



## Pipeline Reconfiguration

# Crude Oil Pump System

The core of pipeline reconfiguration is represented by the new electrically driven pumps being installed at Pump Stations 1, 3, 4, and 9. These pumps will replace the existing turbine-engine-driven pumps that have moved oil through the Trans Alaska Pipeline System (TAPS) since startup in 1977.

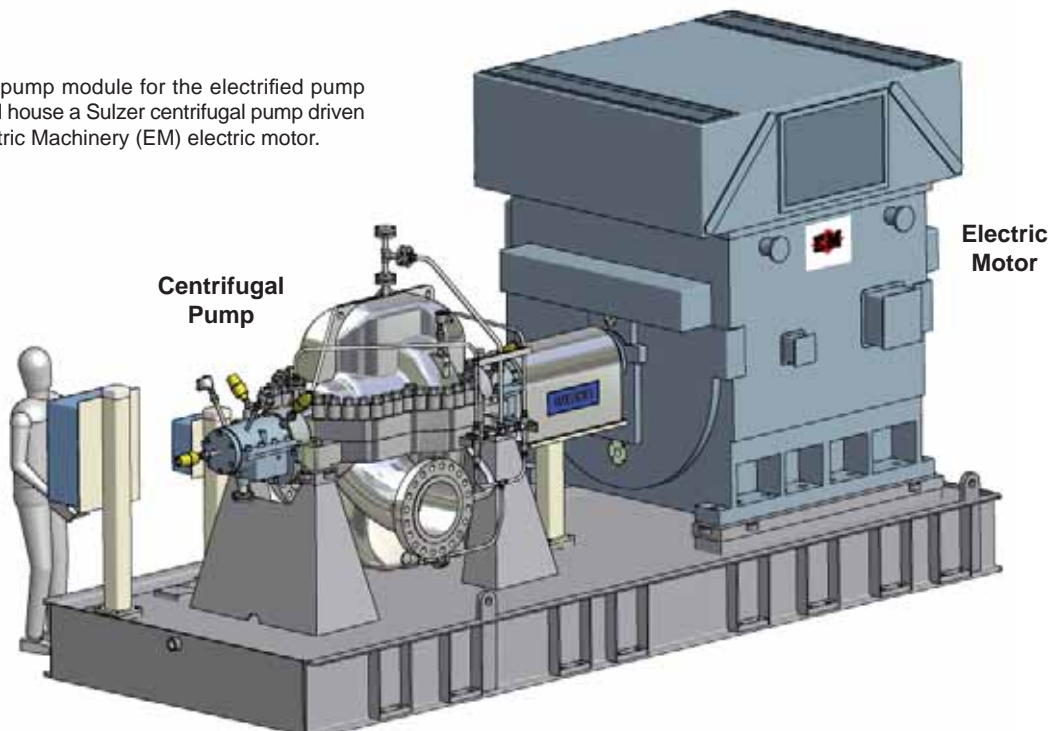
The current system consists of a reliable but dated Rolls-Royce Avon gas generator driving a Cooper Bessemer reaction turbine coupled to either a Byron-Jackson or United centrifugal pump. Three such drive packages are installed at each of Pump Stations 1, 3, 4, and 9, while two packages are installed at Pump Station 7. Although dependable over the years, these drive packages and support facilities are complex and labor-intensive to operate and maintain.

The new pump modules to be installed at Pump Stations 1, 3, 4, and 9 have a flexible design that allows the pump modules to be installed in parallel. Each pump station will have three pump modules to house the new pumps, their motors, and lubrication and ventilation systems.

The 12 pump modules to be installed will support throughputs between 350,000 and 1.14 million barrels per day. Capacity can be increased to 1.5 million bpd by adding more pump modules at these four pump station and installing modules at Pump Stations 7 and 12.

The next page contains diagrams and photos depicting the pump modules and how they work. A description of the main components of the modules can be found on page 4.

Each new pump module for the electrified pump stations will house a Sulzer centrifugal pump driven by an Electric Machinery (EM) electric motor.



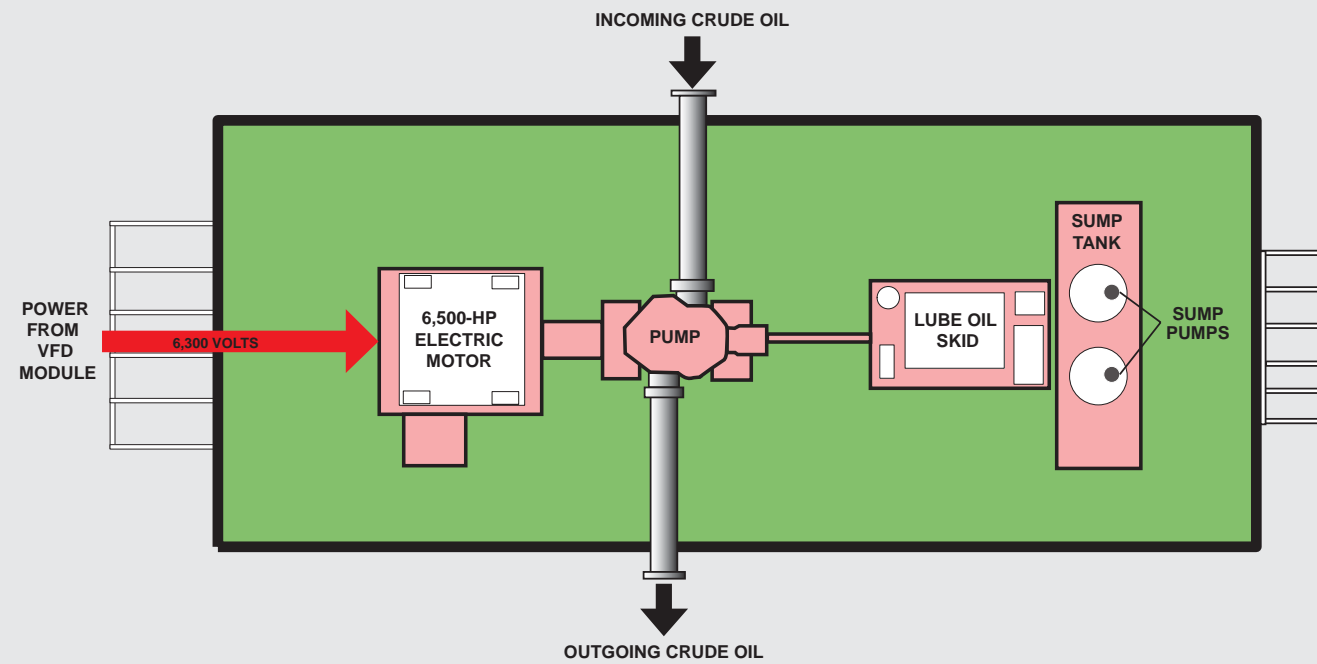
### Crude Oil Pump



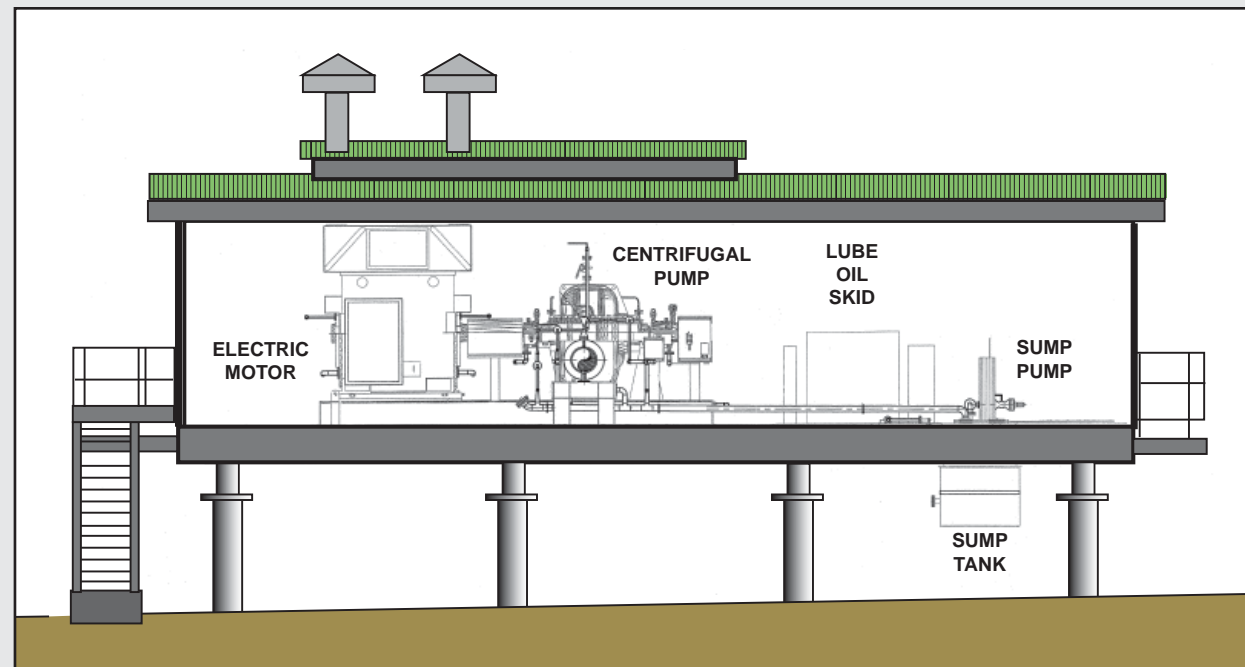
Each operating pump station will house three Sulzer two-stage centrifugal pumps. Each pump will be driven by a 6,500-horsepower electric motor. The two photos below show the crude pump connected to the electric motor during a test at Sulzer's plant in Portland, Oregon.



### Anatomy of a Pump Module



Three pump modules will be installed at each of Pump Stations 1, 3, 4, and 9. All will contain an electric motor, a crude oil pump, a lubricating oil skid for the pump and motor, and a sump tank to collect any oil leaks. Oil enters the module on the suction side of the pump and leaves on the other side of the module through the discharge side of the pump. The drawing below shows a side view of the typical pump module. The two stacks on the roof of the module are part of the ventilation system designed to cool the electric motor, which requires 7,500 cubic feet of cooling air per minute. The sides of the modules will consist of louvers open to the outside to help ensure proper ventilation. Crude oil piping will run into and out of the pumps through a new pipe header system that will tie in to the existing crude oil piping near the pump station manifold buildings.



### Electric Motor



The electric motors being installed in the pump modules have large square housings. The red rings in the center are the windings for the motor. This is the "stator", which remains stationary while the motor is in operation. The magnetic field in the stator creates an opposing magnetic field in the "rotor" to make the rotor spin. These motors run off 6,300-volt electrical power.



The electric motors were purpose-built for TAPS pipeline reconfiguration based on a proven design. Alyeska's extensive testing program revealed vibration problems at a particular speed. As a result, the housings for the motors have been modified to include circular springs (right) to eliminate the unacceptable vibrations in the housing. The photo above shows the modified motor undergoing tests at the manufacturer's facility in Minneapolis, Minnesota.



## Electric Motors

The motors to run the crude oil pumps are being custom-manufactured by Electric Machinery of Minneapolis, Minnesota. These three-phase, two-pole motors require 6,300 volts of electrical power. To provide this power, each pump motor will be connected to a VFD (*variable frequency drive*) to control, regulate, and distribute the power to the motor. The VFD will control the speed of the electric motor and thus the speed of the pump. Each pump will have a dedicated motor.

These electric motors require a great deal of cooling to dissipate the heat they generate. Each module is fitted with a ventilation system that feeds a minimum of 7,500 cubic feet of cooling air to the motor each minute. This air is drawn in through intakes on the roof of the module into the motor housing, and is then discharged into the module. The sides of the pump module building are fully louvered so that air flows continuously through the module.

Unexpected modifications were required for the origi-

nally manufactured motors. Alyeska's quality assurance testing program found problems with excessive vibration in the motor housing at certain operating speeds. Circular core-isolation springs were added between the housing and the motor windings to solve the problem.

## Crude Oil Pumps

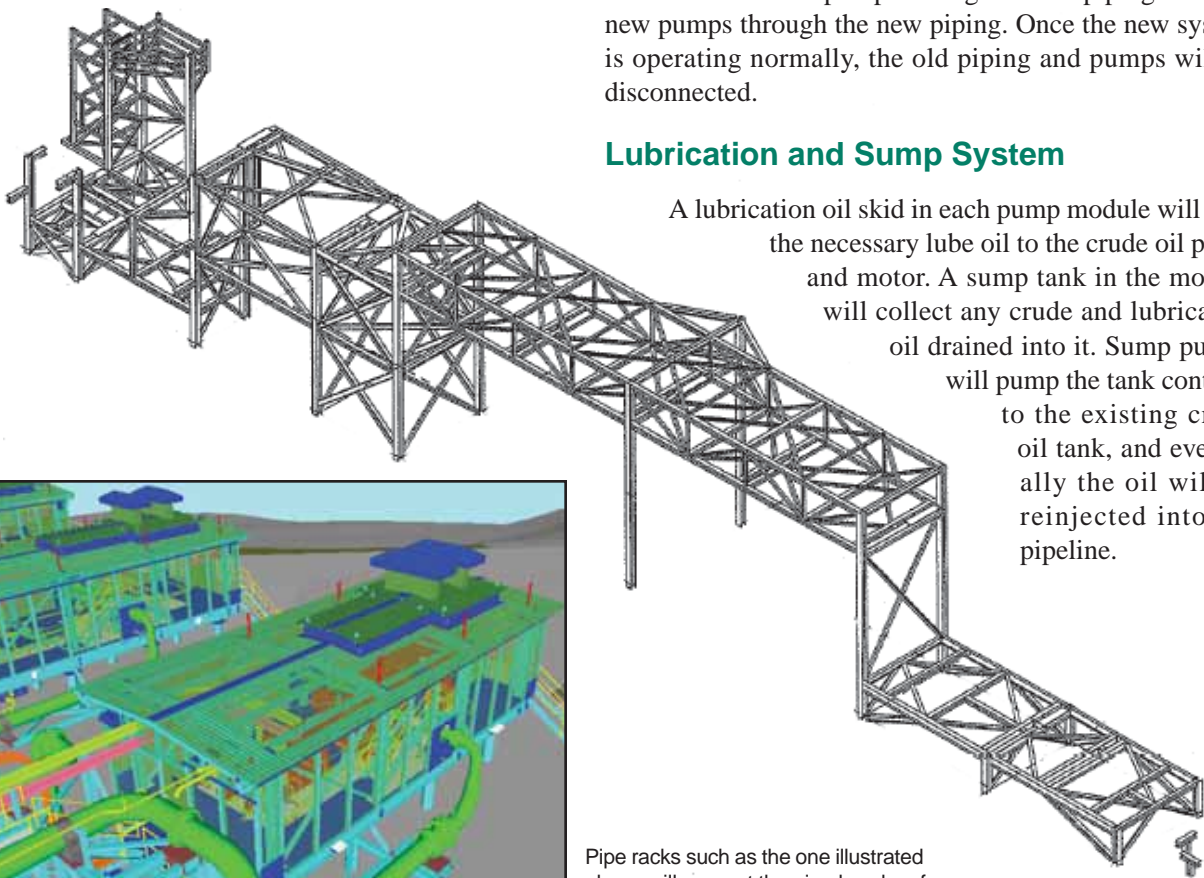
Sulzer Pumps is manufacturing the crude oil pumps in Portland, Oregon. The Model MSD-D is a two-stage centrifugal pump that increases the pressure of the crude oil by means of impellers rotating inside the pump housing. A two-stage pump has two impellers in one pump housing.

The intake (or suction) piping to the three pump modules at each pump station will connect to a header that runs to the existing pipe manifold building for tie-in to the mainline pipe. The same is true of the discharge piping, which connects to its own header.

During startup of the new pumps, the existing piping will be kept intact. It will be possible to direct the flow of oil either to the old pumps through the old piping or to the new pumps through the new piping. Once the new system is operating normally, the old piping and pumps will be disconnected.

## Lubrication and Sump System

A lubrication oil skid in each pump module will feed the necessary lube oil to the crude oil pump and motor. A sump tank in the module will collect any crude and lubricating oil drained into it. Sump pumps will pump the tank contents to the existing crude oil tank, and eventually the oil will be reinjected into the pipeline.



Pipe racks such as the one illustrated above will support the pipe headers for the new pump modules. Such a rack can be seen in the cutaway schematic of the pump modules at left. The above-ground steel racks provide access clearance.