
Transportation and Refining

“Downstream”

Oil transport and shipping

Refining

Distribution and retailing

Steps in Producing and Selling Gasoline

Production of crude

Purchase of crude

Transportation of crude to refinery

Refining

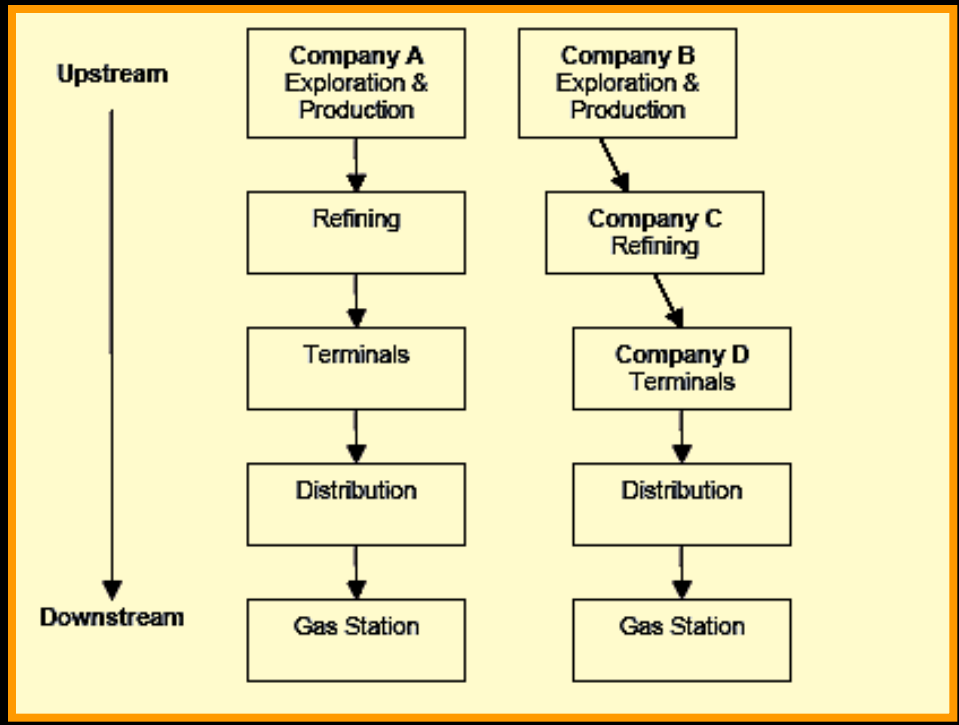
Distribution of refined products

Retailing gasoline at local gas station

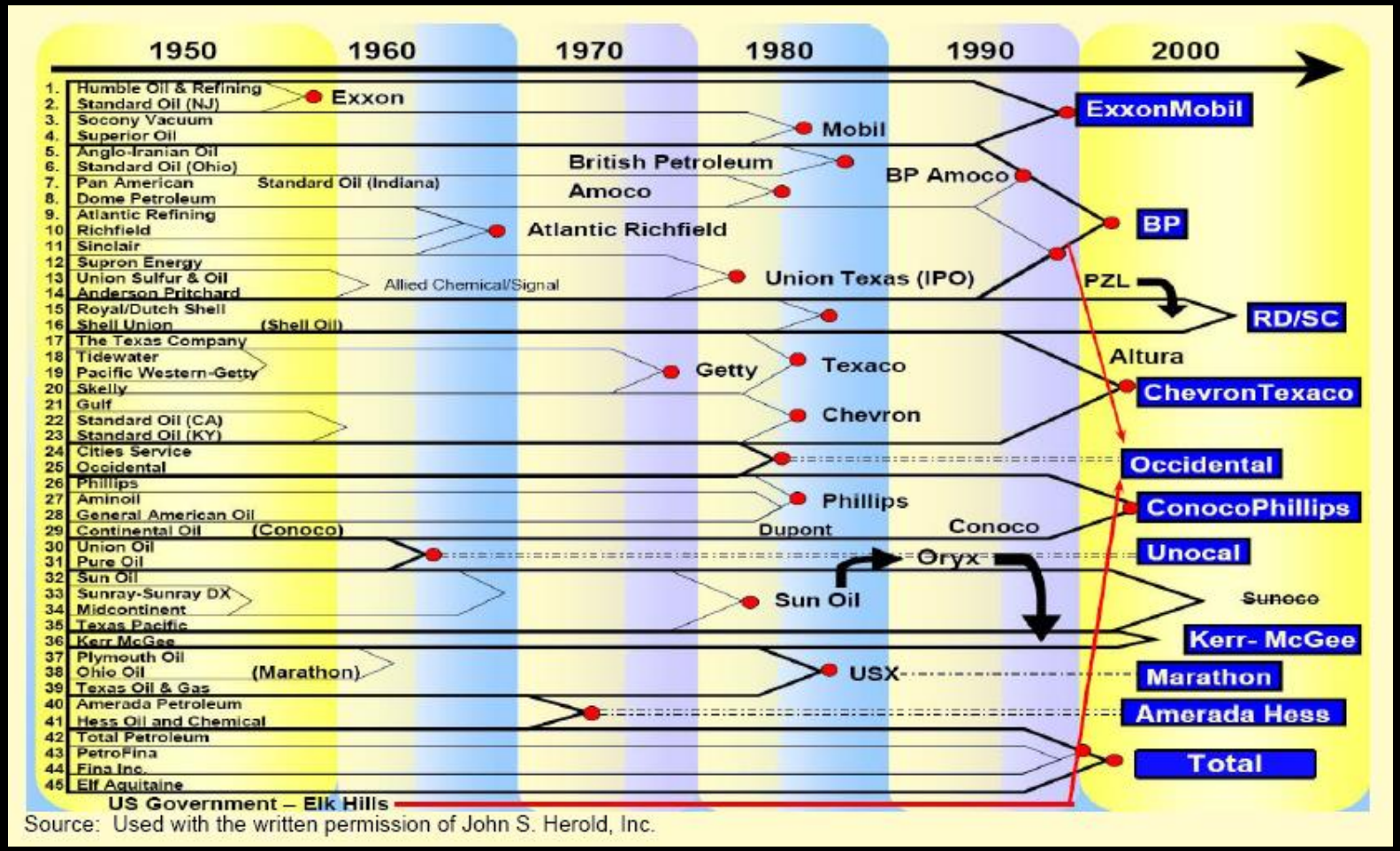
Integration within Industry

Vertically integrated: total control from production to distribution (Shell Oil- produces, refines distributes, and sells it).

Non vertically integrated: either produce crude, or refine products, do not do both.



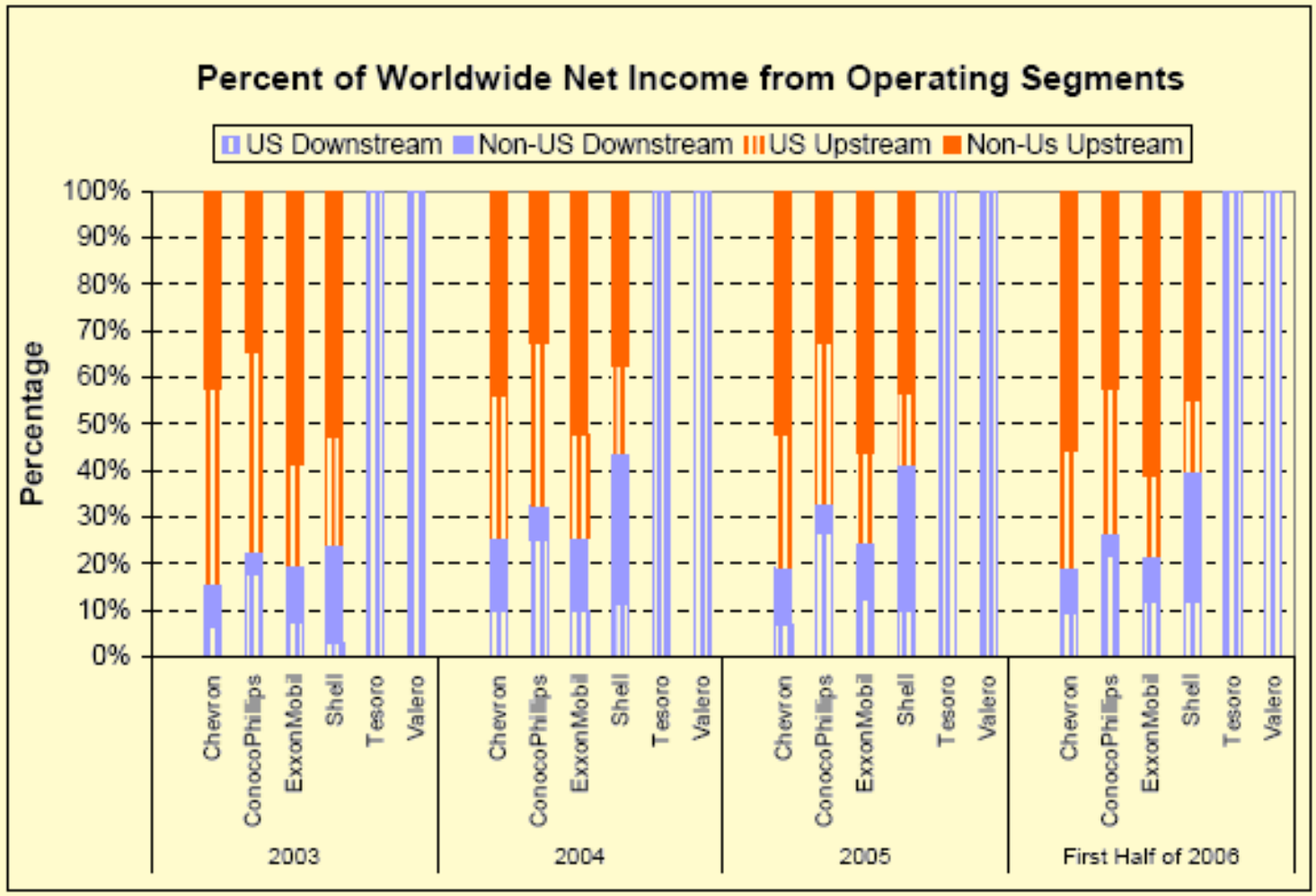
Consolidation within Industry



Source: Used with the written permission of John S. Herold, Inc.

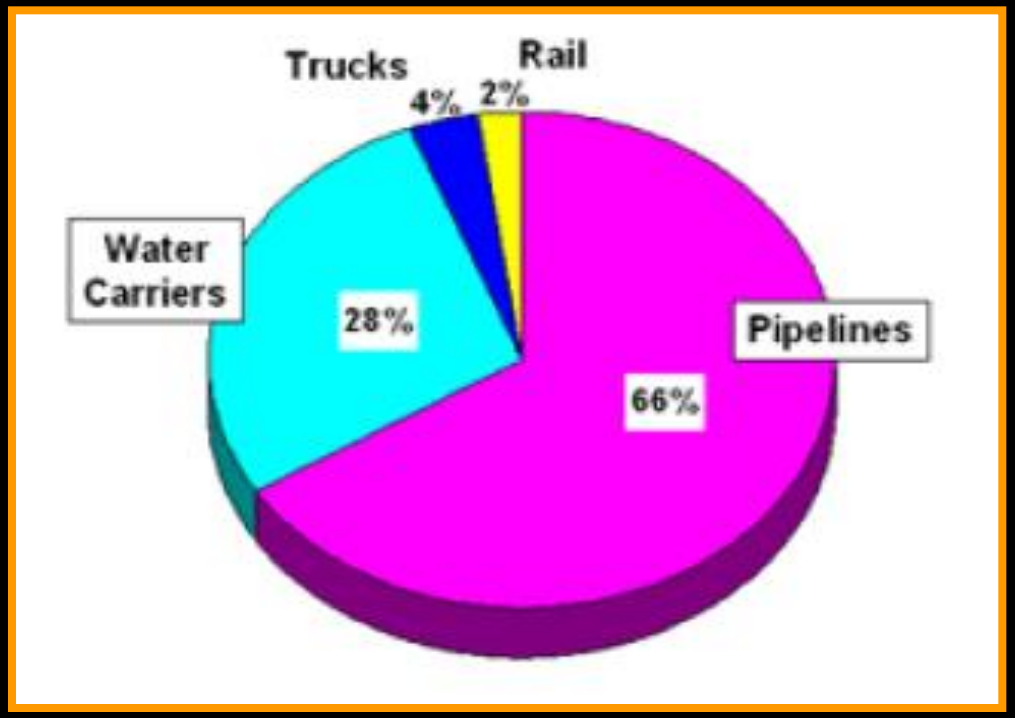
Consolidation has dampened the volatility within the gasoline market

Where is the Money Made?



Source: CEC analysis of company management reports, SEC 10-K, 10-Q, 20-F, and 6-K filings.

Transport of Crude Oil



- Trucking
- Rail
- Pipeline
- Water carriers (tankers)
- Combination of above

Tank Truck

Used only in small fields that are not big enough to warrant the construction of a pipeline.

Modern Truck Transportation

Carries about 8500 gals of fuel (gasoline or diesel)

Rail Tank Cars

Ocean Going Tanker

River Barges

Pipelines

Trans Alaska Pipeline

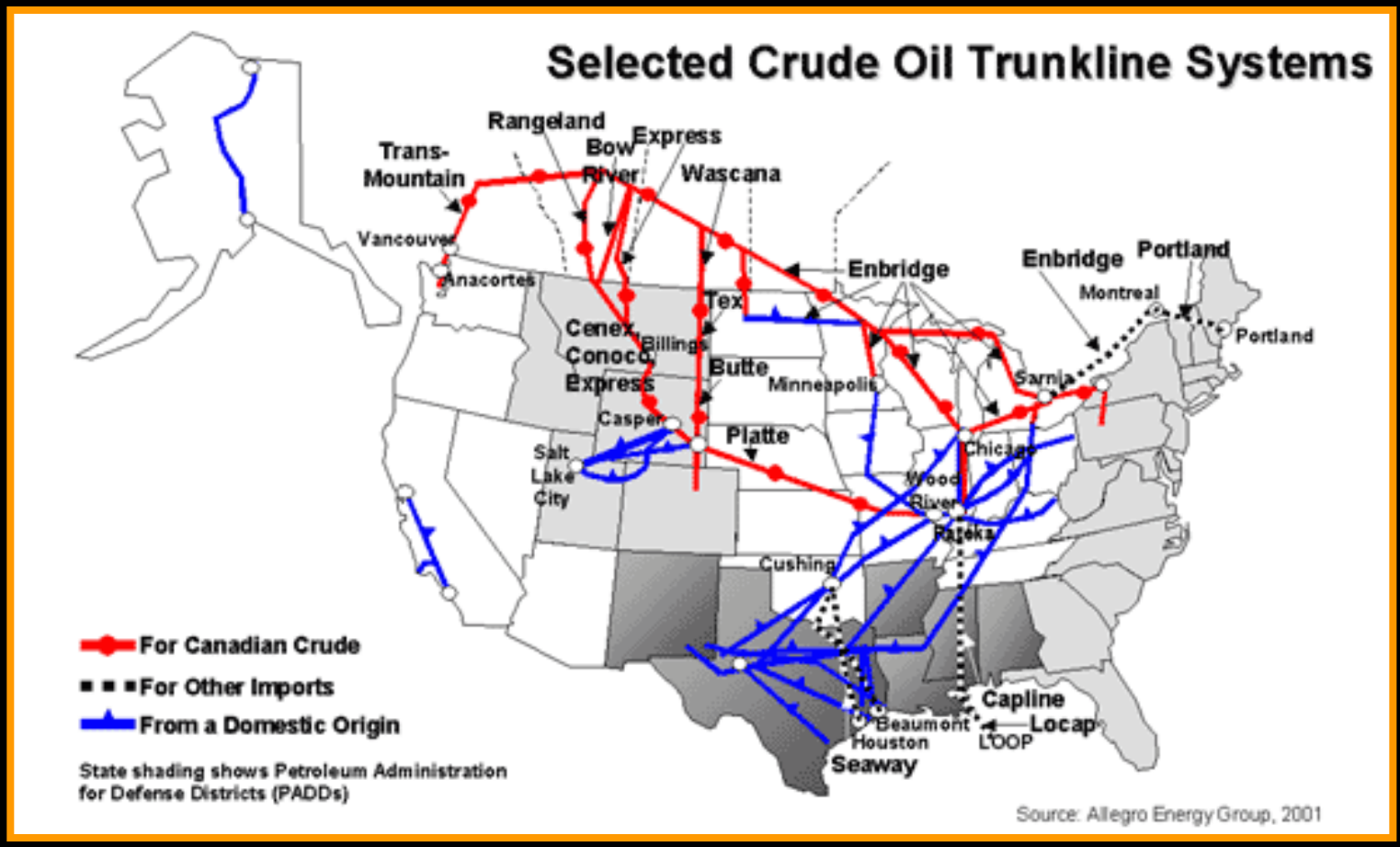
Pipeline

Ideal for shipping liquids bulk commodities:

- **Oil Products**
- **Natural gas**
- **Coal slurry**
- **Chemical**

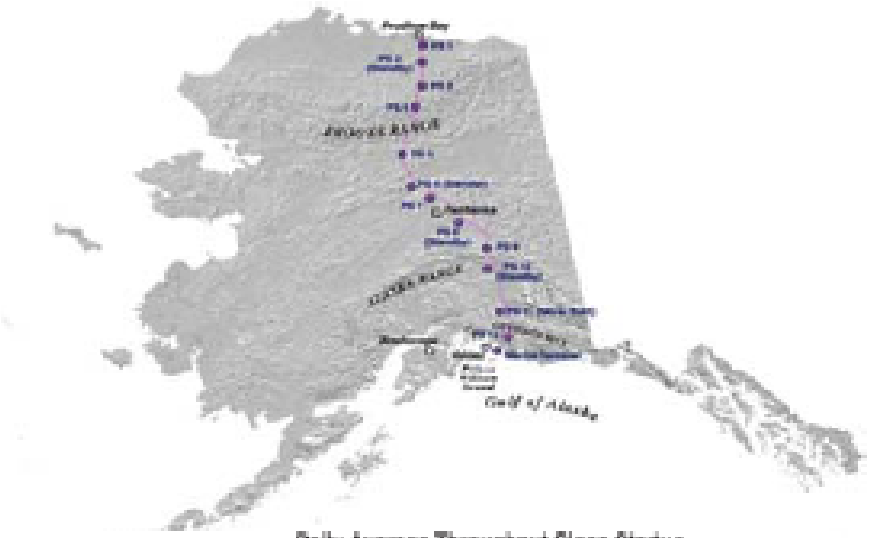
Only means of transport witho

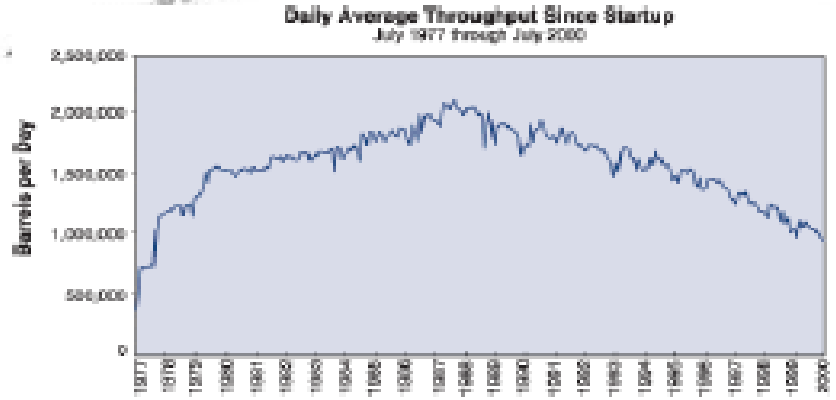
Major Crude Oil Pipelines



Sometimes Pipelines are the Only Way to Get Oil to Market

- Largest pipeline system in the world
- April 1974 and was completed in June 1977 at a cost of approximately $8 billion.
- From **Prudhoe Bay** on the Arctic Ocean to the terminal at **Valdez** -800 miles





Trans Alaskan pipeline

Pipelines Present a Number of Problems

Construction problems:

Leakage

- Accidental
- Malicious activity
- Sabotage

Maintenance

Construction

Trans Alaskan pipeline

Pipeline Leaks

A Drunk Shot the Trans Alaskan Pipeline

Pipeline Maintenance

Build up and removal of crude

Care and Maintenance of Pipelines with Pigs

Not Really!!

“Pigs” maintain the pipeline:

- **Any build up of grunge inside the pipeline.**
- **Presence of any pipe corrosion and leaks.**
- **Use temporary pipeline plugs.**
- **Clean the pipeline to maximize flow and reduce contaminants.**

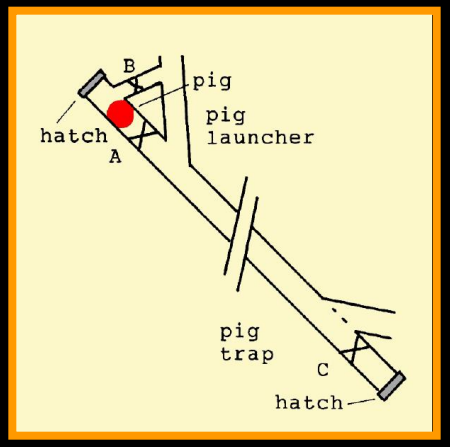
Pigs

Pigs come in all shapes and sizes.

Used to clean or check for corrosion in the interior of pipe.

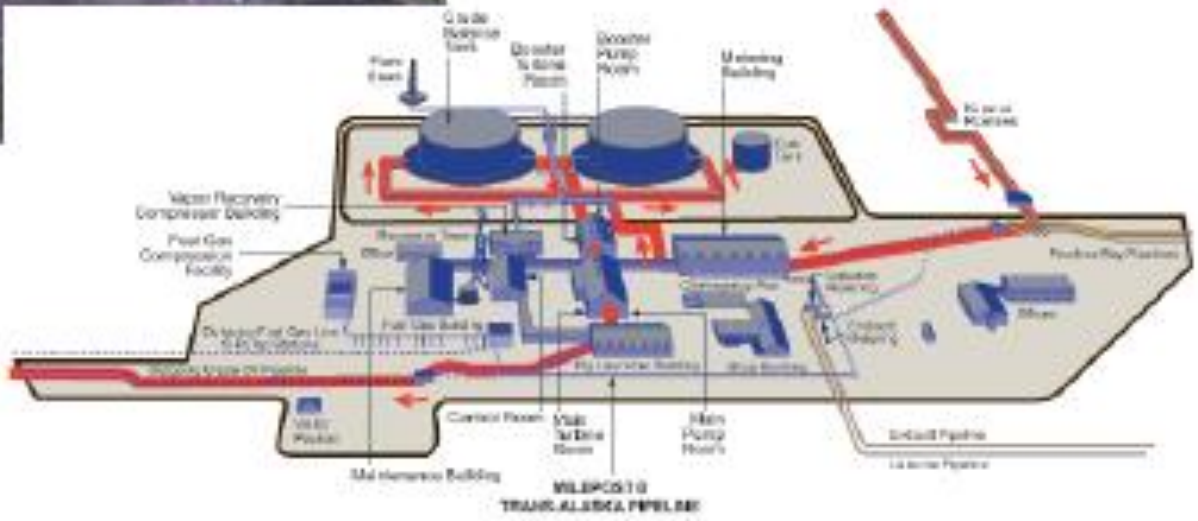
Pig in a Pipeline

"Pig in a Poke"



Pig launcher

Pump Stations along the Pipeline Route

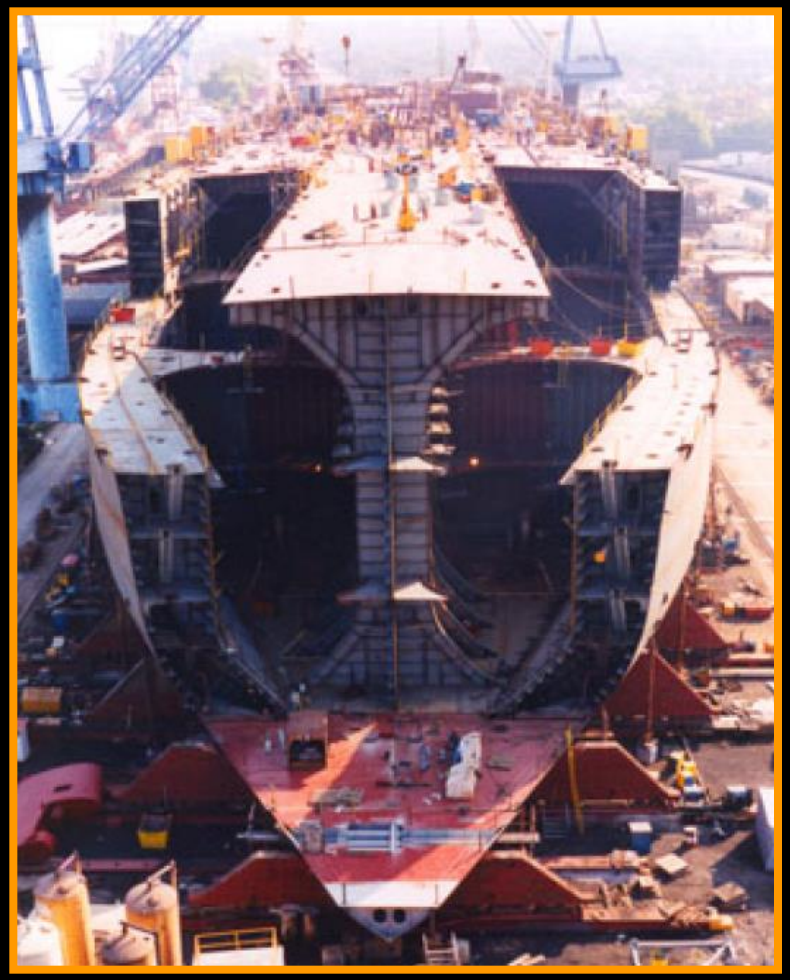


Pipeline Terminals

Valdez, Alaska

Modern Tanker

Modern Double Hull Tanker



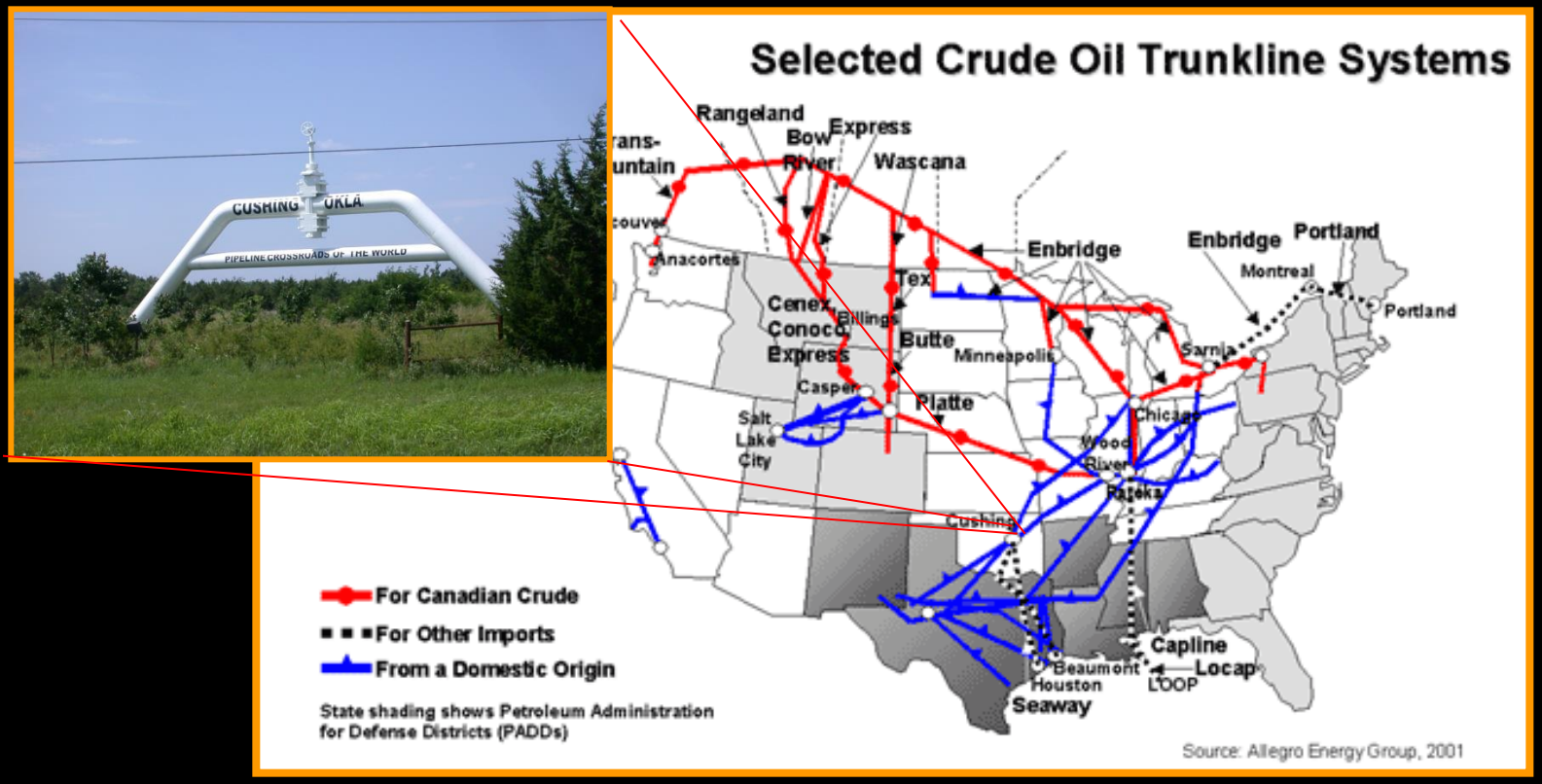
Important Crude Characteristics when Transporting by Tanker

- API (storage factor = can carry more heavy crude than light crude).
- Pour point (may have to heat cargo).
- Cloud point (build up of wax).
- % of water.

Off Loading Terminal

Tank farm, which will transport crude to refinery

Crude Oil Distribution



Cushing, OK is a major oil storage and distribution center.

Site where the physical exchange of oil occurs.

NYMEX price of oil depends heavily on oil stocks at Cushing.

Oil Futures

Difference $4.88

LIGHT SWEET CRUDE

1,000 bbl.- dollars per bbl.

	Open	High	Low	Settle	Chg.
Nov 07	80.85	82.40	80.55	81.62	-.16
Dec 07	79.89	81.19	79.67	80.64	...
Jan 08	79.26	80.34	79.16	79.99	+.14
Feb 08	78.75	79.63	78.69	79.44	+.27
Mar 08	78.25	79.10	78.19	78.98	+.38
Apr 08	77.99	78.65	77.55	78.56	+.46
May 08	78.15	78.30	77.46	78.16	+.49
Jun 08	77.20	77.85	76.73	77.80	+.51
Oct 08	75.97	76.56	75.97	76.56	+.59

Est. sales ...

Thu's sales 505,235 Thu's open int 1,416,147, down 42,806

Backwardization

Price in the future is lower

LIGHT SWEET CRUDE

1,000 bbl.- dollars per bbl.

	Open	High	Low	Settle	Chg.
Feb 09	38.45	39.55	32.70	38.74	+2.23
Mar 09	40.98	43.79	39.11	40.84	-1.73
Apr 09	44.05	47.12	43.19	44.25	-2.77
May 09	46.15	49.40	45.75	46.56	-2.95
Jun 09	47.83	51.20	47.50	48.28	-3.07
Jul 09	49.64	51.06	48.87	49.64	-3.15
Aug 09	50.00	53.00	50.00	50.59	-3.23
Sep 09	51.05	52.80	50.90	51.51	-3.30
Oct 09	52.29	53.47	52.00	52.40	-3.36
Nov 09	52.73	53.33	52.70	53.27	-3.40

Est. sales 518,644

Fri's sales 530,274 Fri's open int 1,245,743, down 18,854

Contango

Price in the future is higher

Difference 14.28

Cushing Tank Farm

Floating Tank Top

Refinery

What Does a Refinery Do?

Separates the complex mixtures of hydrocarbons in crude oil into usable products.

Removes toxic elements.

Formulates the products to burn cleanly and be as environmentally friendly as possible.

Produce enough product:

- To meet demand.
- Cheap enough to encourage demand.
- Make a profit.

Refineries are Potential Bombs

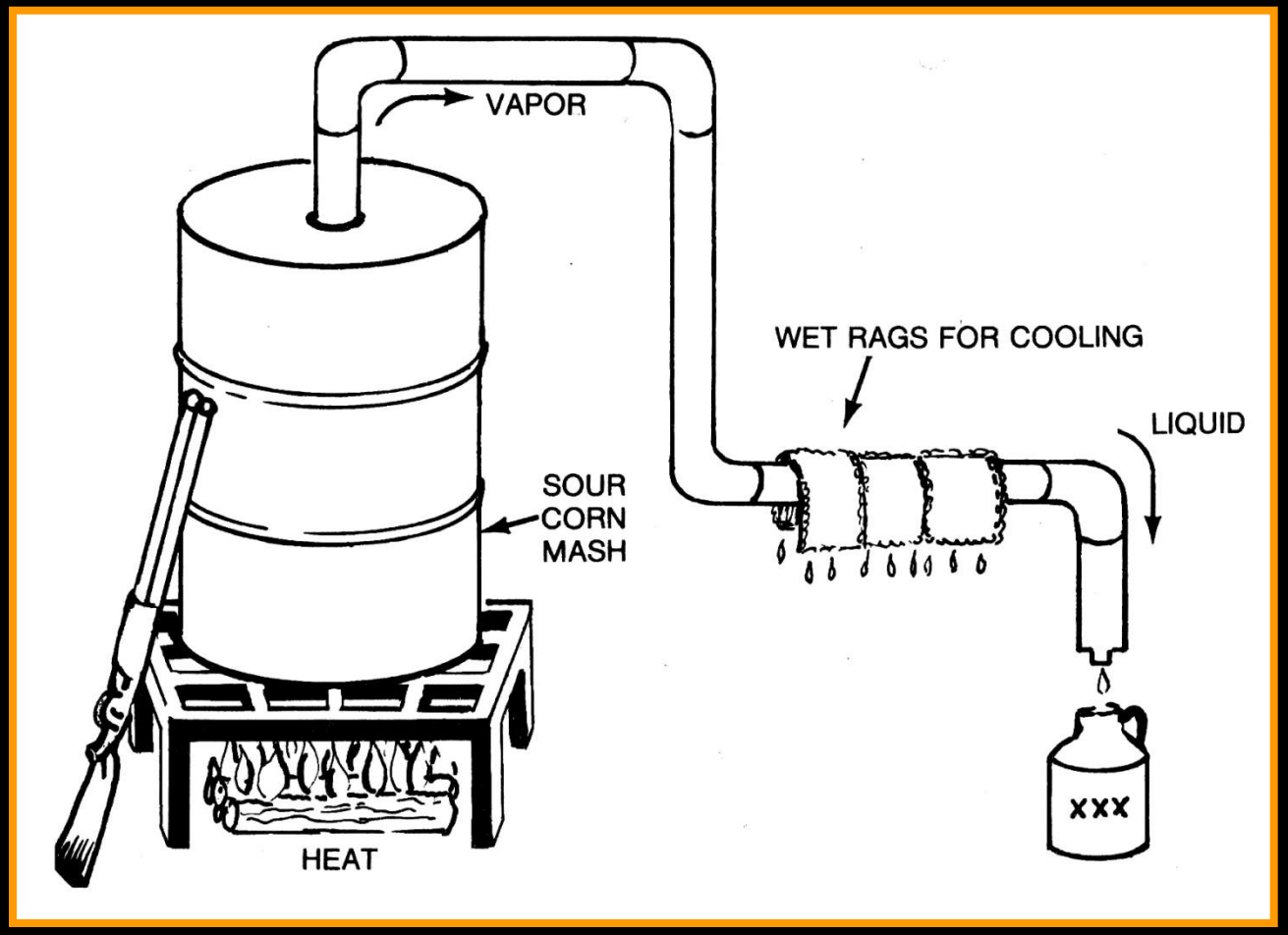
Process a highly flammable products.

Process these flammable products at high temperatures = up 1,000ºF.

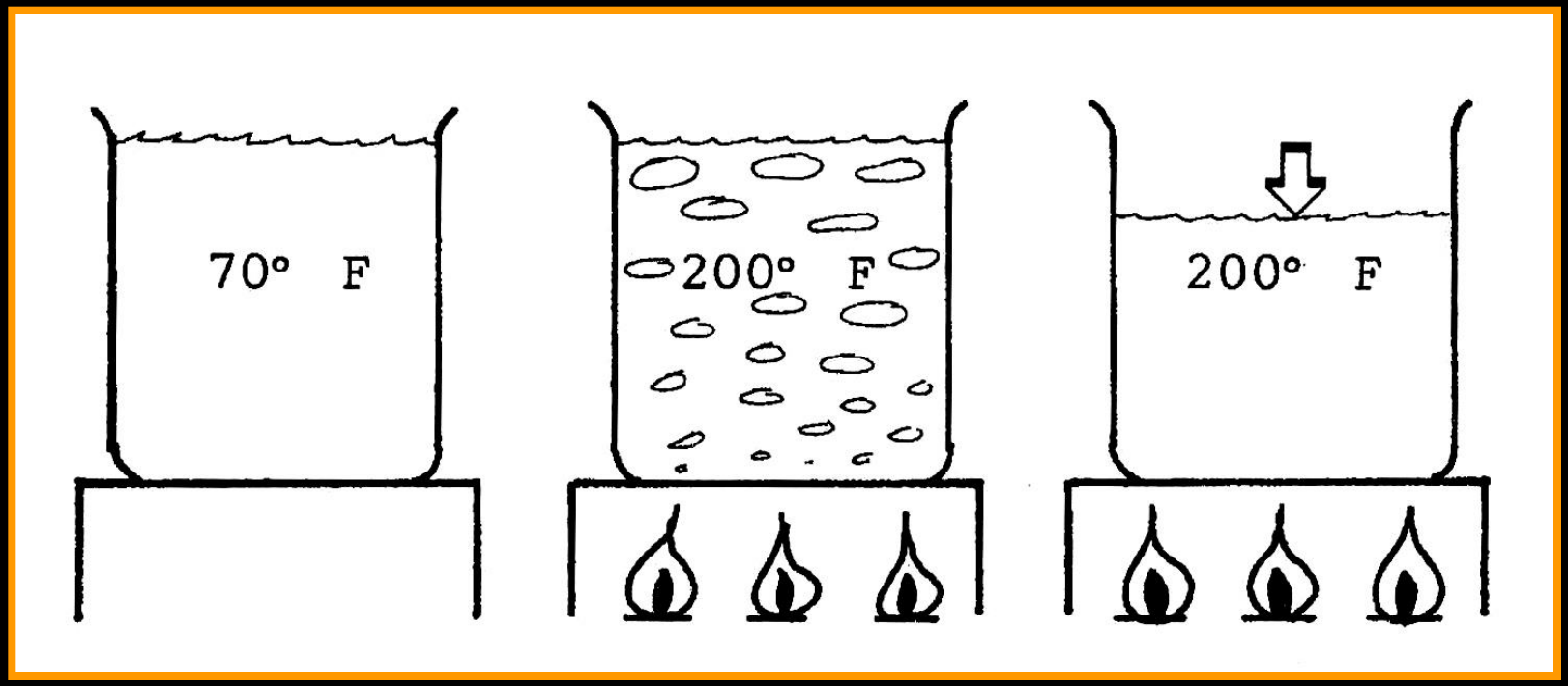
Process these products under high and low pressures.

Along every step in the refining process the products may explode into a catastrophic inferno.

Refinery is a Sophisticated Moonshiner's Still

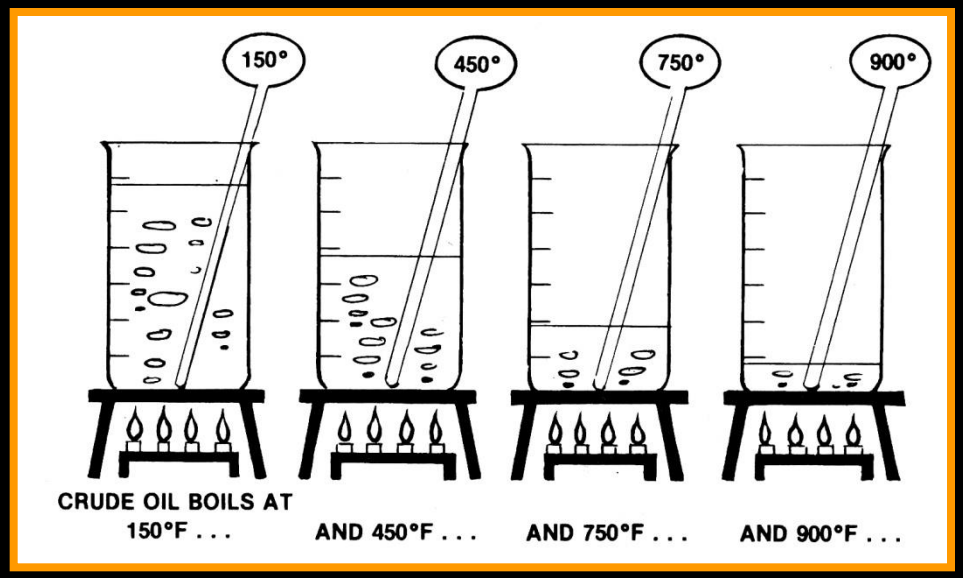


Specific Boiling Points of Different Hydrocarbon



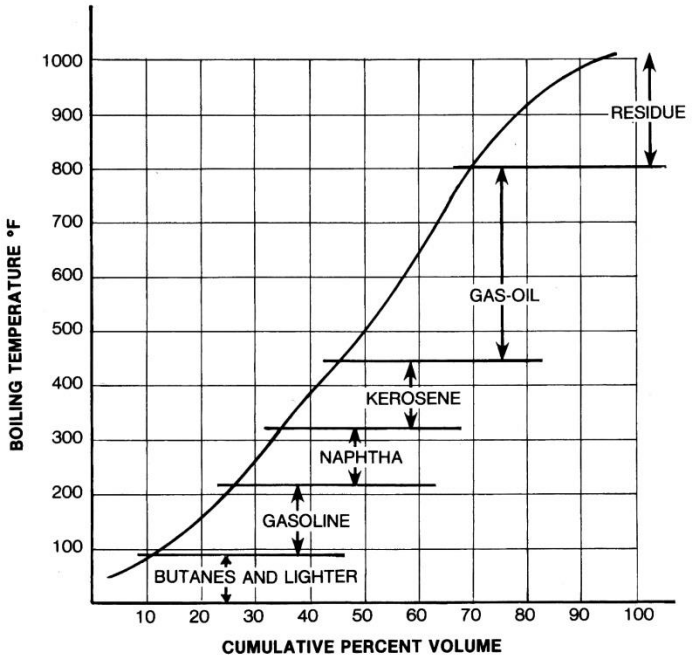
Each species or fraction of hydrocarbon has its own boiling point

Boiling Temperature Distribution

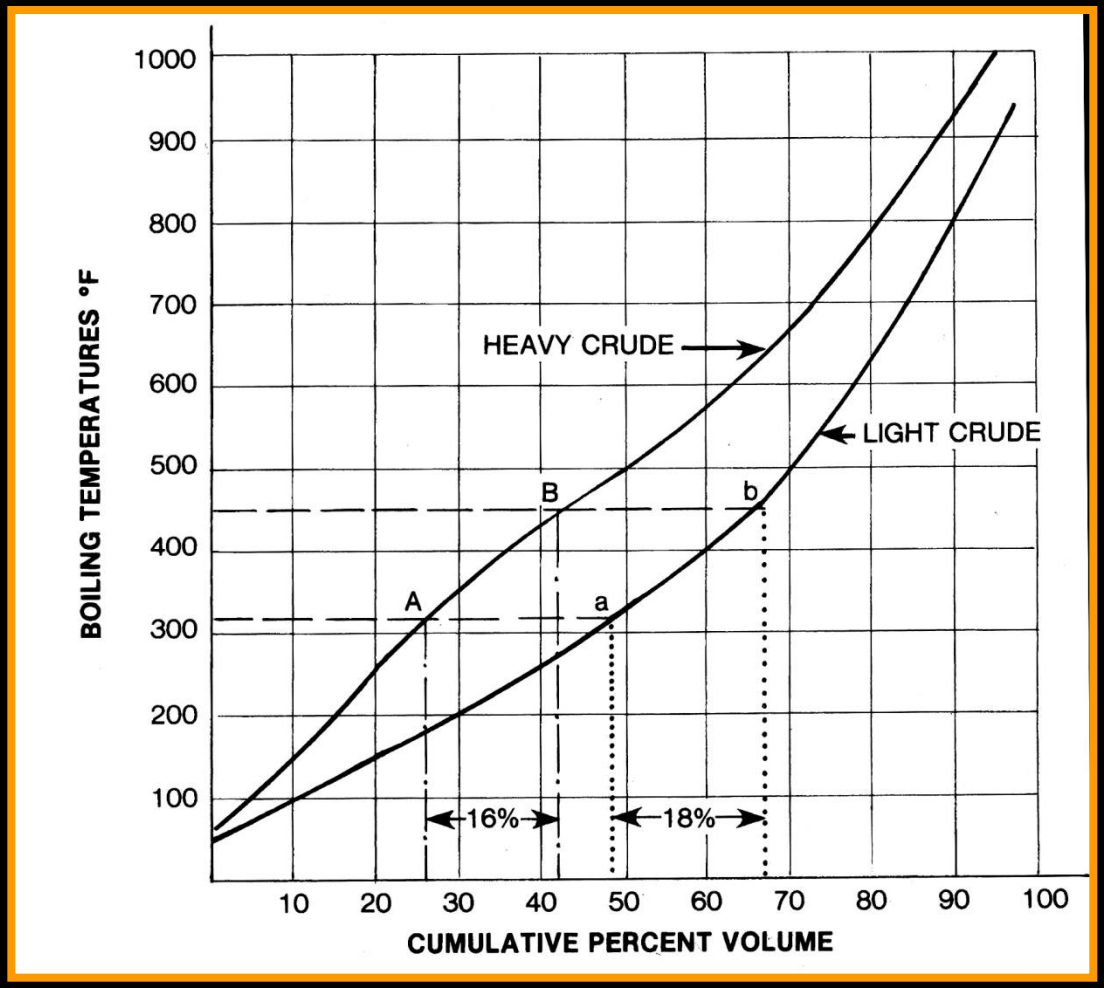


Each fraction of hydrocarbon has its own boiling point

Temperatures	Fraction
Less than 90°F	Butanes and lighter
90 - 220°F	Gasoline
220 - 315°F	Naphtha
315 - 450°F	Kerosene
450 - 800°F	Gas Oil
800°F and higher	Residue



Boiling Temperatures of Different Crudes



Higher temperatures are required to fractionate heavier crudes; more expensive.

Economics of Refining Crude Oil

Far from simple.

Very expensive to build and operate.

Produce a variety of products.

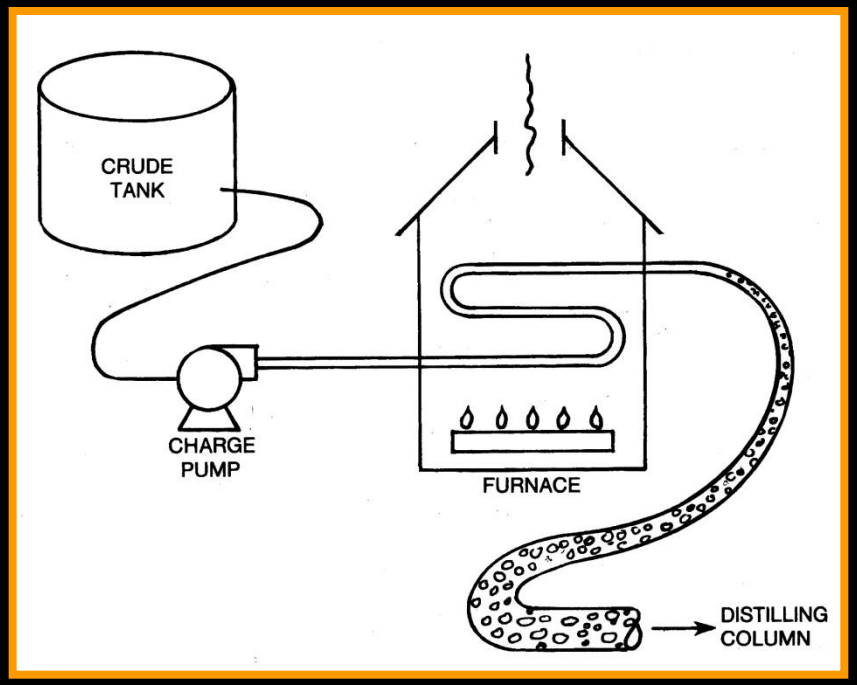
Demand for products vary seasonally.

Price, type, and availability of feedstock unpredictable.

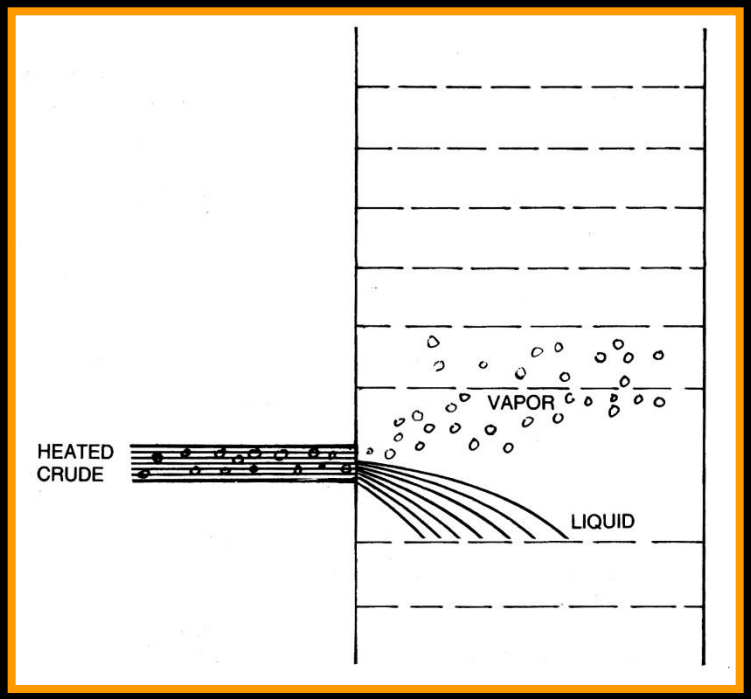
Profit margins changes daily.

Heavy crudes may in some instances, produce a higher margin of profit than light crudes.

Heated Crude is Fed into a Distillation Column

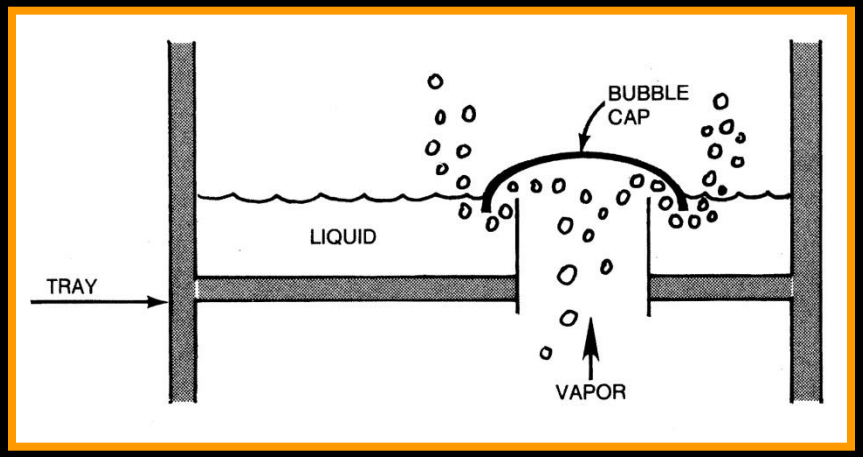


Step one = heating the crude

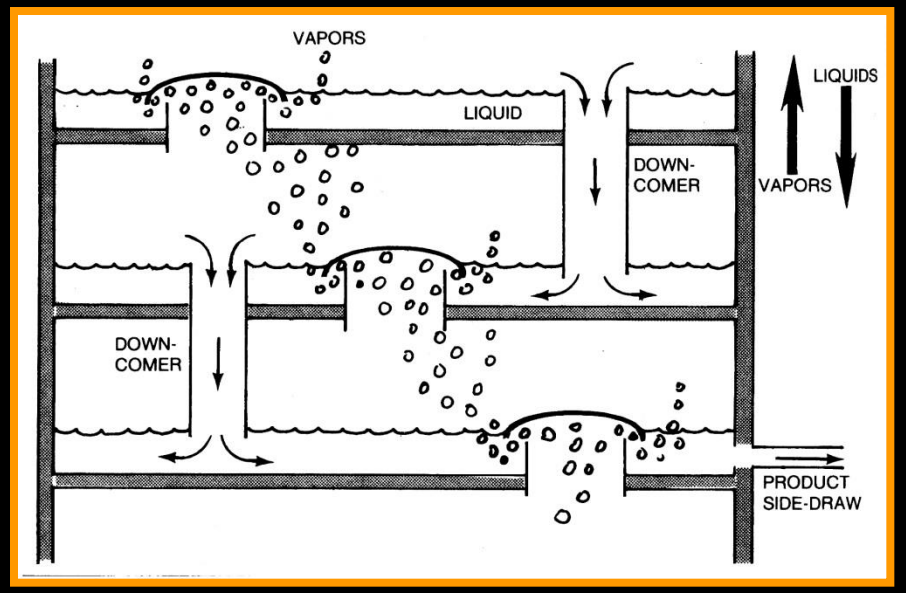


Step two = feed into distilling column with additional heating

Distilling Process within Distilling Column



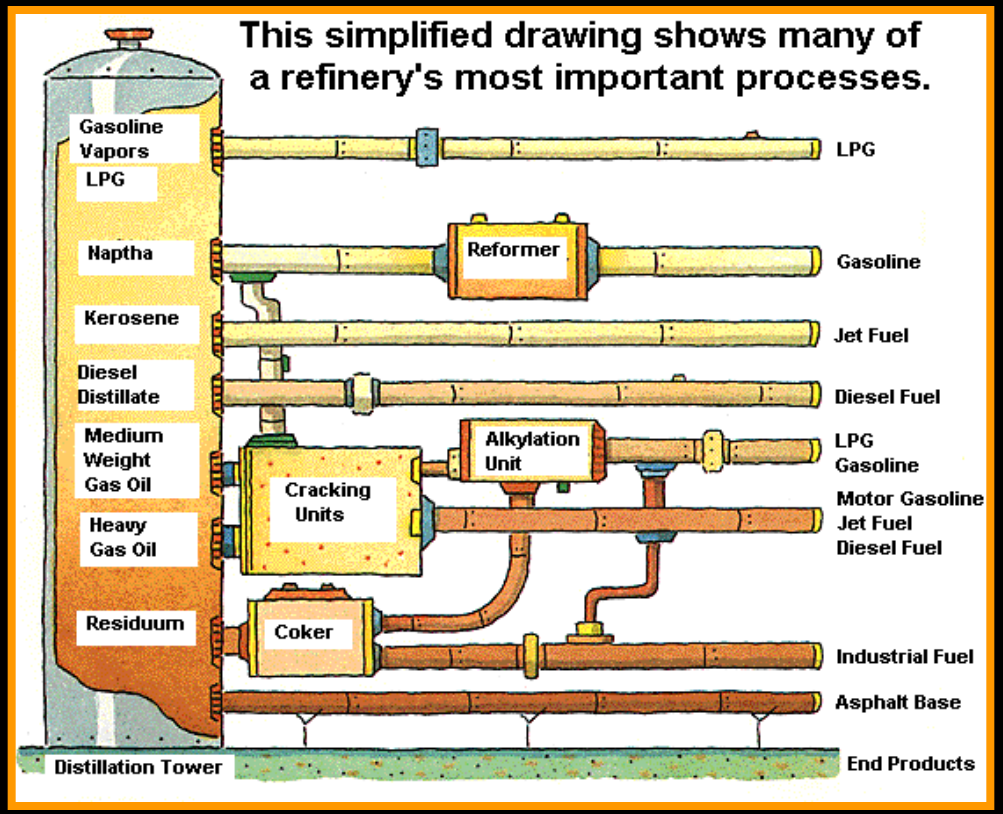
Distilling trays and bubble cap



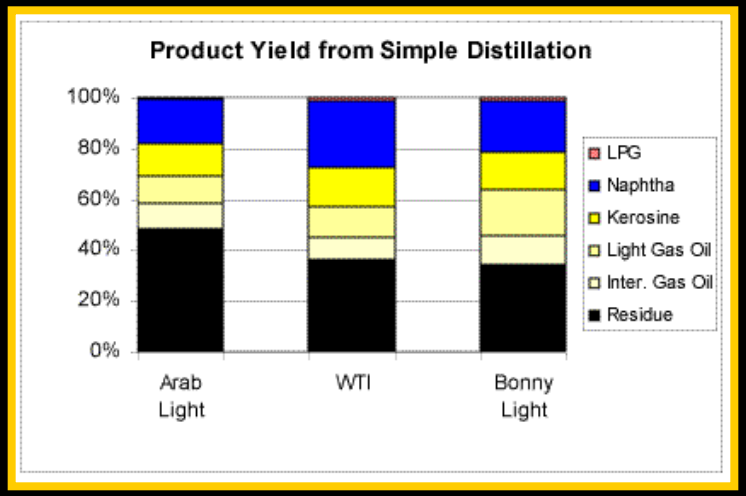
Downcomers and sidedraws

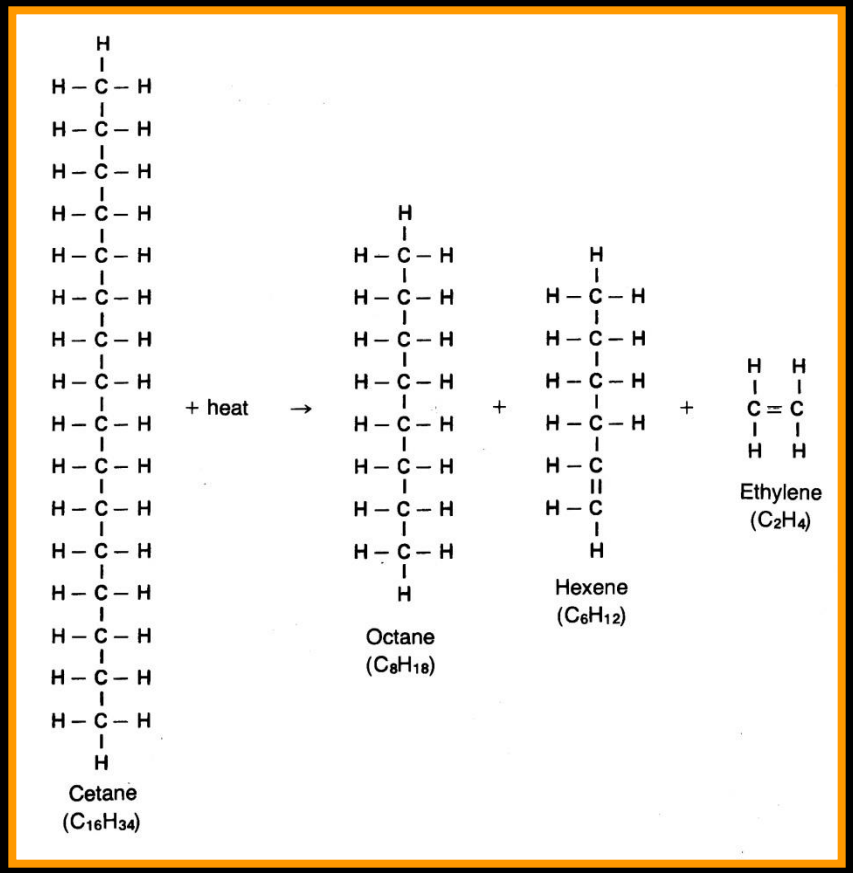
- The bubbling is the essence of the distilling process.
- Heat is transferred from the bubbles to the liquid during the bubbling.
- The lowering of the temperature causes the heavier hydrocarbons in the vapor to liquefy and accumulate in the trays.
- Vapor continues upward and the process is repeated.

Simplified Refinery



Cracking = Splitting Large Molecules into Smaller Molecules

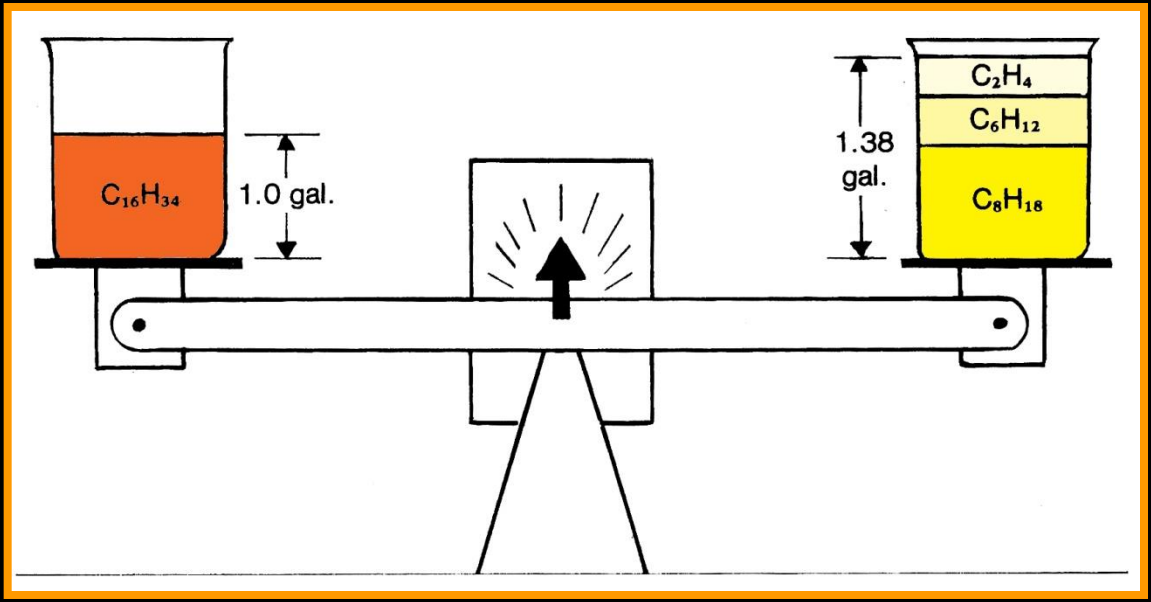




Between 900 and 1000ºF something strange happens to the liquefied hydrocarbons.

They break down into simpler and shorter hydrocarbon chains = this is called cracking and results in volume increase!

End Up With More Than Your Started With! Not Really



cracking 100% of $C_{16}H_{34}$ = 7.2 lb ÷ 7.2 lb/gal = 1.00 gal

results in

50% yield of C_8H_{18} = 3.6 lb ÷ 5.9 lb/gal = 0.61 gal

38% yield of C_6H_{18} = 2.7 lb ÷ 5.6 lb/gal = 0.48 gal

12% yield of C_2H_4 = 0.9 lb ÷ 3.1 lb/gal = 0.29 gal

100% 7.2 lb 1.38 gal

Refinery Complexity

Simple:

Crude distillation, cat reforming, distillates hydro-treating.

Complex:

Simple refinery plus a cat cracker, alky plant, gas processing.

Very complex:

Complex refinery plus a coker, which eliminates residual fuel products.

Percent Product Yields from a "Medium Crude"

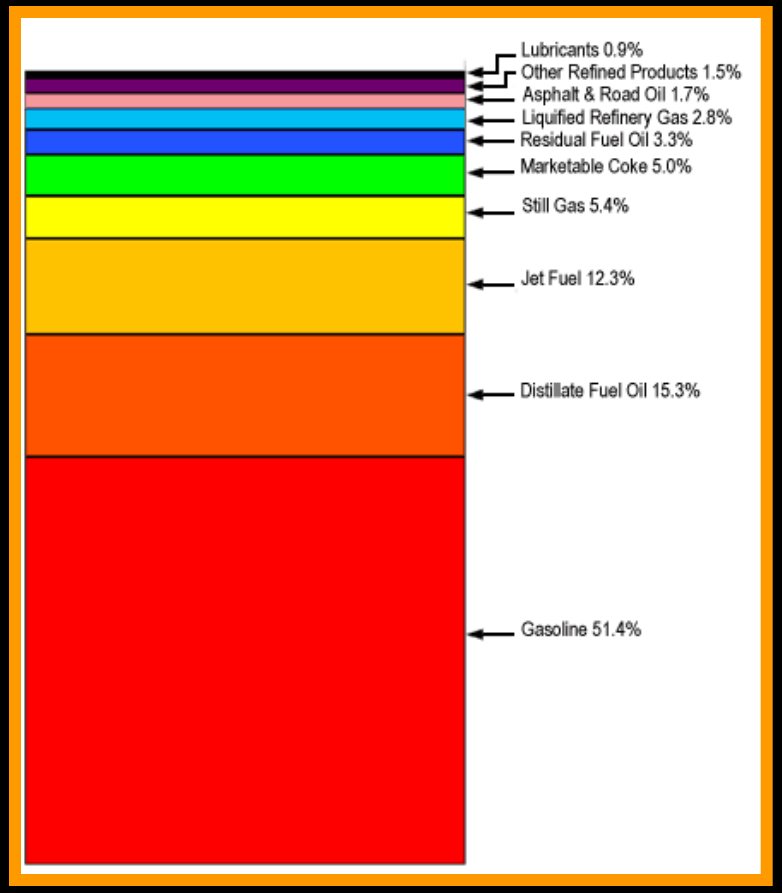
	Simple	Complex	Very Complex
Gasoline	30	50	60
Jet fuel	10	10	10
Distillates	20	25	25
Residual fuel	35	10	_
LPG	_	3	4
Coke	_	_	3
Refinery fuel	8	12	13
Gain	(3)	(10)	(15)

Cat Cracking

As the demand for gasoline increased in the early 20th century, excess fuel oils were produced. Direct contrast to the 19th century when kerosene was in higher demand.

This led to the development of **cat (catalytic) cracking** = a process that converts heavier fuel oils to gasoline.

Amount of Gasoline from a Barrel of Crude Oil



Approximately 22 gallons of gasoline are obtained from a barrel of crude. The amount of gasoline depends on the type of crude being refined.

Refining Costs

Cost and type of crude oil refined.

Type of gasoline produced.

Demand for refined products (time of year.)

Operation costs:

- Storage of products.
- Day to day costs of running refinery.
- Repair and modernizing equipment.

Refining costs are approximately 18 - 20% of retail price of gasoline.

Profit margin is constantly changing.

Crack Spread

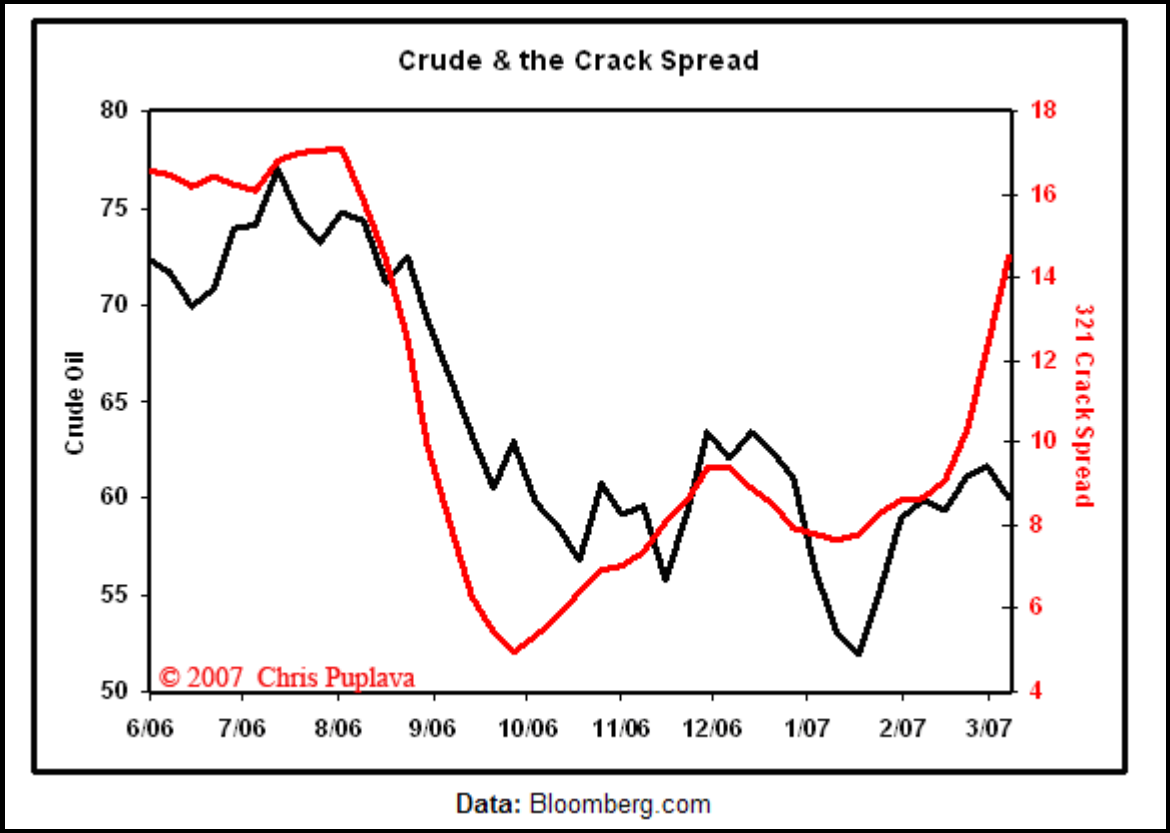
Difference between the cost of crude and price of the refined products.

Factors affecting crack spread:

- Type of refinery.
- Cost of crude.
- Cost of refined products.
- Demands of local and regional markets.

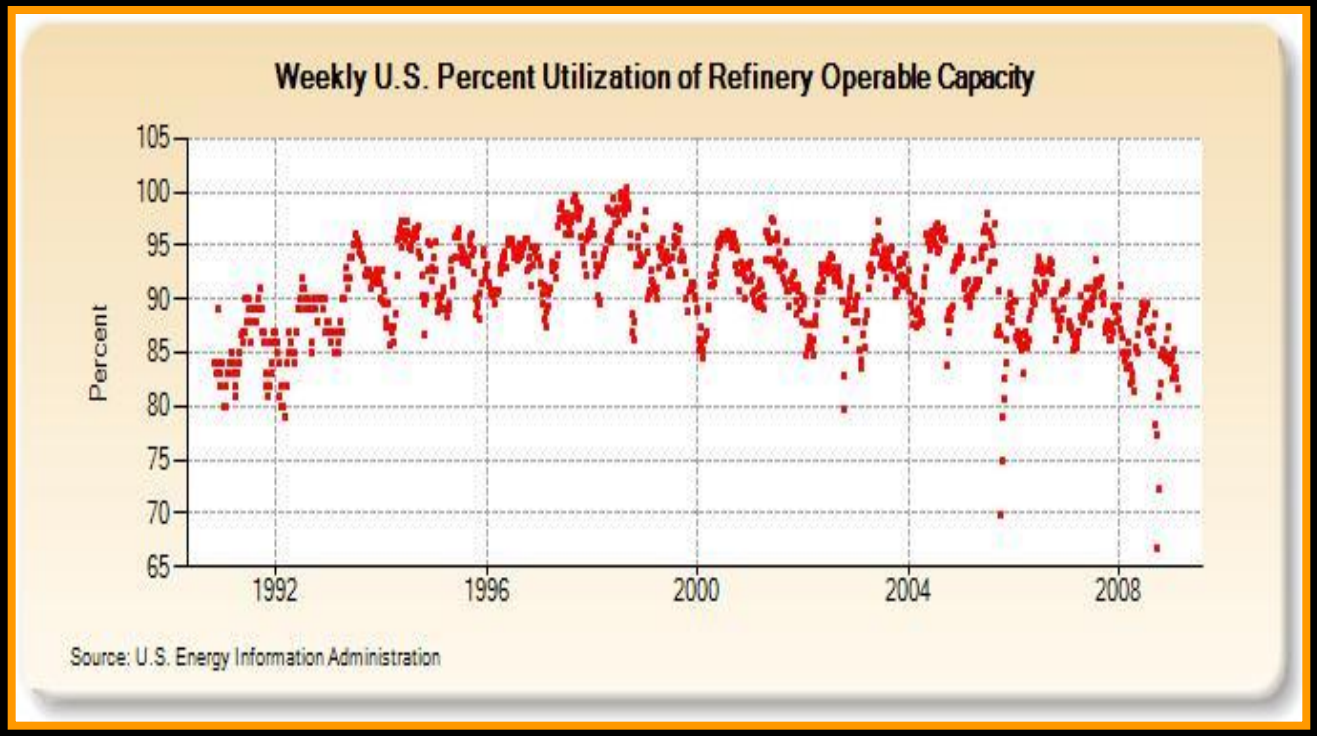
3:2:1 = 3 barrels of crude, 2 barrels of gasoline, and 1 barrel of distillates.

Refinery Profit Margin



Price of Refined Products: cost of crude + refining costs = profit margin

Refinery Capacity/Utilization



Capacity/utilization depends:

- **Demand**
- **Profit margin**

Refinery Turn-around

Planned refinery shutdowns for maintains and upgrading.

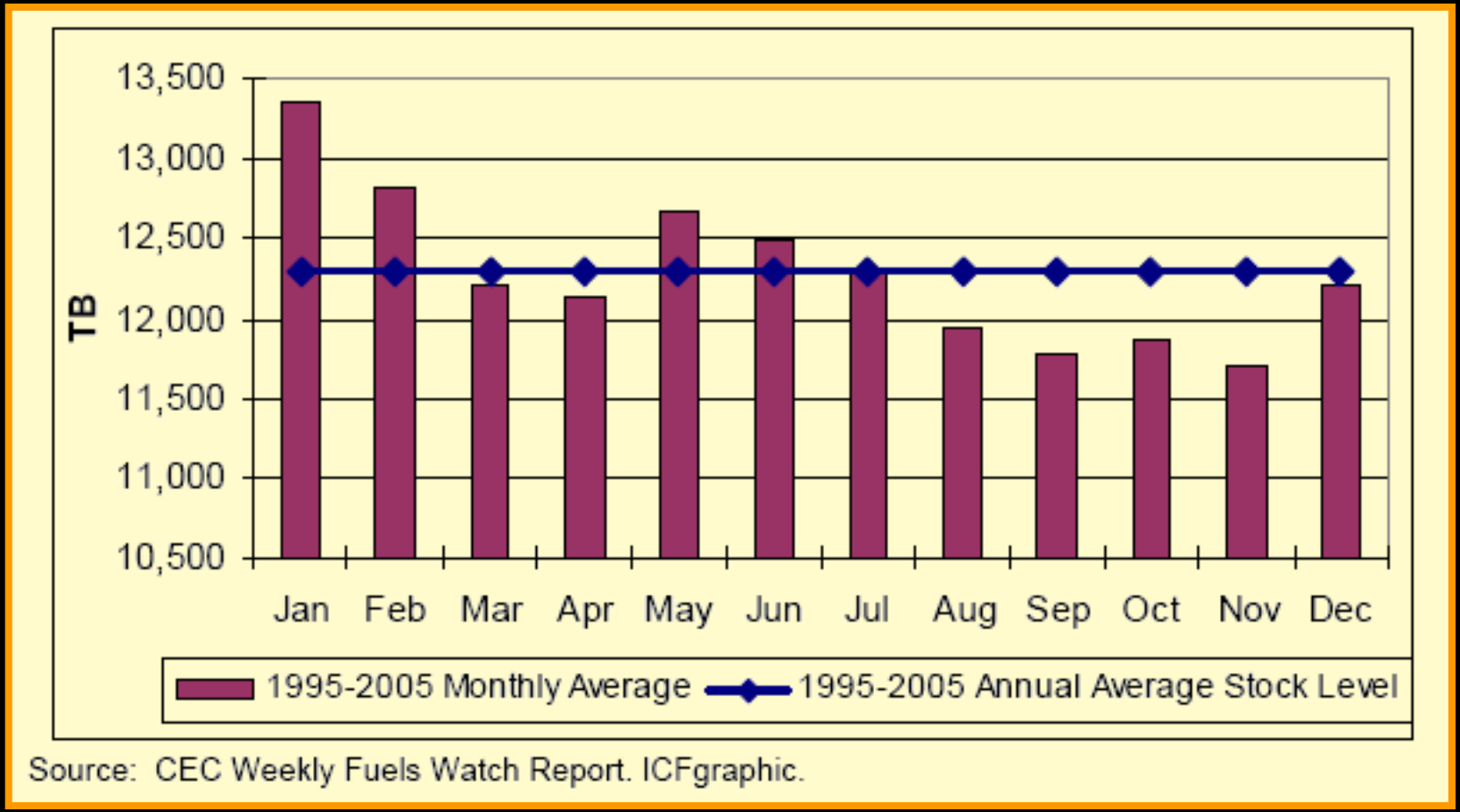
Planned well in advanced (1 to 2 years).

Plan for reduction of refined products.

Minimal impact on price.

Unplanned shutdowns can have a significant impact on prices!

California Gasoline and Blended Stock Inventory



Source: CEC Weekly Fuels Watch Report. ICFgraphic.

Turnarounds are generally scheduled during the winter when demand is the lowest.

Number of Refineries and Refinery Capacity

Why no new refineries?

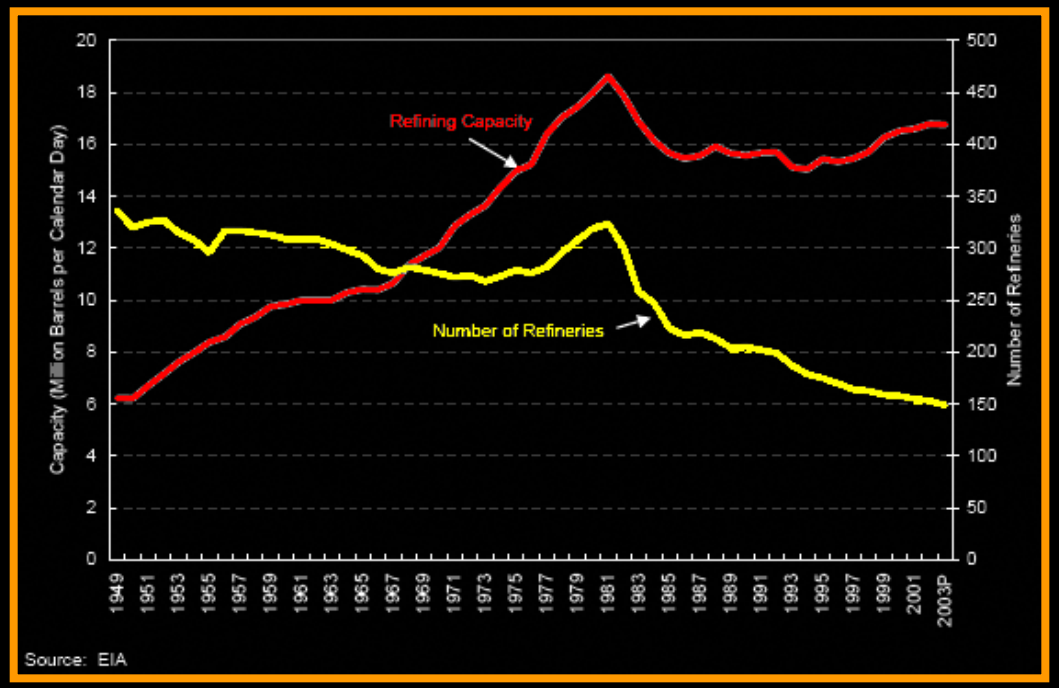
Nimby.

Long lead time for approval.

Expense of building a new refinery.

Cheaper and quicker to upgrade and expand existing refineries.

Is it wise to build new refineries when gasoline demand may decrease because of alternative fuels?




Oil reserves and stocks

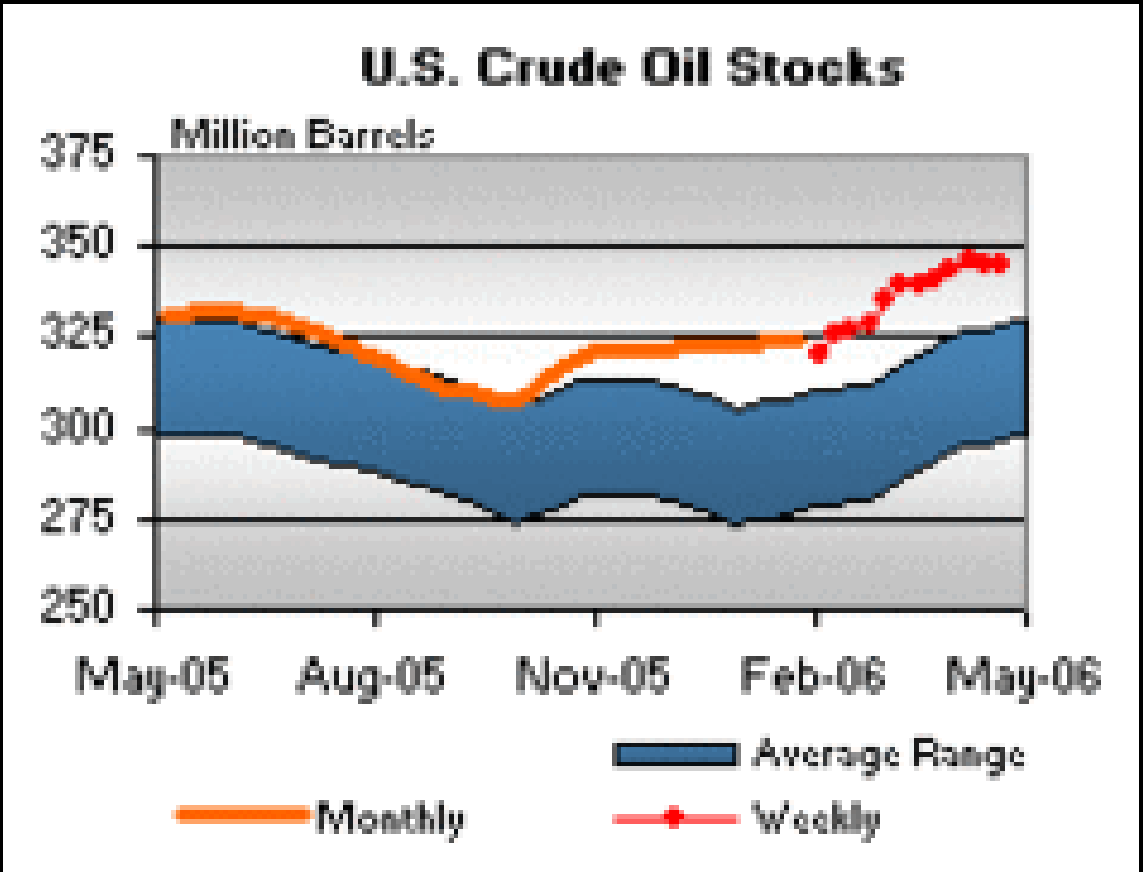
Types of Reserve

Oil in the ground: crude oil that can be produced using current technology and economic conditions.

Stored (stocks) crude oil or refined products: ready to be refined or sold.

1. Crude oil or refined products in tank farms or in pipelines.
2. Crude oil in the Strategic Petroleum Reserve.

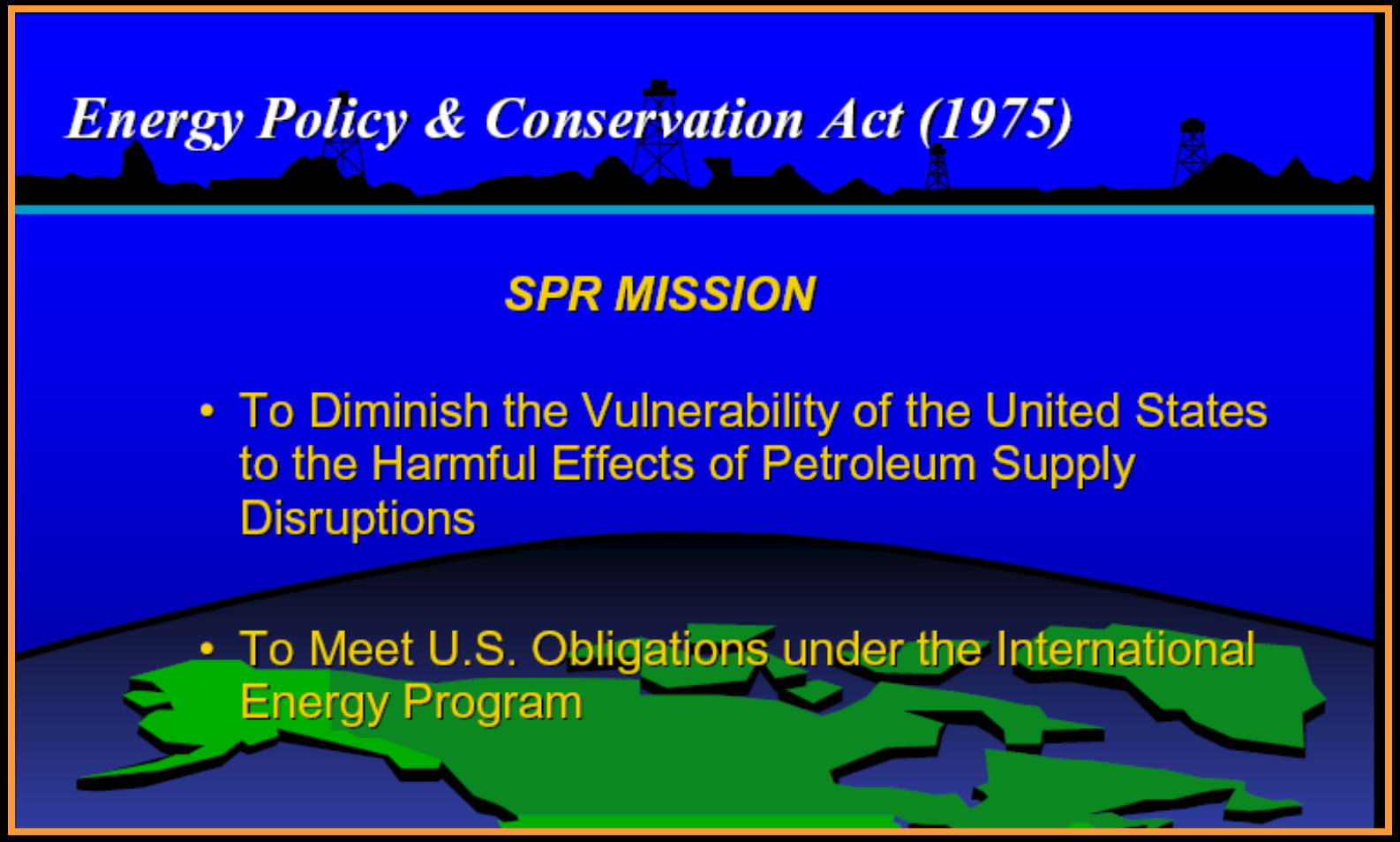
U.S. Crude Oil Stocks



Stocks: crude oil in tank farms refineries, and pipelines, minus crude oil in the Strategic Petroleum Reserve.

Typically ~ 350 mb in stocks and ~750 mb in SPR.

What is the Strategic Petroleum Reserve?



Strategic Petroleum Reserve

Storage sites

Design storage capacity: 727mb

Advantages of the Gulf Coast for SPR

- Presence of numerous salt domes:
  - Secure
  - Economical
  - Low environmental risk
- Major refinery area.
- Major crude oil distribution center.
  - Pipelines
  - Tanker terminals
- Provides maximum flexibility to respond to a wide range of disruptions.

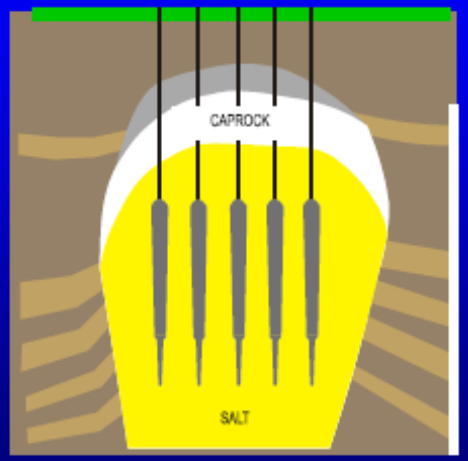
Salt Cavern Storage Technology

Storage is located in Underground Salt Dome Formations

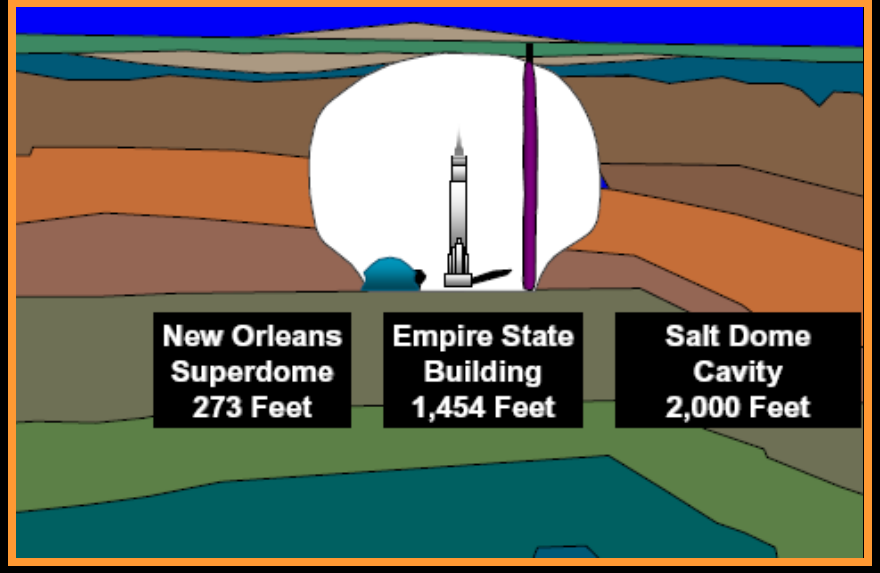
Storage Caverns (cavities) are created through Solution Mining

A salt dome can contain a number of storage caverns

Storage Caverns range in size from 1,000 to 50,000,000 barrels.

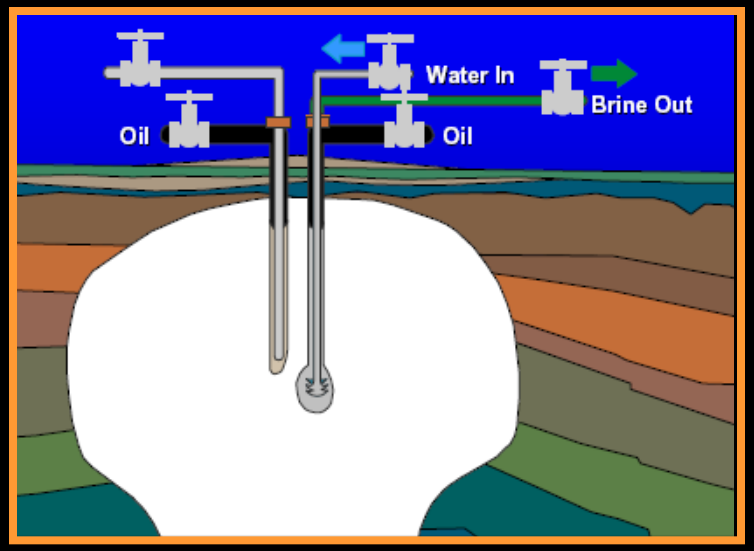


Salt dome storage

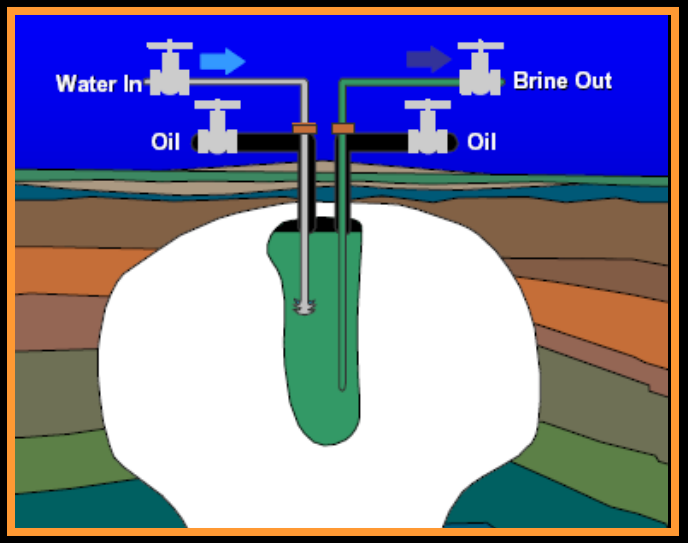


Relative size of salt cavern

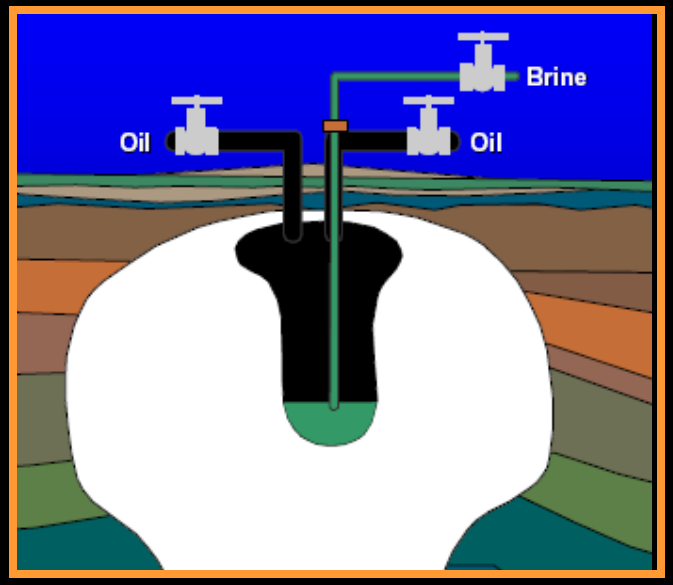
Construction of Salt Cavern



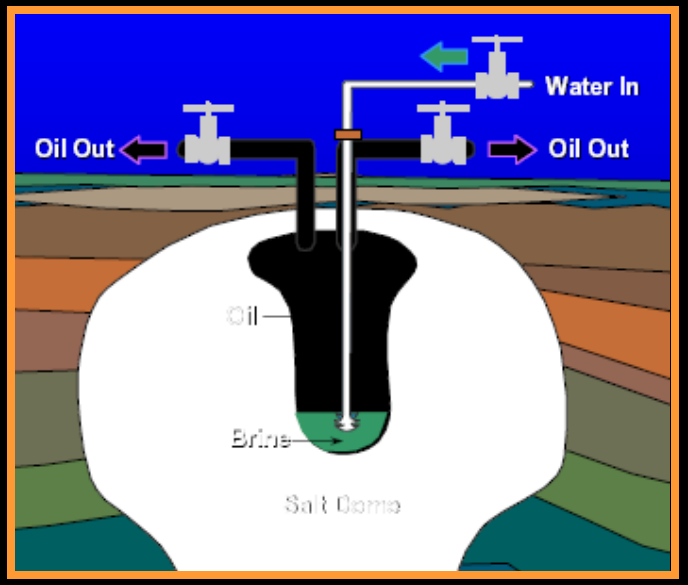
Initial drilling



Excavating with water

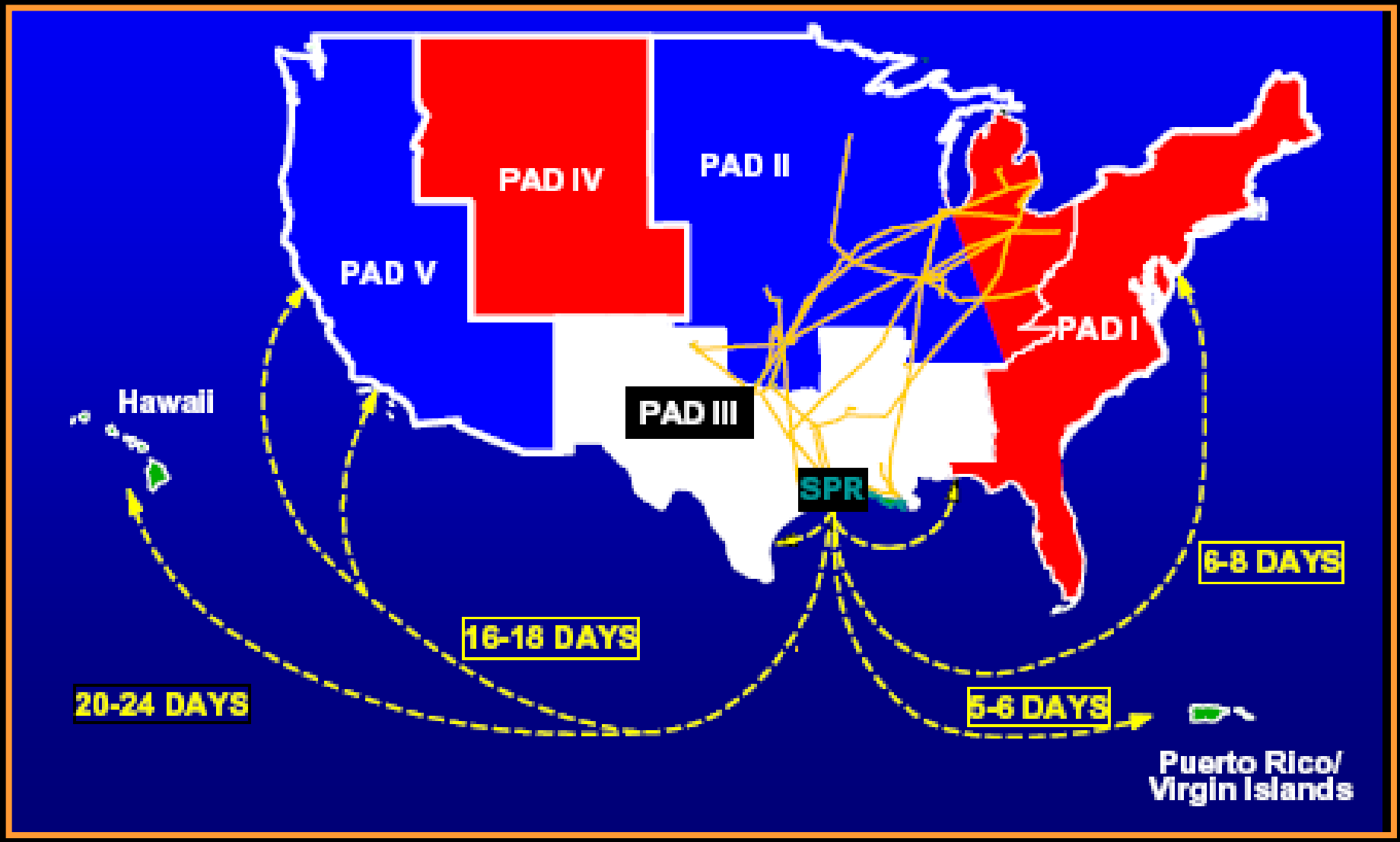


Filling

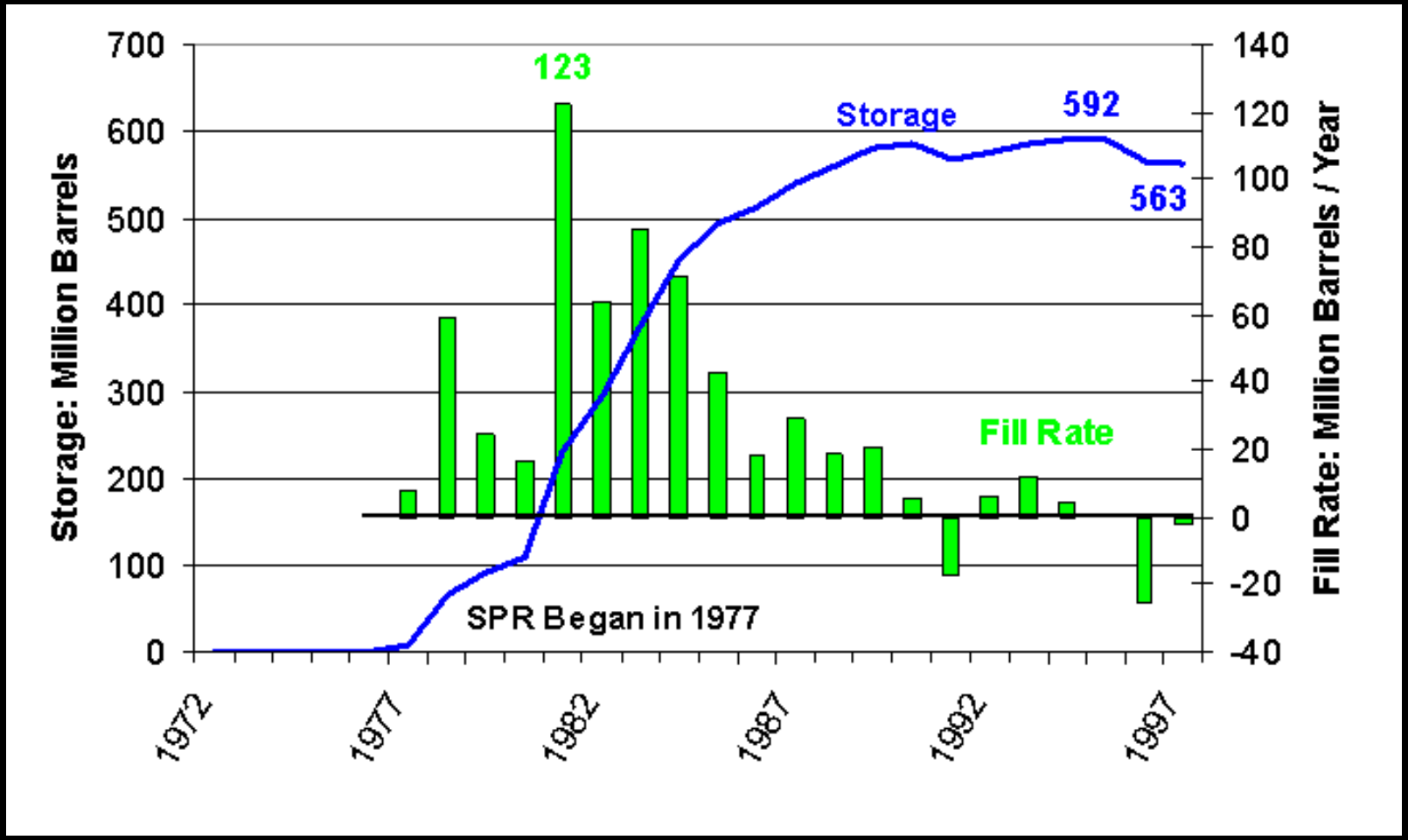


Draw down

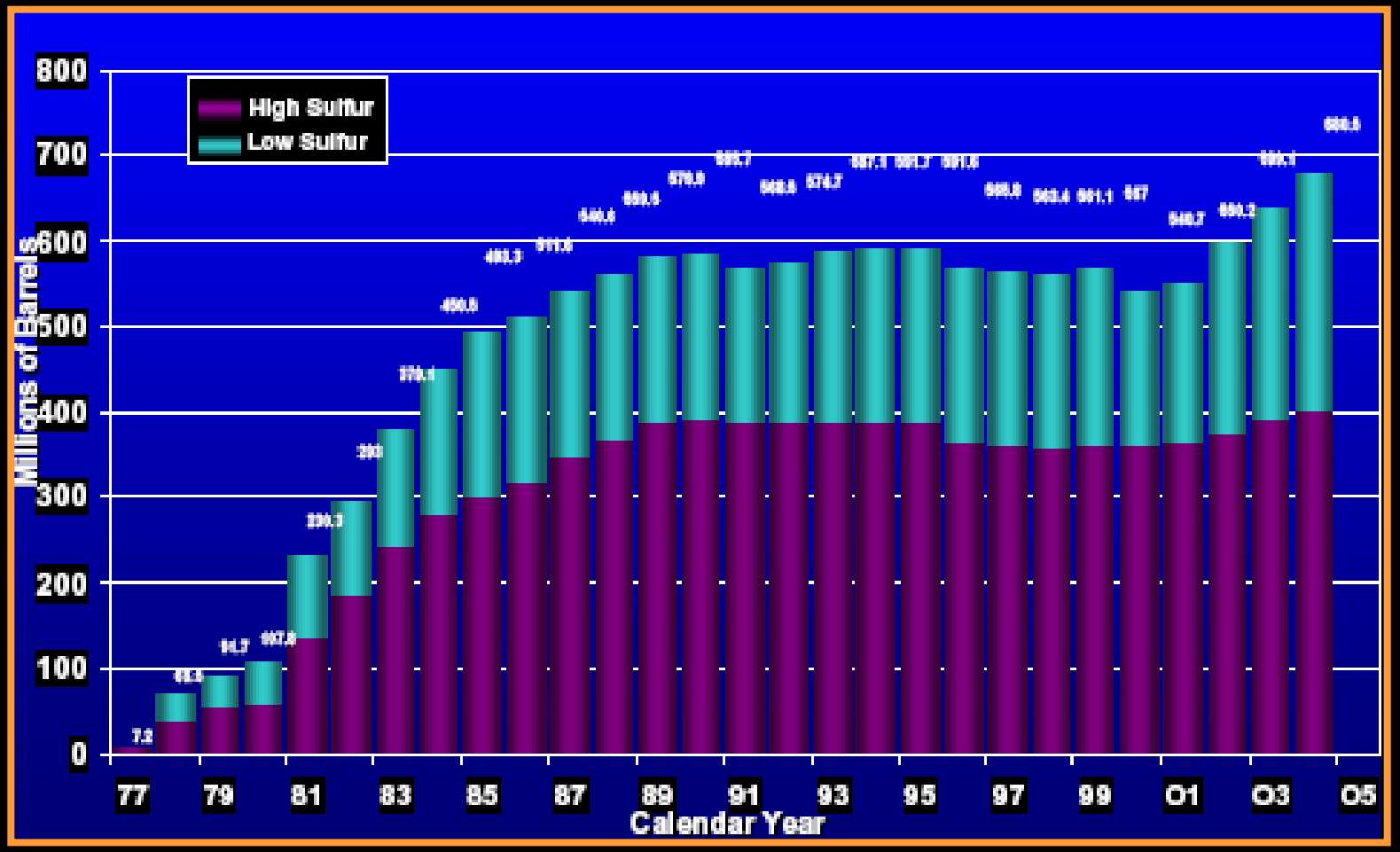
Reserve Distribution Crude Oil Capacity



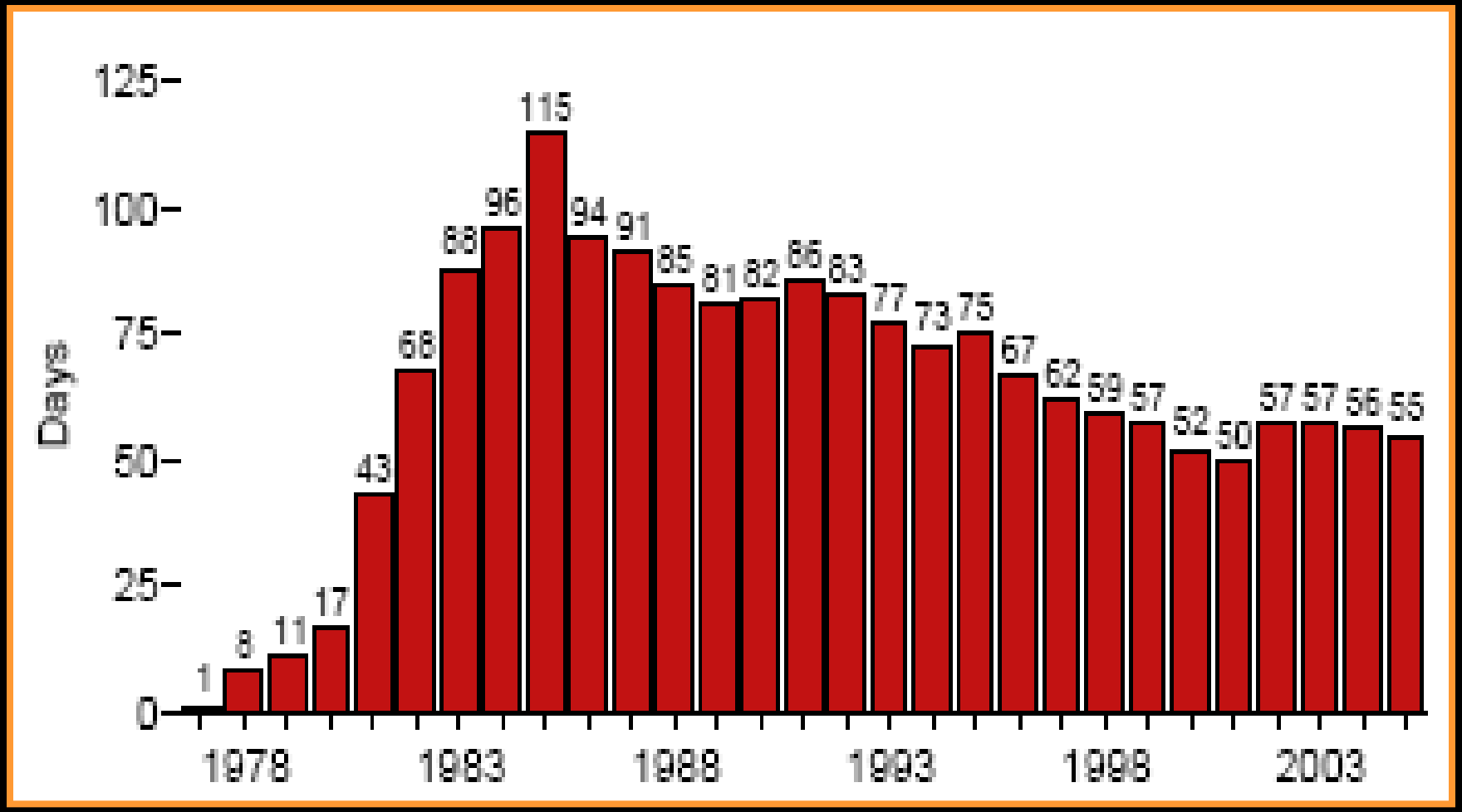
Developed Strategic Reserve Program



Accumulation of Oil for SPR

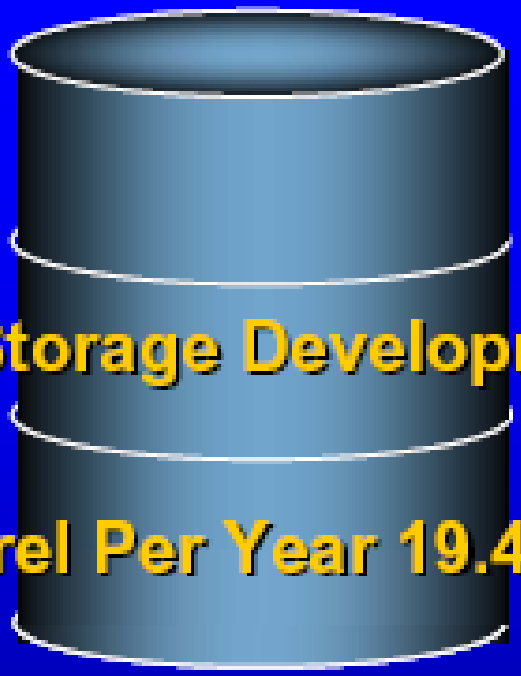


SPR Stocks as Days of Petroleum Net Imports



Cost per Barrel

Cost Per Barrel



- $4.50-$5.00 Per Barrel Storage Development
- Operating Cost Per Barrel Per Year 19.4 Cents
- Cost Per Barrel Drawdown Reserve 10.28 Cents (With 90 Day Drawdown Of 395 mmb)

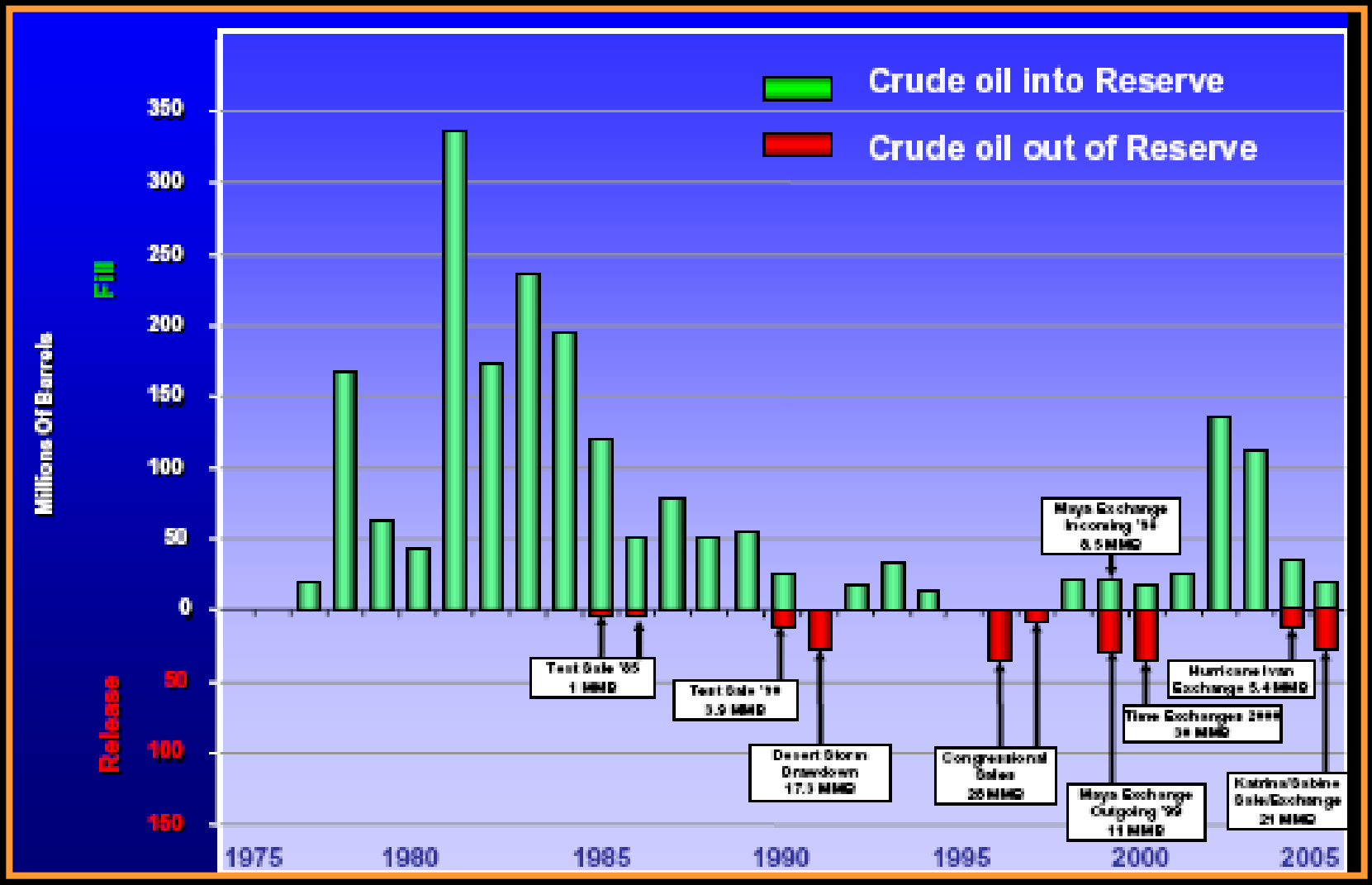
Authority and Conditions of Use

US Presidential Authority

Presidential Finding:
- A "Severe Energy Supply Disruption"
- IEP Obligations

Two Levels Defined:
- Section 161(d) Full Drawdown
- Section 161(h) Limited Drawdown - 30 MMB

Past Drawdowns



Heating Oil Reserves

- Heating Oil Reserve Estab. in 2000
- Purpose: Emergency Inventories for Weather Related Shortages
- Product: No.2 Heating Oil
- Volume: 2 Million Barrels

- Storage Facilities: Storage in Commercial Terminals
- Storage Method: Commingled
- Required Availability: 100% (Above Tank Bottoms)

- New Haven, CT
  - Magellan Terminal (500,000 Barrels)
  - Motiva Terminal (250,000 Barrels)
- Providence, RI
  - Motiva Terminal (250,000 Barrels)
- New York Harbor, NJ
  - Hess First Reserve (1,000,000 Barrels)

Federal government established a heating oil reserve for the northeast sector of the country for severe weather emergencies during a crude oil crisis.

Politics of Drawdowns

People do not like high gasoline or heating oil prices.

Politicians do not like to have unhappy constituents, especially before and elections.

Examples of Presidential political decisions:

- Clinton ordered a drawdown before 1998 election.
- Hillary Clinton urged Bush in 2008 winter to open the heating oil storage reserves = election ploy? Surely not.
- Bush continued to increase SPR volume which may have kept the price of crude higher.
- Stop filling the SPR and more oil would be on the world market.