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# Strategic Petroleum Reserve

Louisiana and Texas

## Client

U.S. Department of Energy

## Background

America's vulnerability to an oil embargo was an issue of national concern in 1975 when Congress authorized the creation of a strategic petroleum reserve to store up to one billion barrels of crude oil, an amount that would supply the total need of the U.S. for approximately six months. The act required the Federal Energy Administration (FEA), now the DOE, to submit an Early Storage Reserve (ESR) plan for storing a minimum of 150 million barrels of crude oil by December 1978, and then to provide a Strategic Petroleum Reserve (SPR) plan for designing, constructing and filling the one-billion barrel reserve. In 1977, Congress approved plans for the majority of the crude oil to be stored in a few large underground sites located primarily on the Gulf Coast, within easy reach of tankers and major crude oil pipelines.

## Parsons Brinckerhoff Role

### Phase I

For Phase I development of the first 250 million barrels of storage capacity in existing caverns, PB Energy Storage Services (PBESS), formerly PB-KBB), a Parsons Brinckerhoff affiliate, was retained to provide:

- Design of overall site development
  - Landfill
  - Roads
  - Well-pads
  - Drilling and well workover programs
  - Rig specifications
  - Grading
  - Required drainage
- Design of all onsite piping systems for fresh water, brine and crude oil.
- Design of the electrical systems, communications network, instrumentation, controls, dikes, settling ponds and cathodic protection
- Preparation of geotechnical reports
- Preparation of operating and testing manuals for all facilities
- Design of 22 buildings
  - Laboratories
  - Control buildings
  - Equipment buildings

- Technical input into the environmental impact statement
- Support of DOE for permitting, licensing and public hearings
- Value engineering
- Systems integration

### Phase II

PBESS was subsequently engaged to provide subsurface engineering for new caverns under the Phase II development of the second 250 million barrels of storage capacity.

### Phase III

PBESS also played a key role in the Phase II development of the final 160 million barrels of storage capacity at a brown field site. PBESS prepared conceptual designs for all facilities, designed and managed the drilling and cavern development activities and served as owner's engineer for overall project development.



### Continuous Support

PBESS has continued to provide technical support to the SPR Program Office for program planning, design and special consulting tasks. Some examples of these tasks include:

- Planning and design for underground storage facilities to expand the reserve's capacity to one billion barrels.
- Planning and design for a complex of five above ground terminals and one salt cavern storage facility to develop a Regional Petroleum Products Reserve (RPPR). The RPPR would store

refined products at strategic locations throughout the southeastern US to provide immediate emergency fuels supply at times when hurricanes disrupt gulf coast refineries and pipelines.

- Planning and support for the Northeast Home Heating Oil Reserve, which maintains two million barrels of oil in above ground tankage to supply heating oil during times of supply and distribution disruptions.
- Asia-Pacific Economic Counsel (APEC) SPR study – feasibility studies on behalf of APEC for developing local oil reserve programs through APEC region.
- SPR oil custody transfer study – a technical evaluation of the modes and procedures for oil inventory accountability in use at facilities that connect to the SPR oil distribution network.

### SPR Program Elements

- (Presently) four storage locations situated along the Gulf Coast in Louisiana and Texas
- 65 new and existing caverns at depths to 5,000 feet
- All of the infrastructure to move, control, measure and regulate more than a billion gallons of water, brine and oil in 65 caverns at six different sites.



### Noteworthy Features

- For *Phase I*, PBESS (PB-KBB) demonstrated the systems engineering and management capability to manage a large, fast-track, complicated project. The magnitude of the firm's accomplishments becomes evident with an understanding of the size and complexity of the project:
  - 650,000 underground design labor hours over 15 months
  - 10,000 tracings
  - 16,000 pages of specifications
  - 850,000 copies of plans

- 3,500,000 pages of review specifications
- 80 major submittals to the DOE

- Early integration of environmental impact mitigation measures enabled the production of an implementable design
- Major infrastructure requirements, for six widely dispersed sites, were designed in overlapping phases and integrated into a single system
- PBESS utilized CSCS (cost schedule control system) which enabled us to provide quality design on time and within budget



### Phase I Project Description

In July 1977, Parsons Brinckerhoff's affiliate PBESS (PB-KBB) was selected to prepare detailed drawings, specifications and contract drawings for *Phase I* facilities, consisting of 16 existing and 29 new salt dome caverns and support facilities in three locations:

- Bryan Mound, Texas (184 million barrel capacity)
- West Hackberry, Louisiana (209 million barrel capacity)
- Bayou Choctaw, Louisiana (56 million barrel capacity)

The task was immense—and set in a tight time frame. The majority of the design work had to be completed within five months from notice-to-proceed; all of it within ten months. PB-KBB and its team responded swiftly and decisively to the urgency and magnitude of the project:

- Within 24 hours of notice-to-proceed, 40 engineers experienced with the West German SPR were on route to our New York headquarters to start work on the project.
- Within a week—through reassignment and intensive recruitment of additional personnel—we had 177 people working in 23,000 square

feet of newly leased office space in New York City.

- Within two weeks, we had established a client liaison office in Washington, D.C.
- Using a fast-track design-construct approach, our team prepared 30 separate contract packages to enable construction to begin before the designs were complete.



Five months after notice to proceed, we had completed the design of facilities for the first 250 million barrels of oil; Phase 1 was completed on-time and within budget. The project, however, was far from complete; as a result of our response, the scope of work expanded by leaps and bounds:

- Two additional contracts were added to our responsibilities:
  - Design of a fourth site in Sulphur Mines, Louisiana
  - Investigation of stability problems with the salt dome at Bayou Choctaw and concurrent design of three alternate sites
- We accepted responsibility for supervising the \$15.5-million drilling program. The overall schedule was extended from 10 to 15 months.
- Ultimately, 72 modifications were made to the original contract; 31 of these were technical tasks.

Phase 1 of the project involved developing all of the infrastructure to tie 16 existing storage caverns into a single system. (These existing caverns had been created by private-sector firms that produced the salt for a variety of industrial purposes.) Phase 2 involved solution mining 29 new caverns, designing all the support facilities, and integrating this infrastructure with the facilities from Phase 1.

The drilling management program, the investigation of Bayou Choctaw, construction of

Phase I, and design of Phase 2 were all occurring concurrently; consequently, discoveries made during the drilling program, new knowledge derived from the geological study of Bayou Choctaw, and conditions encountered in the field during construction all fed into the design of the total project in a classic example of systems engineering in action. In addition, long lead procurement items were identified early in the project to facilitate fast-track construction.

With a peak staff of 200 working 50-hour weeks, 55 construction bid packages, the equivalent of 3 to 4 years of work on a normal project, were produced and delivered in 15 months.

In 1979, the project moved into Phase III with the conceptual design for yet another site, at Big Hill, as well as additions to existing facilities for a total of 20 caverns. The firm also formulated a leaching module design as a planning vehicle to evaluate the viability of future sites, and instituted formal systems engineering: RAM (reliability, availability, maintainability), security, safety, quality, distribution analyses, retrofit analyses, alternatives analyses, and hydraulic models for every site to determine choke points in the ability to move fluids and to assess costs and benefits.



Environmental considerations were a major factor in the project. From the outset, the team's environmental planners worked with the engineering team to build environmental impact mitigation measures into the design. The firm also identified the many federal, state, and local permits required for construction. The firm prepared the permit applications and performed related studies and analyses. Permit requirements included:

- Dredge and fill (Section 404) permit from the U.S. Army Corps of Engineers
- NPDES water quality permit from the U.S. Environmental Protection Agency

- State permits relating to air quality and oil storage facilities
- County site approvals

Value engineering, devising ways to fulfill the same function at a reduced cost, was applied from the very beginning of the project. We also consulted with the DOE on a continuing basis regarding ways to reduce costs and to advance oil storage targets during construction.

The Bayou Choctaw stability investigation is an example of both value engineering and our continuous interface with the DOE. After we had designed surface facilities to set on top of the existing Bayou Choctaw salt dome, doubts arose concerning the dome's stability. We were requested to investigate the geological integrity of the dome while simultaneously developing three alternate off-dome locations for the support facilities. While the center of the dome proved geologically unsound, we found that facilities could safely be supported by stringing them around the periphery of the dome. When it became clear that moving completely off the dome was not necessary, we terminated the offsite designs, advised the DOE of our findings, and pointed out the cost-effectiveness of building as close to the dome as possible. By siting the support facilities around the edge of the dome rather than 8 to 10 miles away, the DOE was able to save between \$30 and \$35 million.

#### **Teaming**

Parsons Brinckerhoff's affiliate, PBESS provided services directly to the client.

#### **Schedule**

Our services for this \$2-billion construction program were provided on a fast-track basis, beginning in 1977 and completed in 1980. We are continuing to provide services for the SPR program under subsequent contracts.

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**Approved By:** T. Reichwein