North Dakota Department of Mineral Resources

http://www.oilgas.nd.gov   *http://www.state.nd.us/ndgs*

600 East Boulevard Ave. - Dept 405

Bismarck, ND 58505-0840

(701) 328-8020   (701) 328-8000

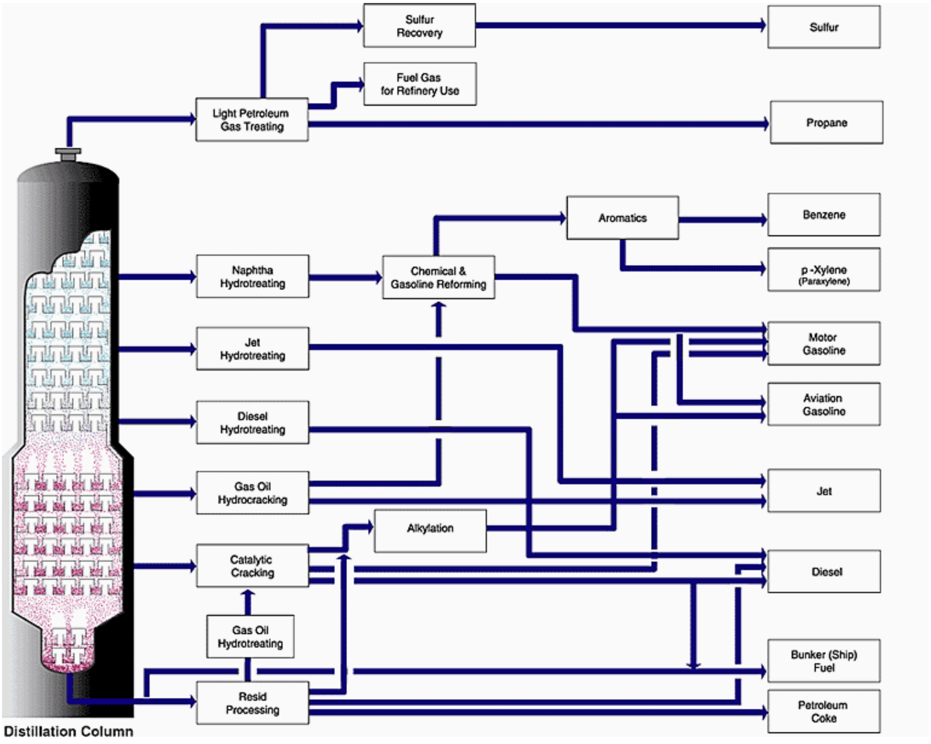
Crude Oil Processing / Refining

1. Distillation

Modern distillation involves pumping oil through pipes in hot furnaces and separating light hydrocarbon molecules from heavy ones in downstream distillation towers – the tall, narrow columns that give refineries their distinctive skylines.

During this process, the lightest materials, like propane and butane, vaporize and rise to the top of the first atmospheric column. Medium weight materials, including gasoline, jet and diesel fuels, condense in the middle. Heavy materials, called gas oils, condense in the lower portion of the atmospheric column. The heaviest tar-like material, called residuum, is referred to as the "bottom of the barrel" because it never really rises.

In some cases, distillation columns are operated at less than atmospheric pressure (vacuum) to lower the temperature at which a hydrocarbon mixture boils. This "vacuum distillation" (VDU) reduces the chance of thermal decomposition (cracking) due to over heating the mixture.

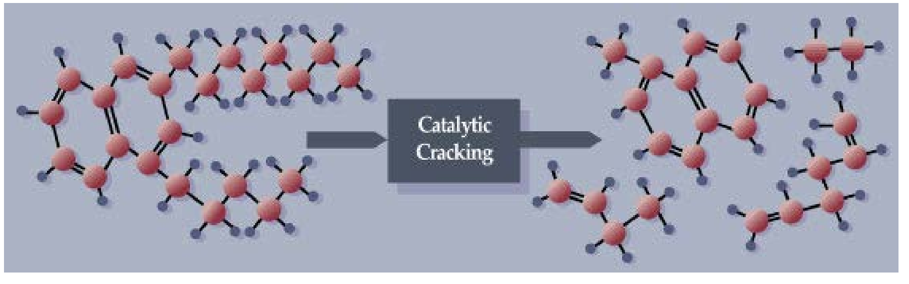


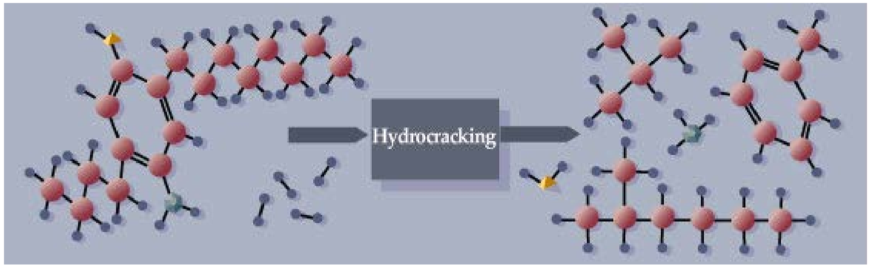
2. Cracking
Efficiently converts middle distillate, gas oil and residuum into the highest value products like gasoline, jet and diesel fuels by using a series of processing plants that literally "crack" large, heavy molecules into smaller, lighter ones.

Heat and catalysts are used to convert the heavier oils to lighter products using three "cracking" methods: fluid catalytic cracking (FCC), hydrocracking (Isomax), and coking (or thermal-cracking).
The Fluid Catalytic Cracker (FCC) uses high temperature and catalyst to crack heavy gas oil mostly into gasoline.

Hydrocracking uses catalysts to react gas oil and hydrogen under high pressure and high temperature to make both jet fuel and gasoline.

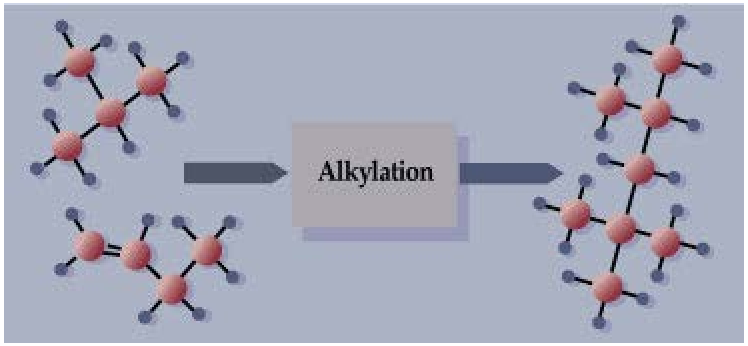
The Delayed Coking Unit (Coker) converts low-value residuum using the coking, or thermal-cracking process to high-value light products, producing petroleum coke as a by-product. The large residuum molecules are cracked into smaller molecules when the residuum is held in a coke drum at a high temperature for a period of time. Solid coke (similar to anthracite coal) remains and must be drilled from the coke drums for use as fuel or in cement manufacturing.





3. Combining
While the cracking processes break most of the gas oil into gasoline and jet fuel, they also break off some pieces that are lighter than gasoline.

Combining uses Alkylation Units. This process takes the small molecules and recombines them in the presence of acid and catalyst to convert them into high octane gasoline.



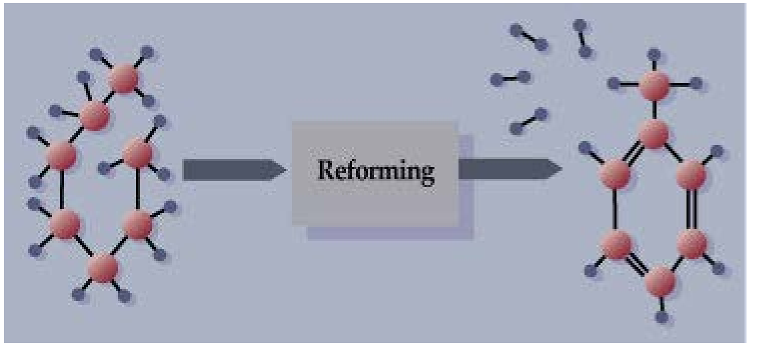
4. Reforming

Octane rating is a key measurement of how well a gasoline performs in an automobile engine. Much of the gasoline that comes from the Crude Units or from the Cracking Units does not have enough octane to burn well in cars.

The gasoline process streams in the refinery that have a fairly low octane rating are sent to a Reforming Unit where their octane levels are boosted. These reforming units employ precious-metal catalysts - platinum and rhenium – and thereby get the name "rheniformers.“

In the reforming process, hydrocarbon molecules are "reformed" into high octane gasoline components. For example, heptane is reformed into toluene.

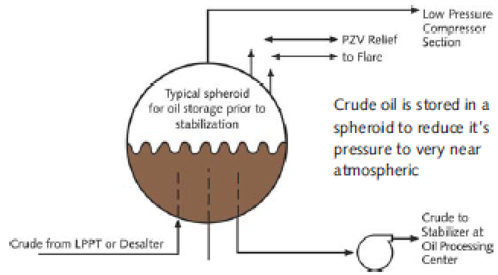
The reforming process actually removes hydrogen from low-octane gasoline. The hydrogen is used throughout the refinery in various cracking (hydrocracking) and treating (hydrotreating) units.



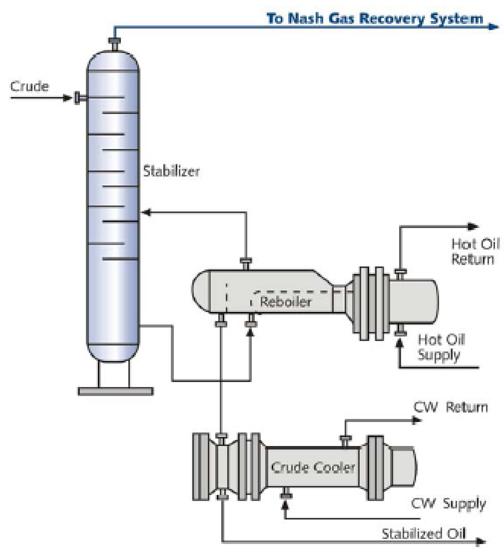
Crude Oil Stabilization

Crude Stabilization Systems

Liquid ring pumps are used to remove dissolved gases from crude oil tanks, thus stabilizing the true vapor pressure of the crude. The removed gas can be boosted downstream and used for fuel.



	Before Treatment	After Treatment
Water Content	up to 3% emulsion	0.3% by volume, maximum
Gas Content	dissolved gases in varying amounts depending on the Gas-Oil Ration (GOR)	vapor pressure: 5-20 psia RVP (Reid Vapor Pressure)
Hydrogen Sulfide (H_2S)	up to 1,000 ppm by weight	10-100 ppm by weight



Crude Stabilization

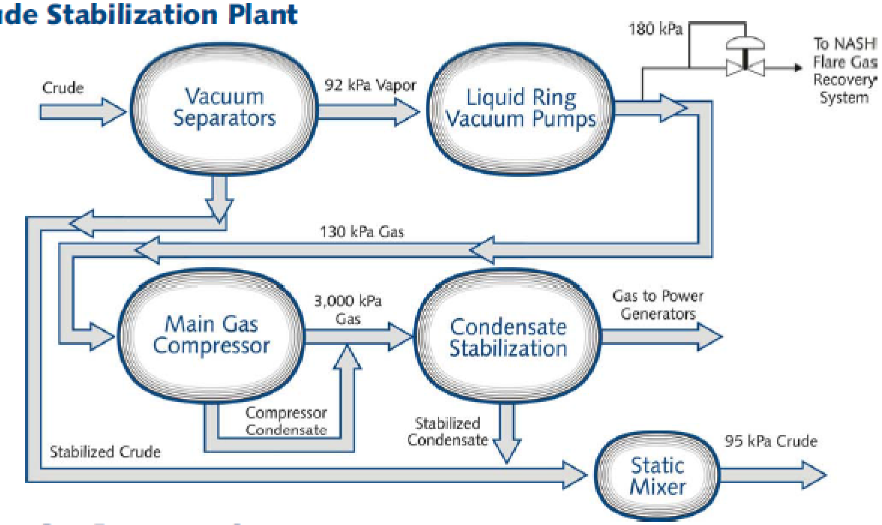
Stabilization removes light gases, along with hydrogen sulfide, before the oil is stored. Hydrogen Sulfide is commonly found in crude oil, and when exposed to water (also common in crude) it forms H_2SO_4 - sulfuric acid. This acid can eat its way through a steel pipeline or storage tank. If released into the air, it is poisonous to all who inhale it.

The stabilization process does two jobs: it sweetens the "sour" crude (removes the hydrogen sulfide) and it reduces vapor pressure, making the crude safe for shipment in tankers. The vapor pressure is caused by light hydrocarbons - such as methane, ethane, propane, and butane - changing from liquid to gas as the crude's pressure is lowered.

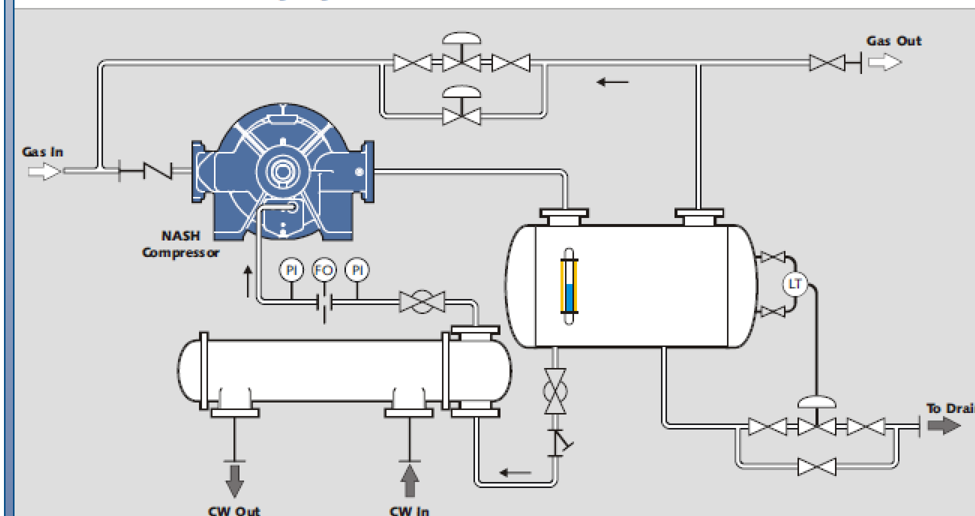
The gas cannot be released all at once, because a significant amount of liquid would then be lost at the same time. The gas is thus released in a series of separators, ending in a spheroid where the pressure is reduced to about 2 psi. It is then pumped to the crude storage tanks at the stabilizer. From there it is pumped to the top of the stabilizer column.

As the crude works its way down the column, it flows through a series of "bubble trays." Near the bottom, the oil is channeled to a reboiler that heats it. By the time it reaches the bottom of the column, the crude is hot and the gases begin to boil off. They rise to the top, and are collected by a Nash gas recovery system, at the same time heating the incoming sour crude and stripping out some of the gases it contains. The stable crude remains at the bottom.

Crude Stabilization Plant



Flare Gas Recovery System



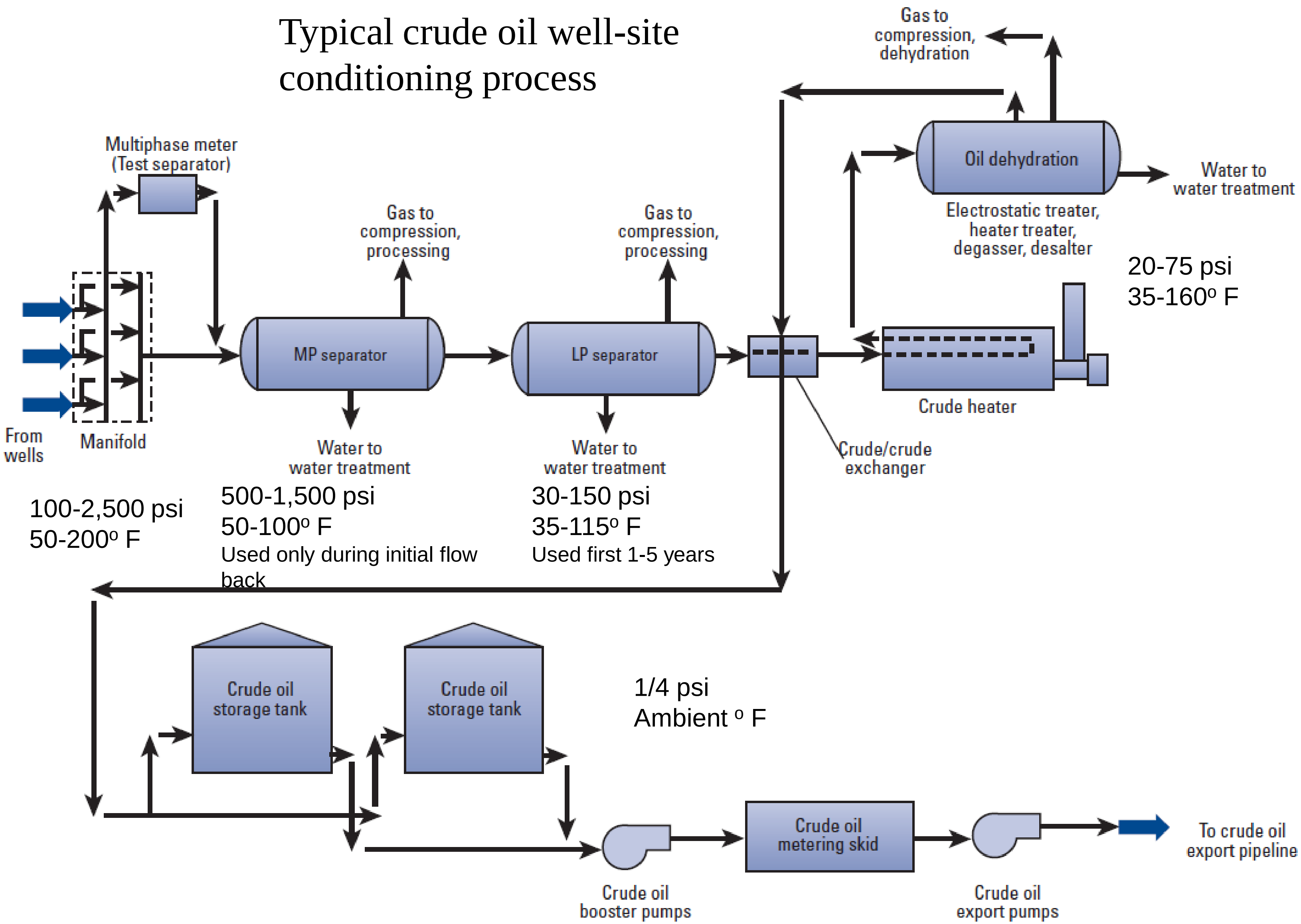
Gardner Denver
Engineered Products Division
9 Trefoil Drive, Trumbull, CT 06611
phone: +1 800 553 NASH
fax: +1 203 459 3988
nash@gardnerdenver.com
GDNash.com

NASH
A Gardner Denver Product

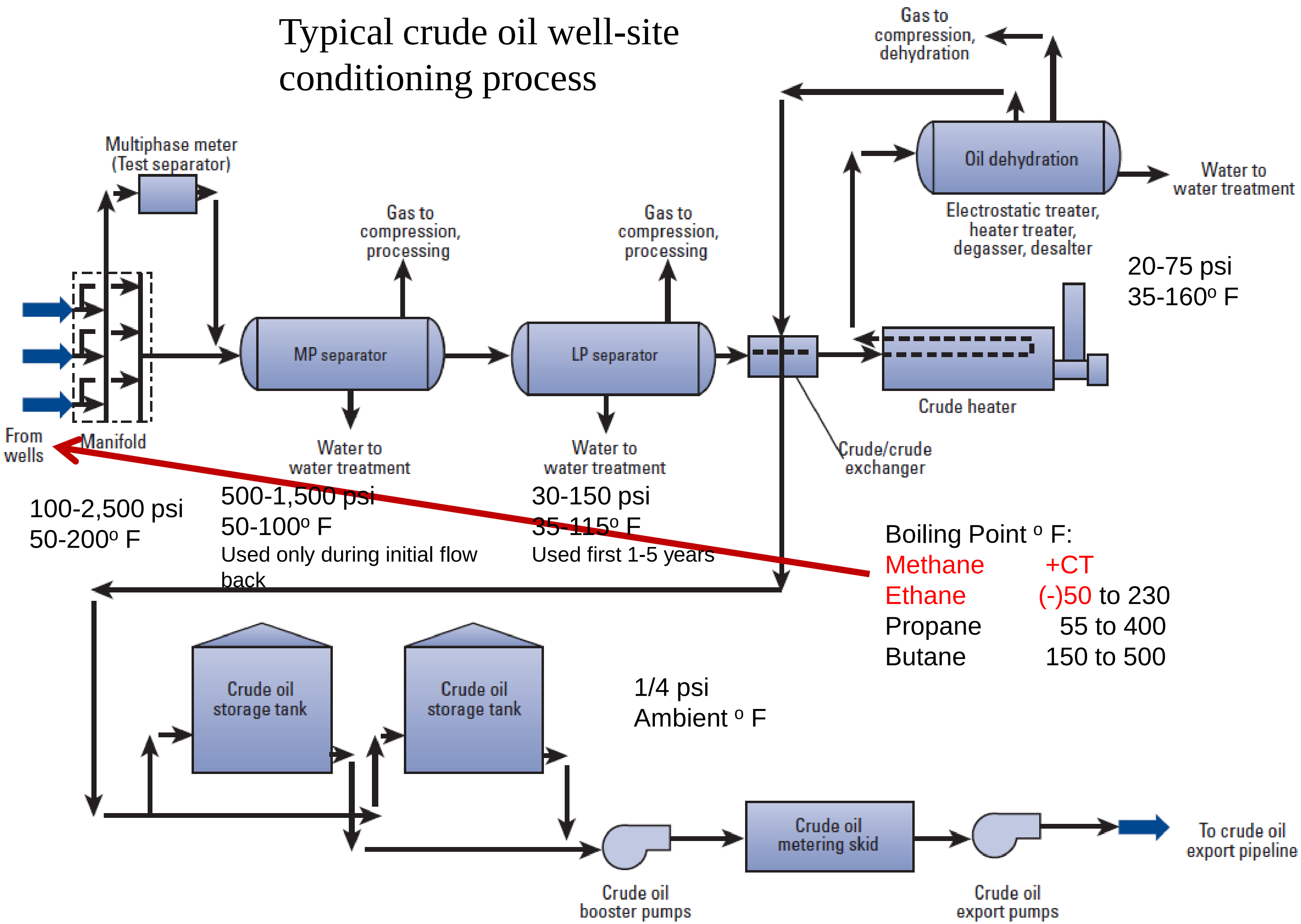
APP-1055A-042008

Crude Oil Conditioning

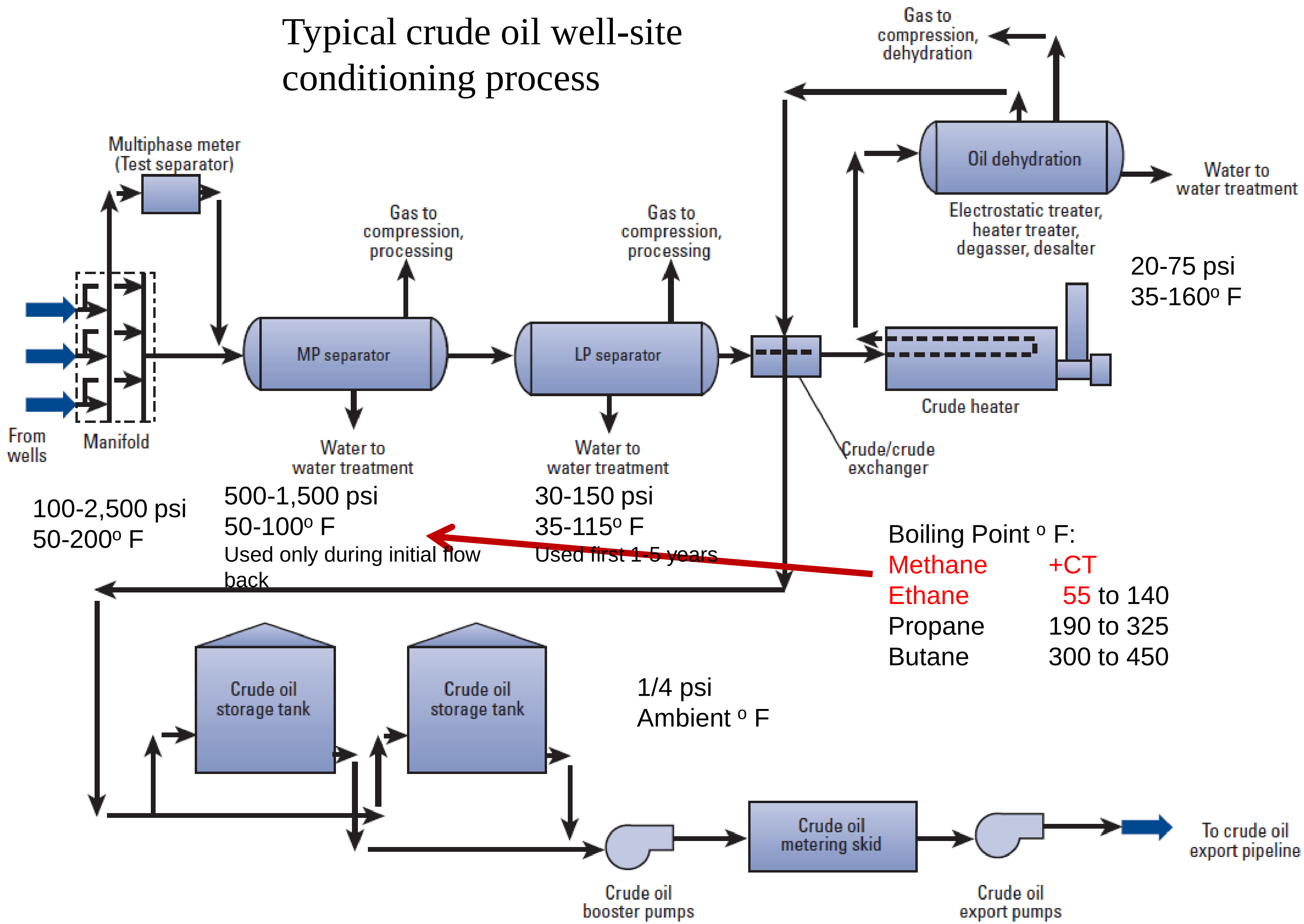
Typical crude oil well-site conditioning process



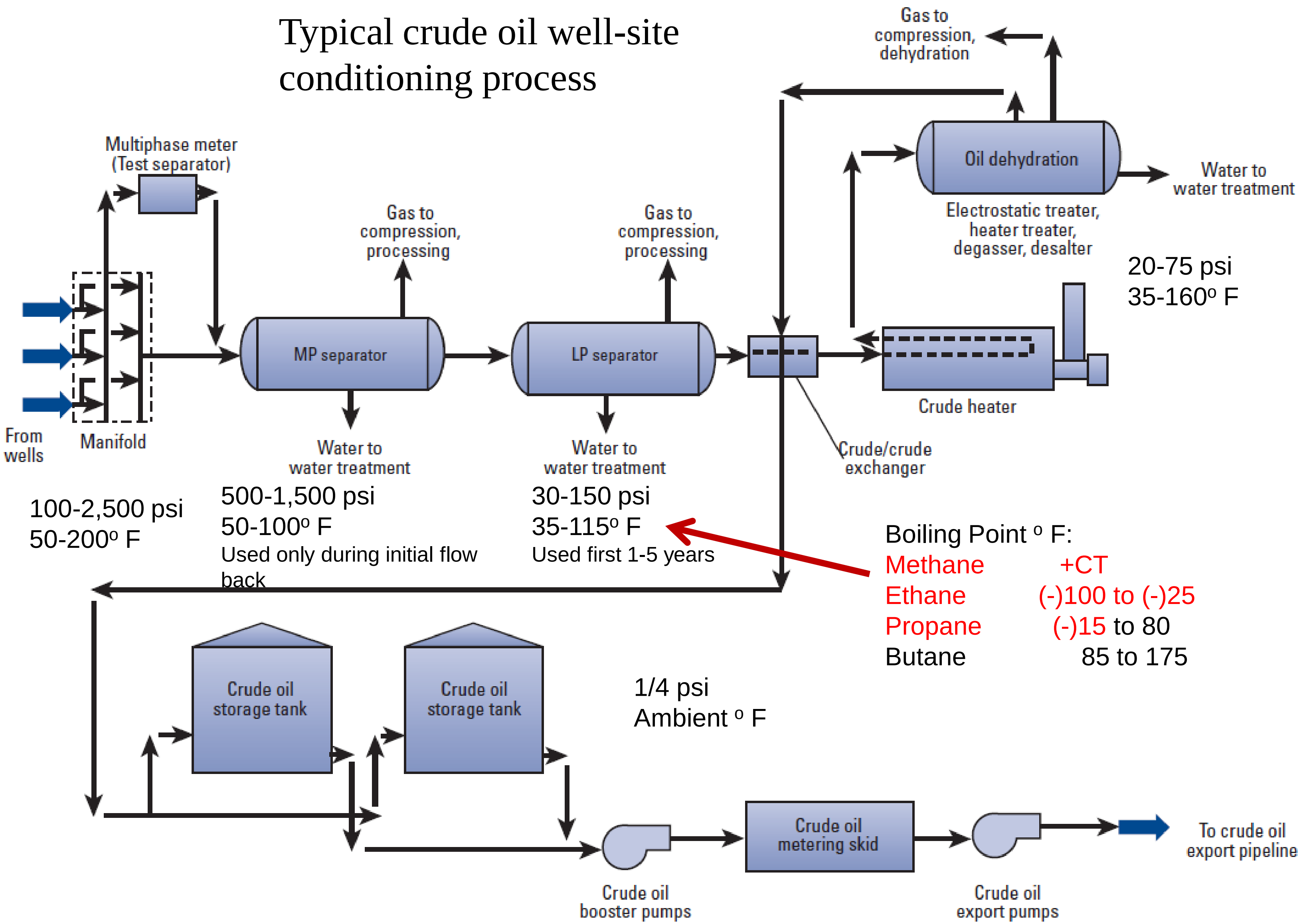
Typical crude oil well-site conditioning process



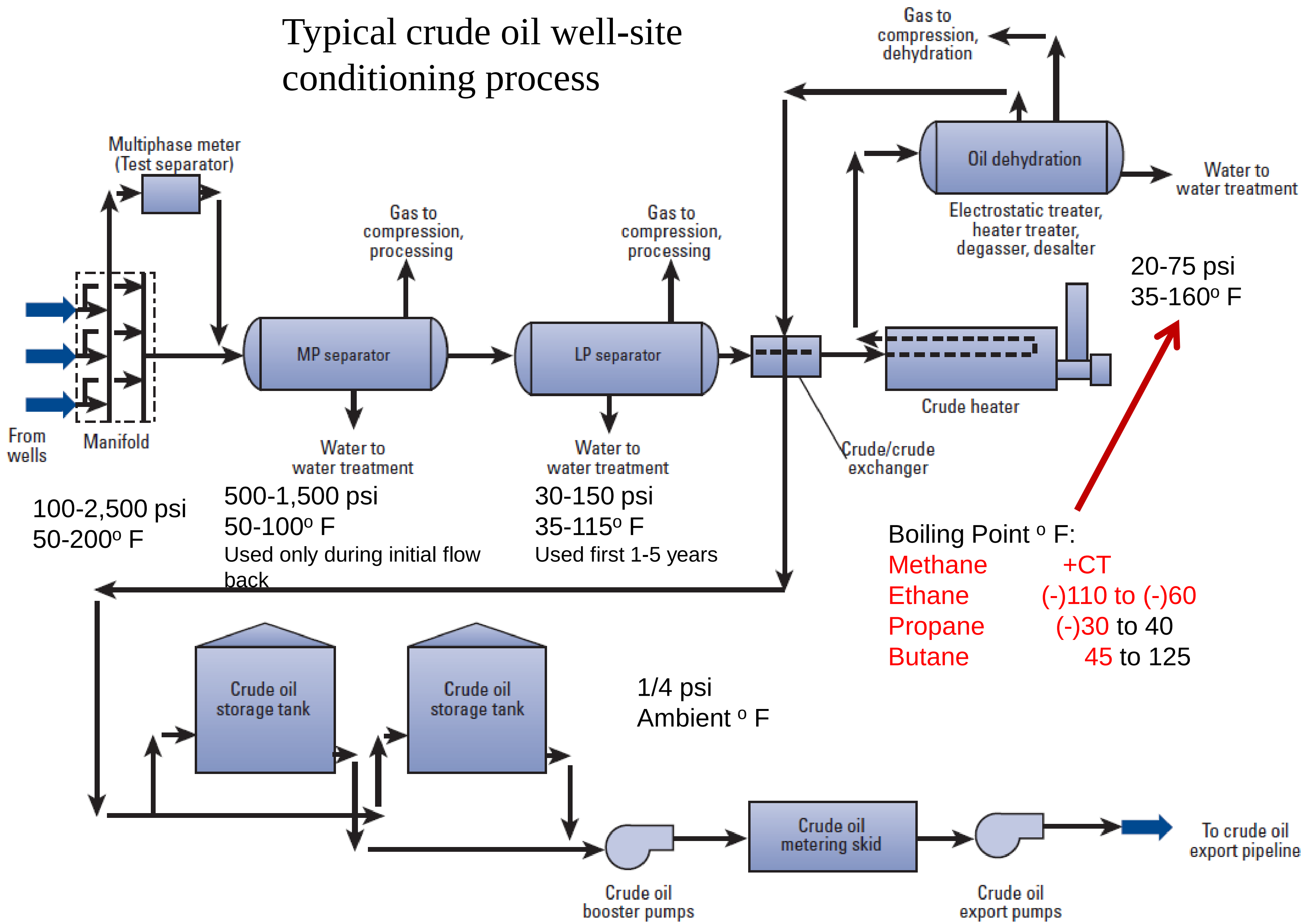
Typical crude oil well-site conditioning process



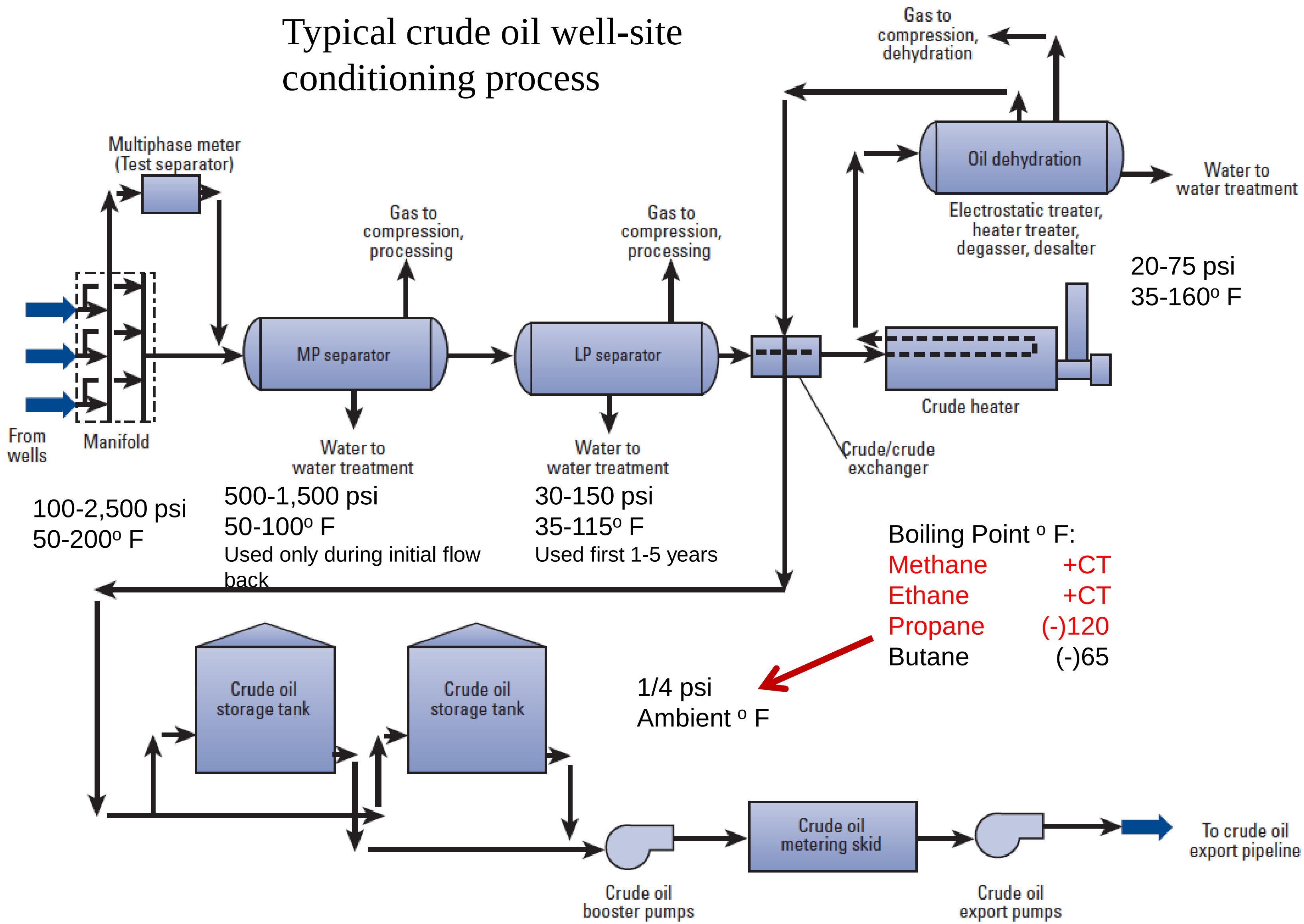
Typical crude oil well-site conditioning process



Typical crude oil well-site conditioning process



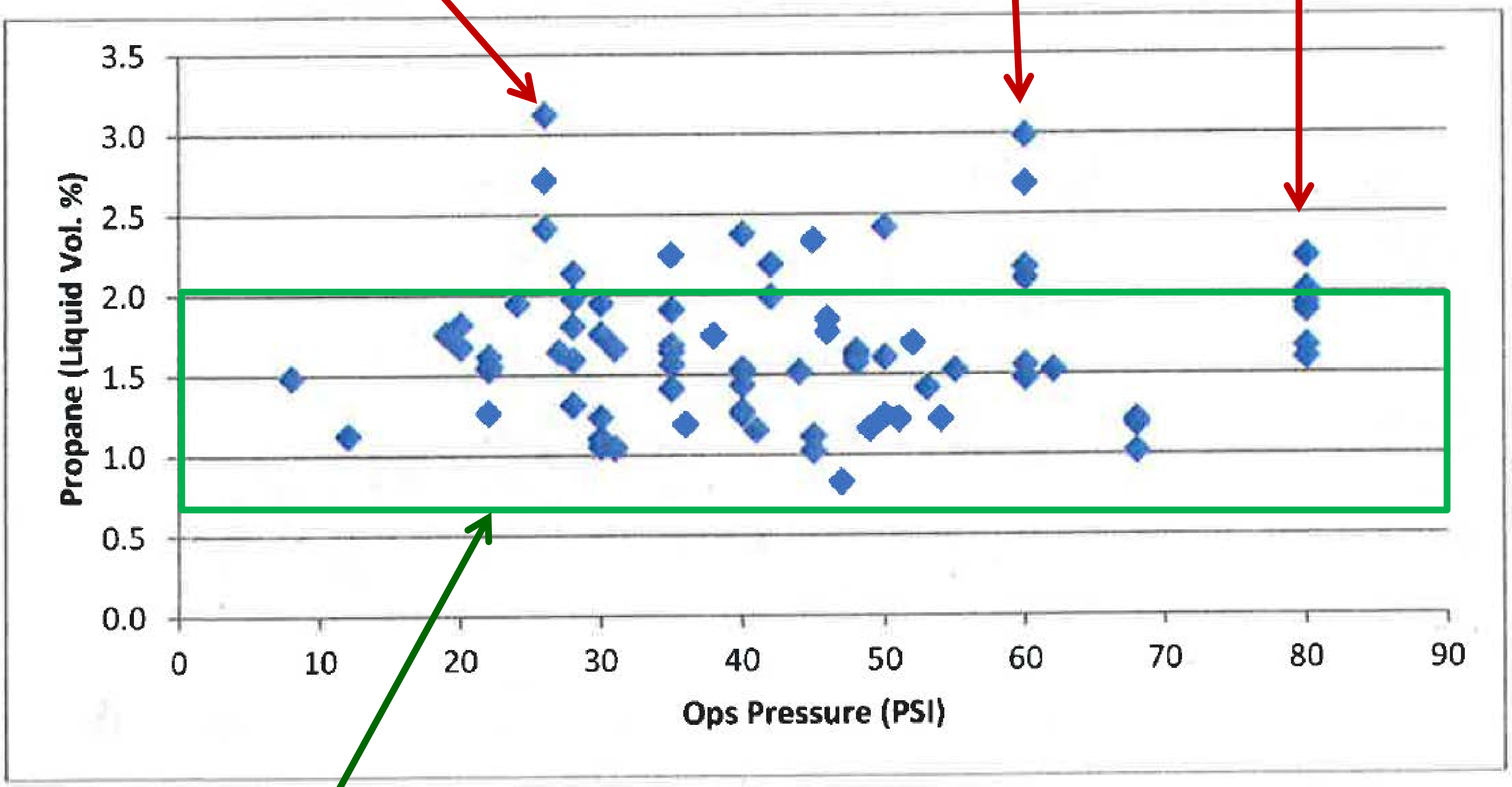
Typical crude oil well-site conditioning process



Operating Temperature 35 to 120 º F

80 to 120 º F

Unknown



Industry definition of stable crude oil

Figure 1-4 Turner Mason "Bakken Crude Characterization Task Force Report"

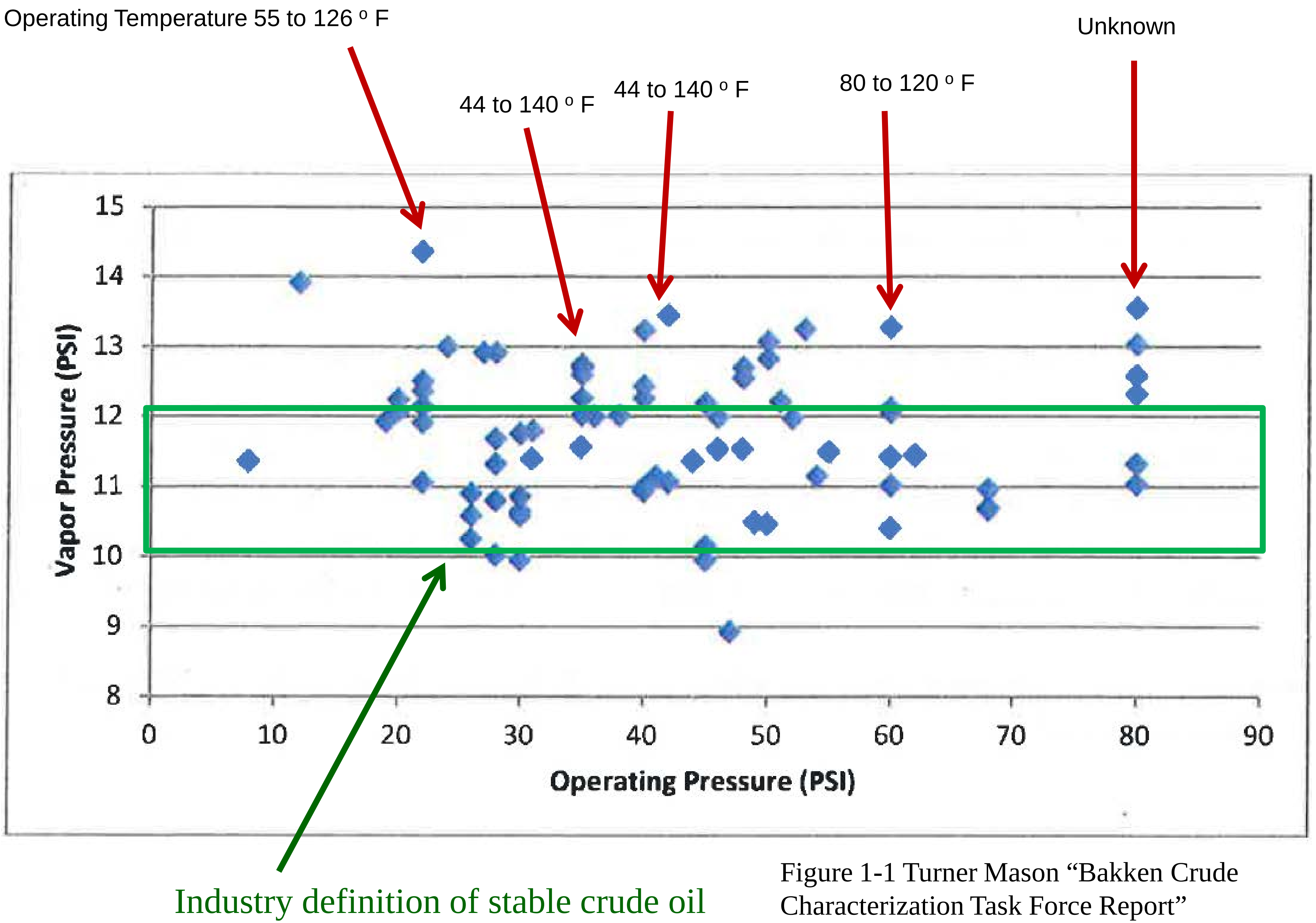


Figure 1-1 Turner Mason "Bakken Crude Characterization Task Force Report"