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Arctic Oil and the S.S. Manhattan

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The discovery of oil on Alaska's North Slope in 1968 not only focused attention on that remote part of our world, it set the stage for one of the most exciting and significant scientific expeditions of our time—the voyage of the ice breaking tanker SS Manhattan through the Northwest Passage.

In the space available I would like to discuss with you that historic expedition, how it came to be, and comment on the results, as we see them.

GEOGRAPHY AND OIL

But first, let's consider the geography involved. The North Slope of Alaska covers about 69,000 square miles, extending from the Bering Sea on the West to the Canadian border on the east—a distance of 500 miles; and from the Brooks Range on the South to the Arctic Ocean, a distance varying from 50 to 200 miles. Because of Naval Petroleum Reserve Number 4 on the west and a wildlife refuge on the east, only about one-third of the Slope—or some 15 million acres—is available for competitive exploration.

The presence of hydrocarbon deposits in the area has been known since the early 1800's, when several natural seeps were described and investigated. And although the Navy and others had explored for petroleum off and on during the last 25 years, it wasn't until Humble and Atlantic Richfield in partnership brought in the Prudhoe Bay No. 1 well as a discovery in June, 1968 that people began to appreciate the potential of the North Slope. Confirmation of a major deposit of oil—conservatively estimated at between 5 and 10 billion barrels—was indicated a short time later with completion of the Sag River well seven miles to the southeast.

Currently, the industy has about 1.3 million acres under lease in North Alaska, including those purchased in the record $900 million state lease sale in September 1969.

Prudhoe Bay is a large oil field with great promise, but let me say two things about it. First, it cannot possibly make the U.S. totally self-efficient in oil over the coming decades. And second, it cannot logically be competititve with the Middle East. A look at a few of the economic factors involved with will underscore this latter point.

ENVIRONMENT COSTS AND ECOLOGY

In Alaska, environment is a major economic factor. Take the weather, for example. Severe temperatures require that the working areas of a drilling rig be enclosed for the protection of crews. Even so, temperatures are extremely low and men must work heavily bundled in clothing. Drill pipe becomes brittle, all operations slow down, and the result is high cost. In the lower 48, average drilling costs for an oil well run $13 per foot. On the North Slope, costs jump to a whopping $142 per foot. And operating costs are also astronomical—$18,000 per day in Alaska, as compared to $10,000 a day for an offshore rig in the Gulf of Mexico, and $3,000 daily for a conventional West Texas land rig.

We also have nature to think about. We have to make sure that our operations do not harm the wildlife and other elements of the Arctic's ecology. We cannot cut corners—and we certainly are not going to try. We at Humble firmly believe that it is far better to prevent a problem from developing than try to rectify one after the fact.

With high drilling costs like these, it became apparent that not only must we have a large reserve of crude oil to work with but transportation from well head to the refinery must be done in the most economical manner possible.

ARCTIC MARINE TRANSPORTATION

When we launched our investigation into Arctic marine transportation possibilities, we considered such factors as ship performance in ice, economic analysis and environmental conservation. We found mathematical formulations which deal with the performance of ships in ice and investigated them with the help of computers in Houston. In cooperation with the Coast Guard, we conducted model tests of ships in ice in the Navy's Underwater Warfare Center tank in San Diego. Other model tests were performed using one to twenty scale models on a lake in the French Alps. From this research we learned something about the action of ice as it breaks around a ship's bow. Additional pre-test ice data came from research by University of Alaska scientists at Port Clearence.

After examining all of the assembled data, we began to feel that it was possible to operate a large ship with high power in the Arctic on a year-round basis. We also knew, however, that the data obtained with math and model studies did not necessarily apply to full-scale or "real world" conditions. And we realized that at some point the tests, theories, and calculations had to be applied to the real thing.

So we decided to take a $40 million gamble and put an icebreaking tanker in the Arctic as a data collection vehicle. Two other companies—Atlantic Richfield and BP Oil—elected to participate in the project for $2 million each and share the information gained.

THE SS MANHATTAN

The first step was to find a suitable ship and after surveying the world fleet we selected the SS Manhattan, a 115,000 deadweight-ton tanker with 43,000 shaft horsepower. In addition to her size and heavy construction, she possessed a higher than usual power to weight ratio. (Figure 1)

Extensive modifications were required to convert her to an icebreaking tanker and data acquisition system. Because of the magnitude of the conversion and the need for its quick completion, we decided to cut the ship into sections and utilize the services of four different shipyards simultaneously. At one time, there were as many as 10,000 men working on the job.

In addition to strengthening the hull, they installed new high-strength propellers, tail shafts, and rudders to protect from possible ice damage. But these changes were, in a sense, minor. The most important modifications fell into three relatively new areas.

Probably the most unusual new feature of the Manhattan was her new icebreaking bow. It was designed to take advantage of the most important component of force which a ship places on ice—downward pressure. The bow strikes the ice at a very shallow angle—18 degrees—generates a large inclined-plane force, then rides up until the weight of the ship causes the ice to break. This bow design, with its very shallow forward angle, gives a large sustained force on the ice while causing a relatively small peak load to be exerted on the ship. It worked very well during the voyage.

The second innovative design feature of the Manhattan was an extension of the bow eight feet beyond the hull on each side. This provided more free water along the sides of the hull and reduced ice friction (Figure 2).

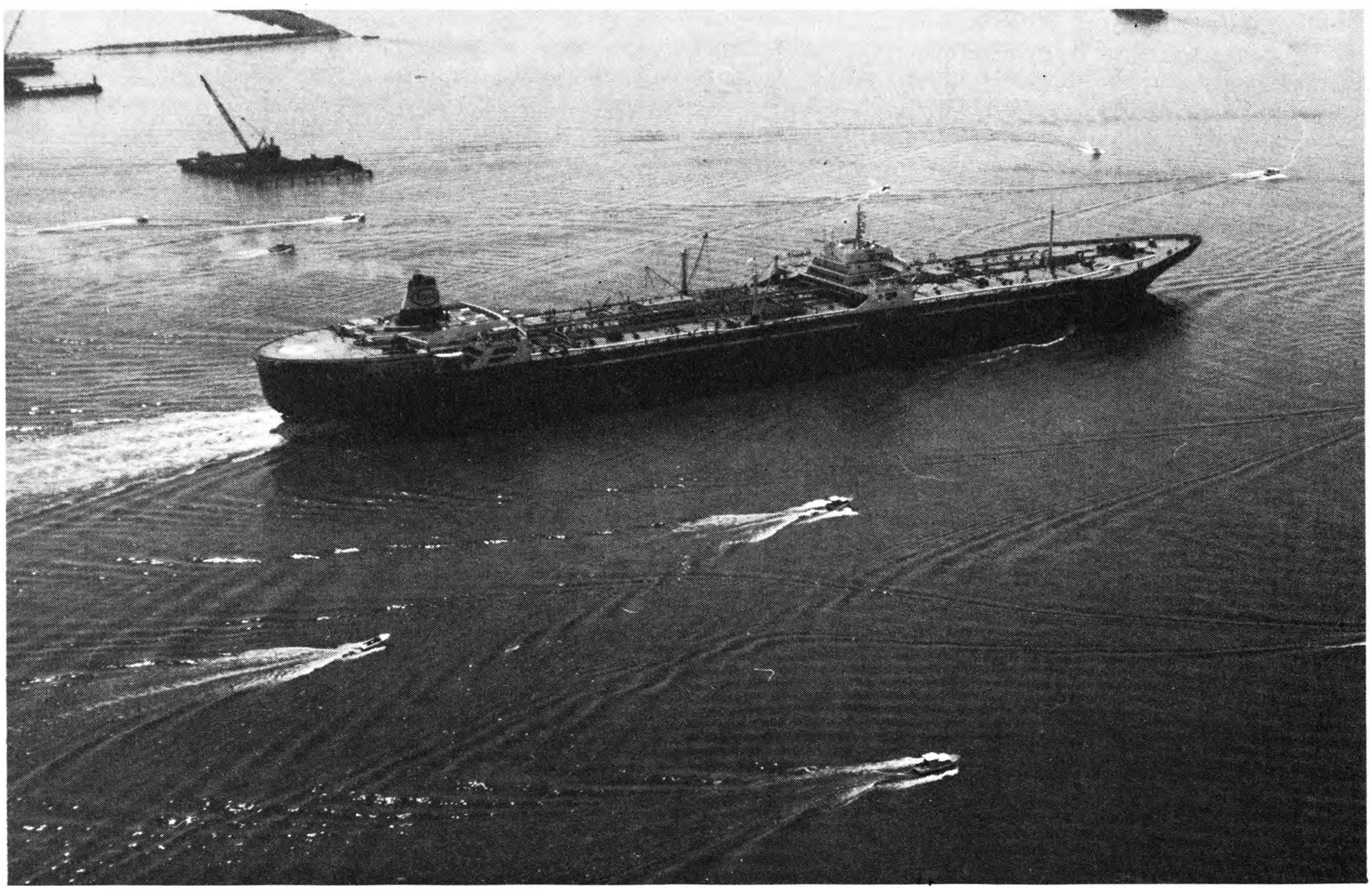

Figure 1. The SS Manhattan in Open Water

Figure 2. DOUBLE CRUNCH-Humble Oil & Refining Co.'s icebreaking tanker, the SS Manhattan, and the Canadian Ministry of Transport's newest icebreaker, the Louis S. St. Laurent, crunch through the snow-covered ice of northern Baffin Bay. The Manhattan is completing its second Arctic voyage to collect data for use in determining the economic feasibility of transporting Alaskan crude oil through the ice-covered Northwest Passage to the U.S. East Coast.

The third innovation was an external sloping ice belt along the sides of the hull. This belt of inch-and-a-quarter steel added extra strength and protection.

When reassembled, The Manhattan was longer than the Eifel Tower is tall. Her length increased from 940 to 1,005 feet and her beam, or width at the broadest point, grew from 132 feet to 155 feet. And she was 10,000 tons heavier. She also was equipped with the most sophisticated communications and electronics devices ever installed on a commercial ship. To overcome the notorious Arctic radio blackouts, she had a communications network effectively 500 times more powerful than that normally found on commercial ships. The Manhattan's navigation system used radio signals from four earth satellites placed in polar orbit as part of the U.S. Navy's Navigation Satellite System program. When a satellite dropped below the horizon, sonar took over. Impulses bouncing off subsurface water currents flowed to the computer which determined the ship's velocity. The captain knew his location to within half the ship's length and his craft's speed within one-tenth of a knot. Instruments on board also measured the ship's motions, pressure against the hull, and power plant performance. Closed circuit television monitored the ice flow and breakage patterns around the ship.

While the Manhattan was being modified, deck officers underwent extensive training activities aboard the Canadian icebreaker John A. Macdonald and the Coast Guard's Staten Island to become acquainted with the operation of an icebreaking vessel. Other officers visited ice-routing offices operated by the Canadian Department of Transport in Halifax and the U.S. Navy's Ice Observation School in Maryland.

They might well have attended the Navy's Supply School, too, because stocking the Manhattan for her voyage proved to be a major task. Provisions included 5,600 quarts of fresh milk, 51,000 pounds of meat, 70,000 pounds of canned and dried food, 40,000 pounds of fresh fruits and vegetables, and 51,000 fresh eggs. They even loaded 300 watermelons. Stores included 4,800 bars of soap, 1,500 light bulbs, jogging machines, a putting green, a portable x-ray machine, 100 full-length movies, and three ice makers. All told, the ship took on 8,000 different store items.

The Manhattan's fuel order of 184,000 barrels of bunker oil went into the record books as the largest in commercial marine history. (The normal bunker fill-up of the luxury liner United States runs about 40,000 barrels). In addition to her own fuel, the Manhattan carried 30,000 barrels of special diesel oil for refueling the U.S. and Canadian icebreakers that accompanied her, plus 5,000 barrels of jet fuel for the helicopters.

From a technical and scientific viewpoint, the voyage of the Manhattan through the Northwest Pasage in the fall of 1969 gave us a great volume of useful information. However, it was impossible to draw conclusions about the power requirements of an icebreaking tanker because of the great variation in ice thicknesses encountered at that time of the year (Figure 3). This thickness ranged from four to 22 feet and varied to this extreme over such short distances as the length of the ship, making it difficult to relate the power required to move through given ice conditions.

And so to focus more accurately on power requirements, the Manhattan made a second data-collection voyage in the spring of 1970. This is the heaviest ice season of the year in the Arctic just piror to start of the summer melt. On this second trip, the ice available for testing approached laboratory conditions with variations in thickness of only one to two inches for several miles along the route. These conditions allowed us to collect

Figure 3. The SS Manhattan in Arctic waters.

highly reliable data on ship speed-power relationships. By coordinating these data with environmental statistics collected during the past winter by side looking radar overflights and by ground-based personnel, we were able to assess the potential of Arctic shipping with a considerably higher degree of confidence (Figure 4).

After analyzing all of the operating data from the two voyages, we have drawn two basic conclusions: First, that use of icebreaking tankers to transport crude oil from Alaska's North Slope to U.S. markets is feasible; second, that pipeline transportation of this oil appears to have an economic edge over icebreaking tankers—at least at the present time. Accordingly, Humble has suspended its icebreaking tanker studies while concentrating on pipeline alternatives. Should economic factors change, however, or other circumstances warrant—tanker development work can be resumed on short notice.

Although we are suspending our icebreaking tanker studies for the present, we will continue marine studies concerned with tanker movements of oil from Valdez, an ice-free port on the southern coast of Alaska, to the U.S. West Coast.

Humble is firmly committed to the proposed Trans Alaska Pipeline—extending 800 miles from Alaska's North Slope to Valdez—which would serve as a key link in the transportation system to serve West Coast crude oil needs. Conventional tankers, with no icebreaking equipment, would load crude oil at Valdez for delivery to West Coast refineries.

Even though Humble has decided on the pipeline alternative for transporting crude oil from the North Slope, the voyages of the Manhattan may prove highly significant in the development of the Arctic and its resources. A new international trade route through the Northwest Passage also could have a profound influence on world trade patterns. It would mean the fulfillment of the 500-year-old dream of a shorter and more direct route from Europe to the Far East. There is a point on the north shore of Banks Island, some 500 miles east of Prudhoe Bay, which is roughly equidistant from the cities of New York, London, and Tokyo. With this central position, the Northwest Passage could become the catalyst which opens the resources of far northern Alaska and Canada to the world. A year-round sea route could do for this area what the railroad did for the western United States—and might do it quicker.

The mining industries of the Arctic are still in their infancy stage, primarily due to transportation problems. But there is great mineral wealth there, just awaiting—if you will pardon the pun—for the breaking of the ice.

We believe that the Manhattan's voyage has made a contribution to the scientific and educational community and to both the U.S. and Canadian governments. We feel that the Manhattan's voyage will stimulate interest in the Arctic in the same manner that other historic voyages have spurred development in the other places. Whatever the long-range consequences of her voyages, we know that the Manhattan's findings will add immeasurably to our knowledge of the world we live in.

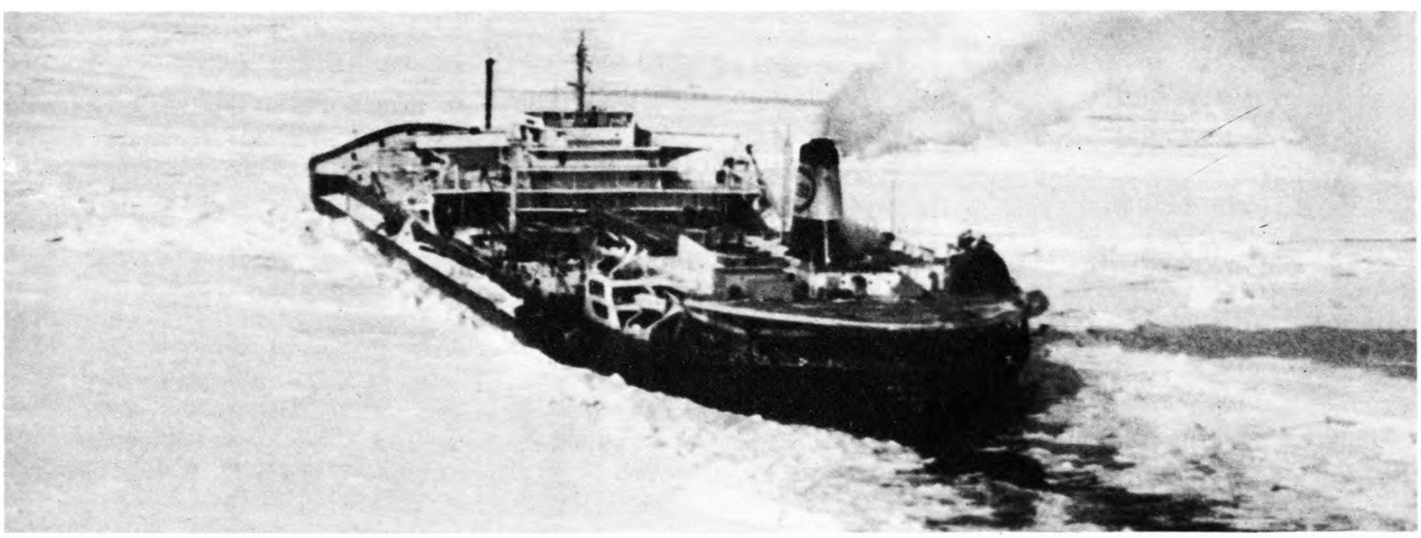

Figure 4. BREAKING A PATH—The largest commercial ship ever built in the United States, the SS Manhattan, breaks a path through the ice as it nears the completion of testing during its second Arctic voyage. On its maiden Arctic voyage last year, the Manhattan became the first commercial ship to transit the Northwest Passage.

R. H. Venn

R. H. Venn, vice president and director of Humble Oil & Refining Company, was born in Pentwater, Michigan. He graduated from Wayne State University, Detroit, in 1933 with a B.S. degree in chemical engineering. He received a M.S. degree in chemical engineering in 1934 from the Massachusetts Institute of Technology. He also attended the Management Program at the Harvard Graduate School of Business Administration.

Mr. Venn joined Humble in 1934 as a junior chemical engineer at the Baytown, Texas, refinery. He was promoted in 1938 to section head, Baytown Technical Service. In 1942, he was made a senior project engineer, and in 1945 became technical assistant to the director in charge of refining, Houston office. He was promoted to manager of the Refining Department in 1955, and became manager of the Marketing Department in 1958. On December 1 of the following year, he was named to the board of management of the Humble Division.

Mr. Venn was named vice president in charge of the Southeast Esso Region of Humble late in 1960, with headquarters in New Orleans. In 1962, he was elected to the Board of Directors of Humble Oil & Refining Co. and was named vice president in 1963.

He is a member of the American Petroleum Institute, the Houston Engineering and Scientific Society, the American Association for the Advancement of Science, the Texas Manufacturers Association, the National Association of Manufacturers, and is vice chairman of the board of Junior Achievement of Southeast Texas. He is also a member of the Southern Region Board of Junior Achievement, Inc., and the National Executive Committeee of Junior Achievement, Inc. He is a member of St. Martin's Episcopal Church, the Petroleum Club, the Houston Club, and the Lakeside Country Club.

Mr. and Mrs. Venn make their home at 5913 Crab Orchard in Houston. They have three daughters: Victoria, Cynthia, and Katherine.