FACT

09/08 | **PERMAFROST MONITORING**

The 800-mile trans alaska pipeline has its origin at the prudhoe bay oil fields on the north slope of alaska and its terminus at the ice-free port of valdez. The pipeline route is underlain with continuous permafrost in the north where the climate is the coldest. South of the brooks range, across interior alaska, the permafrost is discontinuous, transitioning to sporadic permafrost along the southern portion of the copper river basin. Climate records indicate a gradual warming trend along the entire pipeline route. Permafrost temperature monitoring shows similar trends but with slower warming. Alyeska has focused much of its attention where the permafrost is discontinuous and sporadic because it is closer to its melting temperature. Climate and ground temperature monitoring is ongoing in order to track and appropriately respond to these changes.

MONITORING CLIMATE CHANGE

Alyeska monitors climate change in several ways. Alyeska constructed and operates 43 instrumented thermal monitoring sites along the pipeline corridor from the Brooks Range to Thompson Pass. At these sites, air, surface, subsurface ground and permafrost temperatures are recorded three or four times a day, 365 days a year. Alyeska also analyzes local weather station data available from the Western Regional Climate Center along the pipeline corridor. In addition, there are over 80 thermistor strings installed in the ground along the pipeline route that measure soil temperatures. These strings are monitored every year or two with the temperature data available through Alyeska's Engineering Data Management system for trend monitoring. Alyeska records subsurface ground temperatures at the base of select VSMs following heat pipe maintenance as part of its trending program.

TAPS PIPELINE SUPPORT

- Vertical Support Members (VSMs) are pipe piling embedded in the ground to support the aboveground pipe in areas of thaw-unstable permafrost.
- Most VSMs south of the Brooks Range have heat pipes installed to keep the ground surrounding the embedded portion of the VSMs frozen. These heat pipes are sealed thermo-siphons that begin to remove heat from the ground when air temperatures fall below ground temperatures.
- There are a total of 78,000 VSMs throughout the pipeline that are embedded in the ground 15 to 70 feet deep.
- 61,000 VSMs are configured with 122,000 individual heat pipes, two per VSM.
- Alyeska heat pipe monitoring and other thermal studies indicate that the ground around VSM piling is effectively being maintained in a frozen state.
- The vast majority of VSMs are not moving which means climate changes are not presently affecting VSM stability.
- Any VSM settlement or movement can be caused by a variety of reasons. When discovered, engineering studies determine the appropriate action necessary to reestablish stability.

⚠ FACT

PERMAFROST MONITORING

Alyeska pipeline SERVICE COMPANY

CLIMATE MONITORING

- Recorded climate data are used by Alyeska as an input to computer models to determine the amount of thermal energy that must be removed from the ground to maintain frozen conditions of the permafrost surrounding the Vertical Support members (VSMs).
- Infrared survey of all the heat pipes on the Trans Alaska Pipeline occurs on a three-year cycle. These data are used to predict the performance of the heat pipes installed at every thermal VSM.
- Heat pipes not meeting the required performance criteria are then listed for repair. The repair procedure requires recharging the listed heat pipe with refrigerant and subsequent infrared surveys to check performance.

INFRARED EVALUATIONS

- After recharging, infrared evaluations are performed to ensure the heat pipes are working properly after maintenance.
- The temperature of the permafrost at the base of the VSM is determined after the heat pipe has been recharged through pressure measurements that are converted to temperatures.
- If the permafrost temperature is approaching 32 degrees Fahrenheit, additional temperature monitoring is conducted.
- Other spot checks measure permafrost temperatures both where heat pipes have been recharged and where heat pipe recharging is not required to verify the methods used to maintain frozen conditions are working.

HEAT PIPE AND SETTLEMENT MONITORING

The regions of the pipeline corridor where the majority of the heat pipe recharging has occurred lies within the Copper River Basin. This is an area of discontinuous permafrost transitioning to sporadic permafrost. The temperature of the permafrost is relatively warm. At this region's southern boundary, north of Thompson Pass, some permafrost has thermally degraded. Alyeska has replaced or modified a few thermal VSMs—VSMs with heat pipes—with standard friction VSMs at several locations. However, the vast majority of this region remains locked in permafrost that currently remains frozen all year long. Heat pipe recharge monitoring and other thermal studies, in addition to settlement surveys, indicate that the ground around VSM piling is effectively being maintained in a frozen state where needed, and that the VSMs are stable.

Infrared Imaging showing minor compromise of heat pipe thermal rejection performance.