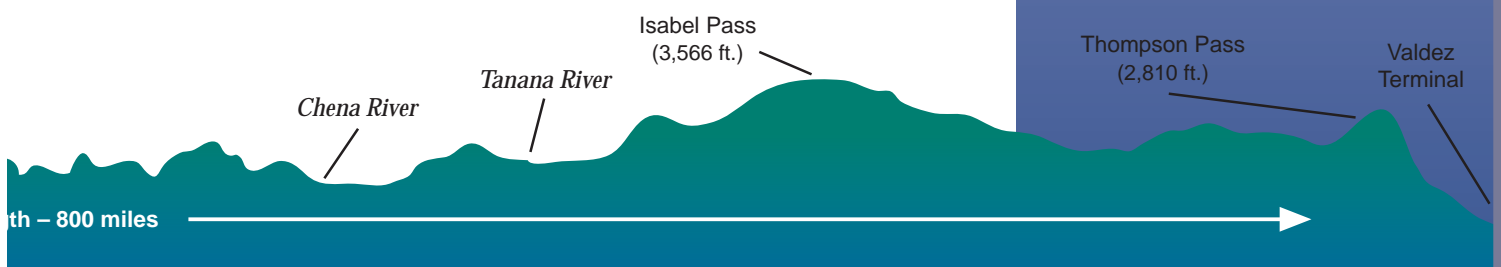
DESIGNERS GOT IT RIGHT

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101 on the back page) that allow the ground to shift underneath the (relatively) stationary pipeline. They also built sections of the pipeline in zigzag or trapezoidal configurations to allow for temperature-related expansion and contraction and movement, including earthquakes.

The earthquake predictions and pipeline design were tested on Nov. 3, 2002, when the magnitude 7.9 Denali Fault earthquake erupted some 50 miles west of the pipeline. It was North America's largest strike-slip earthquake in 150 years, caused more than \$44 million in damage in Interior Alaska and was felt as far away as Washington and Louisiana.

The temblor shifted the ground inside the pipeline corridor some 14 feet horizontally and 2.5 feet vertically. But careful preparation avoided serious pipeline damage. Alyeska shut down the pipeline for 66 hours after the earthquake to assess damage, make repairs and guard against aftershocks. It then quickly returned to full service. TAPS carries about 17 percent of America's domestic oil supply, approximately a million barrels per day.



SLEEPERS

The trans-Alaska pipeline weighs about 1,000 pounds per foot when it is full of crude and is designed to withstand all sorts of stresses, including earthquakes. A special engineering design at the Denali Fault crossing was used to accommodate large ground displacements expected from fault movements caused by earthquakes as large as magnitude 8.0.

Engineers fitted sections of the pipeline with shoes that rest on top of specially designed slider beams that lay at 60-foot intervals roughly perpendicular to the pipe. These beams are welded to buried "sleepers" so that the slider beams move with the ground during earthquakes. A Teflon coating reduces friction between the slider beams and shoes so that the pipeline can move independently from the sleepers during earthquakes to relieve stress.

Pipeline 101



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