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The Strategic Petroleum Reserve

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The Strategic Petroleum Reserve

AMERICA'S ENERGY INSURANCE

U.S. Department of Energy, Office of Fossil Energy
Washington, DC 20585

Oil is the lifeblood of America's economy. Each day an average of 17 million barrels of petroleum is used in the United States to power or heat the nation's factories, businesses and homes, to produce gasoline and other fuels for transportation, and to manufacture a variety of chemical products ranging from paints to plastics. Crude oil accounts for nearly 40 percent of the energy consumed in the U.S.

The need for a national oil storage reserve has been recognized for at least four decades. Secretary of the Interior Harold Ickes advocated the stockpiling of emergency crude oil in 1944. President Truman's Minerals Policy Commission proposed a strategic oil supply in 1952. President Eisenhower suggested an oil reserve after the 1956 Suez Crisis. The Cabinet Task Force on Oil Import Control recommended a similar reserve in 1970.

But few events so dramatically underscored the need for a strategic oil reserve as the 1973-74 oil embargo. The cutoff of oil flowing into the United States from many Arab nations sent economic shockwaves throughout this nation and much of the industrialized world. In the aftermath of the oil crisis, America established the Strategic Petroleum Reserve (SPR).

The SPR is an emergency supply of crude oil stored in huge underground salt caverns along the coastline of the Gulf of Mexico. Authorized by Congress in 1975, the Reserve is today the nation's energy "insurance policy," the largest stockpile of crude oil in the world.

MASTER *yo*

Building THE RESERVE

The Strategic Petroleum Reserve today has an inventory of nearly 600 million barrels of crude oil. It represents an investment of nearly \$20 billion in facilities and oil purchases.

Among the member nations of the Organization for Economic Cooperation and Development, the U.S. SPR accounts for nearly 60 percent of government owned or controlled strategic stocks. Japan (with 206 million barrels) and Germany (with 53 million barrels) are the only other nations with large government owned oil reserves. Other nations require individual companies to hold stocks of crude oil or product equal to a specific number of days of consumption.

Today the Reserve can compensate for a total cutoff of crude oil imports into the U.S. for about 75 days. Considering only oil imports from the Persian Gulf nations (prior to the August 1990 Iraqi invasion of Kuwait), the SPR represents nearly a 290-day supply of crude oil.

Early History

President Ford set the SPR program into motion when he signed the Energy Policy and Conservation Act (EPCA) on December 22, 1975. The legislation declared it to be U.S. policy to establish a reserve of up to 1 billion barrels of petroleum.

Within four months after EPCA was enacted, the Federal Energy Administration (a predecessor of the Department of Energy) had prepared an early storage plan to accom-

modate the first 150 million barrels of crude oil. The plan identified underground caverns created in salt domes as the preferred means for storage (see page 5), and in June 1976 the first in a series of environmental impact statements on the proposed storage sites was published.

The Gulf of Mexico coastline was a logical choice for oil storage sites. More than 500 salt domes are concentrated along the coast. It is the location of many U.S. refineries and distribution points for tankers, barges and pipelines. In April 1977, the government acquired several existing salt caverns to

serve as the first storage sites. Construction of the necessary surface facilities began in June 1977.

On July 21, 1977, the first oil was delivered to the SPR. Approximately 412,000 barrels of Saudi Arabian light crude were unloaded and sent to the West Hackberry storage site near Lake Charles, Louisiana. Fill of the nation's emergency oil reserve had begun.

The Reserve Grows

By the end of 1977, the SPR held 7 million barrels—about one day's supply of imported crude at the time. But as new

facilities were completed, fill accelerated. During 1978, the first full year of the Reserve's existence, more than 60 million barrels of oil were added.

In May 1978, the Department of Energy (created seven months earlier) outlined plans to achieve 750 million barrels of stored oil. (Decisions on the remaining 250-million barrels were deferred at that point.) Storage capacity would be developed in three phases:

- Phase I would use existing caverns (created for commercial production of brine for nearby petrochemical plants) at five sites in Texas

SPR Fill History, 1977-90
(unadjusted for 1990 test sale deliveries)

The Reserve Grows

and Louisiana. These sites would hold the first 260 million barrels of crude oil.

- Phase II would add new caverns at three of the original sites to increase storage capacity to 550 million barrels.
- Phase III would continue expanded the same three sites by 60 million barrels and add a new site to reach the 750-million barrel storage target.

Oil fill continued until the spring of 1979, when the nation experienced its second oil shock. A revolution in Iran cut off Iranian oil exports to the United States. With oil supplies constrained, the government suspended SPR purchases for 18 months with 92 million barrels

of oil in storage, too little to be used to counter the oil shortfall. In September 1980, as world oil markets began to recover, crude oil purchases were resumed.

The 1979 oil disruption again demonstrated the nation's vulnerability to oil shortages, and filling the SPR took on a new sense of urgency. In 1981, the year after oil fill was resumed, an average of 336,000 barrels of crude oil per day was added to the SPR, the fastest fill rate achieved in the stockpiling program.

In April 1982, the SPR passed the 250-million-barrel level. On June 1, 1986, the 500 millionth barrel of crude oil was added, and by late 1990, the SPR had reached the 590-million-barrel mark.

On August 2, 1990, Iraq's armed forces invaded neighboring Kuwait. Within days, the

United Nations, at the urging of the U.S. and the great majority of its fellow members, imposed economic sanctions against Iraq, including a cutoff of oil purchases from Iraqi and Kuwaiti oil fields. With the world's crude oil supplies again tightened, the U.S. suspended SPR crude oil purchases.

On September 15, 1990, President Bush signed into law an extension of the Energy Policy and Conservation Act, the legislation that had established the SPR. Included in the extension was a Congressional initiative to expand the SPR to one billion barrels as originally envisioned. A 1989 study by the Energy Department estimated that expanding the SPR to one billion barrels would require approximately \$1.3 to 2.3 billion for additional storage and distribution facilities, plus the funding required to purchase the oil. The expansion would take 9 to 10 years to complete. Oil fill could be initiated within 6 to 7 years.

Assuming that SPR fill resumes in 1991 and averages 50,000 barrels per day, the 750 million barrel interim target would be achieved in 1999 and the 1 billion barrel goal in 2013.

At a 100,000-barrel-per-day fill rate, the 750 million barrel level would be reached in 1995 and the 1 billion barrel target in 2002.

The 1990 law also established a "pilot" program for a refined product reserve, an adjunct to the SPR intended to stockpile petroleum products, such as gasoline and heating oil, rather than the crude oil currently stored in the SPR.

Days of Import Protection Provided by the SPR

CREATING THE CAVERNS

Storing oil in salt caverns was chosen after evaluating options ranging from constructing surface tanks to refilling depleted oil reservoirs. Even the possibility of floating oil on artificially created lagoons or burying the crude in rubber bags were examined.

Salt cavern storage, however, emerged as the preferred option for several reasons. Salt is impervious to oil. At the depths of the caverns (the roofs of the caverns are 1000 to 2000 feet deep), the salt has a strength comparable to concrete. With the weight of the overlying rock, it acts like plastic to seal any fractures almost instantaneously.

The hundreds of salt domes that dot the Gulf Coast offer ideal oil storage potential. Millions of years ago the domes formed as ancient seas evaporated. Geologic forces pushed the salt deposits upward through overlying rock. A typical salt dome along the Gulf Coast can measure up to 5 miles across and 5 to 10 miles deep. As huge as the SPR storage caverns are, they are essentially pinpricks when measured against the massive expanse of a Gulf Coast salt dome.

An SPR storage cavern is essentially a huge, slightly tapered oil cavity created within the salt dome. Each cavern developed for the SPR is typically 200 feet in diameter by 2,000 feet deep, large enough for one tower of the New York World Trade Center to fit comfortably inside it. A single cavern of this size holds 10 million barrels of crude oil. More than 60 of these

Creating the Caverns

caverns now make up the SPR complex; the number will grow to more than 100 when the 1-billion barrel SPR is completed.

Currently the SPR is made up of 6 storage sites (a 7th site will likely be added during the buildup to the 1-billion-barrel level). Five of the six sites use underground caverns for oil storage. The sixth (at Weeks Island, Louisiana) uses a converted "room-and-pillar" salt mine to hold oil.

Caverns are created by a technique called "solution mining." A well is drilled into the salt dome, and fresh water is pumped in to dissolve the surrounding salt at the base of the well. Resulting brine is pumped to the surface for disposal in deep injection wells or into the Gulf of Mexico.

A small blanket of oil is injected early in the cavern formation process to float on top of the water and protect the salt roof from being dissolved.

As more fresh water is injected, the dissolving action extends deeper into the salt, and the cavern grows larger. By regulating the flow of fresh water at different depth, the cavern shape and size can be controlled.

For every 1 barrel of oil to be stored in the cavern, 7 to 9 barrels of water is required for the dissolving, or leaching, process. A typical cavern can take up to 2-1/2 years to complete.

First-Stage Leaching

Second-Stage Leaching

Third-Stage Leaching

Standby Stage

THE SPR STORAGE NETWORK

The U.S. Strategic Petroleum Reserve

Texas

**Sulphur
Mines**

**Big
Hill**

**Bryan
Mound**

Gulf o

Bryan Mound

Location: 3 miles west
of Freeport, Texas
Acquired: 1977
No. of Caverns: 20
Capacity: 226 million
barrels
Status: Cavern
development
completed in 1987;
oil fill continuing

Big Hill

Location: 20 miles
southwest of
Beaumont, Texas
Acquired: 1982
No. of Caverns: 14
Capacity: 160 million
barrels
Status: Cavern
development under-
way; oil fill began
in 1990

Sulphur Mines

Location: 12 miles
southwest of Lake
Charles, Louisiana
Acquired: 1979
No. of Caverns: 3
Capacity: 26 million
barrels
Status: Fill completed
in 1983; now in
standby; being readied
for decommissioning

Louisiana

Mississippi

Alabama

Bayou
Choctaw

West
Hackberry

Weeks
Island

Mexico

West Hackberry

Location: 22 miles southwest of Lake Charles, Louisiana
Acquired: 1977
No. of Caverns: 22
Capacity: 219 million barrels
Status: Cavern development completed in 1988; oil fill continuing

Weeks Island

Location: 95 miles southwest of New Orleans, Louisiana
Acquired: 1977
No. of Caverns: 1 (salt mine)
Capacity: 73 million barrels
Status: Development and oil fill completed in 1982; now in standby

Bayou Choctaw

Location: 12 miles southwest of Baton Rouge, Louisiana
Acquired: 1977
No. of Caverns: 6
Capacity: 72 million barrels
Status: 5 caverns filled; 6th being leached

SPR Distribution System

The Strategic Petroleum Reserve storage sites are arranged into three distribution complexes:

Seaway System

Bryan Mound — Two crude oil pipelines extend from Bryan Mound: a 4-mile pipeline to the Phillips terminal in Freeport, TX, and a 46-mile pipeline to the ARCO Pipeline Co. terminal in Texas City, Texas. Current drawdown rate: 1.1 million barrels per day. Planned drawdown rate: 1.25 million barrels per day.

Texoma System

Big Hill — The Big Hill site is linked to the Sun terminal at Nederland, Texas, by a 25-mile pipeline. No current drawdown capability (site being developed). Planned drawdown rate: 930,000 barrels per day.

Sulphur Mines — The Sulphur Mines site is connected to the Sun terminal at Nederland, Texas, through a 16-mile, 16-inch spur pipeline that is tied into a 42-inch pipeline to the terminal. The Sun terminal is approximately 48 miles away from the site. Current drawdown rate: 100,000 barrels per day. Site is planned for decommissioning in 1992.

West Hackberry — The West Hackberry site is connected to the Sun terminal through a 43-mile, 42-inch pipeline. Also, a new pipeline has been constructed from the site to the Lake Charles refining area where it ties into Texaco's Texas-22 common carrier pipeline. Current drawdown rate: 1.25 million barrels per day.

Capline System

Weeks Island — Oil from the Weeks Island site is moved to the DOE-owned St. James Terminal on the Mississippi River, 56 miles away. Current drawdown rate: 590,000 barrels per day.

Bayou Choctaw — The Bayou Choctaw site delivers oil to the St. James Terminal through a 37-mile pipeline. Current drawdown rate is 480,000 barrels per day.

St. James Terminal — This DOE terminal is 30 miles southeast of Baton Rouge. Its twin docks can accommodate vessels up to 123,000 deadweight tons. It is also linked to the LOCAP and Capline terminals.

ACQUIRING Oil for THE RESERVE

The crude oil stored in the SPR has been obtained under a set of rigid specifications from the most economical sources possible. Virtually all of the crude oil stored in the SPR is "light" crude which is easily transported and handled by the U.S. oil industry.

Both "sweet" (low-sulfur) crude oil and "sour" (higher sulfur) crude oil is stored since both crudes are used by U.S. refineries. Currently about 1/3rd of the SPR oil (about 200 million barrels) is sweet crude, and 2/3rds of the oil (about 400 million barrels) is sour crude—a ratio that reflects the shift in recent years to a greater proportion of sour crudes being imported into the U.S. (The crude oil classified as "sour" in the SPR typically has a sulfur content of less than 1.9 percent, a quality that is significantly better than many of the "sour" crudes in the U.S. oil market.)

Throughout its history, the SPR has acquired crude oil either from (1) purchases on the international spot market, (2) long-term (1 year or longer) contracts with both domestic and foreign suppliers, or (3) special sales arrangements for oil from Government-owned oil fields.

The first crude oil bought for the SPR came from Saudi Arabia in 1977. Since then, the United States has acquired oil from 18 different countries. In addition, about 38 million barrels of U.S.-produced crude oil is stockpiled in the SPR.

About 40 percent of the SPR crude oil has been purchased from Mexico's state-owned oil company, Petroleos

Acquiring SPR Crude Oil

Mexicanos (PEMEX). The first Mexican oil was bought in 1978. In 1982, the U.S. Government made a single \$1 billion purchase of crude oil from Mexico. Most of the oil purchased from PEMEX, however, has been acquired under a series of 1- or 2-year contracts that ran through 1990.

When the PEMEX contracts expired in 1990 and the Energy Department's oil purchase plans called for obtaining a sweeter crude than that offered by Mexico, the government renewed its spot market purchases (with the Department of Defense's Defense Fuel Supply Center acting as DOE's purchasing agent). Oil acquisition was suspended at the beginning of the 1990 Iraqi-Kuwaiti crisis.

The mix of crude oils acquired for the SPR has changed slightly in recent years to reflect the increasing percentage of sour crudes imported by the U.S. Numbers have been adjusted to reflect test sale deliveries.

Sources of SPR Crude Oil

**Unadjusted for 1990 and 1991 test sales.*

Source Country	Cumulative	Percent
Mexico	256.7	43.5
United Kingdom	139.2	23.5
United States	61.9	8.5
Saudi Arabia	27.1	4.6
Libya	30.2	4.1
Iran	20.0	3.3
United Arab Emirates	18.4	3.1
Nigeria	15.1	2.6
Oman	0.0	1.0
Egypt	8.9	1.5
Norway	8.9	1.5
Ecuador	6.2	1.1
Algeria	6.2	1.1
Cameroon	3.4	0.6
Iraq	3.4	0.6
Gabon	2.4	0.4
Qatar	2.3	0.4
Venezuela	0.9	0.2
Peru	0.4	0.1
Totals*	590.8	100.0

DRAWDOWN AND DISTRIBUTION

Should the United States again be confronted with the potential for a severe energy supply interruption, the Strategic Petroleum Reserve is now large enough to provide the energy "insurance" originally envisioned.

The Sales Process

Given the unpredictable conditions that might characterize an energy supply disruption, there is no preset "trigger" for the use of the SPR. The 1975 Energy Policy and Conservation Act (EPCA) stipulates that the SPR can be tapped when the President determines that it is "required by a severe energy supply interruption or by obligations of the United States." The Act defines a "severe energy supply interruption" as one which:

- is, or likely to be, of significant scope and duration, and of an emergency nature,
- may cause major adverse impact on national safety or the national economy, and
- results, or is likely to result, from an interruption in the supply of imported petroleum products, or from sabotage or an act of God.

When Congress renewed EPCA in September 1990, it added additional authorities for a limited drawdown for circumstances that constitute, or are likely to become, a "domestic energy supply shortage." The

SPR Drawdown and Distribution

amendments also permitted test sales of up to 5 million barrels each (DOE had one-time-only authority to conduct a 1985 test sale.)

Should the President decide to order an emergency drawdown of the SPR, the principal method for distributing the oil would be by competitive sale to the highest bidders (although the Secretary of Energy may establish a minimum price).

The sales process would involve four primary steps which could be completed in as little as 15-16 days, as follows:

Day 1—Issuance of a "Notice of Sale"

Within 24 hours of a Presidential decision, the Energy Department would issue a public notice specifying the amount, characteristics and location of the oil to be sold, the approximate delivery dates and procedures for submitting offers. Bidders would be given up to 7 days to prepare offers.

Day 8—Receipt of Bids

Anyone who meets certain financial and other qualification criteria may bid. All offerors must accept the government's sale terms unconditionally and include an offer guarantee of up to \$10 million (or 5 percent of the bid price, whichever is less). Offerors bid against one or more "master line items" (a "master line item" is a specific quantity of crude oil offered from a specific SPR site) and indicate their proposed delivery methods.

Day 11/12—Selection of Bidders

After evaluating the bids, the Energy Department would select "apparently successful offerors." The selected offerors must then provide a letter of credit or cash deposit for 110 percent of the contract value, typically within 5 business days. When these payments are received, the department can begin awarding contracts.

Day 16-30—Delivery of Oil

The first SPR crude oil can be delivered as soon as the purchaser arranges transport (by pipeline, barge or tanker). This could take place as quickly as the day after a contract is awarded. Typically, however, commercial oil shipments are

scheduled on calendar month cycles to allow time for reserving space in pipelines or for arranging delivery through commercial shipping terminals. Consequently, most SPR would likely be moved to market during the month following the actual sale. Final payments are made following receipt of the crude oil based on a price indexing system (see box). Should the energy supply interruption persist, the SPR sales cycle could be repeated every 30 days.

The Secretary of Energy also can direct the sale of up to 10 percent of the volume of crude oil sold in a calendar month for special purposes. The price for such oil would be the average price of the oil sold under the contemporaneous or most recent competitive sale.

The Price Indexing System

An emergency SPR drawdown would most likely occur when world oil markets are unstable and crude oil prices subject to wide fluctuations. Since final payments for SPR oil are not made until the oil is delivered which may be several days or weeks after bids are submitted, DOE will implement a price indexing system to ensure that bid prices can be adjusted to reflect changes in the oil market.

One such indexing system was employed during the 1990 SPR test sale (see p. 16). Under this system, DOE sets a "base reference price" for both sweet and sour crude oil at the time it issues the Notice of Sale. The "base reference price" would be determined by averaging prices for several domestic crude oils shortly before the call for bids is issued.

When purchasers take delivery of their oil, the reference price will be recalculated using the same "basket" of crudes. Bid prices would then be raised or lowered by the same amount the reference price has changed. For example, if the reference price has gone up by \$2 a barrel, a purchaser's bid would be raised by \$2 a barrel. If the reference price had gone down, bid prices would be reduced by the same amount.

Drawdown

The physical process of withdrawing crude oil from an SPR cavern relies on the fact that oil floats on water. To begin a drawdown, fresh water would be pumped into the cavern to force crude oil out through a metering station and on to nearby terminals. The same equipment used for creating and filling a storage cavern is used for drawdown. (The Weeks Island site operates differently from the others. Because it was originally a salt mine, submersible booster pumps are installed to move the oil to the surface.)

Today the SPR can withdraw oil at a sustained rate of 3.5 million barrels per day for a 90-day period. As caverns are emptied, the drawdown rate would decrease in a stair-step fashion (see chart). At its current inventory of nearly 600 million barrels, a full-scale drawdown would reduce the inventory by 91% (or 545 million

barrels) in 6 months, leaving 45 million barrels that could be withdrawn at much reduced rates for the next 6 months. Withdrawing oil at a lower rate can sustain a drawdown over a longer period of time. A 2 million-barrel per day drawdown could continue for 9 months; a one-million-barrel per day rate could last for 1 1/2 years; a 500,000-barrel-per-day rate could continue for more than 2 years.

When the SPR reaches the 750-million-barrel level (and the sixth site becomes operational), the drawdown rate will increase to 4.5 million barrels per day.

Distribution

The six SPR storage sites are grouped into three distribution complexes: Seaway, Texoma and Capline (named after major interstate pipelines in each area).

Each SPR distribution complex is connected to one or more private or government-owned

terminals that in turn are tied into the nation's commercial oil transport network. From these terminals, oil can be distributed through interstate pipelines directly to nearly 45 percent of the nation's oil refineries. Or it can be loaded into waterborne vessels for transportation to any refinery in the U.S. that receives oil imports from overseas. (For example, it is estimated that SPR crude oil could be shipped to Hawaii within 24 days, although in reality exchanges would likely occur so that oil originally destined for other markets would reach Hawaii much sooner.)

The conversion of two interstate oil pipelines (Seaway and Texoma) to natural gas in 1984 prompted a major effort by the Department of Energy to enhance the SPR distribution network to ensure that the planned distribution capabilities could be achieved. New pipelines and terminalling facilities were constructed to compensate for the loss of the two oil pipelines.

Reviewed by COTI

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MAINTAINING THE RESERVE'S READINESS

Tests of the SPR hardware and procedures are a routine aspect of maintaining the SPR.

Typically, one or more large scale, actual drawdowns of individual sites are conducted annually, and numerous other oil movements are carried out at all the sites as part of routine operations. In addition, the Energy Department conducts regular training exercises simulating the sales and distribution process to ensure that personnel gain experience with the procedures associated with an emergency drawdown.

Since the SPR was created, two actual test sales of crude oil have occurred.

On November 25, 1985, the Energy Department, under special Congressional authorization, began a test sale of 1.1 million barrels. Seventeen companies responded to the sales notice. Five of these firms were designated as successful offerors.

On September 26, 1990, in the wake of the Iraqi invasion of Kuwait, President Bush directed another test sale to be conducted, this one offering 5 million barrels (the legal maximum under newly-signed legislation). The test sale attracted offers from 33 companies. The Energy Department deemed bids from 11 companies for 3.9 million barrels to be acceptable and carried out the sales, drawdown and delivery process on schedule and without significant difficulty. The Energy Department delivered its first oil two days after awarding a purchase contract and 21 days after the test began.

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